POLYTHERAPIC MEDICINAL PLANTS AND SPICES

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Multitherapic Medicinal & Spiceal Plants Series

Polytherapic Medicinal Plants & Spices

Post Harvest Management & Export Potential

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PREFACE

The quest for good health, happiness and immortality has been a continuous endeavour of human being since the beginning of human civilization throughout the world. This quest has been in the centre of development and advancement of various systems of healing. Plants have always been in the base of all these doctrines of medicine and health management. Initially these plants had made the bulk of folk or ethnomedicine which laid the foundation of medical practice in India and China followed by other parts of the world. Later on this indigenous knowledge was formulated, documented and eventually passed to organised systems of medicine. Ayurveda and Siddha systems were the pioneers in this venture. Out of over 2,00,000 plant species found on the globe 'WHO' listed about 20,000 plants having therapeutic potential. However, only a few of them (about 50) are under cultivation whereas rest are being alarmingly exploited from wild resources. This over extraction has resulted in driving many species to threatened plants category.

Hence, we are now, forced to develop conservational strategies for protection, domestication and cultivation of herbal drug yielding plants. Such strategies involve research and development activities on plant genetic resources, plant improvement, plant physiological studies, crop production aspects, plant protection measures and also good marketing network. However, WTO regime, globalization and liberal export/import scenario have further brought a change in over scientific requirement and we have to design our programmes according to acceleratively changing situation. Besides the conventional aspects (like plant genetic resources, plant breeding, agronomical practices, plant pathological measures and entomological aspects), we have to magnificantly intensify our research and development efforts on post harvest management practices, technological innovations for agroprocessing and value addition. We are also bound to conserve and develop the plant biodiversity and its judicious utilization for plant domestication with the active participation of rural masses. This may be achieved through rural medicinal plants co-operatives of women and men which may certainly lead to economic development by herbal farming. The involvement of traders, exporters, importers, marketing boards/institutions/organizations is also crucial for getting good results. Feedback from pharmaceutical industries and food processing units may further impart strength to our concerted efforts.

For fulfilling these socially useful goals, efforts were made to interact with people of different walks of life including university teachers, several government and non-government organizations, scientists, planners, administrators, social workers, progressive politicians and even medical practitioners. Available and published literature was also thoroughly screened and it was realized that comprehensive treatise in the form of a book on above mentioned aspects (interdisciplinary approach) is the need of the day. Present treatise (book) is the outcome of such concerted efforts. The book has successfully brought out scientifically and judiciously processed basic and applied information on dimensions of post harvest science and technology including processing equipments (machines), phytobiodiversity and its conservation and sustainable exploitation for plant domestication, rural and economic development through herbal ecofarming, trade, export, import and marketing scenario (global and domestic), pharmaceutical formulations based on medicinal and spiceal plants as raw materials for the industry (drugs). Relevant and reliable database on propagation and nutrients' management in medicinally valuable seedy spices has also been incorporated alongwith a special mention of therapeutic value of Indian eatables of plant origin. Owing to such peculiarities the book will certainly work as a comprehensive text cum reference source for all walks of life. We express our heartiest gratitude to the publishers (Aavishkar Publishers, Distributors, Jaipur) for this quality publication.

Karan Singh
Mohan Lal Jakhar
Dhirendra Singh

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Section 1

Harvest and Post Harvest Management, Technology and Agroprocessing for Value Addition

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Post Harvest Management & Technology: Agroprocessing for Value Addition of Medicinal and Spiceal Plants

Karan Singh, D.P. Darmora,
M.S. Fageria, N.K. Jain and M.L. Gupta

The use of different parts of herbs, shrubs, climbers and trees for different ailments of human being is in vogue from ancient time. This application has led to the development of different system of medicine including Ayurveda, Siddha, Unani, Tibbi, Homoeopathy and Orthodoxpathy (Allopathy). Resulting from vast variation in agro climatic conditions, the biodiversity at global level has widened. This biodiversity is much more broad in respect of medicinal plants which are the basic raw materials for pharmaceutical industry with the concerted research and development efforts, many medicinal plants are now providing raw material for indigenous pharmacies and local herbalists. However, there is a strong need of better linkage between medicinal plants grown, dealim, marketing, health experts, pharmaceutical establishments and exporter.

With the growing awareness about ecofarming of medicinal plants throughout the world, the production is bound to increase and to make the pace within production, there is need to develop agro-processing technologies for value addition to medicinal plants and spices both. In the comparision of number of species of plants having definite curative properties, the work on isolation and characterization of active principles (therapeutically valuable plant molecules—pharmaceuticals) is limited to a few plants (Bhattacharjee, 2004). These pharmaceuticals include Ephedrine (Ephedra), Morphine (Papaver), Quinine (Cinchona), Emitine (Cephaelis), Baladona (Atropa), Cascara (Rhamnus), Digitalis (Digitalis), Ipecac (Cephaelis), Opium (Papover), rauwolfia (Rauwolfia), Veratrum (Veratrum) etc. Therefore, equal emphasis should be given, now, on the concurrent development of post harvest technologies and processing of medicinal plants and spices (Ghosh *et al.*, 1999; Singh and Tyagi, 2004).

Jones *et al.* (1996) reviewed the lilerature on status of agroprocessing in the world and highlighted the importance of processing of food, spices, and medicinal plants for value addition at various stages both in developed and developing countries. These processing technologies are based on biotechnological innovation such as fermentation technology of cereals, millets, pulses and other legumes, some fruits, vegetables, oilseeds, nuts, roots. The products so developed have better storability, quality, social acceptability and market demand.

