Compendium of

Medicinal and Aromatic Plants

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Asia

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Coverpage insets include pictures of:

Front: *Rauwolfia serpentina* (L.) Benth. ex Kurz
Ginkgo biloba L.

Back: *Terminalia chebula* Retz., *T. bellirica* (Gaertn.) Roxb., and *Phyllanthus emblica* L. (fruits of these three trees comprise Triphla of Ayurveda)

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ASIA

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Preface

Asia is the world's most densely populated continent with sixty percent of the world's people living there. It is one of the largest biodiversity regions in the world and home to some of the countries richest in medicinal and aromatic plant resources. It has diverse plant flora however, species richness is concentrated mainly in tropical and sub-tropical regions. Six of the world's 18 biodiversity hot-spots: the Eastern Himalayas, the Western Ghats of South India, North Borneo, Peninsular Malaysia, Sri Lanka and the Philippines are part of Asia. The continent has well documented traditional knowledge, a longstanding practice of traditional medicine and potential for socio-economic development of medicinal and aromatic plants in primary healthcare and industrial scale production. Medicinal and aromatic plants constitute the basis of primary healthcare for the majority of the population and are a valuable source of income for rural populations. Approximately 90% of plants is still collected from forests. Only a few countries such as China, India, Indonesia, Nepal, Thailand and Viet Nam produce medicinal and aromatic plants through cultivation on a commercial scale.

Despite advances in western medicine, ancient traditional systems of medicine are practised in Asia mainly because of historical circumstances and cultural believes. Medicinal plants are an accessible, affordable and culturally appropriate source of primary healthcare for more than 80% of the Asian population according to the World Health Organization. Indian Ayurveda along with Jamu, Kampo, Sidha, Tibetan, TCM and Unani systems of medicine are an important source of health and livelihood for millions of Asian people. International and national trade in alternative medicine including herbal products is increasing rapidly. The estimated global trade in medicinal and aromatic plant materials was more than US$60 billion in 2000, and is expected to reach US$5 trillion by 2050 according to the World Bank report. China and India are the world's leading exporters of medicinal and aromatic plant materials. Various international organization such as the Food and Agriculture Organization (FAO), the United Nations Industrial Development Organization (UNIDO), the World Health Organization (WHO), the International Development Research Centre (IDRC) and others have been addressing issues concerning medicinal and aromatic plants through support for research, networking and coordination.

However, the biodiversity of medicinal and aromatic plants has yet to be studied in depth in many countries. Commercial exploitation, unsustainable use, cultural changes

and lack of institutional support have threatened resources and local traditional knowledge. A number of countries are developing national policies on traditional medicines to cover quality and safety. Bhutan, China, India, Indonesia, Lao PDR, Nepal and Pakistan maintain considerable natural forest cover and are still able to collect plants from the wild. A few countries including China, India and Sri Lanka have formulated legislation to conserve their natural resources of medicinal and aromatic plants. Many other countries in the region have ceased the practice of collecting from the wild. There is a need for coordination among the various institutes of the region working on medicinal plants and traditional medicines in order to exploit them commercially and utilize them fully.

The International Centre for Science and High Technology (ICS-UNIDO) has prepared this Compendium of Medicinal and Aromatic Plants of Asia to present the status of medicinal and aromatic plants of Asian countries. The Compendium gives information on the traditional systems of medicine, government efforts to promote them, medicinal and aromatic plant resources, research and development activities, trade and the major problems faced by sustainable commercial exploitation. It will help the countries of the region to improve the health and living standards of their people using their own resources and promoting traditional systems of medicine, which are less expensive and well respected by Asian communities. This publication will be useful to policy-makers, the scientific community and user groups to frame effective policies, formulate projects to advance research and development activities, and establish environmentally sustainable and economically viable enterprises.

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Contents

Introduction

Asia is the largest continent, with 60% of the world's population living here. The region consists of the continent of Asia plus the islands in the Indian and the Pacific Oceans. It has abundant medicinal and aromatic plant species and traditional medicine in Asia has been practised since ancient times. The continent has well-documented traditional knowledge, long-standing practice of traditional medicine and the potential for social and economic development of medicinal and aromatic plants in primary health care and industrial scale production.

The flowering plant species of the world have been estimated to be about 422,000. Between 35,000 to 70,000 species are used for medicinal purposes of which at least 6,500 in Asia (Karki and Williams, 1995). It is one of the largest biodiversity regions in the world containing some of the richest countries in plant resources. The continent has diverse plant flora but species richness is concentrated mainly in tropical or subtropical regions. Six of the world's 18 biodiversity hot-spots, namely the Eastern Himalaya, North Borneo, Peninsular Malaysia, Sri Lanka, the Philippines and the Western Ghats of South India lie in Asia. The countries of the region have large flora, for example China (30,000 species of higher plants), Indonesia (20,000), India (17,000), Myanmar (14,000), Malaysia (12,000) and Thailand (12,000). The island of Borneo has about 20,000 to 25,000 higher plant species (Anonymous, 2004). The number of plant species and the endemics in the region are:

Region	Species	Endemics
Southeast Asia	42-50,000	40,000
China and East Asia	45,000	18,650
Indian subcontinent	25,000	12,000
Southwest Asia	23,000	7,100

Medicinal and aromatic plants constitute the basis of primary health care for the majority of the population in Asia and are a critical source of income for rural populations. They earn their living by selling wild or cultivated plant materials. Ap-

proximately 90% of the plants is still collected from forests. Only a few countries, mainly China, India, Indonesia, Nepal, Thailand and Viet Nam produce medicinal and aromatic plants commercially. There are a few others that produce them on a commercial scale but the quantities are small and mainly for domestic consumption. Some commercially cultivated important species of medicinal and aromatic plants in Asia are presented in Table 1 (Chapman and Chomchalow, 2005).

Many ancient traditional medicine systems are practised in Asia despite advances in western medicine mainly because of its historical circumstances and cultural beliefs. Medicinal plants are an accessible, affordable and culturally appropriate source of primary health care for more than 80% of the population of Asian according to the World Health Organization. People who cannot afford or access formal health care systems are especially dependent on traditional medicines.

Some of the various traditional medicine systems practised in Asia are highly developed and well documented, based on systematized knowledge, comprehensive methodology and rich clinical experience. Traditional Chinese and Indian medicines belong to this category. A large number of other simpler traditional practices have been developed and practised within small and isolated ethnic groups. These are based largely on empirical treatment. Practitioners do not receive any formal training and knowledge is passed orally for the most part from generation to generation without writing it down.

Indian Ayurveda along with the Jamu, Siddha, Tibetan, traditional Chinese and Unani systems of medicine are an important source of health and livelihood for millions of Asian people. Ayurvedic medicine is widely practised especially in Bangladesh, India, Nepal, Pakistan and Sri Lanka. The Chinese traditional medicine technique, particularly acupuncture, is the most widely used and is practised in every region of the world. Unani medicine draws from the traditional systems of medicine of China, Egypt, India, Iraq, Persia and the Syrian Arab Republic and is also known as Arabic medicine (WHO, 2001).

International and national trade in alternative medicines including herbal products is increasing rapidly. Significant quantities of herbal products are now imported by countries in Asia, Europe and North America. The estimated global trade in medicinal and aromatic plants was over US$60 billion in 2000 and is expected to reach 5 trillion by 2050. China and India are the world's leading exporters of medicinal and aromatic plant materials (Kumar, 2003).

Interest in medicinal plants has been revived in recent times and various national and international organizations including the Food and Agriculture Organization (FAO), the International Development Research Centre (IDRC), the United Na-

tions Industrial Development Organization (UNIDO), the World Health Organization (WHO) and others have been addressing issues concerning medicinal and aromatic plants through support for research, networking and coordination. In almost every Asian country there is a vast indigenous knowledge of the use of medicinal plants. However, the biodiversity of medicinal and aromatic plants is yet to be studied thoroughly in many countries. The commercial exploitation, unsustainable use, cultural changes and lack of institutional support threaten resources and local knowledge. A growing number of countries are developing national policies on traditional medicine that cover quality and safety. Bhutan, Lao PDR, Nepal and to a lesser extent Bangladesh, China, India, Indonesia and Pakistan maintain considerable natural forest cover and are still able to collect these plants from the wild. A few countries including China, India and Sri Lanka have formulated legislation to conserve their natural resources of medicinal and aromatic plants. Many other countries of the region have ceased the practice of wild collection (Chapman and Chomchalow, 2005).

The huge human population supported by the continent inevitably causes deforestation and loss of native vegetation. The widespread and unregulated collection of plants from the wild for use in traditional medicine threatens many plant species. Some of the major constraints in commercial exploitation of medicinal plants are due to the fact that the countries of the region include poor agricultural practices, poor harvesting and post-harvest treatment practices, lack of research on development of high-yielding varieties and validation of traditional remedies, domestication, poor propagation methods, inefficient processing techniques, poor quality control procedures, lack of current good manufacturing practices, lack of research and development on product and process development, difficulties in marketing, lack of local market for primary processed products, lack of trained personnel, lack of equipment and facilities to fabricate equipment locally and lack of access to the latest technologies and market information. There is need for coordination among the various institutes of the region working with medicinal plants and traditional medicines for commercial exploitation and to develop their full potential.

Detailed information on the status of medicinal and aromatic plants is important to policy makers, the scientific community and user groups to be able to frame effective policies, formulate projects to advance research and development activities and establish environmentally sustainable and economically viable enterprises. The International Centre for Science and High Technology (ICS-UNIDO) has prepared this compendium of the medicinal and aromatic plants of Asia. Their status in Asian countries along with information on traditional systems of medicine, government efforts to promote them, resources, research and trade and the main problems faced in

their commercial exploitation are examined. The intention is to aid the countries of the region to improve the health and living standards of their populations using their own resources and developing a system of medicine which is less expensive than modern medicine and already well respected and accepted by Asian communities.

Table 1: Some medicinal and aromatic plants commercially cultivated in Asia

Botanic name	Family	Country of cultivation
Aconitum napellus L.	Ranunculaceae	Nepal
Adhatoda vasica Nees	Acanthaceae	Nepal, Viet Nam
Alisma orientale (Sam.) Juz.	Alismataceae	China
Aloe barbadensis Mill.	Asphodelaceae	Thailand
Ammi majus L.	Apiaceae	Nepal, Viet Nam
Andrographis paniculata (Burm. f.) Wall. ex Nees	Acanthaceae	Thailand, INS, Viet Nam
Angelica acutiloba (Siebold & Zucc.) Kitag.	Apiaceae	Viet Nam
Angelica gigas Nakai	Apiaceae	Rep. Korea
Areca catechu L.	Arecaceae	Thailand, Viet Nam
Artemisia annua L.	Asteraceae	China, Thailand, Viet Nam
Atropa belladonna L.	Solanaceae	India, Nepal, Viet Nam
Cassia angustifolia Vahl	Fabaceae	India, Thailand, Viet Nam
Catharanthus roseus (L.) G. Don	Apocynaceae	India, Viet Nam, Philippines
Cephaelis ipecacuanha (Brot.) Tussac	Rubiaceae	India, Brazil
Chrysanthemum morifolium Ramat.	Asteraceae	China, Thailand, Viet Nam
Chrysanthemum cinerariifolium (Trevir.) Vis.	Asteraceae	India, Viet Nam
Cinchona ledgeriana (Howard) Bern. Moens ex Trimen	Rubiaceae	India, Thailand, Viet Nam
Cinnamomum camphora (L.) J. Presl	Lauraceae	China, Thailand, Viet Nam
Cornus officinalis Siebold & Zucc.	Cornaceae	China
Corydalis yanhusua (Y.H. Chou & Chun C. Hsu) w.T. Wang	Fumayiaceae	China
Cuminum cyminum L.	Apiaceae	Turkey, Iran
Curcuma domestica Valeton	Zingiberaceae	India, Indonesia, Pakistan, Sri Lanka, Thailand, Viet Nam
Cymbopogon winterianus Jowitt	Poaceae	India, Indonesia, Nepal, Sri Lanka, Thailand
Dendranthema morifolium (Ramat.) Tzvelev	Asteraceae	China
Dioscorea deltoidea Wall. ex Griseb.	Dioscoreaceae	India
Hibiscus sabdariffa L.	Malvaceae	Thailand, Viet Nam
Kaempferia galanga L.	Zingiberaceae	Indonesia, Viet Nam
Matricaria chamomilla auct.	Asteraceae	Nepal
Mentha arvensis L. var. piperascens Malinv. ex L. H. Bailey	Lamiaceae	China, India, Nepal, Pakistan, Thailand, Viet Nam
Morinda officinalis F. C. How	Rubiaceae	China, Viet Nam
Ophiopogon japonicus (L. f.) Ker Gawl.	Convallariaceae	China, Viet Nam

Continued

Table 1 continued

Botanic name	Family	Country of cultivation
Origanum onites L. & *Origanum vulgare* L. subsp. hirtum (Link) Ietsw.	Lamiaceae	Turkey
Paeonia lactiflora Pall.	Paeoniaceae	Rep. Korea, Viet Nam
Panax ginseng C. A. Mey.	Araliaceae	China, Rep. Korea
Panax notoginseng (Burkill) F. H. Chen ex C. Y. Wu & K. M. Feng	Araliaceae	China
Panax pseudoginseng Wall.	Araliaceae	China, Viet Nam
Panax quinquefolius L.	Araliaceae	China
Panax vietnamensis Ha & Grushv.	Araliaceae	Viet Nam
Papaver somniferum L.	Papaveraceae	India
Piper betle L.	Piperaceae	Sri Lanka, Thailand, Viet Nam
Piper nigrum L.	Piperaceae	India, Indonesia, Malaysia, Sri Lanka, Thailand, Viet Nam
Piper retrofractum Vahl	Piperaceae	India, Indonesia, Sri Lanka, Thailand
Plantago ovata Forssk.	Plantaginaceae	India
Platycodon grandiflorus (Jacq.) A. DC.	Campanulaceae	Rep. Korea
Rauvolfia serpentina (L.) Benth. ex Kurz	Apocynaceae	India, Nepal, Viet Nam
Rosa damascena Miller	Rosaceae	Turkey
Solanum laciniatum Aiton	Solanaceae	Nepal
Solanum viarum Dunal	Solanaceae	India
Swertia chirayita (Roxb. ex Fleming) H. Karst.	Gentianaceae	Nepal, Pakistan
Syzygium aromaticum (L.) Merr. & L. M. Perry	Myrtaceae	India, Indonesia, Malaysia, Sri Lanka
Tinospora crispa (L.) Hook. f. & Thomson	Menispermaceae	India, Philippines
Valeriana jatamansi Jones	Valerianaceae	India, Pakistan
Valeriana officinalis L.	Valerianaceae	Nepal, Pakistan
Vitex negundo L.	Lamiaceae	Philippines
Withania somnifera (L.) Dunal	Solanaceae	India
Zingiber officinale Roscoe	Zingiberaceae	China, India, Indonesia, Rep. Korea, Sri Lanka, Thailand
Zingiber purpureum Roscoe	Zingiberaceae	Thailand

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Chapter 1

East Asia

1.1 Introduction

East Asia covers an area of about 6,640,000 square kilometres, which is about 15% of the continent and includes China, Japan, Mongolia, the Democratic People's Republic of Korea and the Republic of Korea. About 40% of all Asians (more than 1,500 million people) and a fourth of the total world population live here, making it one of the most densely populated regions. It supports an unparalleled biodiversity of flora, containing one-fourth of the world's most productive mangrove forests.

Traditional medicine is widely practised across the countries of East Asia and is an integral part of the public health care system in China, Japan and the Republic of Korea. China has a long history of traditional medicine and it is one of the most widely used and well documented systems of medicine in the world. The country is rich in biodiversity of medicinal and aromatic plants with more than 7,000 species used for medicinal purposes. Traditional Chinese Medicine (TCM) accounts for 30 to 50% of total medicine consumption in China. Japanese traditional medicine, Kampo, is based on TCM but has been adapted to Japanese culture over the years and is extremely popular. It is fully integrated into the health care system of the country, and with slight modifications has also been adopted in Taiwan province. From 1974 to 1989, a 15-fold increase was observed in the sale of Kampo medicine products and the annual consumption of Kampo drugs is worth US$1 billion. China and Japan, along with India, have the highest per capita consumption of traditional medicine among Asian countries (Kumar, 2003). The Republic of Korea also has rich resources of medicinal plants. The government has imposed strict regulations on herbal medicine preparations and Korean traditional medicines produced by domestic pharmaceutical companies to comply with the Korean Good Manufacturing Practice standards for the manufacturing processes, quality control and handling of herbal medicines. Mongolian traditional medicine also shares a close relationship with the traditional systems of medicine in China, India and Tibet. The medicinal and aromatic plants of the region have great potential in enhancing the social and health standards of the people.

1.2 China

The People's Republic of China is the third largest and one of the most populous countries in the world. It is bounded to the north by Mongolia and Russia, to the north-east by Russia and the Democratic People's Republic of Korea, the Yellow Sea and the East China Sea to the east, the South China Sea, Viet Nam, Lao PDR, Myanmar, India, Bhutan, and Nepal to the south, Pakistan, Afghanistan, and Tajikistan to the west and Kyrgyzstan and Kazakhstan to the northwest. The population of China is about 1,287 million and it has an area of 9,596,960 square kilometres that includes more than 3,400 offshore islands, Hong Kong (reverted to China in 1997), Macau (returned to Chinese administration in 1999) and Taiwan province. China has a great diversity in natural resources and around 14% of the total area is forest. The largest forests are found in the northeast and inner Mongolian provinces, ten southern provinces and the Si-chuan and Yunnan provinces. Great importance has been given to forestry development and afforestation in China and territory greening have been defined as a common duty of society by the government. Traditional medicine has been integrated into the national health care system. The country has a vast diversity in medicinal and aromatic plant species and a large number of these have been brought under cultivation.

Traditional Medicine Systems

TCM has a history of more than 4,000 years. It is very much a part of the present health care system and co-exists with allopathic medicine in China. TCM treatment is based on a holistic view of the patient and disease symptoms. It consists of acupuncture, moxibustion, herbal medicines, manual therapies, exercises, breathing techniques and diet. Acupuncture is the most widely used and is practised in almost every region of the world (WHO, 2001). Almost 40% of total health care services of the country are covered by TCM. In urban areas, medical services are mainly hospital based and western medicine predominates, however, in the rural areas accessibility of hospitals is low and TCM practitioners provide most of the primary medical care. China has more than 1.3 million TCM practitioners (Moltke and Spaninks, 2000), including about 450,000 in national government based hospitals and institutions. The *Chinese Pharmacopoeia* was first published in 1963 and is considered to be legally binding. It contains 992 national herbal monographs. Regulatory requirements for herbal medicines include adherence to information contained in pharmacopoeias and monographs. There are more than 9,000 registered herbal medicines and by the end of 2002, 1,242 herbal medicines had been included on the national essential drug list. The national post-marketing surveillance system has included adverse-effect monitoring since 1984 (WHO, 2005).

Government Efforts in Development of Traditional Medicine

The constitution of China specifies that modern and traditional medicine should be developed simultaneously. As a result TCM has developed steadily since the foundation of the people's republic in 1949 when there were 276,000 practitioners of traditional medicine which increased to 393,000 in 1965 and 525,000 in 1995. Among the traditional medicine practitioners 257,000 doctors have knowledge of both traditional and allopathic medicine, 10,000 are allopathic doctors with traditional medicine knowledge, 83,000 pharmacists specialized in herbal medicines, 72,000 assistant traditional medicine doctors and 55,000 assistant herbal pharmacists. There are more than 2,900 traditional medicine hospitals at present in China of which 2,500 are traditional medicine hospitals only, 204 practise integrative medicine (combining traditional Chinese and allopathic medicine) and 165 are Chinese minority medicine hospitals. Of the general hospitals 95% have traditional medicine units and 50% of rural doctors can prescribe both traditional and allopathic medicine. Consumption of traditional medicine is 30% of the total medicine consumed in the country.

Article 21, adopted in 1982 promotes both allopathic and traditional Chinese medicine. In 1984, as part of the Central Health Administration, the Bureau of Traditional Medicine was set up. The State Administration of TCM was established in 1986 and in 1997 the Chinese government reiterated its principles of equality in policies related to traditional and allopathic medicine both of which are practised at every level of the health care system. The national office for TCM was established in 1949 under the Ministry of Health but in 1998 the State Drug Administration became responsible for regulatory issues relating to traditional medicine. It is independent of the Ministry of Health (WHO, 2005). China has 57 TCM secondary schools for rural and basic units and there are 28 universities and colleges providing 14 professional undergraduate programmes along with master's and doctorates in TCM and pharmacology. A chiropractic college is in the process of being established. Each of the allopathic schools has a TCM department and every traditional medical school has a department of allopathic medicine. About 10 to 20% of the teaching in allopathic medical schools is allocated to TCM and in traditional medicine colleges, due emphasis is also placed on allopathic medicine. Traditional medicine is covered by the National Health Insurance.

In the Hong Kong Special Administrative Region of China (Hong Kong SAR), allopathic medicine is the main health care system. However, TCM is also commonly used. A survey in 1996 by Census and Statistics Department reported that there are 6,890 TCM practitioners and 37 chiropractors and 10.5% of medical consultations are provided by TCM practitioners. The Basic Law of Hong Kong SAR provides for the govern-

ment to formulate policies for development of allopathic and TCM health services. The Public Health and Municipal Services Ordinance controls the sale of drugs unfit for human consumption and the Pharmacy and Poisons Ordinance prohibits the adulteration of TCM with allopathic drugs. The Secretary for Health and Welfare set up the Working Party on Chinese Medicine in 1989 in order to promote the proper use and good practice of TCM and in 1995 appointed the Preparatory Committee on Chinese Medicine. The Committee submitted reports on TCM regulation and development in March 1997 and 1999. Educational institutions offer refresher courses in TCM. Recently undergraduate courses in TCM and pharmacy have also been introduced at local universities (WHO, 2001). The majority of traditional Chinese medicines are imported from China including raw or processed medicinal materials.

In Macao TCM is a popular form of health care. In order to provide better public health through licensing of medicines, import, export and wholesale companies, dispensing pharmacies, pharmacists and other technicians of traditional pharmacies, a new law Decreta-Lei n 53/94/M, was enacted in November 1994. Based on the law, a list of 456 types of traditional medicinal material that may only be sold in the Chinese pharmacies of Macao was prepared. Only traditional medicine registered in the country is imported into Macao (WHO, 1998).

Medicinal and Aromatic Plant Resources

China is one of the richest countries in terms of plant biodiversity. It has more than 30,000 species of higher plants among which 17,300 are endemic constituting more than 57% of all Chinese higher plants. More than 11,000 are medicinal plants (Anonymous, 1998). Over 300 medicinal herbs are under cultivation in Anguo City, Hubei Province covering an area of approximately 8,670 hectares. It is a leading producer of high demand Chinese medicinal herbs such as adenophora root (*Adenophora triphylla* (Thunb.) A. DC.), anemarrhena rhizome (*Anemarrhena asphodeloides* Bunge), chrysanthemum flower (*Dendranthema xgrandiflorum* (Ramat.) Kitam.), Chinese yam rhizome (*Dioscorea oppositifolia* L.), fragrant angelica root *(Angelica dahurica* (Fisch.) Benth. & Hook. f. ex Franch. & Sav.) and Job's tears seed (*Coix lacryma*-jobi L.) which, besides domestic consumption are also exported to Japan, Southeast Asian countries and Western Europe. The city produces 25,000 tonnes of medicinal herbs annually (ITC, 2004).

Approximately 1,000 species are commonly used in Chinese medicinal preparations with more than three-quarters of these collected from the wild. Since 1979 the demand of TCM has increased at a rate of 9% per year. This increase in demand both at home and abroad has resulted in overexploitation and accelerated the depletion of natural resources of medicinal and aromatic plants.

Some important medicinal and aromatic plant species of China are:

American ginseng (*Panax quinquefolius* L.) was introduced to China in 1975. It is cultivated in more than 10 provinces with an annual output of over 50 tonnes. Muling Forestry Bureau, Heilongjiang Province, the biggest production base in China, has an area of 47,000 square meters of American ginseng.

Common Macrocarpium (*Macrocarpium officinalis* (Sieb.et Zucc.) Nakai.) occurs in many provinces, including Zhejiang, Anhui, Henan, Shandong, Shanxi and Sichuan. The country's annual output fluctuates between 600 and 900 tonnes. The total planted area in 1987 was 1,333 hectares with an annual output of 160 tonnes.

Gingko (*Ginkgo biloba* L.) is distributed over more than 20 provinces with 0.7 to 0.8 million fruit-producing trees. The annual production amounts to: kernels, 5,000 to 6,000; leaves, 7,000 ; and fleshy seed coats 10,000 to 12,000 tonnes.

Ginseng (*Panax ginseng* C. A. Mey.) is one of the key plants from North China. Jilin Province is the major ginseng-producing area. It produces about 80% of the ginseng of the country, making up 40% of the world total. The Baishishan Forestry Bureau, Jilin Province has developed an area of 20 hectares of ginseng with an output of 175 tonnes.

The annual essential oil production of China is 20,000 to 30,000 tonnes. *Litsea cubeba* (Lour.) Pers. is an important aromatic plant that is distributed widely in almost all provinces. Almost all the plant parts including root, stem, leaf, bark and fruit contain aromatic oil especially the fruit from which cubeba oil is obtained. Secondary processing of cubeba has resulted in considerable benefits (FAO, 2002). Eucalyptus was introduced in China more than a hundred years ago. It is now cultivated on over 670,000 hectares distributed over 16 provinces (Kunshan, 1994).

Since the 1980s, there has been a rapid increase in the cultivation of medicinal plants. Approximately 340,000 farmers are engaged in medicinal and aromatic plant cultivation and the total area planted is about 137,594 hectares (WHO, 2001). More than 250 species of medicinal plants are being commercially cultivated and about 60 of them have performed particularly well under cultivation. Many of the exotic species have also been introduced and brought under cultivation and about 30 species have successfully been grown over the last 30 years. Approximately 2,000 exotic species of medicinal plants are maintained in various botanical gardens. Some of the important cultivated species of medicinal plants are presented in Table 1 (He and Sheng, 1995). The Institute of Medicinal Plant, Chinese Academy of Medical Sciences (CAMS) has prepared a series of monographs (available on CD) of the common Chinese medicinal plants. It consists of three volumes giving information on habitat, distribution, collection, drug description, constituents, pharmacological actions, usage and dosages and pictures of the plants. Some of the Chinese medicinal and aromatic plants presented on the CD along with their medicinal uses are listed in Table 2.

Research and Development Activities

After the establishment of the People's Republic of China, and especially since 1978, remarkable achievements have been made in research on natural medicaments, traditional Chinese medical science and technology. China has established governmental or non-governmental cooperative relations in the field of traditional medicine with most countries in the world and has also carried out exchange and cooperation in TCM with more than 40 countries and regions. In cooperation with the WHO, seven centres for cooperation on TCM have been established in China (Anonymous, 2003). A number of institutes in the USA, England, Viet Nam, Australia, Belgium, Malaysia and various other countries are engaged in research on TCM collaborating with Chinese TCM researchers or institutes.

The WHO published a book "Medicinal Plants in China" in collaboration with the Institute of Chinese Materia Medica. It catalogues the 150 species of medicinal plants most commonly used in TCM giving their botanical names, synonyms, Chinese and English names, parts used and plant description, habitat, geographical distribution, clinical indications, dosage and photographs of the plants (WHO, 1989).

Scientists at the Chinese Academy of Sciences, Beijing have recently developed a database of ready-prepared Chinese medicines, for their rational use and effective study. The database contains detailed descriptions of 885 of the most famous and frequently used ready-prepared Chinese medicines in China, 120 most important officinal plants, 150 diseases and corresponding treatments (Li *et al.*, 2001).

The *Pharmacopoeia of the People's Republic of China 2000* contains up to 2,691 monographs of drugs in two volumes. In volume I, 992 monographs of Chinese crude drugs and traditional Chinese patent medicines have been included, while volume II contains 1,699 monographs of chemical drugs (Anonymous, 2003). Recently the University of Macao has published volume I of the first Chinese-English manual on 50 medicinal herbs growing in China's Macao Special Administrative Region (ITC, 2003).

Trade and Marketing

According to the Hong Kong Trade Development Council (TDC), the global Chinese medicine market is worth US$20 billion a year (ITC, 2003). There are 800 manufacturers of herbal products in China, with a total annual output worth US$1,800 million and 13,000 central farms are specialized in the production of materials for traditional medicines (WHO, 2001).

With production as its base, industry as the main body and commerce as the link, a system for the production and circulation of Chinese herbal medicines has been pre-

liminarily formed in China. There are over 600 production bases for medicinal materials with an output of about 400,000 tonnes per year. More than 4,000 Chinese patent herbal medicines in over 40 forms of drug formulation are produced by 684 herbal pharmaceutical factories. In addition, over 1,500 plants are involved in the production of processed herbal materials. There were more than 30,000 wholesale outlets and retail shops for herbal medicines with total domestic sales of US$1.62 billion in 1995. In 1997, the total output value of the Chinese herbal medicament industry was US$3.37 billion. China used to spend a large amount of foreign exchange on importing nearly 100 varieties of medicinal materials every year. With the successful introduction of some medicinal species and protection of their wild resources and ecological environment imports have gradually been reduced (Anonymous, 2003). According to the International Trade Centre, the value of Chinese imports in category HS 121190 (plants and parts of the plants including seeds and fruits used primarily in perfumery, pharmacy or for insecticides etc. in fresh or dried forms) for 1997-2001 were US$9,273, 12,514, 8,541, 8,210 and 9,565 respectively. The prices of some of the herbal plant materials of China are presented in Table 3 (ITC, 2003).

The average output of eucalyptus oil is about 3,000 tonnes per year, of which one-third is exported, mainly to France and Germany. The annual output of essential oil in the Kunming Perfume Factory, Yunnan Province, is about 500 tonnes, including the "Yilan" Brand which contains 80 percent eucalyptus oil and enjoys high prestige on the international market. The *Eucalyptus citriodora* Hook. oil produced in the Baihua Perfume Factory, Guangzhou, and pure citronellal, citronellol and rhodinol extracted from crude oil in the Fuzhou and the Zhangzhou Perfume Factories have resulted in high economic returns (Kunshan, 1994).

Along with the formal, state controlled market there is a large informal TCM market, which is capable of providing even banned materials. The formal, state controlled product chain of TCM materials also supplies this informal market. There are eight major markets where TCM materials are traded in China. However, no reliable information on price trends, the dimensions and dynamics of this market is available. Total demand for herbal plant materials is estimated at 1.6 million tonnes per annum. Of this only approximately 0.3 million tonnes are from cultivated plants. However, information in this area is not very reliable (Moltke and Spaninks, 2000).

Problems and Constraints

There is a need for effective development plans for forest areas and management capacity should be strengthened. China should also strengthen technical training of personnel, carry out international technical cooperation and exchanges and draw additional

foreign capital. There is need to control the illegal markets, regulation of TCM trade, scientific validation of medicinal materials and more efforts for conservation and cultivation of medicinal and aromatic plants.

Table 1: Important cultivated medicinal and aromatic plant species in China

Botanical name	Plant species
Anemarrhena asphodeloides Bunge	*Gastrodia elata* Blume
Asarum heterotropoides var. *mandshuricum* (Maxim.) Kitag.	*Gentiana manshurica* Kitag.
Astragalus membranaceus (Fisch. ex Link) Bunge	*Glycyrrhiza uralensis* Fisch. ex DC.
Belamcanda chinensis (L.) DC.	*Gynostemma pentaphyllum* (Thunb.) Makino
Bupleurum chinense DC.	*Macrocarpium officinale* (Siebold & Zucc.) Nakai
Cimicifuga foetida L.	*Panax ginseng* C. A. Mey.
Coptis chinensis Franch.	*Panax notoginseng* (Burkill) F. H. Chen ex C. Y. Wu & K. M. Feng
Corydalis turtschaninovii f. *yanhusuo* Y. H. Chou & Chun C. Hsu	*Pinellia ternata* (Thunb.) Makino
Crocus sativus L.	*Polygonum multiflorum* Thunb.
Dendrobium nobile Lindl.	*Salvia miltiorrhiza* Bunge
Eucommia ulmoides Oliv.	*Saposhnikovia divaricata* (Turcz.) Schischk.
Fritillaria cirrhosa D. Don	*Schisandra chinensis* (Turcz.) Baill.
Fritillaria thunbergii Miq.	

Table 2: Some common medicinal and aromatic plants with their common uses

Botanical name	Family	Part(s) used	Uses/Indications
Acacia catechu (L. f.) Willd.	Fabaceae	Bark	As astringent, in skin diseases, mouth ulcers
Aconitum carmichaelii Debeaux	Ranunculaceae	Root	In diarrhoea, impotence, chronic arthritis, oedema
Astragalus chinensis L. f.	Fabaceae	Seed	As kidney tonic, in dizziness, seminal emission
Astragalus membranaceus (Fisch. ex Link) Bunge	Fabaceae	Root	As tonic, diuretic, anti-inflammatory, in diarrhea, oedema.
Belamcanda chinensis (L.) DC.	Iridaceae	Rhizome	In cough, as expectorant
Broussonetia papyrifera (L.) Vent.	Moraceae	Fruit	As kidney & liver tonic, stomachic, diuretic
Cannabis sativa L.	Cannabaceae	Seed	As hypotensive, cathartic
Cinnamomum cassia auct.	Lauraceae	Stem bark	As analgesic, in emmenagogue, diarrhoea, frigidity, impotence
Citrus medica L.	Rutaceae	Fruit	As carminative, analgesic, in anorexia, vomiting
Coptis chinensis Franch.	Ranunculaceae	Rhizome	As antibiotic, antipyretic, in insomnia, dysentery
Cornus officinalis Siebold & Zucc.	Cornaceae	Fruit	As liver & kidney tonic, in dizziness, impotence

Continued

Table 2 continued

Botanical name	Family	Part(s) used	Uses/Indications
Crocus sativus L.	Iridaceae	Stigma	As detoxicant, tranquilizer
Datura metel L.	Solanaceae	Flower	Anti-asthmatic, analgesic
Dendrobium nobile Lindl.	Orchidaceae	Stem	Stomachic, in dry cough
Digitalis lanata Ehrh.	Scrophulariaceae	Leaf	Cardiac regulator
Ephedra equisetina Bunge	Ephedraceae	Stem	As diaphoretic, anti-asthmatic, diuretic, in cold, edema, bronchitis
Ephedra sinica Stapf	Ephedraceae	Root, rhizome	As antihidrotic, diuretic, anti-asthmatic, diaphoretic, in cold
Erodium stephanianum Willd.	Geraniaceae	Arial parts	As anti-rheumatic, in diarrhoea, dysentery, traumatic injuries
Eucommia ulmoides Oliv.	Eucommiaceae	Stem bark	As liver & kidney tonic, in impotence.
Ginkgo biloba L.	Ginkgoaceae	Seed, leaf	Astringent, analgesic, in asthma
Hyoscyamus niger L.	Solanaceae	Seed	Antispasmodic, anti-asthmatic, sedative, analgesic
Juglans regia L.	Juglandaceae	Seed	Tonic, emollient, anti-asthmatic
Lonicera japonica Thunb.	Caprifoliaceae	Flower	Febrifuge, detoxicant, in arthritis
Magnolia officinalis Rehder & E. H. Wilson	Magnoliaceae	Stem bark, root, flower	In dyspepsia, as carminative, expectorant, aromatic, in constipation
Matteuccia struthiopteris (L.) Tod.	Dryopteridaceae	Rhizome	Anti-inflammatory, haemostatic, in influenza, as parasiticide
Morus alba L.	Moraceae	Root, leaf, fruit	Anti-asthmatic, diuretic, in cough, asthma, vertigo, diabetes
Origanum vulgare L.	Lamiaceae	Arial part	Diaphoretic, diuretic, in oedema, headache, diarrhoea
Panax ginseng C. A. Mey.	Araliaceae	Root	In insomnia, impotence
Panax quinquefolius L.	Araliaceae	Root	Adaptogenic, tonic, tranquilizer
Papaver somniferum L.	Papaveraceae	Fruit	Analgesic, in chronic cough, diarrhea
Pinellia ternata (Thunb.) Makino	Araceae	Tuber	Diuretic, expectorant, antemetic
Pinus massoniana Lamb.	Pinaceae	Pollen	Astringent, haemostatic, antirheumatic, analgesic, in eczema
Piper longum L.	Piperaceae	Fruit	Carminative, analgesic, in vomiting, diarrhoea, migraine
Piper nigrum L.	Piperaceae	Fruit	Stomachic, in diarrhoea, epigastralagia, vomiting, anorexia
Plantago asiatica L.	Plantaginaceae	Whole plant	Antipyretic, antidote, diuretic, in cough, carbuncles & sores
Platycladus orientalis (L.) Franco	Cupressaceae	Leaf, seed	Astringent, cardiac tonic, sedative
Platycodon grandiflorum (Jacq.) A. DC.	Campanulaceae	Root	Expectorant, in sore throat
Polygonum aviculare L.	Polygonaceae	Arial parts	Anti-inflammatory, diuretic, jaundice, eczema, vaginitis
Polygonum cuspidatum Siebold & Zucc.	Polygonaceae	Root, rhizome	Analgesic, antipyretic, diuretic, expectorant, in jaundice
Polygonum multiflorum Thunb.	Polygonaceae	Root	Detoxicant, antirheumatic, laxative, in insomnia
Polygonum orientale L.	Polygonaceae	Fruit	Analgesic, digestant, in amenorrhea, distending pain in gastral cavity
Polygonum perfoliatum L.	Polygonaceae	Arial parts	Diuretic, anti-swelling agent, in dysentery, edema, snake bite

Continued

Table 2 continued

Botanical name	Family	Part(s) used	Uses/Indications
Portulaca oleracea L.	Portulacaceae	Arial parts	Febrifuge, detoxicant, in dysentery, carbuncles & sores
Pulsatilla chinensis (Bunge) Regel	Ranunculaceae	Root	Febrifuge, antidote, in diarrhoea, dysentery
Pyrrosia petiolosa (H. Christ) Ching	Polypodiaceae	Leaf	Diuretic, antitussive, in edema, cough
Ricinus communis L.	Euphorbiaceae	Seed	Anti-swelling agent, antidote, in skin ulcer, sores & boils
Rosa chinensis Jacq.	Rosaceae	Flower bud	Ammengogue
Rubia cordifolia L.	Rubiaceae	Root	Blood purifying agent, haemostatic
Salvia miltiorrhiza Bunge	Lamiaceae	Root	Analgesic, in insomnia, amenorrhoea
Saururus chinensis Baill.	Saururaceae	Whole plant	Febrifuge, detoxicant, diuretic, in dysuria, edema
Schisandra chinensis (Turcz.) Baill.	Schisandraceae	Fruit	In diarrhoea, cough, asthma, kidney tonic
Terminalia chebula Retz.	Combretaceae	Fruit	Astringent, in diarrhoea, chronic cough
Vaccaria segetalis Garcke, nom. illeg.	Caryophyllaceae	Seed	Induces lactation, in mastitis, amenorrhoea
Vitex trifolia L.	Lamiaceae	Fruit	Gingivitis, headache, dizziness, blurred vision
Zanthoxylum bungeanum Maxim.	Rutaceae	Fruit pericarp	Analgesic, anthelmintic, in vomiting, diarrhea
Ziziphus jujuba (L.) Gaertn., nom. illeg.	Rhamnaceae	Fruit	Appetizer

Table 3: The indicative prices of some Chinese herbal materials in 2003

Botanical name	Part(s) used	Price (US$/kg)
Allium sativum L.	Bulb	1.12
Angelica sinensis (Oliv.) Diels	Root	8.8-12.5
Astragalus membranaceus (Fisch. ex Link) Bunge	Root	7.5-15 .4
Camellia sinensis (L.) Kuntze	Leaf	2.1
Carthamus tinctorius L.	Seed	8.1-8.8
Cassia angustifolia Vahl	Leaf	1.01
Eleutherococcus senticosus (Rupr. & Maxim.) Maxim.	Root	6.6
Ephedra sinica Stapf	Herb	0.46
Epimedium brevicornum Maxim.	Herb	0.62
Foeniculum vulgare Mill.	Fruit	1.1
Glycyrrhiza uralensis Fisch. ex DC.	Root	6.6-8.8
Illicium verum Hook. f.	Fruit	4.3-4.5
Lycium barbarum L.	Fruit	1.8-3.8
Panax ginseng C. A. Mey.	Root	61.7
Rhodiola rosea L.	Root	55
Schisandra chinensis (Turcz.) Baill.	Fruit	11.0
Zingiber officinale Roscoe	Rhizome	1.1-1.2

1.3 Korea (Democratic Republic of)

The Democratic People's Republic of Korea occupies the northern portion of the Korean Peninsula. It is bounded to the north by China, to the northeast by Russia, to the east by the East Sea (Sea of Japan), the Republic of Korea to the south and the Yellow Sea to the west. The population of the country is about 22.4 million and it has an area of 120,540 square kilometres. Much of the country is still densely forested despite the huge destruction caused by the Korean War and allied bombing in the 1950s. The northern and eastern regions of the country are mostly rugged mountains with dense forests which are difficult to exploit. The country has 50% of its land under state owned forests and around 300,000 hectares of land in protected areas. In 1995-96 severe flooding caused damage to an estimated 1.2 million metric tonnes of crops resulting in severe food shortage and adversely affecting the health care system. The lack of facilities and essential drugs in the hospitals caused by severe floods and famine has increased people's reliance on traditional medicine.

Traditional Medicine Systems

The traditional medicine system Koryo plays an important role in Korean medical practice. It has evolved from traditional Chinese and Korean folk medicine. The herbal medicine system known as eastern medicine (Tonguihak), is highly esteemed. Moxibustion, acupuncture and oral preparations are generally practised by practitioners of eastern medicine (Anonymous, 2003). At present people use herbal or traditional medicine unless they have the means to buy modern medicines (Natsios, 2003). According to the Ministry of Health approximately 80% of the population was treated by modern medicines and only 20% relied on traditional medicine before 1995. The recent crisis has however, reversed this ratio (Goguadze, 2000). Herbal medicines are regulated as prescription and over-the-counter medicines. By law, medical claims may be made for herbal medicines. The most recent edition of the *Pharmacopoeia of the Democratic People's Republic of Korea* was published in 1996 and is legally binding. Korean herbal medicine monographs are used, although these are not legally binding. Manufacturing requirements for herbal medicines include adherence to information in the pharmacopoeia and the same GMP rules as those required for conventional pharmaceuticals. There are 1,195 registered herbal medicines in the country. The post-marketing surveillance, including adverse reaction monitoring for herbal medicines, was set up in 1947 (WHO, 2005).

Government Efforts in Development of Traditional Medicine

Traditional medicine has been integrated into the official health-care system of the

Democratic People's Republic of Korea. A number of policies related to this integration have been declared since 1947. It was a prominent feature of the government's 1967 political programme and was reiterated in a 1980 public health law. Under Article 15 of this law, the State is required to combine traditional medical practices with allopathic diagnosis in medical establishments (WHO, 2001). Traditional medical facilities are available throughout the country and people are highly dependent on them at present. Many institutes and pharmacies deal in traditional remedies in the Democratic People's Republic of Korea including the Central Eastern Medicine Hospital in Pyongyang and Research Institute of Eastern Medicine of the North Korean Academy of Medical Sciences (Anonymous, 2003). The national policy on traditional medicines was issued in 1980, as were laws and regulations. The law on Medical Product Management was issued in 1999, covering both herbal medicines and conventional pharmaceuticals (WHO, 2005).

Medicinal and Aromatic Plant Resources

A continental climate with sea on the three sides of the Korean peninsula makes the Democratic People's Republic of Korea rich in plant species diversity. There are 4,200 species of higher plants in 235 families including 200 well known medicinal and 60 aromatic plant species (Bong, 1995). The medicinal plants are cultivated as well as collected from the wild. A variety of herbs and spices are used for medicinal and culinary purposes.

Research and Development Activities

Korean scientists have developed a pharmacopoeia of curative herbs. The Academy of Traditional Korean Medicine, Pyongyang carries out work in collaboration with WHO on activities related to the use of traditional, complementary and alternative medicine in primary health care. The Korea Technical Centre for Traditional Medicine functions as the centre for the development of process parameters, introduction of new products, formulation technologies, quality assessment methods and specifications for traditional medicine used for the promotion of health and treatment of diseases. The Centre is working to develop antibiotics based on traditional medicine, improving dosage forms and modernizing production processes and acts as a centre for scientific and technical exchange of traditional medicine in Korea. It carries the analysis and assay of products prepared through scientific research on Koryo medicines and is also responsible for efficacy evaluation of newly developed Koryo medicines and health foods; scientific and technological exchange and cooperation with international organizations and foreign countries for the development of domestic resources and export of Koryo medicines. The Centre has collaborations with the United Nations Industrial Development Organization and many countries including Belarus, China, India, Russia and Sri Lanka (Anonymous, 1997).

Trade and Marketing

The Soviet Union and eastern European countries were major suppliers of drugs to the Democratic People's Republic of Korea. After the Soviet break-down, drug importation to the country stopped. The local pharmaceutical production collapsed in 1995 due to disasters and economic crisis. The United Nations Children's Fund (UNICEF) and the International Federation of Red Cross and Red Crescent Societies are providing regular pharmaceutical assistance to the country. UNICEF supports the Ministry of Public Health with supplies of raw materials for the production of a limited number of medicines locally.

The shortage of medical supplies has forced hospitals to rely more on traditional medicine. Hospitals usually have a Koryo production unit with qualified pharmacists who grow their own herbs in hospital gardens. It is reported that about 70% of medicines currently used are homemade herbal remedies (Weingartner and Weingartner, 2000). According to the Ministry of Public Health, pharmaceutical factories and herb medicine management stations under the Koryo Medicine Production and Management Bureau created 3,470 hectares of herb gardens in 1998 (Anonymous, 1998).

Problems and Constraints

Years of crop failure, disastrous weather and economic crisis have severely affected the Democratic People's Republic of Korea's health care system. At present, people rely mainly on traditional medicine which has increased the pressure on natural resources of medicinal and aromatic plants. Efforts should be directed towards the regulation of plant cultivation, collection, raw material processing, marketing and research and sustainable use of medicinal and aromatic plant resources in order to exploit them commercially.

1.4 Japan

Japan is located in the northwestern Pacific Ocean. It lies off the east coast of mainland Asia near Russia, Korea, and China and consists of several thousands of islands, of which Honshu, Hokkaido, Kyushu and Shikoku are the largest, extending in a curve of about 1,900 kilometres from northeast to southwest. The total area of Japan is 377,835 square kilometres. The country is one of the most densely populated in the world with a population of about 127 million people. Japan is a heavily forested country, with forests covering around 66 per cent of the total land area. The country has more than 10.5 million hectares of plantation forests, containing predominantly coniferous species in relatively young age classes. Japan's distinctive geographic and climatic char-

acteristics, the most remarkable being the wide range of temperatures and significant rainfall, means that it supports considerable diversity and a rich flora in relation to its size. However many species have, been endangered by unsustainable exploitation.

Traditional Medicine Systems

In Japan, two types of traditional herbal medicines coexisted for centuries. The first was traditional Japanese and Chinese medicine and the second type originated in Europe and southeast Asia and gained popularity after 1874. Some of the herbal products from these systems are still used as prescription drugs in Japan (Saito, 2000).

TCM was introduced to Japan between the 3rd and 8th centuries. These medicines were modified to meet local needs and are known as Kampo medicine. Since the time of its introduction until it was superseded by allopathic medicine in 1875, Kampo was the mainstream Japanese medicine. The newly established government, following the Meiji Restoration in 1886, favoured allopathic medicine. Doctors were trained only in allopathic medicine, with the result that Kampo medicine almost disappeared. However, it regained popularity and public interest after the Second World War and today Kampo plays an important role in Japan and is practised extensively. Acupuncture, moxibustion, Japanese traditional massage/finger pressure and judo therapy are also widely practised in present day Japan (WHO, 2001). National herbal regulations on herbal medicines in Japan were issued in the revised Pharmaceutical Affairs Law; these regulations are the same as those for conventional pharmaceuticals. The *Japanese Pharmacopoeia* was last published in 2001, and is legally binding. There is an approval system rather than a registration system for herbal medicine; at least 1,469 herbal medicines have been approved so far (WHO, 2005).

Government Efforts in Development of Traditional Medicines

There are no restrictions on the types of medical procedures allopathic physicians may use in their practice. The Medical Practitioners Law 201 of 1948 states that only allopathic physicians may practise medicine, including Kampo medicine. A person must be qualified as a pharmacist in order to practise services related to traditional medicine according to the Pharmacists Law 146 of 1960. The Pharmaceutical Affairs Law does not distinguish between traditional and allopathic medicine in Japan. Both types of preparations are subject to the same regulations. The standards for medicinal plants material are included in the *Japanese Pharmacopoeia*, the *Japanese Herbal Medicine Codex* and *Japanese Standards for Herbal Medicines*. In 1990, the Society of Japanese Oriental Medicine started a registration system of allopathic physicians specializing in Kampo medicine. The system requires registration to be renewed every five years in ac-

cordance with the rules set out by the Society. Both the Pharmaceutical Affairs Law which was amended in April 1993 and the Regulations for Manufacturing Control and Quality Control of Drugs that came into effect in April 1996 were changed from manufacturing requirements for drug companies to a prerequisite for licences to manufacture drugs. The good manufacturing practices for investigational products were adopted via a notice issued by the Director-General of the Pharmaceutical Affairs Bureau of the Ministry of Health and Welfare in April 1997. The Japan Pharmacists Education Centre issues a certificate, renewable every three years, for pharmacists specializing in Kampo medicine and herbal materials. The Practitioners of Massage, Finger Pressure, Acupuncture and Moxibustion Law 217 of 1947 stipulates in Article 1 that anyone other than an allopathic physician who wishes to practise acupuncture, moxibustion, or massage/finger pressure must pass the relevant national examination and obtain either a licence in massage/finger pressure alone or a combination licence in acupuncture, moxibustion, and massage/finger pressure from the Minister of Health and Welfare.

There is no systematic programme exclusively for teaching Kampo medicine in Japan. The Toyama Medical and Pharmaceutical University offers a four-year postgraduate doctorate programme in Kampo medicine, as well as the only officially recognized undergraduate medical curriculum where Kampo medicine is taught alongside allopathic medicine. Started in 1998, the Japan Society for Oriental Medicine offers a summer programme in Kampo medicine for 60 undergraduate students of allopathic medical schools each year. Forty-six colleges and universities across Japan provide four-year undergraduate programmes in pharmaceutical sciences with traditional medicines as part of the curriculum, with 7,720 new students enrolled in these programmes each year. The Research Institute for Natural Medicines, established in 1963, is a national research institute in Kampo medicine and pharmaceutical sciences providing undergraduate, master's and doctorate programmes. Twenty-two schools and training institutions offer three-year programmes in acupuncture and moxibustion. Eighty-seven schools and training institutions offer joint programmes in western Pacific acupuncture, moxibustion, and Japanese traditional massage/finger pressure. For visually impaired persons, 31 schools and training institutions offer three-year programmes in Japanese traditional massage/finger pressure alone and seven schools and training institutions offer five-year joint programmes in acupuncture, moxibustion, and Japanese traditional massage/finger pressure. Acupuncture, moxibustion, Japanese traditional massage, and judo therapy are also covered by national health insurance (WHO, 2001).

Medicinal and Aromatic Plant Resources

It is estimated that there are some 3,500 species of higher plants. There are many

kinds of medicinal plants commonly used in traditional Japanese medicine. One hundred and twenty kinds of crude drugs (almost all of plant origin, except a few which are of animal or mineral origin) are listed in the *Japanese Pharmacopoeia* (JP XIV) and are used or recommended as the source of Kampo medicine or traditional medicine. One third of the crude herbal drugs listed in JP XIV are also listed in WHO monographs and are used mainly in Kampo medicine (Ikegami, *et al.*, 2004). Japan has more than 2.5 million hectares of land in formally protected areas. It is covered with lush green forests sheltering a variety of herbs and shrubs. Some medicinal and aromatic plants found in Japan are given in Table 1 (Anonymous, 2004). Six of the leading medicinal and aromatic plants of Japan are presented in Table 2.

Research and Development Activities

In the 1970s, oriental medicine wings of teaching hospitals were established for physician training programmes. These institutions undertook clinical research on how to use traditional Kampo formulae for treating health care problems. The Toyama Medical and Pharmaceutical University in Toyama; the Kitazato Institute in Tokyo and the Kinki University Medical Teaching Hospital were among the first to carry out this type of work. The results of various clinical and laboratory studies have led to an expanded use of traditional formulae in mainstream Japanese medicine. Various traditional formulae such as *shosaikoto* (minor bupleurum combination), *kamishoyosan*, *kotosan* (gambir formula), *juzentaihoto* (ginseng and tang kuei ten combination), *keishibushito* (cinnamon and aconite combination), *tokishakuyakusan* (tang kuei and peony formula), *hangeshashinto* (pinellia combination), *shoseiryuto* (minor blue dragon combination) and *bofutsushosan* (siler and platycodon formula) used for various diseases have been extensively researched (Kenner, 2001).

Hokkaido University, University of the Ryukyus, Kyoto Pharmaceutical University, Meiji Pharmaceutical University, Ochanomizu University, Ehime University, Tokyo Medical and Dental University and University of Tokyo are some of the institutes recently engaged in research on medicinal plants and Kampo medicine formulae carrying out clinical and therapeutic evaluation, isolation of new compounds and establishing their medicinal properties (Wen, 2003).

A survey to evaluate the present status of complementary medicine education in Japanese medical schools conducted by Department of Community and Family Medicine, Jichi Medical School, Tochigi was published (Tsuruoka *et al.*, 2001).

A brief review on the phytochemical research in Japan has recently been presented in the Phytochemistry journal. The review gives a brief account of research, publications, symposia and meetings held, institutes and various societies involved along with their

activities in the field of phytochemistry in the country. Major achievements are also highlighted (Asakawa, 2003).

A study on the clinical uses and toxicity of some Kampo medicines based on herbal crude drugs in WHO monographs has been conducted jointly by the scientists from Center for Environment, Health and Field Sciences, Chiba University, Kashiwa, Tsumura & Co., Niban-cho, Chiyoda-ku, Tokyo and Biomedical Research Institute, Hiratsuka, Shiroi, Japan. Among 210 medicinal prescriptions used in present-day Japan, the clinical uses and the acute, chronic and mutagenic toxicity study of 16 Kampo medicines are summarized in the review. The composition of 31 crude drugs studied for toxicity and numbers of the Japanese prescriptions in the *Japanese Pharmacopoeia* XIV are also listed. (Ikegami *et al.*, 2003). A recent study by the same institutes lists 31 Japanese prescriptions that were investigated for toxicity. It also focuses on the studies of some potential interaction between Kampo medicines and allopathic drugs (Ikegami *et al.*, 2004).

Trade and Marketing

Japan is totally dependent on overseas supplies of dried herbs, essential oils or extracts and herbal products for its domestic needs. About half of the herbal products in retail stores is imported as finished products and the rest are processed in the country from imported raw materials. The bulk of imported herbal products come from France, Germany and the United States, and raw herbs from Bulgaria, Egypt, Morocco, Pakistan, Poland, and Turkey. Some of the Japanese companies which import herbs are also engaged in product development. The majority of European and American brand products used in aromatherapy have an established presence on the Japanese market. An inconsequential quantity of herbs is produced and commercially supplied as fresh herbs to restaurants on the Japanese market. The fresh herb market is only in the order of US$0.027 to 0.045 billion (3 to 5 billion yen). The herbs are grown on farms spread all over the country but they primarily serve as tourist attractions and the products sold at stores attached to these farms are mostly imported items (Anonymous, 2001).

Japan depends on imports for all crude spices. Domestically produced spices are limited to a few items such as chili pepper, garlic, sansho and wasabi. Almost all spices for home use, food processing and industrial use are processed and packed domestically. Japan imports many kinds of spices from all over the world including Asia, the Mediterranean, the Middle and Near East Asia, Africa, North America, Central and South America. Malaysia is the largest supplier of spices to Japan with US$0.034 billion (3.7 billion yen) worth of spices imported in 1999. In 1999, Malaysia alone represented about 25% and China, India, and Indonesia together represented 37% of the total spice market value. These four countries make up over 60% of the value of all spices

imported. Among imported spices, the largest in volume and value are pepper (8,023 tonnes, about US$0.048 billion) and chili pepper (10,335 tonnes, about US$0.029 billion) (Anonymous, 2001).

Problems and Constraints

The country relies heavily on imported herbal plant materials neglecting and ignoring its own resources. The tree plantations in Japan are neglected because of materials imported from other countries. There are no initiatives to develop the domestic forest industry.

Table 1: Some important medicinal and aromatic plant of Japan

Botanical name	Family	Part(s) used	Uses/Indications
Acanthopanax senticosus (Rupr. & Maxim.) Harms	Araliaceae	Root cortex, leaf	Adaptogen
Acer nikoense (Miq.) Maxim.	Vitaceae	Bark, twigs, leaf	In liver and eye diseases
Actinidia polygama (Siebold & Zucc.) Maxim.	Actinidiaceae	Leaf	As preventive for cardiac ailments
Angelica keiskei (Miq.) Koidz.	Apiaceae	Leaf, stem	In poor digestion, infections, skin disease
Artemisia princeps Pamp.	Asteraceae	Leaf, root	In asthma, inflammatory skin and joint disease, cough, cold, infections
Bupleurum falcatum L.	Apiaceae	Root	In debility, immune dysfunction
Chaenomeles sinensis (Thouin) Koehne	Rosaceae	Fruit	In cough and cold
Coix lacryma-jobi L. var. ma-yuen (Rom. Caill.) Stapf	Poaceae	Grain	In making food for convalescent, in debility
Diospyros kaki Thunb.	Ebenaceae	Leaves	In bleeding, haemorrhoids
Epimedium grandiflorum C. Morren var. thunbergianum Nakai	Berberidaceae	Leaf, stem	In poor vitality, debility, lack of sex drive, infertility
Eriobotrya japonica (Thunb.) Lindl.	Rosaceae	Leaf	In chronic skin respiratory diseases
Gastrodia elata Blume	Orchidaceae	Tuber	In nervous abnormalities, headache
Geranium thunbergii Siebold ex Lindl. & Paxton	Geraniaceae	Aerial parts	As stomachic, digestive and in diarrhoea
Glehnia littoralis F. Schmidt ex Miq.	Apiaceae	Root	In stiff shoulders, neuralgia, rheumatism, muscle and joint injury
Houttuynia cordata Thunb.	Saururaceae	Leaves and stem	As detoxification agent
Leonurus sibiricus L.	Lamiaceae	Aerial parts	In gynaecological disorders
Lycium chinense Mill	Solanacae	Fruit, root and bark	In debility, weakness, lack of vitality, poor health
Morus bombycis Koidz.	Moraceae	Leaf	In diabetes and as weight loss aid
Paeonia lactiflora Pall.	Paeoniaceae	Root	In female reproductive tract pain
Perilla frutescens (L.) Britton var. acuta Kudo	Labiatae	Leaf and stem	In allergies, hay fever, asthma, arthritis, eczema
Phellodendron amurense Rupr.	Rutaceae	Inner bark	In chronic inflammatory diseases of mucous membrane and skin
Prunus mume Siebold & Zucc.	Rosaceae	Fruit	In acid indigestion and nausea

Continued

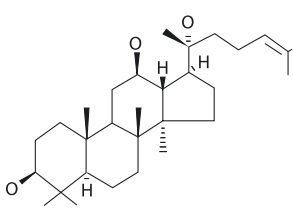
Table 1 continued

Botanical name	Family	Part(s) used	Uses/Indications
Pueraria lobata (Willd.) Ohwi	Fabaceae	Root starch	As convalescence tonic, heart tonic
Sasa senanensis (Franch. & Sav.) Rehder	Graminae	Leaf	In infection prevention
Swertia japonica (Roem. & Schult.) Makino	Gentianaceae	Leaves and stems	In indigestion, abdominal pain, diarrhoea, dyspepsia

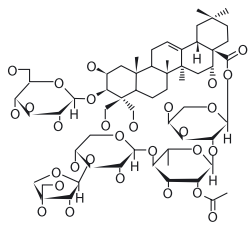
Table 2: Leading medicinal and aromatic plants of Japan

Botanical name	Chemical constituents	Uses/Indications	Part(s) used	Comments
Angelica acutiloba (Siebold & Zucc.)Kitag.; *A. acutiloba* Kitag. var. sugiyamae Hikino	Coumarins, Kinolide A & B	As analgesic, sedative, in gynaecological disorders	Roots	Used in Kampo formulations, listed in Japanese Pharmacopoeia. Domestic production in 2000 was 14,000 kg
Coptis japonica (Thunb.) Makino	Isoquinoline, quaternary alkaloids coptisine & berberine	As stomachic, antiseptic, sedative, anti-inflammatory	Rhizomes	Used in Kampo formulations, listed in Japanese Pharmacopoeia. Production in 2000 was 250 kg
Geranium thunbergii Siebold ex Lindl. & Paxton	Flavonoids & tannins	In diarrhoea, digestive problems	Aerial parts	Domestic production in 2002 was 537 kg
Houttuynia cordata Thunb.	Pyridine alkaloids & terpenes	As antipyretic and anti-inflammatory	Leaves and stem	Domestic production in 2002 was 16,100 kg
Lithospermum erythrorhizon Siebold & Zucc.	Pyrrolizidine alkaloids	In burn treatment	Roots	Used in Kampo formulations, listed in Japanese Pharmacopoeia. Domestic production in 2002 was only 20 kg
Paeonia lactiflora Pall.	Glucosides, monoterpens and volatile oil	In gynaecological disorders	Roots	Used in Kampo formulations, listed in Japanese Pharmacopoeia. In 2002 production was 4,900 kg

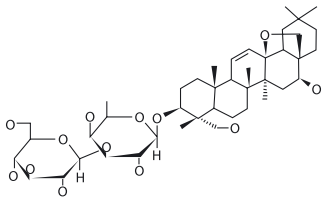
Structures of some important molecules derived from Korean medicinal plants



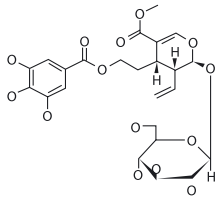
20(R) Protopanaxadiol from Ginseng root



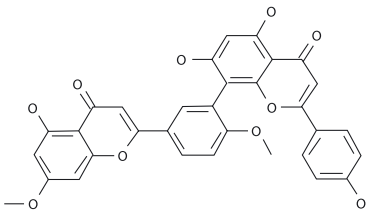
Platycodin A from Platycodi root



Saikosaponin A from Bupleri root



Cornuside from Corni fruit



Ginkgetin from Ginkgo seed

1.5 Mongolia

Mongolia is a landlocked country, located in central Asia. It is bordered by Russia to the north and China to the east, west and south. The population of the country is about 2.7 million and the area is 1,566,500 square kilometres of which about 8.1% is covered by forests. The policies of the former communist regime promoting rapid urbanization, industrial growth, deforestation and mining activities have resulted in depletion of the country's natural resources. Medicinal and aromatic plants have been popularly used for the preparation of a number of traditional remedies. The government is working for the integration of traditional medicine in the official health care system of the country.

Traditional Medicine Systems

The official health care system of Mongolia is allopathic medicine. However, hospitals, especially those in the rural areas, lack both facilities and trained staff and rural people still prefer traditional treatments. The development of Mongolian medicine can be divided into several stages and dates back to the 12th century. Ancient Mongolian medicine gradually came into being at the beginning of the 13th century. The Indian Ayurvedic and Tibetan Buddhist medicines were integrated into Mongolian medicine during the 16th century thus resulting in the formation of a complete medicine system representing the cultural heritage of the Mongolians.

The traditional medicines were prohibited and allopathic medicines were promoted during the Soviet regime (1920-90) in Mongolia. The socio-economic changes in the

country during the 1980s led to the development of the national culture and revival of traditional medicine, which were maintained secretly during the Soviet period. Traditional medicines are now available and popular (WHO, 2001). In traditional treatments, plants, animals as well as acupuncture and moxibustion are frequently used. Mongolian traditional medicine is said to be very effective against vascular diseases and believed to cure over 90% of cardio and cerebro-vascular diseases such as coronary heart diseases and strokes (Anonymous, 2001). There are 22 registered herbal medicines in Mongolia, however, none is included in the essential-drug list of the country. In place of a national pharmacopoeia, many other reliable resources are used including the *Chinese Pharmacopoeia*, the *State Pharmacopoeia of USSR* and the *Indian Pharmacopoeia* but these are not considered to be legally binding. National herbal monographs are found in the 'Manual of Traditional Medicine raw material and prescription control 2003'; the four herbal monographs it contains are considered legally binding (WHO, 2005).

Government Efforts in Development of Traditional Medicine

Traditional medicine is being promoted by the Mongolian government and is considered to be an important health care resource for the population. The government is working to incorporate traditional medicine remedies into the official health services of the country. At present there are about 600 allopathic physicians providing traditional medicine, acupuncture and other traditional therapies in the country. Mongolia has one large (100-bed), 15 small (10-20 beds) and 19 outpatient traditional medicine hospitals. In addition there are 81 private clinics and five manufacturing units for traditional medicines. In 1989 the government also started training of traditional medicine doctors in the Department of Traditional Medicine at the National Medical University.

The Ministry of Health and Social Welfare worked out a development plan for traditional medicine during 1997-2000, focusing on training new personnel, standardizing training curricula, improving research and expanding the manufacture of herbal remedies. According to the State Policy on Development of Mongolian Traditional Medicine, approved by Parliament on 2nd July 1999, the government of Mongolia will give high priority to the development of traditional medicine. The policy aims at developing Mongolian traditional medicine over the next 10 to 15 years and covers 19 areas of work including developing the structure and organization of traditional medicine hospitals; interrelating the activities of training traditional medicine personnel; production of safe herbal medicines in line with good manufacturing practices; supporting traditional medicine doctors and private health institutions; exploring the possibilities of curing critical diseases with traditional methods; and applying some traditional medicine methods to ambulance services and primary health care (WHO, 2001). Regulations on herbal

medicines were issued in 1998 and 2001, and these are regulated as prescription and over-the-counter medicines (WHO, 2005).

The Pharmacology Department for the study of Mongolian medicinal plants was established in 1959. It was restructured as the Institute of Natural Compounds under the Academy of Sciences in 1973 and renamed as the Institute of Traditional Medicine of the Ministry of Health in 1981. In 1998 it was reorganized to become the Traditional Medical Science, Technology and Production Corporation. The Corporation now has a research centre, graduate and post-graduate training departments for traditional medicine and a traditional medical drug factory. It focuses on the study of the ancient traditional medicine system, upgrading of the quality of treatment and medical services, training and consultation and development of government policies on traditional medicine (Anonymous, 2003). The Traditional Medical Department of the National Medical University of Mongolia was reorganized into the School of Traditional Medicine in 2000. It is engaged in providing training, treatment facilities and conducting research on traditional medicine and manufacture of drugs based on traditional recipes.

The Manba Datsan Clinic established in 1760 in Mongolia was prohibited during the communist era. It has now been revived and licensed to train in traditional medicine. The Clinic is engaged in various activities on traditional medicine including religious services on Buddha medicine, clinical and medical treatment services, traditional medicine production and training and research on traditional medicine. A traditional medicine institute is also run by the clinic. About 44,000 people visited the centre for medical check-ups and treatments during the period 1990-97 (Anonymous, 2003).

Medicinal and Aromatic Plant Resources

Mongolian flora comprises 2,823 species of vascular plants of which 845 are used in traditional Mongolian medicine. Due to inappropriate harvesting methods several of these species are now threatened. The Mongolian Red Data Book in 1997 listed 75 medicinal plant species as endangered and threatened (Anonymous, 2003). Among the medicinal plant species used in traditional Mongolian medicine, 335 are found in the eastern region of the country. Some of these species are listed in Table 1 (Anonymous, 2003).

Research and Development Activities

The Training and Research Centre of the Manba Datsan Clinic is in the process of translating treatises on traditional medicine from Tibetan into Mongolian and compiling data on indigenous Mongolian herbs. The medicine factory of the centre produces over 100 traditional products from plant and animal ingredients (Anonymous, 2003).

The Traditional Medical Science Technology and Production Corporation, in addi-

tion to activities on traditional medicines is focusing on research and developmental activities, cultivation of medicinal plants, studies on natural compounds and production of new medicines. A department of the corporation is engaged in studying the theoretical aspects of Mongolian, Tibetan and Oriental traditional medicines. Another department is responsible for producing and collecting the raw material for traditional drugs from plants and animals. The herbal medicine factory of the corporation produces about 130 products (Anonymous, 2003). The School of Traditional Medicine has worked on various aspects of traditional Mongolian medicine and published some books on the subject. The school has international collaborations to carry out joint research projects.

Research on Mongolian medicinal plants is also being carried out by various institutions and universities in other countries. The Toyama Medical and Pharmaceutical University, in Japan has tested 30 Chinese and Mongolian medicinal plants for their inhibitory activity against HIV-1 and has reported anti-HIV activity for 23 out of the total 60 extracts tested (Ma, *et al.*, 2002). The University of Ryukyus, Japan has evaluated the free radical scavenging activity of the Mongolian medicinal herbs *Chamaenerion angustifolium* (L.) Scop. (Ch. ang), *Equisetum arvense* L. (Eq.arv), *Gentiana decumbens* L. f. (Gn.dec), *Geranium pratense* L. (Gr.pra), *Lomatogonium carinthiacum* (W) R. (L.car), *Nonea pulla* (L.) DC. (N.pl), *Phodococcum vitis-idaea* (Ph.v), *Sphallerocarpus gracilis* (Besser ex Trevir.) Koso-Pol (Sph.gr), *Stellera chamaejasme* L. (St.cha) and confirmed that these herbs possess high anti-oxidant activity in-vitro and in-vivo (Myagmar and Aniya, 2000). Some work on Mongolian herbs has also been carried out by scientists at the University of Karachi, Pakistan.

Trade and Marketing

There are no direct funds available for production of drugs in the national budget. The country is highly dependent on drug imports. Nearly 90% of drugs are imported and about half of all drugs come from donations from abroad. About 14% of the required drugs are made by local companies and more than 20 drug manufacturers are functional in the country. However, no Mongolian manufacturing company strictly follows the good manufacturing practices and some of the manufacturers do not even have quality control units (Anonymous, 1999).

Traditional medicine is still in the developmental stages as compared to western medicine. The Traditional Medical Science, Technology and Production Corporation and Manba Datsan clinic have small herbal medicine factories which produce traditional medicines to be used at domestic level. The WHO supports the use of traditional medicine methods in Mongolia which fulfil the criteria of safety and effectiveness. However, information on the production and consumption of traditional medicine and medicinal and aromatic plants is unavailable at present.

Problems and Constraints

Traditional medicine has only been renewed in the 1990s. Lack of experienced persons, medicinal plant resources and funds for R&D are some of the major factors that affect the proper utilization and development of traditional medicine in Mongolia.

Table 1: Some medicinal and aromatic plants found in Mongolia

Botanical name	Family	Uses/Indications
Aconitum barbatum Pergs.	Ranunculaceae	In various illnesses
Berberis sibirica Pall.	Berberidaceae	In jaundice, scurvy
Bupleurum bicaule Helm	Apiaceae	In kidney, stomach problems
Cirsium esculentum C.A. Mey.	Asteraceae	In heart, kidney problems
Delphinium grandiflorum L.	Ranunculaceae	In sinusitis, stomach problems
Dianthus superbus L.	Caryophyllaceae	In blood pressure
Dianthus versicolor Fisch. ex Link.	Caryophyllaceae	In haemorrhage
Gentiana macrophylla Pall.	Gentianaceae	Blood related illnesses
Juniperus sabina L.	Cupressaceae	In urinary problems
Oxytropis pseudoglandulosa Gontsch. ex Grubov.	Fabaceae	As anti-bacterial, in blood problems
Polygonum alopecuroides Turcz. Turcz. Ex Meinssh.	Polygonaceae	In stomach problems
Rhodiola rosea L.	Crassulaceae	In giddiness
Schizonepeta multifida (L.) Briq.	Lamiaceae	In various illnesses
Tanacetum vulgare L.	Asteraceae	In stomach problems

1.6 Republic of Korea

The Republic of Korea occupies the southern portion of the Korean Peninsula. It is bounded to the north by the Democratic People's Republic of Korea, the East Sea (Sea of Japan) to the east, the Korean Strait to the southeast and south, and to the west by the Yellow Sea. The Republic of Korea has a total area of 98,480 square kilometres and a population of about 48 million people. The diverse climatic conditions, that is the subtropics in the southern coastal area and the frigid high land zone in the northern mountains make the country's flora diverse and specific compared to those of surrounding countries. The forests make up 65% of total land mass and are the abode of many important medicinal and aromatic plant species. However, since the early 20th century, more than half of the forests have been destroyed by the Japanese, the Korean War and other social disturbances. Many of the native plant species of the country have been destroyed and threatened as a result of the expansion of agriculture, settlements, military activities and illegal collection of plants for medicinal purposes. Traditional medicine is

popular among the people especially the rural population and is supported by national Medicare-Insurance policy.

Traditional Medicine Systems

Traditional Korean medicine has been used for thousands of years. Only traditional Korean medicine was available for the treatment of various diseases and health care of the people before modern allopathic medicine was introduced by missionaries from the United States and Canada in the late 19th century (Hann, 1999).

Traditional medicine is known as oriental medicine in the Republic of Korea. The oldest reference of their use in the country dates back to the Gochosun period i.e. about 4,332 years ago. This medicine system was faded out during the Japanese colonial period leading up to 1945. Oriental medicine was revitalised after the end of the Second World War and is gaining popularity today. Acupuncture and herbal remedies are commonly used in Rep. Korea (WHO, 2001). Although Traditional Korean Medicine was influenced by TCM, it has developed its own unique way of diagnosis and treatment. At present there are many attempts of experimentation on fusion medicine, which combines traditional remedies with modern medicine. There are about 4,000 registered herbal medicines, 515 herbal medicines are included in the national essential drug list issued in 1959 (WHO, 2005).

Government Efforts in Development of Traditional Medicine

The Rep. Korea government recognizes both traditional and western medicines in its national medical system. The Civil Medical Treatment Law in 1951 established a dual system of medical treatment comprised of oriental and allopathic medicine. In the Rep. Korea a system of cooperation between oriental and western medicine doctors has however not yet been established.

In 1993, the Oriental Medicine Division was established and upgraded to the Oriental Medicine Bureau in November 1996 with two of its own divisions. It works on policy planning, research support and the administration of oriental medicine in the country. The Bureau also emphasizes the importance of quality control in manufacturing and distributing oriental medicines through licensing. An advisory council on oriental medical policy was established in the Ministry of Health and Welfare in 1993. Doctors of oriental medicine are allowed to provide medical services including acupuncture and moxibustion; however, they are not allowed to use western medical instruments such as X-rays and modern pathological tests. Under the Medical Affairs Act, only acupuncturists holding a licence are allowed to practise (WHO, 2001).

Formal education and training in oriental medicine were started in 1964. The

curriculum of a six-year college course includes basic medical sciences such as biochemistry, microbiology, and physiology, etc. as well as Chinese and Korean medicine. After completion of college education, graduates have to take a national examination in order to receive an oriental medical doctor's licence. Under the Pharmaceutical Affairs Law (1994), pharmacists must pass the national oriental medicine exam in order to practise oriental herbal therapy with limited numbers of formulae (a total of 100 herbal formulae are allowed). In 1996, the government approved the establishment of oriental pharmacy departments at several universities. The oriental medical college of Kyung-Hee University has produced 4,053 graduates since February 2000 (Anonymous, 2003), and is followed by the oriental college of Won-Kwang University.

Traditional Korean medicine was included in the national medical insurance of the Republic of Korea on 1 February 1987 (Son, 1998). At present the country has 107 oriental medical hospitals, 6,590 oriental medical clinics, 9,914 oriental medical doctors and small numbers of acupuncturists in tandem. However, the licence examination for acupuncturists is no longer available as oriental medical doctors practise both acupuncture and herbal therapy. The education system for oriental medicine in the Republic of Korea was established in 1964. The acupuncturist and herbalist systems were introduced as an auxiliary to regular medical practice and the clinics were usually opened in remote areas where allopathic medicine services were unavailable; however, this system is no longer functional. There are about 10,000 members of the Korean Oriental Medical Association (KOMA), the central organization of herbal doctors in the Republic of Korea (WHO, 2001).

Since 1991 the Republic of Korea government has imposed strict regulations on herbal medicine preparations including Korean traditional medicines produced by domestic pharmaceutical companies. They are required to comply with the Korean Good Manufacturing Practice standards in the management of the manufacturing processes, quality control and handling of herbal medicines. The Korean Food and Drug Administration encourage and support the development of new drugs derived from traditional herbal medicines. Oriental medicine is prepared in accordance with the formulae described in eleven oriental medical classics published in the Republic of Korea and China. The government has permitted their manufacture without submission of any clinical or animal toxicity data by the manufacturers. The monographs on each herbal medicine are included in the *Korean Pharmacopoeia* and *Korean Herbal Pharmacopoeia* published by the Korean Food and Drug Administration (Choi *et al.*, 2002).

Medicinal and Aromatic Plant Resources

Korea has great diversity in medicinal plant resources. There are about 4,500 kinds of naturally growing plants, which include 3,400 species and 762 varieties. There

are about 2,000 medicinal plants growing in the wild and/or cultivated of which about 300 are currently being used in herbal medicines. The major cultivated medicinal plants in the Republic of Korea include *Angelica gigas* Nakai (Korean angelica), *Astragalus membranaceus* (Fisch. ex Link) Bunge (Astragalus root), *Bupleurum falcatum* L. (Bupleuri root), *Cornus officinalis* Sieb. et Zucc. (Corni fruits), *Eucommia ulmoides* Oliv. (Eucommia bark), *Ginkgo biloba* L. (Ginkgo leave and fruits), *Lycium chinense* Mill. (Lycii fruits), *Paeonia lactiflora* Pall. (Peony root), *Panax ginseng* Meyer (Ginseng root) and *Platycodon grandiflorum* (Jacq.) A. DC. (Platycodon root). Unsustainable harvesting of medicinal plant resources has resulted in extinction of most of the species (Choi *et al.*, 2002). Some medicinal and aromatic plant species found in the country are listed in Table 1 (Lee *et al.*, 2000; Han *et al.*, 2001; Kim *et al.*, 2000).

Research and Development Activities

Korean scientists have studied a number of herbal medicinal plants grown either in the Republic of Korea or in other countries. Scientific research has been focused mainly on four priority areas:

- Identification of useful medicinal plants;
- Isolation of pharmacologically active constituents;
- Establishment and validation of quality standards; and
- Establishment of safety and efficacy of Korean traditional herbal medicines based on the concepts of modern medical science.

The studies on the constituents from 260 Korean medicinal plants were carried out during the last century. Among the 2,367 isolated constituents 391 compounds turned out to be new active constituents (Choi *et al.*, 2002).

The Crop Experiment Stations and Provincial Rural Development Administrations (RDA) and Agricultural College of Seoul National University carry out research work on breeding and cultivation of medicinal plants of the country. The Department of Medicinal Crops in Crop Experiment Station has published a booklet entitled "Survey for Growth Characteristics of Medicinal Crops" containing information on naturally grown medicinal plants of Korea. During the studies, 563 medicinal plants were collected of which 242 species were evaluated for their growth characteristics, 15 cultivars for 9 crops were bred and 13 medicinal crops were developed for the farmers. In order to obtain seeds of important medicinal crops, the mass propagation through tissue culture technique were used mainly for *Cornus officinalis* Sieb. et Zucc., *Bupleurum falcatum* L. and some other medicinal plant species (Seong and Yeon, 1993).

The World Health Organization (Western Pacific Regional Office) has published a book entitled *Medicinal Plants in the Republic of Korea* in collaboration with the

Natural Products Research Institute, Seoul National University. It contains 150 monographs along with the photographs of the most commonly used medicinal plant species in the Republic of Korea. The book provides information on scientific names of the plants, Korean names, parts used, botanical description of the plants, their habitat and geographical distribution, biological actions, clinical uses and chemical components (WHO, 1998). The mineral contents of 13 medicinal plants listed in the Standard Codes of Herbal Medicines have also been studied by the Division of Food Standards of Korea (Han *et al.*, 2001). Additional achievement on the information of traditional oriental herbal therapy was made with the support of the Ministry of Science and Technology, Republic of Korea. Since 1992 a comprehensive database TradiMed DB (Korean, Japanese, and in late 2004 an English version) has been constructed. It contains more than 12,000 herbal formulae, botanical information with colour photographs of 3,000 herbal materials, 3D chemical structures of about 20,000 natural constituents, about 8,000 disease classifications in both oriental and western medicinal terms and traditional processing methodology of about 600 herbal materials (www.tradimed.com).

Trade and Marketing

Since 1993 it has been possible to legally distribute standardized herbal medicines in the Republic of Korea. The total number of herbal medicines used in the country is 514 of which 130 are listed in the *Korean Pharmacopoeia* and 384 in the *Korean Herbal Pharmacopoeia*. The export of herbal medicines from the Republic of Korea increased from US$0.8 million in 1999 to US$7.4 million in 2000 while there was only a marginal increase in imports from almost US$79.0 to 80.6 million in the same period. The amomum fruits (*Amomum villosum* Lour.), arillus fruits (*Euphoria longan* (Lour.) steud.), cinnamon bark (*Cinnamomum verum* J. Presl), cornus fruits (*Cornus officinalis* Sieb. et Zucc.), licorice roots (*Glycyrrhiza glabra* L.), pinellia tubers (*Pinellia ternata* (Thunb.) Breit.), polygala roots (*Polygala tenuifolia* Willd) and white atractylodes rhizomes (*Atractylodes macrocephala* Koidz.) were some of the major herbs imported into the Republic of Korea in 2000. The herb import values and the production of some cultivated herbs are listed in Table 2 and 3 respectively (Choi *et al.*, 2002).

Problems and Constraints

There is a need to undertake scientific studies for most of the herbal medicines used in the country. The decoction process which is generally used for Korean herbal medicine preparations results in various interactions among the constituents thus making the quality control of these medicines difficult compared to western herbal drugs.

Government policy makers also face problems because of the independent existence of Korean and western medicines in the country and the ongoing conflicts between the practitioners of the two systems. The deforestation for timber, fuel and unsustainable harvesting methods have endangered and resulted in depletion of the natural resources of medicinal plants.

Table 1: Some of the medicinal and aromatic plants found in the Republic of Korea

Botanical name	Family
Aconitum carmichaelii Debeaux	Ranunculaceae
Aconitum jaluense Kom.	Ranunculaceae
Agrimonia coreana Nakai	Rosaceae
Anemarrhena asphodeloides Bunge	Anemarrhenaceae
Angelica dahurica (Fisch.) Benth. & Hook. f. ex Franch. & Sav.	Apiaceae
Angelica gigas Nakai	Apiaceae
Aralia continentalis Kitag.	Araliaceae
Arctium lappa L.	Asteraceae
Asarum sieboldii Miq.	Aristolochiaceae
Astragalus membranaceus (Fisch. ex Link) Bunge	Fabaceae
Atractylodes japonica Koidz. ex Kitam.	Asteraceae
Beckmannia syzigachne (Steud.) Fern.	Poaceae
Belamcanda chinensis (L.) DC.	Iridaceae
Bupleurum falcatum L.	Apiaceae
Cassia obtusifolia L.	Fabaceae
Cinnamomum cassia auct.	Lauraceae
Citrus aurantium L.	Rutaceae
Clematis florida Thunb.	Ranunculaceae
Codonopsis pilosula (Franch.) Nannf.	Campanulaceae
Coptis japonica (Thunb.) Makino	Ranunculaceae
Cornus officinalis Siebold & Zucc.	Cornaceae
Crataegus maximowiczii C. K. Schneid.	Rosaceae
Curcuma longa L.	Zingiberaceae
Ephedra sinica Stapf	Ephedraceae
Epimedium koreanum Nakai	Berberidaceae
Equisetum hyemale L.	Equisetaceae
Eucommia ulmoides Oliv.	Eucommiaceae
Euonymus japonica Thunb.	Celastraceae
Gastrodia elata Blume	Orchidaceae
Gynura japonica (Thunb.) Juel	Asteraceae
Imperata cylindrica (L.) P. Beauv.	Poaceae
Kochia scoparia (L.) Schrad.	Chenopodiaceae
Ledebouriella seseloides (Hoffm.) H. Wolff	Apiaceae

Continued

Table 1 continued

Botanical name	Family
Ligusticum jeholense (Nakai & Kitag.) Nakai & Kitag.	Apiaceae
Liriope platyphylla F. T. Wang & T. Tang	Liliaceae
Lithospermum erythrorhizon Siebold & Zucc.	Boraginaceae
Lycium chinense Mill.	Solanaceae
Paeonia albiflora Pall.	Paeoniaceae
Paeonia japonica (Makino) Miyabe & Takeda	Paeoniaceae
Panax ginseng C. A. Mey.	Araliaceae
Phellodendron amurense Rupr.	Rutaceae
Platycodon grandiflorum (Jacq.) A. DC.	Campanulaceae
Pueraria lobata (Willd.) Ohwi	Fabaceae
Rehmannia glutinosa (Gaertn.) Steud.	Scrophulariaceae
Rheum undulatum L., nom. illeg.	Polygonaceae
Rhus chinensis Mill.	Anacardiaceae
Rubus coreanus Miq.	Rosaceae
Scirpus maritimus L.	Cyperaceae
Scrophularia buergeriana Miq.	Scrophulariaceae
Scrophularia oldhamii Oliv.	Scrophulariaceae
Scutellaria baicalensis Georgi	Lamiaceae
Sinomenium acutum (Thunb.) Rehder & E. H. Wilson	Menispermaceae
Torilis japonica (Houtt.) DC.	Apiaceae
Vitex rotundifolia L. f.	Verbenaceae

Table 2: Major imported herbal medicines in the Republic of Korea in 2000

Herbal medicines	Amount (US$10,000)
Atractylodes rhizome white, Cinnamon bark, Licorice root, Longan arillus, Pinellia tuber	More than 100
Bupleurum root, Coptis rhizome, Cornus fruit, Polygala root	50-90
Amomum cardamomum fruit, Aurantii fruit, Magnolia bark, Platycodon root, Safflower, Saussurea root	20-40
Achyranthes root, Asiasarum root, Asparagus tuber, Codonopsis Pilosulae root, Dioscorea rhizome, Lindera root, Liriope tuber, Pueraria root	10-20

Table 3: Production values of some cultivated herbs of the Republic of Korea

Herbal medicine	Botanical name	Production values (tonnes)				
		1990	1992	1994	1996	1998
Korean angelica	*Angelica gigas* Nakai	2623	3243	5305	3749	3022
Astragalus root	*Astragalus membranaceus* (Fisch. ex Link) Bunge	2739	2530	3115	3750	2399

Continued

Table 3 continued

Herbal medicine	Botanical name	Production values (tonnes)				
		1990	1992	1994	1996	1998
Eucommia bark	*Eucommia ulmoides* Oliv.	174	385	1366	2680	2652
Peony root	*Paeonia lactiflora* Pall.	3360	5808	5272	3877	2026
Platycodon root	*Platycodon grandiflorum* (Jacq.) A. DC.	4202	4901	4389	5396	3006

Table 4: Leading medicinal and aromatic plants of the Republic of Korea

Botanical name	Chemical constituents	Uses/Indications	Part(s) used	Comments
Bupleurum falcatum L.	Saiko-saponins	As hepato-tonic, in fever, apoplexy.	Roots	Cultivated, used domestically for preparation of drugs, health foods and raw materials
Cornus officinalis Siebold & Zucc.	Iridoids, lectins, tannins	As tonic, in liver protection, arthritis, impotence.	Fruits	Cultivated, domestic use
Ginkgo biloba L.	Phenolics, ginkgolides, flavonoids, biflavonoids	To improve blood disorders, in asthma, cough, dementia,	Seeds, leaves	Cultivated, domestic use
Panax ginseng C. A. Mey.	Saponins, ginsenosides sesquiterpenes, phenols,	As anticancer, tonic, in diabetes, weakness, alcoholism	Roots	Cultivated, exported (US$80 millions)
Platycodon grandiflorum (Jacq.) A. DC.	Saponins, polyacetylenes	In hypertension, diabetes, cough, as expectorant.	Roots	Wild as well as cultivated, domestic use

Photographs of some leading medicinal and aromatic plants of the Repulic of Korea

Bupleurum falcatum L. & *Cornus officinalis* Siebold & Zucc.

Ginkgo biloba L. & *Panax ginseng* C. A. Mey.

1.7 Taiwan Province of China

Taiwan province is a group of islands located on the Western Pacific rim, facing mainland China on the west, Japan to the north and the Philippines and Indo-Malayan islands to the south. The area of Taiwan province is about 35,980 square kilometres and it has a population of about 22 million. Its location, along with a diversified climate and a high range of mountains, support a diverse flora including many species of medicinal plants. The forest cover of Taiwan province is estimated to be about 52% and the government has established six national parks to preserve the natural resources. Intensive agricultural and industrial development has however, severely affected the country's natural environments and medicinal and aromatic plant resources. Traditional Chinese and herbal medicine are very popular and form an integral part of the national health care system.

Traditional Medicine Systems

TCM was introduced in Taiwan by Chinese immigrants in the 16th century. Since then Chinese medicine practitioners have been providing various forms of medical services to the Taiwanese population. After the Japanese takeover of the country in 1895, allopathic medicine was regarded as the main health system by the government, yet local people continued to rely on TCM. Throughout the Japanese rule (1895-1945) allopathic medicine was promoted resulting in the decline of the role of Chinese medicine in the national health care system. However, with the Chinese takeover of Taiwan in 1945, TCM started to flourish and now coexists with allopathic medicine (Chi *et al.*, 1996).

Government Efforts in Development of Traditional Medicine

TCM was officially made part of the Taiwanese national health care programme on 1 March 1995. The Taiwan provincial government has made considerable efforts to modernize Chinese medicine. The Committee on Chinese Medicine and Pharmacy (CCMP) is the main research body specializing in TCM. Five types of Chinese medicine practitioners including Chinese Medicine Physicians (CMP), Chinese Medicine Pharmacist (CMPharm), Chinese Medicine Registered Nurse (CMRN), Chinese Medicine Nurse (CMN) and Chinese Medicine Physician's Aid (CMPA) are officially recognized in Taiwan province. Except for the CMPA, all personnel are licensed by the National Department of Health (Chi *et al.*, 1996).

The China Medical College Hospital offers a seven-year programme in Chinese medicine and a four-year post-baccalaureate programme to train modern Chinese medicine doctors. In 1998, Chang Gung University also started a seven-year programme of Chinese medicine. In order to qualify as a Chinese medicine doctor, a candidate has

to take the national examination offered by the Education Department. Non-Chinese candidates have to pass another special examination and undergo eight months of training in basic medical sciences followed by ten months of clinical practice to be certified as a Chinese medicine doctor. The Taipei Municipal Chinese Medical Hospital and the Kaohsiung Municipal Chinese Medicine Hospital were established to promote the development of Chinese medicine. The teaching hospitals are encouraged to set up affiliated departments of Chinese medicine. There are only two medical schools with TCM departments for formal training and 42 teaching hospitals with departments of Chinese medicine in Taiwan province at present. In December 2000, the number of licensed Chinese medicine doctors practising in Taiwan province was 3,733 with 2,513 Chinese medical hospitals and clinics in the country. Treatment with Chinese medicine is covered by the National Health Insurance programme (Anonymous, 2002).

Medicinal and Aromatic Plant Resources

Taiwan province with its subtropical climate, diverse topography and great variations in altitude is home to a diverse flora of over 4,000 vascular plant species. About 1,500 plants have been reported to have medicinal properties (Anonymous, 1996).

Many valuable medicinal plants and herbs are reported to be found in the central mountain ranges of Taiwan province. However, the indiscriminate collection of these plants in large quantities to meet the increasing needs of traditional crude drugs has threatened many species with extinction. The collection of plants from national parks created for the protection of natural biodiversity has been declared illegal. Some of the medicinal and aromatic plants found in Taiwan province and used in TCM are listed in Table 1 (Nalawade *et al.*, 2003).

Research and Development Activities

Research on medicinal and aromatic plants in Taiwan province is proceeding under the auspices of the Academia Sinica and the National Science Council (NSC) and is being conducted at various medical schools. The NSC has been promoting research on TCM plants since 1988 with the main emphasis on the collection of information about important and rare traditional medicinal herbs, the development of simple methods for their identification and techniques for mass propagation of medicinal plants through tissue culture, the study of their active principles and pharmacology for safer use, and to promote export. Taiwan Agricultural Research Institute and Chaoyang University of Technology have carried out research on in vitro mass propagation of some important medicinal plants of Taiwan (Nalawade *et al.*, 2003).

Considerable research on acupuncture and other Chinese medical practices is also

being carried out. A number of research projects has been carried out to evaluate the effects of Chinese medicine and acupuncture on various types of illnesses. The China Medical College has undertaken studies on the effects of Chinese medicine and acupuncture on various chronic diseases including hepatitis, nephrosis and sciatica. Chinese herbal remedies for diseases such as systemic lupus erythematosus, intestinal ulcers and bronchial asthma have also been developed. The Committee on Chinese Medicine and Pharmacy sponsored 339 research projects on Chinese medicine during the period 1996-2001. Three books: *The Quality Control of Chinese Medicine, A Compilation of Medical Fauna Used by Aborigines in Taiwan* and *The Treatment of Osteoporosis with Chinese Medicine* were published as a result of these efforts. The Department of Health and the China Medical College studied the distribution and cultivation of medicinal plants in the Taiwan area. With the assistance of agriculture and forestry agencies, some rare medicinal plants of high economic value have been cultivated on a trial basis. The Kaohsiung Medical College and the China Medical College are assigned to evaluate and assess the efficacy of the available Taiwan-grown herbs to establish a database on raw materials for Chinese medicine. In July 1990 a programme to standardize some 337 Chinese medicine prescriptions was started and about 200 prescriptions were standardized for use by June 2000 (Anonymous, 2002).

Trade and Marketing

During the period 1992 to 1997, Taiwan province ranked fifth in world imports of medicinal and aromatic plants, after Hong Kong, Japan, USA and Germany. A recent TRAFFIC, joint programme of World Wide Fund for Nature (WWF) and the World Conservation Union (IUCN), study revealed that Taiwan province is a major market for agarwood. Most of the agarwood imported into Taiwan province is used for medicinal purposes and the manufacture of incense (Anonymous, 2000).

The term pharmaceuticals in Taiwan province refers to both allopathic and traditional Chinese herbal medicines. There are 9,217 licensed dealers of herbal medicines, roughly 250 registered herbal medicine producers and 280 registered Western medicine manufacturers in the country. Taiwan province's pharmaceutical industry grossed US$2.52 billion in sales in 2000. Imports of pharmaceuticals account for about 70% of the Taiwanese market with about 25% from the USA. Domestic sales of pharmaceuticals were expected to reach US$3 billion by 2003 (Anonymous, 2002).

Problems and Constraints

The Taiwan province pharmaceutical industry is largely dependent on forests for the supply of raw materials. Due to lack of proper cultivation practices, habitat destruction of medicinal plants and illegal and unsustainable collection of these plants from

their natural habitat, many of them are severely threatened. Lack of market information and long-term international marketing plans are some other major problems faced by the Taiwanese pharmaceutical industry.

Table 1: Some important medicinal and aromatic plants of Taiwan province

Botanical Name	Family
Aconitum carmichaelii Debeaux	Ranunculaceae
Adenophora triphylla (Thunb.) A. DC.	Campanulaceae
Alpinia galanga (L.) Sw.	Zingiberaceae
Angelica acutiloba (Siebold & Zucc.) Kitag.	Apiaceae
Angelica sinensis (Oliv.) Diels	Apiaceae
Anoectochilus formosanus Hayata	Orchidaceae
Aralia cordata Thunb.	Araliaceae
Artemisia annua L.	Asteraceae
Astragalus membranaceus (Fisch. ex Link) Bunge	Fabaceae
Atractylodes japonica Koidz. ex Kitam.	Asteraceae
Atractylodes lancea (Thunb.) DC.	Asteraceae
Atractylodes ovata (Thunb.) DC.	Asteraceae
Bupleurum falcatum L.	Apiaceae
Bupleurum scorzonerifolium Willd	Apiaceae
Camptotheca acuminata Decne.	Cornaceae
Cnidium officinale Makino	Apiaceae
Coptis japonica (Thunb.) Makino	Ranunculaceae
Coriandrum sativum L.	Apiaceae
Corydalis ambigua Cham. & Schltdl.	Fumariaceae
Corydalis pallida (Thumb.) Pers.	Fumariaceae
Corydalis yanhusuo (Y. H. Chou & Chun C. Hsu) W. T. Wang	Fumariaceae
Cuminum cyminum L.	Apiaceae
Curculigo orchioides Gaertn.	Hypoxidaceae
Curcuma longa L.	Zingiberaceae
Dendrobium linawianum Rchb. f.	Orchidaceae
Digitalis lanata Ehrh.	Scrophulariaceae
Dioscorea bulbifera L.	Dioscoreaceae
Dysosma pleiantha (Hance) Woodson	Berberidaceae
Foeniculum vulgare Mill.	Apiaceae
Fritillaria thunbergii Miq.	Liliaceae
Fritillaria unibracteata P. K. Hsiao & K. C. Hsia	Liliaceae
Gardenia jasminoides J. Ellis	Rubiaceae
Gentiana crassicaulis Duthie	Gentianaceae
Gentiana lutea L.	Gentianaceae
Gentiana scabra Bunge	Gentianaceae

Continued

Table 1 continued

Botanical Name	Family
Gentiana triflora Pall.	Gentianaceae
Gentiana triflora Pall. G. triflora x G. Scabra	Gentianaceae
Glehnia littoralis F. Schmidt ex Miq.	Apiaceae
Glycyrrhiza glabra L.	Fabaceae
Holarrhena antidysenterica (Roxb. ex Fleming) Wall. ex A. DC.	Apocynaceae
Houttuynia cordata Thunb.	Saururaceae
Hyoscyamus niger L.	Solanaceae
Isatis indigotica Fortune	Brassicaceae
Kaempferia galanga L.	Zingiberaceae
Linum usitatissimum L. var. humile (Mill.) Pers.	Linaceae
Lithospermum erythrorhizon Siebold & Zucc.	Boraginaceae
Lonicera tatarica L.	Caprifoliaceae
Macleaya cordata (Willd.) R. Br.	Papaveraceae
Mentha spp.	Lamiaceae
Murraya koenigii (L.) Spreng.	Rutaceae
Panax ginseng C. A. Mey.	Araliaceae
Panax japonicus C. A. Mey.	Araliaceae
Panax notoginseng (Burkill) F. H. Chen ex C. Y. Wu & K. M. Feng	Araliaceae
Papaver bracteatum Lindl.	Papaveraceae
Papaver somniferum L.	Papaveraceae
Pinellia ternata (Thunb.) Makino	Araceae
Piper longum L.	Piperaceae
Platycodon grandiflorum (Jacq.) A. DC.	Campanulaceae
Pleione formosana Hayata	Orchidaceae
Plumbago zeylanica L.	Plumbaginaceae
Podophyllum peltatum L.	Berberidaceae
Rehmannia glutinosa (Gaertn.) Steud.	Scrophulariaceae
Rheum emodi Wall. ex Meisn.	Polygonaceae
Rheum rhaponticum L.	Polygonaceae
Ruta graveolens L.	Rutaceae
Saposhnikovia divaricata (Turcz.) Schischk.	Apiaceae
Saussurea lappa (Decne.) C. B. Clarke	Asteraceae
Scopolia japonica Maxim.	Solanaceae
Scutellaria baicalensis Georgi.	Lamiaceae
Stevia rebaudiana (Bertoni) Bertoni	Asteraceae
Vitex negundo L.	Lamiaceae
Yushania niitakayamensis (Hayata) Keng f.	Poaceae
Zingiber officinale Roscoe	Zingiberaceae
Zingiber zerumbet (L.) Sm.	Zingiberaceae

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Chapter 2

Southeast Asia

2.1 Introduction

Southeast Asia includes Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, Singapore, Thailand, Timor-Leste and Viet Nam. It covers an area of 4,000,000 square kilometres and is has the population of more than 550 million (as of 2004), of which about a fifth (110 million) live on the Indonesian island of Java.

Southeast Asia is home to the most extensive areas of tropical rainforest apart from Central and South America. However, much of the forest is under threat from logging, clearing for agriculture and dam building. Current rates of deforestation suggest that most of the rainforest will be gone from Malaysia and Indonesia within 20 years.

Indonesia is one of the world's top two mega biodiversity centres together with Brazil with around 25,000 to 30,000 flowering plant species, about 10% of which is estimated to have medicinal value. Indonesia's traditional Jamu system of medicine is the oldest, best understood and most widespread system that relies on medicinal plants collected largely from the wild (Erdelen *et al.*, 1999). It is estimated that over 80% of the Indonesian population depends on traditional medicine to meet their primary health care needs (Plotkin, 1999). Malaysia is among the world's top 12 biodiversity rich countries where Ayurveda, Siddha, traditional Chinese, traditional Malay, Unani and other traditional systems of medicine are commonly practised. The indigenous medicinal system of Malaysia, the traditional Malay medicine has been influenced by the medicine practices of Arabia, India, Java and those practised by numerous aboriginal races. The Philippines traditional medicine system also has common roots with other traditional healing methods in Southeast Asian countries including Burma, Cambodia, Indonesia, Laos, Malaysia, Thailand, Viet Nam and outlying islands. In general the traditional medicine systems of the region have been greatly influenced by those practised in the neighbouring regions especially of East and South Asia, mainly that of China and India. There is potential of commercial exploitation of the region's medicinal and aromatic plant resources to enhance the social and health status of its people.

2.2 Brunei Darussalam

Brunei Darussalam is situated on the northwest coast of the island of Borneo. It is bordered by the South China Sea in the north and on all other sides by the Malaysian state of Sarawak. The total land area of Brunei is about 5,770 square kilometres with a population of about 0.35 million people. The country has large areas of natural forests covering more than 80% of the land area. These forests are the source of many valuable species of medicinal and herbal plants. The Brunei forests because of their richness in plant diversity and well-preserved conditions can be exploited for their socio-economic values including potentially valuable medicinal, aromatic and other plants but have largely been kept free from commercial exploitation by the government.

Traditional Medicine Systems

The health care services provided by the Brunei government are based on allopathic medicines. However, for many years Bruneians have been using various plant species for the preparation of traditional medicine. Herbal remedies have remained as part of the folklore especially among the rural communities and are still used in the country. Many people still believe in traditional medicine while others opt for a combination of both modern and traditional medicine (Anonymous, 2004). These medicines are derived from medicinal plants, which are widely available in Brunei rainforests. Indonesian traditional medicine, Jamu has also been used in Brunei.

Government Efforts in Development of Traditional Medicine

The Public Health Services division of the Ministry of Health is responsible for providing community based preventive and promotive primary health care services in the country. The Brunei government provides free medical and health care services to its people via hospitals, health centres and clinics. In remote areas, primary health care is provided by the Flying Medical Services.

A traditional Chinese medicine expert was invited from Australia recently to work with the World Health Organization in Brunei on a project for the Ministry of Health to develop safe and effective traditional medicine services, assist the Ministry to formulate a national policy for traditional medicine, recommend appropriate standards, assess current uses, patterns and safe practices of traditional medicine and advise on the possible integration of proven traditional medicine into the mainstream health services of the country (Anonymous, 2003).

Medicinal and Aromatic Plant Resources

Brunei possesses a considerable diversity of plant species that offers immense

potential. Various herbs commonly grow wild in gardens, on roadsides and in forests. Medicinal and aromatic plants can be exploited commercially and could support industrial development to produce pharmaceuticals, flavouring, perfumery and cosmetic industries. There is no commercial scale cultivation of medicinal plants in the country and medicinal and related materials are generally collected from forests.

About 5,000 native plant species consisting of trees, shrubs and medicinal plants are found in Brunei's tropical rainforests but most of these have not yet been identified scientifically. Some important plants including *Costus speciosus* (J. Konig) Sm. (used in new born baby baths), *Curculigo latifolia* W. T. Aiton (used to cure headaches and thrush in the mouth), *Dianella ensifolia* (L.) DC. (a remedy for jaundice), *Eurycoma longifolia* Jack (remedy to lower high blood pressure), *Gendarussa vulgaris* Nees (used as herbal bath after childbirth), *Morinda citrifolia* L. (used in spleen problems) and *Zingiber purpureum Roscoe* (a traditional remedy to relieve fever in children), have been cultivated in gardens for conservation (Anonymous, 2004).

The pepper species are used medicinally for their curative properties. *Piper abbreviatum* Opiz, *Piper canimum* Blume, *Piper muricatum* Blume and *Piper poryphyrophyllum* N.E.Br. are some of the species reported in Brunei whereas many have not been identified as yet (Tawan *et al.*, 2002). Brunei was long known in early times as a source of superior quality camphor recognized for its medicinal properties. It is derived from the trunk of *Dryobalanops aromatica* C. F. Gaertn. tree, which is found naturally in Brunei forests.

Research and Development Activities

An Association of South-East Asian Nations (ASEAN)-Australian collaboration project on the development of therapeutically and biologically important substances from plants in was started in 1989. The project extended over five years and resulted in the establishment of a herbal and spice garden in Birau and the publications *Medicinal Plants of Brunei Darussalam-Part I and II*, which provide detailed descriptions of the plants, their therapeutic values and traditional usages in folk medicines. The phytochemical evaluation of these plants was carried out at Brunei Agricultural Research Centre (BARC). The Centre is still engaged in collection and identification of medicinal plants of the country (Sulaiman, 2003).

The government gives high priority to biotechnology in recognition of its potential to enhance the role of agriculture and foster links with industries. BARC focuses its research activities on management of the country's bioresources, exploration and evaluation of indigenous medicinal plants and the development of crops through tissue culture.

The Department of Agriculture has conducted a study and exploration of the potential of the country's botanical heritage and has made concerted efforts to collect,

propagate and document the uses of the herbal products of the country. Various medicinal plant species have been planted in gardens for their conservation. The Department is at present looking for other options of producing herbal medicine in capsule form and its marketing (Anonymous, 2004).

Trade and Marketing

Brunei is a small country with no pharmaceutical industry of its own. Almost all the pharmaceutical needs are imported from neighbouring countries. At present it is trying to promote and commercialize its medicinal and aromatic plants and other non-wood forest products. The cultivation and processing of medicinal plants, herbs and spices has been included in the list of priority industries in the investment guide of the country.

The Jamu medicines are imported from Indonesia; however, recently the Ministry of Health has banned some of these medicines due to the presence of poisonous substances in them. The exact volumes of consumption of medicinal and aromatic plant and their products are not available.

Problems and Constraints

The shortage of trained work force, relatively small areas of forest and countryside, lack of scientific information and research related to identification and characterization of medicinal and aromatic plants of the country and lack of production facilities for herbal medicine are the major constraints in the commercial exploitation of country's natural medicinal and aromatic plant resources.

Table 1: Leading medicinal and aromatic plants of Brunei Darussalam

Botanical name	Chemical constituents	Uses/Indications	Part(s) used	Comments
Andrographis paniculata (Burm.f.) Nees	Andrographolide, lactones	In diabetes, high blood pressure, skin irritation and insect bites	Leaves	Sometimes grown in pots or in gardens for medicinal uses
Angiopteris evecta (Forst.) Hoffm.	Volatile oil	In piles, boils, difficulty in urination, headaches, skin eczema, irritation	Stalk, stipules	Grown near streams in undisturbed forests in the lowlands
Centella asiatica (L.) Urb.	Triperpenoids	In urinary tract infection, stones	Leaves	Grown on wet grounds near drains and bunds, cultivated also in gardens
Kaempferia galanga L.	Anisic acid, camphene, cineol, paraceumarin, borneol	In aching joints, flavouring, tonic	Rhizomes	Often cultivated in gardens and sold on the local markets
Piper betle L.	Phenols, eugenol, chavibetol, caryophyllene, cadinene, cineol, menthone	To relieve stomachache, as anti-bacterial	Leaves	Commonly grown in backyard or home gardens

2.3 Cambodia

Cambodia is bordered by Thailand to the west, Laos to the north and Viet Nam to the east. It covers an area of 181,035 square kilometres. About 90% of the 12.8 million people of Cambodia are Khmer and the rest are Vietnamese, Chinese, Charms, Burmese, Thai and small minorities of hill tribes. The central part of Cambodia has fertile plains with mountainous ranges forming a natural boundary with Thailand. The Cardamom Mountains are in the west, the Elephant Mountains in the southwest and the Dangrek Mountain ranges in the northern part of the country. Up until now these mountain ranges have been densely covered with forests. Almost 50% of the land area is under forest cover; with about 20% of the land area under legal conservation protection, however, illegal logging and cross-border log smuggling are significant problems. The overall deforestation rate is close to 2% per year. Almost 85% of the population of Cambodia lives in rural areas, where agricultural production is the main livelihood. The forests provide an important source of non-commercial timber, fuel wood, rattans, bamboo, resin, wax and medicinal and aromatic plants that rural people rely on to meet their basic needs. However, their ability to meet these basic needs is at risk, as unregulated logging and industrial developments threaten these natural resources and forest sustainability. Inappropriate management and monitoring of enourmous forest concession areas to investors causing serious concern to the survival of several medicinal and aromatic plants on the ground. Furthermore, the population in these areas moves and conducts 'slash and burn' activities elsewhere which further depletes the forest cover.

Traditional Medicine Systems

In Cambodia, herbal medicines have been used for thousands of years and because of their biomedical benefits and place in cultural beliefs, the practice continues even today. People have access to over-the-counter drugs at low cost but have few hospitals and physicians. They deal with illness through traditional medicine and self-medication, often using more than one treatment for the same illness. Modern medicines are available in urban areas however, their cost is relatively high and people opt for them only when all the indigenous remedies fail.

The Khmer system of traditional medicine has made a great contribution to maintaining health in Cambodia. It was first formulated by the ancient Khmers during and around the Angkor period and has served the health care needs of people up until today. In 1950, modern medicines began to be used in the treatments however, only the rich could afford them and rest of the population continued to depend on traditional medicines. The practitioners of this therapy are known as *Kru Khmer*. The Khmer traditional medicine is

the form of naturopathy that combines different plant parts such as roots, barks, leaves, some minerals and other natural ingredients and is used for the treatment of more than 100 different diseases (Se, 2002). There are currently 48 registered herbal medicines however; none of them is included in the national essential drug list (WHO, 2005).

Government Efforts in Development of Traditional Medicine

The government enacted a law on the organization of traditional therapeutics and traditional pharmacopoeia in 1964 that defines traditional therapeutics as treatment and care using traditional methods excluding surgical, obstetrical, chemical or bacteriological methods of therapy (WHO, 2001).

Traditional medicine was officially integrated into the national health system after 1979. In 1982, the Ministry of Health established the National Centre for Traditional Medicine (previously known as the Centre for Research on Traditional Medicine and Pharmacy), at central level with aid from the United Nations Children Fund (UNICEF), the Netherlands Organization for International Development Cooperation (NOVIB), the International Cooperation for Development and Solidarity (CIDSE), the Foundation Danielle Mitterrand (FRACE-LIBERTES) and the World Health Organization (WHO). A traditional medicine hospital in Phnom Penh was set up to provide the services of traditional healers and a community dispensary and garden of the most needed medicinal plants. The Phnom Penh municipal health-service and non-government organizations (NGO's) have trained traditional healers in fundamentals of medical science (Kraisintu, 2003).

Today the traditional medicine hospital is no longer functional and the above-mentioned network has deteriorated mainly because of competition from newly formulated traditional remedies, lack of collaboration between traditional healers and medical doctors, benefit-sharing problems, budget scarcity and the loss of the traditional medicine knowledge base. The National Drug Policy developed in collaboration with the World Health Organization, is intended to increase the importance of traditional medicine and encourage traditional medicine practice as a complement to allopathic medicine. The Law on the Management of Pharmaceuticals was adopted on 9 May 1996, replacing relevant existing legislation. A draft decree pertaining to the manufacture, importation, exportation and supply of traditional medicines was submitted by the Ministry of Health to the Council of Ministers, following the adoption of this law by the National Assembly (WHO, 2001).

On 6 October 1998, the Ministry of Health issued a decision on the conditions of opening, closing and changing traditional medicine stores. A sub decree for production, importation, exportation and traditional medicine trading for health was issued on 28 April 1998 by the Royal Government. The Department of Drug-Foods-Medical Materials and Cosmetics, the Ministry of Health, also issued the procedures for regulations of

locally produced and imported traditional medicine products (Kaing, 2000). A national pharmacopoeia neither exists nor is in preparation. National monographs on herbal medicines are found in *Cambodia's Medicinal Plant - Vol. I*, approved by the Ministry of Health in 1996, *Cambodia's Medicinal Plant - Vol. 2*, approved in 1997 and in *Your Medicines in Your Garden* which was approved in 2000. Volume 3 of *Cambodia's Medicinal Plants* is currently under development. No information is available on the legal status of these monographs (WHO, 2005).

Medicinal and Aromatic Plant Resources

Several forest resources are used for medicinal and aromatic plants in Cambodia. The documentation on medicinal and aromatic plants is however limited. Some important medicinal and aromatic plants species include *Albizia lebbekoides* (DC.) Benth., *Aquilaria crassna* Pierre ex Lec., *Azadirachta indica* A. Juss., *Cassia alata* L., *Diospyros* spp., *Dioscorea hispida* Dennst., *Leucaena leucocephala* (Lam.) de Wit., *Pterocarpus santalinus* L. f., and *Strychnos nux-vomica* L. (FAO, 2002). Cambodia has the potential to make use of raw materials from more than 500 available species of medicinal and aromatic plants; some of the important species found in the country are listed in Table 1 (Kaing, 2000).

Research and Development Activities

The National Centre for Traditional Medicine has been restarted from the beginning however with inappropriate infrastructure and human resources. It has been running with donations from different NGOs since its establishment. The Centre is responsible for collecting information on traditional remedies of importance in primary health care; medicinal plant species of commercial/industrial interest; diseases or disorders treated by traditional medicine; and promoting the appropriate use of traditional medicine in communities. The Centre also conducts studies on conservation and reproduction aspects of medicinal plant species, manufacturing methods and technologies for quality control of herbal medicines and development of traditional remedies. It also provides consultancy to the Ministry of Health on traditional medicine related issues, acts as national coordinator for a traditional medicine network and is responsible for the development of monographs of selected plants and the Medflor database. In addition Khmer traditional doctors are given recognition and training, and it is translating, books from Pali to Khmer, which describe traditional medicines and contain the experiences of intellectuals, monks and traditional healers (Se, 2002).

The Centre has documented 514 plants of therapeutic value in an inventory of medicinal plants in six provinces of the country. To date it has published a booklet of

40 Medicinal Plants for Common Diseases; three volumes of *Medicinal Plants*; two volumes of *Illustrated Brochures on Medicinal Plants in Cambodia* and *Medicines in Your Garden* (booklet containing 11 medicinal plants commonly used for primary health care). A list of 16 selected diseases treated with medicinal plants in primary health care system, a list of 47 industrially and economically important medicinal plant species, 12 toxic and venomous and 11 plants with toxic effects has also been compiled by the Centre. With the ensured quality and efficacy, the pharmaceutical dosage forms from medicinal plants have been developed for a variety of problems through clinical trials. In October 1997, a National Workshop on Traditional Medicine and Natural Products with WHO support was organized at Phnom Penh. The Centre has also developed the Medflore database with information on 160 medicinal plants (Kaing, 2000).

Trade and Marketing

There is considerable illegal logging and trade in forest products in Cambodia, which makes it difficult to obtain accurate statistics. A number of forest products are exported from the Ratanakiri province. This trade is mostl illegal through the markets of Phnom Penh and Viet Nam to Chinese markets. Traditional Chinese medicine has created a tremendous demand for wildlife and plant products for which Phnom Penh is one of the major destinations (Paterson, 2002).

Cambodia's annual export of Sleng (*Strychnos nux vomica* L.) seeds to Europe and China during the period 1958-1967 was about 425 tonnes. Seeds of krabao tree (*Hydnocarpus anthelmintica*) were also sold to Viet Nam and Singapore (Suntra, 1995). During the period 1993-1998 along with Thailand, Cambodia exported over 300 tonnes of agarwood (*Aquilaria malaccensis* Lam.) to Taiwan (Barden *et al.*, 2000). Traditional medicines are generally sold to traders on local markets. However, exact information and data on this trade are not available.

Problems and Constraints

All kinds of forestry infrastructure in Cambodia was destroyed and burnt during the Pol Pot regime. The Department of Forests and Hunting was reorganized in late 1979. Institutional weaknesses, lack of adequate laws and harvesting expertise, lack of information and data on forest products, illegal exploitation of forest resources, corruption and lack of skilled and experienced personnel are the major constraints faced by Cambodia in commercial exploitation of natural resources of medicinal and aromatic plants. There is a need for the development of markets, local processing technologies, trade regulations, proper conservation strategies and scientific research on medicinal and aromatic plants and traditional remedies used in the country.

Table 1: Some important medicinal and aromatic plants found in Cambodia

Botanical name	Family	Uses/Indications
Allium cepa L.	Liliaceae	In asthenia, fatigue
Allium odorum L.	Liliaceae	Digestive, carminative, in cough
Allium sativum L.	Liliaceae	As antivenomous, in hypertension
Amomum krevanh Pierre	Zingiberaceae	As carminative, expectorant
Artabotrys odoratissimus Br. Ex. Ker. Gawl.	Annonaceae	As diuretic, carminative
Atalantia monophylla (L.) DC.	Rutaceae	Digestive, in cough
Blumera balsamifera (L.) DC.	Asteraceae	As laxative, febrifuge
Cinnamomum cambodianum Lecomte	Lauraceae	As carminative, digestive
Citrus aurantium L.	Rutaceae	Digestive, in cough
Citrus hystrix DC.	Rutaceae	In influenza
Citrus medica L.	Rutaceae	Digestive, antispasmodic, in cough
Citrus nobilis Lour.	Rutaceae	Digestive, in cough
Citrus sinensis (L.) Obseck	Rutaceae	Digestive, in cough
Coleus amboinicus Lour.	Lamiaceae	In cough
Coriandrum sativum L.	Apiaceae	As digestive
Curcuma longa L.	Zingiberaceae	As haemostasis, in pneumonia, gastritis, flatulence
Cymbopogon nadrus (L.) Rendel	Poaceae	As febrifuge, carminative
Cyperus rotundus L.	Cyperaceae	As emmenagogue, in colic, diuretic
Eryngium foetidum L.	Apiaceae	As febrifuge, digestive
Eucalyptus globulus Labill.	Myrtaceae	As febrifuge, antiseptic
Eugenia caryophyllus Bullock of Harrison	Myrtaceae	As local anaesthetic
Eugenia zeylanica Wight	Myrtaceae	As analgesic, in sprain
Feroniella lucida Swingle	Rutaceae	In influenza, as digestive
Illicium verum Hook. f.	Magnoliaceae	As carminative, antispasmodic
Jasminum sambac (L.) Ait.	Oleaceae	As antispasmodic
Melaleuca leucadendron L.	Myrtaceae	As febrifuge, in sprain, in cough
Michelia champaca L.	Magnoliaceae	As carminative, febrifuge
Murraya paniculata Jack	Rutaceae	As diuretic, carminative
Ocimum basilicum L.	Lamiaceae	As antispasmodic, carminative, digestive
Ocimum gratissimum L.	Lamiaceae	In influenza
Ocimum sanctum L.	Lamiaceae	As antispasmodic, carminative
Petroselium sativum Hoffm.	Apiaceae	In headache
Piper betle L.	Piperaceae	As carminative, in cough
Piper cubeba L .f.	Piperaceae	In migrain, rheumatism, boils
Piper lolot C. DC.	Piperaceae	As carminative, in diarrhoea
Piper nigrum L.	Piperaceae	As digestive, carminative
Polygonum odoratum Lour.	Polygonaceae	In alimentary infections
Spilanthes acmella Murr.	Asteraceae	As analgesic, febrifuge
Tagetes erecta L.	Asteraceae	Detoxicant, in cough
Zingiber officinale Roscoe	Zingiberaceae	As Hypocholesterolemiac, tonic, in rheumatism

2.4 Indonesia

Indonesia is comprised of 17,000 islands and is the world's largest archipelago. It lies between the Indian Ocean to the west and south and the Pacific Ocean to the north-east and is separated from the peninsular of Malaysia and Singapore by the Straits of Malacca and the South China Sea, from the Philippines by the Sulawesi Sea and from Australia by the Arafura and Timor seas. The total land area of the country is 1,826,440 square kilometres. Indonesia has around 60% of the total area of the country under forest cover. The forests are very diverse representing about 10% of all tropical forests of the world and containing almost 15% of all higher plants. Indonesia has a network of around 250 protected areas; covering an area in excess of 20 million hectares. It is the world's second largest mega centre of biodiversity after Brazil and home to about 90% of medicinal plant species found in Asia. Most of the population relies mainly on traditional medicine for their health care needs even in areas where modern medicines are readily available. The rich biodiversity provides a sound base for future export development of medicinal plants and their products. The Indonesian government is promoting sustainable utilization of its medicinal plant resources both to provide better health care to its people and to promote export.

Traditional Medicine Systems

Indonesia has many varieties of traditional medicine associated with the different ethnic groups and the historical developments that have shaped the nation. About 40% of Indonesians use herbal medicine of which 70% are from rural areas. In 1995, there were 281,492 practitioners of traditional medicine in the country with about 96% of them using traditional Indonesian methods of treatment (WHO, 2001). The commercialization of Jamu medicines is an indicator of interest in traditional herbal medicine in Indonesia. Jamu is generally used for promotive, preventive and curative purposes. Of the 89% of Indonesians who use health care services 45.1% rely on traditional remedies and only 26.9% use formal health services. The rest use both, contributing to the rapid growth of the herbal drug industry over the last two decades. Through a separate law for herbal medicines, regulation was established in 1993 and updated in 1994 and 1995. Herbal medicines are regulated as over-the-counter medicine, as a separate regulatory category and as traditional medicine. There are 8,632 registered herbal medicines in Indonesia. No herbal medicines are included in the national essential drug list. A postmarketing surveillance system was established in 2002 including adverse effect monitoring. Three editions of the *Farmakope indonesia* have been published, the most recent dating from 1979. The national pharmacopoeia is legally binding. *Materia Medica*

Indonesia contains 246 of the national monographs, which are legally binding. It was published between 1977 and 1995 (WHO, 2005).

Government Efforts in Development of Traditional Medicine

The Indonesian Health Law Act of 1992 classifies Indonesian traditional medicine into two groups: Jamu and phytopharmaca. Jamu medicines include natural medicines constituting either crude drugs or galenical preparations produced by individuals or by home industries. Their efficacy is entirely based on experience but do not comply with the formal minimum requirements. These medicines need not be registered, labeled or marked except with the empirical name. The Ministry of Health is providing assistance to Jamu manufacturers to ensure production of quality products. It is the oldest, most widespread and best-understood system of traditional medicine in the country. It originated in Java during the late 8th or early 9th century and then spread to the whole Java Island, Bali and many neighbouring islands over the course of time. Today, Jamu medicine is an important constituent of the national health care system and plays a major role in the economy of rural people (Erdelen *et al.*, 1999).

The phytopharmaca includes natural medicines, constituting either crude drugs or galenical preparations, with guaranteed safety and efficacy. Their efficacy is tested and quality parameters comply with the specified standards. The Ministry of Health has distributed a publication, *Guidance for Clinical Trial of Traditional Drug* to help manufactures fulfil these requirements. Guidelines for good manufacturing practice (GMP) for herbal medicine, extraction of plants and performance of clinical tests on herbal medicine have also been issued in Indonesia.

The national health system of Indonesia consists of modern medicine as per the health laws but traditional treatments are not forbidden. As a result of the increased acceptability of herbal medicines among medical doctors and their scientific validation for safety and efficacy, the use of herbal medicines has increased significantly in the country over the last five years. Individual patients are free to switch between the two systems or use them simultaneously. The government worked for effective implementation of the policy for development of the traditional medicine industry through sustainable utilization of resources during the last two five-year development periods, 1988 and 1993. Efforts were made to modernize diagnostic procedures and production processes including quality control of traditional medicines. Diagnosis through modern techniques and treatment with traditional medicines has been promoted in the country. Good manufacturing practices have been introduced and a quality specifications and registration system has been developed to ensure the quality standards for herbal medicine. Various guidelines and regulations have been issued for the production and quality control of traditional medicine. The

National Agency of Drug and Food Control has been assigned to perform the duties of controlling the quality and safety of newly developed and marketed herbal drugs on the national and international market to encourage the use of Indonesian medicinal plants in the formal health sector. In the late 1990s, the government set up, phase-by-phase, 12 phytopharmaca testing centres for preclinical and clinical trials in the 12 provinces of Indonesia. The standardized phytopharmaca products will be gradually introduced in formal medication in hospitals, public health centres and at other levels (Mursito *et al.*, 2003).

State efforts for health and traditional medicine were strengthened in accordance with the 1993 Guidelines of State Policy and National Healthcare Legislation. Traditional birth attendants are permitted to practise without registration or licence. The Centre for Traditional Medicine Research, under the Ministry of Health and Social Welfare is responsible for providing training in traditional medicine (WHO, 2001). National policy on development of Traditional Medicines was issued in 2000. Laws and regulations on traditional medicine were first issued in 1993 and the national programme on traditional medicine was established in 2003. The national office on traditional medicines is administered by the National Agency of Drug and Food Control and was established in 2001 (WHO, 2005).

Medicinal and Aromatic Plant Resources

Indonesia is a tropical country with abundant natural resources of medicinal and aromatic planst. It is the second largest biodiversity centre in the world and can be placed in the first position if marine biodiversity is also taken into consideration. About 80% of the global medicinal plant resources are found in the Indonesian tropical forests spreading over 143 million hectares. More than 40 million Indonesians depend directly on biodiversity, making use of about 6,000 plant species. According to the Indonesian Country Study on Biodiversity (ICSBD) there are about 25,000 to 30,000 species of flowering plants in the country. About 10% of the total Indonesian flora is thought to possess medicinal value (Erdelen *et al.*, 1999). According to the National Agency of Drug and Food Control (Badan Pengawas Obat dan Makanan, BPOM) 250 species are directly harvested from forests and 283 species have been registered for use by traditional medicinal industries.

The majority of the medicinal plants used in Indonesian traditional medicines are collected from the wild and very few are cultivated. Twenty-five percent of the 55 most important plant species used for Jamu, are collected from forests (Erdelen *et al.*, 1999). The collection is conducted either by specialized collectors or herbalists in rural areas who grow the plants in their gardens. Some important cultivated medicinal and aromatic plants include *Cinchona* spp., *Curcuma longa* L., *Kaempferia galanga* L., *Orthosiphon aristatus* (Blume) Miq., *Piper nigrum* L., *Piper retrofractum* Vahl, *Syzygium aromaticum* (L.) Merr. & L. M. Perry L., T*anacetum cinerariifolium* (Trevir.) Sch. Bip and *Zin-*

giber officinale Roxb,. Most cultivation methods are traditional except for Cinchona spp., which is grown on estates. Pyrethrum (*Tanacetum cinerariifolium* (Trevir.) Sch. Bip.) is grown at higher altitudes in Irian Jaya province. Extensive use, unsustainable collection and over exploitation has endangered the existence of some species mainly available *Alstonia scholaris* (L.) R. Br., Alyxia reinwardtii Bl., *Pimpinella pruatjan* Molkenb., *Rauvolfia serpentina* (L.) Benth. ex. Kurz and *Strychnos ligustrina* Bl. In the wild. Some plants known under the term sanitation per aqua (SPA), besides their use for manufacture of herbal medicines, are also used for cosmetics and hydrotherapy. Plants containing volatile oils such as cananga oil from *Cananga odorata* Hook. F. & Thoms., black pepper oil from *Piper nigrum* L. and clove oil from *Syzygium aromaticum* (L.) Merr. & L. M. Perry are used in SPA and are becoming popular among the people of Indonesia. The important medicinal and aromatic plant species of Indonesia used in Jamu and phytopharmaca medicines are listed in Table 1 and 2 respectively (Mursito *et al.*, 2003).

Cajeput oil (*kayu putih*) used as medicine is extracted from the leaves of *Melaleuca leucadendra* (L.) L and *Melaleuca minor* Sm. The trees grow naturally in Maluku and Nusa Tenggara and have also been planted in Yogyakarta, Western, Central and Eastern Java. Sandalwood oil is produced by many species of the genus *Santalum* mainly *Santalum album* L. The tree is found to grow naturally in Belu, Timor, North Central Timor, South Central Timor, Kupang, West Sumba and East Sumba. The village chiefs are authorized to issue harvesting permits for exploitation of sandalwood (FAO, 2002).

The cultivation of medicinal plants in buffer zones of natural conservation areas and under forest stands have been carried out to reduce forest encroachment by providing alternative income sources, reducing direct collection of plants from natural habitats and to increase the supply of medicinal plants. Field trials on farm lands in the buffer zone of the Halimun conservation area has given positive results for four plant species, namely *Amomum compactum* Sol. ex Maton, *Foeniculum vulgare* Mill., *Guazuma ulmifolia* Lam. and *Zingiber cassumunar* Roxb. (*Zingiber purpureum* Roscoe). The quality of the symplicia met the Indonesian Materia Medica standard. In central Jawa cultivation was undertaken for some high demand medicinal and aromatic plants such as ginger, turmeric and temoelawak under forest stands of *Albizia falcata* (L.) Backer or teak forest (*Tectona grandis* L. f.).

The cultivation of high demand medicinal plants in Jawa and Sumatra provinces is progressing towards meeting the demand of industry. The centres in these locations are close to industry. More than 90% of raw materials used in the Jamu industry come from domestic resources. Inconsistency in the quantity and quality of raw materiasl either from natural or cultivated sources is the main constraint of the industry. Some companies have formed partnerships with the farmers in order to cultivate certain medicinal

plant species and have started cultivation of more than 50 plant species.

Research and Development Activities

A number of institutes such as the Research and Development of Health Department, Indonesian Research Institute (LIPI), the Agency for Development and Application of Technology and various universities, industries and non-governmental organizations (NGOs) are involved in research and handling of the traditional medicine sector in Indonesia. The Division of Phytochemistry and Pharmacognosy of the Faculty of Science and Mathematics, University of Indonesia is involved in phytochemical studies and standardization of herbal preparations (Elya, 2000).

Cooperatives undertake the production of raw materials. The NGOs deal with popularization of medicinal plants cultivation in home gardens and ensure supply of herbal material to the cooperatives. Almost all state and private universities conduct research on medicinal plants with the main focus on the search for new bioactive compounds and new medicines. Until 1991, a total of 490 species had been researched, of which about 80% of the work concentrated on pharmacological and phytochemical aspects, 16% on the cultivation and the rest on post harvest and other aspects (Mursito *et al.*, 2003).

Research activities on medicinal and aromatic plants over the last 10 years in Indonesia have been documented and considerable data has been accumulated. Scientific research has been concerntrated on plants used by indigenous people in Indonesia, ranging from Heyne's classical publication *De Nuttige Planten Van Indonesie* to modern publications on the medicinal herbs of Indonesia by P.T. Eisai and the volume of medicinal plants to be published by the Plant Resources of South-East Asia (PROSEA) in Bogor. Scientists from different institutions in the country in 1998 founded a coordinating body called the Interdisciplinary Working Group on Indigenous Medicinal Plants of Indonesia (IWIM) with the objective of developing new conceptual approaches for a better understanding and conservation of traditional medicine systems in Indonesia. The IWIM members carry out joint research programmes on medicinal plants (Plotkin, 1999).

The Research and Development Centre for Biology has undertaken cultivation of *Curcuma zedoria* (Christm.) Roscoe, *Plantago major* L. and *Sonchus arvensis* L., while the Technical Implementation Unit for Botanical Gardens of the Institute of Science and Technology (LIPI) studied the cultivation potential of *Alpinia purpurata* (Vieill.) K. Schum., *Gynura procumbens* (Lour.) Merr. and *Typhonium trilobatum* (L.) Schott. PT Indofarma in collaboration with Gadjah Mada University. PT Kalbe Farma, has discovered 10 derivatives of curcumin from *Curcuma longa* L., five of which have been patented in the USA and six in Europe. Some of the plants have been tested in preclinical and clinical trials for their development and utilization in health care. The preclinical

studies of extracts of *Phyllanthus niruri* L. showed immuno-stimulant activity, *Graptophyllum pictum* Griffith was anti-infective and analgesic and *Curcuma xanthorrhiza* Roxb. showed promising hepatotoxic activity (Mursito *et al.*, 2003).

The Indonesian Spices and Medicinal Crops Research Institute (ISMECRI) has undertaken research on plant genetic resource conservation, characterization, evaluation, cultivation, plant breeding and post harvest technology on a number of medicinal plants such as *Andrographis paniculata* (Burm. f.) Wall. ex Nees, *Andropogon nardus* L., *Centella asiatica* (L.) Urb., *Curcuma domestica* Valeton, *Curcuma xanthorrhiza* Roxb., *Kaempferia galanga* L., *Morinda citrifolia* L., *Orthosiphon aristatus* (Blume) Miq., *Piper nigrum* L., *Piper longum* L., *Piper retrofractum* Vahl, *Pogostemon cablin* (Blanco) Benth., *Syzygium aromaticum* (L.) Merr. & L. M. Perry, *Vetiveria zizanioides* (L.) Nash, *Zingiber officinale* Roscoe and various others. Standard Operational Procedure for Cultivation of Medicinal Plants has also been published.

The domestication of potential medicinal and aromatic plants is the top priority of the government in order to provide sustained supply of raw materials to industry and conserve species of medicinal value. The National Planning Development Agency (BAPPENAS) carried out the coordination among technical departments to encourage the production of medicinal plants in order to ensure the supply of raw materials. As a result of the expansion of the National Programme of Transmigration, the Department of Health encouraged new settlers to plant medicinal plants in their gardens under an action programme called TOGA (Tanaman Obat Keluarga) or Medicinal Plants Garden, started in 1985. The objectives were to improve health care, reduce community diseases, improve nutrition, conserve nature, replant medicinal plants, distribute profit and growth and development of cooperatives (Sidik, 1994). A total of 106 species of medicinal and aromatic plants have been recommended for cultivation under the TOGA programme.

The Fukuyarna University Hiroshima and Kinki University Osaka, Japan have investigated the Indonesian plants *Monocarpia marginalis* (Scheff.) Sinclair, *Orthosiphon aristatus* (Bl.) Miq. and *Scurrula fusca* (Bl.) G.Don for their biologically active components and pharmacochemical studies (Shibuya, et al., 1999). The Laboratory of Pharmacognosy and Mycology, UPRES, Rennes, France in collaboration with Andalas University, Padang, Indonesia has carried out screening and evaluation of some Indonesian medicinal plants for antiviral and cytotoxic activities (Devehata *et al.*, 2002).

Trade and Marketing

In Indonesia, both the herbal drug industry and the crude drug trade are developing significantly. They are expected to grow further as the government is interested in bringing expansion to both sectors in order to earn a further share of the global mar-

ket. According to the Convention on Biological Diversity (CBD) report, the Indonesian contribution to the global herbal medicine market of US$43 billion was about US$100 million in 2000. The total sales turnover of US$226.6 million of the traditional medicine industry in Indonesia in 1994 was US$30.3 million, which increased to approximately US$150 million in 2000 (Mursito *et al.*, 2003).

The increasing use of traditional medicine has followed the expansion of the traditional medicine industry. In 1992, the country had 469 registered units (449 small and 20 large industries), which increased to 810 (723 small and 87 large industries) by 2000. This increment was due to the growing consumption of herbal medicines, which increased significantly from about 6,052 (in 1995) to about 7,685 tonnes (in 2000). The annual growth rate of between 25 to 30% is highly impressive (Pramono, 2002).

The herbal medicine industry provides livelihood sources to about 1% of the Indonesian population. The domestic market of Jamu medicines and their raw materials are extremely competitive. Large firms dominate the sector with a 70 to 75% share while the medium and small firms, household Jamu manufacturers and Jamu peddlers work to compete locally for nationwide distribution. The export centres of raw materials and finished Jamu medicines operate at regional level. These medicines are exported mainly to France, Malaysia, Netherlands, New Zealand, Singapore and Taiwan province. The industry faces strong market competition from China. The export volume of medicinal plants is relatively low. In 1993, medicinal plants exports were worth only US$24.33 million. With respect to aromatic plants, Indonesia is among the top essential oil and spice exporting countries. Indonesia is estimated to possess 70 species of prospective aromatic plants, of which 37 have already been developed at various levels, but only nine species were being utilized up until the late 1990s. The country mainly exports vetiver, cananga, citronella, patchouli and clove oils. In 1995 essential oils worth US$27 to 28 millions were exported (Mursito *et al.*, 2003).

The number of companies involved in the traditional Jamu medicine industry in 1981 was 165, which increased to 427 in 1991 and reached 1,023 in 2002. According to the of amount working capital these companies are divided into two groups. The first group belongs to big companies or Industri Obat Tradisional (IOT) with more than 90 companies with annual working capital of more than Rp. 600 millions. The second belongs to small companies or Industri Kecil Obat Tradisional (IKOT). Their market value in 2003 was more than US$300 millions.

Problems and Constraints

There is a lack of technologies for cultivation, production and product development, lack of standardization, inadequate scientific information to support the products, poor

financial resources and insufficient market information. There are also inconsistencies in demand and supply, and in raw materials and a lack of documentation and scientific literature to support the safety and efficacy of traditional medicines. The close interlinking of Jamu with the traditional lifestyle also hinders its modernization. The production and processing of essential oils generally makes use of traditional equipment resulting in higher energy inputs, lower yield of quality oil, insufficient quality control in production and packaging. Research activities are fragmented and not product oriented. There is a need to put more research effort into developing technologies for modernization of traditional medicine units. Knowledge and experience of many Indonesian tribes should be documented and thoroughly validated for their development and commercial exploitation.

Table 1: Some medicinal and aromatic plant species used in Jamu medicine

Botanical name	Family	Common name	Part(s) used
Abelmoschus moschatus Medik.	Malvaceae	Musk mallow	Root
Abrus precatorius L.	Fabaceae	Indian licorice	Leaf
Achillea millefolium L.	Asteraceae	Yarrow	Leaf
Acorus calamus L.	Acoraceae	Sweet flag	Rhizome
Aegle marmelos (L.) Corr.	Rutaceae	Bael tree	Leaf
Aglaia odorata Lour.	Meliaceae	Chulan	Leaf
Aleurites moluccanus (L.) Willd.	Euphorbiaceae	Candle nut	Seed
Allium cepa L.	Liliaceae	Onion	Bulb
Allium sativum L.	Liliaceae	Garlic	Bulb
Aloe vera (L.) Burm. f.	Liliaceae	Aloe	Stem
Alstonia scholaris (L.) R. Br.	Apocynaceae	Milky pine	Bark
Alyxia reinwardtii Bl.	Apocynaceae	Pulasari	Bark
Amomum cardamomum L.	Zingiberaceae	Kapol	Fruit
Anacardium occidentale L.	Anacardiaceae	Cashew	Leaf
Andrographis paniculata (Burm. f.) Wall. ex. Nees	Acanthaceae	King of bitters	Whole herb
Anisum vulgare Gaertn.	Apiaceae	Anise	Fruit
Annona muricata L.	Annonaceae	Soursop	Leaf
Apium graveolens L.	Apiaceae	Celery	Fruit
Aquilaria malaccensis Lam.	Thymelaeaceae	Agarwood	Wood
Arcangelisia flava (L.) Merr.	Menispermaceae	Kikoneng (liana)	Leaf, stem, flower
Areca catechu L.	Arecaceae	Betel nut palm	Seed
Artemisia vulgaris L.	Asteraceae	Mother wort	Whole herb
Averrhoa bilimbi L.	Oxalidaceae	Cucumber tree	Flower
Baeckea frutescens L.	Myrtaceae	False ru	Fruit
Blumea balsamifera (L.) DC.	Asteraceae	Blumea camphor	Leaf
Boesenbergia pandurata (Roxb.) Schltr.	Zingiberaceae	Black gallingale	Rhizome
Caesalpinia sappan L.	Fabaceae	Sappan wood	Wood

Continued

Table 1 continued

Botanical name	Family	Common name	Part(s) used
Cananga odorata Hook. f. & Th.	Annonaceae	Ylang-ylang	Flower
Capsicum annuum L.	Solanaceae	Chilly	Fruit
Carica papaya L.	Caricaceae	Papaya	Leaf
Carthamus tinctorius L.	Asteraceae	Safflower	Flower
Carum copticum (L.) C. B. Clarke	Apiaceae	Ajowan	Fruit
Cassia angustifolia Vahl	Fabaceae	Senna	Leaf
Centella asiatica (L.) Urb.	Apiaceae	Gotu kola	Whole herb
Cinchona calisaya Wedd.	Rubiaceae	Cinchona tree	Bark
Cinnamomum burmanni (Nees & T. Nees) Bl.	Lauraceae	Cinnamon	Bark
Cinnamomum sintoc Bl.	Lauraceae	Sintok	Bark
Citrus aurantiifolia (Christm.) Swingle	Rutaceae	Sour lime	Fruit
Citrus hystrix DC.	Rutaceae	Kaffir lime	Fruit
Cocos nucifera L.	Arecaceae	Coconut	Oil
Cola nitida (Vent.) Schott & Endl.	Sterculiaceae	Kola	Seed
Coleus atropurpureus L.	Lamiaceae	Ati-ati	Leaf
Coriandrum sativum L.	Apiaceae	Coriander	Fruit
Cucurbita moschata Duch.	Cucurbitaceae	Pumpkin	Seed
Curcuma aeruginosa Roxb.	Zingiberaceae	Temu hitam	Rhizome
Curcuma domestica Vahl	Zingiberaceae	Turmeric	Rhizome
Curcuma heyneana Vahl & Zyp.	Zingiberaceae	Temu giring	Rhizome
Curcuma xanthorrhiza Roxb.	Zingiberaceae	Javanese turmeric	Rhizome
Cymbopogon citratus (DC.) Stapf	Poaceae	Lemon grass	Leaf
Cyperus rotundus L.	Cyperaceae	Nutgrass	Rhizome
Datura metel L.	Solanaceae	Thorn apple	Leaf
Desmodium triquetrum (L.) DC.	Fabaceae	Daun duduk	Leaf
Dioscorea hispida Dennst.	Dioscoreaceae	Asiatic bitter yam	Rhizome
Elaeocarpus scaber L.	Elaeocarpaceae	Anyang-anyang	Fruit
Elephantopus scaber L.	Asteraceae	Prickly leaved elephants foot	Leaf
Elletaria cardamomum (L.) Maton	Zingiberaceae	Cardamom	Fruit
Equisetum debile Roxb. ex. Vaucher	Equisetaceae	Geges otot	Whole herb
Eugenia cumini (L.) Druce	Myrtaceae	Java plum	Fruit
Euphorbia hirta L.	Euphorbiaceae	Australian jasthma weed	Whole herb
Ficus septica Burm. f.	Moraceae	Fig of Java	Flower
Foeniculum vulgare Mill.	Apiaceae	Fennel	Fruit, seed
Glycyrrhiza glabra L.	Fabaceae	Mulathi	Root
Graptophyllum pictum (L.) Griff.	Acanthaceae	Caricature plant	Leaf
Guazuma ulmifolia Lam.	Sterculiaceae	Bastard cedar	Leaf
Gunnera macrophylla Bl.	Melastomaceae	Sukmo	Fruit
Helictres isora L.	Sterculiaceae	Kayu ules	Fruit
Hibiscus rosa-sinensis L.	Malvaceae	Shoe flower	Leaf

Continued

Table 1 continued

Botanical name	Family	Common name	Part(s) used
Imperata cylindrica (L.) P. Beauv.	Poaceae	Cogon grass	Rhizome
Jasminum sambac (L.) Ait.	Oleaceae	Arabian jasmine	Flower
Kaempferia galanga L.	Zingiberaceae	Galangal	Rhizome
Languas galanga (L.) Stunz.	Zingiberaceae	Greater galangal	Rhizome
Litsea cubeba (Lour.) Pers.	Lauraceae	May chang	Bark
Litsea odorifera Vahl	Lauraceae	Trawas	Leaf
Loranthus sp.	Loranthaceae	Oak mistletoe	Stem
Melaleuca leucadendra (L.) L.	Myrtaceae	Cajeput	Leaf
Melastoma malanathrichum L.	Melastomataceae	Singapore rhododendron	Leaf
Mentha arvensis L.	Lamiaceae	Mint	Whole herb
Merremia mammosa (Lour.) Hall. f.	Convolvulaceae	Bidara upas	Tuber
Mesua ferrea L.	Clusiaceae	Iron wood	Flower
Momordica charantia L.	Cucurbitaceae	Bitter gourd	Fruit
Morinda citrifolia L.	Rubiaceae	Indian mulberry noni	Leaf
Murraya paniculata (L.) Jack.	Rutaceae	Chinese murtle	Leaf
Myristica fragrans Houtt.	Myristicaceae	Nutmeg tree	Seed
Nigella damascena L.	Ranunculaceae	Jintan manis	Seed
Nyctanthes arbor-tristis L.	Verbenaceae	Srigading	Flower
Ocimum basilicum L.	Lamiaceae	Sweet basil	Leaf
Ocimum sanctum L.	Lamiaceae	Holy basil	Leaf
Orthosiphon stamineus Benth.	Lamiaceae	Java tea	Leaf
Oryza sativa L.	Poaceae	Rice	Grain
Parkia roxburghii G. Don	Fabaceae	African locust bean	Seed
Phaseolus vulgaris L.	Fabaceae	Kidney bean	Seed
Phyllanthus niruri L.	Euphorbiaceae	Stone breaker	Whole herb
Physalis minima L.	Solanaceae	Morel berry	Leaf
Piper betle L.	Piperaceae	Betel pepper	Leaf
Piper cubeba L. f.	Piperaceae	Cubeb	Fruit
Piper nigrum L.	Piperaceae	Black pepper	Fruit
Piper retrofractum Vahl	Piperaceae	Javanese long pepper	Fruit
Plantago major L.	Plantaginaceae	Ribwort	Leaf
Plectranthus scutellarioides (L.) R. Br.	Lamiaceae	Iler	Leaf
Pluchea indica Less.	Asteraceae	Beluntas	Leaf
Psidium guajava L.	Myrtaceae	Guava	Leaf
Punica granatum L.	Lythraceae	Pomegranate	Bark
Quisqualis indica L.	Combretaceae	Chinese honeysuckle	Seed
Raphanus sativus L.	Brassicaceae	Radish	Root
Rauvolfia serpentina (L.) Benth. ex. Kurtz	Apocynaceae	Pule pandak	Root
Ruta graveolens L.	Rutaceae	Rue	Leaf
Saccharum officinarum L.	Poaceae	Sugarcane	Stem

Continued

Table 1 continued

Botanical name	Family	Common name	Part(s) used
Santalum album L.	Santalaceae	Sandalwood	Wood
Sauropus androgynus (L.) Merr.	Euphorbiaceae	Sweet leaf bush	Leaf
Sesamum orientale L.	Pedaliaceae	Sesame	Leaf
Sesbania grandiflora (L.) Pers.	Fabaceae	Cook wood tree	Bark
Sterculia foetida L.	Sterculiaceae	Stink malve	Leaf
Syzygium aromaticum (L.) Merr. & L.M. Perry	Myrtaceae	Clove	Flower
Tamarindus indica L.	Fabaceae	Tamarind tree	Fruit
Thea sinensis L.	Theaceae	Tea	Leaf
Tinospora crispa Hook. f. & Thumb.	Menispermaceae	Putrawali	Leaf
Usnea barbata (L.) Wigg.	Usneaceae	Dung of the wind	Thallus
Vetiveria zizanioides (L.) Nash	Popaceae	Vetiver grass	Leaf, root
Vitex trifolia L.	Lamiaceae	Indian wild pepper	Leaf
Woodfordia fruticosa (L.) Kurz	Lythraceae	Sidawayah	Flower
Zingiber officinale Roscoe	Zingiberaceae	Ginger	Rhizome

Table 2: Some medicinal and aromatic plants approved for phytopharmaca

Botanical name	Common name	Part(s) used	Uses/Indications
Abrus precatorius L.	Saga telik	Leaf	In stomatitis
Acorus calamus L.	Dringo	Rhizome	As sedative
Allium sativum L.	Bawang puith	Bulb	In candidiasis, as hypolipidemic
Anacardium occidentale L.	Jambu mede	Leaf	As analgesic
Andrographis paniculata (Burm. f.) Wall. ex. Nees	Sambilata	Whole herb	As antiseptic, antidiabetic
Apium graveolens L.	Seledri	Whole herb	As hypotensive
Blumea balamifera (L.) DC.	Sembung	Leaf	As analgesic, antipyretic
Carica papaya L.	Papaya	Latex, leaf, seed	As antimalarial, male contraceptive
Centella asiatica (L.) Urb.	Pegagan	Leaf	As diuretic, antiseptic, hypotensive
Citrus aurantiifolia (Christm.) Swingle	Jeruk nipis	Fruit	As antitussive
Cucurbita moschata Duch.	Labu merah	Seed	In taeniasis
Curcuma domestica Vahl	Kunyit	Rhizome	In chronic hepatitis, as anti-arthritic, antiseptic
Curcuma xanthorrhiza Roxb.	Temulawak	Rhizome	In chronic hepatitis
Graptophyllum pictum (L.) Gritt.	Handeuleum	Leaf	In haemorrhoids
Guazuma ulmitolia Lam.	Jati blanda	Leaf	As hypolipidemic
Loranthus sp.	Benalu teh	Stem	As anticancer
Momordica charantia L.	Pare	Fruit	As antidiabetic
Myristica fragrans Houtt.	Pala	Fruit	As sedative
Orthosiphon stamineus Benth.	Kmis kucing	Leaf	As diuretic
Piper betle L.	Sirih	Leaf	As antiseptic

Continued

Table 2 continued

Botanical name	Common name	Part(s) used	Uses/Indications
Psidium guajava L.	Jambu biji	Leaf	As antidiarrhoeal
Punica granatum L.	Delima putih	Fruit pericap	As antiseptic
Quisqualis indica L.	Ceguk	Seed	In ascariasis
Ruta graveolens L.	Inggu	Leaf	As antiseptic, antipyretic
Sonchus arvensis L.	Tempuyung	Leaf	In nephrolitiasis, as diuretic
Sauropus androgynus (L.) Merr.	Katuk	Leaf	As breast milk stimulator
Strobilanthes crispus Bl.	Kejibeling	leaf	In nephrolithiasis, as diuretic
Tinospora crispa Hook. f. & Thumb.	Brotowali	Stem	As antimalarial, antidiabetic
Vitex trifolia L.	Legundi	Leaf	As antiseptic
Woodflordia floribunda Salisb.	Sidowayah	Leaf	As antiseptic, diuretic
Zingiber officinale Roscoe	Jahe	Rhizome	As analgesic, antipyretic, anti-inflammatory

Table 3: Important molecules derived from Indonesian medicinal and aromatic plants

Botanical name	Uses/Indications	Part(s) used	Molecule derived
Curcuma xanthorrhiza Roxb.	In chronic hepatitis	Rhizomes	Diaryl heptanoids - octahydrocurcumin
Kaempferia galanga L.	As stimulant, carminative, in dyspepsia, vomiting, flatulence,	Rhizomes	4-butylmenthol
Murraya paniculata (L.) Jack.	As tonic for young women's irregularities, in toothache	Leaves	Phebalosine
Piper retrofractum Vahl	As spice, condiment	Fruits	Retrofractamide A
Tinospora crispa Hook. f. & Thumb.	As antimalarial, anti-inflammatory, anti-diabetic	Stem	Tinocrisposide

Photographs of some leading medicinal and aromatic plants of Indonesia

Plants and rhizome of *Curcuma xanthorrhiza* Roxb.


Piper retrofractum Vahl & *Tinospora crispa* Hook. f. & Thumb.

2.5 Lao People's Democratic Republic

The Lao People's Democratic Republic is a landlocked country surrounded by the Myanmar and Yunnan provinces of China to the north, Viet Nam to the east, Cambodia to the south and Thailand to the west. It has a population of about 5.9 million and an area of 236,800 square kilometres. The landscape of the country is mostly mountainous especially in the north and east. Lao PDR has comparatively rich forest cover relative to most Asian countries. The tropical rainforests, covering about 47% of the area, are not only important for the conservation of biodiversity but also serve as a large reserve of natural resources, including medicinal and aromatic plants. Over the last few decades, these plants have been not only exploited by pharmaceutical companies but also used by traditional practitioners as domestic raw material for the preparation of their remedies. The forest degradation and deforestation have become serious problems for the country. In 1975, Lao PDR commenced a modest plantation programme and around 20 National Biodiversity Conservation Areas covering about 10% of the total area have been legally established. Medicinal and aromatic plants play an important role in the socio-economics of the country and have contributed significantly to improving the life of the people.

Traditional Medicine Systems

Lao PDR traditional medicine is known as 'ya phurn meung', meaning medicine from the foundation of the country and plays an important role in the health care of Laotians. The origin of this medicine system dates back to the 12th century. With the unification of the country traditional Buddhist and Indian medicinal systems were integrated into the society. With the French invasion, in 1893 allopathic medicine was introduced in Lao PDR (WHO, 2001).

A number of medicinal traditions are practised in Lao PDR and together they comprise traditional Lao medicine. These medicinal traditions vary depending on the ethnic groups. The three largest ethnic divisions in the country are the Lao Loum, Lao Soung and Lao Theung. These ethnic divisions are further divided into smaller ethnic subgroups which differ from each other in dialect, customs and beliefs and medicinal traditions. The traditional healers from any of these groups are generally specialists treating specific illnesses (Riley, 2003).

Most of the hospitals and clinics lack modern facilities and do not meet western standards. People, especially those who live far from clinics, depend on traditional medicine for their health care. Traditional medicines consist of remedies of herbal and animal origin and complement modern medicine.

Government Efforts in Development of Traditional Medicine

The Lao PDR government actively promotes traditional medicine, which is well articulated and well represented throughout the country. The government has a national programme on traditional medicine with a five-year work plan. There are traditional medicine hospitals at all levels and a patient is free to opt for modern or traditional medicine. The Traditional Medicine Research Centre (TMRC) previously known as the Research Institute of Medicinal Plants (RIMP) was set up to record ethnomedical information i.e. the remedies prescribed by traditional healers; conduct surveys of the country's medicinal plant resources; study the efficacy of the formulae and their method of processing, improve the galenic forms and facilitate the transfer of traditional medicines to domestic, government sponsored pharmaceutical companies for large scale production. It is the only institute of its kind in Lao PDR dedicated to research on medicinal and aromatic plants and traditional Lao medicine (Riley, 2003).

In February 1993, a national seminar to review the use of traditional medicine in primary health care at the provincial and district levels was held and a draft national policy on traditional medicine was submitted to the Ministry of Health. In some provinces training courses on the use of traditional medicine in communities were held by the government in 1996 (WHO, 2001). The national policy on traditional medicine was included in the National Drug Policy issued in 1998. The National Programme on traditional medicine was issued in 2000 and regulations on herbal medicines were issued in 2002; these were separate from those of conventional pharmaceuticals. A national pharmacopoeia is neither in existence nor in development. National monographs on herbal medicines are found in *Medicinal Plants of ASEAN*; these ten herbal monographs are considered to be legally binding. Thirty herbal medicines were included in the national essential drug list which was issued in 2002 (WHO, 2005).

Medicinal and Aromatic Plant Resources

Lao PDR has abundant natural resources. The forests are rich in diversity of medicinal and aromatic plants. An accurate survey on medicinal and aromatic plants of Lao PDR has not been accomplished yet. However, there are an estimated 4,000 plant species found in Lao PDR. The *Lao Pharmacopoeia* cited about 3,000 species among which about 1,000 species are collected by healers and about 500 medicinal plant species are being used for treating various common diseases. Some important medicinal and aromatic plants of Lao PDR are presented in Table 1 (Southavong, 2004; Kraisintu, 2003).

Cardamom (*Amomum* spp.) is among the important plants used for its medicinal properties and collected mainly from natural resources. It grows abundantly in natural forests in all parts of the country. There are eight species of cardamom that occur throughout the country, the four main ones are *Amomum longiligulare* T. L. Wu., *Amomum ovoideum* Pierre ex Gagnep., *Amomum* spp. (locally known as maak naeng hua lohn) and *Amomum villosum* Lour. The first species is found mainly in the south, the others in the north. Since 1975, it has been domesticated and is grown with rice in the provinces of Champasack and Salavan. Because of its high yield *Amomum xanthioides* Wall. from China was also introduced in the Oudomxay Province. *Boehmeria malabarica* Wedd. has been reported to be used by local villagers in traditional medicines for treating digestive and intestinal disorders and is found mainly in the northern provinces of Oudomxai, Luang Prabang, Sayabouly, Luang Nam Tha, Bokeo, Xiang Khouang and Phongsaly. People have started to cultivate the plant. Studies to domesticate it are underway (FAO, 2002).

Research and Development Activities

A survey carried out in 1976 by the Pharmacognosy Section, Traditional Medicine Research Center recorded 866 medicinal plants species. There are abundant species of aromatic plants in Lao PDR but few studies have been conducted on them. Almost all the raw materials for essential oil production are collected from the wild. Some small private companies are interested in exploiting wild raw materials for essential oil extraction and plantation (Southavong, 2004). A number of policies have been formulated by the government to promote the use of medicinal plants and traditional medicines since independence, however, the number of institutes dealing with research and development of herbal medicines are limited in Lao PDR.