Post harvest management technology includes primary, secondary, tertiary and sometimes quarternary processing operation performed on farm produce (Bisht, 2006). It is to provide longer shelf life, maintain/improve quality and enhance form, space and time utility of the produce for various purposes like food, feed, fibre, fuel and industrial uses. The farm produce includes food crops, horticultural produce, spices and medicinal plants. The processing embodies on farm handling, cleaning, grading, moisture conditioning, milling, extraction, cooling, freezing, rosting, puffing, floking, retort processing, packaging, curing, partial fermenting, purifying, bottling, transport and storages. Post harvest and value addition has been recognized as one of the high employment potential sector in Indian economy in the India Vision 2020 document of Government of India. "Vision 2020 Perspective Plan" of ICAR, New Delhi also recognized PHT as one of the important area for ICAR and state to minimized post harvest losses and improvement in produce quality. In the context of medicinal and spiceal plants, development of technologies and processes to support export oriented agriculture has also been aimed. This will be achieved through the scientific systematic and sustainable exploitation of terrestrial, aquatic and marine flora/fauna for extraction of rare chemicals, drugs, enzymes and harmones of pharmaceutical, medicinal and nutritional importance. ICAR has anticipated 20000 manufacturer's and 1 million artisens by the year 2020 to support farm machinery and post harvest sector and to reduce post harvest losses by 50% saving a sum of 225000 million of rupees.

There are data to indicate that processing of medicinal plants and spices at various stages of handing in poor and majority of these crop produces are marked raw and exported unprocessed. It was emphasized that for reduction of post harvest losses and for value addition in produce, holistic approach is essential at various stages of policy planning, execution and monitoring of the programmes including human capital/resources development. (Kumar and Kumar 2005 and Bisht, 2006). Among the R&D organizations, in the area of post harvest technology and value addition in India, there are 17 ICAR Institutes, 4 CSIR laboratories, 18 SAUs, 2 IITs and 11 others. Besides there are 50 adhoc projects. AICRP on Post Harvest Technology (ICAR) is operative at 34 PHT centres with head quarters at CIPHET, Ludhiana. This also emphasize on equipments development for reducing harvest and post harvest losses, proper handling, management processing, value addition, maintaining quality standards, energy production, by products utilization, organic products, with the terning of 'Food Processing Industry' as Sunrise Industry, we can realize the importance of processing which should be equally effective for medicinal and spiceal plants.

The situation of agro processing in Rajasthan is not encouraging at all. This situation is much more critical for processing and value addition to medicinal plants and spices. Looking to the importance of medicinal plants, each state has established Medicinal Plants Board. Hence, production is bound to increase. Therefore there is an utmost need to develop agro processing and value addition units besides suitable marketing support. Hence, this chapter has been added within special reference to condition of Rajasthan but is equally applicable to other states and union territories of India.

Although all the Institute of India are doing good work, there is special need to mention that Central Food Technological Research Institute, Mysore has done commendable research and development work during last 75 years. Process development and technological innovations on spices and some medicinal plants are worth mentioned. There is a long list of such achievements but development of such process/technologies for medicinal plants need special consideration.

The AICRP on Post Harvest Technology (ICAR) project is operative in India since September, 1972. At present its PC Cell is located in CIPHET, Ludhiana which is working with a national network of 34 centres. In Rajasthan two centres are working since a long (more then 20 years) but looking to the need of Rajasthan and its diverse agroclimatic conditions, one more centre was formally inaugrated on 29 March, 2005.

India produces 230.08 million tones of durables (cereals, pulses and oilseeds), semi perishables (78.29 million tones- tuber crops, spices, condiments, plantation crops, commercial crops) and perishables (255.96 million tones-fruits, vegetables, fish, milk, meat, poultry and eggs). About 10% (Cereals), 15% (Pulses), 12% (Oilseed), 20% (Tuber crops), 12% (Spices, condiments), 12% (Plantation crops) and 10% (Commercial crops) crop produces are lost due to various factor during harvest to storage. Among perishable crops like fruits and vegetables, losses are much more (30%). As these estimates are quite old (20-25 years) the Government of India has directed AICRP on PHT to study such losses afresh. In Rajasthan, work on the fresh assessment of harvest and post harvest losses of the crops like coriander, soybean, maize, pearl millet, cottonseed, chickpea and mustard is being carried out since August 2005. Study of these losses is required to give insight and develop measures for reducing such losses at various stages of post harvest handling & processing of medicinal plants and spices.

The scope for the development of agro processing industry for medicinal plants in the state is ample. With the changing world market's demand scenario, there is a need to for medicinal plants effect a shift from the traditional industries to modern industries. There is still a vast untapped key potential project area in the sector like crude drug processing & derivatives, tissue culture/oleoresin, frozen fruits & vegetables and herbal derivatives.

Presently about 10 percent of grains and 35 percent of fruits and vegetables goes waste due to post-harvest losses alone and a large portion of this loss can be prevented by creating suitable infrastructure for processing in the state. The simple primary processing and value addition activities can provide additional income from 10 to 30%. As per some estimates, about 30 percent of total marketable surplus gets processed outside the state. The investments by state government, in the past have been mainly to create agricultural marketing infrastructure, in the form of Krishi Upaj Mandi yards and rural roads only. Construction of godowns, cold storages, primary-processing facilities for cleaning and grading has not been created up till now. The drug processing industry in India needs immediate attention.

MARKETING LINKED MATTER

1. Weakness of existing marketing system—Fruits & Vegetables: (Therapeutically valuable)

- Poor quality produce
- Lacking sustained supply
- Poor adoption of improved post harvest technology at farm level—
  - Timeliness and method of harvesting
  - Cleaning
  - Grading and sorting
  - Pre-cooling
  - Storage
  - Packing
- Lack of refrigerated transportation—
  - For consumption markets
  - For export
- Inadequacy of cold storage structures
- Long chain of middlemen resulting in
  - Price Escalation
  - Poor share to farmers
  - Delay in supply
  - Deterioration in quality
  - Creation of gap between producer and consumer
- Long distances between production and marketing centres, inadequate market accessibility
- Irrelevant by-laws prevailing in market committees regulating trade of fruits & vegetables
- Poor market intelligence services
- Poor retention capacity and bargaining power of farmer due to smaller size of holding and low productivity.
- Dominance/monopsony/ biopsony/oligopsony make it in non-perishables.
- Absence of buyers for new or irregular produce
- Lack of support for diversification and adoption of new technology
- No designated marketing for minor forest produce/organic produce/medicinal plants

2. Extent of adoption of PHM techniques:

The existing status of adoption of post harvest management and value addition in the state is almost non-existent and still primitive. The traditional practices are being followed which result in huge quantative and qualitative losses. The following table-1 gives the extent of adoption of post harvest management techniques.

Table 1 : Extent of adoption of PHM techniques

Crop/technique	Cleaning	Grading	Packaging	Transportation	Labeling	Storage
Wheat	Partial	Partial	Partial	Full	Nil	Partial
Pearl-millet	Partial	Nil	Nil	Full	Nil	I Partial
Maize	Partial	Nil	Nil	Full	Nil	Partial
Pulses	Partial	Nil	Nil	Full	Nil	Partial
Oilseed	Partial	Nil	Nil	Full	Nil	Partial
Coriander, Cumin, Fennel,	Partial	Nil	Nil	Full	Nil	Partial
Garlic and Onion	Full	Nil	Nil	Full	Nil	Partial
Fruits & Veg .	Full	Nil	Partial	Partial	Nil	Partial

3. Extent of losses (%) in various operations from harvesting to storage:

The national data are available on various losses from harvesting to storage on different crops. However, such data for Udaipur district (year-1990) are available for wheat and Maize (Table-2).

Table 2 : Losses (%) to various operations from harvesting to storage

Crop/unit operation	Harvesting	Drying	Threshing	Transportation	Storage	Total
Wheat	2.21	0.78	1.47	0.31	4.70	9.47
Maize	0.00	2.73	1.35	0.08	6.16	10.32

In Rajasthan, work on the fresh assessment of harvest and post harvest losses of the crops like coriander, soybean, maize, pearl millet, cottonseed, chickpea and mustard has started since August 2005.

4. Existing processing units:

- Total small-scale level units —41835 with Rs 415 crore investment
- Total large and medium scale units —77 with Rs 630 crore investment

a. Fruits and vegetables processing —
- Negligible organized sector processing in the State
- Entire produce is exported raw to the neighbouring states.
- No. of units in the unorganised sector under KVIC

b. Spices processing -
- Not much processing of spices in the organized sector at present.

- Cleaning and packaging of spices is carried out in the unorganised sector.
- However, two oleoresin plants have been set up recently.

c. Dairy products-
- Dairy sector is dominated by cooperatives.
- Few dairies in the private sector producing value-added products, while most of the milk processing is in the unorganised sector.
- About 2,700 dairy cooperative societies collecting around 121 million litres of milk every year.
- 10 dairy plants with a total processing capacity of 900,000 litres a day and 24 chilling plant with a capacity of 400,000 litres per day.

d. Oilseeds-
- 50 solvent extraction plants,
- 1,300 oil mills,
- 50 oil refineries and
- 15 Vanaspati plants, in addition to thousands of tiny oil seed crushing units spread all over the state
- The oil seeds crushing industry suffers from 50% overcapacity, led to a majority of units becoming sick or closing down.
- The raw material shortage is around 18 lakh tons per annum (TPA). for rabi and kharif oil seeds together.
- Solvent extraction of oils, from soyabean and oilcakes is an opportunity area, as a capacity gap of 6 lakh TPA exists at present.

e. Cereals-
- The total milling/grinding capacity available in the State is 16 lakh TPA, which results in a procurable surplus of 35.4 Iakh TPA.

f. Cotton-
- Only 10 per cent of the 10 lakh bales produced are processed in the State.

g. Guar-
- The existing processing capacity is sufficient to process 20 per cent of production and hence there is a procurable surplus of 4.5 lakh TPA.

The following proposals have been received (Under the scheme of Ministry of Food Processing Industries, Govt. of India, through State Industries Department) showing the interest for development of new industries in the state:

1.	Flour, suji, besan plant	23
2.	Mustard, soyabean oil extraction plant	25
3.	Salt, papad	9
4.	Dal (pulses)	15
5.	Bread, toast, biscuit, bakery	6
6.	Fruit juice, pure, syrup & sharbat	4
7.	Milk & milk products — Ghee, ice-cream	9
8.	Spices/Aata industries	3

9.	Isabgoal, bhussi/powder	1
10.	Guar-gum, powder, split plant	10
11.	Ready to eat vegetable food	1
12.	Corn flakes	2
13.	Mint oil	1
14.	Confectionery, bubble gum, toffee	1
15.	Meat processing	1
16.	Rice grading	1
17.	Entrepreneurship development program	6
18.	Food processing & training centre/HRD/seminar (FPTC)	8
19.	Dairy and food science college infrastructure	1

This clearly indicates that the entrepreneurs expressed their interests towards already existing type traditional industries mainly based on non-perishable commodities. The perishable commodity sector has been almost neglected. Therefore, there is an urgent need to review on the identification of new avenues for value addition in both perishable and non perishables and enhancing exposure of them to potential investors along with the implementation manner of MOFPI schemes.