The Ministry of Health has developed a unique system of promotion and protection of the traditional medicine practices in Lao PDR. The TMRC has been working with traditional healers at the local level through a network of Traditional Medicine (TM) Stations. Most provinces in Lao PDR have one TM station, with staff well versed in both traditional

and conventional medicine and are engaged in recording local remedies from traditional healers. A large number of plant material is collected, dried and stored at the TM stations and the specimens of popularly used medicinal plants will be studied to determine their known medicinal effects, phytochemical properties and biological activities (Riley, 2003). TMRC is also working with the International Cooperative Biodiversity Group (ICBG) Programme based at the University of Illinois-Chicago (UIC) for discovering prospective medicinal products from plants. The programme is dedicated to research on ethical drug discovery and works in collaboration with research scientists and institutions from the country. Since 1999, 597 plant species have been discovered, identified and screened for their effects against Malaria, HIV/AIDS, TB, Cancer, CNS and various other diseases. The data has been recorded in the NAPIS database at the Centre. Some medicinal plants tested for biological activities are presented in Table 2 (Southavong, 2004).

The Pharmaceutical Development Centre (PDC) funded by the Japanese government is engaged in the production of conventional medicines and extraction of active principles from plants (Sengsavang, 2000).

The Forest Research Center has formulated a project to develop an effective programme for cardamom plantation throughout the country, to form a network of cooperation between farmers and traders and to meet the quantity and quality demand of the local and external markets. The ASEAN Regional Centre for Biodiversity Conservation (ARCBC) is carrying out a project *Quantitative Survey of the Medicinal Plants in Hin Nam No Areas, Khammouane Province* with a number of agencies including TMRC. The objectives of the project include survey and inventory of commonly used medicinal plants; collection of new herbarium specimens; creation of a medicinal plants database; community education on the importance of medicinal plant diversity; and encouragement and cooperation of local people in the preservation of valuable and endangered plant species (Anonymous, 2003).

Trade and Marketing

There are few industries dealing with herbal medicines in Lao PDR. The country produces only 30 to 40% of both allopathic and traditional medicines domestically. There are seven pharmaceutical factories in the capital, of which three belong to the state, one is a joint venture with China and the rest are privately owned. These produce only a small quantity of plant based medicines. The factories in the private sector produce largely modern medicines and only a small portion from plant material. Most traditional medicine factories in the private sector produce traditional remedies consisting of one or more medicinal plants. The raw material is pretreated and processed for both domestic sale and export purposes. The production size of state and private companies is

so small that demand can only be met at domestic level (Kraisintu, 2003).

In 1994, the Pharmaceutical Factory No. 2 started production of some herbal medicines and most of the products from Factory No. 104 are also based on herbal and medicinal plants. The three home based industries namely Golden Mouse Brand, Naga (Serpent) Brand and Tiger Brand cater for traditional medicine needs of rural and urban populations of the country. A newly established company, BIOIL is working on cultivation of aromatic plants. The company has plans for the distillation of essential oils (Sengsavang, 2000).

Cardamom is exclusively exported to China and Rep. Korea at fluctuating prices. Among medicinal products, which cover about 70% of the total export income, cardamom accounts for 90%. The *Boehmeria malabarica* Wedd. bark is exported mainly to China where it is used to produce incense, mosquito repellent and glue as Lao PDR has no processing facilities for the final product. Luang Nam and Bokeo provinces export largest quantities of the commodity. However, little trade or pricing information is available (FAO, 2002).

Essential oil production from aromatic plants is considered to be a new branch of economy in Lao PDR but the industrial level exploitation of aromatic plants is limited. No systematic inventory has been made to know the potential of aromatic plant species and their abundance in the country. Many foreign businessmen are interested in cooperating with TMRC to undertake feasibility study of exploiting medicinal and aromatic plant of Lao PDR (Kraisintu, 2003).

Problems and Constraints

Lao PDR has abundant biodiversity, especially of medicinal and aromatic plants. However, their exploitation and utilization has not been carried out properly. There is a lack of information on potential plant resources for both exploitation and conservation, lack of facilities for carrying out research on safety and efficacy, pharmacological, pharmacodynamic, pharmacokinetic, toxicological and clinical studies of active constituents from plants and lack of funds to organize specialized training. There is a need for technology, human resources and funds to ensure the sustainable development of plant raw materials into medicines and aromatic products for domestic and foreign markets.

Table 1: Some common medicinal and aromatic plants of Lao PDR

Botanical name	Family	Part(s) used	Uses/Indications
Acorus gramineus Soland	Araceae	Rhizome	In arrhythmia, asthma, as stomachic, cardio-tonic
Ageratum conyzoides L.	Asteraceae	Whole herb	In bleeding disorders
Alocasia macrorrhiza (L.) G. Don	Araceae	Rhizome	In malaria, asthma

Continued

Table 1 continued

Botanical name	Family	Part(s) used	Uses/Indications
Alpinia officinarum Hance	Zingiberaceae	Rhizome	In cholic, as stomachic
Alstonia scholaris (L.) R. Br.	Apocynaceae	Bark	In malaria, gastric disorders
Amomum sp.	Zingiberaceae	Fruits	For digestion
Amomum xanthioides Wall.	Zingiberaceae	Fruits	In flatulence
Amorphophallus riviera Durr.	Araceae	Tuber	In malaria
Andrographis paniculata (Burm. F.) Nees	Acanthaceae	Whole herb	In infections, dysentery, as antiseptic, tonic
Aquilaria crassna Pierre	Thymeleaceae	Wood	In colitis, nausea, hiccup
Artemisia annua L.	Asteraceae	Leaves	In malaria, fever
Artemisia vulgaris L.	Asteraceae	Whole herb	In headache, menstrual disorder
Artocarpus lakoocha Roxb.	Moraceae	Wood	For tapeworm infestation
Asparagus cochinchinensis (Lour.) Merr.	Liliaceae	Rhizome	As diuretic, in cough
Azadirachta indica A. Juss.	Meliaceae	Wood	In malaria
Bidens pilosa L.	Asteraceae	Whole herb	In headache, caries, hiccough
Blumea balsamifera (L.) D. C.	Asteraceae	Leaves	In cold, coryza
Caesalpinia sappan L.	Fabaceae	Wood	As tonic, in dysentery
Canangium odorata Hook.	Annonaceae	Flower, wood	In hypertension
Cassia alata L.	Fabaceae	Root, leaves	For eczema
Cassia occidentalis L.	Fabaceae	Seed	In eye disorders, constipation
Catharanthus roseus (L.) Don.	Apocynaceae	Leaves	In leukemia
Centella asiatica Urban	Apiaceae	Whole plant	In cancer, diabetic
Chenopodium ambrosioides L.	Chenopodiaceae	Essential oil	Anthelmintic
Cinchona ledgeriana Moens.	Rubiaceae	Bark	In malaria, as tonic
Cinnamomum camphora (L.) J. Presl	Lauraceae	Wood	In colic, chest pain, as cardio-stimulant
Cinnamomum cassia Blume	Lauraceae	Stem bark/twig	As tonic, balm ingredient, in coryza
Cinnamomum cortechinii Gamble.	Lauraceae	Leaves	In influenza
*Cinnamomum iner*s Reinw.	Lauraceae	Bark	In influenza
Coscinium usitatum Pierre	Menispermaceae	Vine	In dysentery, as cholagogue
Costus speciosus Smith.	Zingiberaceae	Rhizome	In arthritis
Crataegus pinnatifidus Bunge	Rosaceae	Fruit	As stomachic, cardio-tonic
Cymbopogon spp.	Poaceae	Aerial part	In flu, influenza, cold
Dichroa febrifuga Lour.	Hydrangeaceae	Leaf	In malaria
Drynaria fortunei J. Smith.	Polypodiaceae	Rhizome	In rheumatism
Eclipta alba (L.) Hassk.	Asteraceae	Whole herb	In bleeding disorders
Elephantopus scaber L.	Asteraceae	Root	In allergy, diarrhoea, fever, as diuretic
Elsholtzia cristata Willd.	Lamiaceae	Whole herb	In cold, headache
Embelia ribes Burm. F.	Myrsinaceae	Fruit	For tapeworm infestation
Eucalyptus spp.	Myrtaceae	Leaf	In influenza
Eupatorium odoratum L.	Asteraceae	Root, leaf	In bleeding disorders, appendicitis
Evodia lepta (Spr.) Merr.	Rutaceae	Root	In asthma

Continued

Table 1 continued

Botanical name	Family	Part(s) used	Uses/Indications
Glycosmis citrifolia Lindl.	Rutaceae	Root, leaf	In asthma
Gnaphalium indicum L.	Asteraceae	Flower	In cough, bronchitis
Heliotropium indicum L.	Boraginaceae	Root	In backpain
Hibiscus abelmoschus L.	Malvaceae	Seed, root	As diuretic, in constipation
Holarrhena antidysenterica (Roxb. ex Fleming) Wall. ex. A. DC.	Apocynaceae	Bark,seed	In dysentery
Homalomena occulta (Lour.) Schoot	Araceae	Rhizome	In rheumatism
Justicia adhatoda L.	Acanthaceae	Leaf	In bone fractures
Lasia spinosa (L.) Thwaites	Araceae	Rhizome	In angina, oedema
Leea sambusina Willd.	Leeaceae	Root	As tonic, in rheumatism
Litsea cubeba (Lour.) Pers.	Lauraceae	Fruit	As stomachic
Mahonia bealei Carr.	Berberidaceae	Wood	In conjunctivitis
Melia azedarach L.	Meliaceae	Root bark	As anthelmintic
Micromelum falcatum Tanaka	Rutaceae	Whole herb	In asthma
Morinda citrifolia L.	Rubiaceae	Wood, fruit	In arterial hypertension, constipation, pain, diabetes
Ocimum basilicum L.	Lamiaceae	Seed	In nausea, fever, kidney diseases
Ocimum gratissimum L.	Lamiaceae	Whole herb	In cold, caries
Ocimum sanctum L.	Lamiaceae	Whole herb	In malaria
Passiflora foetida L.	Passifloraceae	Aerial part	As tranquilizer, in anxiety
Pinus khesya Royle ex Gordon	Pinaceae	Wood resin, essential oil	In cough, as antiseptic
Polygonum kingianum Coll. et Hemsl.	Asparagaceae	Rhizome	As tonic
Rauvolfia canescens L.	Apocynaceae	Root bark	In hypertension
Rauvolfia serpentina (L.) Benth. ex. Kunz	Apocynaceae	Root bark	In hypertension
Rauvolfia verticillata (Lour.) Baill.	Apocynaceae	Root bark	In hypertension
Schefflera elliptica Harms.	Araliaceae	Bark	As tonic, in rheumatism
Smilax glabra Roxb.	Smilacaceae	Rhizome	As tonic
Spilanthes acmella (L.) L.	Asteraceae	Flower, leaf	In caries
Stephania glabra Miers.	Menispermaceae	Bulb, tuber	As tranquillizer
Sterculia lychnophora Hance	Sterculiaceae	Fruit	In constipation
Streptocaulon extensus Wight L.	Asclepiadaceae	Vine	As anthelmintic
Streptocaulon juventas (Lour.) Merr.	Asclepiadaceae	Root	As tonic
Strychnos nux vomica L.	Loganiaceae	Seed	In neurasthenia, as tonic
Styrax tonkinesis (Pierre) Craib	Styraceae	Resin	In cough, bronchitis
Tetrapanax papyrifer (Hook.) K. Koch	Araliaceae	Root, wood	As diuretic
Tinospora crispa Miers.	Menispermaceae	Vine	As bitter tonic, in joint pain
Uncaria sp.	Rubiaceae	Vine	In hypertension, rheumatism, fever convulsion
Wedelia calendulacea Less.	Asteraceae	Whole herb	As antibiotic
Xanthium strumarium L.	Asteraceae	Fruit	In allergy, goiter
Zanthoxylum spp.	Rutaceae	Fruit	In flatulence
Zingiber officinale Roscoe	Zingiberaceae	Rhizome	In influenza, as stimulant, carminative

Table 2: Some medicinal plants tested for biological activity

Activity	Botanical name	Family	Part(s) studied
Antiviral effect	*Asparagus cochinchinensis* (Lour.) Merr.	Asparagaceae	Root
	Colubrina pubescens Kurz	Rhamnaceae	Root
	Diospyros ehretioides Wall.	Ebenaceae	Twig
	Parinarium annamense Hance	Rosaceae	Twig
	Plumeria acutifolia Poir.	Apocynaceae	Wood
Anti-TB effect	*Stixis* sp.	Capparidaceae	Twig
	Polialthia suberosa Benth.	Annonaceae	Entire plant
Anti-malarial effect	*Gardenia philastrei* Pierre ex Pit.	Rubiaceae	Root
	Hibiscus praeclarus Gagnep.	Malvaceae	Twig/leaves
	Hygrophila polysperma Nees	Acanthaceae	Entire plant
	Memecylon sp.	Melastomaceae	Wood
	Phylloclymis spinosa Burm.	Moraceae	Twig
	Premna latifolia Roxb.	Verbenaceae	Twig
	P*terospermum* sp.	Sterculiaceae	Wood
	Rourea minor Leenh.	Connaraceae	Vine
	Sarcocephalus caudatus Miq.	Rubiaceae	Twig

2.6 Malaysia

Malaysia consists of two major landmasses, the Peninsular Malaysia at the tip of mainland Southeast Asia and the states of Sabah and Sarawak on the island of Borneo. The population is about 23 million consisting of different races (Malays, Chinese, Indians, Ibans, Kadazans and others). The Malays dominate with about 58% of the total population. The country is located in the tropics and has an equatorial climate with uniform temperature throughout the year. It covers an area of 329,750 square kilometres with approximately 60% under forest cover. Malaysia is blessed with an abundant and diverse flora, much of which is believed to possess medicinal value. It is among the world's top 12 biodiversity rich countries. However, the economic potential of the country's natural resources has yet to be fully realized or investigated.

Traditional Medicine Systems

The Malaysian government has adopted allopathic medicine as its official health care system. However, Ayurveda, Siddha, traditional Chinese, traditional Malay, Unani and other traditional systems of medicine are commonly practised in Malaysia. The diversity in medical systems reflects the diverse population of Chinese, Indians, Malay and indigenous heritage. Traditional medicine is looked upon as an alternative or supple-

ment to modern medicine and has made significant contributions to the health care of the Malaysians over the past decades. Various diseases such as diarrhoea, skin problems, headache, fever, cough, wounds, hypertension, diabetes and rheumatism are treated with herbal medicine. Traditional medicines continue to be practised by the community to treat disease and maintain health especially in remote areas where modern facilities are not readily available (WHO, 2001).

The indigenous medicinal system of Malaysia is traditional Malay medicine, which has been influenced by the medicine practices of Arabia, India, Java and those practised by numerous aboriginal races. These medical practices, based on practical experiences and observations which are handed down from generation to generation are particularly popular in rural areas. A traditional Malay folk medicine practitioner is called a bomoh. The traditional treatment includes spiritual therapy, massage therapy and herbs used in the form of liquids, oils, balms, pills, tablets, powders or leaves (Jasim, 2002).

Chinese traditional medicine and the traditional Indian medical systems Ayurveda, Siddha and Unani are also practised in Malaysia. Chinese medical practitioners are known as sinseh. The National Health and Morbidity Survey II of 1996 showed that 2.3% of Malaysians consulted traditional or complementary medicine practitioners and 3.8% used both allopathic and traditional Chinese medicine. Although no statistics are available, traditional medicine is mainly practised by traditional medicine providers, whereas allopathic medical providers practise both traditional as well as allopathic medicine (WHO, 2001). Malaysia does not have a national pharmacopoeia. However, international pharmacopoeias such as the *Chinese Pharmacopoeia*, and the *Pharmacopoeia of India* are used as references, but are not considered legally binding. Malaysia published the first *Malaysian herbal monograph* in 1999 but this is also not considered to be legally binding (WHO, 2005).

Government Efforts in Development of Traditional Medicines

The Ministry of Health has taken a positive approach to ensure quality and safety of traditional medicine for the consumers and the government supports the efforts of their integration with modern medicine. According to the National Policy on Traditional/Complementary Medicine (T/CM), 2001 this system should be an important component of the health care system and coexist with modern medicine. The government will facilitate the development of T/CM in the country and ensures the quality and safety of T/CM practices and products. The policy also supports the identification of health, economic and social benefits of traditional medicine (Anonymous, 2001).

The use of certain substances and the treatment of eye diseases have been restricted to practitioners of allopathic medicine by the Poisons Ordinance of 1952 and the Medical

Act of 1971 respectively. The Midwives (Registration) Regulations of 1971 legalized the practice of eligible traditional birth attendants. There are no other laws affecting traditional medicine practice in Malaysia; however, the production and sale of traditional medicine is regulated by a number of laws, mainly the Poison Act 1952, Sale of Drug Act of 1952, Advertisement and Sale Act of 1956 and the Control of Drugs and Cosmetics Regulations of 1984. The registration of traditional medicinal products in the country started in 1992. The Drug Control Authority is responsible for registration, quality and safety of the drugs. Traditional medicine manufacturers and importers are required to comply with good manufacturing practices and good storage practices respectively. Homeopathic medicines have to be registered with the National Pharmaceutical and Drug Control Board. The government is also considering the integration of traditional Chinese medicine into the official health care system. Recently a Steering Committee on Complementary Medicine has been set up to advise and assist the Ministry of Health in formulating policies and strategies for monitoring the practice of traditional Chinese medicine in the country. A national policy on traditional Chinese medicine for encouraging established practitioners to form their own self regulatory bodies to enable a system to be officially recognized, has also been drafted (WHO, 2001). As of December 2003, the Drug Council Authority (DCA) has registered approximately 12,000 traditional medicines, including herbal products. However, none of these products are included in the national essential drug list. The post marketing surveillance programme was introduced for pharmaceuticals in 1987 and was extended to cover traditional medicines in 1997. Adverse drug reaction monitoring of traditional medicines, market sampling and investigation of product complaints have since been included in the programme. In Malaysia herbal medicines are sold in pharmacies as over the counter drugs without any restriction (WHO, 2005).

The Ministry of Health appointed five umbrella bodies namely, the Malay, Chinese, Indian, Complementary and Homeopathy T/CM groups to accredit the curriculum and training institutions and register and self regulate T/CM practitioners. However, these umbrella bodies were dissolved in 2004 and the government is currently striving to regulate the herbal and health industries more effectively.

Medicinal and Aromatic Plant Resources

There are more than 14,500 species of flowering plants available in Malaysian forests and approximately 1,200 of these are reported to have medicinal properties. However, currently only 200 species are used in the preparation of various traditional medicines (FAO, 2002).

Most of the medicinal plant species are collected from the wild, a few are being cultivated. The commercial potential of these plants has not yet been exploited. Some of the

common medicinal and aromatic plant species used as major ingredients in local herbal products is given in Table 1. Many of the plants in the country are rich in aromatic compounds that can be used commercially as flavour and fragrance agents in beverages, food products, confectionery, toothpaste, cosmetics and medicinal preparations. The important ones include *Curcuma domestica* Valeton, *Cymbopogon citratus* (DC.) Stapf, *Cymbopogon nardus* (L.) Rendel, *Pandanus odorus* Ridl. and *Polygonum minus* Huds. Plants such as pepper, turmeric, ginger, cinnamon, lemon grass etc. are exclusively used in the food and flavouring industry (Mohd Ilham *et al.*, 2003). The economic potential of these species for commercial application is very promising because of the tremendous diversity in the country and the continuous demand for flavour and fragrance industries. Although various medicinal and aromatic plant resources are available locally for industry only a small amount is being harvested from Malaysian forests. The main supply of the medicinal plant material continues to come from China, India and Indonesia (FAO, 2002).

Research and Development Activities

A number of research institutes and universities in Malaysia are carrying out research on medicinal plants. More than 90% of the research is carried out by local institutes. The main institutes involved in research are the Forest Research Institute Malaysia (FRIM), the Malaysian Agriculture Research and Development Institute (MARDI), University Putra Malaysia (UPM), University Malaya (UM), University Science Malaysia (USM), University Technology Malaysia (UTM) and the University Kebangsaan Malaysia (U.K.M.) [National University of Malaysia (NUM)]. Most of the research activities are based on the discovery of bioactive components and phytochemical work.

In 1994, FRIM was identified to lead national research activities in medicinal plants. In 1995, a Medicinal Plants Division was established under the Cabinet's directives. In 2004, the Division was restricted to the Medicinal Plants Programme in Biotechnology Division and has maintained a multidisciplinary approach to medicinal plants research by working in close collaboration with other research institutes and universities. The main objective of the Division is to promote medicinal and aromatic plants research and to assist the local herbal industry in Malaysia. The Institute draws up a five-year strategic research programme under each of the Malaysian Economic Plan. Under the Eighth Malaysian Plan (2001-2005) the natural product discovery activities have been given emphasis. The three main subprogrammes are agronomics of medicinal plants and screening for bioactive compounds in plants; development of nutraceuticals and herbal products; and Malaysia-MIT (USA) biotechnology partnership programme (MMBPP) (Lim, 2000).

In 1992, University Malaya in collaboration with the Institute of Chemistry of the Natural Substances (CNRS) France carried out research on alkaloid bearing plants.

The University Kebangsaan Malaysia (National University Malaysia) has worked on *Alstonia angustifolia* Wall. ex A.DC., *Dehaasia incrassata* Bl. and *Mitragyna speciosa* Korth. for isolation of bioactive and novel chemical compounds. UTM has worked on the chemistry of the ginger family and USM on antimalarial drugs from plants and tissue culture work for the production of high yielding medicinal plants (Anonymous, 2003).

The University Malaysia Sabah is focusing on multidisciplinary research in building phytochemical and genomics databases, designing new methodology, discovering novel molecules and uncovering new uses of known molecules to be developed as pharmaceuticals and neutraceuticals. In Sabah, an ethnobotanical garden for conservation and research on the important medicinal plants used by local communities has been established. In 1998, the Forestry Research Centre, Sabah conducted an ethnobotanical survey of the Tatana people from the Kadazandusun tribe (largest group occupying the area) in Kuala Penyur districts and documented 87 medicinal plants used by the tribal people for treating various diseases (Kulip *et al.*, 2003). A proposal for setting up a herbarium and an integrated database on non timber forest products including medicinal and aromatic plant is also under consideration by the government.

The University Malaysia Sarawak (Unimas) has been involved indirectly with the identification of several anti-HIV components. Calanolide A and other calanolides with anti-HIV activity were originally isolated from *Calophyllum lanigerum* Miq. tree cuttings found in Lundu, Sarawak. A joint venture company Sarawak MediChem Pharmaceuticals, Inc. was set up by the Sarawak Government and MediChem Research, Inc. to look into the primary clinical development of (+)-Calanolide A for the treatment of HIV and the development of other compounds displaying antiviral activities. In addition the storage properties of the latex of two of the *Calophyllum* spp. are being investigated in collaboration with the College of Pharmacy at the University of Illinois at Chicago, U.S.A (Anonymous, 2003).

In a project under the Intensification of Research in Priority Areas (IRPA) scheme of the government, scientists from Malaysia's National University has compiled a book entitled *Malaysia's Medicinal Plants*. The book, released in 2002, describes the medicinal values and properties of 915 species of local plants. This is one of the most comprehensive works on the medicinal plants of the country after *A Dictionary of Economic Products of the Malay Peninsular* published in 1935. The Malaysian government has allocated US$0.42 billion (Malaysia Ringgit (MYR) 1.6 billion) under the Eighth Malaysian Plan (2001-2005) and US$236.84 million (MYR 900 million) under the Intensification of Research in Priority Areas (IPRA) grant scheme for the research and development on medicinal and aromatic plant in the country (Anonymous, 2003).

An area of 250 hectares in Sg. Klah, Sungkai, Perak has been allocated by the

government for a project on cultivation of medicinal plants. A number of medicinal and aromatic plants have been identified for planting. Lembaga Kemajuan Kelantan Selatan (KESEDAR), South Kelantan Development Authority is collaborating with FRIM on a project on the mass production of medicinal plants of commercial importance. A total area of 60 hectares has been allocated in Gua Musang, Kelantan for this project (Mohd Ilham *et al.*, 2003). The two national committees National Medicinal Plant Committee and the MIGHT Interest Group on Herbs have helped in bringing about partnerships between various industries, researchers and universities working on medicinal plants.

Trade and Marketing

Medicinal plants are usually collected from the forest and sold to the traditional practitioners in fresh or dried form. A licence is required for collection of medicinal plants from the forests. Since royalties are not collected, the exact medicinal and aromatic plant production figures can not be estimated.

The pharmaceutical and natural product industries use medicinal plant extracts, standardize their active constituents and process them for the production of functional foods, herbal drugs and tonics. Current statistics show that the country's herbal industry has 104 traditional medicine manufacturing premises, mostly in the Peninsular Malaysia. There are 53 traditional medicine manufacturers producing medicines in various forms such as pills (43), powders (41), external preparations (28), syrups (18), tea bags (13), tablets (11), tonics (10) and plasters (3). However, currently most of the products are imported. Malaysia consumes about US$0.31 billion (MYR 1.2 billion) worth of imported herbal products annually (Anonymous, 2001).

The country's herbal and medicinal plant industry is worth US$1.19 billion (MYR 4.55 billion) with local market share of only 5%. In 2000, Malaysia exported US$79.64 million (MYR 302.63 million) worth of medicinal and pharmaceutical products which was 5.7% higher compared to the previous year. The imports were also up by 6.51% over the previous year and amounted to US$346.12 million (MYR 1315.25 million). China, India and Indonesia were the top countries for import while the main export destinations were Singapore, Japan, Hong Kong, Brunei and Viet Nam. Garlic is the important import item under the spice category. The export of ginger declined from US$0.63 million (MYR 2.4 million) in 1992 to US$0.16 million (MYR 0.6 million) in 1996. The import and export values of medicinal and aromatic plant for 1995-1999 are given in Table 3 (Anonymous, 2000).

Problems and Constraints

The government is addressing such issues as the shortage of quality local raw

materials, cultivation activities, standards, technological mechanization, skilled human resources and scientific evidence for health related claims through the implementation of the New National Agriculture Policy. The country's traditional knowledge on medicinal plants is likely to be lost with the current elderly generation of healers due to a lack of awareness and interest among the younger generations. Documentation and preservation of indigenous knowledge must be accorded high priority if future generations intend to benefit from it to overcome some of the new emerging problems in health, agriculture and the pharmaceutical industry. There is a need for integration of various disciplines to make the herbal industry a more scientific one that will eventually lead to international recognition in terms of safety, quality and efficacy of products. In order to facilitate the herbal industry to enter the international market, commercially viable medicinal plant species need to be identified with efficacies that have been scientifically validated.

Table 1: List of some medicinal and aromatic plants of Malaysia

Botanical name	Family	Uses/Indications
Aloe barbadensis Mill. (=*Aloe vera* (L.) Burm. f.)	Asphodelaceae	For hair care, as facial cleanser
Andrographis paniculata (Burm. f.) Wall. ex Nees	Acanthaceae	As herbal tea
Areca catechu L.	Arecaceae	In tapeworms, round worms infestation
Baeckea frutescens L.	Myrtaceae	As fragrance
Blumea balsamifera (L.) DC.	Asteraceae	As health tonic, lotion
Cananga odorata (Lam.) Hook. f. & Thomson	Annonaceae	For hair care, in perfumery
Cassia alata L. (=Senna alata (L.) Roxb.)	Fabaceae	As antiseptic
Centella asiatica (L.) Urban	Apiaceae	As health tonic
Cinnamomum sintoc Blume	Lauraceae	In cosmetics
Cinnamomum zeylanicum Blume (=*Cinnamomum verum* J. Presl)	Lauraceae	As spice, fragrance
Citrus spp.	Rutaceae	In perfumery, cleanser
Curcuma domestica Valeton (=*Curcuma longa* L.)	Zingiberaceae	As cosmetic, food additive
Cymbopogon nardus (L.) Rendle	Poaceae	In cosmetics, insect repellent
Eugenia aromatica (L.) Baill., nom. illeg. (=*Syzygium aromaticum* (L.) Merr. & L. M. Perry)	Myrtaceae	In toothache
Eurycoma longifolia Jack	Simaroubaceae	As aphrodisiac, tonic, in fever
Jasminum sambac (L.) Aiton	Oleaceae	As fragrance
Kaempferia galanga L.	Zingiberaceae	As spice
Labisia pumila Benth. & Hook. f.	Myrsinaceae	In post-partum preparation
Lawsonia inermis L.	Lythraceae	In cosmetics
Leptospermum flavescens Sm. (=*Leptospermum polygalifolium* Salisb.)	Myrtaceae	As health tonic
Melaleuca cajuputi Powell	Myrtaceae	As analgesic
Melastoma decemfidum Roxb. (=*Melastoma sanguineum* Sims)	Melastomataceae	In intestinal measles
Mentha arvensis L.	Lamiaceae	In toothpaste

Continued

Table 1 continued

Botanical name	Family	Uses/Indications
Michelia champaca L.	Magnoliaceae	In cosmetics
Morinda citrifolia L.	Rubiaceae	As health tonic
Myristica fragrans Houtt.	Myristicaceae	In diarrhoea, vomiting, indigestion, abdominal pain
Ocimum basilicum L.	Lamiaceae	In cosmetics
Oldenlandia diffusa (Willd.) Roxb.	Rubiaceae	In dysentery, snakebite
Piper nigrum L.	Piperaceae	As flavour
Smilax myosotiflora A. DC.	Smilacaceae	As health tonic
Zingiber zerumbet (L.) Sm.	Zingiberaceae	In Jamu preparations

Table 2: Some leading medicinal and aromatic plants of Malaysia

Botanical name	Chemical constituents	Uses/Indications	Part(s) used	Comments
Andrographis paniculata (Burm. f.) Wall. ex Nees	Bitter principles, the most active ingredient is andrographolide	As febrifuge, tonic, antispasmodic, anthelmintic, stomachic, alterative	Above ground parts, especially leaves	Andrographolide is currently being studied by Institute for Medical Research and University Science Malaysia as a chemical/bioactive marker in extract standardizations and formulations.
Centella asiatica (L.) Urb.	Triterpenoids, flavonoids	As cardio-depressant, hypotensive, weakly sedative, tonic, treatment for skin diseases	Whole plant	The cultivated areas are generally less than 20 hectares. No current official statistics on the total cultivated area.
Eurycoma longifolia Jack	Alkaloids, quassinoids	In high blood pressure, fever, diarrhoea, jaundice	Roots, root bark, leaves	Mainly from wild resources. A large-scale cultivation of the plant has only started recently.
Labisia pumila (Bl.) F. Vill. & Naves	Benzoquinone & alkenyl resorcinols	To expedite labour during childbirth, it revitalizes body, in diarrhoea	Roots, leaves, stems, entire plant	No commercial cultivations. Collected mainly from forests.
Orthosiphon stamineus Benth.	Polyphenols caffeic acid derivatives & diterpene	In kidney diseases & urinary stones, arteriosclerosis, circulatory disorders	Leaves, entire plant	Cultivated mainly by smallholders on lands of approximately 10 hectares. The domestic market demand is still dependent on imported materials.

Table 3: Malaysian trade in medicinal and aromatic plants (1995 - 1999)

Year	Imports (US$)	Exports (US$)
1995	107,867,708.95	12,209,523.42
1996	113,305,569.47	16,682,456.05

Continued

Table 3 continued

Year	Imports (US$)	Exports (US$)
1997	100,923,702.63	13,902,091.05
1998	103,572,941.05	12,572,330.53
1999	164,912,154.74	21,880,813.16

(I US$ = 3.80000 MYR)

Photographs of some leading medicinal and aromatic plants of Malaysia

Fruiting and flowering twigs of *Andrographis paniculata* (Burm. f.) Wall. ex Nees

Fruits and habitat of *Centella asiatica* (L.) Urb. At fruiting stage

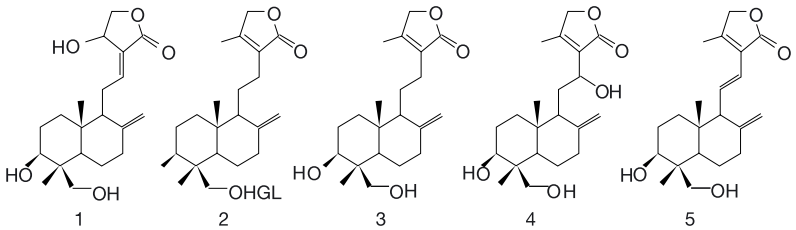
Fruits, leaves and six-year old plants of *Eurycoma longifolia* Jack (Tongkat Ali)

Habit and close up of *Labisia pumila* (Bl.) F. Vill. & Naves

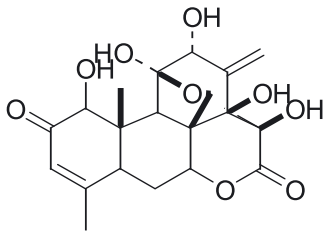
Labisia pumila var. alata with inflorescence & fruits

Flowering plants of *Orthosiphon stamineus* Benth.

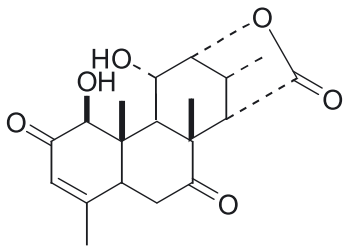
Some important molecules from Malaysian medicinal and aromatic plants



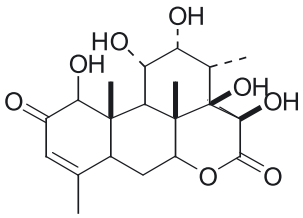
Chemical constituents from *Andrographis paniculata* (Burm. f.) Wall. ex Nees 1) andrographolide 2) neoandrographolide 3) 14-deoxyandrographolide 4) 14-deoxy-11,12-dihydroandrographolide 5) 14-deoxy-12-hydroxyandrographolide



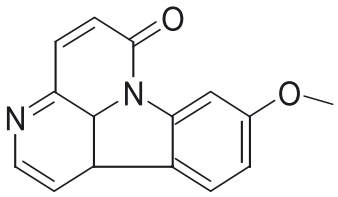
Eurycomanone



Eurycomalactone



14, 15 ß-dihydroxyklaineanone



9-methoxy-canthine-6-one

Chemical constituents of *Eurycoma longifolia* Jack

2.7 Myanmar

Myanmar is the largest country in Southeast Asia with an area of 676,553 square kilometres. It shares its border with Bangladesh, India and the Bay of Bengal in the west, China in the northeast, Lao PDR and Thailand in the east and the Andaman Sea to the south. Myanmar is a poor country having a population of more than 51 million of which 80% live in rural areas. Agriculture along with forestry is the major contributor to the national economy. The country is rich in forest resources with 43% of the total area under forest cover. These forests provide valuable medicinal and aromatic plants for the preparation of various traditional remedies used commonly by the people. Sash and burn cultivation, encroachment of forests for agriculture and illegal felling have however, resulted in considerable decline in forest resources. The government has made reforestation and conservation of its natural resources a top priority by involving the rural communities in the forestry development programmes.

Traditional Medicine Systems

The rural communities of Myanmar have been using traditional medicines since ancient times. Myanmar traditional medicine system is based on Buddhist philosophy and the theories of Ayurveda. It has developed through the long history of the country with the contribution of several famous physicians since the times of the Myanmar

kings. Traditional medicine was the only health care system serving people from all walks of life until the introduction of modern medicine.

Allopathic medicine were promoted over traditional medicine, from the beginning of the colonial period (1885) in Myanmar. Traditional medicine regained prominence due to the shortage of allopathic medicines during World War II. Since then it has been encouraged and people now rely more on these rather than on modern medicine for health care (WHO, 2001). These now play an important role in the health care of people in remote and rural areas with the use of herbal medicines also gaining popularity among the urban populations.

Government Efforts in Development of Traditional Medicine

The Myanmar government has been giving priority to the development of traditional medicine for public health care services. It is working for the systematic development of traditional medicines. Various development programmes on the conservation of medicinal plants, supporting the indigenous medicine practitioners, encouraging research and developmental activities have been implemented by the government.

The Ministry of Health established the Institute of Indigenous Medicine in 1976 and the Department of Traditional Medicine in 1989 for promotion, preservation and training of traditional medicine in the country. Traditional medicine hospitals were opened in a number of cities (Maung, 1997). At present there are two 60-bed, two 50-bed, ten 16-bed traditional medicine hospitals and 214 district and town level traditional medicine centres providing traditional medicine services throughout the country (Anonymous, 2003).

The traditional medicine development project has been included in the national health plans and the government is working for the implementation of the following objectives:

- Enabling the skills of traditional medicine practitioners and making arrangements for conducting successive training programmes;
- Open more traditional medicine hospitals and treatment centres to improve health care services;
- Promote and conduct research on traditional medicine; and
- Provide necessary assistance for manufacturing standard traditional medicines.

The Institute of Traditional Medicine was upgraded and in 2001 the University of Traditional Medicine was established in Mandalay with the objective of producing qualified traditional medicine practitioners. Attempts have been made to integrate traditional and modern medicines in combating health problems and diseases such as diabetes, hypertension, malaria and tuberculosis (Nyunt, 2002).

The Myanmar Indigenous Medical Committee instituted in 1952, drafted the Indigeneous Myanmar Medical Practitioners Board Act 74 (renamed recently to the Traditional Medicine Council Law), which was passed in 1953 and amended in 1955, 1962 and 1984. The Act established Indigeneous Myanmar Medical Practitioners Board, for giving advice to the government on research, development, revival and promotion of public health through traditional medicine. The Ministry of Health enacted Traditional Medicine Law and Traditional Medicine Council Law for the development of quality, production, sales and systematic use of traditional medicine and treatment in health care (WHO, 2001). Myanmar Traditional Medicine Practitioners Association was founded to apply advanced research methods to traditional medicine progress, restoring the medicines, therapies and treatises of traditional medicine, providing better health care by traditional medicine and enabling them to take part in implementing the health projects of the government. Since the promulgation of the Traditional Medicine Law in 1996, a total of 3,678 traditional medicines have been registered and 632 manufacturers have been issued production licences. The national post marketing surveillance system does not include adverse effect monitoring, but such a system is being planned. Herbal medicines are sold as over the counter medicines without any restriction (WHO, 2005).

Medicinal and Aromatic Plant Resources

About 7,000 plant species have been recorded so far in Myanmar with 1,071 as endemic. Various plants have been used as sources of indigeneous medicines by the people. The demand for medicinal plants and herbal raw materials has increased as a result of up grading of indigeneous medicines by the Myanmar Medical Research Department and the pharmaceutical industry. However, there is limited cultivation of medicinal plants in the country with the majority of them being collected from the forests. The plants such as *Aquilaria agallocha* Roxb., *Hesperethusa crenulata* (Roxb.) M. Roem., *Mansonia gagei* Drumm., *Premna integrifolia* L., *Pterocarpus santalinus* L. f. and *Santalum album* L. are found commonly and used in incense sticks, fragrances, production of cosmetics and medicines. Some important medicinal and aromatic plants found in Myanmar are listed in Table 1 (FAO, 2002).

Research and Development Activities

The Myanmar government is determined to preserve its heritage of traditional medicine knowledge, which has been neglected in the past. Various programmes on the establishment of herbal gardens for conservation and cultivation of medicinal plants have been implemented and research is aimed at inventing new drugs from plants. Many institutions and universities are engaged in research on botanical, chemical and medicinal aspects of

native medicinal plants. National level conferences on traditional medicine are being organized in different parts of the country (Anonymous, 2002). The dosages for 48 kinds of indigenous medicines have been standardized and their efficacy has been tested as a result of these efforts. The country is working to raise the standard of its traditional medicine.

In order to produce raw material for drug manufacturing factories, rare and potent medicinal plants have been cultivated on about 81 hectares at nine herbal gardens established in different parts of the country (Anonymous, 2000). Some work for the development of new drugs from plants has also been carried out by the Department of Medical Research of the Ministry of Health.

The University of Yangoon is focusing its research mainly on folk medicinal herbs, their pharmacognostic studies and bioassays of plants with antitumor, antipyretic and antidiabetic properties. Some of the research projects carried out by the university is focused on antibacterial and antituberculosis activities of Myanmar's traditional medicines. (Thu, 2002).

Trade and Marketing

Trade information is greatly understated because of the illegal trade activities. All the medicinal items are listed under essential import items as the local production of medicinal herbs is very low and the domestic pharmaceutical production falls short of internal demand. The medicinal plants and pharmaceutical drugs are largely imported from neighbouring countries such as Bangladesh, China, India and Thailand. Local manufacturers cater to the needs of domestic markets with some export of the traditional drugs to neighboring countries such as China and Thailand but the trade is largely illegal and thus unrecorded (Anonymous, 1995).

Problems and Constraints

Traditional medicine has been used for a long time without standardization and quality control measures. The lack of appropriate post harvest technologies, including collection, harvesting, drying, packaging and storage, standards for quality and safety of traditional drugs, skilled personnel, raw material, equipment, technology for drug manufacture and research are the major constraints in the commercial development of this sector.

Table 1: Some common medicinal and aromatic plants of Myanmar

Botanical name	Family	Part(s) used	Uses/Indications
Acacia arabica (Lam.) Willd.	Fabaceae	Bark	As astringent, in diarrhoea
Adina cordifolia (Roxb.) Hook. f. ex Brandis	Rubiaceae	Bark	As tonic, febrifuge, antiseptic
Alpinia galanga (L.) Sw.	Zingiberaceae	Root	As aromatic

Continued

Table 1 continued

Botanical name	Family	Part(s) used	Uses/Indications
Aquilaria agallocha Roxb.	Thymelaeaceae	Wood	As aromatic, stimulant, aphrodisiac, tonic, diuretic
Aristolochia tagala Cham.	Aristolochiaceae	Root	As tonic, carminative
Butea frondosa Roxb. ex Willd., nom. illeg.	Fabaceae	Flower	As astringent
Cassia angustifolia Vahl	Fabaceae	Leaf	As laxative
Citrus medica L.	Rutaceae	Peel	In scurvy
Curcuma longa L.	Zingiberaceae	Rhizome	As anti-inflammatory
Cyperus rotundus L.	Cyperaceae	Tubers	As liver tonic, digestive tonic
Eclipta alba (L.) Hassk.	Asteraceae	Whole plant	As antihepatotoxic
Emblica officinalis Gaertn.	Euphorbiaceae	Fruit	As antioxidant, tonic
Litsea glutinosa (Lour.) C. B. Rob.	Lauraceae	Leaf, bark	In gastro-intestinal disorders
Nigella sativa L.	Ranunculaceae	Seed	As anthelmintic, carminative
Phyllanthus amarus Schumach. & Thonn.	Euphorbiaceae	Whole plant	In jaundice, gonorrhoea. diabetes
Piper betel (Linn.)	Piperaceae	Leaf	As antiseptic, poultice for boils
Pterocarpus santalinus L. f.	Fabaceae	Bark	As astringent, in diarrhoea
Rauvolfia serpentina Benth. et Kurz.	Apocynaceae	Root	As hypotensive, sedative
Santalum album L.	Santalaceae	Wood	As antiseptic

2.8 Philippines

The Republic of the Philippines is an archipelago of some 7,100 islands. It is bounded on the east by the Philippine Sea, on the south by the Celebes Sea and on the west by the South China Sea. The country is divided into four geographic regions namely Luzon, Mindanao, Palawan and Visayas, which are further subdivided into 13 administrative regions and 71 provinces. During the period 1960s to 1980s the extensive clearing of forests for agriculture resulted in major deforestation and degradation leaving the forest cover at about 20% of the total area and 70 parks and reserves under the protected area network. The country has vast potential resources of medicinal and aromatic plants that could be commercially exploited.

Traditional Medicine Systems

Traditional medicine is commonly used in the Philippines. The record of their use in the country goes back to before the 1800s. The use of traditional medicine is more prevalent in rural areas than in urban areas where it is continuously sought out despite the availability of modern hospitals and clinics. Even people in the cities or towns visit a folk doctor for certain ailments before consulting a medical doctor. More than 80% of the rural population uses herbal remedies (FAO, 2002).

Folk medicine practitioners are known as albularyo. Various other types of folk healers include the herbalist (mangngagas), the bonesetter (mammullo), the obstetrician (partera) and other specialists such as snake or animal bite curers (mannuma) and shamans or spiritual healers (mangallag). All these traditional practices have common roots with other traditional healing methods in Southeast Asian countries including Burma, Cambodia, Indonesia, Lao PDR, Malaysia, Thailand, Viet Nam and outlying islands (Apostol, 2003). The regulations on herbal medicine were issued in 1984; these regulations are separate from those of conventional pharmaceuticals. Herbal medicines are regulated as over the counter medicines. By law medical claims may be made for herbal medicines with supporting scientific proof (WHO, 2005).

Government Efforts in Development of Traditional Medicine

The National Health Care Delivery System of the Philippines is mainly allopathic. There are about 250,000 traditional medicine practitioners and five to eight chiropractors in the Philippines. No private hospitals formally provide traditional medical services. Only a handful of government hospitals offer acupuncture services to the general public. With technical support from WHO, a traditional medicine division to support the integration of traditional medicine into the national health care system was established within the Department of Health in 1993. The Traditional and Alternative Medicine Act of December 1997, states that it is the policy of the government to improve the quality and delivery of health care services to the people through the development of traditional medicine and its integration into the national health care system. Following the Act, the Philippine Institute of Traditional and Alternative Health Care (PITAHC), was established to oversee and promote the use of herbal medicines in the Philippines. Training in traditional medicine for allopathic practitioners is a priority. Collaboration on education and research between various Philippine institutions with those in other countries has also been established. The Board of Medicine Resolution 31 of 2 March 1983 recognizes acupuncture as a mode of treatment for certain ailments to be practised only by registered physicians. The Board also governs the practice of acupuncture and evaluates the annual reports of traditional practitioners in order to decide if they should continue to practise. There are more than 200 government allopathic physicians trained in acupuncture. There is no chiropractic law in the Philippines at present (WHO, 2001). Pending the development of a national pharmacopoeia, the *United States Pharmacopoeia*, the *Japanese Pharmacopoeia* and the ESCOP monographs are used and are considered to be legally binding (WHO, 2005).

A group of researchers from different institutions formed the National Integrated Research Program on Medicinal Plants (NIRPROMP) in 1974 to carry out research on medicinal plants in order to provide safe, effective and affordable herbal medicines

(Hao, 2000). The Letter of Instruction, 1973 was issued by the Department of Education to encourage state schools to include medicinal plants in health education.

Medicinal and Aromatic Plant Resources

The Philippines has about 13,500 plant species with about 3,500 endemic and 1,500 medicinal plants (Tan, 2003). More than 50 plants which contain essential oils have been identified. The plants *Aleurites moluccana* (L.) Willd., *Aleurites saponaria* Blanco, *Andropogon nardus* L., *Cananga odorata* (Lam.) Hook. f. & Thomson, *Cymbopogon citratus* (DC.) Stapf and *Vetiveria zizanioides* (L.) Nash have the potential for commercial exploitation (FAO, 2002). Medicinal and aromatic plants are generally collected from the forest by the rural communities for their own use and commercial purposes. Some common medicinal and aromatic plants of the Philippines and their traditional uses are listed in Table 1 (Anonymous, 1995).

Research and Development Activities

The cultivation of medicinal and aromatic plants in the Philippines dates back to pre-Spanish times. Their studies were mostly documented by Spanish missionaries. A book, *Medicinal Plants of Philippines*, written by Dr Pardo de Tavera in 1892 (WHO, 1998) and reprinted in 1978, describes 850 medicinal plants found in the country. More than 200 plants with potential phytochemicals have been identified and 84 medicinal plants have been included in *The Philippine National Formulary (Volume 1)*, 1978. There are 32 monographs of 55 priority medicinal species of the Philippines included in *The Philippines Pharmacopoeia Part II* of BFAD-DOH (Tan, 2003).

Research on herbal medicine is expanding rapidly in the Philippines. A number of institutions mainly the University of the Philippines, Los Banos (UPLB), the University of Santo Thomas, Ateneo de Manila University and De La Salle University are engaged in research and promotion of herbal medicine in the country. The institutions involved in NIRPROMP such as the colleges of Agriculture, Science, Medicine, and Pharmacy of the University of the Philippines; the National Institute of Science and Technology and the departments of Health, Education, Culture and Sports, and Agriculture have focused on studies on production and propagation of medicinal and aromatic plants in addition to the agricultural, medical, pharmaceutical and phytochemical components and their marketing. As a result of the research carried out by the National Integrated Research Program on Medicinal Plants (NIRPROMP), the Department of Health has identified 10 plants (Table 2) for promotion. PITAHC has also produced a guidebook on the use of these plants. Among these only *Blumea balsamifera* (L.) DC., *Momordica charantia* L. and *Vitex negundo* L. are currently marketed (Hao, 2000).

The UPLB and University of the Philippines, Manila have taken initiatives to bring together the members of NIRPROMP and also started a series of seminars to determine the state of research and technology of medicinal plants and to assess business opportunities. The seminar series aims to identify technologies, research gaps in validation, production, processing and marketing of medicinal plants and the identification of the next 10 priority species (Dominguita, 2003).

Trade and Marketing

The increased demand for natural products has resulted in the expansion and establishment of a number of medicinal and aromatic plant production farms. The cooperative government manufacturing units do not meet the demand for herbal products, most of which are distributed through the Department of Health, its subsidiaries and community projects throughout the country. A number of imported herbal products have also entered the market (Kraisintu, 2003). The annual Philippine herbal market was estimated at US$30 to 50 million compared to synthetic drug sales of US$1 billion in 2001. Herbal medicines, except for relief from *Blumea balsamifera* (L.) DC., Amargozin from *Momordica charantia* L. and Ascof from *Vitex negundo* L. are mostly sold as nutritional supplements or teas. The other plants currently sold on the retail market include Banaba (*Lagerstroemia speciosa* (L.) Pers.), Malunggay (*Moringa oleifera* Lam.), Luya (*Zingiber officinale* Roscoe) and tea blends of various medicinal plants. PITAHC has four herbal medicine factories in Cotabato, Davao, Tacloban and Tuguegarao (Tan, 2003).

The production of aromatic plants is higher compared to medicinal plants in some regions. However, due to inefficient manufacturing practices, more than 90% of raw materials are imported. In 1997, the cosmetic and pharmaceutical industries imported essential oil products worth US$96.5 million (FAO, 2002).

The Department of Trade and Industry through CITEM holds the annual trade fare, Bio-Search in June showcasing Philippine organic and herbal medicine products. CITEM also participates in major international trade shows abroad to promote Philippine herbals (Tan, 2003). Bio-Search, 2003 exceeded its sale target by 81% and generated a total of US$0.045 million (Philippine Pesos 2.5 million). The event highlights organically grown fresh produce and processed food, nutraceuticals and herbal medicines and other commodities. The Philippines seeks to establish itself as a reliable global source of medicinal and aromatic plant raw material and finished products.

Problems and Constraints

The Philippines herbal industry is in the early developmental stages and the full potential of country's medicinal and aromatic plant resources has not yet been exploited.

Lack of collaboration among research institutions, the private and public sectors, lack of investment in research and development, raw material production, post harvest processing and herbal manufacturing, the low level of scientific technology in herbal medicine research and manufacture among small and medium sized enterprises are the main problems in commercial development of medicinal and aromatic plant resources in the Philippines. There are no standardized procedures in local manufacture of most herbal products and slow registration processes are a major deterrent in herbal products development.

Table 1: Some common medicinal and aromatic plants of the Philippines

Botanical name	Family	Part(s) used	Uses/Indications
Abrus precatorius L.	Fabaceae	Leaf	In conjunctivitis, colic, flu, fever, cold
Allium cepa L.	Liliaceae	Bulb	Diuretic, emmenagogue
Allium odorum L.	Alliaceae	Leaf	In wounds, bruises
Allium sativum L.	Liliaceae	Clove	In blood pressure
Aloe vera (L.) Burm. f.	Asphodelaceae	Leaf juice	In falling hair, baldness
Alstonia scholaris (L.) R. Br.	Apocynaceae	Bark	In fever, diarrhoea, diabetes, as anthelmintic
Artemisia vulgaris L.	Asteraceae	Leaf	As expectorant, antispasmodic, carminative, emmenagogue
Blumea balsamifera (L.) DC.	Asteraceae	Leaf	As anti-spasmodic, astringent, expectorant
Carthamus tinctorius L.	Asteraceae	Flower	As carminative
Carmona retusa (Vahl) Masam.	Boraginaceae	Leaf	In colic, as anti-diarrhoeal
Cassia acutifolia Delile	Fabaceae	Seed	As laxative
Cassia alata L.	Fabaceae	Leaf	In skin diseases, athlete's foot
Cassia fistula L.	Fabaceae	Seed	As laxative
Catharanthus roseus (L.) G. Don	Apocynaceae	Leaf, root	As anti-diabetic, vermifuge, purgative
Centella asiatica (L.) Urb.	Apiaceae	Leaf	As diuretic, in wounds
Chrysanthemum indicum L.	Asteraceae	Flower	In stomach pain, colic, cervix infection
Cinnamomum zeylanicum Blume	Lauraceae	Flower	In urinary, kidney and stomach troubles
Clausena anisum-olens (Blanco) Merr.	Rutaceae	Leaf	In headache, dizziness, cough, asthma, bronchitis
Coleus blumei Benth.	Lamiaceae	Leaf	In bruises and contusions
Coriandrum sativum L.	Apiaceae	Fruit	In chicken pox
Curcuma longa L.	Zingiberaceae	Rhizome	In wounds, bruises
Curcuma zedoaria (Christm.) Roscoe	Zingiberaceae	Rhizome	In abdominal cramps, pains, amenorrhoea
Cymbopogon citratus (DC.) Stapf	Poaceae	Root, leaf	As diuretic, diaphoretic
Cymbopogon nardus (L.) Rendle	Poaceae	Leaf	In fever
Datura metel L.	Solanaceae	Leaf, flower	In asthma, as narcotic, anodyne, antispasmodic
Eucalyptus sp.	Myrtaceae	Leaf	In cough, as anesthetic, antiseptic
Euphorbia hirta L.	Euphorbiaceae	Leaf	In cataract, dermatitis
Foeniculum vulgare Mill.	Apiaceae	Fruit	In gaseous distention
Garcinia mangostana L.	Guttiferae	Fruit peel	In diarrhoea

Continued

Table 1 continued

Botanical name	Family	Part(s) used	Uses/Indications
Hibiscus rosa-sinensis L.	Malvaceae	Flower	As poultice for boils, in cancerous swelling, mumps
Isotoma longiflora (L.) C. Presl	Campanulaceae	Leaf	In wound healing
Jasminum sambac (L.) Aiton	Oleaceae	Leaf, flower	As anti-pyretic, decongestant, in diarrhoea
Jatropha curcas L.	Euphorbiaceae	Bark	As poultice for sprains and dislocation
Kaempferia galanga L.	Zingiberaceae	Leaf, rhizome	In sore throat, rheumatism, swelling, as tonic
Lagerstroemia speciosa (L.) Pers.	Lythraceae	Leaf	In fever, diabetes, diarrhoea, as diuretic
Lantana camara L.	Verbenaceae	Leaf	As an antidote, as poultice for sprains
Lawsonia alba Lam.	Lythraceae	Root, leaf	As emmenagogue, anthelmintic
Leucosyke capitellata (Poir.) Wedd.	Urticaceae	Root	In cough, headache, tuberculosis
Lygodium flexuosum	Schizaeaceae	Root, leaf	In skin problems
Mangifera indica L.	Anacardiaceae	Root, leaf	As diuretic, in sore throat, cough, colds
Mentha arvensis L.	Lamiaceae	Leaf	As antispasmodic, carminative
Mentha cordifolia Opiz ex Fresen.	Lamiaceae	Leaf	In headache, toothache, stomachache
Mentha spicata L.	Lamiaceae	Leaf	In colds, gaseous distention
Momordica charantia L.	Cucurbitaceae	Fruit, leaf	In chronic colitis, bacillary dysentery, cough, as colic astringent
Nopalea cochenillifera (L.) Salm-Dyck	Cactaceae	Stem	In rheumatism, earache, toothache
Ocimum sanctum L.	Lamiaceae	Leaf	As aromatic, stimulant, in paralysis, cough colds
Pandanus odoratissimus auct.	Pandanaceae	Oil	As purgative, cardiotonic, in small pox
Portulaca oleracea L.	Portulacaceae	Leaf, root	In wounds, ulcers, cough, colds
Premna odorata Blanco	Lamiaceae	Leaf	In fever, as expectorant
Quisqualis indica L.	Combretaceae	Fruit	As antihelmintic
Ricinus communis L.	Euphorbiaceae	Seed	As purgative, anti-rheumatic, arthritis, in paralysis, epilepsy
Solanum surattense Burm. f.	Solanaceae	Leaf	In boils
Tagetes erecta L.	Asteraceae	Flower	As tonic, in dysmenorrhoea
Tinospora crispa (L.) Hook. f. & Thomson	Menispermaceae	Bark, leaf	In eczema, rheumatism
Triphasia trifolia (Burm. f.) P. Wilson	Rutaceae	Leaf	In colic, diarrhoea, skin diseases
Vitex negundo L.	Verbenaceae	Leaf	In colds, cough, fever, muscular pain
Vitex trifolia L.	Verbenaceae	Leaf	As analgesic, diuretic, emmenagogue, febrifuge
Zingiber officinale Roscoe	Zingiberaceae	Rhizome	In rheumatism, sore throat, cough, as stimulant, stomachic, carminative

Table 2: Ten plants promoted by the Philippines Department of Health

Botanical name	Local name	Family	Uses/Indications
Allium sativum L.	Bawang	Liliaceae	Lowers blood cholesterol
Blumea balsamifera (L.) DC.	Sambong	Asteraceae	As diuretic, urinary tract stones
Cassia alata L.	Akapulko	Fabaceae	In fungal infections, athlete's foot, scabies

Continued

Table 2 continued

Botanical name	Local name	Family	Uses/Indications
Ehretia microphylla Lam.	Tsaang Gubat	Boraginaceae	In abdominal pain
Mentha cordifolia Opiz ex Fresen.	Yerba buena	Lamiaceae	In body aches and pains
Momordica charantia L.	Ampalaya	Cucurbitaceae	In diabetes
Peperomia pellucida (L.) Kunth	Ulasimang Bato	Piperaceae	Lowers serum uric acid levels in patients with gout
Psidium guajava L.	Bayabas	Myrtaceae	In wounds, mouth sores, swelling gums, dental caries
Quisqualis indica L.	Niyug-niyogan	Combretaceae	In ascaris infection
Vitex negundo L.	Lagundi	Verbenaceae	In cough, asthma, fever

2.9 Singapore

The Republic of Singapore is located off the southern tip of the Malay Peninsula. It is comprised of one main island (604.2 square kilometres) and a number of islets scattered to the northeast and south. The major island is separated from Malaysia on the north by the narrow Johor Strait and is connected by two causeways. The main island is separated from Indonesia's Riau Archipelago by the Singapore Strait to the south. The total area of Singapore, including the main island and all the islets is 697.1 square kilometres. It is one of the most densely populated countries in the world with about 4.19 million people. More than half the island is urban and the rainforests that once covered the island now occupy only 7% of the total land area. The major forest reserves are the Bukit Timah Nature Reserve and the Central Catchment Nature Reserve, the only substantial area of primary rainforests left in Singapore and the Sungei Buloh Wetland Reserve and Pulau Ubin, which contain areas of remnant rainforests, mangroves, rubber and coconut plantations.

Traditional Medicine Systems

The health care services of Singapore are based on allopathic medicine however it is common practice among various ethnic groups to consult traditional medicine practitioners for general ailments. Chinese, Indian and Malay traditional therapies form part of the complementary health care of Singapore. A 1997 list published by the local traditional Chinese medicine community reported 1,807 traditional Chinese medicine (TCM) practitioners in Singapore. Half of these practitioners practised TCM on a fulltime basis, one-third practised part-time and the remainder were not practising at the time of listing. There are approximately 10 chiropractors practising in the country. About 10,000 persons visit TCM clinics everyday, compared to 74,000 persons who visit allopathic clinics. In the

Republic of Singapore, the national policy on traditional medicine was issued in 1995. In 2000, the TCM Practitioner Act established regulations on traditional medicine. There are national regulations on herbal medicine. A subgroup of herbal remedies is Chinese Proprietary Medicine (CPM), which is traditional Chinese herbal medicine in finished dosage forms (e.g. tablet, capsules) (WHO, 2005).

Public interest in TCM has increased and continues to enjoy considerable popularity especially among the Chinese, however, its practice is mainly confined to outpatient care. A survey carried out by the Ministry of Health in 1994 showed that 45% of Singaporeans had consulted traditional medicine practitioners at one time and 19% of the population had consulted a traditional medicine practitioner during the last year (WHO, 2001). The Indonesian and Malay traditional medicine, Jamu is practised in Singapore and is especially popular among the Malay community (Tuschinsky, 1995). Singapore does not possess a national pharmacopoeia or national herbal monographs. There are currently, no registration requirements for herbal medicines and none are included in a national essential drug list. The post-marketing surveillance system for all herbal medicines has included adverse effect monitoring since 1993. There are no restrictions on the sale of herbal medicines, as long as they comply with the national regulations (WHO, 2005).

Government Efforts in Development of Traditional Medicine

The health authorities recognize the importance of traditional medicine in health care and have initiated efforts to promote and ensure their safe practice. In 1994, the Ministry of Health appointed the TCM Committee to review the practice of traditional Chinese medicine and recommend measures to safeguard patients' interests and safety and to enhance the standard of training of TCM practitioners. The committee report in 1995 recommended the regulation of TCM practices and the upgrading of training standards. A TCM Unit was set up in November 1995 by the Ministry to coordinate implementation of the Committee's recommendations. With effect from September 1999, new regulations requiring licensing, labelling and quality control for the control of Chinese proprietary medicines were enforced in Singapore. A TCM Practitioners Act passed in 2000, provides for the establishment of the TCM Practitioner Board to approve or reject applications for registration and accredit courses in the practice of TCM, among other things. A registered practitioner must make an application to the Board in order to obtain a certificate to practise TCM. Only registered acupuncturists can practise in Singapore.

The Minister for Health, under the power conferred by the TCM Practitioners Act of 2000, issued the TCM Practitioners (Registration of Acupuncturists) Regulations of 2001 that came into effect on 23 February 2001 and the TCM Practitioners (Register and Prac-

tising Certificates) Regulations of 2001 issued by the TCM Practitioners Board came into effect on 18 April 2001. There is no chiropractic law in the country. The majority of TCM practitioners has been trained locally by TCM schools. A standardized six-year part-time training programme in TCM has been adopted by Singapore and national examinations for both acupuncture and TCM are required for practitioners (WHO, 2001).

Medicinal and Aromatic Plant Resources

Singapore has very few natural resources and has lost up to 73% of its plants and animals over the last two centuries. More than 95% of Singapore's 540 square kilometres of tropical forest have been felled in the past mainly to cultivate agricultural crops such as black pepper and for urban development. Less than one tenth of the remaining 24 square kilometres of forest is old-growth vegetation and much of it has been re-established on abandoned farmland (Pickrell, 2003).

The primary rainforests in the country are confined mainly to the Bukit Timah Nature Reserve and the Central Catchment Nature Reserve, which are the only major areas of primary rainforest left in the country. The reserves are composed of a mixture of lowland and coastal hill forest and secondary forest. The nature reserves consist of 3,347 hectares and are managed by the National Parks Board, formed in 1990 (Webb, 2000). Some medicinal plant species found in Singapore are listed in Table 1 (Anonymous, 2003; Lim *et al.*, 2001; Wee, 1992).

Research and Development Activities

The Department of Pharmacy, National University of Singapore; Department of Medicine, National University Hospital; National Skin Centre; Health Sciences Authority of Singapore and Temasek Life Sciences Laboratory are some of the institutes involved in research and development work on TCM.

A TCM taskforce comprised of members from academia, research institutes and the industry was set up in 2000 by the Economic Development Board of Singapore. In a proposal submitted to the Biomedical Research Council of Singapore for review, the taskforce made several recommendations, including allocation of funds for TCM research and education and the creation of a university programme to raise the level of TCM education in the country (Anonymous, 2002). The TCM Committee recommended collaboration among TCM experts and western trained doctors/scientists to carry out research including clinical work in order to promote the development of TCM. The committee also recommended research collaboration with various institutes working on TCM abroad.

A regional meeting, *Singapore TCM Symposium 2001* and the US National Institutes of Health (NIH), the National Center for Complementary and Alternative Medi-

cine (NCCAM) workshop on *Clinical Research Methodology and Grantsmanship* was organized by the TCM Taskforce in November 2001 to encourage greater interaction among researchers. The NUS-John Hopkins Consortium for Botanical Drug Development together with the National University of Singapore and National University Hospital organized an international congress, *Herbal medicines; ancient cures, modern science* in February 2005 in Singapore.

The Centre for Analytical Science, Health Sciences Authority, Singapore has been working on chemical standardization of medicinal plants and has recently reported the extraction and isolation of components such as berberine, glycyrrhizin and baicalein from medicinal plants (Ong. and Len, 2003).

Trade and Marketing

Singapore is one of the main re-exporters of medicinal plants in Asia. The Trade Development Board reported that Singapore imported US$46.06 million (Singapore Dollars 79 million) worth of herbs and ginseng products in 1993. The local consumption of herbs has also increased during the last five years (WHO, 2001). According to the International Trade Centre the Singaporean imports under the category HS 121190 (plants and parts of the plants including seeds and fruits used primarily in perfumery, pharmacy or for insecticides etc. in fresh or dried forms) for 1997-2001 were US$34,057, 20,544, 22,717, 22,095 and 22,021 respectively.

The majority of Jamu medicines sold in Singapore is imported from Indonesia and some from Malaysia. A very limited amount is produced in Singapore using little machinery and manually intensive processes. These Jamu medicines are sold in the country without any packaging or other descriptions. Three companies are engaged in production and marketing of Jamu (Tuschinsky, 1995).

Problems and Constraints

Singapore's rapid urbanization and industrial growth have taken a heavy toll on its flora and resulted in depletion of many valuable medicinal and aromatic plant resources. There is a need for coordination and cooperation in research and conservation of these natural resources for the development of traditional medicine.

Table 1: List of some medicinal and aromatic plants found in Singapore

Botanical Name	Family
Abrus precatorius L.	Fabaceae
Acanthus ebracteatus Vahl.	Acanthaceae

Continued

Table 1 continued

Botanical Name	Family
Acanthus ilicifolius L.	Acanthaceae
Acanthus volubilis Wall.	Acanthaceae
Adiantum capillus-veneris L.	Adiantaceae
Ageratum conyzoides L.	Asteraceae
Allamanda cathartica L.	Apocynaceae
Aloe barbadensis Mill.	Liliaceae
Ardisia elliptica Thunb.	Myrsinaceae
Areca catechu L.	Arecaceae
Derris trifoliata Lour.	Leguminosae
Lumnitzera littorea (Jack) Voigt.	Combretaceae
Merope angulata (Willd.) Swingle	Rutaceae
Nepenthes gracilis Korth.	Nepenthaceae
Rhizophora mucronata Lam.	Rhizophoraceae
Scyphiphora hydrophyllacea Gaertn. f.	Rubiaceae
Sonneratia caseolaris (L.) Engler	Sonneratiaceae
Xylocarpus granatum J. König	Meliaceae
Xylocarpus moluccensis (Lam.) M. Roem.	Meliaceae

Table 2: Leading medicinal and aromatic plants of Singapore

Botanical name	Chemical constituents	Uses/Indications	Part(s) used
Crinum asiaticum L. var. japonicum	Alkaloids	A poultice for aches, in sores and chaps, wounds, abscesses, piles	Leaves, root (fresh bulb)
Eurycoma longifolia Jack	Quassinoids, various canthine-6-one alkaloids	In high blood pressure, fever, diarrhoea, jaundice, tuberculosis, dysentery, as aphrodisiac, tonic	Roots, root bark, leaves
Morinda citrifolia Linn.	Glucosides	As antibacterial, antiviral, antifungal, analgesic, hypotensive, immune enhancing effects, anti-inflammatory	Leaves, fruits, flowers
Piper sarmentosum Roxb.	Many amides, lignans & stigmasterol	In coughs, flu, rheumatism, pleurisy, toothache, lumbago, as antioxidant	Fruits

2.10 Thailand

The Kingdom of Thailand is located in southeast Asia, covering an area of 514,000 square kilometres with a population of about 63.6 million. It is bounded by Myanmar to the north and west, Lao PDR to the northeast, Cambodia and the Gulf of Thailand (Siam) to the southeast, Malaysia to the south and by the Andaman Sea and Myanmar to the southwest. Thailand is moderately forested with less than 33% forest cover. Most of this area is restricted to relatively inaccessible mountainous areas. In 1989, logging

in natural forests was banned and a series of supporting measures to protect the forests and promote private sector involvement in forest management and plantations has been implemented. The country has about 347,700 hectares of plantation forests. Herbal medicine is commonly used and the government has undertaken various initiatives to popularize the use of medicinal plants for health care and economic gains.

Traditional Medicine Systems

Thai traditional medicine has a well recorded history that dates back to 1182-1186 when 102 hospitals were established in the country and about 27 kinds of herbs were used in treatments. At present, the Western medical services are restricted mainly to modern hospitals and clinics in cities and towns. However, in villages and rural areas large numbers of Thais still practise various forms of traditional medicine and healing methods that encompass a holistic philosophy and is drawn from Indian and Chinese systems of traditional medicine. Thai traditional medicine is based principally on plants, including the use of herbal saunas, medicines, steam baths, hot compresses, traditional massages, acupressure and reflexology. Traditional medicine practitioners are an important part of country's health care system (Deevisej, 2003; WHO, 2001). There are over 2000 herbal medicines registered in Thailand; a total of 16 herbal preparations are included in the national essential drugs list. A post marketing surveillance system with adverse reaction monitoring was established in 2001 (WHO, 2005).

Government Efforts in Development of Traditional Medicine

Thai traditional medicine has received renewed interest in the last few decades. The National Institute of Thai Traditional Medicine was established on 26 March 1992, as a division of the Department of Medical Services. The main objective of the Institute is the integration of Thai traditional medicine into the public health services. An amendment to a royal decree in 1987 enabled the Ministry of Public Health to integrate Ayurvedic doctors into the medical work force of both state run hospitals and private clinics. Ayurvedic doctors and Thai traditional practitioners are allowed to use some basic allopathic medical tools in their practice but are not allowed to prescribe allopathic medicines. In 1999, Thai traditional medicine was integrated into the facilities of 1,120 health centres, most of which are health stations at the subdistrict level and represent more than 75% of national health facilities. Traditional medicine practitioners are registered with the Medical Registration of the Ministry of Public Health. National laws and regulations on traditional medicines were issued in 1967 under the Drugs Act B.E. 2510 which is divided into two parts covering modern and traditional medicines and was later amended four times in 1975, 1979, 1984 and 1987. As of 2003, *The Thai Herbal Phar-*

macopoeia' published by the Department of Medical Sciences, comprises two volumes containing 21 monographs, however, the information is not considered legally binding. There are five other traditional formularies of herbal medicines that the Food and Drug Administration of Thailand uses as standard references for herbal medicine registration. The information in these formularies is considered legally binding (WHO, 2005).

The government works for the development of the use of herbal medicines. The Eighth Public Health Development Plan (1997-2001) aimed to increase the use of allopathic and traditional medicine and promote traditional treatments within the national public health care system in addition to the development of research into medicinal herbs, training of traditional medicine practitioners and the use of medicinal herbs and traditional medicine practitioners in an official capacity. The specific objectives of the plan were: promotion of Thai traditional medicine in the national health care system by developing a comprehensive system and strategy for its official use; up grading of the standard of Thai traditional medicine; supporting both government and private sector organizations and agencies dealing with Thai traditional medicine; and supporting the production of plants; developing the pharmacopoeias and collaboration with traditional medicine practitioners to increase the use of medicinal herbs.

In 1951, the first school for Thai traditional medicine was established at Wat Po and the graduates from these schools, since 1962, have been licensed to practise general traditional medicine. In December 1997, the Ministry of Health's National Institute of Thai Traditional Medicine established the Thai Traditional Medicine Training Centre, which offers programmes in pharmacy, Thai traditional healing, massage and reflexology. The National Institute of Thai Traditional Medicine in collaboration with the Department of Non-Formal Education also offers courses in Thai traditional medicine at non-formal education centres at primary and secondary school levels for people who do not have the opportunity to attend a university. In 1983, an Ayurved-Vidyalaya college was established by the Foundation for the Promotion of Thai Traditional Medicine, a government supported private organization. Act 7 of 30 December 1966 also enables allopathic physicians, pharmacists, nurses, and midwives to practise Thai traditional medicine. Allopathic practitioners are required to follow a three year course of training and instruction with a registered and licensed traditional medicine practitioner and pass an examination set by the Commission for the Control of the Practice of the Art of Healing in order to be eligible to practise traditional medicine (WHO, 2001).

Medicinal and Aromatic Plant Resources

Thailand has about 11,000 species of vascular plants of which 10,200 are flowering plants. About 1,400 are listed as indigenous medicinal and aromatic plants used in the

Thai Traditional Materia Medica. A large number of medicinal and aromatic plant materials are produced and used in pharmaceutical, perfumery, cosmetics, aroma-chemicals and related industries. Several medicinal plant species used on the domestic market are also exported as raw materials or intermediary chemicals to Europe, Japan and the USA. Cultivation is largely dependent on the market demands outside the country. The important medicinal and aromatic plant species found in Thailand are listed in Table 1 (Kraisintu, 2003). Some leading medicinal and aromatic plants of Thailand are also listed in Table 2.

Spices such as *Allium cepa* L., *Allium sativum* L., *Amomum krervanh* Pierre, *Capsicum frutescens* L., *Cinnamomum bejolghota* (Buch.-Ham.) Sweet, *Cinnamomum iners* Blume, *Piper nigrum* L. and *Syzygium aromaticum* (L.) Merr. & L. M. Perry are commonly used for flavouring of foods and to stimulate digestion. They are exotic species such as *Apium graveolens* L., *Cinnamomum verum* J. Presl, *Eugenia caryophyllus* (Spreng.) Bullock & S. G. Harrison and *Myristica fragrans* Houtt. (Subansenee, 1995).

Research and Development Activities

A large number of institutions are engaged in research and development of medicinal and aromatic plants and the transfer of technology to the private sector in Thailand. The Government Pharmaceutical Organization (GPO), a state enterprise operating under the Ministry of Public Health, was established in 1966 to supply pharmaceuticals and other medicinal products and perform basic, applied and pilot scale research. A number of herbal medicinal products have been manufactured by the Thai Herbal Product Company; a subsidiary company of GPO and have been fully investigated with respect to botany, pharmacognosy, phytochemistry, pharmacology, toxicology and clinical studies. Other institutions involved in research on medicinal plants include the Thailand Institute of Scientific and Technological Research (TISTR) and the Department of Science Services, under the Ministry of Science, Technology and Environment; the Department of Medical Sciences under the Ministry of Health; the Department of Agriculture affiliated to the Ministry of Agriculture and Co-operatives; the Thai Industrial Standards Institute (TISI) and the Department of Promotion affiliated to the Ministry of Industry; Mahidol University (MU), Kasetsart University (KU), Chulalongkorn University (CU), Khon Kaen University, Naresvan University and Chiang Mai University all affiliated to the Ministry of University Affairs. All the institutes have plant nurseries to ensure a steady supply of raw materials for research laboratories involved in the national programmes. High technological improvements in production has been achieved through tissue culture and studies have been undertaken on cultural requirements, physiological factors, yield of active constituents of priority plants and; on harvesting and monitoring of active constituents of some selected plants. A number of important species including allium, betel nut, citronella, ginger, nutmeg, pepper and turmeric

are intercropped with coconut and palm plantations (Kraisintu, 2003).

The Department of Pharmacognosy and Pharmaceutical Botany of the Faculty of Pharmaceutical Sciences, Prince of Songkla University in southern Thailand is also involved in research on medicinal and aromatic plants. Recently the Department has started research projects for the search for pharmacologically active constituents from medicinal plants; preparation of herbal monographs and formulation of herbal preparations; and medicinal plant tissue culture to increase the yield of their active constituents (Subhadhirasakul, 2000).

Trade and Marketing

Asia, Europe and North America are Thailand's major export markets for herbs and spices. Over 60% of total exports were to Pakistan, Japan and the United Kingdom in 1999. However, exports to Pakistan declined compared with 1998. Japan, on the other hand, demonstrated an upward trend and from 1998, has increased the total imports value by approximately 92%. In July 2000, Japan surpassed Pakistan, as well as other major export markets and is Thailand's number one importer of herbs and spices. The United Kingdom is Thailand's third largest export market for herbs and spices.

The majority of imports were from Burma, Japan, the UK and the USA, with over 91% of the total import value. Imports from Burma, the UK and the USA showed growth from 1998 to 1999 while it decreased from Japan during the same period. However, imports from Japan picked up in 2000 and the import value (as of July 2000) exceeded those from Burma, the UK and the USA. The import of herbs and spices from China also increased in 2000, as compared with the previous year. Spice prices vary every year depending on buyer demand and fresh supplies available on the market, for example dried garlic prices (US$ per kilogram) in 1999, 2000 and 2001 were 0.7, 0.6 and 0.49 respectively. Although pepper is an important spice for export, the prices of both black and white pepper have also dropped during the above period (Anonymous, 2004).

The cultivation area and production of spices such as garlic, ginger, hot pepper, chili pepper, shallot, clove and pepper, according to the Ministry of Agriculture and Co-operatives, decreased from 1998 to 2001. From 2000 to 2001, the production area of hot pepper across Thailand was 70,303 hectares compared to 89,901 and 83,588 hectares from 1998 to 1999 and 1999 to 2000 respectively. The total production of hot pepper also decreased from 472,807 tonnes from 1998 to 1999 to 444,558 tonnes from 1999 to 2000 and 389,396 tonnes from 2000 to 2001 (Anonymous, 2004).

A large number of factories had been established for commercial scale production of essential oils such as citronella (*Cymbopogon mardus* (L.) Rendel), lemon grass (*Cymbopogon citratus* DC. Stapf), eucalyptus (*Eucalyptus* spp.), horapha basil (*Ocimum*

spp.), kaphrao (*Ocimum teniflorum* L.), pepper (*Capsicum* spp.) and Japanese mint (*Mentha arvensis* L.) in Thailand over the years. However, according to the Thailand Institute of Scientific and Technological Research (TISTR), only a few of these still exist and are operational. The important ones include the Natural Flavour and Fragrances Company Limited, Nan Tobacco Leaf Company Limited, Thai Chemical Products Company Limited, Menthol Thai Import-Export Company Limited and Thai-China Flavour and Fragrances Industry Company Limited (TCFF) (Kraisintu, 2003).