5. Potential of agro-processing:

I. Potential for investment in agro-based industry

Following additional capacity would be required immediately in the agro-processing sector in Rajasthan:

Solvent extraction	22.15 Lac tonnes per annum (TPA)
Refined oil	10.95 Lac TPA
Dairy products	7 million litres per day
Vegetable processing	3.94 Lac TPA
Spice processing	5.40 Lac TPA

II. Processing potential in Rajasthan

Fruit products	Mango	Sliced, canned, frozen mango products, beverages, chutney, jam, juices, pickles, pulp and squash
	Kinnow	Juice
	Orange	Juice, concentrate, marmalade
Vegetable Products	Tomato	Jelly, puree, paste, ketchup, sauce, soups, chutneys, powder
	Onion	Pickle, onion flakes, onion powder
	Brinjal, Potato	Dried products
Spices	Chilly	Paste, powder, oleoresin
	Coriander	Cleaning, grading, powder
	Garlic	Dehydrated garlic, powder, flakes, paste

contd. ...

... contd.

	Ginger	Powder, paste, oleoresin, pickles, squash
	Cumin, Ajwain	Cleaning, grading
Vegetable Oil	Mustard	Oil, cake
	Groundnut	lecithin, protein isolate
	Soybean	Soya flour, soya-sauce
Cereals	Wheat	Flour, maida, suji, instant foods, bakery product
	Barley	Beer
	Maize	Starch, corn oil, corn flakes, animal feed
Guar		Guar split, powder
Cotton		Yarn, cloth, cotton seed oil
Isabgol		Husk
Milk Products		Milk powder, butter, ghee, ice cream, cheese
Meat & Poultry		Meat, eggs, poultry products

Source: TCS Study Report

III. Preferential locations for processing activities

- **Economic group - Oil seeds**
  1. Soybean — Kota, Baran, Bundi, Jhalawar, Chittorgarh
  2. Mustard — Major parts of Rajasthan
  3. Groundnut — Bikaner, Jaipur, Nagaur, Dausa, Karauli, Tonk, Sawai Madhopur
- **Economic group - Cereals**
  1. Wheat — Ganganagar, Hanumangarh, Kota, Chittorgarh, Jaipur, Bharatpur, Dausa
  2. Barley — Jaipur, Sikar, Nagaur, Hanumangarh, Alwar
  3. Maize — Chittorgarh, Udaipur, Bhilwara, Banswara, Jhalawar
  4. Pearl millet — Western Rajasthan
  5. Paddy — Bundi, Hanumangarh
- **Economic group - Spices**
  1. Coriander — Kota, Baran, Bundi, Jhalawar, Chittorgarh
  2. Cumin — Jodhpur, Barmer, Nagaur, Pali, Jalore
  3. Fennel — Sirohi, Dholpur, Bharatpur
  4. Fenugreek — Nagaur, Chittorgarh, Jhalawar, Sikar, Jaipur
  5. Ajwain — Chittorgarh
  6. Chillies — Sawai Madhopur, Tonk, Jodhpur, Bharatpur, Karauli
  7. Garlic — Kota, Baran, Jhalawar, Chittorgarh, Udaipur
  8. Onion (Spice) — Jaipur and nearby districts.
- **Economic group - Vegetables**
  1. Potato — Bharatpur, Dholpur, Bundi

2.	Tomato	Jaipur, Sirohi, Alwar, Jalore, Karauli
3.	Onion (Vegetable)	Ajmer, Alwar, Jaipur, Sikar, Jhunjhunu, Nagaur, Jodhpur
4.	Bitter Guard	Ajmer, Jaipur, Kota, Tonk
5.	Peas	Jaipur, Bundi
6.	Clusterbean	Jaipur, Alwar, Nagaur
7.	Methi	Nagaur
8.	Round gourd	Jaipur

➢ **Economic group - Fruits**

1.	Lime	Banswara, Chittorgarh, Udaipur, Kota, Bharatpur, Jaipur
2.	Aonla	Alwar, Jaipur, Jhalawar, Chittorgarh
3.	Orange	Jhalawar
4.	Ber	Jodhpur, Jaipur, Jhalawar
5.	Custard apple	Sirohi, Udaipur

➢ **Economic group - Medicinal Plants**

1.	Isabgol	Jalore, Barmer, Nagaur
2.	Mehandi	Pali, Jodhpur
3	Sena leaves	Pali, Jodhpur
4.	Safed musli	Baran, Rajsamand, Udaipur
5.	Ashwagandha	Kota, Jhalawar, Chittorgarh
6.	Leman grass	Gangapur

➢ **Economic group - Minor Forest Produce**

1.	Jatropha	Udaipur, Banswara, Bhilwara, Dungarpur, Chittor, Bikaner
2.	Dolma	Udaipur, Dungarpur, Banswara (for gripe water)
3.	Kattha	Chittorgarh, Jhalawar

Use of biomass for energy production

The crop residues of mustard crop are being used as boiler fuel in soya-processing industries in Kota and Baran districts. The gasifier based decentralized energy system has potential in the state.

Study of regulatory and legal framework

The required amendment in APMC Act for contract farming, direct procuring, Private Mandi, Farmer Consumer Market in private sector has been done.

MAJOR INVESTMENT OPPORTUNITIES IN HORTICULTURE (MEDICINAL & SPICES)

- Establishing waxing centre, pack house, cool chain etc.
- Fruit juice concentrate

- Oil extraction from Aonla
- Drying & dehydration of fruits & vegetables
- Oleoresin and essential oil extraction of spices, medicinal & aromatic plants.
- Medicines based on Aonla, Isabgol, Sonamukhi, Aswagandha.
- High tech nurseries for fruit plant sapling production.
- Green houses for off-season and exotic vegetable production.