Problems and Constraints

The major problems in research and development of medicinal and aromatic plant in Thailand include the lack of multidisciplinary teams, skilled personnel, funds, agro-technology and processing technologies, feed back, price support and working on large numbers of crops simultaneously. There is a need to develop the herbal medicine industry and encourage the cultivation and conservation of important species of medicinal and aromatic plant.

Table 1: Some medicinal and aromatic plants found in Thailand

Botanical name	Family
Abrus precatorius L.	Fabaceae
Acacia mangium Willd.	Fabaceae
Acanthus ebracteatus Vahl	Acanthaceae
Acorus calamus L.	Acoraceae
Allium sativum L.	Alliaceae
Aloe vera (L.) Burm. f.	Asphodelaceae
Alpinia nigra (Gaertn.) B. L. Burtt	Zingiberaceae
Amaranthus spinosus L.	Amaranthaceae
Amomum xanthioides Wall. ex Baker	Zingiberaceae
Aquilaria crassna Pierre ex Lec.	Thymelaeaceae
Artemisia vulgaris L.	Asteraceae
Azadirachta indica A. Juss.	Meliaceae
Bambusa arundinacea (Retz.) Willd.	Poaceae
Basella alba L.	Basellaceae
Bauhinia acuminata L.	Fabaceae
Bauhinia malabarica Roxb.	Fabaceae
Bauhinia winitii Craib	Fabaceae
Brucea javanica (L.) Merr.	Simaroubaceae
Brunfelsia calycena Benth.	Solanaceae
Calophyllum inophyllum L.	Clusiaceae
Camellia sinensis (L.) Kuntze var. assamica (J. W. Mast.) Kitam.	Theaceae
Cananga odorata (Lam.) Hook. f. & Thomson	Annonaceae

Continued

Table 1 continued

Botanical name	Family
Cassia alata L.	Fabaceae
Cassia fistula L.	Fabaceae
Cassia javanica L.	Fabaceae
Cassia tora L.	Fabaceae
Cinnamomum camphora (L.) J. Presl	Lauraceae
Citrus hystrix DC.	Rutaceae
Clerodendrum viscosum Vent.	Lamiaceae
Coffea bengalensis B. Heyne ex Schult.	Rubiaceae
Curcuma domestica Valeton	Zingiberaceae
Curcuma xanthorrhiza Roxb.	Zingiberaceae
Cymbopogon citratus (DC.) Stapf	Poaceae
Cymbopogon nardus (L.) Rendle	Poaceae
Cyperus rotundus L.	Cyperaceae
Desmodium triflorum (L.) DC.	Fabaceae
Duranta repens L.	Verbenaceae
Eucalyptus globulus Labill.	Myrtaceae
Eugenia caryophyllus (Spreng.) Bullock & S. G. Harrison	Myrtaceae
Eurycoma longifolia Jack	Simaroubaceae
Foeniculum vulgare Mill.	Apiaceae
Gloriosa superba L.	Colchicaceae
Hibiscus sabdariffa L.	Malvaceae
Ipomoea aquatica Forssk.	Convolvulaceae
Jasminum auriculatum Vahl	Oleaceae
Jasminum grandiflorum L.	Oleaceae
Jasminum sambac (L.) Aiton	Oleaceae
Kaempferia galanga L.	Zingiberaceae
Lonicera japonica Thunb.	Caprifoliaceae
Mangifera indica L.	Anacardiaceae
Mentha spicata L.	Lamiaceae
Mentha ×piperita L.	Lamiaceae
Momordica charantia L.	Cucurbitaceae
Myristica fragrans Houtt.	Myristicaceae
Nymphaea spp.	Nymphaeaceae
Ocimum americanum L.	Lamiaceae
Ocimum basilicum L.	Lamiaceae
Olea europea L.	Oleaceae
Pandanus amaryllifolius Roxb.	Pandanaceae
Passiflora laurifolia L.	Passifloraceae
Phyllanthus emblica L.	Euphorbiaceae
Piper betle L.	Piperaceae

Continued

Table 1 Continued

Botanical name	Family
Piper nigrum L.	Piperaceae
Punica granatum L.	Lythraceae
Rauvolfia cambodiana Pierre ex Pit.	Apocynaceae
Rosa spp.	Rosaceae
Sesamum indicum L.	Pedaliaceae
Solanum indicum L.	Solanaceae
Themeda triandra Forssk.	Poaceae
Theobroma cacao L.	Malvaceae
Vitex trifolia L.	Lamiaceae
Zingiber officinale Roscoe	Zingiberaceae

Table 2: Leading medicinal and aromatic plants of Thailand

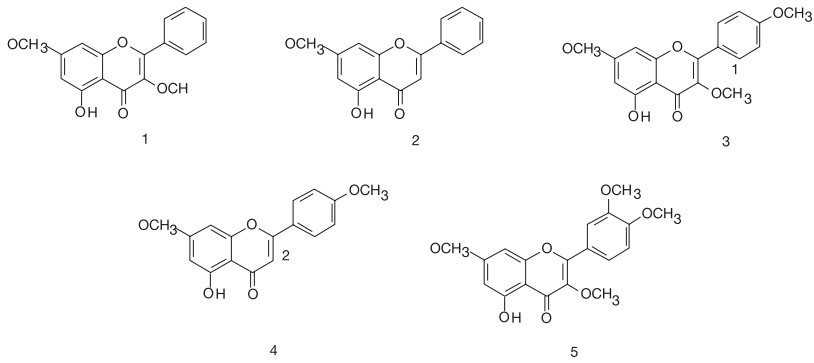
Botanical name	Chemical constituents	Uses/Indications	Part(s) used	Comments
Andrographis paniculata (Burmann filius) Nees	Andrographolide Neoandrographolide Deoxandrographolide Deoxy-didehydroandrographolide	As anti-inflammatory to sore throat, For relief of cold	Aerial parts	Cultivated in Chantaburi, Kanchanaburi, Kampaengpet Nakornpathom, Ubonraatchathani Pitsanulok, Raatchaburi and Supaanburi provinces
Curcuma comosa Roxb.	Flavonoids	In gynaecological diseases	Tubers	Cultivated in Loei and Petchaboon provinces
Curcuma longa Linn.	Curcumenoids	As antiflatulence, in peptic ulcers	Tubers	Cultivated in Chumporn and Suraadthani provinces
Kaempferia parviflora Wall. Ex Baker	Flavonoids	As tonic, for men	Tubers	Cultivated in Loei, Lumpang, Petchaboon and Taak provinces
Solanum trilobatum Linn.	---	As anti-tussive and expectorant	Fruits	Cultivated in Chiangmai, Lampang and Petchaboon provinces

Photographs of some leading medicinal and aromatic plants of Thailand

Curcuma comosa Roxb. crop in the field

Aerial and underground parts of *Curcuma longa* Linn.

Ripe fruits and flower of *Solanum trilobatum* Linn.



Kaempferia parviflora Wall. Ex Baker active ingredients
1) 3,7-dimethoxy-5-hydroxyflavone, 2) 5-hydroxy-7-methoxyflavone, 3) 5-hydroxy-3,7,4′-trimethoxyflavone, 4) 7,4′-dimethoxy-5-hydroxyflavone and 5) 5-hydroxy-3,7,3′,4′-tetramethoxyflavone

2.11 Timor-Leste

Timor-Leste is located in southeastern Asia, on the southernmost edge of the Indonesian archipelago, northwest of Australia. The country includes the eastern half of Timor Island as well as the Oecussi enclave in the northwest portion of Indonesian West Timor and the islands of Atauro and Jako. Timor-Leste became a fully independent republic in May 2002, following approximately two and a half years under the authority of the UN Transitional Administration in Timor-Leste (UNTAET). The area of the country is approxi-

mately 15,007 square kilometres with an estimated population of about 0.85 million.

The September 1999 violence led to the departure of most of the civil service staff to West Timor leaving Timor-Leste without any working institutions. The country is extremely poor with the basic income, health and literacy indicators among the lowest in Asia. Two-thirds to three-fourths of the population is engaged in subsistence agriculture. The Interim Health Authority (IHA) was formed in February 2000 to enhance Timor-Leste health system. The World Bank and United Nations Transitional Administration in Timor-Leste (UNTAET) in June 2000 announced a grant of US$12·7 million for the development of the health care system of Timor-Leste (Morris, 2001). The creation of a sustainable economy poses a daunting challenge. The initial focus has been on rehabilitation and health. The Ministry of Health with the participation of the European Commission and the World Bank has elaborated a national health programme. The programme focuses on the institutional set-up of basic health care and referral services. A strategy has been designed to assist the country to develop and manage its own resources.

Over-logging in the past led to the disappearance of natural sandalwood resources and only minor teak plantations exist now. Many locals rely on traditional medicine involving specific herbal and heat treatments for their health care needs. However, there is no information regarding the extent of their use and the current status of the country's medicinal and aromatic plant resources.

2.12 Viet Nam

Viet Nam is situated in Southeast Asia, bordering the Gulf of Thailand, the Gulf of Tonkin, and the South China Sea, China, Lao PDR, and Cambodia. The country has a population of about 81 million people and it covers an area of 330,000 square kilometres with mountains and highlands covering about three quarters of the total area. Forests account for 19 million hectares covering about 60% of the national territory. They are important sources of medicinal and aromatic plants, which have used in the preparation of various kinds of traditional medicine for many years. Local medicinal plants have been harvested in a sustainable way in the past but the recent development of the market economy and commercial exploitation has threatened resources.

Traditional Medicine Systems

Viet Nam has a unique traditional medicine system which plays an important role in national health care especially for poor communities living in remote areas. Vietnamese traditional medicine has a long history that reflects the country's cultural diversity. There are 54 ethnic minorities living in mountainous areas. They are the main source

of traditional knowledge. The Vietnamese have treated diseases with herbs and plants gathered from their gardens and the forests for thousands of years (Kim, 2003).

Traditional medicine in Viet Nam can be divided into two categories: traditional and oriental medicine. Vietnamese traditional medicine has been influenced by the Chinese, Japanese and Korean traditional medicines and is popular among the communities living in remote areas of the country. In cities and lowlands a combination of both traditional and oriental medicine is generally used. Both these medicine systems form an integral part of the national health care system (WHO, 2001). The *Vietnamese Pharmacopoeia* is legally binding, as are the national herbal monographs found in *Viet Nam medicinal plants*. There are currently 1,573 registered herbal medicines; 267 herbal medicines are included in the national essential drugs list of 1996. The post market surveillance system includes monitoring of adverse effects for herbal medicines (WHO, 2005).

Government Efforts in Development of Traditional Medicine

The Vietnamese government encourages the development of traditional medicine and supports public sector facilities for traditional medicine. The government has realized that there is a need for cooperation between traditional and modern medicine to build a sound national medicine system and is working to establish a network of traditional medicine parallel to the modern medicine system in urban and rural areas. With the objectives of disease prevention and treatment, medicine production, training and scientific research, promoting traditional and modern medicine systems and implementing its policies on traditional medicine, the government established the Viet Nam National Institute of Traditional Medicine in 1957, the Ho Chi Minh Institute of Traditional Medicine in 1976 and the Institute of Acupuncture in 1982. At present there is a traditional medicine hospital in each province of the country, health centres at district and commune level with traditional medicine departments and clinicial services. The pharmacy departments at these centres are also equipped with facilities for processing traditional medicine (Kim, 2003).

At present, there are about 4,000 traditional physicians and more than 5,000 western physicians in Viet Nam with traditional medicine knowledge. Traditional medicine hospitals will be set up in all provinces and cities nationwide by 2010. At present, 46 out of 61 provinces and cities have such hospitals. The first traditional medicine supermarket was built in 2002 in Hoa Lac in the northern Ha Tay province in order to preserve and develop Vietnamese traditional medicine (Anonymous, 2004).

An Army Institute of Traditional Medicine for carrying out clinical work, research, training and manufacture of herbal products was established in 1978, serving about 25,000 out- and in-patients annually. In 1996, the Traditional Medicine Hospital of the

Ministry of Interior Affairs was inaugurated. Additionally there are 286 departments of traditional medicine in general hospitals, 45 provincial hospitals of traditional medicine and four institutes of traditional medicine in Viet Nam. The Institute of Acupuncture serves about 11,000 patients each year.

The government provides training to health workers in traditional medicine and encourages people to cultivate medicinal plants. A large number of traditional therapies including medications from plants and animals, massage, acupuncture, moxibustion, cupping and thread embedding have been recognized officially by the government. According to Article 39 of the Constitution of Viet Nam the state should work to develop and integrate allopathic, traditional and pharmaceutical practices and official, traditional and private medical care. The Ministry of Health advocates socialization and diversification of traditional medicine. At present there is no college or university of traditional Vietnamese medicine in the country, although Hanoi Medical University has a department of traditional medicine but it does not meet the requirements of a developing country's traditional medicine. The government is planning to create a traditional medicine university to provide programmes for secondary, undergraduate and postgraduate study (WHO, 2001). In the Socialist Republic of Viet Nam, a national policy on traditional medicine is currently being developed. Laws and regulations were issued in 1989 and a national programme was issued in 1986 (WHO, 2005).

The Prime Minister in decision No 35/201/QD-TTg and No 108/2002/QD-TTg has promulgated two documents *Strategy of community health care in the period of 2001-2010* and *Strategy of development of pharmaceutical sciences in the period of 2002-2010*. The main aim of the strategy is to: stimulate the production of generic drugs and pharmaceuticals from medicinal plants and traditional medicines; research and develop pharmaceutical technology, biotechnology and pharmacognosy; quality control for development of new drugs; combining human resources and equipment to investigate new resources of raw materials, herbal medicines; and incorporating research activities of pharmaceutical companies.

Medicinal and Aromatic Plant Resources

Viet Nam is considered to be the sixteenth most biodiverse country in the world and is home to 12,000 plant species of which 40% of the total flora has been identified as endemic (An, 2000). Viet Nam has more than 2,000 medicinal plant species belonging to 238 families, which are used commonly in folk medicines (FAO, 2002). About 700 species are often mentioned in oriental medicine. There are around 150 to 180 medicinal substances derived from medicinal plants used by various traditional medicine hospitals or local physicians and about 120 medicinal plant species used commonly by

local people especially those living in rural or mountainous areas. Some of the important medicinal and aromatic plants of Viet Nam are given in Table 1 (An and Ziegler, 2001; de-Beer, 1993; Kraisintu, 2003).

Eleven national parks have been created by the government for the conservation of national biodiversity. The Bach Ma National Park, created in 1991 has around 1,400 plant species of which 432 are used by the local population for a variety of medicinal purposes. Over exploitation and illegal harvesting have however, threatened the existence of many of them. Some important species under threat of extinction in the country are *Anoectochilus* spp., *Aristolochia* spp., *Asarum* spp., *Berberis julianae* C.K. Schneid., *Berberis wallichiana* DC., *Coptis chinensis* Franch., *Coscinium fenestratum* (Gaertn.) Colebr, *Mahonia bealei* (Fortune) Carriere, *Mahonia japonica* (Thunb.) DC., *Nervilia* spp., *Panax* spp. and *Thalictrum* spp. About 22 medicinal plants from the Bach Ma National Park have been listed in the Viet Nam Red Data Book (An and Ziegler, 2001).

Essential oils are produced and exported. The important ones include anise star seed oil (*Illicium verum* Hook. f.), cajeput oil (*Melaleuca leucadendra* (L.) L), cassia oil (*Cinnamomum cassia* Blume), citronella oil (*Cymbopogon citratus* (DC.) Stapf), litsea oil (*Litsea cubeba* (Lour.) Pers.), basil oil (*Ocimum basilicum* L.), pemou oil (*Fokienia hodginsii* (Dunn) A. Henry & H. H. Thomas), peppermint oil (*Mentha piperita* L.), and sassafras oil (*Cinnamomum* spp.). Cardamom grows naturally in Viet Nam and the three species *Amomum villosum* Lour., *Amomum xanthioides* Wall. ex Baker and *Amomum longiligulare* T.L.Wu grow abundantly. More than 80% of the cardamom production is from the wild while the remainder comes from cultivation. The planting of cinnamomum is being improved and it has been introduced to a number of provinces. Eaglewood (*Aquilaria crassna* Pierre ex Lec.) used to make incense has been planted by farmers in the provinces of Ha Tinh, Quang Binh, Quang Nam, Binh Phuoc due to the extinction of the species in natural forests. The anise star tree planting has been allocated for management by households (FAO, 2002).

Research and Development Activities

The medicinal literature of the country dates back to the 10th century. The prominent ones include two treatises: *The Miraculous Efficacy of Vietnamese Medicines*, describing 580 indigenous drugs in 3,873 prescriptions and the *Medical Book from Village Hong Nghia* summarizing the indications of 630 drugs with a theoretical part on traditional medicine by Tue Tinh (17th century) and the *Treatise of Traditional Medicine'* with more than 30 volumes by Le Huu Trac (1720 to 1791). Traditional medicine in the country was rehabilitated to its present position only after the August Revolution of 1945 (Loi and Dung, 1991).

Since 1981 the Vietnamese government has started science and technology activities and set up state research programmes for different fields. Two programmes on medicine and pharmacy have been started by the Ministry of Health. So far four research and development programmes on pharmacy from 1981 to 1985, 1986 to 1990, 1991 to 1995 and 1996 to 2000 to generate medicinal plant raw material for traditional medicine and pharmaceutical industry have been finalized. Research mainly focuses on cultivation, selection, breeding, protection and preservation of medicinal and aromatic plants; process technology for extraction of active ingredients and essential oils and; new herbal and modernized traditional medicine. In 1961, the Institute of Materia Medica (IMM) was established as the main R&D centre of medicinal and aromatic plants. It has carried out agronomical studies in parallel with summarizing popular experiences to develop cultivation technologies adapted to local needs and provide technical directions to farmers in collaboration with provincial stations for medicinal plants research. IMM has introduced several exotic species of medicinal and aromatic plants to the country and to date 70% of these have been adapted and grown under Vietnamese climatic conditions. The tissue culture technique for the improvement of the strain of *Mentha arvensis* L. and *Costus speciosus* (J. Koenig) Sm. started in the 1980s in Viet Nam. The technique is applied for the amelioration, multiplication, breeding and conservation of the clones of some selected medicinal plants. Work on selection of high quality planting material has been carried out on *Artemisia annua* L. Improvement and standardization work has been done on the strains of *Achyranthes bidentata* Bl., *Angelica acutiloba* (Seibold & Zucc.) Kitag., *Angelica dahurica* (Fisch.) Benth. & Hook. f.ex Franch. & Sav., *Mentha arvensis* L. and *Rehmannia glutinosa* (Gaestn.) steud (Kraisintu, 2003).

Started in 1993, the Viet Nam Forest Research Programme also focuses on providing training in cultivation and production techniques on medicinal plants with the objective of development of an alternative income source for local farmers. In a project entitled *Conservation of Medicinal Plants in Bavi National Park* the main focus is on the development of the fastest techniques for growing plants and helping local people to cultivate medicinal plants in their home gardens (Chong, 1998). The government under the National Five Million Hectare Reforestation Program (5MHRP) launched in 1998, has planned 20,000 hectares of new plantations for anise star tree (*Illicium verum* Hook f.), 65,000 hectares for cinnamon (*Cinnamomum cassia* Blume) plantation and 155,000 hectares for tung oil tree (*Aleurites montana* (Lour.) Wils.) (FAO, 2002).

The book, *Medicinal Plants in Viet Nam* cataloging the 200 most commonly used species of medicinal plants in traditional Vietnamese medicine has been translated by WHO from the original Vietnamese. The book presents plant description, therapeutic uses, chemical composition, distribution along with their local and botanical names and photo-

graphs (WHO, 1990). The *Vietnamese Pharmacopoeia* published in 2002, contains 678 monographs on pharmaceutically active ingredients, herbal materials and dosage forms.

The Faculty of Pharmacology, University of Hanoi is carrying out research on *Cinnamomum officinarum* (L.) J. Presl and has suggested the tree for enrichment planting in existing forests or mixed planting on barren hills. The University has also developed a drug, Gacavit with momordica (*Momordica cochinchinensis* (Lour.) Spreng. and *Momordica charantia* L.) seeds as its major constituents. The drug is said to reinforce the immune system, repair DNA and is being tested as a cancer medicine (de-Beer, 1993). The diuretic effect of four traditional Vietnamese herbal remedies from *Imperata cylindrica* (L.) P. Beauv., *Orthosiphon stamineus* Benth., *Plantago major* L. and *Zea mays* L., were studied at Viet Nam-Sweden Hospital of Uong Bi (Doan *et al.*, 1992). The work on the isolation of new components from rhizomes and roots of *Panax vietnamensis* Ha et Grushv. commonly known as Vietnamese ginseng has been carried out at the Science-Production Centre of Vietnamese Ginseng, Ho Chi Minh University of Medicine and Pharmacy, Viet Nam (Nguyen *et al.*, 1993).

Trade and Marketing

In Viet Nam, the annual demand for medicinal plant material for 20,000 traditional medicinal practitioners is at least 3,000 tonnes. Recently, attention has been paid to production of cosmetics and fragrances from natural materials (Kraisintu, 2003).

About 4,000 different types of medicines including traditional herbal and western medicines are produced in the country. In northern Viet Nam it has been estimated that 80 to 90% of the medicinal plants produced are exported in the form of dried plants or extracts and only 10 to 20% are consumed or processed domestically. Out of the total production of traditional medicine 30 to 40% is in the form of tonics, which also constitutes the major portion of medicines exported. Some spices such as anise star, cardamom, cinamon and mackhen are exported to China and other overseas markets. More than 80% of cardamom is gathered from the forests with the remainder being cultivated. It is exported mainly to China, Japan and Hong Kong. In 1995 Viet Nam exported about 17,800 kg of cardamom to Japan while from 1999 to 2000 exports to China alone were 8,000 kg. The production of anise star tree in 2000 was 3,000 tonnes from the district of Van Quan. Essential oils are mainly exported to France, the Netherlands and Japan with limited domestic consumption. The country's average annual export of essential oils to overseas markets is around 1,600 tonnes comprised primarily of anise seed oil (200 to 300 tonnes), cajeput oil (10 to 12 tonnes), cassia oil (10 to 15 tonnes), citronella oil (200 to 350 tonnes), litsea oil (10 to 15 tonnes), basil oil (10 tonnes), pemou oil (10 to 15 tonnes) and sassafras

oil (1000 to 1200 tonnes). In 1995, the country exported 34,071 kg of eaglewood to Japan alone while from 1999 to 2000 the export of eaglewood to Japan and China collectively was only 2000 kg (FAO, 2002).

A New Zealand company, Forest Herbs Research Ltd is working on a non-profit basis on a project with financial support from the New Zealand Agency for International Development to carry out research and market plant products for the benefit of hill tribe people of northern Viet Nam. There are six large pharmaceutical companies, namely Phytopharco, Vimedimex, OPC, Central pharmaceutical factory No 25, Mekophar and Central pharmaceutical factory No 27 involved in production and distribution of medicinal plants, essential oils, herbal products for the domestic market as well as for export. OPC among these is the leading company in production of herbal medicine with an annual turnover of about US$0.0095 billion (VND 150 billion). Some other regional and private companies such as Pharimex, District 5 Oriental Medicine Company, 2/9 Pharmaceutical company, 3/2 Pharmaceutical company, Bao-long Oriental Pharmaceutical Company Ltd., Thien-long Oriental Pharmaceutical Company Ltd are also involved in related trade.

Problems and Constraints

Unsustainable harvesting methods have endangered the existence of many valuable medicinal and aromatic plant species from the wild. The main problems in commercial exploitation of Viet Nam's medicinal and aromatic plant sector are the lack of formal scientific training in cultivation, improved harvesting techniques and storage facilities, processing methods and proper domestic markets for manufacturers of medicinal plants and their products. There is a lack of sufficient research and development in the field because the institutes working on medicinal plants lack equipment and scientific literature.

There are many cases where knowledge of medicinal plants and traditional therapeutic methods remains secret. Valuable traditional knowledge is disappearing at an alarming rate mainly because of the unwillingness to share it. Results are not shared between research institutes and traditional knowledge holders who are poor people in remote areas., There is no regulation of the trade of medicinal plant products and most of it is unregistered because of the lack of proper government policies.

Table 1: Some medicinal and aromatic plants of Viet Nam

Botanical name	Family	Part(s) used	Uses/Indications
Abrus precatorius L.	Fabaceae	Root, leaf, seed	As expectorant, anti-inflammatory, antiallergenic
Acorus calamus L.	Araceae	Root	As analgesic, in toothache, headache
Ageratum conyzoides L.	Asteraceae	Whole plant	As homeostatic, in scabies, colic

Continued

Table 1 continued

Botanical name	Family	Part(s) used	Uses/Indications
Amaranthus spinosus L.	Amaranthaceae	Aerial parts	As amenorrheic
Amomum aromaticum Roxb.	Zingiberaceae	Seed	Spice, medicine
Aquilaria crassna Pierre ex Lec.	Thymelaeaceae	Wood	As incense, in cosmetics
Artemisia annua L.	Asteraceae	Seed	In skin diseases, jaundice
Artemisia vulgaris L.	Asteraceae	Leaf, root	As digestive tonic, antiseptic
Azadirachta indica A. Juss.	Meliaceae	Seed, leaf	As antibiotic, organic pesticide and fungicide
Butea monosperma (Lam.) Taub.	Fabaceae	Bark, flower, leaf, seed	As febrifuge, aphrodisiac, purgative
Cananga odorata (Lam.) Hook. f. & Thomson	Annonaceae	Flower	As fragrance for soap
Cinnamomum camphora (L.) J. Presl	Lauraceae	Stem, root	In various drugs
Cinnamomum cassia Blume	Lauraceae	Bark, leaf	In bakery products, as flavouring
Coptis chinensis Franch.	Ranunculaceae	Root	As antibacterial, emollient
Coscinium fenestratum (Gaertn.) Colebr.	Menispermaceae	Old parts or root	In colic, stomachache
Cymbopogon citratus (DC.) Stapf.	Poaceae	Leaf, essential oil	As digestive As tonic, carminative, febrifuge, antifungal
Datura metel L.	Solanaceae	Leaf, flower, seed	As antiasthmatic, febrifuge
Dioscorea deltoidea Wall. ex Griseb.	Dioscoreaceae	Tuber	For producing steroid drugs
Dracaena angustifolia (Medik.) Roxb.	Dracaenaceae	Old parts or root	As adaptogen
Drosera rotundifolia L.	Droseraceae	Bulb	In cough, as antispasmodic
Eclipta prostrata (L.)	Asteraceae	Aerial parts	As liver tonic, styptic, in gynecologic disorders
Euphorbia hirta L.	Euphorbiaceae	Aerial parts	As antispasmodic, sedative
Ficus carica L.	Moraceae	Fruit, latex	As laxative, emollient, expectorant
Ficus religiosa L.	Moraceae	Fruit, leaf, bark, latex	As astringent, laxative, antifungal
Fokienia hodginsii (Dunn) A. Henry & H. H. Thomas	Cupressaceae	Root, stump	In cosmetics
Homalomena aromatica Schott	Araceae	Root	In perfume
Illicium verum Hook. f.	Illiciaceae	Fruit, seed	In alcohol beverages, as carminative
Jasminum sambac (L.) Aiton	Oleaceae	Flower	Flavouring tea
Jasminum subtriplinerve Blume	Oleaceae	Branch, leaf	For recovey after giving birth.
Kaempferia galanga L.	Zingiberaceae	Rhizome	As expectorant, carminative
Lactuca indica L.	Asteraceae	Whole plant	In chest ache, sore eyes
Litsea cubeba (Lour.) Pers.	Lauraceae	Fruit	As source of citral
Lonicera japonica Thunb.	Caprifoliaceae	Flower, leaf, bark	As diuretic, liver tonic, astringent, hypotensive
Momordica spp.	Cucurbitaceae	Seed	For flavouring drugs
Morinda officinalis F. C. How	Rubiaceae	Root	As kidney tonic, impotence remedy
Myristica fragrans Houtt.	Myristicaceae	Essential oil	As carminative, antispasmodic
Plantago major L.	Plantaginaceae	Leaf	As expectorant, decongestant, irritable bowel relief
Polygonum multiflorum Thunb.	Polygonaceae	Root	In cholera

Continued

Table 1 continued

Botanical name	Family	Part(s) used	Uses/Indications
Smilax glabra Roxb.	Smilacaceae	Root	In backache
Strychnos nux-vomica L.	Loganiaceae	Nut	As muscle relaxant, drug flavouring agent
Terminalia chebula Retz.	Combretaceae	Fruit	As laxative, astringent
Verbena officinalis L.	Verbenaceae	Aerial parts	As nerve tonic, tonic, sedative
Zanthoxylum rhetsa (Roxb.) DC.	Rutaceae	Bark	As antibacterial, in gastrointestinal disorders

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Chapter 3

South Asia

3.1 Introduction

South Asia is a subregion of Asia comprising the states of Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka that covers about 4,480,000 square kilometres (10% of the continent). It is also known as the Indian subcontinent and ranks among the most densely populated regions of the world. About a third of all Asians and a fifth of all people live here.

South Asia's rich biodiversity resources especially in the Himalayas and the Western and Eastern Ghats are the major sources of traditional and modern pharmaceutical products. The region is extremely rich in medicinal and aromatic plants - estimated to be more than 50% of global biodiversity. More than 8,000 plant species are known for their medicinal properties in the region; about 10% of them are used regularly. These plants are collected mainly from their natural habitats.

South Asia has a rich traditional medicine heritage, which is widely used and respected. The region is home to many traditional systems of medicine. Ayurveda along with the Siddha, Unani and Tibetan systems are an important source of everyday health and livelihood for millions of people. Medicinal and aromatic plants are an essential part of traditional health care systems in the region. Their gathering and cultivation provide a critical income source for rural communities. India is the centre of South Asia's export trade in medicinal plants. It is estimated that around 3,000 species are used in India, of which 540 are used in major herbal drugs. About 100 species in Nepal, 300 in Bhutan, 250 in Bangladesh and 400 species in Pakistan are exploited for commercial purposes. Medicinal and aromatic plants are very important to South Asian economies and primary health care systems (Karki and Williams, 1995).

3.2 Bangladesh

Bangladesh is surrounded by Indian territories in the west, north and east except a small strip in the southeast which boarders Myanmar. It is one of the most densely populated countries in the world with a population of about 141 million people. The

total area of the country is 144,000 square kilometres of which only 1,559 square kilometres is forest. It is estimated that 73,000 hectares of forests have been lost through encroachment for aquaculture and agriculture during the last two decades. Natural calamities such as cyclone, tornado, flood and tidal surge often hit the country resulting in widespread damage to life, property and natural resources including medicinal and aromatic plant. A number of protected areas that are abode to various medicinal and aromatic plants of high value are under the jurisdiction of the Forestry Department, though most of these have been degraded by illegal logging and forest clearings.

Traditional Medicine Systems

Ayurvedic and Unani are widely practised systems of medicine in Bangladesh. Homoeopathy is also quite popular. There was a time when Ayurvedic, Unani or Hakimi treatment were the only remedies that both the rich and the poor used to cure their illness. A majority of the people still use herbal medicines manufactured by indigenous institutions using various plants as raw materials. People in remote areas rely on Ayurvedic and Unani medicines mainly because of the lack of modern health care services. The traditional medicine practitioners (TMPs) are called *kabiraj* or *hakims*. These TMPs generally treat everything from temporary illness to chronic diseases.

Government Efforts in Development of Traditional Medicine

The Bangladesh government, after independence from Pakistan, restructured the Pakistani Board of Unani and Ayurvedic Systems of Medicine as the Board of Unani and Ayurvedic Systems of Medicine, Bangladesh, following the Bangladesh Unani and Ayurvedic Practitioners Ordinance 1972. A research institute has been functioning under the Board since 1976. The Board is responsible for standardization of Unani and Ayurvedic medicines. Registration in order to practise Unani and Ayurvedic medicines was made mandatory by the Bangladesh Unani and Ayurvedic Practitioners Ordinance of 1983. A national policy on traditional medicine was issued in 1995. National laws and regulations are in the process of being drafted. The national programme was issued in 1998. The *Bangladesh national formularies on Unani and Ayurvedic medicine* are legally binding (WHO, 2005).

Some government and private education institutes train health workers in the field of traditional medicine. There are nine institutions under the Board of Unani and Ayurvedic Systems of Medicine teaching Unani and Ayurvedic medicine in the country. Among these, five institutions are for Unani and four for Ayurvedic medicine offering diplomas on completion of a four-year programme (WHO, 2001). The Government Unani and Ayurvedic Degree College Hospital (GUADCH) was set up following WHO recom-

mendations with the objectives of developing trained manpower in Unani and Ayurvedic medicine and support delivery in these traditional systems to the people.

The government promotes awareness of the effective use of plants as medicines, an understanding of the philosophy and cultural traditions behind ethnomedicinal uses of plants and their cultivation. As a result of these efforts, the Ministry of Health and Family Planning has published a handbook entitled *Medicinal Plants in Health Care: Introduction, Cultivation and Use*, describing cultivation, trade and use of the 50 most commonly used medicinal plants of Bangladesh (Anonymous, 2002). The compilation and publication of a number of other books in the same series is also underway. Furthermore, the country has established herbal gardens in all the district hospitals and taken various other measures in favour of traditional medicines.

Medicinal and Aromatic Plant Resources

Bangladesh, together with India, constitutes the largest part of South Asian genetic diversity. It has about 5,000 species of higher plants of which over 500 have ethnomedical value. Recently, 546 species have been identified as having medicinal and therapeutic use, of which 257 in effective remedies for diarrhoea and 47 for diabetes. (Haque, 2004). Some medicinal and aromatic plants found in Bangladesh are given in Table 1 (Haque *et al.*, 2000; Rahman *et al.*, 2001). The medicinal plants, particularly Indian lilac (*Azadirachta indica* Juss.), sacred basil (*Ocium sanctum* Linn.), snake root (*Rauwolfia serpentina* (Linn.) Benth.), malabur nut (*Adhatoda vasica* Nees.), white murdah (*Terminalia arjuna* (Roxb.) W. & A.) etc. are very popular. However, indiscriminate destruction and lack of new plantations have significantly reduced the number of these plants. Some leading medicinal and aromatic plants of Bangladesh are listed in Table 2 (Rahman *et al.*, 2002).

Plants such as *Blumea* spp., *Clerodendrum inerme* (L.) Gaertn., *Holarrhena antidysenterica* (Roxb. ex Fleming) Wall. ex A. DC., *Ipomoea pes-caprae* (L.) R. Br., *Leea aequata* L., *Pandanus foetidus* Roxb., *Phyllanthus emblica* L., *Premna corymbosa* Linn., *Terminalia belerica* Roxb, and *Terminalia chebula* Retz. found in Sundarbans are commonly used for their medicinal as well as aromatic properties. The leaves of *Blumea densiflora* DC. and *Blumea lacera* (Burm. f.) DC. are used for camphor manufacture. The ripe inflorescence of Pandanus odoratissimus auct. yield an essential oil called kewda katta attar which is a popular perfume that has been extracted and used since ancient times (FAO, 2002).

Research and Development Activities

The Ministry of Health, initiated the planting of medicinal plants in hospitals and clinics throughout the country as part of an extended national tree planting initiative in 2003. This initiative generated strong public opinion in favour of herbal plantation throughout the

country, supporting the government's policy on herbal culture. Experts have suggested a comprehensive programme to be taken up by the government providing financial assistance and increased institutional support particularly through expanding existing research facilities of a number of public universities in order to make the programme a success.

The Faculty of Pharmacy (formerly the Department of Pharmacy) at the University of Dhaka has been contributing tremendously to natural product research since its inception in 1964. Several bioactivity-guided investigations adopting multifarious bioassays such as analgesic, anticancer, antidiabetic, anti-inflammatory and antimicrobial activities are being conducted in isolating bioactive principles from medicinally important plants of Bangladesh (Datta *et al.*, 2004; Mottakin *et al.*, 2004; Kumarasamy *et al.*, 2003). The faculty has extensive collaborations with various international research institutions including the National Cancer Institute (NCI), Maryland, USA, Manchester and Strathclyde Universities, UK and the HEJ Research Institute of Chemistry, Pakistan. The Faculty also has projects on the innovation of modern medicines from traditionally used formulations. The Biomedical Research Centre at the University of Dhaka has extensive research programmes on herbal medicines, including development of remedies for arsenic intoxication, which at present is a fatal problem throughout the country.

The Chemistry Department of Dhaka University is carrying out analytical research and product development of medicinal and aromatic plants while the Pharmacy Department of Jagangir University is working on demand and supply of medicinal plants. The Food and Agriculture Organization of the United Nations in collaboration with the Ministry of Environment and Forests is in the process of formulating a project for improving the marketing, cultivation and conservation of medicinal and aromatic plant resources in Bangladesh. The Bangladesh Council for Scientific and Industrial Research (BCSIR) Laboratory in Chittagong is carrying out research on cultivation and biochemical aspects of medicinal plants aimed at determining optimal conditions for planting and harvesting and to develop appropriate agro, post-harvest and chemical technologies along with a pharmacopoeia of the plants. Gonosyeshta, a private non-profit development organization produces herbal medicines. The Bangladesh Forest Research Institute (BFRI) is engaged in collection, identification and plantation of endangered forest species in *ex situ* conservation plots of the Institute. The BFRI and BCSIR have recently published a botanical study on the cultivation and use of plants for medicinal purposes by hill people in Bangladesh (Anonymous, 2003).

The Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM) has undertaken a project on the systematic study of plants used for treating diabetes. The Institute is working in collaboration with the Department of Chemistry of Dhaka University and other institutes abroad. Various tri-

als of the plant commonly known as fenugreek (*Trigonella foenum-graecum* L.) are also under way for its medicinal ability to act as a substitute for insulin (Khan, 2003).

The Development of Biotechnology and Environmental Conservation Centre (DEBTEC), has undertaken a programme on medicinal plant plantations in Luxmipur. The Centre has published a *Hand Book of 20 Commercially Important Medicinal Plants in Bangladesh* which explains their usefulness in curing diseases. It has recommended both the creation of a centre for medicinal plant research, by ministries concerned about the cultivation and conservation of medicinal and aromatic plants and a vigorous mass media campaign to create awareness among the people of their importance (Anonymous, 2002).

A review on the pharmacological activities of 64 medicinal plants of Bangladesh has been published (Rahman *et al.*, 2001). The results of various investigations reveal important pharmacological activities of the plants which may be used as leads in developing novel therapeutic agents.

Trade and Marketing

The country relies heavily on imports of herbal materials. The cultivation of herbal plant ingredients has almost stopped and as a consequence around 80% of them are imported by the manufacturers of traditional herbal medicines from neighbouring countries, mainly India,. About 496 companies are engaged in the production of homeopathic, Unani and Ayurvedic medicines in Bangladesh, producing herbal medicines worth US$0.5 million (taka 30 million) using 5.8 million tonnes of herbal plants every year. Recently, cultivation of 1,000 hectares of land as tea gardens under the medicinal tree plantation programme has been taken up by the Bangladesh Tea Board. Under this scheme, different types of medicinal plants will be planted on 150 hectares of land in the first three-year period costing US$0.75 million (taka 45.4 million). It is expected that at the end of the project about 25,000 million tonnes of herbal medicines will be produced (Anonymous, 2003). The country has spent about US$250 million (taka 15,000 million) in the last five years on importing medicinal plants from abroad. The annual expenditure of the Bangladesh herbal industry is US$0.16 billion (taka 10 billion).

Problems and Constraints

Bangladesh is an attractive repository of various medicinal plants. The scientific evaluation of the pharmacological properties of these plants would provide enormous potential and promise for developing newer, safer and more effective drug candidates. The information on proper identification, ecological niches and conservation measures of medicinal plants are yet to be included in scientific studies and documented. The conservation emphasis is limited mainly to rice and jute and information on genetic erosion

and extinction of plant species is also scanty. Overpopulation, deforestation, poor strategies for marketing, cultivation, conservation, lack of research and development (R&D) activities and processing technologies for medicinal plants are the major problems in development of the country's medicinal and aromatic plant resources.

Table 1: Some medicinal and aromatic plants of Bangladesh

Botanical name	Family	Uses/Indications
Abroma augusta Linn.	Sterculiaceae	In dysmenorrhoea
Albizzia lebbeck Benth., syn. *Acacia lebbeck* Willd.	Fabaceae	In skin diseases, toothache, asthma, leprosy, piles, diarrhoea
Amorphophallus campanulatus (Roxb.) Bl.	Arecaceae	In piles, constipation, tumour, asthma, bronchitis, vomiting, rheumatism, insect bites, as tonic
Aphanamixis polystachya Blatter., syn. *Amoora rohituka* W. et A.	Meliaceae	In spleen and liver diseases, rheumatism, as astringent
Azadirachta indica Juss.	Meliaceae	In inflammation, leprosy, urinary discharges, skin diseases, piles, biliousness, rheumatism
Blumea lacera (Burm. f.) DC.	Asteraceae	For camphor manufacture
Catharanthus roseus G. Don., syn. *Vinca rosea* L.	Apocynaceae	In diabetes, as hypotensive stomachic, sedative
Centella asiatica Linn. syn. *Hydrocotyle asiatica* Linn.	Umbelliferae	As diuretic and tonic, in leprosy
Clerodendrum viscosum (L.) Kuntze., syn. *C. infortunatum*	Verbenaceae	In asthma, skin diseases, malaria, scorpion sting, snake bite, as laxative
Coccinea indica Wight & Arn.	Cucurbitaceae	As aphrodisiac, antipyretic, in skin eruptions, jaundice, diabetes
Daucus carota L.	Apiaceae	In dysentery, piles, bronchitis, jaundice, chronic diarrhoea, as aphrodisiac
Euphorbia nerifolia L.	Euphorbiaceae	In cold, wheezing in babies
Euphorbia tirucalli L.	Euphorbiaceae	In gonorrhoea, asthma, leprosy, dyspepsia, jaundice, as purgative
Feronia limonia (L.) Sw., syn. *F. elephantum* Corr.	Rutaceae	In cough, heart diseases, asthma, indigestions, vomiting, dysentery
Ficus glomerata Roxb. syn. *F. racemosa* L.	Moraceae	In bronchitis, diseases of kidney and spleen, dysentery, diarrhoea
Gynandropsis gynandra Merrill, syn. *G. pentaphylla*	Capparidaceae	In tumour, ulcer, spleen, bilious fever, headache
Ocimum sanctum Linn.	Labiatae	As stomachic, in asthma, bronchitis, malaria
Pandanus odoratissimus Auct.	Pandanaceae	In perfumery
Rosa damascena Mill.	Rosaceae	As laxative, antipyretic, astringent, in leprosy, headache, toothache
Terminalia arjuna Wight & Arn.	Combretaceae	In dysentery, ulcers, urinary discharges, heart diseases, anaemia, asthma
Terminalia bellerica Gaertn.	Combretaceae	In piles, leprosy, fever, rheumatism, snake bite and scorpion sting
Terminalia chebula Retz.	Combretaceae	As stomachic, expectorant, tonic, carminative, in dysentery, sore throat, inflammations
Tinospora cordifolia Willd (Hk. & Th.)	Meninspermaceae	In jaundice, fever, cardiac problems, rheumatism, haemolysis, dysentery, gonorrhoea, chronic diarrhoea
Xanthium indicum Koenig, syn. *X. strumarium* L., *X. orientale* L.	Asteraceae	In chronic malaria, cancer, inflammation, as diuretic, CNS depressant

Table 2: Leading medicinal and aromatic plants of Bangladesh

Botanical name	Chemical constituents	Uses/indications	Part(s) used	Comments
Adhatoda vasica Nees.	Quinazoline alkaloids, essential oils	As expectorant, bronchodilator, respiratory stimulant, antispasmodic	Flower, leaves, bark and roots	Large gardens in Habiganj, Jessore, Maniganj and Satkhira districts
Azadirachta indica A. Juss.	Triterpenes, saponins, flavonoids, tannins, alkaloids	In inflammation of the gums, gingivitis, in fevers including malaria, diarrhoea.	Flower, leaves, bark, oil and seeds	Cultivations in Habiganj, Jessore and Satkhira districts
Ocimum sanctum L.	Essential oil, eugenol derivatives	As expectorant, analgesic, for lowering blood pressure and blood sugar, in diarrhoea.	Leaves and seeds	Large cultivations in Habiganj, Jessore and Satkhira districts
Rauwolfia serpentina (Linn.) Benth.	Indole alkaloids including reserpine, rescinnamine, deserpine, yohimbine	As sedative, remedy for high blood pressure, schizophrenia, in insomnia, epilepsy and other disorders of central nervous system	Roots	Cultivated in Habiganj, Jessore and Satkhira districts
Terminalia arjuna (Roxb.) W. & A.	Tannins, saponins, triterpenoids, sterols, flavonoids, alkaloids, glycosides	Reduces blood pressure and cholesterol levels	Bark, leaves and fruits in some cases	Planted all over Bangladesh

Photographs of some leading medicinal and aromatic plants of Bangladesh

Azadirachta indica A. Juss. and *Ocimum sanctum* L.

Adhatoda vasica Nees.


Rauwolfia serpentina (Linn.) Benth. and *Terminalia arjuna* (Roxb.) W. & A.

3.3 Bhutan

Bhutan is a small country in the Himalayas bordering India, Tibet and Nepal. The total land area of Bhutan is approximately 47,000 square kilometres with a population of 2,094,176. The country is rich in natural resources and over 60% of the endemic species of the Eastern Himalayan region can be found within its borders. Bhutan is one of the poorest countries in the world where most of the population lives in rural areas and rely mainly on traditional medicines for their health care needs. Chronic diseases such as arthritis, rheumatism, liver and nervous disorders are generally treated with traditional medicines. Only acute and severe diseases are treated by modern medicine.

Traditional Medicine Systems

Traditional medicine was introduced in Bhutan at the beginning of the 16th century by Lam Shabdrung Ngawang Namgyal and served as the main form of health care in Bhutan until the introduction of modern medicine in the 1970's. Traditional medicine is an official part of Bhutan's public health system. This medicine system uses herbal combinations, limited acupuncture therapy, and minor surgical interventions, in the context of Buddhist ritual (WHO, 2001).

The medicine system referred to as Sowa Rigpa owes its origin and development to ancient Tibet and is practised in many countries including Bhutan. It is based on the principles of Buddhism and uses about 300 of the 600 medicinal plants used in Bhutanese traditional medicines. Despite the wide availability of modern medicine, the local perception of illness is still deeply rooted in a strong Buddhist tradition. Different forms of traditional medical care are widely used and available in Bhutan (Dharmananda, 2002).

Government Efforts in Development of Traditional Medicine

The indigenous medicine system based on local plants and remedies is officially recognized by the government and provided free of charge along with modern medicine services.

The traditional medicine service was started as an offshoot of the Department of Health Services and officially became a part of the national health system in 1967. Two traditional dispensaries and the Institute of Traditional Medicine Services were founded in 1979 with the objective of establishing a traditional medicine system that is scientifically sound and technologically appropriate. The capital of Bhutan, Thimpu has a traditional medicine hospital (Dharmananda, 2002). There are another 15 traditional medicine units across the country serving about 60% of the population. The government plans to establish more such units to cover all 20 districts in the country. In early times, the traditional medicine practitioners were trained in Tibet. The officially recognized formal training of traditional medical doctors (drungtsho) began in 1971 in Bhutan with the establishment of a five-year drungtsho programme. In 1978 the training curriculum was finalized and in 1979 it became a part of the National Institute of Traditional Medicine (WHO, 2001). The national policy on traditional medicine of the kingdom of Bhutan is currently being developed, as are laws, regulations and a national programme. There is no registration system for herbal medicine. As of 1998, there were 103 herbal medicines listed on the national essential drug list (WHO, 2005).

Medicinal and Aromatic Plant Resources

There are about 5,600 species of plants in Bhutan and 600 of them are medicinal. A wide range of plant diversity is found in two main mountain ranges, the Lho-Menjong and the Druk-Yul. These mountains provide over 300 plant species traditionally used in indigenous medicine. The medicinal plants are mainly collected from the forests. Plants collected from Bhutan's temperate and lower zones are known under the traditional broad classification of *Thro-Men* where specific parts of the plants (the roots, bark, wood, leaves, flowers or fruit) are generally collected. Plants from the country's alpine zone are known as *Ngo-Men* where the whole plant is gathered. Some of Bhutanese medicinal and aromatic plants are given in Table 1 (Nawang, 1996).

Bhutan also has a potential for producing various essential oils, namely calamus oil (*Acorus calamus* L.), agar oil (*Aquilaria agallocha* Roxb.), lemon grass (*Cymbopogon flexuosus* (Nees ex Steud.) J. F. Watson), palmarosa oil (*Cymbopogon martini* (Roxb.) J. F. Watson), winter green oil (*Gaultheria procumbens* L.), cedar oil (J*uniperus macropoda* Boiss.), champ oil (*Michelia champaca* L.), keora oil (*Pandanus tectorius* Parkinson), pine needle oil (*Pinus* sp.) and ginger oil (*Zingiber officinale* Roscoe) (FAO, 2002).

Research and Development Activities

The National Institute of Traditional Medicine (NITM) works to provide traditional medicine; attain self-reliance in medicinal raw materials, conservation, cultivation, collection and preservation of rare and endangered species; improve the quality of traditional

medical services by training traditional doctors and increase the production of traditional medicines for export. NITM is the only institute with a programme for research and cultivation of medicinal plants. In 1988, a research unit was established within the Institute to conduct research for quality control of raw materials and finished products for traditional medicines as well as developing new products (Dharmananda, 2002). Menjong Sorig Pharmaceutical, the pharmaceutical production unit of the Institute started in 1998 and launched its first commercial product 'Tsheringma' herbal tea in 2000. At present the Unit is assessing the possibility of marketing its products on Western markets (Gyeltshen, 2000). The standardization of raw materials is carried out by the Pharmaceutical and Research Unit of NITM. More than 200 medicinal plants from Bhutan and about 20 from India that are commonly prescribed in traditional formulations are subjected to standard quality procedures. About 25 Bhutanese medicinal plants have been tested for their antifungal and anti-mitotic properties (Wangchuk, 2000).

In 1982 Bhutan, with the assistance of WHO, started small-scale mechanised production of traditional medicines. Previously all medicines had been prepared manually. Now herbals are manufactured mechanically using good manufacturing practices (WHO, 2001).

The plants *Inula helenium* L. and *Saussurea lappa* (Decne.) C. B. Clarke are cultivated and used locally for medicinal and incense purposes either at NITM or by the villagers themselves. During the reign of Bhutan's second king, His Majesty Jijme Wangchuck (1926-52), these two medicinal plant species were cultivated in the Bumthang. One of the plants *Inula helenium* L. is now cultivated in Ura by a family for supply to the indigenous hospital in Thimphu and NITM. The fate of the second plant is not known (Nawang, 1996).

The European Commission has funded a project in Bhutan to improve local health by developing the cultivation and marketing of the country's medicinal plants. The Commission has spent 4.2 million euros and has set up a local traditional medicine production system in order to preserve the country's herbal heritage helping it to meet its medicinal needs and start a high value export trade. The Commission's experts identified and catalogued all 600 medicinal plants and isolated the 300 most regularly prescribed herbs with the help of the country's traditional doctors. High altitude rural communities of Bhutan now grow these plants as cash crops and a factory has been set up for processing and manufacturing standardized medicines (Anonymous, 2000).

Trade and Marketing

At present, there are more than 300 herbal products and 35 tonnes of herbal materials produced each year in Bhutan. About 130 traditionally used formulations are made from 110 different herbal preparations. Seventy percent of the raw materials for herbal preparations are available in the country and the rest is imported from India and

Nepal (WHO, 2001; Dharmananda, 2002).

A Pharmaceutical and Research Unit for the production of traditional medicine was set up in 1998. The Unit meets the European GMP (good manufacturing practice) standards and formulates about 125 traditional drugs. The annual yield of the Unit in 1999 was more than seven tonnes (Wangchuk, 2000).

In the past, medicinal plants such as *Piper longum* L., *Piper nigrum* L., *Rubia cordifolia* L., *Rauvolfia serpentina* (L.) Benth. ex Kurz and *Swertia chirayita* (Roxb. ex Fleming) H. Karst among others, were sold to India. The sales method used was the leasing of large tracts of land through tenders or auctions. Such produce was classified as minor forest produce (MFP). The Royal Government of Bhutan realized that in the long run, however, such nonscientific harvesting of plant species would cause more damage than revenue generated. As a result the government imposed a ban in the early 1980s on the export of MFP including medicinal plants, which remains valid to date (Nawang, 1996).

Medicinal plant species such as *Aconitum* sp., *Aquilaria agallocha* Roxb., *Ephedra gerardiana* Wall. ex Stapf, *Nardostachys jatamansi* (Jones) DC., *Rauvolfia serpentina* (L.) Benth. ex Kurz, *Rheum nobile* Hook. f. & Thomson, and *Taxus baccata* L. growing naturally in Bhutan have international market potential for pharmaceuticals. That has not been fully exploited. The production and trade of lemon grass oil was introduced in 1983-1984 and was carried out initially by the Aromatic and Phytochemicals Section of Tashi Commercial Corporation which has a large distilling unit at Kurizampa. Agar wood is not being exploited commercially because the quantity available is not sufficient. A few trial plantations were established in the 1980s but no reports regarding agar wood production have been received so far (FAO, 2002).

Problems and Constraints

The lack of technical directives and proper guidelines has resulted in a decrease of some species of almost 50% over the past 20-25 years in localities where they once grew abundantly. There is a shortage of skilled manpower and raw materials for preparation of herbal drugs. There is a need for proper collection, cultivation, conservation, training, research and management of the herbal trade in order to explore the country's potential commercial resources of these plants.

Table 1: List of some important medicinal and aromatic plant of Bhutan

Botanical name	Family	Part(s) used	Uses/Indications
Acacia catechu (L. f.) Willd.	Fabaceae	Heartwood	As astringent, haemostatic, in diarrhoea
Adhatoda vasica Nees	Acanthaceae	Flower	In bronchitis, asthma

Continued

Table 1 continued

Botanical name	Family	Part(s) used	Uses/Indications
Aegle marmelos (L.) Correa	Rutaceae	Fruit	As antifungal, antibacterial
Aquilaria agallocha Roxb.	Thymelaeaceae	Heartwood	As stimulant, antimicrobial
Areca catechu L.	Arecaceae	Fruit, seed	In fever, rheumatism, headache, as aromatic
Asparagus racemosus Willd.	Liliaceae	Root	As antispasmodic, aphrodisiac
Bombax ceiba L.	Malvaceae	Flower	As antiangiogenic
Butea monosperma (Lam.) Taub.	Fabaceae	Fruit	As stringent, febrifuge, aphrodisiac, in diarrhoea
Cassia fistula L.	Fabaceae	Fruit, seed	As astringent, laxative, purgative, vermifuge
Cinnamomum zeylanicum Blume.	Lauraceae	Bark, leaf	In diarrhoea, rheumatism, diabetes, as hypoglycemic
Clematis montana Buch. Ham. ex DC.	Ranunculaceae	Seed, flower	In perfumery
Curcuma longa L.	Zingiberaceae	Rhizome	As anti-inflammatory, tonic, antioxidant, diuretic
Curcuma zedoaria (Christm.) Roscoe	Zingiberaceae	Bulb, root	As anticarcinogenic, carminative
Cymbopogon flexuosus (Nees ex Steud.) J.F. Watson	Poaceae	Leaf extract	For digestion, muscle tone, acne
Datura metel L.	Solanaceae	Fruit	As narcotic
Dichroa febrifuga Lour.	Hydrangeaceae	Root	As febrifuge
Diospyros lotus L.	Ebenaceae	Fruit	As astringent
Drosera peltata Sm. ex Willd.	Droceraceae	Whole plant	As antirheumatic
Embelia ribes Burm. f.	Myrsinaceae	Seed	As diuretic, carminative, contraceptive
Eugenia jambolana Lam.	Myrtaceae	Fruit	In diabetes
Galium aparine L.	Rubiaceae	Whole plant	As diuretic, in skin problems
Hedychium spicatum Buch.-Ham.	Zingiberaceae	Rhizome	In perfumery
Holarrhena antidysenterica (Roxb. ex Fleming) Wall ex A. DC.)	Apocynaceae	Fruit	As stomachic, febrifugal, tonic, astringent, in dysentery
Inula helenium L.	Asteraceae	Root	For lower blood sugar, blood pressure
Kaempferia galanga L.	Zingiberaceae	Rhizome	As carminative, expectorant
Malva verticillata L.	Malvaceae	Flower	In gastrointestinal problems
Mucuna pruriens (L.) DC.	Fabaceae	Seed	As analgesic, androgenic
Nardostachys jatamansi (Jones) DC.	Velarianaceae	Root	In perfumery
Panax pseudo-ginseng Wall.	Araliaceae	Tuber, root	As tonic, herbal tea
Phyllanthus emblica L.	Euphorbiaceae	Fruit	As anti-hepatitic
Phytolacca acinosa Roxb.	Phytolaccaceae	Bulb, root	As anti-tumor
Piper longum L.	Piperaceae	Fruit	In cough, anorexia, as analgesic
Punica granatum L.	Rosaceae	Fruit, seed	As antifungal
Rauvolfia serpentina (L.) Benth. ex Kurz	Apocynaceae	Root	As hypotensive, sedative
Rhododendron anthopogon D. Don	Ericaceae	Flower	In perfumery
Ricinus communis L.	Euphorbiaceae	Seed	As laxative, purgative, tonic, vermifuge
Rubia cordifolia L.	Rubiaceae	Root	As anti-tumor, astringent, diuretic, haemostatic
Saussurea lappa (Decne) C. B. Clarke	Asteraceae	Root	As atispasmodic, aphrodisiac, astringent, tonic, stomachic

Continued

Table 1 continued

Botanical name	Family	Part(s) used	Uses/Indications
Semecarpus anacardium L. f.	Anacardiaceae	Seed	In arthritis, tumors, infections
Swertia chirata (Wall) C. B. Clarke	Gentianaceae	Whole plant	As tonic, stomachic, febrifuge, antimalarial
Taraxacum officinale Wigg.	Asteraceae	Whole plant	In jaundice
Taxus baccata L.	Taxaceae	Bark, leaf	As anticancer
Terminalia belerica Roxb.	Combretaceae	Fruit	As antiseptic, astringent, tonic, expectorant, laxative
Terminalia chebula Retz.	Combretaceae	Fruit	As tonic, astringent, laxative, expectorant, alterative
Tinospora cordifolia (Willd.) Hook. f. & Thomson	Minispermaceae	Stem	In diabetes
Zingiber officinale Roscoe	Zingiberaceae	Rhizome	In nausea, asthma, cough, colic, dyspepsia

3.4 India

The Republic of India situated in southern Asia is the 7th largest country in the world and the second largest in Asia with an area of 3,287,263 square kilometres and population of about 1,049.7 million people. It is bounded by Afghanistan, China, Nepal, and Bhutan to the north, Bangladesh, Myanmar and the Bay of Bengal to the east, by the Arabian Sea and Pakistan to the west and to the south by the Palk Strait and the Gulf of Mannar, which separates it from Sri Lanka and the Indian Ocean. India has large and diverse forest resources with almost 20% of the total land area classified as forest land. However, the country's large population also exerts intense demands on the forests. The forest types vary from tropical rainforest in northeast India, to desert and thorn forests in Gujarat and Rajasthan, mangrove forests in West Bengal, Orissa and other coastal areas and dry alpine forests in the western Himalayas. Tropical moist and dry deciduous forests and wet tropical evergreen forests are the most common types.

India is a unique country and proud to possess a well documented and well established system of medicine which has been practised for centuries, flourishing from 2500 to 500 B.C. The Ayurvedic system of medicine has written Vedic texts dating back to 3,000 B.C. that deal extensively with the medicinal properties of plants. Two other systems of medicine, Siddha (developed and established in South India) and Unani (introduced by Mughals) are used in the country. Ayurveda and Siddha are perhaps the longest, continuous healing traditions in the world. Besides these established systems, India possesses a vast array of folk practices among the tribal people. All of these systems make profound use of medicinal plants. Traditional medicine is widely used in India, especially in rural areas where 70% of the Indian population lives.

Traditional Medicine Systems

There are two levels of medicine system in India, the classical well documented systems of Ayurveda, Siddha and Unani, which have text books, are taught in colleges, grant degrees to practitioners and are incorporated into the official health care system. The other system of folk medicine is informal and exists in communities. It is passed orally from generation to generation. These systems have survived for thousands of years because of their common use and associated cultural beliefs of the populations (Sahai, 2000). The Ayurveda, Siddha and Unani systems of medicine have coexisted with homeopathy for centuries in India (WHO, 2001).

The Ayurveda system of medicine was taught in ancient universities in India, established as early as 700 B.C. (Takshila) and 500 B.C. (Nalanda). Ayurveda is believed to have matured between 2,500 and 500 B.C. and is deeply rooted in the Indian culture. During the medieval period, it suffered first because of the Mughals and then the British who patronized their own systems of medicine. However, it survived because of its inherent strength, cultural support and use by common people. Medicine and surgery are two well developed branches of the Ayurvedic system of medicine. The specialization branches of modern medicine have similar counterparts in Ayurveda, which reflects the completeness of the system. There are over 2,000 medicinal plants used in the Ayurvedic medicine system.

The Siddha system of medicine was developed in the South of India simultaneously with the Ayurveda. Siddha is one of the oldest systems of medicine practised in India. The Ayurveda and Siddha systems are being integrated with the modern system in the national health care programmes and patient care.

The Unani medicine system is based on Greek philosophy and Hippocrates (460-377 B.C.), the father of modern medicine, was its founder. It was then adopted by the Islamic rulers of the Arabian countries and flourished and developed during the medieval period. It was introduced to India by the Arabs in 1351 A.D.

Homeopathy, founded by Dr Samuel Hahnemann (1755-1843), originated in Germany and entered India in 1839 when Dr John Honigberger successfully treated Maharaja Ranjit Singh, the ruler of the Punjab for paralysis of the vocal cords. It is now one of the popular medicine systems practised in India.

Some of the Indian population on the Indo-China border area practises the Tibetan system of medicine, which is based on herbs. The Tibetan Medicine and Astrological Institute at Dharamsala in the state of Himachal Pradesh offers a six-year degree course in Tibetan medicine and has 30 branches throughout India and Nepal (Vasisht and Maninder, 2003).

The Indian system of medicine and homeopathy including Ayurveda, Siddha, Unani and drugless therapies such as yoga and naturopathy are widely practised in India. These systems are well integrated into the national health care system and are officially recognized by the central and state governments. These are safe, easy to use, economically viable and are widely accepted by the masses. The Vaidyas and Hakims had been practising these systems on the strength of their own merit. Each of these systems of medicine is based on its own individual philosophy and principles and has its own core areas of strengths and weaknesses. In post independence India, the government recognized the merit of each of these medicine systems and made attempts to develop them as viable systems of medicine for the health care needs of its people.

Government Efforts in Development of Traditional Medicine

The national policy on traditional medicines was introduced in India in 1940. National laws and regulations were issued in 1940, and updated in 1964, 1970 and 1982. The national programme was issued in 1964. The national office, the Department of Indian Systems of Medicine and Homeopathy was established in 1995 as part of the Ministry of Health and Family Welfare. There are a number of expert committees and a Drugs Technical Advisory Board on traditional medicines. India has multivolume national pharmacopoeias, such as the *Ayurvedic Pharmacopoeia of India*' (in five volumes), the *Unani Pharmacopoeia of India* and formularies which are considered legally binding. With regard to national monographs, a number of sources are used including a national database on medicinal plants used in Ayurvedic medicine and monographs contained in the national pharmacopoeias (WHO, 2005). Ayurveda, Unani, Siddha and homeopathy are well integrated into the national health care system. There are state hospitals and dispensaries for the systems of both traditional medicine and homeopathy; however, they are not always well integrated with allopathic medicine, particularly in allopathic hospitals. According to the Ministry of Health and Family Welfare there are 3,841 hospitals and 23,597 dispensaries of traditional medicine and 688,802 registered traditional medicine practitioners and homeopaths in India as reported on 1 April 2001 (Sharma, 2002).

The Central Council of Indian Medicine was created by the Central Council of Indian Medicine Act of 1970 with the following objectives:

- Standardization of training by prescribing minimum standards of education in traditional medicine;
- Advise the central government on matters relating to recognition/withdrawal of medical qualifications in traditional medicine;
- Maintaining and revising the central register of Indian medicine and prescribe

standards of professional conduct and etiquette; and

- Develop a code of ethics to be observed by practitioners of traditional medicine.

The Central Council of Homeopathy was constituted in 1973 with the same mandates. The Department of Ayurveda, Yoga & Naturopathy, Unani, Sidha and Homoeopathy (AYUSH), formerly the Department of Indian Systems of Medicine & Homeopathy (ISM&H) was created in March 1995 with the primary work areas of education, standardization of medicines, enhancement of availability of raw materials, research and development, information dissemination, communication and the involvement of traditional medicine and homeopathy in national health care. More than 4,000 personnel work in these areas (WHO, 2001). There are 4,246 registered traditional herbal medicines. A separate essential drug list exists for the three systems of traditional medicine in India. The ayurveda list has 315 herbal medicines on it, the Unani list has 244 herbal medicines and the Sidha list has 98. These lists were issued in 2001, 2000 and 2001, respectively (WHO, 2005).

In 2000, a separate National Medicinal Plant Board under the control of the Department of AYUSH was established to coordinate all aspects of medicinal and aromatic plants. The members of the Board are representatives of all relevant government departments, subject experts, NGOs and industry. It has five committees on cultivation and conservation, research, demand and supply, patent/intellectual property rights (IPRs), exports and imports, to address the particular needs of their respective areas (Vasisht and Maninder, 2003).

All traditional medicine practitioners and homeopaths must be registered to practise. The government is working to standardize their training through the Central Council of Indian Medicine and the Central Council of Homeopathy. Some national institutes and government bodies providing training and education in various branches of traditional medicine are:

- National Institute of Ayurveda, Jaipur;
- National Institute of Homeopathy, Kolkata;
- National Institute of Naturopathy, Pune;
- National Institute of Unani Medicine, Bangalore;
- National Institute of Post Graduate Training and Research in Ayurveda, New Delhi;
- National Academy of Ayurveda, New Delhi;
- Morarji Desai National Institute of Yoga, New Delhi;
- Rashtriya Ayurveda Vidyapeeth, New Delhi; and
- Institute of Post Graduate Training and Research in Ayurveda, Gujarat Ayurved University, Jamnagar.

In addition to these national institutes, there are a number of facilities for medi-

cal education and research under the Department of AYUSH. Traditional medicine is covered under medical insurance, though few people besides civil servants have medical insurance (WHO, 2001).

Medicinal and Aromatic Plant Resources

India is one of the 12 mega biodiversity centres of the world with two major hot spots of endemic species and 49,000 plant species reported in 16 agro-climatic zones of the country. There are about 15,000 to 20,000 plant species reported to have medicinal value with 30% considered as endemic to the country. Among these 7,000-8,000 are reported to be used in unregulated informal systems of medicine and 1,200-2,000 in the regulated AYUSH (Qazi, 2003). Some of the medicinal and aromatic plants found in India along with their traditional uses are listed in Table 1 (Ahmad *et al*., 1998).

Around 70% of Indian medicinal and aromatic plants are found in tropical areas mostly in various forest types spread across the Western and Eastern Ghats, the Vindhyas, the Chotta Nagpur plateau, the Aravalis ranges and the Himalayas. Although less than 30% of the medicinal and aromatic plant species are found in the temperate and alpine areas and higher altitudes, they include species of high medicinal value. About 90% of the medicinal plants used by industries are collected from the wild. While over 800 species are used in production by industry, less than 20 species of plants are under commercial cultivation. More than 70% of the plant collections in India involve destructive harvesting because of the use of parts such as roots, bark, wood, stem and the whole plant in the case of herbs. As a result several medicinal plants have been assessed as endangered, vulnerable and threatened due to over or unskilful harvesting and habitat destruction in the form of deforestation in the wild. The government of India has put 29 species, which are believed to be threatened in the wild, on the negative list of exports (Anonymous, 2000).

India's diverse agro-climatic zones, variation in regional topography and in flora and fauna has contributed to the richness of its biological diversity. Depending on the availability of principal medicinal plants, the country has been divided into eight phyto-geographic regions. The major species of medicinal and aromatic plants found in different regions are listed in Table 2 (Datta, 2001).

India, with its rich and ancient culture of using medicinal plants, has discovered herbs for all human ailments. The country is also famous for its spices for which it has a long tradition of use and production. More than 50 kinds of spices are produced, some in huge quantities. Indian consumption of spices is among the highest in the world with more than 90% of the domestic production used locally (Vasisht and Maninder, 2003). The Indian states with their respective areas under cultivation of medicinal plants are presented in Table 3 (Rajasekharan, 2004).

Brazil, Indonesia, China and India are the leading world producers of essential oils. However, as the consumption of essential oils in India is very high, very little is made available for export. The important essential oils produced in India are from sandalwood, lemon grass, palmarosa, eucalyptus (*Eucalyptus citriodora* Hook. and *Eucalyptus globulus* Labill.), mentha, khus and linaloe. Some commercially important plants in India that provide essential oils are listed in Table 4 (FAO, 2002).

Research and Development Activities

Research and development activities on medicinal and aromatic plants in India are led by the Council of Scientific and Industrial Research (CSIR), a leading research organization in India. It has 40 laboratories spread throughout the country each specializing in research in a particular field, according to the needs of the country. The research on medicinal and aromatic plants is carried out at nearly one quarter of these laboratories. The Central Institute of Medicinal and Aromatic Plants (CIMAP) is the national institute with a mandate focussed on medicinal and aromatic plants. The Indian Council of Agricultural Research (ICAR) and agricultural universities of various states have made significant contributions in developing agro-techniques for fostering cultivation of medicinal and aromatic plants in India. The Defence Research and Development Organization (DRDO) and Central Council of Research in Ayurveda and Siddha (CCRAS) are other national organizations involved in R&D activities related to medicinal plants. The clinical investigations of Indian drugs have been carried out by the Indian Council of Medical Research (ICMR). The ICMR and AYUSH are involved in developing standards for the medicinal plants of India through a network of eminent laboratories. The ICMR Medicinal Plant Unit, under its ongoing activities has published four volumes on quality standards of medicinal plants and five volumes of reveiws on Indian medicinal plants. The newly constituted National Medicinal Plant Board is expected to accelerate applied research in the field. All universities and leading pharmaceutical institutes carry out research on medicinal plants and the major herbal drug industries of the country are also well equipped with state-of-the-art facilities for research.

Many international agencies, research institutes and NGOs have played an active role in promoting sustainable use of biodiversity resources of medicinal and aromatic plants. Initiatives have been taken to increase public awareness, develop technologies for efficient utilization of resources and species cultivation, efficient management of local resources, creation of reserve forests for monitoring biodiversity change and regular review of requirements of conservation plans. The state forest departments of Andhra Pradesh, Karnataka, Kerala and Tamil Nadu have 54 protected areas covering various types of forests known as Medicinal Plant Conservation Areas (MPCAs).

A number of projects to develop agro-technologies for the successful introduction of cultivation of endangered medicinal plants and gene banks to preserve the germplasm have been implemented by the government. The pharmacopoeial standards of crude drugs used in different systems of medicine are nearly complete. Formularies have been published and Good Manufacturing Practices (GMP) have been made applicable to the manufacture of plant based drugs. Agro-technologies for 40 important medicinal plants have been developed with the help of national and state institutes to facilitate medicinal plant cultivation. The knowledge of ancient texts has been translated and digitalized in the form of a Traditional Knowledge Digital Library to protect intellectual property rights (IPR). Five gene banks, one at each of the following institutes: the Central Institute of Medicinal and Aromatic Plant, Lucknow; the National Bureau of Plant Genetic Resource, New Delhi; and the Tropical Botanical Gardens, Trivandrum; the Regional Research Laboratory, Jammu; the Arya Vaidyashala, Kottakal, have been established with the support of the Department of Biotechnology, Ministry of Science and Technology which supports research activities on medicinal, aromatic plants. The Technology Information, Forecasting & Assessment Council (TIFAC), in one of its Vision 2020 Reports, *Herbal Products: Current Status, Vision and Action Plan* has identified 45 medicinal plants on the basis of their endemic nature, volume of domestic and international demand, endangered nature and use in traditional medicine, for action in cultivation, post-harvest technology, processing, manufacturing, research, patenting and marketing. Seven plants including *Aloe vera* (L.) Burm. f., *Artemisia annua* L., *Bacopa monnieri* (L.) Pennell, *Catharanthus roseus* (L.) G. Don, *Centella asiatica* (L.) Urb., *Rauvolfia serpentina* (L.) Benth. ex Kurz and *Taxus baccata* L. were short listed for intense activities from 2001 to 2005 (Vasisht and Maninder, 2003).

Plans are in place to creat more MPCAs covering all ecosystems, ex situ conservation of rare species in established gardens, create Vanaspati Vans for production of medicinal plants in degraded forest lands, establish herbal gardens and nurseries for medicinal plants and promote contact farming to encourage cultivation. The Task Force on Conservation & Sustainable use of Medicinal Plants, Planning Commission of India, 2000 to improve awareness and availability of medicinal plants recommended the cultivation of 25 species of medicinal and aromatic plants which are in great demand (Anonymous, 2000).

Trade and Marketing

Most of the medicinal raw materials produced in the country are used locally. However, with the introduction of cultivation of high demand plants, export is expected to rise in the coming years. The present export volume of crude drugs from India

stands at 36,200 tonnes worth about US$24 million. India expects to achieve export figures of US$850 and 2,000 million by 2005 and 2010 respectively (Vasisht and Maninder, 2003).

India, apart from the request for medicinal plants for internal consumption, is one of the major exporters of crude drugs, mainly to six developed countries: France, Germany, Japan, Switzerland, the UK and the USA, who share 75 to 80% of the total export of crude drugs from India. Despite the potential for producing raw material within the country, some crude drugs are imported from countries such as Afghanistan, Bangladesh, Bhutan, China, Nepal, Pakistan and Singapore. The most prominent are *Glycyrrhiza glabra* L. from Afghanistan, Iran and Pakistan; *Atropa belladonna* L. from Germany; *Hedychium spicatum* from China; *Commiphora wightii* (Arn.) Bhandari Engl. from Pakistan and Swertia chirayita (Roxb. ex Fleming) H. Karst. from Nepal (Anonymous, 2000). India exported finished Ayurvedic and Unani medicines worth US$127 million to countries including Germany, Hong Kong, Malaysia, Russia, the UK and the USA in the year 2000-2001 (Sharma, 2002).

There are 7,843 licensed pharmacies of the Indian System of Medicine in addition to 857 of homeopathy and a number of unlicensed small scale processing units engaged in the manufacture of medicines to meet the requirement of 0.46 million registered practitioners of AYUSH and other users in the country. These pharmacies range from large Indian drug houses such as Baidyanath, Dabur, Himalaya Drugs, Zandu, Charak, etc. that employ modern/sophisticated equipment and methods for the production of drugs on a mass scale to small companies which manufacture drugs generally following the traditional prescriptions of ancient medical texts in the form of Nighantus (Lexicons) and texts on Bhaisaj Kalpana (Pharmacy) that specifically deal with plants and plant products. Many pharmacies attached to Ayurvedic institutes and hospitals and Vaidyas of villages produce drugs for their own consumption. The largest numbers of these pharmacies are located in the states of Gujarat, Kerala, Maharashtra and Uttar Pradesh and the lowest numbers in the States of the North East (N.E.) region. Apart from AYUSH pharmacies there are herbal industries such as Alchem International, Delhi; Hitashi Chemicals, Calcutta; Kanga Aromatics, Madurai; Herbochem, Hyderabad; Chemiloids, Vijayawada; Natural Remedies, Bangalore, etc., which specialize in the production and marketing of plant extracts for use in allopathic and homeopathic products (Anonymous, 2000).

The export market for medicinal plants appears to be growing faster than the domestic market. The cosmetics and aroma therapy industries are important areas

where Indian medicinal plants and their value added extracts/essential oils have a high and as yet untapped market potential. The main medicinal plants exported from India are given in Table 5 (Sahai, 2000).

India has a long history of spice production. It exports and accounts for 46% of world trade in spices. Indian spice production in 1999 and 2000 was 2,243,700 and 2,255,800 million tonnes respectively (Anonymous, 2004). The major spices produced in India in April-March 2002-03 included chilies, turmeric, pepper, coriander, fenugreek, cumin, fennel, garlic and cardamom, in decreasing volume of production. The estimated export values for April-May 2003 in tonnes were highest for chilies (83,000) followed by turmeric (32,000), pepper (20,000), coriander (15,500), fenugreek (11,250), cumin (10,000), fennel (4,200), garlic (1,250) and cardamom (550). The highest in terms of value in million US$ was chilies (62.30) followed by pepper (34.36), turmeric (20.56), cumin (15.71), coriander (9.92), cardamom (7.77), fenugreek (5.16), fennel (3.46) and garlic (1.18) (Anonymous, 2003). India is the main producer of turmeric, ginger and pepper controlling 90, 35 and 30% respectively of their world trade. Among the essential oils sandalwood, lemon grass, citronella, palmrosa, vetiver and rose are the main essential oils produced in the country. The most significant essential oil export of India is sandalwood oil, for which it is the major world producer exporting 50 to 60 tonnes to the world market. India also produces jasmine concrete, which is a high value product in perfumery. The country has a very old cottage industry involved in the production of high value perfumes (attars) for the world market (Vasisht and Maninder, 2003). On the world market, India is the number one producer of menthol from indigenously cultivated *Mentha arvensis*.

Problems and Constraints

Some of the major constraints in commercial exploitation of the medicinal and aromatic plant sector in India include: major dependence on collection from natural sources; poor harvesting (indiscriminate) and post harvest treatment practices; domestication; improper storage; unorganized trade practices; and lack of coordination of the plant based drug industry. There is insufficient data on the demand and supply situation of medicinal and aromatic palnts. Farmers have been taking initiatives to cultivate medicinal and aromatic plants but price instability affects the level of confidence of farmers necessary to take up large scale cultivation. However, for some crops such as senna, plantago, withania, asparagus, chlorophytum, mentha and lemongrass, farmers have developed confidence.

Table 1: Some common medicinal and aromatic plants of India

Botanical name	Family	Common name	Part(s) used	Uses/Indications
Acacia catechu (L. f.) Willd.	Fabaceae	Khair	Bark	As astringent
Acorus calamus L.	Acoraceae	Bach/Vaj	Rhizome	As emetic, in stomachache, dyspepsia, colic
Adhatoda vasica Nees	Acanthaceae	Adulasa	Leaf, root	In cough, chronic bronchitis, asthma, rheumatism
Allium sativum L.	Liliaceae	Lasan	Bulb	As carminative, in cough, fever, ear aches, colic
Allium cepa L.	Liliaceae	Piyaz	Leaf	As expectorant
Aloe barbadensis Mill.	Asphodelaceae	Ghi-kanwar	Plant	In stomachache, piles, as purgative, anthelmintic
Andrographis paniculata (Burm. f.) Wall. ex Nees	Acanthaceae	Kiryat	Whole plant	As febrifuge, tonic, anthelmintic, in dysentery
Asparagus racemosus Willd.	Liliaceae	Satawar	Root	As diuretic, in diarrhoea and liver disorders
Azadirachta indica A. Juss.	Meliaceae	Neem	Bark	As tonic, astringent, antiperiodic, in snake bite
Berberis aristata DC.	Berberidaceae	Darhald	Root	In diarrhoea, jaundice
Beta vulgaris L.	Chenopodiaceae	Chokunder	Root	As cooling, diaphoretic
Bombax ceiba L.	Malvaceae	Mochras/ simul	Gum	As aphrodisiac, astringent, tonic, in diarrhoea
Brassica juncea (L.) Czern.	Cruciferae	Asalrai	Seed	In cough
Butea frondosa Roxb. ex Willd., nom. illeg.	Fabaceae	Palasha/ Dhak	Seed, leaf, flower	As anthelmintic, astringent in diarrhoea and dysentery, tonic
Camellia sinensis (L.) Kuntze	Theaceae	Chai	Leaf	As astringent, diuretic, stimulant
Capparis spinosa L.	Brassicaceae	Kabra	Root bark	As tonic, diuretic, analgesic, expectorant, in rheumatism
Carum copticum (L.) C. B. Clarke	Apiaceae	Ajowan	Fruit	As antispasmodic, tonic, carminative, stimulant
Cassia alata L.	Fabaceae	Dadmurdan /Candle tree	Leaf	In ringworm, scabies, ulcers, itching, asthma
Cassia angustifolia Vahl	Fabaceae	Hindi senna	Leaf	As laxative, purgative, in skin diseases
Cinnamomum tamala [Buch.-Ham.] Nees et Eberm.)	Lauraceae	Tejpat	Leaf	As stimulant, carminative, in rheumatism, colic, diarrhoea
Curcuma longa L.	Zingiberaceae	Haldi	Rhizome	As blood purifier, antifungal, in wounds
Emblica officinalis Gaertn.	Euphorbiaceae	Amla	Fruit	As cooling, diuretic, in diarrhoea, dysentery
Eucalyptus spp.	Myrtaceae	Eucalyptus	Leaf	As antiseptic, in skin diseases, burns, rheumatism
Ficus carica L.	Moraceae	Anjir	Fruit	As purgative
Ficus religiosa L.	Moraceae	Pipal	Leaf	As purgative
Foeniculum vulgare Mill.	Apiaceae	Bari-saunf	Seed	As stimulants, aromatic, carminative, in stomachache
Glycyrrhiza glabra L.	Fabaceae	Mulhatti	Root	As tonic, laxative, in cough, sore throat
Hemidesmus indicus (L.) W. T. Aiton	Asclepiadaceae	Anatamul	Root	As tonic, in skin diseases, syphilis
Lantana camara L.	Verbenaceae	Ghaneri	Leaf	In malaria, rheumatism
Lawsonia inermis L.	Lythraceae	Hena/ Mehdi	Leaf	In headache, burning of skin, sore throat
Mimosa pudica L.	Fabaceae	Lajwanti	Leaf, root	In piles, fistula

Continued

Table 1 continued

Botanical name	Family	Common name	Part(s) used	Uses/Indications
Myristica fragrans Houtt.	Myristicaceae	Jaiphal	Seed	In stomachache, nausea, vomiting, as carminative
Nigella sativa L.	Ranunculaceae	Kalongi	Seed	In eruptions of skin
Ocimum sanctum L.	Lamiaceae	Tulsi	Whole plant	In gastric disorders, ear ache, bronchitis, as antiseptic
Piper betle L.	Piperaceae	Pan	Leaf	As aromatic, carminative
Piper longum L.	Piperaceae	Piplamul	Fruit	In chronic bronchitis, cough
Piper nigrum L.	Piperaceae	Gol mirch	Fruit	In asthmatic attack, cough
Plumbago zeylanica L.	Plumbaginaceae	Chitrak	Root	In skin diseases, dyspepsia
Punica granatum L.	Lythraceae	Annar	Leaf	As astringent, in diarrhoea, ulcers, piles, cholera
Raphanus sativus L.	Brassicaceae	Mouli	Root	In urinary complaints, piles, gastro dynamic pains
Rubia cordifolia L.	Rubiaceae	Manjit	Root	In skin diseases, as astringent
Saussurea lappa (Decne.) C. B. Clarke	Compositae	Kuth	Root	As tonic, in cholera, chronic skin diseases
Strychnos nux-vomica L.	Loganiaceae	Kuchla	Leaf	Applied as poultice to wounds and ulcers
Syzygium aromaticum (L.) Merr. & L. M. Perry	Myrtaceae	Laung	Bud, oil	As stimulant, carminative, in toothache, constipation
Syzygium cumini (L.) Skeels	Myrtaceae	Jamun	Bark	As astringent, in sore throat, diarrhoea
Tamarindus indica L.	Fabaceae	Imli	Fruit	As digestive, carminative, laxative
Terminalia arjuna (Roxb. ex DC.) Wight & Arn.	Combretaceae	Arjun	Fruit	As astringent, in bilious affections, heart diseases
Terminalia belerica Roxb.	Combretaceae	Bahera	Fruit	As antipyretic, in leprosy, diarrhoea, dropsy
Terminalia chebula Retz.	Combretaceae	Harar	Fruit	As laxative, in ulcers, piles
Vetiveria zizanioides (L.) Nash	Poaceae	Khus-khus	Root	As febrifuge, diaphoretic, in stomachache
Vitex negundo L.	Verbenaceae	Nirgandi	Whole plant	In joint pain, pains in arms and legs, partial paralysis
Vitis vinifera L.	Vitaceae	Angur	Leaf	In diarrhoea
Withania somnifera (L.) Dunal	Solanaceae	Asgand	Root	As tonic, diuretic, narcotic, in rheumatism
Zingiber officinale Roscoe	Zingiberaceae	Adrak	Rhizome	In cough, appetite loss

Table 2: Important medicinal and aromatic plants in different phyto-geographic regions of India

Phyto-geographic region	Available plants species
Western Himalayas	*Aconitum* spp.
	Allium spp.
	Atropa belladonna L.
	Berberis spp.
	Bunium persicum (Boiss.) B. Fedtsch.
	Centella asiatica (L.) Urb.

Continued

Table 2 continued

Phyto-geographic region	Available plants species
	Colchicum luteum Baker
	Dioscorea spp.
	Ephedra gerardiana Wall. ex Stapf
	Ferula spp.
	Gentiana kurroo Royle
	Holarrhena antidysenterica (Roxb. ex Fleming) Wall. ex A. DC.
	Inula racemosa Hook. f.
	Mentha spp.
	Nardostachys jatamansi (Jones) DC.
	Ocimum spp.
	Rheum spp.
	Saussurea lappa (Decne.) C. B. Clarke
	Swertia chirayita (Roxb. ex Fleming) H. Karst.
	Terminalia tomentosa (Roxb. ex DC.) Wight & Arn.
	Thymus serpyllum L.
	Zingiber spp.
Eastern Himalayas	*Aconitum* spp.
	Berberis spp.
	Chlorophytum arundinaceum Baker
	Cinnamomum spp.
	Coptis teeta Wall.
	Curcuma spp.
	Dioscorea spp.
	Gentiana kurroo Royle
	Mentha spp.
	Nardostachys jatamansi (Jones) DC.
	Piper spp.
	Podophyllum hexandrum Royle
	Rauvolfia serpentina (L.) Benth. ex Kurz
	Rheum spp.
	Swertia chirayita (Roxb. ex Fleming) H. Karst
	Taxus baccata L.
North eastern region	*Alpinia galanga* (L.) Sw.
	Aquilaria agallocha Roxb.
	Aristolochia bracteolata Lam.
	Coptis teeta Wall.
	Curcuma spp.
	Cymbopogon spp.
	Hydnocarpus kurzii (King) Warb.
	Mucuna nigricans (Lour.) Steud.

Continued

Table 2 continued

Phyto-geographic region	Available plants species
	Mucuna pruriens (L.) DC.
	Piper spp.
	Rauvolfia serpentina (L.) Benth. ex Kurz
	Solanum spp.
Gangetic plains	*Aegle marmelos* (L.) Correa
	Cassia fistula L.
	Curcuma spp.
	Dioscorea spp.
	Phyllanthus fraternus G. L. Webster
	Pluchea lanceolata (DC.) Oliv. & Hiern
	Psoralea corylifolia L.
	Sida spp.
	Terminalia spp.
	Tinospora cordifolia (Willd.) Hook. f. & Thomson
	Zizyphus spp.
Semi arid region	*Aloe barbadensis* Mill.
	Boswellia serrata Roxb. ex Colebr.
	Calotropis procera (Aiton) W. T. Aiton
	Citrullus colocynthis (L.) Schrad.
	Commiphora wightii (Arn.) Bhandari
	Diospyros melanoxylon Roxb.
	Tribulus terrestris L.
	Withania somnifera (L.) Dunal
Western Ghats	*Chlorophytum* spp.
	Cinnamomum tamala (Buch.-Ham.) Nees & Eberm.
	Curcuma spp.
	Elettaria cardamomum (L.) Maton
	Piper betle L.
	Piper longum L.
	Piper nigrum L.
	Strychnos nux-vomica L.
	Terminalia spp.
	Zingiber spp.
Eastern Ghats	*Alstonia scholaris* (L.) R. Br.
	Azadirachta indica A. Juss.
	Boswellia serrata Roxb. ex Colebr.
	Cassia fistula L.
	Celastrus paniculatus Willd.
	Curculigo orchioides Gaertn.
	Curcuma spp.

Continued

Table 2 continued

Phyto-geographic region	Available plants species
	Dioscorea spp.
	Diospyros spp.
	Hemidesmus indicus (L.) W.T. Aiton
	Leptadenia reticulata (Retz.) Wight & Arn.
	Pterocarpus marsupium Roxb.
	Santalum album L.
	Terminalia spp.
Andaman and islands	*Alstonia macrophylla* Wall. ex G. Don
	Ardisia solanacea Roxb.
	Ardisia spp.
	Costus speciosus (J. Konig) Sm.
	Dischidia bengalensis Colebr.
	Pandanus fascicularis Lam.
	Phyllanthus gomphocarpus Hook.f.
	Terminalia bialata (Roxb.) Steud.
	Terminalia bialata (Roxb.) Steud.

Table 3: Areas under medicinal and aromatic plant commercial cultivation in different states of India

Botanical name	Area under cultivation (hectares)	Cultivation areas (states)
Plantago psyllium L., nom. ambig.	50,000	North Gujarat and Northwest Rajasthan
Cymbopogon citratus (DC.) Stapf	20,000	Kerala
Papaver somniferum L.	18,000	Madhya Pradesh, Rajasthan and Uttar Pradesh
Cassia angustifolia	10,000	Coastal districts of Tamil Nadu
Mentha canadensis L.	10,000	Uttar Pradesh and Punjab
Cinchona spp.	6,000-8,000	Dajeeling district (West Bengal) Ootacamund district (Tamil Nadu)
Pimpinella anisum L.	3,000-5,000	Punjab and Western Uttar Pradesh
Withania somnifera (L.) Dunal	4,000	Central Parts of Madhya Pradesh
Solanum viarum Dunal	3,000	Maharashtra
Rosa ×damascena Mill.	3,000	Uttar Pradesh
Cymbopogon martinii stapf var. Motia	2,000	Uttar Pradesh, Karnataka
Cymbopogon nardus (L.) Rendle	2,000	Assam, Meghalaya, Andhra Pradesh
Jasminum grandiflorum L.	2,000	Tamil Nadu, Karnataka
Pelargonium graveolens L'Hér.	1,000	Tamil Nadu, Karnataka
Ocimum basilicum L.	500	Uttar Pradesh
Vetiveria zizanioides (L.) Nash	Scattered	Kerala, Karnataka, Tamil Nadu

Table 4: Some important essential oils produced in India

Botanical name	Trade/local name
Abelmoschus moschatus Medik.	Ambrette plant/ Musk dana
Aquilaria agallocha Roxb.	Agar/Agar
Artemisia pallens Wall. ex DC.	Davana/ Davana oil
Cananga odorata (Lam.) Hook. f. & Thomson	Ylang ylang/Apurvachampaka
Cymbopogon flexuosus (Nees ex Steud.) J. F. Watson	East Indian lemon grass/Lemon grass
Cymbopogon martini (Roxb.) J. F. Watson	Rosha grass/Gandbel
Cymbopogon winterianus Jowitt	Citronella/Java citronella grass
Eucalyptus citriodora Hook.	Eucalyptus oil
Eucalyptus globulus Labill.	Eucalyptus oil
Jasminum grandiflorum L.	Jasmine/Chameli
Lavandula officinalis Chaix	Lavender
Melaleuca leucadendron	Cajuput/Kayaputi
Mentha ×piperita L.	Peppermint/Gainthi phudina
Mentha arvensis L.	Menthol/Peppermint
Mentha spicata L.	Spearmint/Spearmint oil
Myristica fragrans Houtt	Nutmeg
Pandanus odoratissimus auct.	Screw pine/Keura
Santalum album L.	Sandal/Chandan
Syzygium aromaticum (L.) Merr. & L. M. Perry	Clove/Laung
Vetiveria zizanioides (L.) Nash	Vetiver/Khus-khus grass
Zingiber officinale Roscoe	Ginger/Adrak

Table 5: Important medicinal and aromatic plants exported from India

Botanical name	Plant part(s)
Aconitum spp.	Root
Acorus calamus L.	Rhizome
Adhatoda vasica Nees	Whole plant
Berberis aristata DC.	Root
Cassia angustifolia Vahl	Leaf and pod
Colchicum luteum Baker	Rhizome and seed
Hedychium spicatum Buch.-Ham.	Rhizome
Heracleum candicans Wall. ex DC.	Rhizome
Inula racemosa Hook. f.	Rhizome
Juniperus communis L.	Fruit
Juniperus macropoda Boiss.	Fruit
Picrorhiza kurrooa Royle ex Benth.	Root
Plantago ovata Forssk.	Seed and husk

Continued

Table 5 continued

Botanical name	Plant parts
Podophyllum hexandrum Royle	Rhizome
Punica granatum L.	Flower, root, bark
Rauvolfia serpentina Benth. et Kurz.	Roots
Rheum emodi Wall. ex Meisn.	Rhizome
Valeriana jatamansi Jones	Rhizome
Zingiber officinale Roscoe	Rhizome

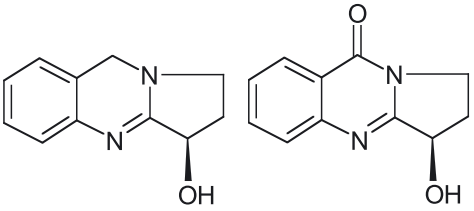
Table 6: Leading medicinal and aromatic plants of India

Botanical name	Chemical constituents	Uses/Indications	Part(s) used	Comments
Adhatoda zeylanica Medic	Alkaloids	In cold, cough, chronic bronchitis, asthma, sedative-expectorant, antispasmodic	Leaves and other aerial parts	Distributed throughout India and collected only from wild sources mainly from the states of Uttar Pradesh and Maharashtra
Aloe barbadensis Miller	Anthraquinone glycosides collectively termed as aloin	To boost the immune system, averts allergies, sinusitis and bronchitis, skin care products	Leaves	Majority of the supply is from cultivated sources mainly from the states of Andhra Pradesh, Gujarat and Rajasthan
Andrographis paniculata (Burm. f.) Wall. ex Nees	Andrographolide, lactones	As bitter tonic, in piles, dysentery, cholera, diabetes, influenza, bronchitis, itches, gonorrhea	Leaves or the aerial parts	The plant is collected from wild resources mainly in the states of Madhya Pradesh, Uttar Pradesh and Bihar
Bacopa monnieri (Linn.)Wettst.	Bacosides	In asthma, cough, hoarseness, insanity, epilepsy, nerve and as cardio tonic, diuretic	Whole plant	Collected from wild and is being cultivated at wet marshy localities throughout India
Cassia angustifolia Vahl.	Glycosides mainly sennoside	In constipation, fever, as expectorant, wound dressing, carminative	Fruit and leaves	Cultivated as well as from wild sources in the states of Tamilnadu, Maharashtra, Gujarat, Rajasthan and Delhi
Plantago ovata Forssk.	Hydrocolloid, sterols, aucubin glycosides	As laxative, antidiuretic, soothing, harmless, antiacidic, emollient, demulescent	Seeds and seed husk	Mainly from cultivations from the states of Gujarat and Rajasthan
Withania somnifera (L.) Dunal	Withanolides, withanone, withaferin	In physiological disorders, checks aging, toothache	Roots	The cultivation is confined to a limited area of Mandsore district of Madhya Pradesh. Widely distributed throughout the dry regions of India

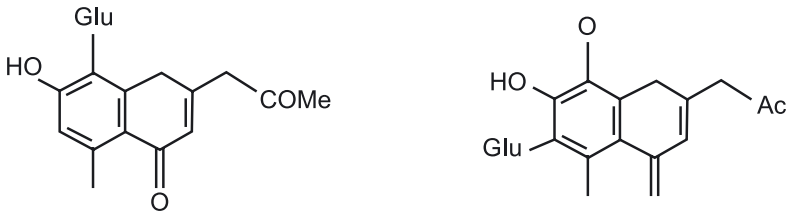

Adhatoda zeylanica Medic flowering branch & *Aloe barbadensis* Miller plant


Flowering branch and leaves of *Cassia angustifolia* Vahl.

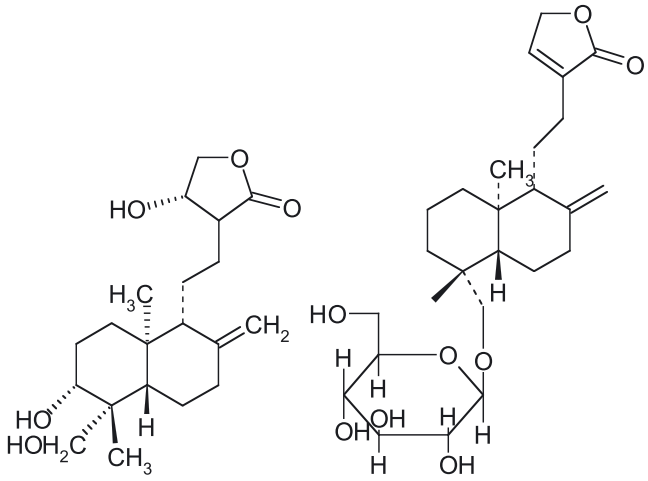
Branch of *Withania somnifera* (L.) Dunal



Vasicine and l- vasicinone from *Adhatoda zeylanica* Medic

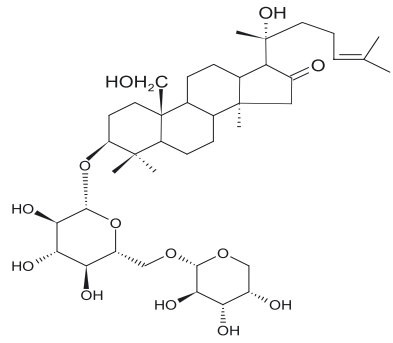


Aloesin and isoaloesin from *Aloe barbadensis* Miller

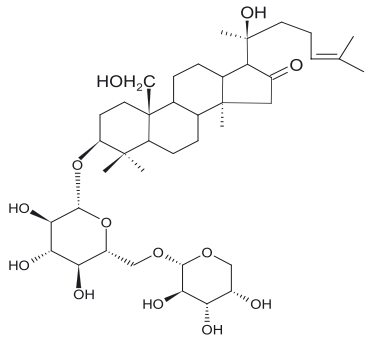


Andrographolide Neoandrographolide

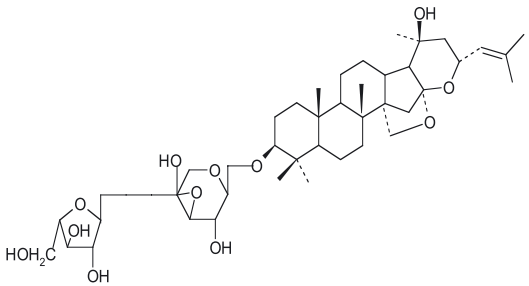
Andrographolides from *Andrographis paniculata* (Burm. f.) Wall. ex Nees



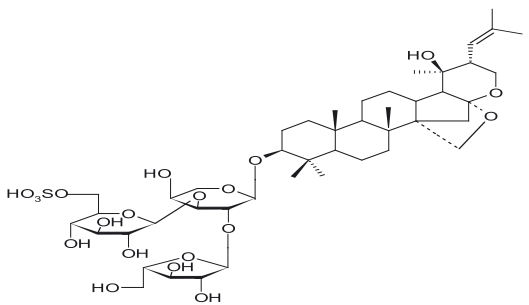
Bacoside A



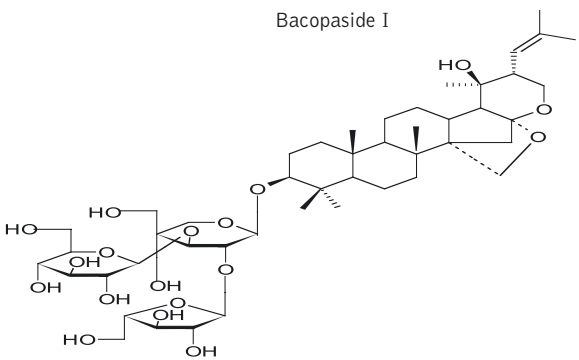
Bacoside B



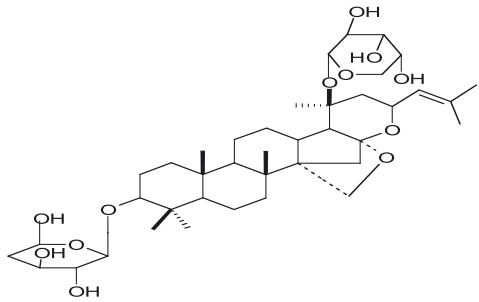
Bacoside A1



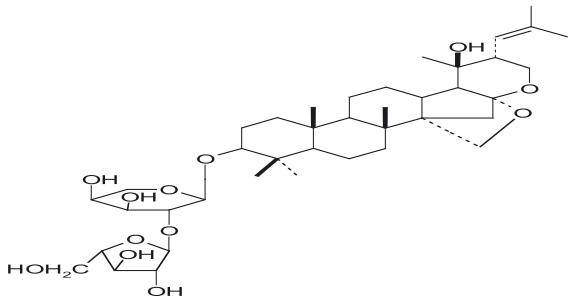
Bacopaside I



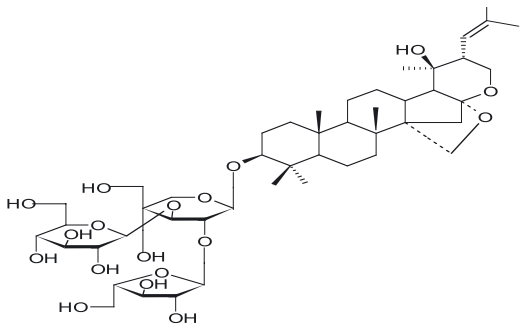
Bacopaside II



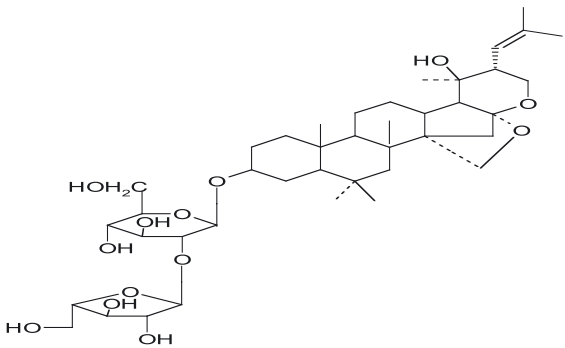
Bacopasaponin A



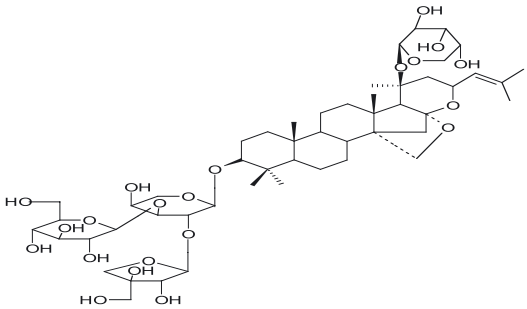
Bacopasaponin B



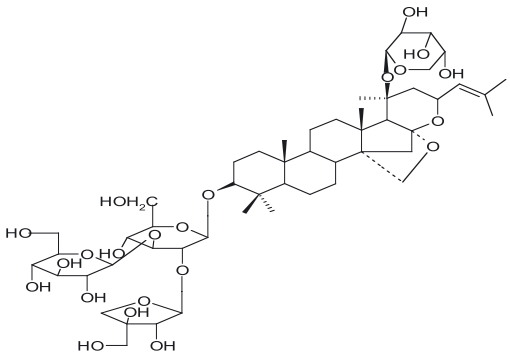
Bacopasaponin C



Bacopasaponin D

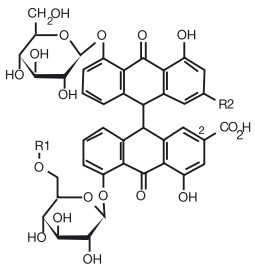


Bacopasaponin E



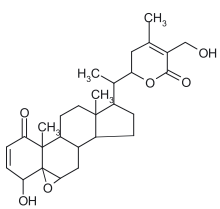
Bacopasaponin F

Bacosides from *Bacopa monnieri* (Linn.)Wettst.

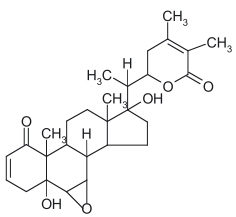


	R1	R2	9-9′
Sennoside A	H	CO2H	R′.R′ (threo)
Sennoside B	H	CO2H	R′.S′ (erythro)
Sennoside C	H	CH2OH	R′.R′ (threo)
Sennoside D	H	CH2OH	R′.S′ (erythro)
Sennoside E	CO-CO2H	CO2H	R′.R′ (threo)
Sennoside F	CO-CO2H	CO2H	R′.S′ (erythro)

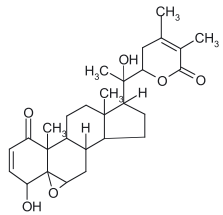
Sennosides from *Cassia angustifolia* Vahl.



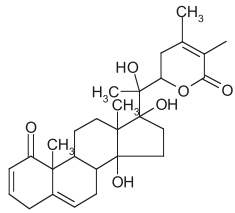
Withaferin A



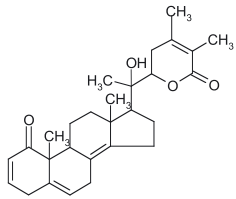
Withanone



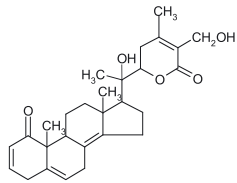
Withanolide D



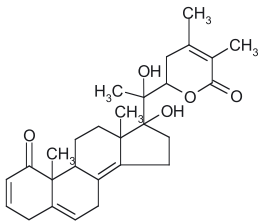
Withanolide F



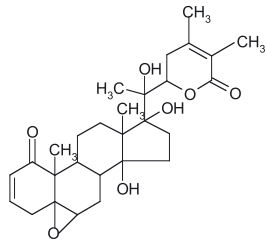
Withanolide P



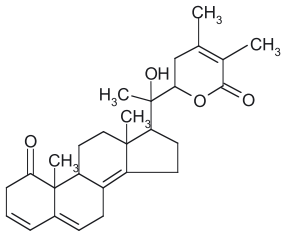
Withanolide H



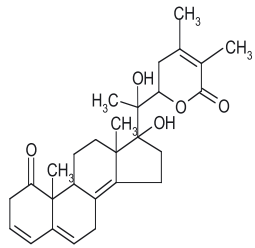
Withanolide J



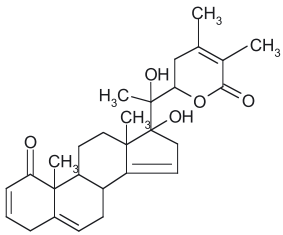
Withanolide E



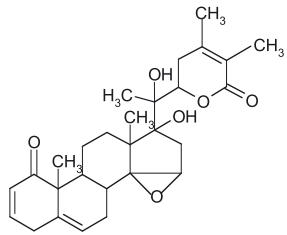
Withanolide I



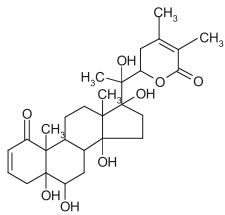
Withanolide K



Withanolide L



Withanolide M



Withanolide S

Withanolides from *Withania somnifera* (L.) Dunal

3.5 Maldives

The Maldives consist of 1,190 islands covering a total area of 90,000 square kilometres of the Indian Ocean and a population of about 0.3 million. Only 202 of the islands are inhabited and there are no problems of space apart from severe overcrowding in the capital Male. The economy of the country depends largely on tourism with agriculture playing a minor role because of limited availability of cultivable land. There is no distinct forest type on the islands and only about 3% of the Maldives is covered by forest and woodland. People use wood and tree products (predominantly coconut) as raw material for boat and house building, fuel, food and medicine. The Maldives government recently stressed the importance of forest cover and is encouraging tree plantation on the islands.

Traditional Medicine Systems

Traditional medicine in the country is known as Dhivehi Beys and has been practised for generations. The medicine treatise written by Sheikh Hussain of Seenu Atoll forms the foundation of today's traditional medicine system of the Maldives which has been influenced by Arab, Chinese, Indian, Malaysian, Persian and Sri Lankan traditional medicine systems. Practitioners of traditional medicine in the Maldives are known as hakeems and are well respected by the village communities. Some of these hakeems are also well versed in Unani medicine combining ancient remedies with new drugs for disease treatment (Anonymous, 2003). The Maldives do not regulate herbal medicines. They are classified as over the counter medicines for self medication only. No claims may be made by law. No national pharmacopoeia or national monographs on herbal medicines exist and none are being developed. There are no regulatory requirements for manufacturing and herbal medicines are sold as over the counter medicines (WHO, 2005).

People depended more on traditional medicine for their health care prior to the introduction of western medicine in the 1950s. Rural people still rely on traditional

medicine largely because of the lack of modern health care facilities. There is still a good community acceptance of the Divehi Beys in the Maldives (Anonymous, 2003).

Government Efforts in Development of Traditional Medicine

Allopathic medicine has been promoted and encouraged by the Maldives government ever since its introduction to the country. As a result the country is among the top medical drug users. There has been little government support for traditional medicine in the past and in some cases government regulations are counter productive to the conservation of plants used in traditional medicine treatments. In the Maldives, a national policy was issued in 1999. National laws and regulations for traditional medicines are in the process of development. The national programme was issued in 1980. The national office for traditional medicines was established within the Ministry of Health (WHO, 2005).

In recent years there has been an attempt to integrate traditional and modern medicine. The government in its 'Health for All' programme with the WHO has appointed an advisor on traditional medicine at the Institute of Health Sciences. The 'Health Master Plan 1996-2005' has been implemented and is working to re-establish traditional medicine in the country. The plan emphasizes supervision and guidance in the effective production and use of traditional medicine accepted by the community while increasing the acceptability of ingredients needed for traditional treatments (Anonymous, 2003).

The Fifth National Development Plan emphasizes the need to maintain the role and utility of traditional medicine in strengthening national capacity in traditional medicine; standardization of traditional medicine practices; fostering community acceptance; and maintaining accessibility to ingredients needed for traditional treatments (Anonymous, 2003).

The country has no school or university of traditional medicine. In 1973, the Allied Health Services Centre was established in the Maldives and was upgraded to the Institute of Health Sciences in 1992. The Institute works to preserve and promote traditional medical treatments. In the past the Institute conducted a traditional medicine course for training personnel in the use of herbs for preparation of medicines (Anonymous, 2003).

Medicinal and Aromatic Plant Resources

The Maldives have 500 species of higher plants of which 70 are considered endemic and more than 300 are used in traditional medicine practices (Anonymous, 2003). The Maldives have a well organized policy on conservation of timber plants but there is no proper form of conservation regarding medicinal plants and herbs because the latter are considered as weeds and so do not require much attention despite their uses in traditional medicine. Some rare and important medicinal plants are still grown in home gardens.

Plants such as *Abutilon indicum* (L.) Sweet (Maabula), *Aerva lanata* (L.) Juss. ex Schult. (Hudhuhuiyppilaa), *Boerhaavia diffusa* Linn. (Brandha gondi,) and *Pedilanthus* spp. are important endemic medicinal plants found in the country, most of which are collected directly from the forests. However, the impact of the modern economy and rapid population growth in recent decades have reduced the natural resources and availability of the plant species on which Divehi Beys depends, resulting in decreasing reliance of people on traditional practices (Anonymous, 2003). Various kinds of spices are grown and used in food and medicines in the Maldives.

Research and Development Activities

No detailed documentation of the local flora has ever been attempted locally or internationally. Very basic data on crops cultivated in the country have been recorded with the help of FAO but there is no data or specimen collection for medicinal and aromatic plants (Anonymous, 1995). Most of the available documentation is in the national language, Divehi but it is not widely available for reference and use.

The United Nations Development Agency submitted a project entitled *Conservation of medicinal species and traditional knowledge in Addu Atoll, the Maldives* in 2000 which was endorsed in 2001. The Agency is working with the Environment Section of the Ministry of Home Affairs, Housing and Environment, national NGOs and local communities to conserve both the resources upon which traditional remedies are based and the knowledge base regarding their preparation and use. There is lack of knowledge regarding the status and medicinal uses of most of the species which hampers the conservation of these species. The project aims to fill the gaps in current knowledge and to establish a scientifically valid inventory and monitoring system for medicinal plant resources of the country (Anonymous, 2003). The project is working for the documentation of the use of traditional medicines and their resources, the enhancement and understanding of traditional medicine to highlight the benefits of adopting the traditional medicine system, enterprise development and commercialization of products based on them through partnerships with various drug companies. The project also aims to make appropriate changes at the government policy level to promote the understanding and use of traditional medicine, provide support to traditional healers and incorporate these medicines and healers as an important component of the health plan. The Maldives have also sought help from India recently for the identification, development and protection of its herbal and medicinal plants.

Trade and Marketing

At present there is no regulation of imported medicine. Ninety percent of drugs is imported and distributed by the private sector. The Ministry of Health regularly updates

the essential drugs list and only drugs on this list can be imported. The high prices of traditional medicines charged by industry and the practitioners make them unaffordable to the communities in the Maldives.

The production of spices in the Maldives in the period 1998-2000 was only six metric tonnes. According to the International Trade Centre database the Maldives import values under the category HS 121190 (plants and parts of the plants including seeds and fruits used primarily in perfumery, pharmacy or for insecticides etc. in the fresh or dried forms) for 1997-2001 were US$38, 39, 56, 64 and 48 respectively.

Problems and Constraints

A number of factors including loss of natural habitat due to land utilization for housing, agriculture and resorts, loss of traditional knowledge due to the unwillingness of the older generations to share their knowledge and lack of interest among younger generations, lack of training institutions, unsustainable use of resources and the lack of appropriate policy support from the government are responsible for the absence of development of traditional medicine and medicinal and aromatic plant resources in the country.

3.6 Nepal

The Kingdom of Nepal is completely landlocked by India on three sides and China to the north. It has a population of about 26.5 million people. Nepal covers an area of 140,800 square kilometres ranging from the Gangetic plain of Terai to the Himalayas. The wide range of altitudes, temperatures, rainfall and its position at the crossroads of different floristic regions has provided Nepal with rich flora. Approximately 35% of the land area is under forest cover and national parks, wildlife reserves and conservation areas account for about 15%. The medicinal and aromatic plants along with various other non-wood forest products are collected from the forests play an important role in the national economy. Unsustainable harvesting and collection have resulted in heavy pressure on natural resources and have reduced forest area. About a quarter of the forest area has been heavily degraded and it is increasingly difficult for people to find essential forest products.

Traditional Medicine Systems

The use of medicinal plants in Nepal's traditional medical system dates back to 500 AD. Ayurvedic, Tibetan, Amchi (local version of Tibetan) and folk medicines are the commonly practised systems of medicine in the country and about 85% of the rural population is dependent on indigenous medicine for their health care needs (Vasisht and Maninder, 2003). Ayurvedic medicine is the national medical system and more than 75% of the population relies on traditional medicine (WHO, 2001). Traditional healers

play an important role in tribal medicine. Practitioners of Ayurvedic and traditional medicine located in remote villages are often the first and only health personnel available to the community.

Government Efforts in Development of Traditional Medicine

Traditional medicine is an integral part of the national health system and is encouraged by the government. Government policy based on five-year plans involves a system of integrated health services, in which both allopathic and Ayurvedic medicines are practised. The office of the Director General of Health Services has a section responsible for Ayurvedic medicine and the Ayurvedic clinics are considered to be part of the basic health services. In 1988, the Ayurvedic Medical Council was set up. Section 2.1 of the Act which established the Council describes its mandate as, among other things, to monitor the Ayurvedic medical system efficiently and register suitably qualified physicians to practise Ayurvedic medicine. Section 5.1.1 of the Act forbids the direct or indirect practice of Ayurvedic medicine by other medical practitioners (WHO, 2001). The 'National Ayurveda Health Policy' was issued in 1996. The national programme which is the second longterm health plan covering the period 1997-2017, was issued in 1997. The Department of Ayurveda was established within the Ministry of Health in 1981.

A committee was set up in 1994 to study the problems of Ayurveda and suggest steps for its improvement by the government. In accordance with the Ayurveda Health Policy formulated by the committee and approved by the cabinet in 1996, the Ayurvedic services have been asked to utilize local herbal resources to the maximum especially at the grass root level and provide specialized Ayurvedic services at the secondary and tertiary levels. The Department of Ayurveda under the Ministry of Health is the most important body for Ayurveda in the country and is responsible for the formulation, implementation and overall supervision of the Naradevi Ayurveda Hospital, the Regional Hospital, Dang, the Anchal level Ayurvedic Aushadhalaya, the District Ayurvedic Aushadhalaya (primary dispensaries) and various other units in the country (Singh, 2003). At present Nepal has 623 qualified practitioners of traditional medicine, about 4,000 traditionally trained practitioners, 141 ayurvedic dispensaries, 14 zonal dispensaries, 15 district Ayurvedic health centres and two Ayurvedic hospitals. Homeopathy has been introduced recently in Nepal. The Institute of Medicine of Tribhuvon University supervises formal education in the Ayurvedic system and the Department of Ayurveda under the Council for Technical Training and Vocational Education is responsible for the Auxiliary Ayurveda Worker training programme (WHO, 2001). No national pharmacopoeia or national monographs yet exist, but they are in the process of being developed. There is a registration system in Nepal and a national post-marketing surveillance system is being planned (WHO, 2005).

Medicinal and Aromatic Plant Resources

Nepal is situated in the central Himalayas and is rich in floral species diversity due to its geographic and climatic conditions. The country ranks 27th on the global scale and 11th on the continental scale in the number of flowering plants which is 2.5% of the total global flora. Five percent of flowering plant species are endemic to Nepal and 30% to the Himalayans (Anonymous, 2003). Nepal has about 7,000 species of flowering plants 246 of which are endemic to the country. There are 700 medicinal plants recorded as found in Nepal consitituting only 10% of the flowering plants of the country. At present the number of medicinal and aromatic plants used in the country has reached about 1,463 species (Tiwari, 2003). Some medicinal and aromatic plants found in Nepal, with their local uses, are listed in Table 1 (Manandhar, 1995; Shrestha and Dhillon, 2003; Tiwari, 2003).

The government of Nepal introduced the Community Forestry Development Programme, under which certain forest areas have been handed over to local rural communities termed as Forest Users' Groups (FUG), which manage and utilize the natural forest resources. Only FUGs are entitled to harvest medicinal plants and other forest products in such areas. The Department of Forests, under the Ministry of Forests and Soil Conservation is the legal authority that oversees the harvesting of wild medicinal and aromatic plants including the collection of royalties for harvested items and regular monitoring of the natural reserve of indigenous flora (Rawal, 1995).

Indiscriminate collection methods have endangered the existence of a number of valuable medicinal and aromatic plant species. A total ban on collection, use and export of *Dactylorhiza hatagirea* (D.Don) Soo, *Juglans regia* L. and *Picrorhiza scrophulariiflora* Pennell has been imposed. The is also a ban on the export of the unprocessed plants *Abies spectabilis* (D. Don) Spach, *Cinnamomum cecidodaphne* Mcissn (syn. *Cinnamomum glaucescens*), *Cordyceps sinensis*, *Nardostachys grandiflora* DC., *Parmelia* sp., *Rauvolfia serpentina* (L.) Benth. ex Kurz, T*axus baccata* L. and *Valeriana wallichii* DC. The trade and export from natural forests of *Acacia catechu* (L. f.) Willd., *Bombax ceiba* L., *Dalbergia latifolia* Roxb., *Juglans regia* L., *Michelia champaca* L., *Pterocarpus marsupium* Roxb. and *Shorea robusta* C. F. Gaertn has also been banned. Some endangered medicinal plants of Nepal are given in Table 2 (Regmi, 2000).

Research and Development Activities

The Royal Nepal Academy of Science & Technology (RONAST) established in 1982, works on the isolation of useful phyto-pharmaceuticals, collection and preservation of medicinal and aromatic plant germplasm, propagation and cultivation techniques and sus-

tainable use of natural resources. The Department of Plant Resources under the Ministry of Forest and Soil Conservation conducts research on phytochemical screening, pharmacological tests and development of techniques for commercial cultivation of important medicinal and aromatic plants. The Royal Drug Laboratory under the Department of Drug Administration is authorized to conduct analysis of Ayurvedic and other herbal drugs in order to approve for manufacture (Regmi, 2000). The Department of Medicinal Plants now renamed as the Department of Plant Resources focuses on scientific validation and research on Nepalese medicinal plants. The establishment of the Royal Drug Research Laboratory now called Natural Products Development Division, the Royal Botanical Garden, the National Herbarium, experimental herbal farms and extraction units are major achievements of the Department. At present the herbarium has about 100,000 specimens and an ethnobotanical museum has been attached to it (Shrestha, 2001). The Department also organizes regular training on conservation and cultivation of economically important medicinal plants for FUGs as a poverty alleviation programme.

The organized processing of medicinal and aromatic plants in Nepal began in 1981 with the establishment of the Herbs Production and Processing Co. Ltd. (HPPCL), under the Ministry of Forest and Soil Conservation. The HPPCL has an area of about 300 hectares for commercial cultivation of aromatic plants and has worked for domestication of a number of important herbs. The annual production of essential oils by HCCPL is more than 20 tonnes. It has pioneered the commercial cultivation of several exotic species of aromatic plants such as palmarosa (*Cymbopogon martini* (Roxb.) J. F. Watson), citronella (*Cymbopogon winterianus* Jowitt), lemon grass (C*ymbopogon flexuosus* (Nees ex Steud.) J. F. Watson), japanese mint (*Mentha arvensis* L.), german chamomile (*Matricaria chamomilla* L., sensu 1753), French basil (*Ocimum basilicum* L.), and a few indigenous species such as tagetes (*Tagetes minuta* L.). The domestication of *Nardostachys jatamansi* (Jones) DC., *Swertia chirayita* (Roxb. ex Fleming) H. Karst. and *Valeriana wallichii* DC. is being considered. The jatamansi oil (*Nardostachys jatamansi* (Jones) DC.) and Zanthoxylum oil (from *Zanthoxylum armatum* DC.) are also commercially produced and commercial distillation of Sugandha kokila oil (from *Cinnamomum glaucescens* (Nees) Hand.-Mazz.) has been patented by HPPCL (Rawal, 1995).

A number of ethnobotanical and ethnopharmacological surveys of medicinal and aromatic plants from different regions of the country have been carried out by national and international institutes. The National Herbarium and Plant Laboratories, Kathmandu in 1984, 1986 and 1991 surveyed and documented the traditional knowledge of healers in the Jajarkot district. The study identified 60 species used by local people for treatment of 25 types of diseases (Manandhar, 1995). The Laboratories in association with the departments of Botany and Pathology and Laboratory Medicine, University

of British Columbia, Canada assayed 20 species of Nepalese medicinal plants for their antiviral activities (Taylor *et al.*, 1996). The Institute of Pharmacy and Ernst-Moritz-Arndt-University, Germany has also screened 23 medicinal plant species of Nepal for their antiviral activity (Rajbhandari *et al.*, 2001). In association with South Asia Cooperative Environment Programme, Sri Lanka the Tribhuvan University, Patan conducted a survey of the Kali Gandaki Watershed Area. The study reported 48 medicinal plants in use, listing the botanical and local names, family names, parts used, methods of preparation and method of administration (Joshi and Joshi, 2000). The Agricultural University of Norway and the University of Oslo, Norway have documented 113 medicinal remedies derived from 58 species of medicinal plants used by nine village communities in the Bonch Village Development Committee (VDC) of Dolakha district of Nepal (Shrestha and Dhillon, 2003).

Dabur Nepal, a sister concern of Dabur India Company Limited, is the only large firm in Nepal manufacturing herbal and plant based products. It has leased about 50 hectares of land from Marpha villagers to cultivate a variety of endangered medicinal plants used in Ayurvedic and Tibetan medicine. Some of the medicinal and aromatic plant species including *Nardostachys jatamansi* (Jones) DC., *Picrorhiza kurrooa* Royle ex Benth., *Rheum emodi* Wall. ex Meisn., *Saussurea lappa* (Decne.) C. B. Clarke and *Taxus baccata* L. are inter-cropped with apple and peach trees (Limbu, 2001).

Trade and Marketing

Until 1960 the export of medicinal herbs from Nepal was limited to India and China. However, trade diversification in Nepal has promoted herbal trade to other countries. According to the data from the Trade Promotion Centre, exports amounted to over 4,000 tonnes in the mid 1970s but declined sharply during the 1980s. However, in the period 1992-93 it increased again reaching about 13,600 tonnes (Shrestha, 2001). The rural people of Nepal have been involved in the collection and harvesting of medicinal and aromatic plants since ancient times. Around 470,000 households in Nepal are involved in the collection of medicinal and aromatic plants and according to District Forest Offices records over 15,000 metric tonnes of medicinal plants were harvested in the period 1997-98. A small portion of the plants collected is used locally in the treatment of diseases and about 90% are sold as crude herbs, mainly for export. Most medicinal plants, collected both legally and illegally, are exported via the region of Terai by wholesalers in large volumes in crude form or after primary processing. It is estimated that 65 to 90% of the total collection in Nepal is exported to India, the rest to Germany, the UK, Japan and the US (Limbu, 2001).

At present, Nepal exports mostly crude herbs and to a negligible extent essential

oils and imports increasing amounts of Ayurvedic and modern drugs, cosmetics, essential oils and extracts prepared from the same herbs. The country imports Ayurvedic drugs for a value of more than US$5.37 million (400 million rupees) and it is increasing by 25% each year. About 200 different brands of Ayurvedic drugs are produced in Nepal by 26 private, mostly familial, companies. More than 150 Indian Ayurvedic drug companies are currently supplying Ayurvedic medicines to Nepal (Singh, 2003). The Singh Durbar Vaidyakhana, established approximately 300 years ago, earlier used to serve the Royal family and high ranking people. It has now been also opened to the public and has about 100 types of Ayurvedic products on the market. The private Gorkha Ayurved Company Ltd produces medicines from medicinal plants (Regmi, 2000).

The private sector handles over 95% of trade, of which 99% is exported to India. About 100 medicinal plants are reported to be collected in Nepal for use by the herbal drug industry. Some of the important medicinal plants with annual collection exceeding 100 tonnes are *Asparagus racemosus* Willd., *Bergenia ciliata* (Haw.) Sternb., *Cinnamomum glaucescens* Nees, *Picrorhiza scrophulariiflora* Pennell, *Sapindus mukorossi* Gaertn., *Swetia chirayita* (Roxeb ex Fleming) H. Karst. and *Zanthoxylum armatum* DC. Some other important plants collected in low volumes but with high utility values include *Acorus calamus* L., *Piper* spp., *Rheum australe* D. Don, *Rubia cordifolia* L. and *Valeriana jatamansi* Jones. Nepalese export of essential oils increased from US$76.62 million in 1996 to 126.06 in the period 1999-2000 (Vasisht and Maninder, 2003). Essential oils from Nepal have been well received on the regional and European markets and the demand for conventional oils such as palmarosa, citronella, lemon grass and tagetes is growing. The future of the essential oil industry looks promising with foreign firms entering Nepal for the manufacture of soaps and detergents. The *Nardostachys jatamansi* (Jones) DC., *Rhododendron anthopogon* D. Don oil and *Zanthoxylum armatum* DC. oils require greater efforts for successful export (FAO, 2002).

Problems and Constraints

The medicinal and aromatic plant resources of the country have not been exploited fully due to lack of policies and planning in R&D, pricing, marketing, capital investment, unclear regulations, investor-unfriendly circumstances and lack of technical know how. There is need for promotion and coordination of research and educational institutes on medicinal and aromatic plant and traditional medicine, development of agro technologies for medicinal and aromatic planst, industrial scale processing of herbs, cultivation and preservation of the endangered species and determination of royalties for collected herbs in order to regulate their supply and monitor their status.

Table 1: Some medicinal and aromatic plants of Nepal and their traditional uses

Botanical name	Family	Part(s) used	Uses/Indications
Acacia catechu (L. f.) Willd.	Fabaceae	Stem	In diarrhoea
Acorus calamus L.	Acoraceae	Rhizome	In cough, cold, dysentery, sore throat
Ageratum conyzoides L.	Compositae	Leaf, aerial parts	In cuts, wounds, stomachache
Allium wallichii Kunth	Alliaceae	Root	In mumps
Aloe vera (L.) Burm. f.	Asphodelaceae	Leaf	In burns
Amaranthus spinosus L.	Amaranthaceae	Root	In boils
Asparagus racemosus Willd.	Asparagaceae	Root, young shoots	In urinary disorders, as tonic
Bauhinia variegata L.	Fabaceae	Bark	In dysentery
Berberis asiatica Roxb. ex DC.	Berberidaceae	Stem, root	In rheumatic pain, for blood purification
Bergenia ciliata (Haw.) Sternb.	Saxifragaceae	Root, rhizome	In fever, maternity problems
Bombax ceiba L.	Malvaceae	Flower	In diarrhoea, dysentery, fever
Cannabis sativa L.	Cannabaceae	Leaf	In indigestion, wounds, rheumatic pain
Capsella bursa-pastoris (L.) Medik.	Brassicaceae	Whole plant	To lower blood pressure
Cassia tora L.	Fabaceae	Leaf, seed	In skin diseases, stomachache
Crotalaria alata Buch.-Ham. ex D. Don	Fabaceae	Whole plant	In fever
Cymbopogon citratus (DC.) Stapf	Poaceae	Whole plant	In cold
Cyperus rotundus L.	Cyperaceae	Root	In boils, blisters
Datura stramonium L.	Solanaceae	Leaf	In asthma
Ephedra gerardiana Wall. ex Stapf	Ephedraceae	Young stems	In bronchitis, asthma
Euphorbia hirta L.	Euphorbiaceae	Latex, root	In eye disease, vomitting
Ficus auriculata Lour.	Moraceae	Leaf	In wound healing
Ficus religiosa L.	Moraceae	Bark, leaf, fruit	In gonorrhoea, scabies, respiratory ailments
Gaultheria fragrantissima Wall.	Ericaceae	Leaf	As aromatic
Glycyrrhiza glabra L.	Fabaceae	Root	In teeth problems
Inula cappa (Buch.-Ham. ex D. Don) DC.	Asteraceae	Young shoots	In snake bite
Jasminum humile L.	Oleaceae	Flower	In throat ache
Jatropha curcas L.	Euphorbiaceae	Twig, latex	In gum problems, eczema
Juniperus communis L.	Cupressaceae	Fruit	As aromatic
Justicia adhatoda L.	Acanthaceae	Leaf	In rheumatic pain, bronchitis
Mangifera indica L.	Anacardiaceae	Bark, cotyledon	In jaundice, stomach disorders, diarrhoea
Mentha arvensis L.	Lamiaceae	Leaf, flower	In heat sensation, tongue infection
Mucuna pruriens (L.) DC.	Fabaceae	Whole plant	As aphrodisiac, tonic, antipyretic, emmenogogue
Nardostachys jatamansi (Jones) DC.	Valerianaceae	Flower, leaf, root	As aromatic, tonic, stimulant, antispasmodic, in hysteria
Nigella sativa L.	Ranunculaceae	Seed	As carminative, diuretic, stimulant
Ocimum basilicum L.	Lamiaceae	Seed, leaf	In urinary disorders, skin diseases
Papaver somniferum L.	Papaveraceae	Seed, flower	As analgesic, antispasmodic
Plantago major L.	Plantaginaceae	Seed, plant	In dysentery, urinary disorders
Quercus lanata Sm.	Fagaceae	Bark	In sprain, fracture

Continued

Table 1 continued

Botanical name	Family	Part(s) used	Uses/Indications
Rauvolfia serpentina (L.) Benth. ex Kurz	Apocynaceae	Root	As hypotensive, neuroleptic, sympatholytic
Rheum emodi Wall. ex Meisn.	Polygonaceae	Root	In bone fracture, diarrhoea
Rhododendron arboreum Sm.	Ericaceae	Flower	In diarrhoea
Rhus javanica L.	Anacardiaceae	Fruit, bark	In dysentery, muscular swelling
Rubus ellipticus Sm.	Rosaceae	Root	In stomach pain, thyroid
Rumex nepalensis Spreng.	Polygonaceae	Root	In wound healing
Rumex nepalensis Spreng.	Polygonaceae	Leaf, root	In tooth problem
*Smilax macrophyl*la Roxb.	Smilaceae	Root	In fever
Swertia chirayita (Roxb. ex Fleming) K. Karst.	Gentianaceae	Whole plant	In fever, indigestion
Terminalia chebula Retz.	Combretaceae	Fruit	In dysentery, skin disease
Urtica dioica L.	Urticaceae	Root, Leaf	In fever, asthma, toothache, paralysis, uterine bleeding
Urtica dioica L.	Urticaceae	Leaf	In rheumatic pain
Valeriana wallichii DC.	Valerianaceae	Root	As sedative, in nervous and digestive disorders, hysteria, migrain
Vitex negundo L.	Lamiaceae	Leaf, stem	In sinusitis, whooping cough
Withania somnifera (L.) Dunal.	Solanaceae	Root	In rheumatism
Zanthoxylum oxyphyllum Edgew.	Rutaceae	Seed, fruit	In chronic gastritis, diarrhoea

Table 2: Some endangered medicinal and aromatic plants of Nepal

Botanical name	Family
Acorus calamus L.	Acoraceae
Asparagus racemosus Willd.	Asparagaceae
Dactylorhiza hatagirea (D.Don) Soo	Orchidaceae
Fritillaria cirrhosa D. Don	Liliaceae
Nardostachys grandiflora DC.	Valerianaceae
Picrorhiza scrophulariiflora Pennell	Scrophulariaceae
Podophyllum hexandrum Royle	Berberidaceae
Rauvolfia serpentina (L.) Benth. ex Kurz	Apocynaceae
Rheum australe D. Don	Polygonaceae
Swertia chirayita (Roxb. ex Fleming) H. Karst.	Gentianaceae
Valeriana jatamansi Jones	Valerianaceae

Table 3: Leading medicinal and aromatic plants of Nepal

Botanical name	Chemical constituents	Uses/Indications	Part(s) used	Comments
Nardostachys grandiflora DC.	Jalamansin	In hysteria, as perfumes	Roots	Root oil is exported, raw material export is banned

Continued

Table 3 continued

Botanical name	Chemical constituents	Uses/Indications	Part(s) used	Comments
Podophyllum hexandrum Royle	Podophyllotoxin	Cytotoxic action	Rhizome and roots	Raw material is exported to India and Europe
Rauvolfia serpentina (L.) Benth. ex Kurz	Reserpine	As hypotensive, neuroleptic, sympatholtic	Roots	Raw material export is banned
Taxus wallichiana Zucc.	Taxol	In the treatment of ovarian, breast and lung cancer	Leaves	Wild collections are banned
Valeriana jatamansi Jones	Valepotriate	As carminatives, antispasmotic, useful in hysteria and other nervous disorders	Roots	Raw material is exported to Europe
Zanthoxylum armatum DC.	Limonene, Linalool & methyl cinnamate	As aromatic, tonic, in fever, dyspepsia and cholera, spice	Fruits	Raw material is exported to India and Europe

Photograhs of some leading medicinal and aromatic plants of Nepal

Plant & roots of *Nardostachys grandiflora* DC.

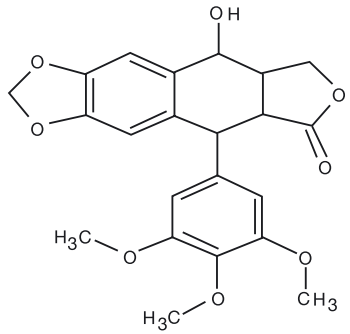
Plant & roots of *Valeriana jatamansi* Jones


Plant & roots of *Rauvolfia serpentina* (L.) Benth. ex Kurz

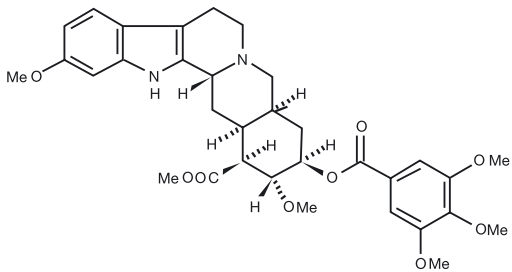

Plant and fruiting branch of *Taxus wallichiana* Zucc.


Plant and roots of *Podophyllum hexandrum* Royle

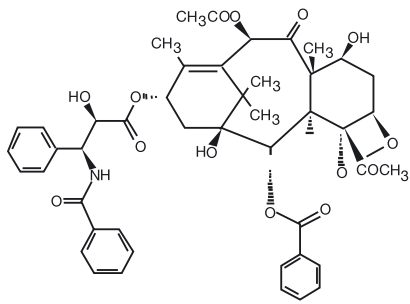

Plant and fruiting branch of *Zanthoxylum armatum* DC.



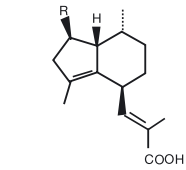
Podophyllotoxin from *Podophyllum hexandrum* Royle

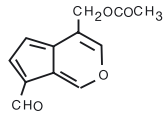


Reserpine, the main constituent of *Rauvolfia serpentina* (L.) Benth. ex Kurz



Taxol from *Taxus wallichiana* Zucc.



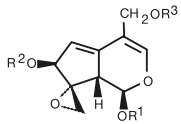


Valerenic acid: R=H

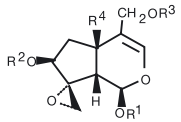
Acetylvalerenic acid: R = OCOCH2

Baldrinal

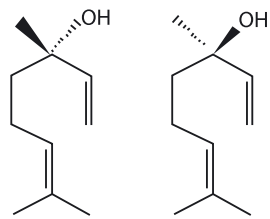
	R1	R2	R3
Valtrate	Isovaleryl	Isovaleryl	Acetyl
Isovaleryl	Isovaleryl	Acetyl	Isovaleryl
Acevaltrate	Isovaleryl	ß-Acetoxyvaleryl	Acetyl



	R1	R2	R3	R4
Didrovaltrate	Isovaleryl	Acetyl	Isovaleryl	-H
IVHD	Isovaleryl	Acetyl	2-(Isovaleryloxy)-Isovalery	-OH



Valepotrate from *Valeriana jatamansi* Jones



Linalools from *Zanthoxylum armatum* DC

3.7 Pakistan

The Islamic Republic of Pakistan is surrounded to the northwest by Afghanistan; to the west by Iran; Russia and China to the north; India to the east and the Arabian Sea to the south. Pakistan covers an area of 803,940 square kilometres and has a population of about 150.7 million people. It is located in the subtropics and has a varied climate. Most of the country is situated in arid and semi-arid zones and the northern and western parts of the country are mainly mountainous. The forest cover in Pakistan is less than 3% of the area, however, the geographical and climatic contrasts of the country have resulted in great diversity in forest plant species. The North West Frontier Province is home to around 40% of the country's total forests. Traditional medicine has been integrated in the national health care system and the majority of the population relies on them.

Traditional Medicine Systems

Unani medicine is part of Pakistani culture and is popularly practised by a large

segment of the population. This medicine system originated in Greece and was brought to the Indo-Pak subcontinent by Muslim scholars. However, the unani medicine currently practised in Pakistan is vastly different from its Greek roots. It has also benefited from the Indian Ayurveda medicine system, (Hassan, 2003). Unani medicine is also termed as *Greco-Arab* or *Tibb*. The use of herbal medicines and homeopathy is common. The Drugs Act of 1962 controls the advertising and prevention of misuse of herbal medicines. They are regulated as over the counter medicine and dietary supplements. No claims may be legally made about them. The national pharmacopoeia is the *Tibbi pharmacopoeia*, 1967. The information it contains is not legally binding. The *Monographs of Unani Medicines Vol I* has been published. The Tibb-e-Unani, Ayurvedic Homeopathic, Herbal and. other non Allopathic Medicine Bill, to regulate the manufacture, sale, storage, import and export of medicine from these systems has been prepared. The Bill is awaiting approval and implementation (WHO, 2005). At present, about 70% of the population of Pakistan, particularly in rural areas, uses traditional medicine (WHO, 2001).

Government Efforts in Development of Traditional Medicine

A national policy on traditional medicines is being developed in Pakistan. Laws and regulations developed in 1965 were amended in 1970 and 2002. The national programme was issued in 1965 (WHO, 2005). Unani, Ayurveda and homeopathy have been accepted and integrated into the national health care system of Pakistan. The Unani, Ayurvedic and Homeopathic Practitioners Act of 1965 was passed for the regulation of qualifications and registration of practitioners of Unani (tabibs) and Ayurvedic (vaids) medicines. The Act established the Board of Unani and Ayurvedic Systems of Medicine, which is responsible for registration of qualified persons, maintaining institutional standards, and carrying out research and various other related activities. The Ministry of Health oversees the qualification of the practitioners through the National Council for Tibb. A candidate, after successful completion of Tibb qualifications and subsequent registration with the Council, can practise traditional medicine. At present, about 52,600 registered Unani medical practitioners serve the nation in urban and rural areas and about 360 Tibb dispensaries and clinics provide free medication to the public. One Tibb clinic under the Provincial Department of Auqaf and about 95 dispensaries have been established under provincial departments of Local Bodies and Rural Development. A Directorate of Hakims has also been established under the Federal Ministry of Population Welfare Programme. About 16,000 diploma holding Unani physicians have been involved in the National Population Welfare Programme in Pakistan (WHO, 2001). The number of homeopathic physicians registered with the National Council for Tibb is about 40,000, with most of them working mainly in the private sector (Hassan, 2003).

The Unani teaching institutions, Tibbia colleges are under the control of the National Council for Tibb, Ministry of Health. One public and 26 private sector colleges offer four-year diploma courses in traditional Unani and Ayurvedic medicine. These colleges have to follow the prescribed curriculum and conditions laid down in the regulations. Hamdard University has recently introduced a five-year programme to follow intermediate training. At the Faculty of Unani Medicine about 5,000 students are enrolled with about 950 graduating annually. Seventy-six colleges of homeopathic medicine in Pakistan offer a four-year diploma programme in homeopathy (WHO, 2001).

Medicinal and Aromatic Plant Resources

Diverse ecological and climatic conditions have provided Pakistan with a vast medicinal flora. There are about 6,000 species of flowering plants in the country with about 2,000 estimated to be medicinal and around 400 plants are used extensively in traditional medicine (Shaheen *et al.*, 2003). Some medicinal and aromatic plants found in Pakistan with their traditional uses are listed in Table 1 (Hassan, 2003; Shinwari and Gilani, 2003).

Medicinal and aromatic plants are generally more abundant in mountainous regions than on the plains. They grow naturally in the areas of Azad Kashmir, Baluchistan, Hazara, Malak and Kurram Agency, Murree Hills and Northern Areas. Their cultivation is carried out in different parts of Baluchistan, North West Frontier Province, Kashmir Punjab and Sindh (Saeed, 2003). Some cultivated species of medicinal and aromatic plants in the Punjab and Sindh provinces are listed in Table 2 (Zaidi, 2003).

Over 85% of the medicinal plant demand is met from the wild especially from moist alpine and high-altitude areas in the north western part of the country and dry montain areas of the Karakoram and Hindukush ranges. Many of these plant species are endangered due to over-harvesting and unsustainable collection methods. The plants *Aconitum heterophyllum* Wall. ex Royle, *Acorus calamus* L., *Atropa acuminata* Royle ex Lindl., *Berberis lycium* Royle, *Bergenia ciliata* (Haw.) Sternb., *Citrullus colocynthis* (L.) Schrad., *Commiphora wightii* (Arn.) Bhandari, *Dioscorea deltoidea* Wall. ex Griseb., *Paeonia emodi* Wall. ex Royle, *Picrorhiza kurrooa* Royle ex Benth., *Podophyllum hexandrum* Royle, *Polygonum amplexicaule* D. Don, *Rheum emodi* Wall. ex Meisn., *Saussurea costus* (Falc.) Lipsch., *Valeriana jatamansi* Jones and *Ziziphus sativa* Gaertn., have been listed as endangered and vulnerable in Pakistan (Shaheen *et al.*, 2003).

Plants including anise, caraway, coriander, fennel, lavender, rosemary and spearmint are used extensively as flavours for domestic consumption and export. However, no official record of their quantities of production, consumption and products are available. Hyderabad (Sindh) is the main centre for production of rose petal with about 80% of

the total production in Pakistan, whereas cut flower cultivation is mainly concentrated around Lahore and Pattoki. The daily production of fresh flowers in Pakistan is around 30 to 35 tonnes (Anwar and Masood, 2003).

Research and Development Activities

HEJ Research Institute of Chemistry, University of Karachi; Pakistan Council of Scientific and Industrial Research (PCSIR) Laboratories, Peshawar, Lahore and Karachi; Pakistan Forest Institute, Peshawar; National Institute of Health, Islamabad; National Agricultural Research Council (Plant Genetic Research Centre and National Herbarium), Islamabad; Pakistan Agricultural Research Council, Hamdard University, Karachi and Botany, Pharmacology and Pharmacognosy departments of various universities in Pakistan are engaged in research on traditional medicine and medicinal and aromatic plants. The research is focused on the areas of phytochemistry, pharmacology, tissue culture, taxonomy, quality, safety and efficacy, ethnobotany, databases, pharmacopoeias, standardization, collection, cultivation and conservation of these plants (Shaheen, 2000).

The Pakistan Council of Scientific and Industrial Research is engaged in standardization of herbal drugs and has analysed 135 commonly used drugs for various parameters. A medicinal plants database is being compiled at the National Agricultural Research Centre and the Plant Genetic Resource Institute (PGRI) and National Agricultural Centre have initiated the *in situ* conservation of medicinal and aromatic plant seeds. The Hakim Mohammad Saied Chamber has been established for preservation of germplasm (Shaheen *et al.*, 2003).

About ten years ago the HEJ Research Institute of Chemistry initiated a programme focused on research and development work in the area of agronomy, chemistry, taxonomy and traditional medicine. The Institute has published a number of studies on the efficacy and safety of herbal medicines and is currently working on various projects related to cultivation, processing and manufacturing of herbal medicines in collaboration with the Pakistan Agricultural Research Council, the University Grants Commission of Pakistan, the Medicinal and Aromatic Plant Program in Asia and a number of private companies (Atta-ur-Rahman and Choudhary, 2003).

The Quaid-i-Azam University, Islamabad recorded 50 plant species used for medicinal purposes by local inhabitants of the Margalla Hills National Park (Shinwari and Khan, 2000). The University, in collaboration with the World Wide Fund for Nature (WWF)-Peshawar also carried an ethnobotanical survey on the marketing of medicinal and aromatic plants in the area of the Utror-Gabral Valleys of Upper Swat in 2002. The survey reported that about 90% of the plants collected in the area are sold in fresh forms to the local markets (Hamayun *et al.*, 2003).

A WWF project entitled *People and Plants-Conservation and Training in Applied Ethnobotany in Pakistan* was started in 1997. Phase II (2001-2004) of the project is under way and besides other activities it focuses on the establishment of medicinal plant nurseries in different regions of the country. WWF Pakistan and the University of Peshawar listed the economically important medicinal and aromatic plants, including occurrence, distribution and abundance to determine their traditional use and pharmaceutical values in Bulashbar Nullah, Astore (Northern Pakistan) recently. The 33 medicinal plants used by the local communities along with their traditional uses were reported (Shinwari and Gilani, 2003).

Trade and Marketing

The pharmaceutical industry of Pakistan is mainly dependent on imported raw materials. The herbs are sold either dried or fresh to the local traders who sell them to wholesalers and ultimately to pharmaceutical concerns or exporters. Approximately 5,000 families residing in the remote areas are engaged in the collection of medicinal plant materials and about 300 to 350 crude herbal drugs are sold in the markets depending upon demand and supplies available. According to a survey by the Medicinal Plants Branch of the Pakistan Forest Institute, total turnover of crude drugs in the country is worth US$2.06 million (120 million Pakistan rupees). The medicinal and aromatic plants exported in crude form are listed in the *Foreign Trade Statistic's of Pakistan*. Crude drugs worth US$0.37 million (21.8 million Pakistan rupees) are exported annually from Pakistan to a number of different countries. However, this trade is erratic and returns are low due to fluctuation in the prices of crude drugs and the standards imposed by developed countries. The availability of crude drugs remains inconsistent and market trends cannot be determined easily. The annual consumption of various herbal drugs is divided into categories A (more than 200 tonnes), B (100 to 200 tonnes), C (51 to 100 tonnes) and D (2 to 50 tonnes) according to the quantities consumed or sold per year (Zaidi, 2003). Some of the drugs in each of these categories are listed in Table 3 (Hussain *et al.*, 2003).

Pakistan's major exporters of medicinal herbs and spices are Hamdard Laboratories, Herbion Pvt Ltd, Hashmi Surma, Qarshi Industries Pvt Ltd, Tayyebi Dawakana, Marhaba and Medics Laboratories. Hamdard Laboratories is one of the leading stakeholders (Aslam, 2002).

The main markets of crude herbal drugs are situated in Bahawalpur, Dir, Faisalabad, Hyderabad, Karachi, Lahore, Mingora, Multan, Peshawar, Rawalpindi and Sukkar. Peshawar is the main supply centre of herbal drugs to a number of different markets in Pakistan. The materials are also procured from Afghanistan and other central Asian re-

publics despite their availability in the country. Karachi is the central market for export based trade in medicinal and aromatic plants. The imports of such materials are mainly from Afghanistan, China, India, Indonesia, Iran and Thailand. Imporst are worth over US$130 million and have increased over the last 10 years (Shaheen *et al.*, 2003).

Problems and Constraints

Most of the medicinal and aromatic plant supply is from the wild, with minimum emphasis on cultivation. Many species are endangered and on the verge of extinction due to over harvesting and destruction of their natural habitats. There is a lack of sound information on trade and medicinal species. The major problems are: quality deterioration; depletion of the existing sources; lack of proper information on endangered and extinct species; and threat of genetic erosion due to indiscriminate exploitation by the collectors.

There is a need to streamline collection methods, cultivation and conservation of important species in order to derive commercial and health benefits from them. The collectors and traders should be provided with training on proper identification and processing of raw materials. Research and documentation of indigenous knowledge on safety, efficacy and utility of medicinal and aromatic plants should be carried out, and there is a need for the development of the technology of propagation and regeneration of medicinal plants in their natural habitats and conservation of their natural resources.

Table 1: Some medicinal and aromatic plants of Pakistan and their traditional uses

Botanical name	Family	Part(s) used	Uses/Indications
Acacia nilotica (L.) Delile	Fabaceae	Root, bark	In skin diseases, oral hygiene
Achillea millefolium L.	Asteraceae	Leaf, flower	As carminative, tonic, in colds
Adhatoda vasica Nees	Acanthaceae	Leaf	In asthma, coughs
Aloe vera (L.) Burm. f.	Asphodelaceae	Leaf	In skin disease
Amaranthus viridis L.	Amaranthaceae	Leaf	As emollient, in scorpion and snake bite
Anaphalis nepalensis Spreng.	Asteraceae	Inflorescence	As aromatic
Artemisia absinthium L.	Asteraceae	Flower	As stomachic, anthelmintic
Artemisia brevifolia Wall. ex DC.	Asteraceae	Leaf, flower	As antispasmodic, stomachic, anthelmintic
Artemisia scoparia Waldst. & Kit.	Asteraceae	Whole plant	In ear ache, burns
Asparagus adscendens Roxb.	Asparagaceae	Root	As tonic, galacatagogue
Azadiracta indica A. Juss.	Meliaceae	Leaf, root, fruit	In skin disease
Berberis lycium Royle	Berberidaceae	Whole plant	In wounds, eye problems, jaundice
Calendula arvensis L.	Asteraceae	Flower, leaf	As stimulant, antispasmodic, in wounds healing
Cannabis sativa L.	Cannabaceae	Leaf, flower	As tonic, narcotic, sedative, anodyne
Carum copticum (L.) C. B. Clarke	Apiaceae	Fruit	As aromatic, spice
Convolvulus arvensis L.	Convolvulaceae	Whole plant	As purgative, in skin diseases

Continued

Table 1 continued

Botanical name	Family	Part(s) used	Uses/Indications
Curcuma longa L.	Zingiberaceae	Rhizome	In gastro-intestinal tract problems, as flavouring agent
Ephedra intermedia Schrenk & C. A. Mey.	Ephedraceae	Root, fruit, twig	As antirheumatic, antiasthamtic
Euphorbia helioscopia L.	Euphorbiaceae	Root, milky juice	As cathartic, anthelmintic
Foeniculum vulgare Mill.	Apiaceae	Fruit	In gastro-intestinal tract problems
Juniperus communis L.	Cupressaceae	Fruit	As aromatic
Malva neglecta Wallr.	Malvaceae	Whole plant	As emollient, demulcent, piles,
Mentha longifolia (L.) Huds.	Lamiaceae	Leaf	As carminative, stimulant, astringent, stomachic
Mentha royleana Benth.	Lamiaceae	Whole plant	As stomachic, carminative
Nigella sativa L.	Ranunculaceae	Seed	In hyperlipidemia
Onosma bracteatum Wall.	Boraginaceae	Root, leaf, flower	In fever
Picrorhiza kurrooa Royle ex Benth.	Scrophulariaceae	Root, rhizome	As cooling, stomachic, cardio tonic
Plantago ovata Forssk.	Plantaginaceae	Seed	In gastro-intestinal tract problems
Podophyllum hexandrum Royle	Berberidaceae	Rhizome, root	As purgative, tonic, hepatic stimulant
Rhazya stricta Decne.	Apocynaceae	Leaf	In urinary tract problems
Rumex chalepensis Mill.	Polygonaceae	Root	As astringent
Saussurea lappa (Decne.) C. B. Clarke (syn. Saussurea costus (Falc.) Lipsch.)	Asteraceae	Root	In sore throat, as aphrodisiac
Swertia petiolata Royle ex D. Don.	Gentianaceae	Root	As opthalmintic
Taraxacum officinale F. H. Wigg. Group	Asteraceae	Leaf, root	As diuretic, tonic, in chronic disorders
Tribulus terrestris L.	Zygophyllaceae	Whole plant	As tonic, diuretic, cooling, aphrodisiac
Vicia sativa L.	Fabaceae	Whole plant	As anti-poison

Table 2: Some cultivated medicinal and aromatic plants in the provinces of Punjab and Sindh, Pakistan

Botanical name	Cultivation areas
Cichorium intybus L.	Deska, Gujranwala, Silkot
Cuminum cyminum L.	Chagi, Kalat, Peshin, Quetta
Curcuma domestica Valeton	Bannu, Gujrat, Haripur, Kasur, Pabbi,
Cyamopsis tetragonoloba (L.) Taub.	Bhawalpur, Hyderabad, Larkana, Multan, Sarghoda
Foeniculum vulgare Mill.	Dadu, Sehavin
Lawsonia inermis L.	Bhawalpur, Sarghoda
Malva sylvestris L.	Gujranwala, Sialkot
Ocimum basilicum L.	Hyderabad, Mirpur Khas
Plantago ovata Forssk.	Bhawalpur, Chistian, Haroonabad, Yazman
Pongamia glabra Vent., nom. illeg.	Bhawalnagar, Bhawalpur, Multan
Ricinus communis L.	Larkana, Multan, Sarghoda, Tharparker
Rosa ×damascena Mill.	Chakwal, Hyderabad, Kalar-Kahar Mirpur Khas, Sukkur
Sesamum indicum L.	Dadu, Gujranwala, Gujrat, Kasur, Muzaffargarh, Sialkot, Tharparker

Table 3: The annual consumption of crude herbal drugs on the markets of Pakistan

Category	Quantity (tonnes)	Botanical name	Part(s) used
A	>200	*Carum bulbocastanum* (L.) W. D. J. Koch	Fruit
		Carum copticum (L.) C. B. Clarke	Fruit
		Cassia fistula L.	Pod
		Coriandrum sativum L.	Fruit
		Cuminum cyminum L.	Fruit
		Foeniculum vulgare Mill.	Fruit
		Glycyrrhiza glabra L.	Root
		Lawsonia alba Lam.	Leaf
		Mentha longifolia (L.) Huds.	Whole plant
		Plantago ovata Forssk.	Seed
		Punica granatum L.	Seed
		Rosa ×damascena Mill.	Flower
		Valeriana wallichii DC.	Root
		Zizyphus vulgaris L.	Fruit
B	101-200	*Adiantum capillus-veneris* L.	Whole plant
		Ferula foetida (Bunge) Regel	Gum
		Myrtus communis L.	Fruit
		Rheum emodi Wall. ex Meisn.	Root
		Terminalia arjuna (Roxb. ex DC.) Wight & Arn.	Fruit
		Terminalia chebula Retz.	Fruit
		Viola serpens Wall. ex Ging.	Leaf
C	51-100	*Artemisia maritima* L.	Twig
		Cassia angustifolia Vahl	Leaf
		Malva sylvestris L.	Seed
		Nigella sativa L.	Seed
		Peganum harmala L.	Seed
		Saussurea lappa (Decne.) C. B. Clarke	Root
		Sisymbrium irio L.	Seed
D	2-50	*Acorus calamus* L.	Root
		Aloe indica Royle, nom. nud.	Dried juice
		Alpinia galanga (L.) Sw.	Root
		Cassia absus L.	Seed
		Centella asiatica (L.) Urb.	Whole plant
		Fumaria indica (Hausskn.) Pugsley	Whole plant
		Hyoscyamus niger L.	Seed
		Lactuca sativa L.	Seed
		Lavandula stoechas L.	Whole plant
		Nepeta ruderalis Hamilt.	Whole plant
		Nymphaea lotus L.	Flower
		Pimpinella anisum L.	Fruit

Continued

Table 1 continued

Category	Quantity (tonnes)	Botanical name	Part(s) used
		Plumbago zeylanica L.	Wood
		Rubia cordifolia L.	Fruit
		Swertia chirayita (Roxb. ex Fleming) H. Karst.	Leaf
		Withania somnifera (L.) Dunal	Root

3.8 Sri Lanka

The Republic of Sri Lanka is situated close to the south eastern corner of the Indian subcontinent and consists of one main island and several small offshore islands. The population of the country is about 2 million and it covers an area of 65,610 square kilometres. Although it is a small island, it is identified as one of the most biologically diverse countries in Asia with about 20% of the area under forest. It has the highest species diversity per unit area in Asia and is one of the mega biodiversity hot spots. The natural forests are home to various species of medicinal plants, which have long been used for the treatment of various ailments. Ayurvedic and traditional medicine systems are quite popular in Sri Lanka. Herbal medicine is used in the treatment of diseases and maintaining health.