So far, Horticulture is the most neglected field in the state. The post harvest losses are very high. Hence proper attention is needed. The state is annually producing approx. 7 lac tones of fruit and vegetables, 6.5 lac tones of seed spices, 1.1 lac tones of medicinal and aromatic plants.

Table 3 : Area and production of horticultural and spice crops (Area in lac ha, Production in lac million ton)

Crop	2001-02		2002-03		2003-04	
	Area	Prod.	Area	Prod.	Area	Prod.
Fruits	0.22	2.00	0.223	1.89	0.233	-
Vegetables	1.00	4.34	0.94	3.54	1.25	5.07
Spices	7.63	6.17	5.33	3.44	5.90	6.47
Medi. & Arom. Plants	1.43	0.90	1.68	0.79	1.61	1.08
Flowers	0.02	0.025	0.0015	0.001	0.20	0.022

Table 4 : High valuable fruits of state

Crop	Production (MT)	Growing belts
Orange	2,00,000	Jhalawar, Kota
Kinnow	7,000	Sriganganagar, Hanumangarh
Aonla	6,000	Jaipur, Ajmer, Alwar

Table 5: High value vegetables of state

Crop	Production (MT)	Growing catchments(Districts)
Onion	2,06,000	Jodhpur, Ajmer, Sikar, Jaipur, Alwar
Tomato	53,000	Jaipur, Sirohi
Potato	28,500	Bharatpur, Dholpur, Ganganagar, Kota
Okra	10,000	Jaipur, Alwar, Bundi, Ajmer
Tinda	20,000	Jaipur, Alwar, Tonk
Cole crops	22,000	Ajmer, Jaipur, Alwar, Tonk, Bundi

Potential for agri-export (outside state and country)

The production of various crops is concentrated in different pockets making different supply zones. For providing focused attention marketing of these crops, some specific markets have been declared and project works are in progress as under:

Table 6 : Important crops and project cost

S.No.	Name of KUMS	Commodity	Project Cost (lakhs)
1.	Jodhpur	Cumin	174.50
2	Sojat Road (Sub Yard Sojat City)	Henna Mehandi	162.66
3	Sub Yard Pushkar	Flowers	91.00
4	Ajmer	Flowers	102.75
5	Chhabra (Sub Yard Chhipa Barod)	Garlic	100.65
6	Alwar (Phase I)	Onion	50.48
7	Bhawanimandi	Orange	50.48
8	Mertacity	Cumin	203.26
9	Ramganjmandi	Coriander	224.70
10	Tonk	Chill	324.06
11	Sawai Madhopur	Guawa	287.21
12	Jaipur (F&V) Sub-yard Shahpura	Round Gourd (Tinda)	128.50
13	Jaipur (F&V) Sub Yard, Bassi	Tomato	179.20
14	Chomu	Gooseberryl (Amla)	216.10
15	Sojat Road (Sub Yard Sojat City)	Sonamukhi	
16	Bhinmal	Isabgol	
17	Jhalrapatan	Aswagandha	
18	Sriganganagar	Kinno	
		Total	**2340.52**

Table 7 illustrates the state rank in production of various crops. The state rank 1st in coriander, cumin, fenugreek, Isabgol, mehandi and mustard oil seed production and 3rd and 4th in oranges and sweet oranges production. Table 8 depicts share of state in national production. Exportable surplus of various seed spices is shown in Table 9. Coriander and cumin are two high value export crops of the state, having 5 AEZ each separately (Table-10).

Table 7 : State's position in production at national level

Crop	State's Rank in Production
Coriander, Cumin, Fenugreek, Isabgol, Mehndi and Mustard	1st
Oranges	3rd
Sweet Oranges	4

Table 8 : Production of spices (MT, Yr: 2001-02)

Spices	India	Rajasthan	share of state (%)
Coriander	318700	233997	73
Cumin	206400	145110	70
Fenugreek	136600	127807	93
Fennel	38500	7072	18
Garlic	367600	44085	12
Chillies	1113100	49089	4

Table 9 : Exportable surplus

Crop	Exportable Surplus MT
Coriander	1,20,000
Cumin	40,000
Fenugreek	20,000
Chillies	40,000
Garlic	25,000
Fennel	3,000
Ajowain	5,000
Oil Seed	1.200

Table 10 : AEZ for coriander and cumin

AEZ for Coriander	AEZ for Cumin
Kota	Barmer
Baran	Jalore
Jhalawar	Jodhpur
Bundi	Nagaur
Chittorgarh	Pali

Table 11 : Centres of export

Centre	Crop
Merta City	Cumin
Jodhpur	Fenugreek, Chillies
Sumerpur / Rani	Fenugreek
Jaipur/Sikar	Fenugreek, Cumin
Ramganjmandi	Coriander
Abu Road / Revdar	Fennel
Pushkar	Rose
Chabra	Garlic
Sojat	Mehndi

Table 12 : Export potential

Fruits	Vegetables	Processed/dried products
Mandarin (Santra)	Fresh vegetables: Tomato, Onion, Okra, Pea Green Chillies	Red chilli & chilli Powder
Kinnow & Oranges	*Capsicum*, Bitter Gourd, Tinda, Cabbage, Cauliflower, etc.	Dried / dehydrated vegetables
Aonla & its products	Honey & its products	Garlic whole paste & powder

Table 13: Processing potential

Crop	Processing products
Orange	Squash, concentrate, marmalede
Kinnow	Squash, concentrate, marmalede
Aonla	Powder, pickle, preserve, squash, RTS, beverages, candy, sweets, ayurvedic medicine, oil etc.
Spices	Powder, oleoresin, volatile oils etc.
Isabgol	Husk
Mehndi	Powder
Aswagandha	Powder
Sonamukhi	Powder
Rose	Perfume, rose, water, gulkund and dry patels

Important underutilized fruits/ vegetables and their processing potential with medicinal and spices point of view

These fruits require a lot of processing operation before use. Most of them can not be used as such. These can be grown very successfully under abiotic stress conditions. These are medicinally important and organic in nature too. The attack of diseases and insect-pest is also very less. Therefore, there is need to exploit these plants in the state both with production potential and processing points of view.