Traditional Medicine Systems

Traditional medicine has been practised in Sri Lanka for 3,000 years. Though the majority of the population today uses Western medicine, traditional medicine is very much used and popular in all types of Sri Lankan communities. Traditional medicine practitioners living in rural areas practise according to their specialties and herbal medicine in the form of mixtures, pastes and oils is used for treatment along with strict dietary controls. There is little written knowledge about such treatments which is normally transferred by hearsay from one generation to the other in the family (Seneviratne, 2003).

At present, there are four systems of traditional medicine in Sri Lanka: Ayurveda, Siddha, Unani and Deshiya Chikitsa (national treatment). The most important among them is Ayurveda, which also forms part of the national health services provided by the government. The Ayurveda system of medicine has its origins in India; however, over the years it has been modified, developed and adopted locally to a system which differs slightly from the Indian Ayurvedic system. The people rely on the Desiya Chikitsa system mainly for the treatment of eye diseases, fractures, dislocations, burns, scalds, boils and carbuncles. The Ayurveda and Desiya Chikitsa systems mainly use plant and herbal preparations for the treatment of diseases. The other traditional systems used in Sri Lanka include the Unani system practised largely by the Muslim population of the country and the Siddha

system related closely to Ayurveda and is practised mainly in the Tamil speaking areas of the country (Kumar, 2000). The health of the nation was looked after by traditional physicians until the introduction of modern medicine by the British in the 19th century. At present, Ayurveda serves a large proportion of the population with one Ayurvedic physician per 3,000 people in Sri Lanka (Pilipitiya, 1995). About 60 to 70% of the rural population relies on traditional and natural medicine for their primary health care (WHO, 2001). No national laws or regulations on herbal medicines have been issued and herbal medicines do not have any regulatory status. They are sold with medical, health, nutrient content and structure/function claims. The national *Ayurvedic Pharmacopoeia* was published in 1979. The *Compendium on medicinal plants*, publsihed in 2002, contains 100 national monographs and is considered to be legally binding (WHO, 2005).

Government Efforts in Development of Traditional Medicine

Traditional medicine forms an integral part of the health care delivery system in Sri Lanka. All post-independence governments have taken an interest in promoting traditional medicine. The Indigenous Medicine Ordinance of 1941 established the Board of Indigeneous Medicine for the regulation of traditional medicine practitioners and the Indigeneous Medicine College and Hospital. In order to strengthen and promote Ayurveda a separate government department under the Ministry of Health was established in 1956. The Department of Ayurveda was established by the Ayurveda Act of 1961 within the Ministry of Health for the establishment of services necessary for the treatment of disease; preservation and promotion of health; encourage study of and research in Ayurveda; develop or encourage measures for the investigation of diseases; and the improvement of public health through Ayurveda. The Act specified the duties of the Ayurvedic Medical Council: including registration of ayurvedic practitioners, pharmacists and nurses and regulation of their professional conduct as well as authority over the Ayurvedic Research Committee, Ayurvedic College and Hospital Board. The Homeopathic Council established in 1979 is responsible for regulating and controlling the practice of homeopathic medicine and maintaining the Homeopathic Medical College. A State Ministry of Indigenous Medicine was established in 1980 and the responsibility of the Department of Ayurveda was transferred to this Ministry, which was raised to cabinet rank in 1994 (WHO, 2001).

The Bandaranaike Memorial Ayurvedic Research Institute (BMARI) was established in 1962 and an Ayurvedic Drug Cooperative was formed in 1965 to provide medicines for government hospitals and dispensaries. The Government College of Ayurveda was upgraded in 1977 and affiliated with the University of Colombo. Traditional physicians were registered after a team of physicians had evaluated their knowledge and practical

experience. Sri Lanka has 47 government hospitals in different districts and 307 central dispensaries which provide Ayurvedic treatment to rural communities and there are about 10,000 private practitioners practising in the villages (Pilipitiya, 1995).

A World Health Organization/United Nations Development Programme project for the development of traditional medicine in Sri Lanka was implemented in the 1980s. The project helped to enhance the teaching and professional capabilities of instructors and practitioners and provided incentives for the establishment of the National Institute of Traditional Medicine to carry out educational and training programmes for traditional medicine in Sri Lanka (WHO, 2001). The training of Ayurvedic doctors is done by the University of Colombo (Institute of Indigenous Medicine), the University of Kelaniya (Gampaha Wikeramarachchi Ayurvedic College) and the National Institute of Traditional Medicine which conducts the post graduate courses (Wijayabandara, 2000).

Medicinal and Aromatic Plant Resources

The medicinal plant stock in Sri Lanka is categorized according to traditional uses, level of use and distribution patterns. A total of 1,414 species are identified as medicinal, of which about 600 are commonly used. Among these about 208 species are used in large quantities and 50 in very large quantities. There are 168 species, which are used as antidotes to treat snakebites, 153 for treatment of fractures and dislocations and 174 in spiritual healings. The wild collection and export of about 79 important endangered plant species is prohibited. The Sinharaja and Kannaliya hill ranges in the South Western region of Sri Lanka has the highest species diversity and endemism percentage. The highest isolated range of hills, Ritigala in the Northern Province has an interesting and peculiar medicinal flora because of climatic and geographic factors. Peak Wilderness (Adam's Peak), Kumaragala, Dolukanda and Knuckles are hill ranges with very peculiar medicinal flora (Silva, 2004).

Most of the medicinal and aromatic plants used by local industry are harvested from the wild and there is no systematic large scale cultivation. Although the exact proportion of medicinal plants that comes from the forests is not known, more than 50% of the plants used in Ayurveda are found in the natural forests. Some of the ancient herbal gardens, from the times of ancient kings, still survive. There are gardens of the three myrobalans: namely *Phyllanthus emblica* L.; *Terminalia bellerica* (Gaertn.) Roxb.; and *Terminalia chebula* Retz. The fruits of these plants are extensively used in Ayurvedic medicine (Pilipitiya, 1995). Sri Lanka is also a major producer of a number of spices: cinnamon (*Cinnamomum verum* J. Presl), cardamom (*Elettaria cardamomum* (L.) Maton), nutmeg (*Myristica fragrans* Houtt.), pepper (*Piper nigrum* L.) and clove (*Syzygium aromaticum* (L.) Merr. et Perry).

Unsustainable harvesting, habitat destruction and the lack of organized cultivation systems have threatened the existence of many of these species. Plants such as Capparis moonii Wight., *Coscinium fenestratum* (Gaertn.) Colebr., *Munronia pumila*, *Rauvolfia serpentina* Benth. et Kurz., *Saraca asoca* (Roxb.) W. J. de Wilde, *Strychnos nux-vomica* L., *Withania somnifera* (L.) Dunal have been exploited heavily because of high demand and are now rare in the forests. Some important medicinal and aromatic plant species found in Sri Lanka are given in Table 1 (Silva, 2004; Ganashan *et al.*, 1995).

Research and Development Activities

A number of institutes and universities in Sri Lanka, mainly the universities of Sri Jayewardanpura, Peradeniya, Colombo, the Industrial Technology Institute (formerly CISIR), the Bandaranaike Memorial Ayurvedic Research Institute (BMARI) and Link Natural Products (Pvt) Ltd are involved in research on medicinal and aromatic plants. Significant research work, particularly on immunomodulation and drug standardization has been carried out by the Department of Chemistry of the University of Sri Jayewardanpura in collaboration with the University of Utrecht, the Netherlands. The University of Peradeniya has worked on the structural elucidation, antifungal, antibacterial and insecticidal properties of active ingredients of a number of medicinal plants. The biotechnological methods for mass propagation of medicinal plants and pharmacological studies of their extracts have been carried out by the University of Colombo. The Industrial Technology Institute has conducted agronomical studies, formulation and preparation of plant based products and pilot scale extraction procedures. Similar studies have also been carried out by the Link Natural Products (Pvt) Ltd (Wijayabandara, 2000).

The Bandaranaike Memorial Ayurvedic Research Institute (BMARI) conducts research in three major fields, (clinical, literary and drug research). The diseases rheumatoid arthritis, diabetes mellitus, bronchial asthma, leucoderma, psoriasis, hydrocephales, obstinate and chronic headaches, epilepsy, urolithiasis, fistula in ano, malaria, haemorrhoids, eczemas and drug addiction have been selected for clinical research with traditional medicine. Research on rheumatoid arthritis, diabetes, urolithiasia and epilepsy was supported by the WHO. In the literary research section of BMARI, the transcription of 'Ola' manuscripts and translation of ancient Sanskrit books is being undertaken. 'Ola' are the ancient medicinal manuscripts whose possession was restricted to certain families. These are now being collected, transcribed and protected by the Department of Ayurveda. With the United Nations Development Programme and WHO support, 100 such books have been published. Leaflets and pamphlets on common ailments, their prevention and suitable diets are being published. National seminars are being conducted regularly to educate the public and school children about the value of traditional medicinal plants and their uses.

Drug research focuses on cultivation, processing and storage of medicinal plants and quality control of traditional medicine. As there is a great demand for traditional medicine, the Department of Ayurveda and the Research Institute have started to popularize the cultivation of medicinal plants. Four herbal nurseries: Nawinna, Haldummulla, Girandurakotte and Pattipola have been established in three different zones. Ten plant species: *Abelmoschus moschatus* Medik.; *Acorus calamus* L.; *Cassia angustifolia* Vahl; *Justicia adhatoda* L.; *Piper longum* L.; *Plumbago indica* L.; *Rubia cordifolia* L.; *Vetiveria zizanioides* (L.); *Withania somnifera* (L.) Dunal; and *Woodfordia fruticosa* (L.) Kurz., which are currently imported from India in large quantities were selected and studied and are now under cultivation. The cultivation of about 150 other herbs, commonly used by traditional physicians is also encouraged. Extension officers involved in cultivation also educate villagers in proper techniques of growing and harvesting these plant species (Pilipitiya, 1995).

The Government Department of Ayurveda, Sri Lanka (DASL) has documented the Sri Lankan medicinal system in the three volumes of *Part I of the Ayurveda Pharmacopoeia* (DASL 1976; DASL 1980; DASL 1985). The plants used locally in Ayurveda have been botanically described and many of these have been investigated by scientists in universities and research institutes for their biological activities (Kumar, 2000).

The Sri Lankan government and World Conservation Union are also working together on a project to conserve important and endangered herbal medicines in the wild. They are working to motivate local communities living near forests to start cultivating important medicinal species and to provide a legal framework for intellectual property rights and conservation of ancient medicinal knowledge (Bakker, 2002). A sustainable approach to the extraction and use of medicinal plants at the community level has been developed in an International Development Research Centre (IDRC) funded project entitled, Medicinal Plants for Improved Health.

Trade and Marketing

Sri Lanka uses about 2,500 tonnes of herbal raw materials annually, about 60% of which is imported (Silva, 2004). Traditional physicians in Sri Lanka generally prepare their own medicines. Shops selling indigenous medicines and herbal preparations are common in both rural and urban areas. Many of the plant species used in such preparations are imported from India and other countries. Requirements of space, labour and technical knowledge have however, meant a move to buying prepared medicines from manufacturers. It has resulted in the development of a new industry to produce pharmaceutical herbal products for the domestic market. Sri Lanka has about 75 such manufacturing units at present (FAO, 2002). Herbal drugs are being produced by several government (such as the Ayurvedic Drug Corporation of Sri Lanka) and private (Link Natural Products (Pvt)

Ltd) organizations. Most of these medicinal products are exported to countries such as Germany, India, the UK and the USA (Wijayabandara, 2000).

A large number of people are involved in the collection, processing and storage of medicinal plant raw materials but the level of employment in this sector is not known as collection is not done on a full-time basis and hence is not recorded. Most families living close to the forests collect medicinal plants mainly for their own consumption with very few families traditionally involved in their collection for commercial purposes. The collectors generally belong to the poorest income groups in the villages. The largest volume of medicinal plants collected has been recorded from the savannah forests in Bibile where over 60% of the villagers are involved in this activity. The average annual income from the collection of medicinal plants in savannah forests and other forest types ranges from US$195 to 244 (Sri Lanka Rupee (LKR) 20,000 to 25,000) and 30 to 78 (LKR 3,000-8,000) respectively. In 1999, Sri Lanka exported US$1.13 million (LKR 116 million) worth of medicinal plants to various countries while the imports in the same year were US$0.64 million (LKR 66 million) (FAO, 2002).

Sri Lankan exports of herbal preparations, spices and essential oils are mainly to Colombia, France, Germany, Hong Kong, India, Italy, Mexico, Netherlands, Singapore, Spain, Switzerland, the UK and the USA. Cinnamon is the most important of these crops. Sri Lanka is the largest producer and exporter of cinnamon in the world. The exports of spices and allied products are worth about US$55.60 million (LKR 5700 million). There are 10 companies involved in growing, processing and exporting herbs and herbal preparations in Sri Lanka (Anonymous, 2004). In 1998, the production values of cardamom, cinnamon leaf oil, cinnamon quills, citronella, cloves, nutmeg and pepper were 60, 150, 10813, 102, 1744, 1257 and 6776 tonnes respectively (Anonymous, 2004).

Problems and Constraints

Unsustainable harvesting methods threaten many of the valuable medicinal and aromatic plant species in the country. Lack of cultivation of these species, lack of scientific research mainly because of the limitations of facilities and equipment for the evaluation of medicinal plant material, lack of raw material and market regulations, and illegal trade are the main problems in the exploitation of the full potential of medicinal and aromatic plant resources in the country.

Table 1: Commonly used medicinal and aromatic plants in Sri Lanka

Botanical Name	Family
Abrus precatorius L.	Fabaceae
Acacia caesia (L.) Willd.	Fabaceae
Acalypha indica L.	Euphorbiaceae
Achyranthes aspera L.	Amaranthaceae
Adenanthera pavonina L.	Fabaceae
Aegle marmelos (L.) Corrêa	Rutaceae
Aerva lanata (L.) Juss. ex Schult.	Amaranthaceae
Ageratum conyzoides L.	Asteraceae
Allophylus cobbe (L.) Raeusch.	Sapindaceae
Amaranthus spp.	Amaranthaceae
Amorphophallus campanulatus Decne.	Araceae
Anisomeles indica (L.) Kuntze	Lamiaceae
Apama siliquosa (Lam.) Ding Hou	Aristolochiaceae
Aristolochia bracteolate Lam.	Aristolochiaceae
Asparagus falcatus L.	Asparagaceae
Averrhoa carambola L.	Oxalidaceae
Calamus rotang L.	Arecaceae
Calophyllum inophyllum L.	Clusiaceae
Calotropis gigantean (L.) W.T. Aiton	Apocynaceae
Canarium zeylanicum (Retz.) Blume	Burseraceae
Capparis zeylanica L.	Brassicaceae
Cassia auriculata L.	Fabaceae
Cassia fistula L.	Fabaceae
Cassia occidentalis L.	Fabaceae
Ceiba pentandra (L.) Gaertn.	Malvaceae
Celastrus paniculatus Willd.	Celastraceae
Cinnamomum verum J. Presl	Lauraceae
Cissampelos pareira L.	Menispermaceae
Clerodendrum infortunatum L.	Lamiaceae
Coix spp.	Poaceae
Coleus amboinicus Lour.	Lamiaceae
Coscinium fenestratum (Gaertn.) Colebr.	Menispermaceae
Costus speciosus (J. Konig) Sm.	Costaceae
Crinum asiaticum L.	Amaryllidaceae
Croton laccifer L.	Euphorbiaceae
Cryptocoryne spiralis (Retz.) Fisch. Ex Wydler	Araceae
Curcuma domestica Valeton	Zingiberaceae
Curcuma zedoaria (Christm.) Roscoe	Zingiberaceae
Cyathea spp.	Cyatheaceae
Cycas circinalis L.	Cycadaceae
Cyperus rotundus L.	Cyperaceae

Continued

Table 1 continued

Botanical Name	Family
Desmodium pulchellum (L.) Benth.	Fabaceae
Dillenia spp.	Dilleniaceae
Dioscorea pentaphylla L.	Dioscoreaceae
Elettaria cardamomum (L.) Maton	Zingiberaceae
Emilia sonchifolia (L.) DC.	Asteraceae
Entada phaseoloides (L.) Merr.	Fabaceae
Erythrina fusca Lour.	Fabaceae
Euphorbia antiquorum L.	Euphorbiaceae
Euphorbia tirucalli L.	Euphorbiaceae
Evolvulus alsinoides (L.) L.	Convolvulaceae
Ficus hispida L. f.	Moraceae
Ficus racemosa L.	Moraceae
Garcinia cambogia (Gaertn.) Desr., nom. illeg.	Clusiaceae
Garcinia spp.	Clusiaceae
Gloriosa superba L.	Colchicaceae
Gmelina arborea Roxb.	Lamiaceae
Gmelina asiatica L.	Lamiaceae
Hemidesmus indicus (L.) W. T. Aiton	Apocynaceae
Hibiscus furcatus Willd.	Malvaceae
Hydrolea zeylanica (L.) Vahl	Hydrophyllaceae
Hypericum japonicum Thunb.	Clusiaceae
Ichnocarpus frutescens (L.) R. Br.	Apocynaceae
Imperata cylindrical (L.) P. Beauv.	Poaceae
Jasminum grandiflorum L.	Oleaceae
Justicia adhatoda L.	Acanthaceae
Lannea coromandelica	Anacardiaceae
Leea indica (Burm. f.) Merr.	Leeaceae
Litsea glutinosa (Lour.) C.B. Rob.	Lauraceae
Lycopodium squarrosum G. Forst.	Lycopodiaceae
Melochia corchorifolia L.	Malvaceae
Mimosa pudica L.	Fabaceae
Morinda citrifolia L.	Rubiaceae
Moringa oleifera Lam.	Moringaceae
Munronia pinnata (Wall.) W. Theob.	Meliaceae
Murraya koenigii (L.) Spreng.	Rutaceae
Myristica fragrans Houtt.	Myristicaceae
Nepenthes distillatoria L.	Nepenthaceae
Operculina turpethum (L.) Silva Manso	Convolvulaceae
Oroxylum indicum (L.) Vent.	Bignoniaceae
Phoenix zeylanica Trimen	Arecaceae

Continued

Table 1 continued

Botanical Name	Family
Phyllanthus emblica L.	Euphorbiaceae
Piper chaba W. Hunter	Piperaceae
Piper longum L.	Piperaceae
Piper nigrum L.	Piperaceae
Pogostemon parviflorus Benth.	Lamiaceae
Pongamia pinnata (L.) Pierre	Fabaceae
Pothos scandens L.	Araceae
Pterocarpus marsupium Roxb.	Fabaceae
Rhododendron zeylanicum T. J. Booth	Ericaceae
Rungia repens (L.) Nees	Acanthaceae
Santalum album L.	Santalaceae
Sapindus emarginatus Vahl	Sapindaceae
Solanum surattense Burm. f.	Solanaceae
Solanum virginianum L.	Solanaceae
Strychnos nuxvomica L.	Loganiaceae
Syzygium aromaticum (L.) Merr. et Perry	Myrtaceae
Terminalia bellirica (Gaertn.) Roxb.	Combretaceae
Terminalia chebula Retz.	Combretaceae
Tinospora cordifolia (Willd.) Hook. f. & Thomson	Menispermaceae
Toddalia asiatica (L.) Lam.	Rutaceae
Trema orientale (L.) Blume	Celtidaceae
Trichosanthes cucumerina L.	Cucurbitaceae
Vernonia cinerea (L.) Less.	Asteraceae
Vetiveria zizanioides (L.) Nash	Poaceae
Vitex altissima L. f.	Lamiaceae
Walsura piscidia Roxb.	Meliaceae
Withania somnifera (L.) Dunal	Solanaceae
Zingiber officinale Roscoe	Zingiberaceae
Zingiber zerumbet (L.) Sm.	Zingiberaceae

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Chapter 4

Central Asia

4.1 Introduction

Central Asia is a region, which consists of the former Soviet Central Asian Republics of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan and the Russian Federation (the Asian part is known as Siberia). It is a region of high plateaus and mountains (Tian Shan), vast deserts (Kara Kum, Kyzyl Kum, Taklamakan) and treeless, grassy plains. Much of the land is too dry or rugged for farming and the majority of people earn their living by herding livestock. There are more than 80 million people living in Central Asia, about 2% of the continent's population. The former republics of the Soviet Union cover 1/6 of the earth's landmass and encompass an extremely broad range of plant diversity. A large number of plant species including medicinal plants originated in this region. The plant biodiversity of the region could be of value to provide new species of medicinal plants and compounds for the traditional herbal drugs and pharmaceutical industry of Central Asia as well as other regions of the world (Zaurov, et al., 2003).

4.2 Kazakhstan

The Republic of Kazakhstan is a large, sparsely populated country located in central Asia with the Russian Federation to the north and China to the east. It is bounded on the south by Kyrgyzstan, Uzbekistan, and Turkmenistan and on the west by the Caspian Sea and Russia. Kazakhstan has a population of about 17 million. It covers an area of 2,724,900 square kilometres and only a small part of the area is under forest, which is located mainly in the northern regions. A large part of the country is desert. The forests are sources of valuable medicinal and aromatic plants along with other non-wood forest products. The medicinal plants are used in the preparation of various traditional remedies, which are an important part of daily life.

Traditional Medicine Systems

Traditional medicine has been used in Kazakhstan for a long time. Until the early 20th century health care services were provided mainly by traditional healers. The poli-

cies of modernization of the then Soviet government resulted in suppression of traditional practices and encouraged the use of modern medicine. However, people continued to rely on traditional healing practices alongside modern medicine. At present, traditional medicine is an integral part of daily life (Michaels, 2003). In the Republic of Kazakhstan, a national policy on traditional medicine is currently being developed. Laws and regulations were issued in 1997 and 2003. Regulations of herbal medicines which date back to 1995 are the same as for conventional medicines (WHO, 2005).

Government Efforts in Development of Traditional Medicine

The Committee of Health (formerly the Ministry of Health) works to formulate policies, prepare legislation, commission research, developing reform strategies, monitor health care, supervise the implementation of reforms and ensure the training of health personnel. An approved list of essential drugs was drawn up in 1995 by the Committee based on WHO categories and 290 items were listed in 1998. There is no state regulation of imported drugs with the exception of the essential drugs list and therefore a great variety of drugs are available on the market (Kulzhanov and Healy, 1999).

The Department of Traditional Medicine of Almaty Advanced Training Institute for Physicians provides some training in traditional methods of healing to physicians (Chemeris and Konyrtaeva, 2004). In lieu of a national pharmacopoeia, the *State Pharmacopoeia of the USSR* is used as well as the *United States Pharmacopoeia*, the *British Pharmacopoeia* and the *European Pharmacopoeia*. They are legally binding. There are 134 registered herbal medicines in Kazakhstan, five were included on the national essential drug list issued in 2003 (WHO, 2005).

Medicinal and Aromatic Plant Resources

The floral diversity of Kazakhstan consists of 6,000 plant species with 533 endemic species. There are about 250 medicinal plants reported in the country (Anonymous, 2000). Medicinal and aromatic plants are generally collected from forests; however, more than 210 wild species of various plants including about 20 medicinal plants are cultivated (Anonymous, 1995). Some medicinal and aromatic plants found in the country are listed in Table 1 (Dzhangaliev *et al*., 2002).

Research and Development Activities

Research on the medicinal and aromatic plant species of the country is limited. The development of herbal drugs production technology and the organization of their serial output are part of the various research programmes carried out by Kazakhstan research institutes in order to develop the local pharmaceutical industry. The Institute of Chemistry

of the Kazakhstani Ministry of Education and Science, the Institute of Phytochemistry, the Institute of Pharmaceutical Bio-echnology, the Kazakh State University, the Research Agriculture Institute of Petropavlovsk and the Research Chemical and Pharmaceutical Institute of Novokuznetsk are working in the same direction (Skripacheva, 2002).

Recently, the International Science & Technology Center (ISTC) has approved two projects for the Kazakh National University on rehabilitation of herbs from environmentally unfavourable regions, on plant adaptogens and on new ratio modifying preparations from the natural vegetation of Kazakhstan. The first project aims to create chemical and phyto-preparations from medicinal plants found in the country and carry out investigations on their toxicity, specific activity, composition and structure in collaboration with the University of Georgia, Athens, USA. The second project is aims to investigate the chemical composition and proportions of natural substances in herbs and rehabilitation of herbs, which are popular but are not sold in drugstores. The project will also prepare recommendations for their utilization, for prophylaxis and health improvement. The phyto preparations will be subjected to further biological tests for anti-tumor activity and enforcement of the immune system. The various institutes supporting these projects are the Kazakh Research Institute of Oncology and Radiology, Almaty; the National Nuclear Center of the Republic of Kazakhstan; and the Institute of Radiation Security and Ecology, Kurchatov (Anonymous, 2004; Anonymous, 2004). Some phytochemical work on native medicinal plants has also been carried out by the Institute of Phytochemistry, Karaganda.

The six botanical gardens: Altaiski (Leninogorsk city); Ililsky (Bakanas); Karagandinski (Karaganda); Zheskazganski (Zheskazgan); Mangistauski (Aktay); and the Main (Almaty) which belong to the National Academy of Science of Kazakhstan are engaged in preservation of the country's flora. The collection of the Main Botanical Garden (Almaty) includes more than 300 species of medicinal plants (Anonymous, 1995).

A medico-pharmaceutical company in Kazakhstan, Vita-Vent carries out research on the pharmacological activity of different medicinal plants and development of new herbal drugs. The company is interested in expanding its activities in the field of investigations on pharmacological characteristics of medicinal drugs, cultivation of medicinal herbs for pharmaceutical production and export and production of herbal extracts (Anonymous, 2004).

Trade and Marketing

Kazakhstan has been totally dependent on imports of medicines since the breakdown of the Soviet Union in 1991. Local production supplies around 3 to 5% while

the rest is imported from Belgium, France, Germany, Hungary, India, Lithuania, Russia, Slovenia, Ukraine and the USA, which were among the top ten exporters of medicines to Kazakhstan during the first half of 2001 (Anonymous, 2001).

Some local companies are also involved in the production of herbal drugs using local medicinal plants. However, information regarding the volume of these drugs produced and consumed in the country is not available at present.

Problems and Constraints

There is a potential for the country to develop its medicinal and aromatic plant resources for commercial exploitation and meet the health care needs of the population. However, there is a need to set-up strategies for conservation of natural resources of medicinal and aromatic plants, to train personnel, to cultivate valuable plants, to adopt sustainable methods of plant harvesting, to promote scientific research and validation of traditional remedies, and collaboration between various institutes working on medicinal and aromatic plants.

Table 1: Some medicinal and aromatic plants species found in Kazakhstan

Botanical name	Family
Achillea millefolium L.	Asteraceae
Chelidonium majus L.	Papaveraceae
Cichorium intybus L.	Asteraceae
Dryopteris filix-mas (L.) Schott	Dryopteridaceae
Elaeagnus angustifolia L.	Elaeagnaceae
Fragaria vesca L.	Rosaceae
Glycyrrhiza uralensis Fisch. ex DC.	Fabaceae
Humulus lupulus L. var. cordifolius (Miq.) Maxim.	Cannabaceae
Hypericum perforatum L.	Clusiaceae
Inula helenium L.	Asteraceae
Lamium album L.	Lamiaceae
Matricaria recutita L.	Asteraceae
Origanum vulgare L.	Lamiaceae
Polygonum bistorta L.	Polygonaceae
Rosa canina L.	Rosaceae
Rubus idaeus L.	Rosaceae
Taraxacum officinale F. H. Wigg. Group	Asteraceae
Urtica dioica L.	Urticaceae
Vaccinium myrtillus L.	Ericaceae
Vitis vinifera L.	Vitaceae

4.3 Kyrgyzstan

Kyrgyzstan gained independence from the former USSR in August 1991. It is a small, mountainous land-locked country of 198,500 square kilometres with about 4.9 million people. It is bordered by Kazakhstan, China, Tajikistan and Uzbekistan to the north, east, south and west respectively. The country lies between the Tien Shan and the Pamir-Alai mountains to the northeast and southwest respectively. Forest and other woodlands account for only 4% of the land area. The coniferous species account for more than two thirds of the growing stock volume with spruce and juniper being the most important species. The wild collection of medicinal plants by the local population is an important activity.

Traditional Medicine Systems

Traditional remedies derived from plants are used mainly by the rural population. The national law on pharmaceuticals of 1997 establishes regulations on herbal medicines that are in part the same as those for conventional pharmaceuticals. Herbal medicines are regulated as prescription medicine, over the counter medicine, dietary supplements and herbal raw material. By law, herbal medicine must be sold with medical claims (WHO, 2005).

Government Efforts in Development of Traditional Medicine

Before independence the Ministry of Health administered policies made in Moscow through a centrally organized structure from the republic level to regional/city administrations level to the subordinate district level. Health care reform was included in the national policy agenda after independence but remained at lower priority compared to economic reforms. The country is developing its own health care policy in response to changing socio-economic conditions and the worsening health status of its population (Sargaldakova *et al.*, 2000). No information on government efforts for the development of traditional medicine in the country is available at present. There is no national pharmacopoeia. The pharmacopoeia of former Soviet Union is used and is considered to be legally binding. National monographs are contained in the *National Medicine Remedy 1985* and the *Scientific Research Basis of Kyrgyz National Medicine* (1985). These publications contain 1,500 monographs, but they are not legally binding (WHO, 2005).

Medicinal and Aromatic Plant Resources

Kyrgyzstan flora consists of more than 4,500 kinds of plants that include 1,600 plants of economic value including 200 medicinal plant species (Desyatkov *et al.*, 2000).

Some important species of medicinal and aromatic plants found in the country are listed in Table 1 (Anonymous, 2001; Anonymous, 2004).

Research and Development Activities

Limited research has been reported on medicinal and aromatic plants in Kyrgyzstan in the past. However, at present some projects to conserve native medicinal and aromatic plants, evaluate them scientifically and to find new compounds have been initiated in collaboration with foreign universities and institutes.

In a joint project among Rutgers University, USA, Tashkent State Agrarian University, Uzbekistan and the National Academy of Science, Kyrgyzstan, over 100 species of medicinal plants were collected from Kyrgyzstan and Uzbekistan and taken to the USA for evaluation. In 2001, a subset of this collection was planted in at the Snyder Research and Extension Farm Rutgers University, New Jersey. The objectives of this research were to evaluate each species for their potential under New Jersey conditions (Zaurov *et al*., 2003)

A project entitled, *Conservation and rational use of natural medicinal plants*, under the Small Grants Programme of the United Nations Development Programme (UNDP) focused on: the development of the local production of medicinal plant raw materials; increasing their value through processing; and encouraging the sustainable harvesting and protection of medicinal plants by the local population. Another project entitled, *Planting knorring hawthorn, white and black currant in buffer zone of Karakol National Park*, focuses on the conservation of rare and disappearing medicinal plants and plans to grow them in plantations on an area of 20 hectares (Anonymous, 2004). No other information related to research on medicinal plants and traditional medicine of the country is currently available.

Trade and Marketing

The pharmaceutical industry of Kyrgyzstan consists of a pharmaceutical plant which produces herbal medications and other pharmaceuticals. It meets about 3% of the country's pharmaceutical needs. There are 430 pharmacies, of which a small but growing number are privately owned (Anonymous, 2000).

Kyrgyzstan imports over 90% of its drugs. In order to develop the local pharmaceutical industry a new biopharmaceutical factory, Aidan-Pharma started production in 1998. It was set up with a US$10 million loan from the Pakistan government (Sargaldakova *et al*., 2000). Accurate information on consumption and production of herbal drugs in the country is not available.

Problems and Constraints

Lack of facilities, of research and developmental activities and of government efforts in the development of traditional medicine and medicinal plant resources along with high volumes of imports, low production and lack of knowledge of valuable plant resources are some of the problems faced by the commercial development of the medicinal and aromatic plant sector in Kyrgyzstan.

Table 1: Some medicinal and aromatic plants found in Kyrgyzstan

Botanical name	Family
Anabasis aphylla L.	Chenopodiaceae
Berberis spp.	Berberidaceae
Ephedra equisetina Bunge	Ephedraceae
Glycyrrhiza glabra L.	Fabaceae
Hypericum perforatum L.,	Clusiaceae
Hippophae rhamnoides L.	Elaeagnaceae
Polygonum spp.	Polygonaceae
Thalictrum foetidum L.	Ranunculaceae
Thymus spp.	Lamiaceae
Tussilago farfara L.	Asteraceae
Veratrum lobelianum Bernh.	Melanthiaceae
Origanum vulgare L.	Lamiaceae
Achillea millefolium L.	Asteraceae
Artemisia absinthium L.	Asteraceae
Musa balbisiana Colla	Musaceae
Rosa canina L.	Rosaceae
Salvia officinalis L.	Lamiaceae

4.4 Russian Federation

The Russian Federation is located in Eastern Europe and northern Asia and is the world's largest country in terms of area: 17,075,200 square kilometres. It is bounded by extensions of the Arctic Ocean to the north, the Pacific Ocean and several of its extensions to the east, China, Mongolia, Kazakhstan, Azerbaijan, Georgia and the Black Sea to the south, the Ukraine to the southwest and by Belarus, Latvia, Estonia, the Gulf of Finland and Finland to the west. The population of the country is about 144.5 million. Forest and other woodlands account for more than half of its land area and more than a fifth of the world's total forest and other woodland areas. The forests are an invaluable source of medicinal and aromatic plants , which are collected by the local populations. The use of herbal remedies has

gained popularity and the government is also working for their development.

Traditional Medicine Systems

The practice of traditional and alternative medicine was discouraged during the Soviet era when only modern medicine was promoted in the country. However, the inaccessibility of national system facilities and the high prices of modern medicine has turned people to the use of traditional treatment methods such as faith healing, mysticism and herbal medicine. The number of traditional practitioners was estimated to be 300,000 in 1995 when about 80% of Russians were consulting these practitioners for medical assistance. People grow their own herbs and their use is gaining popularity (Anonymous, 2004). At present herbal and folk medicine are used along with conventional medicine. The use of traditional medicine is more usual in rural areas where health services and medicines are not readily available. The regulatory status of herbal medicines is the same as prescription medicines, over the counter medicines and dietary supplements. Herbal medicines are sold legally with medical claims, nutrient content and structure/function claims. There are approximately 260 herbal medicines registered in the Russian Federation and all of them are included in the national essential drug list, which is issued annually. There is a post-marketing-surveillance system and a national system to monitor adverse effects of herbal medicines (WHO, 2005).

Government Efforts in Development of Traditional Medicine

The Russian Federation provides a striking example of a change in policy towards traditional and complementary medicine. Section 34 of the Fundamental Principles of Health Legislation of the Union of the Soviet Socialist Republics and of the Union Republics required physicians to use only those diagnostic, prophylactic and therapeutic methods and pharmaceutical products authorized by the Ministry of Health. Homeopathy and homeopathic medicines were not authorized. However, Section 57 of the Russian Federation legislation governing health care protects the right to practise the art of healing by popular medicine also suggesting wide powers for practitioners of traditional and complementary medicine. A 1995 decree permitted the use of homeopathy in every clinic and hospital and also gave it official recognition. There is no specific law regulating chiropractors, although some have been permitted to practise.

National policy on traditional medicines was issued in 1991 and national laws and regulations in 1993. Development of the national programme was taken up from 2001 to 2005. Eleven editions of the *State Pharmacopoeia of the USSR* have been published, the most recent in 1990. Information contained in the pharmacopoeia is legally binding. The title of the national monograph is translated as 'pharmacopoeia monograph, techni-

cal requirements' and is considered legally binding (WHO, 2005).

In 1999, the State Scientific and Practical Centre of Traditional Medicine and Homeopathy under the Ministry of Public Health was created to organize and conduct scientific research and coordinate and realize educational activities in complementary medicine. A standard government education programme in homeopathy has been developed by the Committee for Homeopathy of Russia and approved by the Ministry of Health. Homeopathy has also been introduced at the Russian Medical Academy as a postgraduate speciality (WHO, 2001).

Medicinal and Aromatic Plant Resources

Russian flora has about 11,400 species of aboriginal and endemic plants belonging to 1,488 genera and 197 families. Approximately 20% of the flora is endemic. About 75% of the vascular plants of Russia are represented in protected areas and about 2,000 to 3,000 species are threatened and a few species are considered extinct as a result of human activities. A total of 1,103 vascular plants including 200 officially approved species have been used for medicinal purposes (Anonymous, 2004).

The flora of the Russian Far East is highly unique as a result of the influence of global climate changes, specific impact of the nearby ocean and several marine transgressions. A large number of endemic species are reported to occur on the boundary range. Many rare and protected species in the region are valuable as medicinal plants and are widely used both in conventional and folk medicine. A number of plant species such as *Aristolochia manshuriensis* Kom., *Gastrodia elata* Blume, *Panax ginseng* C. A. Mey., *Schisandra chinensis* (Turcz.) Baill., *Scutellaria baicalensis* Georgi and *Taxus cuspidata* Siebold & Zucc. growing in the Primorye region have been used for a long time in the conventional medicine of East Asian countries. However, the unsustainable collection of plants for their medicinal, nutritional and ornamental values has endangered many of the previously abundant plants of the area. These are becoming rare and extinct (Anonymous, 2004). Some medicinal and aromatic plants found in the Russian Federation are listed in Table 1 (Anonymous, 1995).

Research and Development Activities

The All-Russian Research Institute of Medicinal and Aromatic Plants, Moscow carries out research on various traditional remedies and the plants used in their preparation. It has developed a number of technologies for rational use of medicinal plant raw material to produce valuable products. The technologies for complex processing of eucalyptus leaves, thistle fruit and some other products have been developed (Gromakova *et al*., 2002).

The Laboratory of Biotechnology of the Institute of Biology and Soil Science, Far East Branch of Russian Academy of Sciences, is at present investigating the biological specimens of rare or threatened species of medicinal plants of Far Eastern flora. A study on the functional and mesostructural characteristics of the photosynthetic apparatus and complex of the morphological and functional characteristics of the reproductive system of a number of medicinal plant species has been completed. A database providing information on nomenclature, biological characteristics, distribution, reproduction, chemical composition, medicinal properties and the utilization of plants as medicine is being prepared (Anonymous, 2004).

Trade and Marketing

The level of consumption of pharmaceuticals is difficult to measure because of the various routes through which patients are provided with drugs and also because the system is no longer as regulated as it was in the Soviet era. The break up of the former Soviet Union disrupted the production of pharmaceuticals and most of the production areas ceded to newly independent states. The remaining industry was largely old fashioned and poorly maintained which has led to increased reliance on imports (Tchernjavski, 1998). There are some private companies that produce herbal medicine in Russia but the products are not sufficient to meet the needs of the people and hence a number of herbal drugs are imported. Exact import volumes are not available.

Problems and Constraints

The use of traditional medicine was suppressed during the Soviet era and as a result there is limited research on medicinal and aromatic plants and traditional remedies. Excessive collection of rare plants from natural habitats has led to their extinction in some cases and has disturbed the natural biodiversity. These species require protection. There is a need for scientific evaluation of traditional medicine, conservation and cultivation of valuable medicinal and aromatic plant species, training of personnel, restoration of traditional knowledge, manufacture of herbal remedies, proper marketing strategies and control of illegal imports of such medicines.

Table 1: Some medicinal and aromatic plants of the Russian Federation

Botanical name	Family
Bergenia crassifolia (L.) Fritsch	Saxifragaceae
Brassica campestris L.	Brassicaceae
Brassica juncea (L.) Czern.	Brassicaceae
Bunias orientalis L.	Brassicaceae

Continued

Table 1 continued

Botanical name	Family
Eruca sativa Mill.	Brassicaceae
Glycyrrhiza uralensis Fisch. ex DC.	Fabaceae
Hedysarum gmelinii Ledeb.	Fabaceae
Hippophae rhamnoides L.	Elaeagnaceae
Hypericum perforatum L.	Clusiaceae
Isatis tinctoria L.	Brassicaceae
Lathyrus gmelinii Fritsch, nom. illeg.	Fabaceae
Lepidium sativum L.	Brassicaceae
Lonicera altaica Pall.	Caprifoliaceae
Polygonum bistorta L.	Polygonaceae
Raphanus raphanistrum L.	Brassicaceae
Rhaponticum carthamoides (Willd.) Iljin	Asteraceae
Sinapis arvensis L.	Brassicaceae
Thymus spp.	Lamiaceae
Viburnum opulus L.	Adoxaceae

4.5 Tajikistan

The Republic of Tajikistan gained independence after the break-up of the former Soviet Union in 1991. It is located in the southeast of Central Asia and is bordered by Kyrgyzstan to the north, Uzbekistan to the north and west and by China and Afghanistan to the east and south respectively. Tajikistan has a population of about 6.9 million and covers an area of 143,100 kilometres. Over 90% of Tajikistan is mountainous with forest cover of only about 5%. The forests are mostly for conservation and protection purposes. Medicinal and aromatic plants are of importance for the local population and are collected from the forests.

Traditional Medicine Systems

Traditionally the country has a large range of herbal medicines used for the treatment of various diseases and conditions. Due to the unavailability of modern medicine and other health care facilities most of the people rely upon traditional remedies and treatments. Regulation of herbal medicines was introduced in 2001 in Tajikistan; it comprises the same laws and regulations as applicable to conventional pharmaceuticals. Herbal medicines have no separate regulatory status. No national pharmacopoeia is being developed, in its place the State *Pharmacopoeia of the USSR* is used. The information contained therein is legally binding. There are 12 registered herbal medicines (WHO, 2005).

Government Efforts in Development of Traditional Medicine

Tajikistan inherited the Soviet medical system structured around a network of health facilities with emphasis on in-patient care. This system however, deteriorated due to civil war in the period 1992-1993 and subsequent economic crisis (Falkingham, 2004). The severe drought in 2000 and lack of access to essential primary health care has resulted in the deterioration of the general health of the population. Most of the qualified personnel have left the country. The reduction in the state health budget since independence has further contributed to the deterioration of the system.

The government recognizes the need for health reform and has focused on providing a more cost effective service based on improving the quality of primary care and at the same time reducing dependence on secondary services. In 1998, the Faculty of Family Medicine was opened within the Tajik Medical Institute of Postgraduate Training. Doctors will be provided with a three month training course and training for midwives and nurses is being improved (James, 2000). A centre for research and production of herbal based pharmaceuticals was also established by the Ministry of Health in 1997 (Rahminov *et al.*, 2000).

Medicinal and Aromatic Plant Resources

The flora of Tajikistan is extremely rich and diverse with 4,500 species of vascular plants including 640 endemic species and 3,000 species of lower plants. The Gissar-Darvaz and Badakhshan regions are especially rich in floristic diversity where 3,000 vascular plant species has been registered. The Pamir Mountains are also a famous site for collection of various types of herbs. A large number of locally available plant species are used in the preparation of traditional medicines. More than 400 species of medicinal and 60 plants containing essential oils have been reported to occur naturally in Tajikistan. Juniper forests make up 40% of the total forest cover with *Juniperus semiglobosa* Regel, *Juniperus seravschanica* Kom. and *Juniperus turkestanica* Kom. as the dominant species. The annual capacity of medicinal and aromatic plant collection in Tajikistan is estimated at 4,000 tonnes. Many of the medicinal and endemic plants are illegally collected and used. The recent trend of spontaneous collection of medicinal and aromatic plants by the local population has endangered the existence of many species. About 26 vulnerable species of flora have disappeared from the country in the last 30 to 40 years. Nearly 226 plant species are listed in the Red Data Book of Tajikistan. Some medicinal and aromatic plants found naturally in Tajikistan are listed in Table 1 (Anonymous, 2002).

Research and Development Activities

Botanical gardens are maintained by the Institute of Botany of Pamir Biological Institute at the Academy of Sciences and the Tajik State National University in order to preserve the country's flora. Due to unsatisfactory maintenance, financial constraints and insufficient interest in research most of these floristic collections of the botanical gardens have deteriorated. The government ratified the UN Convention on Biological Diversity in 1997 and is developing the National Strategy and Action Plan on Biodiversity Conservation (Anonymous, 2002). Research on medicinal and aromatic plants is still limited and information on the current state of research is unavailable.

Trade and Marketing

There is no drug production in the country except limited amounts by hospital pharmacies. A joint venture with an Indian company, Tajik-Adjanta, has recently been established to start drug production in the country. In the last five years, hundreds of small private pharmacies and booths have begun to trade in medicinal plants and their products. Only 100 of these are officially registered with the government. Tajikistan has begun to develop its own drug regulatory system. The criteria for drug registration have been set up but is not yet implemented strictly. The regulation that only registered drugs can be imported and sold is not followed and many unregistered drugs are available on the market. In order to certify, register and license all national and imported pharmaceutical and medical products, a Centre for Registration and Quality Control of Pharmaceuticals and Medical Equipment was established in 1996. By 1998, the Centre had registered 333 pharmaceutical products in Tajikistan (Rahminov *et al*., 2000). However, no detailed information on the trade related to medicinal and aromatic plants and herbal drugs is available.

Problems and Constraints

A number of factors are responsible for the lack of commercial exploitation of the country's medicinal and aromatic plant resources. A lack of government effort in encouraging research, lack of initiatives for conservation and cultivation of medicinal and aromatic plants, unregulated deforestation, lack of efforts for the preservation of traditional knowledge, lack of control over the marketing of herbal and other drugs and lack of production facilities are the main reasons for the minimal exploitation of the full potential of the country's medicinal and aromatic plant resources.

Table 1: Some medicinal and aromatic plants of Tajikistan

Botanical name	Family
Artemisia cina O. Berg	Asteraceae
Ephedra equisetina Bunge	Ephedraceae
Hippophae rhamnoides L.	Elaeagnaceae
Hypericum perforatum L.	Clusiaceae
Inula helenium L.	Asteraceae
Origanum vulgare L.	Lamiaceae
Rubus odoratus L.	Rosaceae
Thalictrum foetidum L.	Ranunculaceae
Tussilago farfara L.	Asteraceae

4.6 Turkmenistan

Turkmenistan is located in central Asia to the east of the Caspian Sea. The country has a population of about 4.8 million and covers an area of 488,100 square kilometres. The terrain of the country consists mainly of flat or rolling sandy desert with hills and mountains to the south. More than 80% of the country is occupied by one of the largest sand deserts in the world, the Garagum (or Karakum). The forest cover is less than a tenth of the land area, mostly found on the mountain slopes and flood-plains. There are no forests left undisturbed by man and the collection of a range of non-wood forest products including medicinal and aromatic plants is important for the local communities.

Traditional Medicine Systems

Ttraditional healers using herbs and prayers are common in rural areas and are the only medical care available in many cases. Health care facilities are inadequate because of the under trained physicians, shortage of medicine, supplies and chronic sanitation problems. The traditional healers known as tabibs are consulted in the case of many severe and chronic diseases. At present more and more people are opting for folk medicine to restore health and prevent illness and the use of herbal medicine is gaining popularity in Turkmenistan (Anonymous, 2003).

Government Efforts in Development of Traditional Medicine

The Ministry of Health & Medical Industry (MoH & MI) is responsible for public health services through its Department of Prevention and Treatment, which implements preventive activities in health care institutions. The Turkmen health care system faces many problems as it is still driven by norms and standards established in the Soviet era

(Mamedkuliev *et al.*, 2000). The MoH & HI includes the Turkmendermansenagat Association, the Turkmen-Indian pharmaceutical enterprise, Turkmenderman Ajanta Pharma Ltd and the factory for the manufacture of medicine and preparation of various products including the manufacture of licorice preparations and extracts, and medicine of animal and plant origin (Anonymous, 2004).

Medicinal and Aromatic Plant Resources

Turkmenistan biodiversity is characterised by a great number of endemic and wild varieties of cultivated and medicinal plants. About 7,064 species of plants are reported in Turkmenistan flora that includes 3,140 higher and 3,924 lower plant species. Among the 393 rare plant species about 370 are found in the mountains that include 255 endemic species. About 28 flora species are considered endangered or threatened with extinction and are included in Turkmenistan Red Data Book of 1999 (Anonymous, 2002). According to a 1995 country report to the FAO International Technical Conference on Plant Genetic Resources, about 311 medicinal and 131 essential oil bearing plants are found in Turkmenistan (Anonymous, 1995). Many valuable species of medicinal and aromatic plants and other useful plants are found in the mountainous areas of Kopetdag, the Greater and Lesser Balkhans and the Turkmen part of the Kugitangtau Ridge. Some common medicinal and aromatic plants are listed in Table 1 (Atamuradov and Fedorov, 2002; Anonymous, 2002).

Research and Development Activities

An economic assessment of Turkmenistan biodiversity has not yet been conducted, however, the government recognizes that its protection and support is an investment for the future. The biological diversity of Turkmenistan plays an important role in the country's economy and the flora is of great significance for the development of medicinal, perfume, food and other industries. The number of flora and fauna species involved in the system of economic consumption is increasing. Scientific research in this area is conducted by individual departments of higher institutions and universities. The zapovedniks (Russian nature reserves) and the Garrygala Scientific and Experimental Centre of Plant Genetic Resources are engaged in biodiversity conservation. The National Herbarium of Turkmenistan has more than 250,000 samples of higher plants (Anonymous, 2002). The Turkmenian Experiment Station of Plant Genetic Resources (TES), Garrygala has maintained 172 species of medicinal plants besides various other useful plants found in the Western Kopet Dagh area (Anonymous, 1995). The research on medicinal and aromatic plants and scientific evaluation of traditional remedies is limited and at present much of the information is unavailable.

Trade and Marketing

Around 40% of the drugs used in Turkmenistan contain plant derived ingredients. The demand for licorice increases every year and it also constitutes an important plant for export. The methods for producing licorice on an industrial scale are being developed. Licorice and its by-products are one of the main preparations produced by the Turkmen pharmaceutical industry and are exported worldwide. Turkmenistan exports only two drugs, licorice and the introduced *Cassia senna* L., which is used as a laxative. In the year 2000, licorice export sales totaled approximately US$923 million. About 50 species of local flora have been cultivated during the past few years and nearly 40 of the most valuable medicinal plants are reported to have the potential for high yields in irrigated areas. This may allow Turkmenistan to export some of its own production (Anonymous, 2002).

Problems and Constraints

The lack of knowledge about local medicinal herbs, unskilled gathering and improper use has meant a decline in natural biodiversity. Efforts are needed for cultivation and conservation of valuable medicinal and aromatic plant species, training in sustainable harvesting techniques, cultivation, conservation and sustainable use of resources, production of herbal medicine, research on traditional remedies and agro-technologies for medicinal plants in order to exploit and derive economic and health benefits from them.

Table 1: Some medicinal and aromatic plants of Turkmenistan

Botanical name	Family
Acanthophyllum pungens (Bunge) Boiss.	Caryophyllaceae
Allium cepa L.	Alliaceae
Capparis spinosa L.	Brassicaceae
Ephedra spp.	Ephedraceae
Foeniculum vulgare Mill.	Apiaceae
Galium mollugo L.	Rubiaceae
Hypericum perforatum L.	Clusiaceae
Juniperus communis L.	Cupressaceae
Maclura pomifera (Raf.) C. K. Schneid.	Moraceae
Cassia senna L.	Fabaceae
Elaeagnus angustifolia L.	Elaeagnaceae
Ephedra intermedia Schrenk & C. A. Mey.	Ephedraceae
Glycyrrhiza glabra L.	Fabaceae
Hypericum scabrum L.	Clusiaceae
Rheum turkestanicum Janisch.	Polygonaceae

4.7 Uzbekistan

The Republic of Uzbekistan is a landlocked country in Central Asia. It is bordered by Kazakhstan to the west and north, Kyrgyzstan to the east, Tajikistan to the southeast and Afghanistan and Turkmenistan to the south. The area of Uzbekistan is about 447,400 square kilometres with a population of about 26 million people. It has one of the lowest areas of forest cover per inhabitant of the Commonwealth of Independent States with only one twentieth of the land area under forest. Medicinal and aromatic plants along with other forest products are collected from the wild by the local population.

Traditional Medicine Systems

Use of herbal medicine is common in rural areas where health services and medicines are not readily available. Traditional medicine is considered by many to be less harmful than modern medication and is generally used for maintaining health. The regulation of herbal medicines began in 1997. It is governed by the same laws and regulations as for conventional pharmaceuticals. Herbal medicines are regulated as prescription and over the counter medicines. By law, medical, health, nutrient content and structure/function claims may be made. At present there are 45 registered herbal medicines in Uzbekistan (WHO, 2005).

Government Efforts in Development of Traditional Medicine

Uzbekistan inherited its health care system from the Soviet Union which had a strong health system infrastructure and abundant speciality services and providers. The country adopted a health for all policy after joining the World Health Organization in 1992 and promoted health care reforms with a focus on primary health care. The Department of Drug and Medical Equipment Quality Control of the Ministry of Health is responsible for quality control, standardization and certification of drugs, medicinal foods and equipment. A number of committees including the Pharmacological and Pharmacopoeia Committee also function under the department. There are no good manufacturing practices (GMP) production facilities in the country at present and herbal drugs produced in the country do not meet the standards criteria. Efforts are being made to comply with the GMP and Good Clinical Practice guidelines (Ilkhamov and Jakubowski, 2001).

Medicinal and Aromatic Plant Resources

Uzbekistan's flora is characterized by rich biological diversity with more than 4,000 vascular plant species. More than 500 species of herbs and approximately 400

species of essential oil bearing plants are found growing naturally in Uzbekistan with about 30 of them being used extensively in preparation of scientific and traditional medicine. Some common medicinal and aromatic plants of Uzbekistan are listed in Table 1 (Anonymous, 1995). In the Tashkentskii region (the Parkentskii area) specialized herb growing has been organized and some industrial scale plantations of 12 valuable plants including *Calendula officinalis* L., *Chamaemelum nobile* (L.) All., *Mentha* spp., *Rosa canina* L., and *Valeriana officinalis* L. have been established (Kulahmetova, 2002).

Research and Development Activities

The State Committee for Forestry (Goskomles) and the organization Uzfish (Uzryba) play important roles in the protection of natural biodiversity in Uzbekistan. The Committee also works for the collection and production of medicinal and food plants. The Botanic garden managed by the Academy of Sciences has significant scientific experience in the introduction of native flora and flora from other regions of the world. Over the last 20 years studies of medicinal plants including both local and overseas species have been conducted. Significant attention is being given to the introduction of endemic, rare and endangered species of Central Asia. About 400 new plant species including ornamental, wood, fruit trees and medicinal plants have been introduced (Anonymous, 1998). A programme for the production of 62 substances of herbal and synthetic drugs has been elaborated by the State Committee of Science and Techniques, the Research Institute of the Science Academy, the Ministry of Public Health of Uzbekistan and other organizations (Kulahmetova, 2002).

In a collaborative project among the Rutgers University, New Jersey, USA and the Tashkent State Agrarian University, and the Uzbekistan and National Academy of Science, Kyrgyzstan, over 100 species of medicinal plants from these countries were collected and evaluated. The objective of the study was to generate basic information on their growth, yield and natural products content (Zaurov *et al*., 2003). Some medicinal plants of Uzbekistan have also been evaluated by the Faculty of Pharmaceutical Sciences, University of Tokushima, Japan for new compounds.

Trade and Marketing

Domestic drug production has not been extensively developed. It met less than 10% of the demand in 1999. Since 1992-93 only 3% of essential drugs have been produced domestically, most of the production was of herbal medicines and galenicals. In 1993, the government reorganized the pharmaceutical industry into a joint stock company called Uzpharmprom, which aims to increase the range and quantity of domestic

production of drugs. About 300 basic drugs are produced by Uzpharmprom. There were eight drug manufacturing companies in 1999 (Ilkhamov and Jakubowski, 2001). There are five small companies producing herbal drugs, however they do not meet market processing requirements. About 30 herbal drugs are manufactured in the country (Kulahmetova, 2002). The total volume of medicinal and aromatic plant material collected in 1996 was 189.1 tonnes. The collections volumes of some of the important medicinal and aromatic plants of economic importance in 1996 are given in Table 2. Estimates of their monetary value are not available (Anonymous, 1998).

Problems and Constraints

Medicinal and aromatic plant resources are under threat of extinction due to overgrazing, over exploitation, lack of cultivation, lack of conservation and insufficient research. Manufacturers have major difficulty in obtaining the raw material needed for production. Intensive training and education is required to implement the good manufacturing practice standards. The country has great potential for the commercial exploitation of medicinal and aromatic plants. Scientific investigations, proper conservation of resources, proper marketing and trading will help in their exploitation for the welfare of the people.

Table1: Some medicinal and aromatic plants of Uzbekistan

Botanical name	Family
Artemisia absinthium L.	Asteraceae
Berberis vulgaris L.	Berberidaceae
Bunium persicum (Boiss.) B. Fedtsch.	Apiaceae
Capsella bursa-pastoris (L.) Medik.	Brassicaceae
Casuarina equisetifolia L.	Casuarinaceae
Ficus carica L.	Moraceae
Glycyrrhiza glabra L.	Fabaceae
Hippophae rhamnoides L.	Elaeagnaceae
Hypericum perforatum L.	Clusiaceae
Lagochilus inebrians Bunge	Lamiaceae
Melissa officinalis L.	Lamiaceae
Origanum vulgare L.	Lamiaceae
Rhus coriaria L.	Anacardiaceae
Rosa canina L.	Rosaceae
Salvia officinalis L.	Lamiaceae
Tussilago farfara L.	Asteraceae
Urtica dioica L.	Urticaceae

Table 2: The collection volume of some medicinal and aromatic plants in 1996

Botanical name	Common name	Collection volume (tonnes)
Artemisia absinthium L.	Bitter wormwood	1.8
Berberis vulgaris L.	Barberry	3.5
Capsella bursa-pastoris (L.) Medik.	Shepherd's-purse	1.2
Casuarina equisetifolia L.	Horse-tail	0.2
Celtis occidentalis L.	Nettle	2.1
Glycyrrhiza glabra L.	Licorice	3
Hypericum perforatum L.	St. John's wort	12.9
Musa balbisiana Colla	Plantain	0.05
Origanum vulgare L.	Dushitsa	13.7
Rheum ×hybridum Murray	Rhubarb	60.5
Rosa canina L.	Dogrose	54.6
Salvia officinalis L.	Sage	0.5
Tussilago farfara L.	Coltsfoot	0.08

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Chapter 5

Southwest Asia

5.1 Introduction

Southwest Asia, includes Afghanistan, Armenia, Azerbaijan, Bahrain, Cyprus, Georgia, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, Turkey, the United Arab Emirates and Yemen. The flora of the Near East region is diverse and comprises some 23,000 vascular plant species, of which 6,700 are endemic to the region. The Middle East flora is estimated at 15,000 species. The use of medicinal and aromatic plants, herbs and spices in the region has a long history and forms an important part of a number of cultures. Traditional medicine still plays a major role in health care systems despite the availability of modern medicine (Heywood, 1999).

The collection, grading and processing of medicinal and aromatic plants is one of the main income generating activities. The great majority of these plants are still collected from the wild thus endangering the existence of many valuable species. Some countries such as Cyprus, Israel, Jordan, Lebanon, Syria and Turkey have completed modern inventories of their flora while countries such as Iran, Iraq and the Arabian Peninsula are still in the developmental stage. Information regarding identity, geographical distribution, current uses and conservation status in the wild, cultivation practices and trade statistics is still not fully available. The natural medicinal and aromatic plant resources of the region have a potential to be exploited commercially both to improve health care and the economic status of its inhabitants.

5.2 Afghanistan

Afghanistan is a mountainous land-locked country covering an estimated area of 647,500 square kilometres in Central Asia. It is surrounded by Tajikistan, Uzbekistan, and Turkmenistan to the north, Iran to the west, Pakistan to the south and southeast and China to the northeast. Afghanistan is an extremely poor country with a population of around 28 million. The recent history of Afghanistan has been characterized by war and civil unrest, as a result of which the majority of the population continues to suffer from insufficient food, clothing and housing. Health care problems are exacerbated by

military operations and political uncertainties. However, it is one of the richest centres of plant biodiversity, including medicinal and aromatic plants. Unfortunately the uncontrolled and unlimited use of these natural resources triggered by the 1979 war has resulted in their severe degradation and depletion.

Traditional Medicine Systems

Herbal medicine was the most popular health care system in Afghanistan before the war broke out in 1979. The conflict wiped out the bulk of the knowledge of such health care when most of the educated staff left the country. Afghanistan does not regulate herbal medicine, neither a national pharmacopoeia nor a national herbal monograph exists, and there are currently none in development (WHO, 2005). Conventional western medical treatment is not available widely and the medical facilities are limited. At present rural people are turning to traditional healers for their health care as there is a severe shortage of Western medicines and other basic medical health care services (Omar, 2002). There is a registration system for herbal medicines.

Government Efforts in Development of Traditional Medicine

Health care facilities, especially in rural areas, are largely non-functional due to the lack of supplies, equipment, structural integrity and the absence of trained health care professionals. However, the country is on the road to recovery at present. The United States maintains a large aid programme that also focuses on health care. The United States Agency for International Development (USAID) provided US$5 million to help rebuild the health care system and support the Ministry of Public Health in April 2002. It is working for the training of community health care workers, rehabilitating health facilities and to establish a health surveillance system to meet the needs of the Afghan people (Anonymous, 2002).

Medicinal and Aromatic Plant Resources

Afghanistan is divided by the mountains of the Hindu Kush and is host to rich flora and fauna with about 3% of the total area under forest cover. Most of the forests have been severely degraded by war and at present only remnants of the forests that once covered a large part of the country are visible. The forests are scattered throughout the eastern and the northern Hindu Kush regions. The collection of plants is highly unregulated and has resulted in excessive removal or extermination of some endemic species (Saba, 2001).

There are about 4,500 species of flowering plants and ferns found in Afghanistan. The most commonly available medicinal plants are *Ferula assa-foetida* L., *Ferula*

foetida (Bunge) Regel, *Glycyrrhiza* spp., *Pimpinella anisum* L. and *Zizyphus vulgaris* Lamk. (Sabra and Walter, 2000). Some important medicinal and aromatic plants found in Afghanistan are listed in Table 1 (Anonymous, 2003).

Research and Development Activities

At present no research activities on medicinal and aromatic plants are reported from Afghanistan. Some work has been carried out in the past. The University of Metz, France during the late 1980s studied the traditional uses of plants for medicine in Afghanistan and also reported geographical and ecological distribution, vernacular names and medicinal uses of 215 medicinal plants identified to date (Younos *et al*., 1987).

The FAO and other international agencies are working with the Agency Coordinating Body for Afghan Relief (ACBAR) for rehabilitation of the agriculture and forestry sector in the country. Various projects on collection, conservation and exploitation of medicinal plants have also been proposed by these agencies (Anonymous, 2003).

Trade and Marketing

In the late 1980s the annual value of medicinal plants exploited in Afghanistan was estimated to be about US$12 million. The Department of Forestry and Range Permits was responsible for issuing exporting permits for these items. However, in the present context this system is no longer functional. In 1992 the liquorice trade of Afghanistan was 7.3% of the total (US$0.94 million) international trade in liquorice (Sabra and Walter, 2000). Afghanistan is the sole least developed country exporting liquorice to France, India, Japan and USA with an export value of around US$4.2 million per year (Rajasekharan, 2003).

In the late 1990s, Afghanistan also became the world's largest supplier of opium and heroin. Since 1999 it has produced approximately 75% of the world's opium. It continued to be the world's major supplier of illegal opiates even after the Taliban banned opium poppy cultivation in July 2000. However, a decree issued on 16 January 2002 by the Afghan Interim Authority has banned the cultivation, processing, and trafficking of opiates in Afghanistan (Reeker, 2002).

Most of the medicinal plants and herbal raw materials along with other forest products are reportedly being smuggled across the border to Pakistan and other neighbouring countries. The Taliban once controlled much of this trade but the war has impeded this system of trading and the potential medicinal plant markets remain underdeveloped (Pearce, 2001).

Problems and Constraints

The illegal border trade of medicinal raw materials, conversion of forests into agriculture lands, burning and clearing of forests and trees during the war has resulted in the rapid destruction of natural resources of medicinal plants in the country. Much of the knowledge of traditional treatments for diseases has been wiped out by the war and these are now practised without any scientific validation. At present there are no ongoing research activities on medicinal and aromatic plants and their conservation. There is a need to control the illegal trade activities and develop proper marketing channels for traditional medicine and medicinal and aromatic plants.

Table 1: Some medicinal and aromatic plants of Afghanistan and their traditional uses

Botanical name	Family	Common name	Uses/Indications
Acorus calamus L.	Acoraceae	Sweet flag	As stimulant
Allium sativum L.	Alliaceae	Garlic	In malaria, skin infections, scorpion stings
Arctium lappa L.	Asteraceae	Great Burdock	In venereal diseases
Aurinia saxatilis (L.) Desv.	Brassicaceae	Madwort	In asthma, nervous disorders
Cannabis sativa L. subsp. indica (Lam.) E. Small & Cronquist	Cannabaceae	Marihuana	As painkiller
Capsicum annuum L. var. annuum	Solanaceae	Red pepper	For digestion
Carthamus tinctorius L.	Asteraceae	Safflower	In rheumatism
Carum carvi L.	Apiaceae	Caraway	For digestion
Coriandrum sativum L.	Apiaceae	Coriander	For digestion
Curcuma longa L.	Zingiberaceae	Curcuma	In fever, as antispasmodic, aphrodisiac
Ferula assa-foetida L.	Apiaceae	Asafoetida	As antispasmodic, in cold, digestion
Ferula foetida (Bunge) Regel	Apiaceae	Asafoetida	As antispasmodic, in cold, for digestion
Ferula galbaniflua Boiss. & Buhse	Apiaceae	Galbanum	Administered to women in parturition
Holarrhena pubescens Wall. ex G. Don	Apocynaceae	Holarrhena	In dysentery, diarrhoea, as aphrodisiac
Hyoscyamus muticus L.	Solanaceae	Henbane	In syphilitic ulcers
Ipomoea spp.	Convolvulaceae	Morning-glory	As purgative
Oryza sativa L.	Poaceae	Rice	In diarrhoea, chest problems
Papaver somniferum L.	Papaveraceae	Opium poppy	As painkiller
Pimpinella anisum L.	Apiaceae	Anise seed	As flavour
Salvia officinalis L.	Lamiaceae	Sage	In menstrual bleeding
Ziziphus jujuba Mill.	Rhamnaceae	Common jujube	In dysentery, fever

5.3 Armenia

The Republic of Armenia is a small landlocked country in the southern Caucasus. It is bordered by Georgia to the north, Azerbaijan to the east, Iran to the south, the

Azerbaijani exclave of Nakhichevan to the southwest and Turkey to the west. The population of Armenia is about 3.3 million and its area is about 29,800 square kilometres. Armenia has about 100 mountain lakes, the largest Lake Sevan covers about 5% of the country area. The forests make up only 1/7th of the land area and are located mainly to the north and south of the country. The commercial forestry activities are limited in Armenia; however, the collection of fuel, fruits, fodder and medicinal and aromatic plants from the forests is common and not prohibited.

Traditional Medicine Systems

Traditional medicine has long been used in Armenia for health care. Use is prevalent in rural areas where the modern health care facilities are not always available. A large number of traditional remedies derived from herbs are used commonly.

Government Efforts in Development of Traditional Medicine

Before independence the health care system of Armenia was largely based on the Semashko model of the Soviet Union. After independence in 1992 to 1993, Armenia began health care reforms. A number of measures were taken from 1993-1998 to reform the health care system from a structural, managerial and financial point of view. However, these efforts were only partially sucessful. The World Bank approved US$10 million in 1997 to support the government's health care reforms to improve the quality and efficacy of primary health care.

The National Drug Policy adopted in 1995, encouraged prescription of generic drugs from the national essential drug list and Armenian drug formulary of 1997 (Hovhannisyan *et al*., 2001). The policy, besides other things, encouraged the studies of quality, efficacy and safety of traditional medicines being practised in Armenia in order to ensure their sound use (Anonymous, 2003).

Regulation of herbal medicine in Armenia began in 1998 through the national drug law that also regulates conventional pharmaceuticals. Herbal medicines are regulated as a separate category and as dietary supplements. By law, herbal medicine may be sold with medical claims. No national pharmacopoeia exists. However, the *British Herbal Pharmacopoiea* is used and is legally binding. National monographs on herbal medicines are found in the *Armenian National Formularly for Herbal Medicine*, 2001, which is a legally binding. There are 130 registered herbal medicines and sixty herbal dietary supplements (WHO, 2005).

Medicinal and Aromatic Plant Resources

The flora of the southern Caucasus is abundant with herbs commonly used in European, American and other world markets. Armenia has over 3,500 species of plants

about 10% of which have medicinal use. The species of barberry (*Berberis spp.*), hawthorn (*Crataegus spp.*), juniper (*Juniperus spp.*), buckthorn (*Rhamnus spp.*), rose (*Rosa spp.*) and St John's wort (*Hypericum perforatum* L.) are collected and used in the preparation of traditional remedies. Around 150 species of plants, mainly species of thyme (*Thymus spp.*), helichrysum (*Helichrysum spp.*) and wormwood *(Artemisia spp.*) are known to produce essential oils (Anonymous, 2000). Medicinal and aromatic plants are generally collected from the wild, mainly from alpine habitats. A variety of aromatic plants are also used commonly by the people and produced at the local level. The medicinal plants *Acorus calamus* L., *Anethum graveolens* L., *Bryonia alba* L., *Coriandrum sativum* L., *Falcaria vulgaris* Bernh., *Rumex crispus* L. and *Valeriana officinalis* L. are commonly found in Armenia (Foster, 2003).

Research and Development Activities

There is potential to protect the biodiversity of useful medicinal and aromatic plant species by encouraging their cultivation at the consumer level in household gardens and small farms. However, research on medicinal and aromatic plants is limited in Armenia and much of the information regarding ongoing projects is unavailable. No research activities have focused on sustainable harvesting and the natural resources of medicinal and aromatic plants.

A number of laws regulated biodiversity conservation outside protected areas prior to the collapse of the Soviet Union. Three regulations dealing with licensing of hunting and fisheries; ecological assessment of new business activities; and licensing for the collection and storage of wild medicinal plants have been implemented by the Ministry of Nature Protection (MNP). A first experiment with the regulated collection of medicinal plants has already been implemented (Anonymous, 2000).

The Armenian National Academy of Sciences, Yerevan deals with research on the medicinal species found in Armenia. The Institute of Botany of the Academy has studied the development of planting methods for some species of edible and medicinal plants including *Eremurus spectabilis* M. Bieb., *Falcaria vulgaris* Bernh., *Hippomarathrum microcarpum* B. Fedtsch., and *Valeriana officinalis* L (Kamilla, 2003).

The Gulbenkian Research and DQCL Laboratories of the Drug and Medical Technology Agency established in 1998 acts as a domestic and international focal point for new synthetic compounds and medicinal herb research. The Centre, in collaboration with the Swedish Herbal Institute and an institute in Munich, has worked on the structural analysis of medicinal plants (Anonymous, 2001). A non-government organization, the Producers and Exporters of Natural Active Materials (BANARAR), consisting of research institutes, experimental centres, laboratories, scientists, technology specialists, physicians, specialists

of biology and agriculture and others also focuses on Armenian herbs and their medicinal remedies in accordance with the recipes of medieval physicians (Babakhanyan, 2003).

Trade and Marketing

Armenians have a long tradition of using plant biodiversity for economic purposes. About 52 species of medicinal plants harvested by local people are processed in different forms by various firms (Kamilla, 2003). About 60 wild species for which there is demand in international markets are available in quantities sufficient for commercial harvesting. However, their commercial potential has not been fully exploited. During the Soviet era plants such as *Anethum graveolens* L. and *Coriandrum sativum* L. and various others were commercially produced and exported to the Soviet Union. However, there is no active commercial bulk scale production of medicinal and aromatic plants in the country except some rose geranium oil production from *Pelargonium graveolens* L'Hér. Most of this production caters to the demands of niche markets in decorative, herbal tea and medicinal plant dietary supplement ingredient sectors (Foster, 2003).

The potential pharmaceutical market of Armenia is estimated to be US$40 to 50 million. In 1998, the value of annual sales was US$10 million. The Ministry of Health has licensed 540 pharmacies. About 90% of them are privately owned. The export of pharmaceutical products from Armenia requires registration by the Drug and Medical Technology Agency (DMTA) of Armenia, which also keeps a list of all the registered pharmaceuticals and essential drugs in the country. Humanitarian assistance provides a significant volume of the pharmaceutical products to the country (Isayan, 1999).

Problems and Constraints

A number of important species of medicinal and aromatic plants has become extinct because of habitat loss, over exploitation, pollution, climate changes and the effects of introduced and non-native species. Little effort is made to improve cultivation, conservation, scientific evaluation for quality, efficacy and safety of remedies derived from medicinal and aromatic plants, and the trade and production of herbal medicine. Efforts should be focused on the conservation of medicinal and aromatic plant resources, research and training of personnel, education, and cultivation of plants in order to derive commercial and health benefits from them.

5.4 Azerbaijan

The Azerbaijani Republic is bordered by Russia, Caspian Sea, Iran, Armenia and Georgia to the north, east, south, west and northwest respectively. It has an area of

about 86,600 square kilometres and population of about 7.8 million people. The forest and other woodlands account for little more than one tenth of the area mostly located in the mountainous north of the country. The forests are important to the local population as the source of a number of non-wood products including medicinal and aromatic plants. Various kinds of herbs and fruits have been cultivated and collected from forests in Azerbaijan for decades. Traditional medicine was used in the country despite the promotion of Western medicine during the Soviet era and is still used commonly.

Traditional Medicine Systems

The history of the use of traditional remedies is long and deeply rooted in Azerbaijan. Before 1828, only herbal drug stores (attar) used to provide medicinal herbs imported from Iran and India. During the Soviet era, in the 1920s, the use of traditional medicine was forbidden, the herbal drug stores were closed down and the folk medicine literature, mainly in Arabic script, was burned. However, the older people often continued to seek help from traditional specialists. Traditional specialists in the past used various kinds of herbs for the prophylaxis and treatment of a number of ailments. The *dellaki* did cupping, bloodletting and lancing abscesses; the *synichi* (traditional chiropractors) were involved in setting bones and dealing with fractures; the *gopchi* were involved with treating children and adults with respiratory infections; and the *mamas* (midwives) assisted women in childbirth and treated gynecological difficulties. The advice of clergy and mullahs was often sought in matters related to health. The holy men in the shrines known as *pir*, treated sick people and made offerings for their recovery. These treatments also involved inhaling the smoke of herbs, drinking water from a special spring or eating specially prepared meat (Efendiyeva, 1995). People still prefer to try traditional treatment methods first before opting for the modern health care facilities. No national pharmacopoeia exists but there is a registration system for herbal medicines. National herbal monographs are in the process of development. Herbal medicines are sold in pharmacies as over the counter medicines, in special outlets, by licensed practitioners and without restriction (WHO, 2005).

Government Efforts in Development of Traditional Medicine

The health system in Azerbaijan during the Soviet era was one of the least effective of the republics. The system further deteriorated in the post-Soviet period due of economic collapse, lack of management capacity, failure to adapt to limited resources, disruption of the Soviet health network, weaknesses in primary health care and the disappearance of health promotion programmes. There have been no significant changes in the organization of services since independence; the traditional soviet model is still followed. The low quality of care, lack of drugs, deteriorating conditions of facilities and

obsolete medical equipment are other major problems. The Ministry of Health (MoH) is developing an essential drugs policy and a manual on essential drug use has recently been published. The use of generics and rational drug use policies are promoted by the MoH jointly with UNICEF (Agazade, 1996).

The Institute for Advanced Training for Physicians and the Azerbaijan Medical Institute in Baku are the leading medical schools in the country, which provide training for doctors and pharmacists. No information is available regarding government efforts to enhance and popularize the use of traditional medicine in the country.

Medicinal and Aromatic Plant Resources

The flora of Azerbaijan consists of 4,300 species of plants; more than 270 are endemic species. Unsustainable methods of harvesting and utilization of natural resources has however, endangered many of these species. In total, 37 species are under threat of extinction (Anonymous, 2004). Azerbaijan is famous for its rare herbs used in traditional remedies for various kinds of diseases. Among the 726 medicinal herbs that have been identified only 466 are known to grow at present in the country and only 214 of these are being used for medicinal purposes (Blair, 1997).

A total of 75 spice species including *Artemisia dracunculus* L., *Brassica* spp., *Calamintha* spp., *Carum* spp., *Coriandrum* spp., *Crocus* spp., *Daucus* spp., *Foeniculum vulgare* Mill., *Glycyrrhiza* spp., *Lepidium* spp., *Melissa* spp., *Mentha* spp., *Nepeta* spp., *Origanum* spp., *Pimpinella aromatica* Biebers., *Pistacia* spp., *Polygonum* spp., *Rhus* spp., *Salvia* spp., *Saxifraga* spp., *Thymus* spp., *Ziziphora* spp. have been reported in Azerbaijan. Medicinal plants are largely collected from their wild resources and some plants such as *Allium sativum* L., *Citrus* spp., *Cucumus sativus* L., *Ficus carica* L., *Olea europea* L. and *Thea sinsensis* L. are also cultivated. Some important medicinal and aromatic plants of Azerbaijan are listed in Table 1 (Aliyev, 1995).

Research and Development Activities

The Institute of Manuscripts of the Azerbaijan Academy of Sciences in Baku has a collection of 390 early medical documents which include 363 manuscripts dating back to the 9th century. Most of these are written in Arabic script. (Blair, 1997)

The Institute of Botany of the Azerbaijan National Academy has carried out some field studies on the medicinal plants and traditional medicine of the country in collaboration with King's College of London, Pharmacognosy Research Laboratories, Department of Pharmacy, UK. These studies have documented the traditional knowledge and medicinal use of plants by the Azeri people and the important native medicinal plants of Azerbaijan. A total of 29 plant species used as folk remedies for the treatment of

various human and cattle diseases have also been reported (Mir-Babayev and Houghton, 2002). There is no other available information related to medicinal plant research and development activities.

Trade and Marketing

There are two pharmaceutical production facilities in Azerbaijan but at present only AZERFARM, a joint Azerbaijan-Turkish-Iranian project, is operational. It manufactures about 100 types of medications on a small scale. The plant fulfills local demand. Pharmaceutical products are imported mostly from France, Germany, Hungary, Switzerland, the USA and are preferred by Azeri consumers to the lower priced products imported from India, Iran, Russia, Turkey, and Ukraine. Imports of pharmaceuticals into Azerbaijan in 2000 were valued at about US$37 million. However, the actual market for pharmaceutical products probably exceeds US$80 million annually if the black market trade is taken into consideration (Tomaszewski and Rzayev, 2001).

The Aptek Museum of Baku created in 1984 is a pharmacy museum and has a pharmacy selling traditional herbal medicine (Alakbarov, 2000). No other reliable information is available regarding the trade in herbal medicine and medicinal and aromatic plants in Azerbaijan.

Problems and Constraints

There is a lack of research and scientific validation of traditional remedies, a lack of government initiatives to conserve and promote traditional medicine, a lack of cultivation and conservation of valuable medicinal and aromatic plants and their resources, a lack of education, training and marketing, and a lack of production facilities in Azerbaijan.

Table 1: Some medicinal and aromatic plants found in Azerbaijan

Botanical name	Family
Achillea millefolium L.	Asteraceae
Adonis vernalis L.	Ranunculaceae
Betula pendula Roth	Betulaceae
Buxus colchica Pojark.	Buxaceae
Buxus hyrcana Pojark.	Buxaceae
Calendula officinalis L.	Asteraceae
Capsella bursa-pastoris (L.) Medik.	Brassicaceae
Diospyros lotus L.	Ebenaceae
Helichrysum arenarium (L.) Moench	Asteraceae
Juniperus spp.	Cupressaceae

Continued

Table 1 continued

Botanical name	Family
Mentha longifolia (L.) Huds.	Lamiaceae
Origanum vulgare L.	Lamiaceae
Periploca graeca L.	Apocynaceae
Pyrethrum parthenifolium Willd.	Asteraceae
Quercus castaneifolia C. A. Mey.	Fagaceae
Ranunculus repens L.	Ranunculaceae
Rhamnus pallasii Fisch. & C. A. Mey.	Rhamnaceae
Rosa spp.	Rosaceae
Rubus buschii (Rozanova) Grossh.	Rosaceae
Rumex acetosa L.	Polygonaceae
Salvia glutinosa L.	Lamiaceae
Sambucus ebulus L.	Adoxaceae
Sambucus nigra L.	Adoxaceae
Tilia cordata Mill.	Malvaceae
Ulmus foliacea Gilib., nom. inval.	Ulmaceae
Urtica dioica L.	Urticaceae
Valeriana officinalis L.	Valerianaceae
Viburnum opulus L.	Adoxaceae
Viscum album L.	Viscaceae

5.5 Bahrain

Bahrain is an archipelago of around 36 islands with a total area of about 691 square kilometres and a population of about 0.7 million. The country is overwhelmingly urban with about 85% of the people living in cities or suburbs. Most of the island is low-lying and barren desert and has no formally declared forest areas however, there is a fertile strip along the northern coast on which date palm, almond, fig and pomegranate trees grow. The Al-Areen Wildlife Sanctuary is Bahrain's most notable protected area and around 100,000 trees have been planted in the Sanctuary for wildlife conservation purposes.

Traditional Medicine Systems

Bahrain regulates herbal medicines using the same, or part of the same, legal framework used for conventional pharmaceuticals. Herbal medicines are regulated as dietary supplements, health food and health products (WHO, 2005). Herbal medicines prepared basically from palm tree flowers, pollen and buds are distilled in certain villages of the country and used for treatment of various diseases and conditions. Currently the local and imported herbs are extracted and used as natural remedies in some villages of Bahrain.

The registration system has registered 600 herbal medicines (WHO, 2005).

Government Efforts in Development of Traditional Medicine

The Ministry of Health provides comprehensive health services to the population in accordance with the WHO framework for health system improvement. In 2001, the Bahrain Health Strategy 2002-2010 and Bahrain National Policy for Drugs were formulated by the Ministry of Health. The Ministry also analyses the quality of drugs through the pharmacy and drug control laboratories and a new microbiology section was created in 2001 for the control and enhancement of drug quality. In 2001, the Bahrain National Policy for Drugs was formulated in collaboration with the World Health Organization. The Ministry of Health approved the registration of 139 drugs and 13 companies, which met the required standards (Anonymous, 2001). A new private hospital was opened in February 2001 and there are plans to open clinics for alternative medicine that will include an acupuncture clinic, preventive medicine and health education besides various other sections.

A Chinese delegation visited Bahrain in July 2003 to hold talks with the Ministry of Health to establish a centre for traditional Chinese medicine in Bahrain. It will be a first of its kind in the country (Anonymous, 2003).

Medicinal and Aromatic Plant Resources

There is no natural forest cover in Bahrain, though the islands have relatively lush vegetation compared with other parts of the Middle East. Over 200 species of flora have been identified so far in Bahrain. Desert plants, in particular the halophytic species are the prominent vegetation of the country. The northern and the western areas are heavily cultivated with date palm (*Phoenix dactylifera* L.) and alfalfa (*Medicago sativa* L. subsp. *sativa*) plantations. Some medicinal species such as *Salsola baryosma* (Schultes) Dandy, *Sesuvium verrucosum* Raf. and *Zygophyllum quatarense* Hadidi are important plants used in folk medicines. Some of the common plants used as herbal medicines by villagers are given in Table 1 (Anonymous, 1999; Taha and Alsayed, 2000).

Research and Development Activities

The Department of Chemistry, University of Bahrain has carried out research to evaluate some native medicinal plants for their anti-tumor activity. Some work on the estimation of the chemical contents of medicinal plants growing in Bahrain has also been reported in the past (Taha and Alsayed, 2000). Information on the current status of research on medicinal and aromatic plants in Bahrain is scarce.

Trade and Marketing

Locally prepared herbal remedies are sold in the local markets, super markets and in herbal medicine shops. However, information on their trade, production and consumption volumes is not available.

Problems and Constraints

The extensive residential construction and urbanization in the 1970s converted most of the villages into one large suburban town. Jidd Hafs, one of the main towns, was famous for manufacturing medicinal drugs from palm trees throughout the nineteenth and the first half of the twentieth centuries. However, it had been transformed into the capital Manama's largest suburb by 1975, thus resulting in the depletion of its medicinal plant resources (Anonymous, 2003).

Efforts should be directed towards the conservation and cultivation of important medicinal plant species. The production of herbal medicine should be regulated and encouraged in order to derive commercial benefits from the medicinal and aromatic plants of the country.

Table 1: Some common medicinal plants used as herbal medicines in Bahrain

Botanical name	Common name	Local name	Uses/Indications
Cichorium intybus L.	Chicory	Hindeban	As heart tonic, diuretic, stomach vitalizer, lowering cholesterol, in kidney and liver problems
Cinnamomum verum J. Presl	Cinnamon	Darseen	In respiratory diseases
Mentha ×piperita L.	Mint	Na'naa'	As digestive, in constipation, stomach pain, as flavouring for tea and juice and as tranquilizer
Olea europaea L.	Olive	Zaytoon water	In blood pressure
Salsola baryosma (Schultes) Dandy	-	Gaghraf	As diuretic, anti-inflammatory
Sesuvium verrucosum Raf.	Purslane	Rokhama	In ear disorders
Zygophyllum quatarense Hadidi	-	Harm	As CNS stimulant

5.6 Georgia

Georgia is located in the Caucasus Mountains on the east coast of the Black Sea. The country is bounded by Russia to the north and by Azerbaijan, Armenia, and Turkey to the south. The population and area of the country are about 4.9 million and 69,700 square kilometres respectively. Georgia is a largely mountainous, forested country with over two fifths of the country under forest cover. About one fifth of the forest cover is undisturbed by man and is an important source of various forest products including medicinal and aromatic plants, which are of great importance to the local population.

Traditional Medicine Systems

Georgia has a long, well documented medical tradition dating back to the 4th century. Reliance on plants for food and medicine is deeply rooted in the society. Traditional medicine is a part of folklore and has a solid philosophical foundation in the society and culture of the country. Georgian traditional medicine integrates eastern and western medical traditions comprising the methods of diagnosis and treatment of Chinese, Greek, Indian, Roman, Sumerian and Tibetan medicine. There are more than a thousand traditional remedies that are made from plants, animals, and mineral products with precise technology and dosage in Georgia (Shengelia, 1999). Old Georgian traditional medicine is known as *Kolkhidas' Medicine-Medea's Medicine*. At present, the interest in traditional medicine and its various forms such as acupuncture, Su-Jok therapy and homeopathy is increasing in Georgia (Kordzaya, 2003).

Government Efforts in Development of Traditional Medicine

Georgia declared its independence from the USSR in April 1991. The intense civil conflict and the breakup of the Soviet Union resulted in profound economic collapse resulting in severe damage to the health care system in Georgia. In 1999, the Ministry of Health joined with the Ministry of Social Welfare and is now known as the Ministry of Labour, Health, and Social Affairs (MoLHSA). It is responsible for the development and implementation of government policy on health care and medical research. Under the 1995 reforms, restated in the 2000 to 2009 health programme, the Ministry has changed its emphasis from implementation of health care to support for preventive activities as well as regulation and accreditation of health services and training (Lotuashvili, 2003). The Ministry also supervises the inspection of the pharmaceutical market, legal control of narcotic substances and traditional medicine (Gamkrelidze *et al.*, 2002).

The current regulations categorize herbal medicines, health foods, supplements and other botanicals as semi-medicinal preparations and homeopathic plant extracts as homeopathic preparations. Both of these categories are regulated by the Pharmacological Committee of the Drug and Pharmacy Department of the Georgian Ministry of Health and are registered in the Georgian State Drug Register. The regulated substances are only distributed through pharmacies (Kuritz *et al.*, 2000). Georgia does not have a national policy and national programme on herbal medicines. The national office was established in 2001 and is administered by the Ministry of Health. Regulation of herbal medicine was introduced in 2002 with laws and regulations similar to those that regulate conventional pharmaceuticals. A national pharmacopoeia was published in two volumes in 2000 and 2003 and is legally binding. National monographs on herbal drugs

are being developed. There are 181 registered herbal medicines in Georgia; however none is included in the national essential drugs list. No post marketing surveillance system for herbal drugs exists, nor is one currently being planned. Herbal medicines are sold in pharmacies as over the counter medicines (WHO, 2005).

Medicinal and Aromatic Plant Resources

Georgia is rich in native plant diversity however; these species have not been thoroughly surveyed or documented. The flora of the country is known to include 4,200 to 4,500 species of vascular plants of which about 380 are endemic. Approximately 2,000 of the species, including medicinal and aromatic plants, are considered to be of economic importance. Over exploitation, illegal harvesting and agricultural practices have affected the country's flora adversely. About 50 of the plant species are critically endangered and 300 are known to be rare (Anonymous, 2003). Medicinal and aromatic plants were cultivated on a small scale by the traditional physicians in the past. At present these are mainly collected from the wild. Some important medicinal and aromatic plant species found in Georgia are listed in Table 1 (Dateshidze, 2000; Kuritz *et al.*, 2000).

Research and Development Activities

The Georgian Folk Medicine Association has done a lot of work to publicize folk medicine in the country. In this direction a major contribution is also being made by scientists from the Tbilisi State University. They have researched and developed balms based on folk recipes and medicinal plants and a small commercial scale production of these balms is being carried out (Anonymous, 2000). Georgian traditional medicine has been mentioned in more than 500 manuscripts from the 10th to the 19th century. The first volume of the *Georgian Medical Thesaurus* has recently been published (Kordzaya, 2003).

The Kutateladze Institute of Pharmacochemistry and the Georgian Academy of Sciences have focused their research activities on the chemistry of physiologically active natural compounds and drug development. In particular they have worked on pharmacobotanical studies of Georgian flora and problems related to medicinal plant conservation (Anonymous, 2003). Large scale development of the infrastructure for production of medicinal plants, ethereal oils and other technical crops has been carried out by the NGO, Institute of Medical Plants. Planning and infrastructure development was initiated with financial support from the Eurasian foundation (USAID resources, 1996). Since the year 2000 the World Bank has also supported the programme (Dateshidze, 2000).

The Department of History of Georgian Medicine and Traditional Medicine at the Experimental and Clinical Medical Institute of the Tbilisi State Medical University (founded in 1956) together with the Department of History of Medicine have published thousands

of scientific reports over the last 40 years. Material on Georgian folk medicine including recipes and active components of herbal, animal, and mineral origin has been collected through a number of expeditions and surveys of different parts of the country (Shengelia, 1999). The Academy of Classical and Traditional Medicine of Tbilisi is also responsible for the development and research of traditional medicine in the country.

Trade and Marketing

Export markets for traditional agricultural products including medicinal plants have been lost. Attempts are being made to encourage farmers to produce medicinal plants for commercial purposes. The pharmaceutical production industry of Georgia is small and nearly all pharmaceutical products are imported. About US$50 million worth of drugs are imported annually (Gamkrelidze *et al.*, 2002). At present, only five pharmaceutical manufacturers are operative in Georgia. Pharmaceuticals produced by these companies account for 20% of the market while the other 80% are imported. According to unofficial sources 36% of the pharmaceuticals in the country are smuggled in illegally. The total volume of sales on the local market is worth US$67 million. The largest volumes of pharmaceutical products are imported from Russia and Ukraine and the rest from Bulgaria, Germany, Hungary, India and Slovenia (Lotuashvili, 2001). The herbal products market is also growing in Georgia however; currently no reliable information for trade in medicinal and aromatic plants and herbal medicinal products is available.

Problems and Constraints

The negligence of natural resources of medicinal and aromatic plants, lack of conservation and cultivation activities, research, training, underdeveloped markets, the lack of cooperation between organizations working on medicinal plants, government control, large scale import and illegal marketing of pharmaceutical products are some of the problems faced by the commercial development of the medicinal and aromatic plant sector. There is a need for pharmaceutical manufacturers to follow GMP standards and protection of Georgian traditional medicine on the basis of accumulated experience and the creation of a herbal medicine pharmacopoeia.

Table 1: Some important medicinal and aromatic plants in Georgia

Botanical name	Family
Adiantum capillus-veneris L.	Pteridaceae
Aerva lanata (L.) Juss. ex Schult.	Amaranthaceae
Aloe arborescens Mill.	Asphodelaceae
Chamaemelum nobile L. Allioni, (syn. Anthemis nobilis)	Asteraceae

Continued

Table 1 continued

Botanical name	Family
Asphodelus ramosus L.	Asphodelaceae
Atropa belladonna L.	Solanaceae
Calendula officinalis L.	Asteraceae
Camellia sinensis (L.) Kuntze	Theaceae
Chelidonium majus L.	Papaveraceae
Citrus aurantium L.	Rutaceae
Citrus limon (L.) Burm. f.	Rutaceae
Cornus mas L.	Cornaceae
Cyperus rotundus L.	Cyperaceae
Datura innoxia Miller	Solanaceae
Diospyros lotus L.	Ebenaceae
Eleutherococcus senticosus (Rupr. & Maxim.) Maxim.	Araliaceae
Ficus carica L.	Moraceae
Hypericum perforatum L.	Clusiaceae
Juglans regia L.	Juglandaceae
Lagochilus inebrians Bunge	Lamiaceae
Laurus nobilis L.	Lauraceae
Lavandula stoechas L.	Lamiaceae
Lepidium sativum L.	Brassicaceae
Linum usitatissimum L.	Linaceae
Matricaria recutita L.	Asteraceae
Melissa officinalis L.	Lamiaceae
Mentha ×piperita L.	Lamiaceae
Mentha cervina L.	Lamiaceae
Olea europaea L.	Oleaceae
Origanum dictamnus L.	Lamiaceae
Paeonia officinalis L.	Paeoniaceae
Panax ginseng C. A. Mey.	Araliaceae
Phaseolus vulgaris L.	Fabaceae
Plantago lanceolata L.	Plantaginaceae
Plantago major L.	Plantaginaceae
Salvia officinalis L.	Lamiaceae
Taxus baccata L.	Taxaceae
Thymus vulgaris L.	Lamiaceae
Vitis vinifera L.	Vitaceae

5.7 Iran (Islamic Republic of)

The Islamic Republic of Iran is bounded by the former USSR and the Caspian Sea to the north, Afghanistan and Pakistan to the east,the Persian Gulf and the Oman Sea to the

south and by Iraq and Turkey to the west. It has a population of about 67 million and an area of 1,648,195 square kilometres and only 7% of the total land area under forest cover. More than half of the country is covered with mountains and highlands, about a quarter with deserts and the rest is arable land. Agriculture is the most important contributor to Iran's economy. Medicinal and aromatic plants have traditionally been used in health care for many generations and have been regarded as an integral part of farming systems in Iran.

Traditional Medicine Systems

Traditional medicine dates back more than 3,000 years in Iran. Evidence of the use of medicinal plants goes back thousands of years when Avicenna, the well known Iranian medical scientist and practitioner wrote a volume on medicinal plants upon which western medicine was based until the 13th century (Sabra and Walter, 2000). The book, *Canon in Medicine* by Avicenna has been used by the European scientific community for more than 600 years. The works of Avicenna and Razes, another famous scientist have been translated into various languages (Mosaddegh and Naghibi, 2003).

Traditional medicine forms an integral part of the culture of the Iranian people. Despite a large number of modern medicine physicians practising in the country, traditional healers continue to be consulted. In many regions of Iran, particularly in rural areas, traditional remedies derived from plants are the only accessible health care alternative. Iranian traditional medicine is endeavouring to gain a proper place within the health care system of the country. Folk medicine practitioners known as *hokama*, prepare, sell and practise traditional medicine. With the expansion of allopathic medicine, the number of *hokama* has declined significantly over the years in Iran (WHO, 2001). Herbal medicines are regulated as prescription and over the counter medicines and as dietary supplements. Medical, health and nutrient content claims may be made by law. The *British Pharmacopoeia* and the *Pharmacopoeia of the People's Republic of China* are used in place of national pharmacopoeia, but are not legally binding. The national formularly of Iran (2nd ed. 2000) contains 70 national herbal monographs, but again is not legally binding (WHO, 2005). There are 170 registered herbal medicines (WHO, 2005).

Government Efforts in Development of Traditional Medicines

The government is keenly interested in expansion of traditional medicine and has initiated a number of programmes related to them. The National Academy of Traditional Medicine in Iran was established in 1991 to support research on herbal medicine; study the history and preservation of Iranian traditional medicine; investigate education in them; recommend an education plan to the Ministry of Health and Medical Education;

incorporation of traditional medicine training and research into allopathic medical programmes; educate the public on the rational use of traditional medicine; and republish famous Iranian books on traditional medicine.

In 2001, the Academy recommended official training for allopathic medical students in Iranian traditional medicine. The Food and Drug Control Agency has also been working since 1991 in the field of herbal medicine. In 1996, the Ministry of Health and Medical Education established the Council Committee of Medicinal Herbs and Products for evaluating the safety and efficacy of herbs and herbal products. It has issued rules and regulations for the packaging of herbal medicines. Traditional medicine practitioners are neither supported nor banned by the government as long as their practices are safe for patients. The Iranian government provide subsidies to the pharmaceutical industry to import raw materials, however, there is no such subsidy for herbal products or locally produced herbal raw materials and hence herbal products are often more expensive than generic drugs in Iran (WHO, 2001). A national office for traditional medicine was established within the Ministry of Health in 1981 as a part of the Department of Pharmaceutical Affairs. An expert committee on tradition medicine was established in 1995 and a national research institute on herbal medicines was founded in 1999 (WHO, 2005).

Medicinal and Aromatic Plant Resources

Iran is a country rich in medicinal and aromatic plant resources. About 8,000 medicinal plant species have been reported (WHO, 2001). The Iranian plateau, specially the central Alborz region, Zagros, Hirkan, Persian Gulf and Gulf of Oman are rich in medicinal plant species (Salehi, 1998).

Iran is one of the main producers of cumin (*Cuminum cyminum* L.). It is cultivated in Eastern Khorasan and the Sabzevar, Birjand, Gonabad, Sorkhe, Garmsar and Kerman regions over an area of 50,000 hectares (Riazi, 2000). Aromatic plants have been used traditionally as medicine, perfume and flavours. Production of rose water and water extracts in Kashan in central Iran has led to the growth of a flourishing cottage industry as well as establishment of the first industrial level rose water production unit in the country (Sabra and Walter, 2000). Some medicinal and aromatic plants used in Iran are given in Table 1 (Miraldi *et al.*, 2001; Emad, 2003).

Research and Development Activities

The Iranian government has been providing funds to the scientific community to re-evaluate the use of medicinal plants in order to limit dependence on imports and encourage national potentialities. Research on medicinal plants and herbs is carried out by a number of universities, pharmaceutical institutes, experimental farms and research

centres. The Horticulture Department of the Ministry of Agriculture also deals with medicinal plants and herbal affairs (Sabra and Walter, 2000).

The Tehran University of Medical Sciences has studied antifungal activity of 250 species of native plants gathered from different locations. The study also included some of the plants used by rural inhabitants as herbal medicines (Amin *et al.*, 2002). The Shaheed Beheshti University of Medical Sciences has also been engaged in research on medicinal plants. Most of such research activities in Iran have been pre-clinical as the country has no specific hospital for conducting clinical trials of herbal medicines. Over the last 10 years, the government has undertaken an inventory of medicinal plants. So far out of the 8,000 plants used for medicinal purposes, 2,500 have been recorded in 20 volumes of 125 herbs each. Eighty-four herbal products included in list of essential drugs have undergone clinical trials and been licensed. By the end of 2004 the government intends to have issued licences for 300 herbal products. There are seven faculties of pharmacy conducting research on medicinal plants in seven provinces (WHO, 2001).

Trade and Marketing

There are more than 5,000 druggists selling herbal drugs in Iran. The Ministry of Health and Medical Care has declared 100 to 200 species of herbs as important pharmaceutical agents. By 1998, 60 permits had been issued for the manufacture of herbal drugs and another 21 were under consideration (Salehi, 1998). Iran has 30 pharmaceutical companies producing various types of herbal medicines. There are many small herbal shops that supply herbal materials and spices for medicinal uses (WHO, 2001). Villages have their own markets for selling traditional remedies, drugs and spices to the local communities.

Iran is one of the major countries exporting its pharmaceutical drugs to industrialized nations. Over 2.5 million people deal with medicinal herbs directly or indirectly in Iran. However, there are no reliable statistics on the use of these herbs. Medicinal herbs are exported by the private sector in cooperation with the Export Promotion Center and the Ministry of Commerce with the support of the Forest and Ranger Organization. At present, this sector exports over 3,000 tonnes of herbs, valued at over US$10 million to the Persian Gulf states, European countries, mainly France, Germany and a few nearby nations such as India, Pakistan and Turkey. These products are generally exported in raw form because of the lack of intermediate industries and facilities for processing (Anonymous, 2002).

Problems and Constraints

In order for the country to fully exploit medicinal and aromatic plant resources commercially, there is a need to replace traditional methods of exploitation with indus-

trial methods; to attract increasing numbers of native people to the industry; to identify all possible profitable herbs; to establish policies which support the cultivation of medicinal herbs; to import the required technology for production and processing; and to coordinate exports and create links with plant cultivation research centres. Therefore, identifying potential sources; protecting and developing rare species; processing the herbs in the country; preventing export of medicinal herbs in raw form; striking a balance between demand and supply of by-products; and reviving exploited areas will help the country to use its medicinal plant resources in a commercial way. Developing medicinal herbs processing industries will promote the export of processed herbs and by-products, and boost sustained development programmes.

Table 1: Some common medicinal and aromatic plants found in Iran

Botanical Name	Family	Uses/Indications
Achillea millefolium L.	Asteraceae	In haemorrhoids, cancer, dysmenorrhoea, vertigos, anemia, anorexia
Althaea officinalis L.	Malvaceae	In inflammation of gastrointestinal and respiratory systems, insect stings, as laxative
Anchusa italica Retz.	Boraginaceae	As sedative, diaphoretic, hypotensive
Arctium lappa L.	Asteraceae	In blood purification, as diuretic, diaphoretic, tonic, antiseptic, in rheumatic troubles
Artemisia absinthium L.	Asteraceae	As tonic, diuretic, anti-fever, appetizer, in headache, liver, stomach troubles
Artemisia dracunculus L.	Asteraceae	As laxative, carminative
Asphodelus aestivus Brot.	Asphodelaceae	As tonic, diuretic, choleretic, sedative, laxative, in toothache, cough
Berberis vulgaris L.	Berberidaceae	As choleretic, laxative, flavouring
Borago officinalis L.	Boraginaceae	As diaphoretic, laxative, in blood purification, liver, urinary diseases
Capparis spinosa L.	Brassicaceae	In haemorrhoids
Capsella bursa-pastoris (L.) Medik	Brassicaceae	In tension, agitation, anuria, epilepsy, diarrhoea, liver diseases
Carthamus tinctorius L.	Asteraceae	As digestive, laxative, antiseptic
Carum carvi L.	Apiaceae	As carminative, galactogogue, digestive, disinfectant
Chelidonium majus L.	Papaveraceae	In diarrhoea, inflammation of gall bladder, asthma
Cichorium intybus L.	Asteraceae	As stomachic, depurative, choleretic, laxative, hypotensive, tonic, antipyretic
Cordia myxa L.	Boraginaceae	As anti-helmintic, diuretic, laxative, in skin diseases
Cornus mas L.	Cornaceae	As astringent, antipyretic, flavouring
Cucumis colocynthis L.	Cucurbitaceae	In headache, dropsy, stomach, arthritis, jaundice, liver, urinary diseases
Cynodon dactylon (L.) Pers.	Poaceae	As antidepressive, antiemetic, diuretic, in coughs, epilepsy, haemorrhage
Datura stramonium L.	Solanaceae	In rheumatic troubles, asthma, tuberculosis
Dorema ammoniacum D. Don.	Apiaceae	As laxative, tonic, antiseptic, in liver disorders and asthma
Dracocephalum moldavica L.	Lamiaceae	As tonic, carminative, stomachic, digestive, diaphoretic, sedative, antiemetic

Continued

Table 1 continued

Botanical Name	Family	Uses / Indications
Ferula assa-foetida L.	Apiaceae	In stomachache, plague, cough
Fraxinus excelsior L.	Oleaceae	As vermifuge, diuretic, tonic
Fritillaria imperialis L.	Liliaceae	As laxative, diuretic, anti-cancer, in asthma
Galium verum L.	Rubiaceae	In skin diseases, urinary diseases, eczema, as aphrodisiac
Glycyrrhiza echinata L.	Fabaceae	In coughs, bronchitis, constipation, gastric ulcers
Hyssopus officinalis L.	Lamiaceae	In colic, asthma, toothache
Inula helenium L.	Asteraceae	As eupeptic, analgesic, carminative, diaphoretic
Lythrum salicaria L.	Lythraceae	As astringent, antihaemorragic, in diarrhoea, dysentery, leucorrhoea, epistaxis, dysmenorrhoea
Malva sylvestris L.	Malvaceae	As laxative, in coughs, insect and scorpion stings, to treat burns
Melissa officinalis L.	Lamiaceae	In liver disorders, memory, respiration, hiccups
Myrtus communis L.	Myrtaceae	In stomach, liver, diarrhoeal troubles, as anti-rheumatic, in headache
Nasturtium officinale R. Br.	Cruciferae	As digestive, disinfectant, antiscorbutic, in diabetes, obesity
Peganum harmala L.	Zygophyllaceae	As aphrodisiac, milk stimulant, in headache
Plantago major L.	Plantaginaceae	In toothache, diarrhoea, gastric inflammation
Plantago psyllium L., nom. ambig.	Plantaginaceae	As anti-inflammatory, in diarrhoea, toothache
Polypodium vulgare L.	Polypodiaceae	As purgative, cholagogue, in stomach diseases
Prunus mahaleb L.	Rosaceae	As analgesic
Quercus infectoria Olivier	Fagaceae	In haemorrhage, diarrhoea, enuresis.
Rosa canina L.	Rosaceae	As diuretic, calmative, against kidney and urinary stones
Rumex crispus L.	Polygonaceae	As antihaemorragic, cicatrizant, for hair colouring
Sambucus nigra L.	Adoxaceae	In rheumatism, scrophulosis, respiratory ailments, as laxative
Thymus kotschyanus Boiss. & Hohen.	Lamiaceae	As hypotensive, analgesic, in kidney stone, inflammation, colds
Trigonella foenum-graecum L.	Fabaceae	As aphrodisiac, in haemorrhoids, to treat trachoma
Viscum album L.	Viscaceae	As hypotensive, diuretic, in haemorrhages

5.8 Iraq

Iraq is located in the Middle East on the Persian Gulf and shares borders with Iran, Jordan, Kuwait, Saudi Arabia, Syria and Turkey. The population of Iraq is estimated to be around 24.7 million and the area about 437,072 square kilometres. Most of the land area is desert and only 12.5% is under cultivation. Although the Tigris and Euphrates rivers provide irrigation for the fertile soils on their banks, Iraq has less than 0.5% forest and other woodland cover. Over exploitation of the natural forests as well as shifting agriculture practices, forest fires, uncontrolled grazing and years of war has destroyed large areas of natural resources.

Traditional Medicine Systems

Traditional medicine has been used both for maintaining health and curing disease in Iraq. Traditional healers in Iraq are known as *attars*. In Iraqi folk medicine practices, medicinal plants are used in the form of beverages prepared by soaking either the leaves or the whole plant in boiling water (Sabra and Walter, 2000).

The second Gulf war in 1991 and economic sanctions resulted in acute shortage of modern medicines in the country forcing people to turn to herbal medicines. The rich history and knowledge of alternative therapies of Iraqis and the need for medicine encouraged the search for herb based pharmaceutical alternatives. A large number of herbal pharmacies have recently become evident in various parts of the country. More than 82 diseases of various degrees of severity are treated with traditional remedies derived from plants. Herbal specialists have come up with remedies for treating several conditions and diseases such as high blood pressure, diabetes, gout, psoriasis and certain cancers (Asharqy, 2002).

Government Efforts in Development of Traditional Medicine

Herbal remedies are subject to health regulations and criteria set by the Iraqi Ministry of Health. There is a specialized department affiliated to the Ministry of Health called the Medicinal Herb Centre. It is run by doctors and chemists specialized in plant and herb taxonomy and it supervises and licenses herbal farms. The medicinal herb specialists in the country have adopted scientific methods for packing herbs in the form of dry herbs, tablets, liquids and pastes (Asharqy, 2002).

Prior to the second Gulf war, Iraq had one of the highest standards of living in the Middle East and an elaborate health care system. The war had a devastating effect on the health of the Iraqi people. Repeated air raids destroyed all drug factories and warehouses together with medical and pharmaceutical materials and instruments. Health care institutions and hospitals that were once well equipped, well supplied and easily accessed by patients, have now become overcrowded, unhygienic and short of medical supplies. The health care system further disintegrated under U.N. sanctions (El-Awady, 2002).

Medicinal and Aromatic Plant Resources

Iraq has 3,000 vascular plant species of which about 190 are endemic. Of the approximately 1,500 plants used in Iraq, the majority have been used for their medicinal and aromatic properties. Most of the medicinal plants are collected from the forests but some of them are cultivated. Some medicinal and aromatic plant species found in Iraq are given in Table 1 (Sabra and Walter, 2000; Twaij *et al.*, 1985).

Herbs such as *Cyperus alopecuroides* Rottb., *Cyperus pygmaeus* Rottb. and *Rubus sanctus* Schreb. are common on the riparian islands and riversides. Iraq is one of the leading world producers of liquorice obtained from the dried roots and rhizomes of *Glycyrrhiza* spp. particularly *Glycyrrhiza glabra* L. The plant grows abundantly in wild (Sabra and Walter, 2000).

Research and Development Activities

The current status and information on research activities on medicinal and aromatic plants in Iraq is scattered and unavailable. The Biological Research Centre at the Scientific Research Council, Baghdad and the Universities of Baghdad and Basra have carried out a considerable amount of research work on medicinal plants of the country in the past. The diuretic activity of 13 Iraqi medicinal plants was evaluated at the Scientific Research Council, Baghdad. The plants *Adiantum capillus-veneris* L. and *Crataegus azarolus* L. were screened from the initial investigations and further evaluated (Twaij *et al.*, 1985). Scientists at the Biological Research Centre studied and established the anti-inflammatory activity of the Iraqi medicinal plants, *Achillea santolina* L., *Apium graveolens* L., *Matricaria chamomilla* L., *Myrtus communis* L. and *Withania somnifera* (L.) Dunal (Al-Hindawi *et al.*, 1989). An ethnobotanical survey to identify the medicinal plants used in the country by traditional healers in different regions of Iraq was also carried out and 97 medicinal plants belonging to 43 families were identified (Sabra and Walter, 2000).

Trade and Marketing

Jordan was the largest exporter of medicines to Iraq and the majority of the Kingdom's 17 pharmaceutical companies conducted trade with Iraq. However, trade declined drastically as a result of 11 years of UN sanctions imposed on Iraq. In the early 1990s, six companies operating in Jordan exported around US$50 million worth of their products to Iraq. By mid decade, sales to Iraq declined drastically and in the year 2002, of the total US$200 million in Jordanian pharmaceutical exports, only US$20 million were exported to Iraq (Wakeel, 2003).

The recent war in Iraq has resulted in severe damage to the country's health care services and facilities. The destruction resulted in a severe shortage of medicine and other means of health care. The supply of pharmaceuticals is not sufficient to meet the needs of the population and health services still remain far from adequate. UK based pharmaceutical companies recently supplied emergency medicines worth of £2 million to Iraq (Anonymous, 2003). The United States Agency for International Development recently awarded a US$10 million grant to the World Heath Organization in order to

strengthen the overall health system in Iraq (Anonymous, 2003). No information on the trade and marketing of medicinal and aromatic plant and herbal medicine is currently available.

Problems and Constraints

The recent war has degraded the country's health care system resulting in acute shortage of skilled manpower and basic medicines. Most of the major institutions and the medicine producers have been looted and destroyed by the war. It has also wiped out the major natural resources of medicinal plants and the knowledge related to such remedies.

Table 1: Some medicinal and aromatic plants found in Iraq

Botanical name	Family name
Achillea santolina L.	Asteraceae
Adiantum capillus-veneris L.	Pteridaceae
Anchusa strigosa Labill.	Boraginaceae
Apium graveolens L.	Apiaceae
Capparis spinosa L.	Brassicaceae
Centaurea phyllocephala Boiss.	Asteraceae
Cleome quinquenervia DC.	Capparidaceae
Crataegus azarolus L.	Rosaceae
*Cyperus alopecuroide*s Rottb.	Cyperaceae
Echium italicum L.	Boraginaceae
Ephedra foliata Boiss. & Kotschy	Ephedraceae
Glycyrrhiza glabra L.	Fabaceae
*Haloxylon articulatu*m (Car.) Bunge	Chenopodiaceae
Matricaria chamomilla L., sensu 1753	Asteraceae
Myrtus communis L.	Myrtaceae
Prosopis farcta (Banks & Sol.) J. F. Macbr.	Fabaceae
Quercus infectoria Olivier	Fagaceae
Rubus sanctus Schreb.	Rosaceae
Salvia spinosa L.	Lamiaceae
Withania somnifera (L.) Dunal	Solanaceae

5.9 Israel

Israel is bounded by the Mediterranean Sea to the west, the Sinai Desert to the southwest, the mountains of Lebanon and the Golan Heights to the north, the Jordan Valley to the east and the Gulf of Aqaba at its southern tip. The area of Israel is 27,800 square kilometres and the population is about six million people with the majority of

the population (about 90 %) living in cities. The compact borders of Israel enclose a land of considerable geographic, climatic and genetic diversity. Forest cover account for less than one tenth of the land area and the southern part of the country is desert. The indigenous forests have been almost totally destroyed by centuries of continuous grazing and by the search for wood in the 1900s for the Ottoman trans Levant railway.

Traditional Medicine Systems

Natural materials of mineral, animal and plant origin have been used as sources of medicine in Israel since ancient times. Traditional medicine is of the ancient Hippocratic-Galenic method, which was adapted and improved in Moslem medical science in the Middle Ages. Since then it has been used by the populations living in towns and remote areas without significant changes. An essential change in this medical tradition occurred with the appearance of modern European medicine at the end of the 19th century. Israel shares its medical heritage with Lebanon, Jordan and Syria (Lev and Amar, 2000). Modern medicine is generally available within the country today; however, the usage of natural medicine is also gaining popularity within modern Israel society. The state of Israel is currently developing a national policy, laws and regulations, a national programme and a national office for traditional medicines. There are currently no expert committees or national research institute on traditional medicines. There is no specific regulation of herbal medicines in Israel. Herbal medicines may be considered as dietary supplements and by law no medical claims may be made for them (WHO, 2005).

Government Efforts in Development of Traditional Medicine

The government provides advanced and efficient modern health care services to its population. The Ministry of Health is the principal health agency in the country for licensing medical, dental, nursing, pharmaceutical and paramedical professions as well as for implementing all health-related legislation. The health services are provided by four health insurance companies known as sick funds, each having its own physicians, pharmacies and laboratories serving only those who are insured by the specific fund (Blay, 2002). These sick funds also offer complementary health services. Israel has four medical schools, each affiliated with a major university but there is no special university or institute for traditional medicine. There are several colleges offering various training programmes in different disciplines of complementary medicine. Some major hospitals such as Asaf Harophe also offer complementary medical treatments such as acupuncture. Jerusalem's Hadassah University Hospital has a Natural Medicine Research Unit, which is currently working on Tibetan traditional medicine remedies (Beyer, 1999). No national pharmacopoeia exists in the country; instead the *Homeopathic Pharmacopoeia*,

the *British Pharmacopoeia*, the *French Pharmacopoeia* and the *United States Pharmacopoeia* are considered legally binding. In place of national monographs, the ESCOP monographs, commission E monographs and WHO monographs are used, but these are not considered legally binding. There is currently no registration system, nor are herbal remedies included in the national essential drugs list (WHO 2005).

Medicinal and Aromatic Plant Resources

Medicinal plants grow in abundance in Israel. The plants used in folk medicines are generally collected from wild resources by healers and folk medicine practitioners. About 129 medicinal plant species are still in use in Israel including the Golan Heights and the West Bank. More than 30% of these species have become rare and endangered because of unsustainable harvesting practices. Most of these species grow naturally in the different regions of the country and are used extensively in traditional Arabic medicine. Some medicinal and aromatic plants found in Israel are given in Table 1 (Anonymous, 2003; Azaizeh *et al.*, 2003).

Research and Development Activities

There have been preliminary studies on the use of medicinal plants in indigenous Arabic medicine. Most of the surveys in the past were of the Bedouin communities living in the Negev desert and did not include practitioners from other regions.

During the period 1981-1983 a large scale ethnobotanical survey was conducted by a team of the Volcani Center in collaboration with scientists from Tel Aviv and Haifa Universities (Dafni *et al.*, 1984; Palevitch *et al.*, 1986). A book entitled, Medicinal Plants of the Holy Land was published in Hebrew (1991) and English (2000) based on these surveys. Recently a number of universities and institutes including the Research and Development Regional Centre, the Galilee Society, Shefa Amr (Said *et al.*, 2002), the Bar-Ilan University, Ramat-Gan (Lev and Amar, 2000), the An-Najah National University, the West Bank and Genetic Resources and Seed Research, the Volcani Centre, Bet-Dagan (Ali-Shtayeh *et al.*, 2000), and the University of Haifa (Lev, 2002), in continuation of their earlier studies, carried out various ethnobotanical and ethnopharmacological surveys on medicinal plants in Israel.

In one of the ethnobotanical surveys devoted to diabetes in the late 1980s, a total of 16 species of medicinal plants were identified to be used for hypoglycemic treatments. Some of these plants includ*ed Achillea fragrantissima (Forssk.) Sch.-Bip, Ammi visnaga (L.) Lam, Atriplex halimus* L., *Capparis spinosa* L., *Ceratonia siliqua* L., *Cleome droserifolia* (Forssk.) Del., *Eryngium creticum* Lam., *Inula viscosa* (L.) Ait., M*atricaria aurea* (Loefl.) Sch.-Bip, *Origanum syriacum* L., *Paronychia argentea* Lam, *Prosopis*

farcta (Banks et Sol.) Macbride, *Salvia fruticosa* Mill., *Sarcopoterium spinosum* (L.) Sp., and *Teucrium polium* L. (Yaniv, et al., 1987).

The Section of Aromatic and Medicinal Plants of the Newe Ya'ar Research Centre (belonging to the Agricultural Research Organization) over the last three decades has carried out various projects (Anonymous, 2003). The outcome of these R&D activities has enabled the commercialization of aromatic plants in Israel. Some of the projects (Dudai *et al.*, 1999; Dudai *et al.*, 2002; Zuti *et al.*, 2003) currently being undertaken by the Centre include:

- Introduction, acclimatization and breeding of new aromatic crops
- Development of agro-techniques for profitable cultivation of herbs
- Breeding of sweet basil including resistance to Fusarium wilt disease
- Development of aromatic plants for the ornamental market
- Biological control using herbs, essential oils, oleoresins and isolated components
- Aromatic plants as potential sources of natural antioxidants and chiral compounds
- Functional genomics and biotechnology of genes responsible for the formation of aroma and flavour compounds in spices and other plants

In 2003 the Israeli Association for Medicinal Plant (IAMP) was founded. Its members are leaders in the field of medicinal plants in Israel and are active in research, education, and industrial and clinical herbalism. The IAMP promotes educational activities on the safe and effective use of medicinal plants, organizes conferences and botanical tours. One of its main goals is to promote the control of safety and high quality use of medicinal plants in Israel.

Trade and Marketing

Very little information is available on trade of traditional medicine materials in Israel. Most of the popular medicinal materials sold in the country are of local origin. Almost half of the material in the stores and markets is imported from other countries. Some of the local and imported medicinal plant materials sold in Israel are presented in Table 2 (Lev and Amar, 2000).

In 1999, 24 pharmaceutical companies were registered in Israel. The country used drugs worth US$675 million in the year 2001 of which 60% was spent on imported drugs. The local production of drugs was US$1.25 billion most of which were exported (Blay, 2002). Farmers produced and exported in 2003 fresh herbs worth almost 100 millions US$, dry herbs including sweet paprika worth 40 millions US$, and seeds for culinary use and propagation, herbal tea, pots of herbs and secondary metabolites (es-

sential oils and oleoresins) reached about 15 million US$.

Problems and Constraints

Though there is widespread use of folk and natural remedies they have been used without much scientific interpretation and in a non-commercial way until recently. However, during the last 10 years more practitioners with academic backgrounds are operating and more professional people are involved in the trade of medicinal plants. Steps are being taken for the conservation and cultivation of medicinal plants. There is a need for legislation and rules for appropriate methods of production and use of medicinal plants in Israel.

Table 1: Some important medicinal and aromatic plants of Israel

Botanical Name	Family	Part(s) used	Uses/Indications
Asphodelus microcarpus Viv.	Liliaceae	Root	In eczema, cracked skin, ringworm
Coridothymus capitatus (L.) Rchb. f.	Lamiaceae	Leaf	In cough, cold, constipation, toothache
Lycium europaeum L.	Solanaceae	Root, leaf	In hypertension, diabetes
Melissa officinalis L.	Lamiaceae	Leaf	In depression, nervousness, headache, cough, haemorrhage
Nasturtium officinale R. Br.	Brassicaceae	Leaf	Cleansing of blood, spice for salads
Salvia fruticosa Mill.	Lamiaceae	Leaf	In stomachache, colds, wounds
Sarcopoterium spinosum (L.) Spach	Rosaceae	Root, fruit	In diabetes, stomachache
Vitis vinifera L.	Vitaceae	Leaf	For purifying blood, in skin diseases, hormonal disturbances

Table 2: Some local and imported medicinal and aromatic plant materials sold in Israel

Botanical name	Family	Part(s) used	Uses/Indications
Abrus precatorius L.	Fabaceae	Seed	To prevent conception
Acacia arabica (Lam.) Willd.	Fabaceae	Resin	In voice refining, throat inflammations
Acacia nilotica (L.) Delile	Fabaceae	Fruit	In scabies
Alkanna tinctoria Tausch	Boraginaceae	Root	In digestive problems, joint pains
Allium cepa L.	Alliaceae	Leaf, seed	In cold, for virility enhancement
Aloe vera (L.) Burm. f.	Asphodelaceae	Juice	In skin diseases, wound healing
Brassica campestris L.	Brassicaceae	Seed	In potency, arthritis
Brassica oleracea L.	Brassicaceae	Seed	As general medicine
Capparis spinosa L.	Brassicaceae	Fruit	For pain relief, in rheumatism
Carthamus tinctorius L.	Asteraceae	Seed	As purgative, in liver problems
Cuminum cyminum L.	Apiaceae	Seed	In flatulence
Daucus carota L.	Apiaceae	Seed	As aphrodisiac
Elaeagnus angustifolia L.	Elaeagnaceae	Fruit	In dysentery, diarrhoea

Continued

Table 2 continued

Botanical name	Family	Part(s) used	Uses/Indications
Elettaria cardamomum (L.) Maton	Zingiberaceae	Fruit	In blood sugar, stomach acidity
Embelia ribes Burm. f.	Myrsinaceae	Seed	In headaches
Eucalyptus spp.	Myrtaceae	Bark	For reducing fever
Eugenia caryophyllata Thunb.	Myrtaceae	Flower	As local anesthetic, general remedy
Foeniculum vulgare Mill.	Apiaceae	Fruit	In stomachache, intestinal diseases
Glycyrrhiza glabra L.	Fabaceae	Root	In heartburn, coughs, blood cleansing
Hibiscus esculentus L.	Malvaceae	Seed	As purgative, tranquilizer
Hordeum vulgare L.	Poaceae	Seed	As purgative, in chest and throat treatment
Illicium verum Hook. f.	Illiciaceae	Fruit	As spice
Jasminum spp.	Oleaceae	Oil	As medicinal oil, perfume
Juglans regia L.	Juglandaceae	Seed	As tonic, for hair strengthening, facial skin improvement
Lactuca sativa L.	Asteraceae	Seed	For hair strengthening
Lagenaria vulgaris Ser.	Cucurbitaceae	Seed	As purgative, intestinal worms infestation
Laurus nobilis L.	Lauraceae	Fruit	In arthritis, sugar in blood
Lavandula officinalis Chaix	Lamiaceae	Leaf	In migrains, for preventing miscarriages
Lawsonia inermis L.	Lythraceae	Leaf	In wound healing, haemorrhages
Lepidium sativum L.	Brassicaceae	Seed	In stomachache, for hair strengthening, as aphrodisiac
Lilium candidum L.	Liliaceae	Oil	As antiseptic, anticonvulsant
Linum usitatissimum L.	Linaceae	Oil	In coughs
Liquidambar orientalis Mill.	Hamamelidaceae	Resin	In asthma, skin diseases, as stimulant
Luffa cylindrica M. Roem.	Cucurbitaceae	Seed	As purgative, emetic
Lupinus albus L.	Fabaceae	Seed	For blood sugar reduction
Majorana hortensis Moench	Lamiaceae	Leaf	For pain relief, easing childbirth
Mangifera indica L.	Anacardiaceae	Seed	In medicinal soap
Melissa officinalis L.	Lamiaceae	Branch	As general medicinal tea
Mentha longifolia (L.) Huds.	Lamiaceae	Branch	In flatulence, acidity neutralization
Mentha ×piperita L.	Lamiaceae	Branch	In stomachache
Mentha spicata L.	Lamiaceae	Branch	In flatulence, acidity neutralization
Micromeria fruticosa (L.) Druce	Lamiaceae	Branch	In colds, opening of respiratory canals
Musa ×paradisiaca L.	Musaceae	Fruit	In skin diseases
Myristica fragrans Houtt.	Myristicaceae	Seed	As intoxicant, aphrodisiac
Nardostachys jatamansi (Jones) DC.	Valerianaceae	Oil, Root	As component of various medicines, in heart pain
Nigella sativa L.	Ranunculaceae	Seed	In dizziness, sugar in blood
Ocimum basilicum L.	Lamiaceae	Branch	For clearing halitosis
Ocimum canum Sims	Lamiaceae	Seed	In palpitations, dizziness
Ocimum pilosum Willd.	Lamiaceae	Seed	In heart diseases
Olea europaea L.	Oleaceae	Leaf	As diuretic, in coughs
Orchis spp.	Orchidaceae	Bulb	In sore throat, coughs
Origanum vulgare L.	Lamiaceae	Leaf	In stomachache

Continued

Table 2 continued

Botanical name	Family	Part(s) used	Uses/Indications
Paeonia mascula (L.) Mill.	Paeoniaceae	Root	In nerve diseases
Pandanus odoratissimus auct.	Pandanaceae	Seed	For cough treatment
Paronychia argentea Lam.	Caryophyllaceae	Flower	In urinary tract infections
Peganum harmala L.	Zygophyllaceae	Seed	As tonic, in heart diseases, blood sugar
Pelargonium graveolens L'Hér.	Geraniaceae	Branch	In heartburn, nausea, eye diseases
Petroselinum sativum Hoffm., nom. nud.	Apiaceae	Seed	In kidney stones, impotence
Pimenta officinalis Lindl.	Myrtaceae	Fruit	In stomachache, flatulence
Pinus pinea L.	Pinaceae	Seed	As tonic
Piper cubeba L. f.	Piperaceae	Fruit	In flatulence, as expectorant, diuretic
Piper longum L.	Piperaceae	Fruit	As aphrodisiac, in digestive system
Piper nigrum L.	Piperaceae	Fruit	In colds, fever, pains
Pistacia atlantica Desf.	Anacardiaceae	Fruit	In stomachache
Pistacia lentiscus L.	Anacardiaceae	Resin	In heartburn, stomach soothing.
Pistacia spp.	Anacardiaceae	Resin	As general remedy
Pistacia vera L.	Anacardiaceae	Fruit	As nourishing health food
Plantago afra L.	Plantaginaceae	Seed	As antiseptic, in skin and intestine diseases
Prunus amygdalus Batsch	Rosaceae	Seed	In hair strengthening, wart removal
Prunus mahaleb L.	Rosaceae	Seed	For digestive system
Quassia amara L.	Simaroubaceae	Wood	In blood sugar
Raphanus sativus L.	Brassicaceae	Seed	As warming medication, in coughs, impotence
Rheum officinale Baill.	Polygonaceae	Root	In jaundice, liver pains
Rhus coriaria L.	Anacardiaceae	Fruit	In cholesterol lowering, diarrhoea
Ricinus communis L.	Euphorbiaceae	Oil	In wound healing, as purgative
Rosa spp.	Rosaceae	Flower, oil	As general medicinal tea, flatulence, stomachache
Rosmarinus officinalis L.	Lamiaceae	Branch	In kidney stones, blood sugar
Rubia tinctorum L.	Rubiaceae	Root	As diuretic
Rumex sp.	Polygonaceae	Seed	In mouth sores
Ruscus aculeatus L.	Ruscaceae	Shoot	As diuretic, in prostate
Saccharum officinarum L.	Poaceae	Juice	As tranquilizer, tonic, in respiratory canals
Salvadora persica L.	Salvadoraceae	Branch	In cleaning and disinfecting teeth and gums
Salvia fruticosa Mill.	Lamiaceae	Leaf	In haemorrhages, intestinal diseases and pains
Sambucus nigra L.	Adoxaceae	Flower	In asthma, breathing and chest diseases
Santalum album L.	Santalaceae	Wood	As incense sandalwood
Saponaria officinalis L.	Caryophyllaceae	Root	In diabetes
Securigera securidaca (L.) Degen & Dörfl.	Fabaceae	Seed	For strengthening the womb
Sesamum indicum L.	Pedaliaceae	Seed	In coughs, sore throat
Spinacia oleracea L.	Chenopodiaceae	Seed	As spinach
Strychnos nux-vomica L.	Loganiaceae	Seed	As strong and dangerous poison

Continued

Table 2 continued

Botanical name	Family	Part(s) used	Uses/Indications
Styrax officinalis L.	Styracaceae	Seed	In skin rash, leprosy
Tamarindus indica L.	Fabaceae	Fruit, juice	In cleansing blood and as stimulating
Terminalia citrina (Gaertn.) Roxb. ex Fleming	Combretaceae	Seed	In stomachache, intestinal diseases
Thea sinensis L.	Theaceae	Leaf	In diarrhoea, stomachache and backache, for digestion
Trigonella foenum-graecum L.	Fabaceae	Seed	For sugar reduction, as diuretic
Triticum sp.	Poaceae	Seed	In arthritis, urinary tract infection
Urtica urens L.	Urticaceae	Leaf	In fever, blood cleansing
Vanilla planifolia Jacks.	Orchidaceae	Fruit	As flavouring
Vicia faba L.	Fabaceae	Seed	In skin diseases, eyes, pains
Viola odorata L.	Violaceae	Oil	In relieving backache
Vitex agnus-castus L.	Lamiaceae	Seed	In headache, stomachache, joint pains
Zingiber officinale Roscoe	Zingiberaceae	Root	In flatulence, as digestive, in impotence
Ziziphus spina-christi (L.) Desf.	Rhamnaceae	Fruit	In colds, for weight reduction
Ziziphus jujuba (L.) Gaertn., nom. illeg.	Rhamnaceae	Fruit	For intestinal worms, blood cleansing

Table 3: Leading medicinal and aromatic plants of Israel

Botanical name	Chemical constituents	Uses/Indications	Part(s) used	Comments
Artemisia dracunculus L.	Essential oil	Antiscorbutic, emmenagogue, febrifuge, hypnotic, stomachic, diuretic, vermifuge	Aerial parts, roots	Export of 400 tonnes/year (US$6 million)
Allium schoenoprasum L.	Volatile compounds	Appetizer, tonic, hypotensive, digestive	Flowers, leaves, root	Export of 1350 tonnes/year (US$2.5 million)
Coriandrum sativum L.	Essential oils	Spice	Fruits, leaves and root	Export of 450 tonnes/year (US$2 million)
Mentha longifolia (L.) Huds & M. piperita L.	Essential oil	Flatulence, acidity neutralization, stomachache	Leaves	Export value (tonnes/year) 700 of fresh herb (US$8 million) and 50 (US$2 million) of dry leaves
Ocimum basilicum L.	Volatile compounds	Clearing halitosis	Leaves, frequentlyall aerial parts	Export value (tonnes/year) 2,500 (US$20 millions) fresh herb and 400 (US$5millions) dry leaves
Origanum vulgare L.	Essential oil	Flavouring	Leaves	Export (tonnes/year) 400 (US$6 millions) fresh and 600 (US$2 millions) dry herbs. Approximately 70% production from 51 hectares under open field cultivations
Thymus vulgaris L.	Essential oil	Spice	Leaves	Export value (tonnes/year) 400 (US$5 millions) fresh and 50 (US$0.7 millions) dry herbs

Photographs of some leading medicinal and aromatic plants of Israel

Ocimum basilicum L. & *Mentha piperita* L. under field cultivations

Allium schoenoprasum L. under green house cultivation

Oregano & *Thyme* varieties in field

5.10 Jordan

The Kingdom of Jordan, located in the Middle East, is bounded by Syria to the north, Iraq and Saudi Arabia to the east, Saudi Arabia and the Gulf of Aqaba to the south and to the west by Israel and the West Bank. The area of Jordan is 92,300 square kilometres and the population is about 5.5 million. Jordan is very lightly forested with only about 2% forests and other wood land cover. The forests mainly occur in the northern and southern highlands. Jordan has been distinguished throughout history by a rich inventory of natural medicine substances mainly because of its unique location, climate and the diverse topo-

graphic structure that promoted the richness of the medicinal and aromatic plants.

Traditional Medicine Systems

Traditional medicine is deeply rooted in the history and culture of the country. Folk or traditional medicine provides primary health care and is widely practised by the inhabitants of the remote areas and the nomads who generally inhabit the desert and some areas of the steppe and the uplands. Over the last decade, the interest in traditional medicine including Chinese traditional medicine, acupuncture, phytotherapy, homeopathy and chiropractic has been increasing in Jordan. In the cities traditional medicine is provided by traditional medicine practitioners, allopathic doctors, other health professionals and the herbalists who dispense locally grown as well as imported medicinal herbs (WHO, 2001). Herbal medicines are regulated as prescription medicines, OTC medicines and for self medication. In place of a national pharmacopoeia, the *United States Pharmacopoeia* is used. The herbal medicine registry contains 35 herbal medicines (WHO, 2005).

Government Efforts in Development of Traditional Medicine

Traditional medicines are not integrated into the national health care system however; some traditional and complementary/alternative medicine doctors and health professionals have been approved to practise in primary health care. There are no national policies recognizing traditional medicine. A chiropractic law is pending but there was only one chiropractor practising in Jordan by the end of the year 2000 (WHO, 2001). Herbal regulations in Jordan were developed in 2001, and are partly the same as those for conventional pharmaceuticals.

Medicinal and Aromatic Plant Resources

Despite being a small country Jordan is well known for the great variation in its wild plant species due to its diverse geographical and climatic conditions. Medicinal plants are found all over the country. Jordan is known to have approximately 2,000 plant species belonging to about 700 genera. Among these, 485 species belonging to 330 genera and 99 families are categorized as medicinal plants (Afifi and Abu-Irmaileh, 2000). Some important medicinal and aromatic plants found in Jordan are presented in Table 1 (Syouf and Duwayri, 1995). The plants are widely used by Bedouins or local people in folk medicines in various forms such as drinks and fresh or dry raw materials. A number of culinary and medicinal plants are also cultivated in gardens and farms for home consumption and marketing (Sabra and Walter, 2000). However, these plants are under threat of extinction due to their increased exploitation for domestic and commercial use, marketing, grazing, housing and industrial activities.

Research and Development Activities

The Jordan University of Science and Technology, Irbid has carried out some studies on the country's medicinal plants. The Department of Veterinary Basic Sciences of the Faculty of Veterinary Medicine and the Department of Medicinal Chemistry and Pharmacognosy of the Faculty of Pharmacy of the University have studied the antinociceptive and antiinflammatory effects of 11 Jordanian plants used in traditional medicine (Atta and Alkofahi, 1998). These two departments have also evaluated the antiulcer activity of 18 medicinal plants found in the country (Alkofahi and Atta, 1999). The Department of Applied Biology of the Faculty of Science and the Department of Medicinal Chemistry and Pharmacognosy of the Faculty of Pharmacy of the University also have evaluated the antibacterial activity of 15 plant species used in the traditional medicine in Jordan and other Middle East countries (Nimri, *et al.*, 1999). The Departments of Biological Sciences of the University of Jordan and Amman and the Yarmouk University have studied the antimicrobial activity of nine plant species collected from the Ajloun and Jubaha regions (Mahasneh and El-Oqlah, 1999).

The University of Jordan carried out a survey on herbal medicines used in the country and medicinal herbs that are not well documented regarding their safety and proper use. The study emphasized the need for proper inspection and licensing of herbalists especially in dealing with less common and imported medicinal herbs (Afifi and Abu-Irmaileh, 2000). Bar-Ilam University, Israel also carried out an ethnobotanical survey of the traditional medicinal materials in the Kingdom of Jordan. The survey conducted in the period 1998-1999, covered selected markets of medicinals in the important cities and villages of Jordan including Amman, Salt, Zarqa and Madaba (Lev and Amar, 2000).

Trade and Marketing

Herbal medicines are sold on the local markets through stores located in various cities and towns. The central markets of big cities such as Amman and Zarqa have various herbal stores which besides importing herbal medicines also supply material to small town markets such as those in Salt, Madaba and Kark. The vast majority of plants sold as popular remedies in herbal stores are cultivated with a minority from the wild. This is mainly because wild plants are collected privately and used on a non-commercial basis by patients and traditional healers. Almost half of the traditional medicine substances sold in the stores and markets of the Kingdom are imported. These substances are imported mainly from countries across Asia, Africa and the Arabian Peninsula including Egypt, India, Iran, Iraq, Saudi Arabia and Syria. Some of the imported and locally available medicinal and aromatic plant materials sold on the markets of Jordan are listed in Table 2 (Lev and Amar, 2000).

Problems and Constraints

The country needs proper training, government support and policies, conservation strategies, marketing, scientific evaluation and research on traditional remedies and medicinal plants for their commercial development and exploitation.

Table 1: Some important medicinal and aromatic plants of Jordan

Botanical name	Family	Uses/Indications
Acanthus syriacus Boiss.	Acanthaceae	As emollient
Anthemis cotula L.	Asteraceae	As stimulant, tonic, in colds, epilepsy, dropsy, asthma, rheumatism
Artemisia herba-alba Asso Branch	Asteraceae	In cold, cough, fever, toothache, asthma, sore throat
Calotropis procera (Aiton) W. T. Aiton	Apocynaceae	In skin diseases, stomach ailments, cough, as vermifuge
Capparis spinosa L. root	Brassicaceae	In flatulence, as anti-rheumatic, culinary, in arthritis
Cardaria draba (L.) Desv.	Brassicaceae	As antiseptic, for topical wash
Citrullus colocynthis (L.) Schrad. Fruit	Cucurbitaceae	As purgative, in diabetes
Cyclamen persicum Mill.	Primulaceae	As tonic, in spasm
Euphorbia prostrata Aiton	Euphorbiaceae	In jaundice, as antiseptic, in dermal infections
Ixiolirion tataricum (Pall.) Herb.	Ixioliriaceae	In skin diseases
Laurus nobilis L.	Lauraceae	In arthiritis, blood sugar
Lavandula spp.	Lamiaceae	In migrains, slimming, paralysis
Matricaria aurea (Loefl.) Schultz Bip.	Asteraceae	In stomach and abdominal pains, respiratory problems
Mentha ×piperita L.	Lamiaceae	In stomachache, backache
Mentha spicata L.	Lamiaceae	In flatulence, arthritis, blood sugar
Narcissus tazetta L.	Amaryllidaceae	In burns, to avoid suppuration
Olea europaea L.	Oleaceae	As diuretic, in coughs, skin diseases
Ononis spinosa L.	Fabaceae	As diuretic, expectorant, antiseptic
Pistacia atlantica Desf.	Anacardiaceae	As antidiabetic, in constipation, stomachache
Portulaca oleracea L.	Portulacaceae	Cleans blood, as aphrodisiac
Quercus spp.	Fagaceae	In diarrhoea, ulcer, wounds
Rhus coriaria L.	Anacardiaceae	As astringent, anti-inflammatory, antiseptic, burns, ulcers, diarrhoea, cholesterol lowering
Rosmarinus officinalis L.	Lamiaceae	In kidney stones, blood sugar, as tonic
Rubia tinctoria L.	Rubiaceae	As anti-inflammatory, in burns
Salvia fruticosa Mill.	Lamiaceae	In intestinal diseases, pains
Salvia syriaca L.	Lamiaceae	As tonic, in spasm, gonorrhoea
Sesamum indicum L.	Pedaliaceae	In coughs, sore throat
Stellaria media (L.) Vill.	Caryophyllaceae	In skin inflammation, conjunctivitis
Teucrium polium *L.*	Lamiaceae	As antidiabetic
Thymus spp.	Lamiaceae	As antiseptic, expectorant, antispasmodic, diuretic, astringent, perfumery

Table 2: Some common medicinal plant materials sold in Jordan

Botanical name	Family	Part(s) used	Origin	Uses/Indications
Abrus precatorius L.	Fabaceae	Seed	Imported	
Acacia arabica (Lam.) Willd.	Fabaceae	Resin	Imported	For voice refining, throat inflammations
Achillea millefolium L.	Asteraceae	Leaf	Imported	In leg pains, medicinal tea
Allium cepa L.	Alliaceae	Leaf, seed	Local	In cold, blood sugar, high cholesterol
Aloe vera (L.) Burm. f.	Asphodelaceae	Juice	Imported	In skin diseases wound, as purgative
Amaranthus blitum L.	Amaranthaceae	Seed	Local/ Imported	In fever, diarrhoea, dysentery
Artemisia herba-alba Asso	Asteraceae	Branch	Local	In cold, cough, toothache, asthma, sore throat, fever
Beta vulgaris L.	Chenopodiaceae	Seed	Local	As general tonic
Brassica oleracea L.	Brassicaceae	Seed	Local	As general medicine
Capparis spinosa L.	Brassicaceae	Root	Local	In flatulence, arthritis, culinary, as anti-rheumatic
Carum carvi L.	Apiaceae	Fruit	Local	As uterus constrictor, in flatulence
Cinnamomum camphora (L.) J. Presl	Lauraceae	Wax	Imported	As incense, in skin diseases
Citrullus colocynthis (L.) Schrad.	Cucurbitaceae	Fruit	Local	In stomach and joint pains, diabetes
Citrullus vulgaris Schrad.	Cucurbitaceae	Seed	Local	As diuretic, in blood pressure
Citrus limon (L.) Burm. f.	Rutaceae	Fruit	Local/ Imported	In blood sugar
Cocos nucifera L.	Arecaceae	Fruit	Imported	As aphrodisiac, in skin diseases
Coffea arabica L.	Rubiaceae	Seed peel	Imported	In arteriosclerosis, sugar
Cordia myxa L.	Boraginaceae	Fruit	Local/ Imported	As sedative, in coughs, infections
Curcuma longa L.	Zingiberaceae	Root	Imported	To disinfects sores
Daucus carota L.	Apiaceae	Seed	Local	As aphrodisiac
Eucalyptus spp.	Myrtaceae	Bark, seed, oil	Imported	In fever, respiratory problems
Glycyrrhiza glabra L.	Fabaceae	Root, juice	Local/ Imported	In heartburn, as expectorant, in coughs, blood cleansing
Illicium verum Hook. f.	Illiciaceae	Fruit	Imported	As health spice
Inula viscosa (L.) Aiton	Asteraceae	Leaf	Local	In colds, joint diseases
Jasminum spp.	Oleaceae	Oil	Local	As perfume, medicinal oil
Juniperus spp.	Cupressaceae	Leaf	Imported	As diuretic, anti-inflammatory
Lagenaria vulgaris Ser.	Cucurbitaceae	Seed	Local	As purgative, for intestinal worm infestation
Laurus nobilis L.	Lauraceae	Fruit	Local	In arthritis, sugar
Lavandula officinalis Chaix	Lamiaceae	Leaf, oil	Local/ Imported	In migrains, slimming, partial paralysis
Malva spp.	Malvaceae	Seed	Imported	For intestinal worms, urinary stones
Mentha ×piperita L.	Lamiaceae	Branch, oil	Local	In stomachache, backache, toothache
Mentha spicata L.	Lamiaceae	Branch, seed, oil	Local	In arthritis, sugar, flatulence
Myristica fragrans Houtt.	Myristicaceae	Seed, seed peel	Imported	As aphrodisiac, painkiller

Continued

Table 2 continued

Botanical name	Family	Part(s) used	Origin	Uses/Indications
Nigella sativa L.	Ranunculaceae	Seed	Local/ Imported	In dizziness, sugar, lung diseases, arthritis
Olea europaea L.	Oleaceae	Leaf	Local	As diuretic, in coughs, skin diseases
Phaseolus vulgaris L.	Fabaceae	Seed	Local	As digestive aid
Pimpinella anisum L.	Apiaceae	Seed	Local/ Imported	In stomachache, as aphrodisiac
Piper cubeba L. f.	Piperaceae	Fruit	Imported	In flatulence, as diuretic
Piper longum L.	Piperaceae	Fruit	Imported	As aphrodisiac, digestive
Piper nigrum L.	Piperaceae	Fruit	Imported	In cough, colds, fever, pain
Pistacia atlantica Desf.	Anacardiaceae	Fruit	Local	In stomachache
Portulaca oleracea L.	Portulacaceae	Seed	Local	Cleans blood, as aphrodisiac
Quercus spp.	Fagaceae	Bark, acorn	Local/ Imported	In diarrhoea, ulcer, wounds
Rosa spp.	Rosaceae	Oil, water, flower	Local/ Imported	In flatulence, stomachache, as perfume
Rosmarinus officinalis L.	Lamiaceae	Branch, oil	Local/ Imported	In kidney stones, sugar, as tonic
Salvia fruticosa Mill.	Lamiaceae	Leaf	Local	In intestinal diseases, pains.
Sesamum indicum L.	Pedaliaceae	Seed	Local	In coughs, sore throat
Styrax officinalis L.	Styracaceae	Seed	Local	In skin rash, leprosy
Triticum spp.	Poaceae	Seed	Local	In arthritis, urinary tract infection
Vicia faba L.	Fabaceae	Seed	Local	In skin diseases, eye pains
Zingiber officinale Roscoe	Zingiberaceae	Root	Imported	In flatulence, as digestive, in impotence
Ziziphus jujuba (L.) Gaertn., nom. illeg.	Rhamnaceae	Fruit	Local	For intestinal worms

5.11 Kuwait

The State of Kuwait is located at the north western tip of the Persian Gulf. It is bordered to the north and west by Iraq, to the south and west by Saudi Arabia and to the east by the Persian Gulf. Kuwait has a total area of 17,820 square kilometres and a population of about 2.1 million. Most of Kuwait is semi-desert with forest cover of less than 1% of the total area. The natural vegetation consists mainly of low bushes and sparse shrubs. The country has no natural forests but has established around 5,000 hectares of plantations. Medicines derived from the plants are commonly used by the people. The government has issued various regulations regarding safety, efficacy and registration of herbal medicines.

Traditional Medicine Systems

Kuwaitis did not use modern medicine until the early 20th century. In 1904 the British appointed a physician to popularize modern medicine in Kuwait. Before this time

the people of Kuwait relied on traditional medicine provided by traditional practitioners. The present laws in Kuwait prohibit traditional medicine providers from practising medicine. However, herbal medicines are not banned and are commonly used by the people. Islamic medicine incorporates modern medicine but also considers other useful treatment therapies (WHO, 2001). Kuwait began regulation of herbal medicine in 1989 with the introduction of a separate law on herbal medicines which are now regulated as over the counter medicine, self medication, dietary supplements, health foods and functional foods. In place of a national pharmacopoeia, the *European Pharmacopoeia*, the *British Pharmacopoeia*, the *United States Pharmacopoeia* and *International Pharmacopoeia* are used and legally binding. Nearly thirty herbal medicines have been registered (WHO, 2005).

Government Efforts in Development of Traditional Medicine

The health care system and health conditions in Kuwait improved dramatically after oil export brought revenue to the country. The use of medicinal plants in the official health sector began in 1978. A document and guidelines on the registration of all drugs with regard to safety, efficacy, consistency and quality assurance to be observed when registering herbal medicines, were issued. The document categorizes medicinal plants into three main groups:

- Plants used on a daily basis
- Plants subjected to scientific studies and registered in pharmacopoeias and
- New plants that need to be studied.

There are specific registration requirements for the plants in each category, intended to encourage people to use medicinal plants and to protect them from toxic elements in plants about which there are no published studies. Following the document and guidelines the Ministry of Health issued a resolution for the handling and registration of herbal medicines. A ministerial decree, based on WHO recommendations, established the Centre for Islamic Medicine in 1987 to undertake registration of herbal medicines and to introduce the use of medicinal plants in the treatment of some diseases. The Centre deals with therapeutic services and registration of imported herbal medicines; pharmaceutical studies and evaluation of herbal preparations and products; suitability analyses of medicinal plants for human consumption; importation of plants necessary for the preparation of drugs; and studies on plants, preparations and products to identify the stability, efficacy and safety of the active substances.

In 1986, together with the Islamic Organization for Medical Sciences (IOMS), the World Health Organization Eastern Mediterranean Regional Office in Kuwait worked to establish regional standards for herbal medicines. The registration policy was reviewed and

endorsed by the World Health Organization Eastern Mediterranean Region Member States. This policy which was also endorsed by the Council of Arab Ministers of Health and the Council of Health Ministers of the Gulf has become a reference and basis for the registration of herbal medicines throughout the region (WHO, 2001). The Faculty of Pharmacy, established at Kuwait Universityion February 1996, offers a five–year programme leading to a bachelor's degree in pharmacy. The first batch of 32 students graduated in June 2002.

Medicinal and Aromatic Plant Resources

The native vegetation of Kuwait includes perennial woody shrubs, spring ephemerals and herbs that vary seasonally depending on winter rainfall. Four ecosystems have been characterized and differentiated according to habitat factors: sand dunes, salt marshes, desert plain and desert plateau. Three hundred and seventy four species belonging to 55 families have been reported in Kuwait (Anonymous, 1995). In the sand dune ecosystem plants such as *Artemisia scoparia* Waldst. & Kit., *Emex spinosa* L., *Haloxylon salicornicum* (Moq.) Bunge ex Boiss., *Seidlitzia rosmarinus* (Ehrenb.) Bioss. and *Zygophyllum coccineum* L. are found, which are used by the Bedouins for their medicinal properties (Anonymous, 1994). Astragalus spinosus (Forsskal) Muschler has been used for the treatment of renal colic and bronchial asthma and *Aloe vera* (L.) Burm. f., *Commiphora myrrha* (Nees) Engl. and *Nigella sativa* L. have traditionally been used in remedies for diabetes in Kuwait (Al-Awadi and Gumaa, 1987).

Research and Development Activities

A book entitled *Medicinal Plants of Kuwait* published in Arabic by the Kuwait Foundation for the Advancement of Sciences. In July 1984 the Islamic Organization for Medical Sciences (IOMS) was established to carry out research work, find practical applications and medical treatment using herbal drugs. The Organization has introduced herbal treatments for several diseases and carried out studies on the medicinal effects of several plants and herbs, and has released a book containing requirements for registering and controlling herbal pharmaceutical preparations (Anonymous, 2003).

The IOMS plans to work with WHO to prepare a manual on the use of medicinal plants. A non-profit organization, the Centre for Research on Herbal Medicine, has been established by IOMS, which also provides treatment with herbal medicines (WHO, 2002).

Trade and Marketing

The herb and spice market in Kuwait is worth US$8,570,000. The combined import values for herbs and spices for the period 1998 to 2000 are presented in Table 1. According to FAO statistics the combined import value of herbs and spices for the

year 1998 was US$7,631,935 compared to an export value of US$151,000 in the same year. According to the Kuwait Planning Ministry the total spice imports value in 1998 amounted to US$5,887,162. India is the number one supplier of spices to Kuwait (about 50%) followed by Pakistan and Iran. The export value of herbs and spices from Kuwait was US$12,066 in the year 1998 (Jones, 2000). The production of various spices increased from 230 to 250 million tonnes in the period 1998 to 2000. However, no data is available specifically for the import or export of medicinal plants.

Problems and Constraints

The medicinal and aromatic plant resources of the country have suffered from overgrazing, over exploitation for fuel, urbanization, mining and the Gulf war. Effective conservation strategies for management of native plant species can play an important role in the utilization of the country's medicinal plant resources.

Table 1: Kuwait's combined import values for herbs and spices in 1998

Importing country	Quantity (kg)	Value (US$)
India	1,514,773	2,800,894
Iran	230,829	504,251
Pakistan	287,139	558,974
Saudi Arabia	700	1,581
Sri Lanka	33,060	172,399
Syria	107,871	170,861
Thailand	134,000	63,465

5.12 Lebanon

The Lebanese Republic is located at the eastern end of the Mediterranean Sea. It is bounded by Syria to the north and east and by Israel to the south. The population of Lebanon is estimated to be around 3.6 million, about 80% of which live in urban areas. It has a total area of 10,452 square kilometres and is dominated mainly by mountainous terrain. The country is lightly forested with only 5% forest cover and an additional 7% of other wood lands. These forests provide valuable resources of medicinal and aromatic plants. Lebanon was devastated by civil war from 1975 to 1990; however, there has been a consistent and elaborate effort to rebuild the country. The government has realized the importance of linking the environment to the overall development process. Initiatives have been launched for saving, promoting, protecting and proper management of natural resources.

Traditional Medicine Systems

The national health care system is based on allopathic medicine and the government promotes modern health care facilities for its population. Folk or traditional medicine is used generally by elderly people in rural areas.

Government Efforts in Development of Traditional Medicine

Before the civil war, Lebanon's health care system and medical institutions were seen as a health care centre for the Middle East region. The Ministry of Public Health is working in collaboration with various non-government organizations and international agencies (WHO, UNICEF), hospitals and practitioners for the improvement of the national health care system. A National Health Strategy Plan was adopted by the Ministry of Health in 1998. Health education has been included in the school curriculum. Another important activity includes the training and development of health manpower for placement of personnel throughout the country (Tabarra, 2001). There is no information regarding government efforts to develop traditional medicine.

Medicinal and Aromatic Plant Resources

There are 236 species of wild and cultivated medicinal plants in Lebanon of which about 16 species are localized in specific regions and 29 are endangered. *Ferula hermonis* Boiss. (Zallouh root), which grows on Mount Kekmel is over exploited in the preparaton of remedies for improving sexual potential and overall health conditions, threaten its existence (Sabra and Walter, 2000). *Salvia libanotica* Boiss. et Gaill is extensively used as a popular medicine in the country. The plant is found in Wadi Shnanhir, Jabal Turbul, Sidon to Nabatiyyah, Baabda, Naqoura, Abey, Choueifat, Wadi Chahrour, Khalde', Beirut, Antelias, Broumana, Harissa, Antoura, Ras Chekka, Nahr Ibrahim and Jbail regions of the country (Gali-Muhtasib *et al.*, 2000).

Aromatic plants are used in the daily diet of most Lebanese people, especially *Origanum* spp., which is mixed with the grinded sumac flower, sesame seeds and olive oil. Laurus nobilis L. leaves are used in several recipes; it was used in the past to perfume laundry. Several herbal teas and recipes are used against various diseases. The juice of wild cucumber (*Ecballium elaterium* (L.) A. Rich.) is used for curing hepatitis. Some medicinal and aromatic plant species found in Lebanon are given in Table 1 (Sabra and Walter, 2000).

Research and Development Activities

In the early 1990s the Lebanese government through the Ministry of Agriculture established a project to find substitutes to the hashish plantation in the Bekaa Valley.

Several medicinal and aromatic plants were included as possible substitutes. The Lebanese Agricultural Research Institute (LARI) studied and established the antimicrobial effects of *Salvia libanotica* Boiss. et Gaill.. Department of Biology, American University of Beirut, Lebanon has also carried out research on Salvia libanotica Boiss. et Gaill. with special reference to the traditional uses of the plant and therapeutic value of the individual components present in the essential oil extract of the plant (Gali-Muhtasib, et al., 2000). Another study was focused on the evaluation of seasonal changes in the composition of the essential oil and its toxicity (Farhat, et al., 2001). The Departments of Plant Protection and Plant Breeding and Improvement of LARI are working on biological control of fire blight disease on pome fruits in Lebanon through the use of essential oils and the collection of wild medicinal plants in collaboration with Kew Royal Botanic Gardens, Britain respectively.