Fruits	Processed products
Bael	Pulp, nectar, squash, syrup, toffee, jam, preserve dried powder
Phalsa	Juice, squash, syrup, nectar
Jamun	Juice, squash, nectar, syrup, jam
Custard apple	Puld and beverage
Wood apple	Chutney and dried
Carambola	Chutney and pickle
Karonda	Pickle, dried and candy
Ker	Salt stock, pickle and dried powder

contd. ...

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Fruits	Processed products
Lasora	Salt stock, pickle dried
Sangri	Pickle, dried, fresh for vegetable
Kachari	Pickle, fresh, dried and Powder

MEASURES FOR VALUE ADDITION : GENERAL ASPECTS

- Quality production by applying improved production practices
- Organic production/farming
- Harvesting of produce at right stage for better processing potential
- Development of varieties with better processability and quality
- Knowledge of post harvest technology to produce the quality produces
- Adoption of right methods of processing
- Proper drying (Moisture range between 8-10 %)
- Grading, packaging and storage
- Produce free from all kinds of contaminations
- Production of essential oils from seed spices
- Production of oleoresins from seed spices
- Production of derivatives of essential oil /oleoresins
- Production of curry powder

GENERAL OUTLINE OF MEASURES FOR REDUCTION OF HARVEST AND POST HARVEST LOSSES

These measures are necessary to reduce losses under post harvest operation in harvesting, threshing, packaging and transport from farm gate to market:

A. For grains:

- Harvesting of crop at optimum moisture/maturity time
- Adoption of improved harvesting tools/sickles, mechanical harvesting (crop specific)
- Collection of crop at proper place/pucca floor
- Proper drying of crop to optimum moisture level
- Threshing with proper thresher at optimum m/c parameters
- Optimum drying, cleaning & grading of produce, introduction of improved gadgets
- Proper packaging and transport to market
- Training of farmers and extension officials

B. For Horticultural produce:

- Promotion of safe harvesting, handling and hygienic production of quality products
- Creation of pre-cooling, sorting, grading and packaging facilities nearer to production site for improving shelf life & quality of the product

- Adoption of quality packaging technologies at competitive price
- Training of farmers and extension officials
- Adoption of zero energy evaporative cool storage structure

AGRO PROCESSING AND BIO-FUEL/BIO-DIESEL IN RAJASTHAN

Addressing promptly, the utmost need of the day. GOR has taken effective steps in this direction. These steps include establishment of State Bio-Fuel Authority Jaipur, encouraging the cultivation of Jatropha and other plants and certain other initiative. The commercial production of bio-diesel has been started by a processing unit at Udaipur. A processing unit for production of alcohol from pearmillet (and also from rice) has also been founded in industrial area Ringus. This will give a boost to pearlmillet utilization in Rajasthan. In days to come, such processing units may play valuable role in the economic upliftment of Rajasthan and may pave the way for other units in the state.

PHT FOR SMALL FARMS

A lot of techno-economically sound post harvest equipments and technologies have been developed in different ICAR institutes/SAU's to suit the requirements of small-scale operations at rural level (Table-14). There is a strong need to popularise and technology transfer of these developed technologies to add value to farm produce and increase the farmer's income by 7.5-30% (Table-15).

A three-pronged strategy may be adopted for improving the overall efficiency of post harvest sector. These inputs may be:

1. Application of appropriate / mechanize PHT for conservation of crops both in quality and quantity during their handling, processing and storage.
2. Utilisation of agri. waste/ residues/by-products such as husks/stalks/shells etc. for food, feed, fuel, chemicals, building materials and industrial uses.
3. Diversification of agri-based activities such as bee keeping/poultry/ sericulture, etc. so as to augment the income of small farmers during lean season.

The adoption of improved Post harvest mechanization /equipments will lead to two types of rural industries which may be independent to each other, and provide employment to rural artisans for manufacturing these equipments locally and to rural processors for utilization of these equipments for processing farm produce either on custom hiring basis or for sale purposes.

The renewed emphasis on post harvest mechanization will lead to following benefits:

- Consolidating the existing income generating activities
- No displacement and special adjustment of labour with time
- Simple level of technology would be easy to be adopted by rural people.
- Locally available raw materials may be properly utilized to preserve ecological balance.
- Mechanization will not only reduce drudgery but would also improve efficiency of work and will sooner or later reduce work force. Hence other activities for diversification be encouraged for overall development of small farmers.

Table 14 A : Improved post harvest equipments suitable for farmers

S. No.	Name of m/c	Suitability for crops	Capacity kg/h	Power KW	Cost Machine (Rs)	Cost Operational (Rs/q)
1.	Hand operated double screen for grains	All grains	150-225	Manual	2,000	5.30
2.	Pedal/power operated grain cleaner	All grains	330-800	Manual /0.36	8,500	7.50
3.	Fruits-vegetable grader	Potato, orange, apple, malta	1500-2500	1-2	30,000	3-4
4.	Flour separator	Wheat, gram, soyabean	80-120	0.75	22,000	14
5.	Tubular maize sheller	Maize	18-22	Manual	30	62
6.	Maize dehusker sheller	Maize	800	3.5	33,000	14
7.	Decorticator	G. nut, castor	60-70	Manual	900	18
8.	Decorticator	G. nut	300	1.5	16,000	16
9.	Grain pearler	Wheat, bajra, sorghum, pulses	100-300	3.5	20,000	16
10.	Dhal mill	Moong, urd, arhar	100	1.5	13,500	17
11.	Grain mill	Grains, Pulses, Spices	10-30	0.75	9,500	45-110
12.	Potato peeler	Potato	30-32	Manual	4,000	30
13.	Potato Slicer	Potato	30	Manual	4,500	35
14.	Flaking m/c	Soya, maize, jowar, gram	20	0.75	13,000	75
15.	Solar Dryer	All vegetable	3-5 kg/batch	Solar	6,000	66 Rs/h
16.	Pea sheller	Pea	50-60	0.20	15,000	6-7
17.	Chilli seed extraction m/c	Chilli	50-70	1.5-2	20,000	10-15

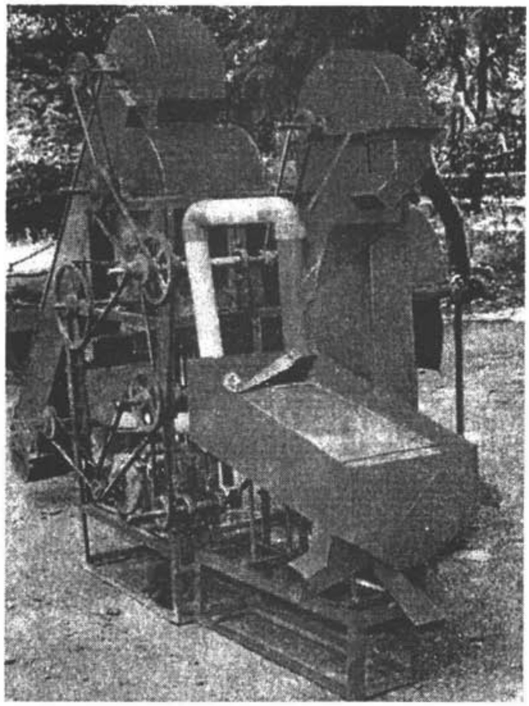

Fig. 1 : Chilli seed extractor.

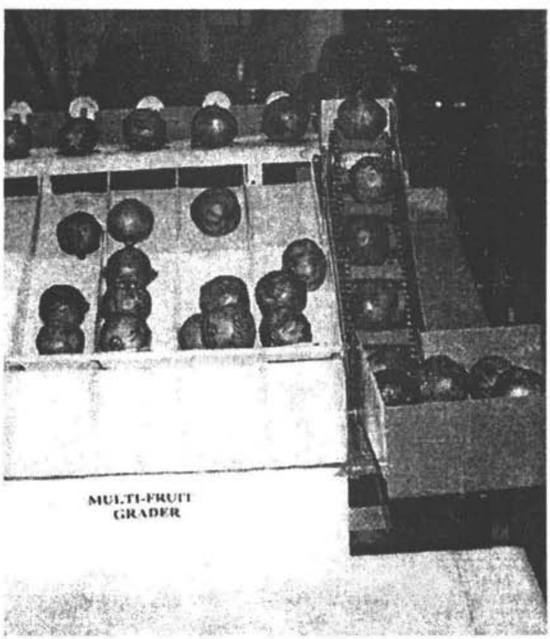

Fig. 2 : Multifruit grader for various fruits.

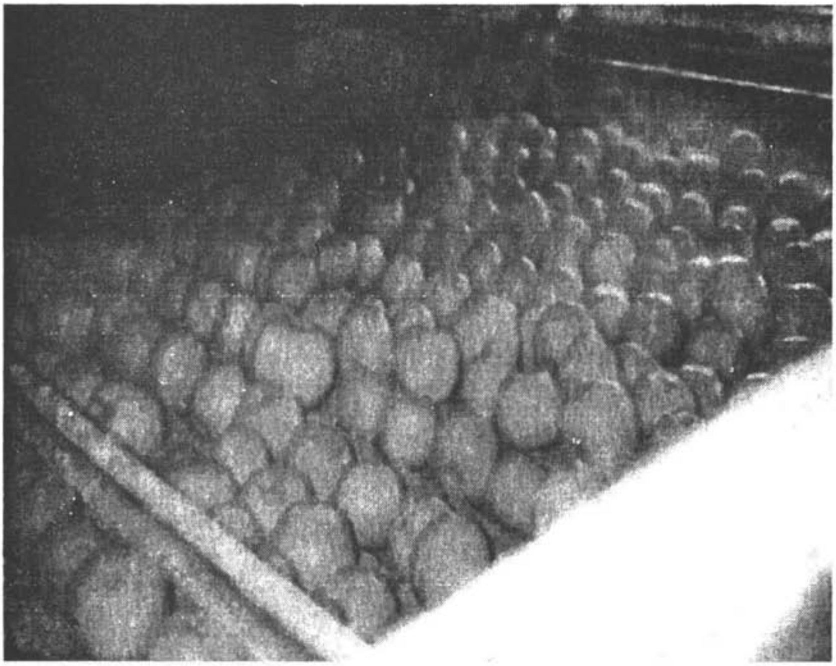

Fig. 3A : Improved washing and waxing technology of fruits.