As part of its policy to protect natural resources, the Lebanese government issued decisions to protect medicinal and aromatic plants and to control their exploitation. Following decision 1/38, issued in April 1982, which prohibited the export of all forest products, the Ministry issued a decree prohibiting the uprooting and exploitation of commercially important plants of the country. Decree 1/29 issued in February 1996, restricts the export of medicinal and aromatic plants such as *Salvia fruticosa* Mill., *Myrtus communis* L. and *Origanum* spp., whereas decision 1/340 of August 1996 aims at organizing the exploitation of wild sage (*Salvia fruticosa* Mill) and the local *Origanum* spp. Picking of *Origanum* spp. is only permitted between August and December while exporting dried material is permitted all year round. Sage can also be picked and exported during the same time with a prior permit from the Rural Development and Natural Resources Directorate; otherwise uprooting of any of these plants is completely forbidden (Sabra and Walter, 2000).

Trade and Marketing

Most medicines in Lebanon are imported, accounting for more than 90% of the market. The value of imported medicines amounted to approximately US$280 million in 2000. The contribution of the six domestic pharmaceutical manufacturers is only about 6 to 7% of the market that is estimated to be worth US$255 million (Voelker, 2002).

Based on 1994 figures, the estimated market value of medicinal and aromatic plants collected from forests was US$18.6 million. Some plant extracts are sold as herbal teas in pharmacies but no exact figures regarding the trade in traditional medicine in the country are available (Sabra and Walter, 2000).

Problems and Constraints

Lack of proper agricultural techniques, wide spread deforestation activities, exces-

sive use of chemical products, over grazing, over hunting, urban and industrial development have threatened most of the natural resources of the country. The lost markets, flood of imports, lack of quality assurance and government efforts are the major factors responsible for under development of the local pharmaceutical industry and medicinal and aromatic plant resources.

Table 1: Some medicinal and aromatic plants found in Lebanon and their uses

Botanical name	Family	Uses/Indications
Ailanthus altissima (Mill.) Swingle	Simaroubaceae	In intestinal tapeworms, dysentery, stomach problems
Anethum graveolens L.	Apiaceae	As flavouring agent
Artemisia arborescens L.	Asteraceae	As anti-inflammatory, anticatarrh, choleretic, antihistamine, mucolytic
Ceratonia siliqua L.	Fabaceae	In diarrhoea
Clematis vitalba L.	Ranunculaceae	In varicose ulcers
Cupressus sempervirens L.	Cupressaceae	In blood circulation disorders
Ecballium elaterium (L.) A. Rich.	Cucurbitaceae	As purgative, diuretic, in rheumatism
Fraxinus ornus L.	Oleaceae	As diuretic
Juglans regia L.	Juglandaceae	Astringent, eupeptic, hypoglycemic, antiseptic, keratinizing
Laurus nobilis L.	Lauraceae	Stimulant
Melia azedarach L.	Meliaceae	As antihelminthic, in skin diseases
Myrtus communis L.	Myrtaceae	As antiseptic, in respiratory infections
Nigella sativa L.	Ranunculaceae	As stimulant, carminative, aromatic, tonic, purgative
Plantago psyllium L., nom. ambig.	Plantaginaceae	As laxative
Punica granatum L.	Lythraceae	In indigestion, loss of appetite
Quercus infectoria Olivier	Fagaceae	As astringent
Rhamnus cathartica L.	Rhamnaceae	As laxative, purgative
Rhus coriaria L.	Anacardiaceae	As diuretic, in fever, stomach upsets, ulcers
Rosa canina L.	Rosaceae	As astringent, carminative, diuretic, tonic
Salvia libanotica Boiss. et Gaill	Lamiaceae	In cold, cough, stomachache
Trigonella foenum-graecum L.	Fabaceae	As appetizer, general tonic, in pulmonary disorders
Tussilago farfara L.	Asteraceae	In cough, respiratory problems, diarrhoea
Ulmus minor Mill.	Ulmaceae	As tonic, astringent

5.13 Oman

The Sultanate of Oman is located in the South Eastern tip of the Arabian Peninsula. Its land borders with Saudi Arabia and the United Arab Emirates to the west and the Republic of Yemen to the south. The eastern side of the Sultanate borders with the Gulf of Oman and the Indian Ocean. It has a population of about 2.8 million and a total

area of about 212,460 square kilometres. The country's terrain mainly comprises a central desert plain occupying 82% of the land area bordered by the Hajar mountain range to the north and the Dhofar Mountains to the south. Dhofar has significant areas of low woodlands and grasslands around a narrow coastal plain. There are very few forests in the country. The date palm (*Phoenix dactylifera* L.) is the most important tree with almost 10 million growing along the northern Batinah coastal strip.

Traditional Medicine Systems

Traditional medicine still plays an important role in health care despite the rapid development and free modern medical services provided by the government. Traditional forms of medicine are used alongside modern health care throughout the Sultanate. They are considered to be complementary and are sometimes integrated with modern medicine. Healers are local people who practise traditional medicine as a service to their communities. Almost every village, town and city has healers who have learned the art from other family members. The traditional knowledge of healing has been handed down from generation to generation. There is no fee structure or mandatory payment and the services of healers are available to everyone. The majority of inhabitants of villages and towns try traditional remedies before consulting a doctor. Traditional medicine includes herbal, faith healing and midwifery practices. Herbal medicine involves ointments and fusion of herbs with water and food. Incisions, cupping, branding and cauterization are also used for various ailments (Groves, 2003).

Government Efforts in Development of Traditional Medicine

In 1988, the Traditional Medicine Clinic was established by Sultan Qaboos in order to conserve Omani national heritage in the field of traditional medicine and to provide free medical treatment to its people. The Clinic employs six traditional healers from different provinces of the Sultanate and treats about 25 to 35 patients daily with traditional remedies. Each traditional healer working in the Clinic specializes in a specific medical field and practises exclusively or primarily in that field. The products and services of the Clinic are provided to patients free of charge and for non-commercial purposes (Anonymous, 2003).

The Ministry of Health (MOH) provides up to 80% of health care in the country. One of the objectives of the National Drug Policy, 2000 was to ensure the safety and efficacy of traditional medicine of Oman and the imported traditional remedies. The policy put more emphasis on investigation of traditional medicine for efficacy, safety and quality; registration of imported traditional medicine; and implementation and enforcement of rules and regulations for traditional medicine stores and pharmacies. A registration system for herbal medicines has been established in Oman, but at present no figures are

available on the number of registered herbal medicines (WHO, 2005).

There is no training programme for pharmacists in the country. An Assistant Pharmacy Institute started a graduation programme for Omani assistant pharmacists in 1991. Thirty assistant pharmacists graduated annually until 2000; since then the number has increased to fifty. In addition, four of the best graduates are chosen annually to study a masters in pharmacy degree programme at the Liverpool John Moores University School of Pharmacy and University of Strathclyde School of Pharmacy, Glasgow (Anonymous, 2000).

Medicinal and Aromatic Plant Resources

Oman has a wide variety of food, fodder and medicinal plants with about 1,021 flora species of which 74 are endemic (Al-Lawati, 2003). The southern and northern mountains of Oman are floristically the most diverse areas. The highest number of species is found in Dhofar, which is also a traditional home for frankincense (*Boswellia sacra* Flueck.), myrrh trees (*Commiphora myrrha* (Nees) Engl.) and various other medicinal and aromatic plants used in Omani traditional medicine. This region is the world's leading source of frankincense, which yields the resin, known locally as luban yielding volatile oils used in perfumery. It is harvested on a small scale for domestic use in the country. Some of the important medicinal and aromatic plants of Oman are listed in Table 1 (Sabra and Walter, 2000).

Research and Development Activities

The country has no specific institutions for carrying out research on medicinal plants. Sultan Qaboos University in the past has published a report on the composition of mercurials found in traditional medicine used in the country (Hardy *et al.*, 1995). The University has also published some studies on a traditional method of healing known as *wasm* in Oman (Ghazanfar, 1995). The Department of Biology at the university has carried out work on the status of flora and plants conservation in the Sultanate of Oman. No areas have been designated primarily for the protection of flora or conservation of plant diversity (Ghazanfar, 1998). No detailed information is available on research and development activities in traditional medicine and medicinal and aromatic plants in the country.

Trade and Marketing

A number of traditional medicines are imported from the Asian subcontinent and made available on the market. The extent of use of traditional medicine indigenous to Oman is not known. Most of the traditional medicine material is procured from East Africa, India, Iran, Pakistan and the United Arab Emirates.

The pharmacy laws enacted in 1973 control the import, distribution and sale of

drugs in the country. In 1987, drug registration started focusing on drug products circulating on the unregulated private market followed by registration of pharmaceutical companies and their products, used by both the government and private sectors. The initial collection of information revealed that 532 manufacturers market their products (8,942) in the country. By June 2000, only 324 companies had been registered and 3,579 out of 4,725 product submissions registered (Anonymous, 2000).

Oman's first drug company, National Pharmaceutical Industries, started commercial production in May 2001. The second pharmaceutical firm, Oman Pharmaceutical Products has started trial production and is in the process of registering its products with the MoH. In January 2004 the firm started commercial production.

Problems and Constraints

The loss of habitat through increased livestock holdings, lack of regeneration, spread of invasive species, and land requirements for housing, industry, roads and cultivation pose increasing threats to plant diversity in Oman. Collaborative training, monitoring of standards of hygiene and quality, research and scientific evaluation of traditional remedies, conservation measures for medicinal plants and development of proper marketing channels will lead to efficient development of the country's medicinal and aromatic plant resources.

Table 1: Some medicinal and aromatic plant species found in Oman

Botanical name	Family	Uses/Indications
Aloe barbadensis Mill.	Asphodelaceae	In eye ointment
Andrachne aspera Spreng.	Euphorbiaceae	For external applications
Boswellia sacra Flueck.	Burseraceae	For essential oils, perfumes
Carthamus tinctorius L.	Asteraceae	In cosmetics
Cassia sophera L.	Fabaceae	In stomachache
Commiphora myrrha (Nees) Engl.	Burseraceae	As antiseptic, in sore throats, skin problems
Ecbolium viride (Forsskal) Alston	Acanthaceae	As tooth cleaners
Ephedra intermedia Schrenk & C. A. Mey.	Ephedraceae	In ointment for sores
Olea africana Mill.	Oleaceae	In livestock wounds and sores
Porophyllum scoparium A. Gray	Asteraceae	As tonic, in rheumatism

5.14 Palestine

The Palestinian territories of the West Bank and Gaza also known as Northern and Southern Palestinian Districts respectively are situated between the Mediterranean Sea, the Jordan River and the Dead Sea. It comprises a total area of 6,065 square kilome-

tres, which is divided into two distinct land masses. The larger of these two areas is the West Bank covering 5,640 square kilometres (population is about 2.3 million people) and the Gaza Strip with an area of only 360 square kilometres (population of about 1.3 million). The Palestinian ecosystems in the West Bank and the Gaza Strip including East Jerusalem cover an estimated 23,159 hectares of forest areas. Palestine is a developing country with little industry. Throughout its history, agriculture has traditionally been the basis for human growth and development. The awareness and popularity of traditional medicine is increasing in the country however, the ongoing conflicts with Israel have resulted in deterioration of its health care services and natural plant resources.

Traditional Medicine Systems

The conflict with Israel necessitated Palestinians to use traditional herbal remedies as a health care source especially those who cannot afford western medicine. The deterioration of the economic situation also contributed to the popularity of folk medicine. Among the people opting for traditional treatments, more than half seek out the services of specialized folk medicine practitioners, whereas the rest rely on self treatments and herbs obtained from spice or herb traders. In the past, the majority of people used to go to the non-specialized healers and traders of folk medicine however, growing awareness has resulted in people opting for specialized practitioners whose number have increased in recent times (Al-Banna, 2003).

Government Efforts in Development of Traditional Medicine

According to a recent WHO survey the Palestinian health system is facing a major crisis and is on the verge of collapse due to the ongoing war with Israel. The health care system has been affected severely. In 2002 up to 95% of Palestinians were still able to reach a health facility. Efforts have been made by Palestinian and international non-governmental organizations, the Palestinian Health Ministry and the United Nations Relief Works Agency (UNRWA) to provide health services and medical care to Palestinians living in war affected territories. There is no information on the government efforts to promote the development of traditional medicine in the country.

Medicinal and Aromatic Plant Resources

The Palestinian mountains are rich in diversity of plant resources with about 2,600 species found on this small Mediterranean area. Among these more than 700 have been mentioned to be of ethnobotanical use (Ali-Shtayeh *et al.*, 2000). The forests of Palestine provide a habitat for great floral diversity. The country has a well known tradition of using various plants such as *Artemisia* spp., *Ceratonia siliqua* L., *Citrullus colocynthis*

(L.) Schrad., *Ficus sycomorus* L., *Olea europaea* L., *Plantago* spp., *Ricinus communis* L., *Teucrium* spp. and others for medicinal purposes. (Ghattas *et al.*, 2004) Herbs such as *Anchusa officinalis* L., *Matricaria recutita* L., *Rosmarinus officinalis* L., *Terminalia chebula* Retz. and *Thymus vulgaris* L. are commonly used herbal remedies. The West Bank and Gaza Strip have many herbs and medicinal plants, which are widespread and have been used as remedies for various diseases and are also in high demand (Al-Banna, 2003). Some common medicinal and aromatic plants found in Palestine are listed in Table 1 (Anonymous, 1996; Ali-Shtayeh *et al.*, 2000).

The West Bank is rich in various species of medicinal and aromatic plants, which are generally harvested and collected by the people from the wild as an income source as well as for use in drugs and various related industries. Practitioners known as *Al A'atarin* gather medicinal and aromatic plants from Bedouins and villagers, who collect them from the wild.

Research and Development Activities

An ethnobotanical study was carried out in the West Bank in 1998-1999 to evaluate the relative efficacy of medicinal plants of the area for the treatment of skin and prostate disorders, jointly with the An-Najah National University, West Bank; the Genetic Resources and Seed Research, Volcani Center, Bet-Dagan; and the R&D Regional Center, the Galilee Society, Eilaboun, Israel. The survey reported 165 species and classified them into different categories based on popularity and use by local communities (Ali-Shtayeh *et al.*, 2000). The Department of Biological Sciences of the An-Najah National University has also investigated 22 plants used in folk medicine in Palestine for their antifungal activity (Ali-Shtayeh and Abu Ghdeib, 1999). The Department of Biology and Biochemistry, Birzeit University has screened 15 Palestinian medicinal plants for antibacterial activity. These plants were collected in 1996 from different locations in Ramallah and Jerusalem (Essawi and Srour, 2000).

The International Development Research Council (IDRC) sponsored the project *Medicinal Plants Used by Palestinian Farmers in the Galilee* to develop sustainable strategies for the genetic preservation of medicinal and pesticidal species in Palestine, Israel and the Golan Heights carried out by the Galilee Society for Health Research and Services, Israel. Researchers undertook an extensive review of the literature on medicinal plants with the aid of the Hebrew University of Jerusalem. Some of the more than 600 medicinal species used in the region have become rare and many have disappeared as a result of unsustainable harvesting and collection. A list of 83 most commonly used species along with their medicinal uses, the part used and their Latin, Arabic and Hebrew names was compiled. The efficacy of some plants in the treatment of liver diseases, cancer, diabetes, cardiovascular diseases and neurological diseases were tested. Some of the endangered

species along with the seeds of various valuable plants were collected and stored at the Research and Development Regional Center of the Galilee Society (Anonymous, 2002).

Trade and Marketing

The Palestinian pharmaceutical industry was born after the 1967 war as a result of the isolation of the West Bank from the rest of the Arab world. Before the war all pharmaceutical products were imported from Amman and Jordan. The war prevented the import of pharmaceutical products from Jordan. Only Israeli medicines or products imported through Israeli agents were available in the country. Nine pharmacists in the West Bank established small laboratories that merged in 1970 to become three larger companies: Jordan Chemicals in Beit Jala; Palestine Medical Company in Ramallah; and Jerusalem Pharmaceuticals in El-Bireh. The industry is growing rapidly with the introduction of modern production techniques and processes, training of workers and quality control practices that have led to significant increases in production. No data related to medicinal and aromatic plant trade in the country is currently available.

Problems and Constraints

The people of Palestine are drawn towards herbal treatments because of their increasing popularity and health benefits. The vast medicinal and aromatic plant resources of the country have been threatened due to the ongoing conflicts with Israel, also severely affecting the health care system of the country. Valuable knowledge of remedies is being lost with the older generation. The government should make efforts to preserve this knowledge, promote traditional remedies and protect the natural resources of medicinal and aromatic plants, and initiate research and development activities in this area. There is a need to promote the production and trade to obtain commercial benefits from the country's natural medicinal and aromatic plant resources.

Table 1: Some common medicinal and aromatic plants of Palestine

Botanical name	Family
Achillea santolina L.	Asteraceae
Adonis aestivalis L.	Ranunculaceae
Allium sativum L.	Liliaceae
Ammi majus L.	Apiaceae
Amygdalus communis L.	Rosaceae
Anagyris foetida L.	Fabaceae
Anemone coronaria L.	Ranunculaceae
Anisum vulgare Gaertn.	Apiaceae
Artemisia herba-alba Asso	Asteraceae

Continued

Table 1 Continued

Botanical name	Family
Avena sativa L.	Poaceae
Calotropis procera (Aiton) W. T. Aiton	Apocynaceae
Capparis spinosa L.	Brassicaceae
Carthamus tinctorius L.	Asteraceae
Ceratonia siliqua L.	Fabaceae
Citrullus colocynthis (L.) Schrad.	Cucurbitaceae
Commiphora opobalsamum (L.) Engl.	Burseraceae
Crocus spp.	Iridaceae
Cupressus sempervirens L.	Cupressaceae
Datura inoxia Mill.	Solanaceae
Daucus carota L.	Apiaceae
Ficus sycomorus L.	Moraceae
Foeniculum vulgare Mill.	Apiaceae
Hyoscyamus aureus L.	Solanaceae
Hyoscyamus spp.	Solanaceae
Inula viscosa (L.) Aiton	Asteraceae
Laurus nobilis L.	Lauraceae
Linum spp.	Linaceae
Lupinus albus L.	Fabaceae
Matricaria chamomilla auct.	Asteraceae
Matricaria recutita L.	Asteraceae
Mentha spicata L.	Lamiaceae
Nigella sativa L.	Ranunculaceae
Olea europaea L.	Oleaceae
Papaver somniferum L.	Papaveraceae
Peganum harmala L.	Nitrariaceae
Phoenix dactylifera L.	Arecaceae
Pinus halepensis Mill.	Pinaceae
Rhus coriaria L.	Anacardiaceae
Ricinus communis L.	Euphorbiaceae
Robinia pseudoacacia L.	Fabaceae
Rosa canina L.	Rosaceae
Rosmarinus officinalis L.	Lamiaceae
Salvia fruticosa Mill.	Lamiaceae
Salvia officinalis L.	Lamiaceae
Teucrium polium L.	Lamiaceae
Thymus vulgaris L.	Lamiaceae
Trigonella foenum-graecum L.	Fabaceae
Urginea maritima (L.) Baker	Hyacinthaceae
Verbena officinalis L.	Verbenaceae

5.15 Qatar

The State of Qatar comprises a low-lying peninsula at the southern end of the Persian Gulf and is bordered by Saudi Arabia on its landward side. It has an area of about 11,437 kilometres and a population of only 0.8 million. It is estimated that 80% of the population live in Doha, the capital. The terrain of the country is mainly gravel desert and it has virtually no forest or woodland. Natural vegetation is predominantly scattered desert scrub with Acacia spp. probably the most common shrub species. Small patches of mangroves occur around the northern third of Qatar. Al- Mashabiah Area, Ras Osheirej Area and Shahanya Park are some of the protected areas for the conservation of natural resources.

Traditional Medicine Systems

Medicinal plants have traditionally been used in Qatar for many generations and herbal medicine is a common tradition in the country (Sabra and Walter, 2000). Health care in Qatar before the discovery of oil consisted of traditional medicine provided by herbalists . At present however, modern medicine is the main source health care for the majority of the population. Herbal medicine regulations were issued in 1990 and updated in 2002. They are regulated as over the counter medicine, dietary supplements, complimentary products and as an independent regulatory category. The registration system has accepted 2,134 herbal medicines (WHO, 2005).

Government Efforts in Development of Traditional Medicine

Qatar has a comprehensive system of well equipped public clinics and hospitals, staffed mainly by foreign personnel. Several private clinics are located in Doha and services are mostly provided free of charge to all residents. The Ministry of Health runs hospitals, health centres, quarantine clinics and issues medical certificates. There are no traditional health care clinics or hospitals in the country and no information on government efforts for the development of traditional medicine is available. There is no national pharmacopoeia. Instead the German and British herbal pharmacopoeia are used and legally binding (WHO, 2005).

Medicinal and Aromatic Plant Resources

The flora of Qatar includes only 301 plant species (Rizk, 1991). The country has no forests but some native plants and shrubs are spread over the desert. Some of the native plant materials are of traditional importance and have been adapted to the local conditions. Date palm, alfa alfa and some vegetables are grown successfully in the country

(Al-Mohammadi, 1995). Some important medicinal and aromatic plant species found in Qatar and their traditional uses are listed in Table 1 (Sabra and Walter, 2000).

Research and Development Activities

The University of Qatar has carried out some research on the medicinal properties of local plants. A scientist from the Scientific and Applied Research Centre, University of Qatar has published a book entitled *Plants along the Persian Gulf: The Phytochemistry of the Flora of Qatar*. The book describes each of the 207 genera of Qatar with their known chemistry and potential uses. Many of the plants used in Arab traditional medicine systems have also been included in the book (Rizk, 1991). Another book *Medicinal and Poisonous Plants of Qatar* describing the constituents, folk and traditional uses, pharmacological data and description of 184 medicinal plants including plants from Africa, America, Asia and Europe has also been published by scientists from the Centre (Foster, 1997). The Department of Biological Sciences, University of Jordan has evaluated the antimicrobial activity of some of the indigenous medicinal plants of Qatar (Mahasneh, 2002).

Trade and Marketing

No information is available regarding the trade and marketing of medicinal and aromatic plants and traditional medicine in Qatar.

Problems and Constraints

Lack of forests, government support in development of traditional medicine and medicinal and aromatic plant sectors and scientific research are the factors responsible for non exploitation of the medicinal and aromatic plant potential of the country.

Table 1: Important medicinal and aromatic plants of Qatar

Botanical Name	Family	Uses/Indications
Anagallis arvensis L.	Primulaceae	In wounds, skin diseases, rheumatism, liver, ulcers, chronic nephritis
Anastatica hierochuntica L.	Brassicaceae	As purgative, anti-inflammatory
Capparis spinosa L.	Brassicaceae	In arthritis
Cistanche phelypaea (L.) Cout.	Orobanchaceae	As aphrodisiac, tonic, in diarrhoea.
Citrullus colocynthis (L.) Schrad.	Cucurbitaceae	In jaundice, asthma, amenorrhoea and as antipyretic
Cymbopogon parkeri Stapf	Poaceae	As antispasmodic
Cynomorium coccineum L.	Balanophoraceae	As aphrodisiac, astringent, in kidney ailments, constipation, sterility
Eruca sativa Mill.	Brassicaceae	As aphrodisiac, in skin eruptions, ulcers, inflammations, toothache

Continued

Table 1 continued

Botanical Name	Family	Uses/Indications
Euphorbia spp.	Euphorbiaceae	In flu, dysentery, diarrhoea, snakebite
Foeniculum vulgare Mill.	Apiaceae	As condiment, anti inflammatory and in jaundice
Herniaria hemistemon J. Gay	Caryophyllaceae	As diuretic, purgative
Justicia adhatoda L.	Acanthaceae	As diuretic, antiseptic, insecticidal, in fever
Phoenix dactylifera L.	Arecaceae	As diuretic, in bronchitis, fever
Phragmites australis (Cav.) Trin. ex Steud.	Poaceae	As antidote, antipyretic, in cholera, cough, arthritis, earaches
Pulicaria crispa (Forssk.) Benth. ex Oliv.	Asteraceae	As diuretic
Reseda muricata C. Presl	Resedaceae	As anti-microbial
Rumex vesicarius L.	Polygonaceae	In jaundice, constipation and for digestion
Salvia aegyptica L.	Lamiaceae	In diarrhoea, haemorrhoids, eye diseases, gonorrhoea and as antispasmodic

5.16 Saudi Arabia

The Kingdom of Saudi Arabia is located in southwest Asia, occupying most of the Arabian Peninsula. It is bounded to the north by Jordan, Iraq and Kuwait; the Persian Gulf and Qatar to the east; United Arab Emirates and Oman to the southeast; the Republic of Yemen to the south and the Red Sea and the Gulf of Aqaba to the west. Saudi Arabia has an area of 1,960,582 square kilometres with a population of 24.3 million. More than half the area of Saudi Arabia is desert sharing its flora with Africa, Asia and the Mediterranean region as a result of its geological history and location. It is lightly forested with less than 1% of forest cover with good resources of medicinal and aromatic plants. The use of herbal medicine has been increasing in the country since the 1990s. The government stresses the safety, efficacy and registration of traditional medicine.

Traditional Medicine Systems

Traditional medicine in Saudi Arabia is based on herbal remedies and spiritual healing. It has been mainly inherited from old tribes and still continues to flourish despite widespread availability of allopathic medicine. Since the introduction of allopathic medicine in 1940, the health authorities have worked for its development and today the country enjoys a sound modern health care system. There was official resistance to alternative medicine until the 1990s when some professionals trained abroad began to practise in the country. At present the use of traditional medicine is increasing and gaining popularity. The most popular traditional therapies used in Saudi Arabia include acupuncture, herbal medicines, nutritional and health food products and homeopathy (WHO, 2001). Herbal medicine regulation in Saudi Arabia was undertaken in 1996 with the issue of a separate law spe-

cifically for herbal medicines. The regulatory categories for herbal medicines include over the counter medicine, self medication, dietary supplements, healthfoods and functional foods. There are 450 herbal medicines registered (WHO, 2005).

Government Efforts in Development of Traditional Medicines

An act governing the practice of pharmacy and trade in medicines and medical products was issued by Royal Decree M/18 dated 18/3/1398 H (26 February 1978). Articles 44 and 50 of the Act require the registration of locally produced or imported products with the Ministry of Health. Paragraph 13A of the special provisions on registration regulations for pharmaceutical companies and their products, requires the registration of medicines and all products with medical claims including herbal preparations. The License Committee established under the Ministry of Health is responsible for approving the marketing and use of herbal preparations and products, health food products and natural health products on the basis of their safety and efficacy. According to guidelines approved by the Ministry of Health, licences to practise acupuncture can only be given to rheumatologists, anesthetists, or orthopedists and persons who have at least 200 hours of training and comply with hygiene standards. Licensing legislation also regulates chiropractic educational standards and practice. The country has no specific institutions for formal education in traditional medicine; interested allopathic physicians go abroad to receive such training. Traditional medicine is not covered by national health insurance (WHO, 2001). No national pharmacopoeia exists so far; however, the German and British pharmacopoeia and WHO monographs are used instead, although they are not legally binding (WHO, 2005).

Medicinal and Aromatic Plant Resources

Saudi Arabia possesses a unique genetic diversity in the form of ecotypes of tree species. The western and southwestern regions of the country are rich in native plant flora of cultivated crops and medicinal plants (Anonymous, 1995). Around 300 species of medicinal plants are used in traditional medicine in Saudi Arabia. Some common medicinal and aromatic plants are listed in Table 1 (Sabra and Walter, 2000; Abbas *et al.*, 2002). The rural population depends to a greater extent on wild plants for medicines. *Salvadora persica* L. (miswak) is used throughout the Kingdom as a toothbrush and has substantial market value. *Commiphora myrrha* (Nees) Engl. is also widely traded in the country for its medicinal value (Faizi, 1998). *Balanites aegyptiac*a (L.) Del, *Haplophyllum tuberculatum* (Frossk) A. Juss and *Rhazya stricta* Decne are commonly used in folk medicine for liver ailments (Ali *et al.*, 2001).

Research and Development Activities

A number of institutions and universities are engaged in research on traditional remedies and medicinal plants in Saudi Arabia. Commonly used tribal and traditional medicines in the country have been evaluated in order to highlight their importance (Al-Awamy, 2001). Similarly the Department of Pharmacology at King Faisal University, (Al-Ghamdi, 2001) the Department of Pharmacognosy, College of Pharmacy (Al-Said, 1993) and the Medicinal, Aromatic and Poisonous Plants Research Centre, King Saud University (Al-Rehaily *et al.*, 2002) have also carried out research work on the medicinal plants of Saudi Arabia. At King Khalid University Hospital, scientists are testing indigenous medicinal plants for the treatment of cancer. The Department of Veterinary Medicine at King Saud University has carried out a survey on ethnoveterinary knowledge and the practice of traditional healers in the Qassim Region. The study reported the use of medicinal plants for the treatment of diseases in animals, particularly camels, by the local people (Abba *et al.*, 2002).

Trade and Marketing

The pharmaceutical market of Saudi Arabia is the largest in the Gulf region. It is worth US$1.17 billion with over 2,400 pharmacies and more than 4,600 registered drugs on the market. The government allocated US$294 million for medicines in 2001. Despite recent government efforts in the domestic pharmaceutical industry, the Saudi market is still heavily reliant on imports with more than 98% of pharmaceutical products being imported (Anonymous, 2002).

The Arabian Peninsula (Saudi Arabia takes up most of it) is a major transit area for herbs, condiments and spices from the Indian subcontinent and the countries of the East Mediterranean, Europe, North Africa and Souteast Asia. Due to its holy places in Makkah and Madinah, Saudi Arabia receives millions of pilgrims every year from all over the world. These pilgrims bring with them their native herbal remedies for personal use as well as for marketing purposes. As a result these cities became trade centres for herbs and crude drugs (Al-Said, 2002). However, precise information on the extent of use of these herbs and their commercial trade is not available.

Problems and Constraints

The lack of training and education regarding traditional medicine and their use, depleting medicinal and aromatic plant resources, lack of conservation strategies, research and development activities, improper marketing and dependence on imports for such materials are some of the factors responsible for improper utilization of the country's medicinal plant resources.

Table1: Some important medicinal and aromatic plants found in Saudi Arabia

Botanical name	Family	Uses/Indications
Acacia arabica (Lam.) Willd.	Fabaceae	In haemorrhage, colds, diarrhoea, scurvy, dysentery
Aloe vera (L.) Burm. f.	Asphodelaceae	As laxative, in asthma, peptic ulcers, diabetes
Azadirachta indica A. Juss.	Meliaceae	In malaria, leprosy, respiratory problems
Balanites aegyptiaca (L.) Del	Balanitaceae	As pesticide, laxative, anthelmintic
Brassica rapa L.	Brassicaceae	As aphrodisiac
Calotropis procera (Aiton) W.T. Aiton	Apocynaceae	In fever, joint pain, muscular spasm, constipation
Capparis decidua (Forssk.) Edgew.	Brassicaceae	As anti-inflammatory, antipyretic
Capparis spinosa L.	Brassicaceae	As anti-inflammatory, in rheumatism, arthritis
Commiphora myrrha (Nees) Engl.	Burseraceae	As astringent, antiseptic, antimicrobial, in throat infections
Datura metel L.	Solanaceae	As antispasmodic, psychoactive
Delonix elata (L.) Gamble	Fabaceae	In pain
Haplophylum tuberculatum (Frossk) A. Juss	Rutaceae	In liver diseases
Lepidium sativum L.	Brassicaceae	In gastroenteritis in camels
Nigella sativa L.	Ranunculaceae	As analgesic, anti-inflammatory
Pimenta dioica (L.) Merr.	Myrtaceae	As anti-inflammatory, analgesic, antipyretic
Prunus amygdalus Batsch	Rosaceae	As aphrodisiac
Rhazya stricta Decne	Apocynaceae	In liver disorders, as antioxidant
Salvadora persica L.	Salvadoraceae	As antiplaque, antiperiopathic, antimicrobial
Tamarix aphylla (L.) H. Karst.	Tamaricaceae	In dermatitis and for eye wash for camels
Teucrium polium L.	Lamiaceae	As aromatic, antispasmodic
Zingiber officinale Roscoe	Zingiberaceae	As antiemetic, aphrodisiac
Zygophyllum album L. f.	Zygophyllaceae	As vermifuge for camels
Zygophyllum coccineum L.	Zygophyllaceae	In rheumatism, cough, asthma, hypertension, as flatulent colic, diuretic

5.17 Syria

The Syrian Arab Republic is located in southwest Asia and is bounded to the north by Turkey, Iraq to the east, Jordan and Israel to the south and by Lebanon and the Mediterranean Sea to the west. The population of Syria is about 17.5 million and it covers an area of 185,180 square kilometres with a forest cover of less than 3% of the total area. These forests are the source of valuable medicinal and aromatic plants used in traditional medicine preparations. The forests of Syria have largely been cleared or degraded and only remnants of mixed-coniferous forests remain. Syria has established a moderately large area of plantations and has a modest network of protected areas. Traditional medicine is common among the rural communities of the country and the government is working to include it in primary health care and is encouraging their production in the country.

Traditional Medicine Systems

The government of Syria provides modern health care facilities for its people however; many Syrians still use traditional health practices to treat illnesses. There are traditional healers especially in the rural areas that practise traditional medicines and also provide herbal remedies made from local or imported plant materials (Anonymous, 2002). Syrian traditional medicine has also contributed to the development of the *Unani system* of medicines practised in many Arab countries. Regulation of herbal medicine was introduced in 1998 as part of the same law that regulates conventional pharmaceuticals. Herbal medicines are registered as prescription medicine, health foods and as an independent regulatory category. There are currently 44 herbal medicines registered (WHO, 2005).

Government Efforts in Development of Traditional Medicine

Traditional medicine practices are limited to specialists and the government provides no licences to the practitioners of herbal medicines. In 1997, the Ministry of Health (MoH) issued decisions on the technical prerequisites necessary for the establishment of laboratories for herbal medicine. In 1998, the Ministry issued decisions on the manufacture, distribution and system of controls for herbal medicines. The manufacture of herbal medicines has been included in the national drug policy. The MoH has given preliminary approval for the establishment of laboratories to manufacture herbal medicines. Three draft laws covering herbal medicine, including the one concerning herbal medicines to be used in primary health care have been prepared. A syllabus on treatment with herbal medicines has been recommended for inclusion in the curricula of faculties of medicine. A syllabus on medicinal plants and herbal medicines has also been introduced into the curricula of pharmacy faculties and at health institutes for pharmacists (WHO, 2001). In place of a national pharmacopoeia, the *United States Pharmacopoeia* is used and legally binding (WHO, 2005).

Medicinal and Aromatic Plant Resources

Syria's moderate climate provides a good environment for a wide range of plants to grow. In the Syrian culture many of these plants are used for aromatherapy, perfumes and medicinal purposes. There are about 3,459 species belonging to 865 genera and 131 families. Medicinal and aromatic plants constitute a high proportion of the country's flora. Many of these plants are collected directly from the wild by rural people for preparation of traditional medicines. A number of Rosa species including *Rosa canina* L., *Rosa dumetorum* Thuill., *Rosa glutinosa* Sm., *Rosa phoenicia* Boiss. and *Rosa sicula* Tratt. have been reported to grow naturally in Syria (Wahbe, 1997).

Essential oils are widely used as essence for perfume, therapeutic remedies and as an aid to emotional well being in Syria. The existence of cultivated and wild raw materials in large quantities along with scientific progress has led to the adaptation and development of essential oils extraction using various methods especially distillation and enfleurage. Some important medicinal and aromatic plants found in Syria are given in Table 1 (Sabra and Walter, 2000; Wahbe, 1997).

Research and Development Activities

In 1985, the Ministry of Defense jointly with the University of Damascus started the Productive Project Administration (PPA), which dealt specifically with medicinal plants in order to provide the army and the Syrian public with herbal products that have been scientifically proven to have beneficial health effects. ISO 9002 was awarded to PPA in 1994. A broad network of farmers and collectors spread throughout the country provide plant material to PPA (Sabra and Walter, 2000). The Syrian government with the private sector has been working to conserve the country's medicinal and aromatic plant resources through:

- Cultivation and protection of important and endangered medicinal plants;
- Survey of medicinal and aromatic genetic resources and establishment of gene resource banks;
- Support for research, training and improvement of production techniques for medicinal plants;
- Establishment of pharmaceutical and insecticide industries based on medicinal and aromatic plants;
- Coordination between ministries, organizations, universities and research centres concerned with medicinal plants;
- Creation of botanical gardens for breeding programmes and raising the productivity of medicinal plants;
- Formulation of extension programmes on the conservation and importance of medicinal and aromatic plants for rural people; and
- Formulation of a policy for production, transport and marketing based on the local and international needs of medicinal plants raw material.

In 2001, a National Symposium on the Strategy for Developing the Manufacturing of Herbal Medicines was held in Damascus. It was organized by the MoH in cooperation with the World Health Organization and the Scientific Council of Pharmaceutical Industries. The farming of medicinal plants, MoH medicine manufacturing strategy, the pharmacological effect of herbal medicines and the treatment by herbal medicine were among the various themes discussed at the symposium. It was stressed that the Agri-

culture Ministry should provide assistance to farmers and pharmaceutical industries to increase the production of herbal medicines and guarantee and supervise good farming of medicinal plants (Anonymous, 2001).

The Horticulture Department of the Directorate of Scientific Agricultural Research has collected seed samples of different medicinal and aromatic plant species found in Syria. The Ministry of Agriculture and Agrarian Reform carried out a project to strengthen its capabilities in collection, maintenance and evaluation of genetic resources of medicinal and aromatic plants and various other crops, aiming to establish three genetic reserves. Another project is working for the establishment of a park near Damascus to grow various crops, trees and medicinal and aromatic plants over an area of 200 hectares (Anonymous, 1995).

A pharmacological study was conducted on five Syrian medicinal species used for the treatment of various problems and diseases by the University of Genoa, Italy (Batello, et al., 2002). A recent FAO publication entitled, *Bedouin Traditional Medicine in the Syrian Steppe. Al-Khatib speaks and interview with a Hadidin traditional doctor* describes traditional knowledge of the Bedouins related to human and veterinary medicinal uses of plants in the Syrian Desert steppe. The book provides information on local habits, beliefs, know-how and a scientific approach to the management and use of natural resources of the Syrian steppe.

Trade and Marketing

Syria's interest in manufacturing of herbal medicine is increasing. At the beginning of 1998, the Ministry of Health in collaboration with the World Health Organization started manufacturing and monitoring herbal medicines in the country. Three categories of medicinal herbs were classified for production. The first category includes herbs available in the country or imported from abroad. The second category is herbs that grow naturally or are cultivated in Syria. The third category consists of 25 herbal plants to start the processing of herbal medicines. (Anonymous, 1999).

The government has set up a committee of companies which manufacture herbal teas in Syria. Some pharmaceutical companies have started manufacturing herbal medicines. Some local companies are engaged in the production of essential oils such as aniseed, neroli, nigella, rose and others. These oils are sold on the domestic market with some export to Arab Gulf countries especially Saudi Arabia and Lebanon (*Anonymous*, 2003). Anise (*Pimpinella anisum* L.), bay leaves (*Laurus nobilis* L.), cumin (*Cuminum cyminum* L.), garlic (*Allium sativum* L.), olives (*Olea europea* L.), pepper (*Piper nigrum* L.) and thyme (*Thymus vulgaris* L.) have been listed under the "Syrian productions eligible for exportation" category by the Syrian Ministry of Economy and Foreign Trade.

Some medicinal and aromatic plants sold on local markets in Syria are listed in Table 2 (Wahbe, 1997). Traditional practitioners make their own remedies and import many of the herbal raw materials that are not available in Syria, from countries such as Egypt and Morocco.

Problems and Constraints

The medicinal and aromatic plant resources of Syria are threatened by the degradation of forests by fires, overgrazing, urban expansion in forest areas, scarcity of water, the cutting down of trees for fuel and unsustainable harvesting of wild medicinal plants. There is a need for proper management, conservation and scientific research on traditional knowledge and medicine and to organize the production and trade of herbal medicine.

Table 1: Some of the medicinal and aromatic plants found in Syria

Botanical name	Family	Uses/Indications
Allium cepa L.	Alliaceae	For heart diseases
Allium sativum L.	Alliaceae	For heart diseases
Artemisia herba-alba Asso	Asteraceae	For malaria fever
Artemisia spp.	Asteraceae	As aromatic
Citrus aurantium L.	Rutaceae	As aromatic
Coriandrum sativum L.	Apiaceae	As carminative, aromatic
Crataegus monogyna Jacq.	Rosaceae	In heart and blood circulation system disorders
Cuminum cyminum L.	Apiaceae	As carminative, aromatic
Glycyrrhiza glabra L.	Fabaceae	As expectorant, flavouring, sweetening agent
Laurus nobilis L.	Lauraceae	As aromatic, flavouring, herbal tea
Matricaria aurea (Loefl.) Schultz Bip.	Asteraceae	In diabetes
Matricaria chamomilla L., sensu 1753	Asteraceae	As carminative, aromatic
Mentha spicata L.	Lamiaceae	As carminative, antispasmodic
Myrtus communis L.	Myrtaceae	As aromatic
Nigella sativa L.	Ranunculaceae	In respiratory diseases, flu, allergies, cough, cold, bronchitis, fever, asthma
Olea europea L.	Oleaceae	In eye lotions, blood pressure, kidney, sore throats, as tonic
Petroselinum crispum (Mill.) Nyman ex A. W. Hill	Apiaceae	As diuretic, carminative
Pimpinella anisum L.	Apiaceae	As spice, aromatic
Piper nigrum L.	Piperaceae	As spice, bioavailability enhancer
Quercus infectoria Olivier	Fagaceae	In haemorrhoids, dental care
Rhus coriaria L.	Anacardiaceae	As diuretic, in fever, upset stomach
Rosa spp.	Rosaceae	For essential oil, perfumery
Sesamum indicum L.	Pedaliaceae	For fixed oil, food
Thymus spp.	Lamiaceae	As aromatic

Table 2: Some medicinal and aromatic plant sold in Syrian local markets

Botanical Name	Family	Form traded
Ceratonia siliqua L.	Fabaceae	Dried
Cnicus benedictus L.	Asteraceae	Fresh
Crithmum maritimum L.	Apiaceae	Fresh
Equisetum telmateia Ehrh.	Equisetaceae	Dried
Laurus nobilis L.	Lauraceae	Dried
Malva sylvestris L.	Malvaceae	Fresh
Matricaria aurea (Loefl.) Schultz Bip.	Asteraceae	Fresh
Micromeria myrtifolia Boiss. et Hohen.	Labiatae	Dried
Nasturtium officinale R. Br.	Brassicaceae	Fresh
Origanum syriacum L.,	Lamiaceae	Dried
Rhus coriaria L.	Anacardiaceae	Dried
Rubia Tinctorium L.	Rubiaceae	Dried
Rumex patientia L.	Polygonaceae	Fresh
Silybum marianum (L.) Gaertn.	Asteraceae	Fresh
Taraxacum officinale F. H. Wigg. Group	Asteraceae	Fresh
Thymus cilicicus Boiss. & Balansa	Lamiaceae	Fresh

5.18 Turkey

The Republic of Turkey is located in southeastern Europe and southwestern Asia. It has boundaries with Greece and Bulgaria to the west, Georgia, Armenia, Azerbaijan, Iran to the east and Iraq and Syria to the south. Most of Turkey (Anatolia) is in Asia while about 3% of the country (Thrace) lies in Europe. The total area of the country is 780,580 square kilometres and the population about 68 million. About 20% of the area is covered with forests rich in plant diversity including medicinal, aromatic and ornamental plants. The forest cover is expanding rapidly in Turkey as a result of government afforestation programmes. The country is rich in medicinal and aromatic plant resources used for traditional remedies which are especially popular among rural communities.

Traditional Medicine Systems

Modern medical facilities are widely available and utilized all over the country. However, traditional medicine is still practised especially by inhabitants of conservative communities. Traditional medicine originated in Anatolia from a centuries old tradition dating back to the Hittites or even before. Many plant remedies are known to local people, especially to the elders. The practitioners of traditional medicine are experienced people who learn treatment methods from their ancestors. These practitioners treat

diseases by using their own medicine derived from animal, mineral and plant sources. The specialist healers whose practice is limited to a specific disease are known as Ocak. They employ mainly shamanistic rituals for the treatment of certain diseases. Despite the accessibility of modern medicine, people still continue to depend on herbal remedies at least for the treatment of simple diseases (Honda *et al.*, 1996).

Government Efforts in Development of Traditional Medicine

A resolution of the Fifth Symposium on Crude Drugs held in Ankara in 1984, recommended a specific regulation for herbal products, which was followed by appropriate action. Prior to this there were no regulations for herbal products in Turkey. Crude drugs were sold in herbalist (*aktar*) shops and no special training was required for the persons responsible. In 1985, a National Registration Committee for Herbal Medicines was established by the Ministry of Health in order to draft regulations for the registration of herbal remedies. The Committee authorized the registration of 40 products, registered for sale only in pharmacies. Based on the committee recommendations the Ministry of Health banned about 70 poisonous drugs and chemicals in aktar shops. A regulation of 1 October 1985 of the Ministry of Health contained a list of plants allowed to be sold in the *aktar* shops. These plants included mainly crude herbs and their parts. Since 11 March 1986, permission is required from the Ministry of Health to open an *aktar* shop. On 17 January 1986, requirements for the establishment of herbal drug manufacturing premises (the GMP rules for herbal products) were published by the Ministry, giving detailed instructions on personnel, equipment, starting material, manufacturing operations, packaging, labeling and quality control. This committee was however abolished in the early 1990s. Recently, new regulations have been introduced by the Ministry for the registration of herbal medicines to be sold in pharmacies (Baser, 2000; WHO, 1998). *The Turkish Pharmacopoeia* was published in 1974 in its second edition; however, the *European Pharmacopoeia* is legally binding. The *Turkish Pharmacopoeia* also contains legally binding monographs on herbal drugs. There are 41 registered herbal medicines, however none is included in the essential drugs list (WHO, 2005). The manufacturing of herbal medicine is required to use good quality plant materials; good harvesting practices; and assessment of the quality of herbal medicine. A regulation on licensing herbal products which have any medicinal indication/claim on the label was published on 2 March 1995 (WHO, 1998). The basic principles of these regulations are the following:

1. Each *aktar* shop must be registered with the local branch of the Ministry of Health to be able to sell herbs.
2. Promotion of products with health claims is strictly forbidden.
3. Herbal products are divided into three classes according to the registration procedure:

- Products from plants without a risk potential for human health and without any health claim on the label, which are handled according to the food regulation;
- Herbal products presented in pharmaceutical dosage forms such as tablets or capsules must be registered by the Ministry in the same way as medicinal products, and require complete documentation; and
- Herbal teas with health claims on the label require registration but the documentation required is limited to quantitative formulae, specifications, quality control methods, summarized production method and a sample of the package insert.

Medicinal and Aromatic Plant Resources

The varied climate and geographic conditions in Turkey have resulted in a very rich flora of medicinal and aromatic plants. There are about 9,500 flowering plant species in Turkey of which 3,000 are endemic. The use of plants as medicine, spices, herbal teas and perfumes forms part of the culture and tradition of the old cities and towns of Istanbul, Kayseri, Gaziantep, Diyarbakir, Malatya, Sivas and Erzurum. The tradition of using medicinal plants is however less common in the urban population.

About one third of the flora of Turkey consists of aromatic plants. Most of these plants are collected from the wild. *Origanum onites* L. (Turkish oregano), *Origanum vulgare* subsp. *hirtum* (Link) Ietsw. (Greek oregano) and *Origanum* hybrids are cultivated in western Turkey in areas exceeding 10,000 hectares. Organic cultivation of oregano is also practised. *Anethum graveolens* L. (Dill), *Coriandrum sativum* L. (Coriander), *Cuminum cyminum* L. (Cumin), *Foeniculum vulgare* Mill. (Fennel) and *Pimpinella anisum* L. (Anis) etc are cultivated. A number of species including *Gentiana lutea* L. in the west and northwest mountains of Anatolia; *Glycyrrhiza glabra* L. (Licorice), *Laurus nobilis* L. (Laurel), *Origanum spp.* (Oregano) and *Salvia spp.* (Sage) have been over exploited and are under threat of extinction (Koyuncu, 1997). Some of the important medicinal and aromatic plants of Turkey are listed in Table 1 (Baser, 1997; Sezik *et al.*, 2001; Tuzlaci and Tolon, 2000; Tuzlaci and Aymaz, 2001). Some leading medicinal and aromatic plants of Turkey are listed in Table 2.

Research and Development Activities

A number of research projects related to the medicinal and aromatic plants of Turkey have been carried out by various universities in the country recently. The department of Pharmacognosy at Gazi University evaluated a number of plants used in traditional remedies for anti-inflammatory and antinociceptive activity as a part of the ongoing programme on plants used in Turkish traditional medicine for the treatment of rheumatism and related inflammatory diseases (Erdemoglu *et al.*, 2003). The Department of Pharmaceutical Botany at Marmara University carried out surveys of folk medicinal

plants of the Sile (Istanbul) and Gonen (Balikesir) regions and has reported 43 and 84 medicinal plants respectively used by local people in traditional medicine (Tuzlaci and Tolon, 2000; Tuzlaci and Aymaz, 2001). Gazi University in association with Kyoto University, Tokushima University and Gifu Pharmaceutical University Japan has carried out a number of studies on the traditional medicine of various regions of Turkey. These studies have recorded the plant species used in folk medicines and their traditional uses (Honda *et al.*, 1996; Sezik *et al.*, 2001; Yesilada *et al.*, 1999). The Institute of Forensic Medicine at Ankara University has studied some of the plants used in Turkish folk remedies for their possible hepatoprotective effects (Aktay *et al.*, 2000).

A separate chapter in the second supplement (Volume 11) of the Flora of Turkey and the East Aegean Islands deals with the chemical work carried out on the plants of Turkey based on 1,000 published papers (Baser, 2000). Recently a report on the priority medicinal and aromatic plants of Turkey has been published (Baser and Ekim, 2003), and three important reports on the essential oils of Turkey have also been published (Baser, 1994; Baser, 2002; Baser, 2002a).

The Medicinal and Aromatic Plant and Drug Research Centre (TBAM), Eskisehir has been engaged in the screening of the country's aromatic flora for new sources of essential oils and has generated a vast volume of information since its foundation in 1982. The Centre was authorized by the Ministry of Health to conduct analysis on essential oils and to undertake research and development work on industrial processing and quality control of plant materials used in the preparation of pharmaceuticals, foods, perfumes, cosmetics and dyes. In November 2002 the name of the centre was changed to the Plant, Drug and Scientific Research Centre (BIBAM). The details of botanical, chemical, pharmacological and technological research into medicinal and aromatic plants of Turkey carried out at TBAM and the Department of Pharmacognosy of the Faculty of Pharmacy, Anadolu University can be found at http://www.khcbaser.com/english/index.htm

A project has been implemented with the financial support of the Scientific and Technical Research Council of Turkey (TUBITAK) with the objectives to find out the domestic consumption of important medicinal and aromatic plants and to investigate the situation on harvesting and consumption of a number of herbs throughout the country. The results of this project are compiled in a book (Baser and Ekim, 2003).

Trade and Marketing

Trade in medicinal and aromatic plants is flourishing in Turkey. The level of industrial processing of medicinal and aromatic plants is however low. Although exact figures for plants collected and exported are not available; an estimated 250 species are probably in commercial use. Medicinal plants are exported as raw material whereas most

of the finished products are imported. This results in high costs of imported finished products, while the raw material is sold at low prices leading to more benefit to the companies involved in import/export and processing of raw material than the producers (Kizmaz, 1997; Koyuncu, 1997).

Turkey has become one of the biggest producers of oregano herb in the world (Baser, 2002b). The Turkish name for oregano is *kekik* which is a collective term given to plants that smell like oregano and thyme including the genera *Coridothymus*, *Origanum, Satureja*, *Thymbra* and *Thymus*. However, the majority of *kekik* exports consist of *Origanum* species. The annual Turkish export of dried oregano is about 5,000 to 8,500 tonnes worth US$13-16.5 million. The leaves and fruits of Laurel (*Laurus nobilis* L.) are harvested for export or production of essential and fixed oils in coastal areas. The exports of Turkish sage (*Salvia fruticosa* Mill.) and licorice (*Glycyrrhiza glabra* L.) have also increased in recent years. The export values of some important medicinal and aromatic plants of Turkey are presented in Tables 3 and 4 (Baser and Ekim, 2003).

Problems and Constraints

The use of unsustainable harvesting methods has resulted in depletion of medicinal and aromatic plant resources threatening some important endemic species with the danger of extinction. The biggest threat to wild growing plants is early harvesting and the malpractice of pulling the herbs out by hand which results in damage to the roots and the death of the plants. In recent years some private companies have also been involved in cultivation of medicinal and aromatic plants. The plants should be processed within the country instead of exporting them as raw materials. The government should encourage the herbal medicinal product industries. A national strategy should be developed for the harvesting and utilization of medicinal and aromatic plants. The conservation of endangered plants is of vital importance and there is a need for stringent legislation to control their excessive wild collection and export.

Table 1: Some medicinal and aromatic plants commonly used in Turkey

Botanical name	Family	Part(s) used	Uses/Indications
Allium sativum L.	Liliaceae	Bulb	Antihypertensive
Althaea hirsuta L.	Malvaceae	Flower	In sore throat, bronchitis
Althea officinalis L.	Malvaceae	Aerial parts	Wound healing
Asphodelus aestivus Brot.	Liliaceae	Root	For burns, wounds, haemorrhoids
Ballota nigra L. subsp. anatolica P.H.Davis	Lamiaceae	Whole plant	In asthma
Brassica oleracea L. var. capitata DC.	Brassicaceae	Seed	In cough, pneumonia

Continued

Table 1 continued

Botanical name	Family	Part(s) used	Uses/Indications
Capsicum annum L.	Solanaceae	Fruit	In stomachache
Centaurium pulchellum (Swartz) Druce	Gentianaceae	Whole plant	In diarrhoea
Cicer arietinum L.	Fabaceae	Seed	For treatment of worms
Cistus creticus L.	Cistaceae	Leaf	For snakebites, burns, wounds
Citrullus lanatus (Thunb.) Matsum. And Nakai	Cucurbitaceae	Pericarp	Wound healing
Citrus limon (L.) Burm.fil.	Rutaceae	Fruit juice	As antiemetic, in kidney stones
Digitalis ferruginea L. subsp. ferruginea	Scrophulariaceae	Whole plant	In eczema
Elaeagnus angustifolia L.	Elaeagnaceae	Fruit	As tonic, antipyretic, in kidney disorders, diarrhoea, ulcer.
Elaeagnus angustifolia L.	Elaeagnaceae	Leaf	In kidney stones
Ficus carica L. subsp. carica	Moraceae	Leaf	In asthma
Gentiana lutea L.	Gentianaceae	Rhizome, root	As digestive aid, in skin problems, fever
Glycyrrhiza glabra L. var. glandulifera Boiss.	Fabaceae	Root	In haemorrhoids, internal pains
Hyoscyamus niger L.	Solanaceae	Seed	In conjunctivitis
Hypericum olympicum L. subsp. olympicum	Hypericaceae	Aerial parts	In stomachache, inflamed wounds, cuts
Hypericum perforatum L.	Hypericaceae	Flower, aerial parts	For burn, wound, cut
Juniperus communis L.	Cupressaceae	Fruit	As diuretic, antiseptic, aromatic, stomachic
Juniperus oxycedrus L. subsp. oxycedrus	Cupressaceae	Cone	In nocturnal discharge
Laurus nobilis L.	Lauraceae	Branch	In bee and snake bites, as stomachic
Lavandula stoechas L. subsp. stoechas	Lamiaceae	Aerial parts	In arteriosclerosis, embolism
Malva sylvestris L.	Malvaceae	Leaf	In asthma
Matricaria chamomilla L. var. recutita (L.) Grierson	Asteraceae	Leaf	As digestive, laxative, in bronchitis, eye strain
Melissa officinalis L.	Lamiaceae	Aerial parts	In asthma, arteriosclerosis, as vasodilator
Mentha spicata L. subsp. tomentosa (Brig.) Harley	Lamiaceae	Leaf	As antiemetic
Olea europaea L. var. europaea	Oleaceae	Leaf	In diabetes
Origanum vulgare L. subsp. hirtum (Link) Iestswaart	Lamiaceae	Leaf	In haemorrhoids
Papaver rhoeas L.	Papaveraceae	Root	As anthelmintic, in gastric pain
Persica vulgaris Miller	Rosaceae	Leaf	As analgesic
Petroselinum sativum Hoffm.	Apiaceae	Leaf	As analgesic, in diabetes, kidney stones
Phaseolus vulgaris L.	Fabaceae	Seed	Wound healing
Plantago lanceolata L.	Plantaginaceae	Leaf, arial parts	For wounds, cuts, boils, embolism
Plantago major L. subsp. major	Plantaginaceae	Leaf, flower	For boil, eczema, stomachache, cancer
Populus nigra L.	Salicaceae	Wood	In rheumatism
Rhus coriaria L.	Anacardiaceae	Fruit	In ulcers.
Rosa canina L.	Rosaceae	Fruit	For cough, colds, in diabetes, cancer, eczema, asthma
Rubus canescens DC. Var. canescens	Rosaceae	Root, fruit, leaf	For haemorrhoids, anemia, diarrhoea, wounds

Continued

Table 1 continued

Botanical name	Family	Part(s) used	Uses/Indications
Salix alba L.	Salicaceae	Stem bark	In rheumatism
Salvia virgata Jacq.	Lamiaceae	Leaf	In uterus cancer
Smilax excelsa L.	Liliaceae	Leaf	For boils
Spinacia oleracea L.	Chenopodiaceae	Leaf	As prophylactic
Thymus longicaulis C. Persl subsp. *longicaulis* var. *subisophllus* (Borbas) Jalas	Lamiaceae	Whole plant	As blood pressure regulator, tonic, in stomachache, eczema, asthma
Tilia argentea Desf.	Tiliaceae	Flower	In cold cough
Urtica dioica L.	Urticaceae	Leaf	As haemostatic
Urtica urens L.	Urticaceae	Whole plant	In rheumatism
Vicia faba L.	Fabaceae	Flower	In kidney problems
Vicia sativa L.	Fabaceae	Aerial parts	In infertility in women
Vitis vinifera L.	Vitaceae	Fruit	In bruises
Xanthium strumarium L.	Asteraceae	Leaf	As anthelmintic

Table 2: Some leading medicinal and aromatic plants of Turkey

Botanical name	Chemical constituents	Uses/Indications	Parts used	Comments
Glycyrrhiza glabra L.	Flavonoids, glycyrrhizin, tannins	In cough, as expectorant, diuretic, in stomach ulcer	Roots	Wild in Bitlis Muß, Siirt and Van provinces. Export volume 654,174 kg in 2002.
Laurus nobilis L.	Volatile oils	As appetizer, diuretic, carminative, emetic, narcotic, stimulant	Leaves and fruits	Wild . Export volume 4,868,798 kg (US$7,686,927) per year.
Origanum onites L. & *Origanum vulgare* L. subsp. hirtum (Link.)	Volatile oils	In cold, stomachache, abdominal pain	Leaves	Wild and cultivated. Export of 8.658.403 kg (US$15.752.165) in 2001.
Rosa damascena Miller	Volatile oils	In tooth ache, inflammations, eczema, as antiseptic, laxative	Flowers	Isparta and Burdur provinces are the only cultivation and production sites. Export values for rose oil and rose concrete in 2001 US$6,008,586.
Salvia triloba L.	Essential oils	In cold, cough	Leaves	From wild sources.

Table 3: Export values for important wild medicinal and aromatic plants

Plant*/Year	1999	2000	2001	2002	2003
Gypsophila	89,609 (190,345)	27,570 (38,037)	69,797 (78,688)	50,118 (60,214)	61,461 (52,204)
Laurel leaf	3,782,765 (7,246,091)	4,423,361 (7,963,750)	4,611,088 (7,827,725)	4,868,798 (7,686,927)	5,098,741 (8,232689)
Licorice	1,129,671 (759,623)	266,451 (308,342)	356,908 (312,369)	654,174 (372,289)	514,064 (425,324)
Oregano	7,606,679 (16,556,474)	7,387,890 (15,366,350)	8,459,235 (15,479,360)	8,255,577 (13,319,998)	8,790,572 (14,067,924)

Continued

Table 3 continued

Plant*/Year	1999	2000	2001	2002	2003
Sage	1,114,728 (2,357,601)	1,248,293 (2,759,834)	1,203,929 (2,585,743)	1,537,141 (3,098,179)	1,720,000 (3,568,000)
Salep	950 (3,630)	152 431	701 759	---	100 130
Tilia	125,852 (587,875)	---	---	178,788 (443,191)	93,000 (374,000)

*volume kg (value US$)

Table 4: Export values for important cultivated medicinal and aromatic plants

Plant*/Year	1999	2000	2001	2002	2003
Aniseeds	3,068,541 (7,097,137)	3,807,693 (6,378,704)	4,113,155 (6,282,920)	2,914,794 (4,910,783)	3,316,117 (5,122,473)
Cumin	7,265,287 (9,198,694)	6,657,345 (12,674,179)	5,668,371 (12,560,948)	23,726,099 (24,758,472)	14,312,734 (13,385,138)
Fennel seeds	2,061,037 (1,807,863)	1,771,816 (1,538,270)	1,965,783 (1,509,719)	1,730,279 (1,222,267)	1,831,765 (1,672,178)
Fenugreek	425,255 (209,563)	488,967 (227,536)	465,054 (227,554)	654,174 (372,289)	934,000 (410,000)

*volume kg (value US$)

5.19 United Arab Emirates

The United Arab Emirates (UAE) is a federation of seven independent states located in the southeastern corner of the Arabian Peninsula. It is bordered by the Persian Gulf to the north, Saudi Arabia to the south and west and by Oman to the east. The population is about 2.5 million and the area including offshore islands is 83,600 square kilometres. Most of the country is desert with only 1% of forest cover. Almost all the forest areas are plantations. An extensive afforestation programme involving the plantation of around 100 million trees has been carried out, particularly around Bainuna in the north of Abu Dhabi, mainly for protection purposes. Despite the widespread availability of modern medicines, herbal medicines are still used in the UAE. The government is working to include traditional medicines in the national health care system.

Traditional Medicine Systems

Traditional medicine constitutes a significant part of the country's heritage. Until the 1960s when oilfields were discovered it was the main health care system. The people of the UAE, especially the desert tribe Bedouins, have practised natural medicines derived from plants for thousand of years. At present, the country enjoys modern health

services however, the use of herbal medicines is common and efforts are being made to include traditional medicines as an important component of the country's health care system (Paul *et al.*, 1993). A registration system for herbal medicines exists that includes 70 herbal medicines and a number of single and combination homeopathic medicines, as well as a few proprietary traditional Chinese medicines (WHO, 2005).

Government Efforts in Development of Traditional Medicines

His Highness Sheikh Zayed Bin Sultan Al Nahyan established the Herbal Research Centre in 1989 in Abu Dhabi that was developed further as the Zayed Complex for Herbal Research and Traditional Medicine in 1996. A committee of allopathic physicians and personnel from the Zayed Centre and the Emirates University in January 1998 prepared the registration criteria for herbal medicines. The criteria include documentation including detailed monographs for the herb, reference sample of the active ingredient, and laboratory analysis for identity, purity, and quality.

The priority in registration was given to single plant products. However, a 1999 report outlined a number of problems with the criteria. Companies have had difficulty in fulfilling the documentary requirements, especially relating to stability data. Many companies deal with traditional products with more than 10 active ingredients to be registered. Enforcement of the law also posed difficulties (WHO, 2001).

The MoH recognizes herbal medicine, traditional Islamic medicine (Unani), traditional Chinese medicine, traditional Indian medicine (Ayurveda and Siddha), homeopathy, naturopathy, chiropractic medicine and osteopathy as Traditional, Complementary and Alternative Medicine (TCAM) specialties. A practitioner should have either medical degree with a diploma or a post graduate certificate in any of the MoH recognized TCAM specialties as necessary qualifications to be eligible to apply for the TCAM qualifying examination.

A registration system for homoeopathic medicinal products under the Office of Complementary and Alternative Medicines of Ministry of Health with the objectives to ensure quality and safety of imported homoeopathic medicines sold in the country has also been established. Manufacturers must have a licence and conform to GMP norms. These products can only be prescribed by licensed homoeopathic practitioners (Behjat, 2002). The Gulf Cooperation Council (GCC) Drug Regulatory Committee comprised of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates, established in 1997, works to centralize drug registration in the region. The Committee worked in three phases. In phase 1, the first two year period, all pharmaceutical companies and their products were registered. In phase 2, the programme was evaluated and generic drugs from local manufacturers were registered. The third phase will cover complementary products including cosmetics, health food and herbs (Rahman, 2002).

The Dubai Herbal and Treatment Centre specializing in complementary medicine was established recently. It provides a variety of ancient Arabic, Chinese and Indian herbal and allopathic treatments. The Centre also aims to raise awareness about complementary medicines in the country.

Medicinal and Aromatic Plant Resources

Medicinal and aromatic plants have been used for centuries in the UAE. The country is rich in plant species many of which are used as traditional remedies. It is estimated that over 600 species grow in the country (Al Masoum, 1998). Some medicinal plants and their traditional uses in the UAE are listed in Table 1 (Anonymous, 2003).

Research and Development Activities

The study and development of herbal medicine in the UAE had been planned under two general approaches. One focused on the evaluation of traditional recipes for their clinical efficacy and safety in clinical trials, while the second focused on the screening of indigenous plants for their pharmacological activity and isolation of pure and new compounds (Paul *et al.*, 1993).

The Zayed Centre for Herbal Research and Traditional Medicine is a reputed Centre with an interdisciplinary research programme on the traditional system of medicine. Various research projects are focused on anti-diabetic, anti-gastric ulcer, anti-microbial, anti-hypertensive, anti-cancer and antihepatotoxic herbal drugs. The drug manufacturing area is currently under development. Research programmes taken up by the Centre include:

- Preparation of a herbal encyclopedia of the UAE (ready for publication);
- Preparation of herbal medicines through research and development;
- Manufacturing different dosage forms of various herbal preparations;
- Arranging conferences, symposia and instituting scientific publications;
- Preparation of monographs of individual medicinal plants and composite herbal drugs.

Plants including *Momordica charantia* L., *Morus nigra* L., *Trigonella foenum-graecum* L. and *Zizyphus spina-christi* possessing anti-diabetic activity have been selected for a composite preparation to combat diabetes. Various studies on medicinal plants and herbal materials have been published in recent years (Kamil, 1996; Kamil, 2001; Kamil, 2001; Liu and Zhao, 2000). The Centre also offers treatment to patients and is engaged in the production of natural pharmaceuticals. The Centre is working with traditional practitioners to record their knowledge of remedies and develop the list of traditionally used plants in the country. Similar work is carried out by the Desert Section of the Desert Marine Environment Research Centre (DMERC), Department of Pharmacology

at the Faculty of Medicine and Health Sciences (FMHS), the UAE University (WHO, 2001).

The Ministry of Health and the UAE University are keen to establish international links with reputable counterpart institutions to accomplish the scientific scrutiny of plants used in traditional herbal medicine of the UAE. The Medicinal Plant Research Unit, which is affiliated with the DMERC and the Department of Pharmacology, FMHS is working towards the advancement of research in this area. Projects on the evaluation of plants used for diabetes, antibacterial, anti-inflammatory and gastrointestinal effects have been carried out by the Unit (Al Masoum, 1998).

Trade and Marketing

The Centre for Herbal Medicines, Abu Dhabi is responsible for establishing a herbal medication industry in the country. It is based on traditional Arab and Islamic culture. The medicines are manufactured using imported or locally available materials. Various traditional remedies are prepared from plants grown in the country however; most of the plant material used in these medicines is imported from India and Nepal. Information regarding the exact amounts traded is not available.

Problems and Constraints

In order to exploit the country's resources of medicinal and aromatic plant, there is a need for their conservation, development of marketing opportunities for herbal materials, training of personnel, scientific evaluation of traditional remedies and recording the knowledge of these remedies from elderly people and traditional healers.

Table 1: Some medicinal and aromatic plants found in the United Arab Emirates

Botanical name	Family	Uses/Indications
Acacia nilotica (L.) Delile	Fabaceae	In burns
Calligonum comosum L'Hér.	Polygonaceae	In stomach ailments, toothache
Calotropis procera (Aiton) W.T. Aiton	Apocynaceae	In toothache
Cassia italica (Mill.) Spreng.	Fabaceae	As laxative, in stomach pains
Citrullus colocynthis (L.) Schrad.	Cucurbitaceae	In diabetes
Haplophyllum tuberculatum (Forssk.) A. Juss.	Rutaceae	For essential oil
Momordica charantia L.	Cucurbitaceae	As antidiabetic, laxative, in fever
Peganum harmala L.	Zygophyllaceae	In headaches
Portulaca oleracea L. subsp. sativa (Haw.) Celak.	Portulacaceae	As antiseptic, diuretic, vermifuge and in urinary disorders
Rhazya stricta Decne.	Apocynaceae	In diabetes, inflammatory conditions, gastric problems
Salsola imbricata Forssk.	Chenopodiaceae	In sinus problems

Continued

Table 1 continued

Botanical name	Family	Uses/Indications
Salvadora persica L.	Salvadoraceae	As anti-gastric ulcer, cytoprotective
Salvia aegyptiaca L.	Lamiaceae	In diarrhoea, gonorrhoea, as antiseptic, antispasmodic, stomachic
Teucrium stocksianum Boiss.	Lamiaceae	In fever
Zataria multiflora Boiss.	Lamiaceae	In cold, indigestion, toothache
Zingiber officinale Roscoe	Zingiberaceae	As digestive, carminative

Table 2: Some leading medicinal and aromatic plant of United Arab Emirates

Botanical name	Chemical constituents	Uses/Indications	Part(s) used
Caralluma arabica N.E.Br.	Flavonoids	As anti-diabetic, anti-inflammatory.	---
Chelidonium majus L.	Alkaloids	As diuretic, laxative, anodyne, purgative, anti-inflammatory, in eczema.	Aerial parts, roots
Portulaca oleracea L. var. Sativa	Alkaloids, flavonoids, glycosides	In skin conditions, pulmonary diseases, snake bite.	Aerial parts
Salvadora persica (L.) Garcina	Alkaloids, Saponins, Tannins	In swellings, blisters, scorpion stings rheumatism, for regulation of menstruation.	Fruits, leaves
Zingiber officinale Roscoe	Zingiberene, zingiberol	In arthritis, dyspepsia, as anti-inflammatory, in fever.	Rhizomes

5.20 Yemen

The Republic of Yemen is located in the southwestern corner of the Arabian Peninsula. It is bordered by Saudi Arabia to the north, the Arabian Sea and the Gulf of Aden to the south, Oman to the east and the Red Sea to the west. Yemen includes several islands in the Indian Ocean and the Red Sea and Socotra the largest island is in the Arabian Sea. The population of the country is about 19.3 million and it covers an area of about 527,970 square kilometres. Most of the Yemen forests have been cleared as a result of agriculture and fuel requirements and at present only about 4% of the total area is under the forest cover. Although Yemen has a modest network of protected areas very little forest is encompassed in these. Socotra Island is known for its high level of endemism in plant species and has been proposed as a biosphere reserve. The use of plants for medicinal purposes is common however, the extent of their commercial exploitation is limited.

Traditional Medicine Systems

Traditional medicine is popular in Yemen. Its use however, is particularly prominent in rural areas where these remedies are used to treat various minor ailments. People

prefer to consult traditional healers before opting for modern medicine. In rural areas, religious healers known as *shaikh* and traditional bone setters known as *tabib 'arabi* are commonly consulted for various problems. Cupping, cauterizing and blood letting are generally used in the treatment of various illness and diseases (Kangas, 1994). No regulations or laws on herbal medicines have yet been established in Yemen. No national pharmacopoeia exists (WHO, 2005).

Government Efforts in Development of Traditional Medicine

Modern health services were introduced in Yemen during the 1970s and 1980s. The Ministry of Public Health (MoPH) has an overall responsibility for the health sector. The health care system consists of a large public sector along with a sizable private sector. Preventive and promotive health care is mostly left to the public sector. The main objective of the government health policy is to improve the health status of the population in both urban and rural areas (Al-Ghabiry, 2002). No information on the specific efforts made by the Yemen government to develop and promote traditional medicine is available.

Medicinal and Aromatic Plant Resources

Medicinal and aromatic plants are of great interest for Yemenis and have been used as traditional remedies to cure diseases, as cosmetics, condiments, dyes, and flavouring agents. Considerable climatic differences have resulted in a rich and diverse flora in Yemen. It has over 3,000 plant species and 10% of these are considered endemic. Approximately 850 plant species have been reported in Socotra with about 254 as endemic (Mohammed, 2001).

Plants including *Aloe vera* (L.) Burm. f., *Artemisia spp.*, *Coriandrum sativum* L., *Crocus sativus* L., *Foeniculum vulgare* Mill., *Jasminum sambac* (L.) Aiton, *Lawsonia inermis* L., *Mentha spp.*, *Ocimum spp.* and *Thymus vulgaris* L. are found growing in the wild. However, continuous developmental activities, use of herbicides, grazing and unsustainable exploitation have endangered these species and many of them are on the verge of extinction (Munibari *et al.*, 1998). About eight species, seven of which are from the Socotra Island, are included in the IUCN Red Data Book as being endangered or rare and 19 are considered to be endangered or rare on a national level (Mohammed, 2001). Some medicinal and aromatic plant species found in Yemen are given in Table 1 (Ali *et al.*, 2001).

Research and Development Activities

Research on medicinal and aromatic plants in Yemen is limited and the medicinal flora of the country is not well documented. During the 1980s, the University of Metz, France carried out some work on the medicinal plants of Yemen. This study reported

130 of the Yemeni medicinal plants along with their vernacular names, geographical and ecological distribution, medicinal uses and pharmacological properties (Fleurentin and Pelt, 1982). Another study published in 1983, focused on the cultural background of medicinal plants in Yemen (Fleurentin *et al.* 1983).

A list of 224 medicinal and aromatic plant species along with their botanical names, families, vernacular names, distribution, active substances, part used and medicinal uses was reported in a study conducted in 1995 (Mohammed, 2001). An Arabic book entitled *Medical and Aromatic Plants of Yemen* was published in 1996 by the Obadi Centre for Studies and Publishing, Sana'a, Yemen. Recently the Sana'a University in collaboration with the Institute of Hygiene Mecklenburg-Vorpommern and the Arndt University, Germany has carried out studies on screening of 20 medicinal plant used in traditional Yemen medicine for their antibacterial properties (Ali *et al.*, 2001).

Trade and Marketing

A large number of medicines are smuggled into Yemen from neighbouring countries due to their high prices and lack of appropriate control measures by the Ministry of Health (Shidiwa, 2000). However, no information is available on the extent of medicinal and aromatic plant and herbal medicine trade. Some herbal medicine practitioners buy materials from countries such as Egypt, India, Indonesia, Iraq, Jordan, Lebanon and Singapore but the extent of this trade is not known.

Problems and Constraints

Yemen's natural plant resources are being drastically reduced as a result of drought, desertification, poor agricultural practices, urbanization, road constructions, over exploitation, over grazing and expansion of housing. There is a need to conserve the natural resources of medicinal and aromatic plants; carry out research on traditional medicine; record the traditional knowledge of elderly people for its conservation, proper training and regulation of trade in order to derive benefits from these potential resources.

Table1: Some medicinal and aromatic plants of Yemen

Botanical name	Family	Part(s) used	Uses/Indications
Albizia lebbeck (L.) Benth.	Fabaceae	Seed	In skin infections
Aloe perryi Baker	Asphodelaceae	Dried juice	In eye infections, wounds, anemia
Aloe vera (L.) Burm. F.	Asphodelaceae	Leaf	As laxative, in asthma, peptic ulcers, diabetes mellitus
Anisotes trisulcus (Forsk.) Nees	Acanthaceae	Leaf	In jaundice
Artemisia spp.	Asteraceae	Leaf, flower	In dyspeptic, liver, gallbladder problems
Boswellia sacra Flueck.	Burseraceae	Resin	As perfumes, incense

Continued

Table 1 continued

Botanical name	Family	Part used(s)	Uses/Indications
Calotropis procera (Aiton) W.T. Aiton	Apocynaceae	Leaf	As antiseptic
Capparis cartilaginea Decne.	Capparidaceae	Leaf	For wounds and boils
Carica papaya L.	Caricaceae	Seed	Wound healing
Chenopodium murale L.	Chenopodiaceae	Leaf	In skin infections
Coriandrum sativum L.	Apiaceae	Seed	As aromatic, antispasmodic, carminative, stomachic
Crocus sativus L.	Iridaceae	Stigma	As aromatic
Dracaena cinnabari Balf. F.	Dracaenaceae	Plant juice	In colic treatment
Foeniculum vulgare Mill.	Apiaceae	Fruit	As diuretic, appetizer, digestive
Indigofera oblongifolia Forsk.	Fabaceae	Leaf	In urinary tract infections, cough
Jasminum sambac (L.) Aiton	Oleaceae	Flower	As aromatic, for eyewash
Lawsonia inermis L.	Lythraceae	Leaf	As antiseptic, in burns, wounds, skin problems, headache, jaundice
Melia azedarach L.	Meliaceae	Leaf	In snake bite, skin infections
Mentha spp.	Lamiaceae	Leaf	As aromatic, in blood pressure, cold, nausea, fever
Meriandra benghalensis (Hamitt.)Benth.	Lamiaceae	Leaf	In skin infections
Nigella sativa L.	Ranunculaceae	Seed	In cough
Ocimum spp.	Lamiaceae	Leaf	As aromatic
Oxalis corniculata L.	Oxalidaceae	Leaf	In gastro-intestinal pain and vertigo
Peganum harmala L.	Zygophyllaceae	Leaf	In fever
Pulicaria orientalis Jaub. Et Spach.	Asteraceae	Leaf	In gastro-intestinal tract pains, fever
Rumex nervosus Vahl var. usambarensis Dammer	Polygonaceae	Leaf	As antiseptic, in pharyngitis
Salvadora persica L.	Salvadoraceae	Root	In gum inflammation, mouth hygiene
Thymus vulgaris L.	Lamiaceae	Whole plant	As aromatic
Tribulus terrestris L.	Zygophyllaceae	Aerial parts	In urolithiasis, dysuria
Withania somnifera (L.) Dunal	Solanaceae	Leaf	In burns, wounds
Zizyphus spina-christi (L.) Willd.	Rhamnaceae	Leaf	In wounds, as antiseptic

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