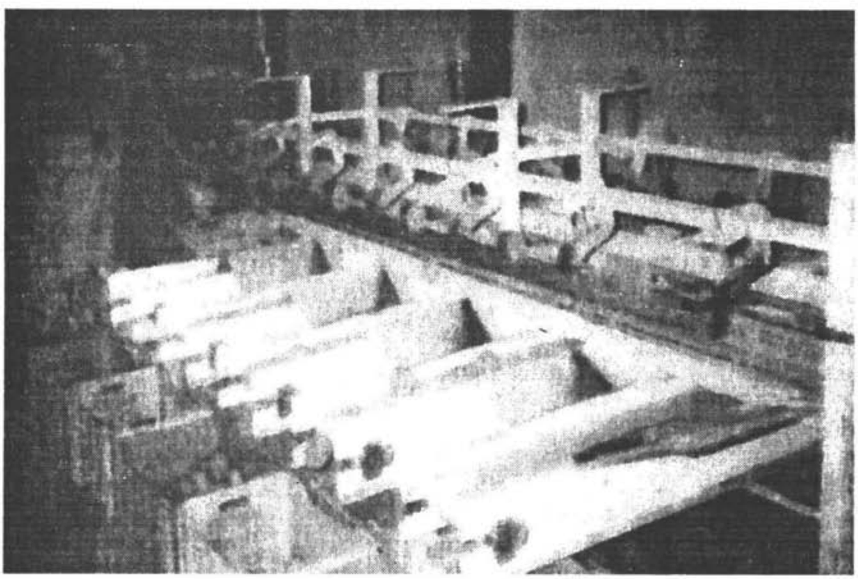

Fig. 3B : Improved technology of grading of medicinally important fruits.

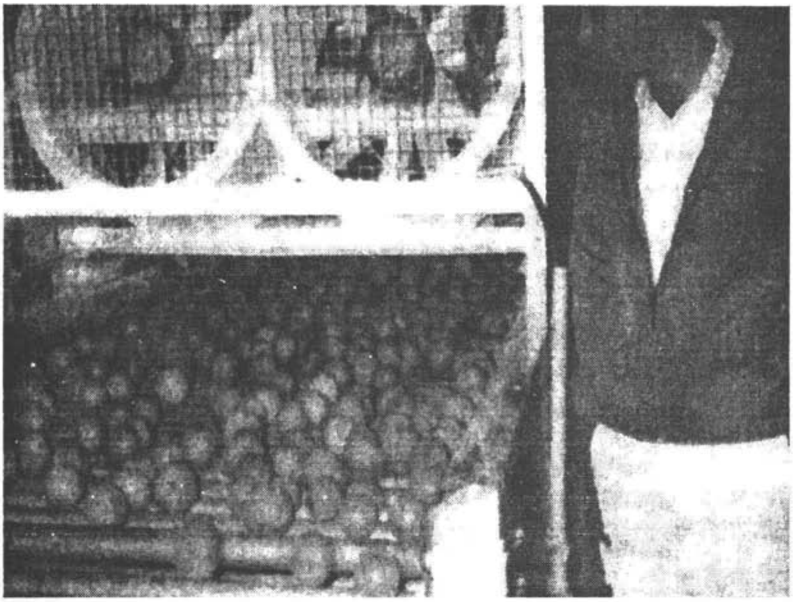

Fig. 3C : Safe drying of fruits after waxing.

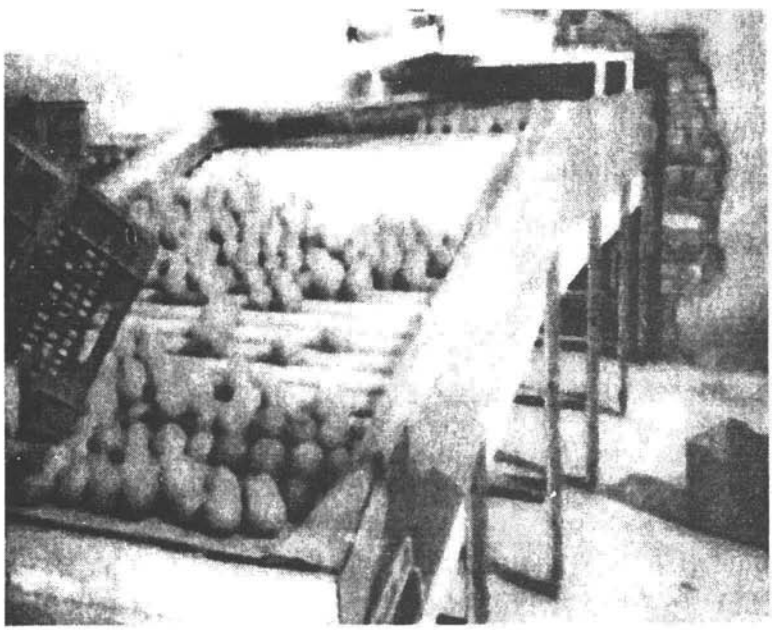

Fig. 3D : Kinnow fruit loaded for washing.

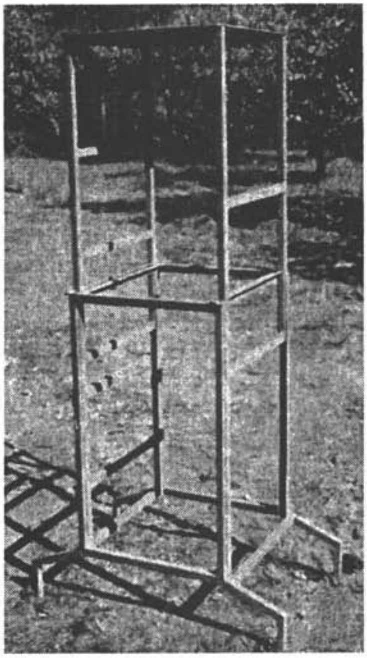

Fig. 4A : Flexible harvesting plate form for ber (RAU, SKNCOA, Jobner contribution): stretched stage.

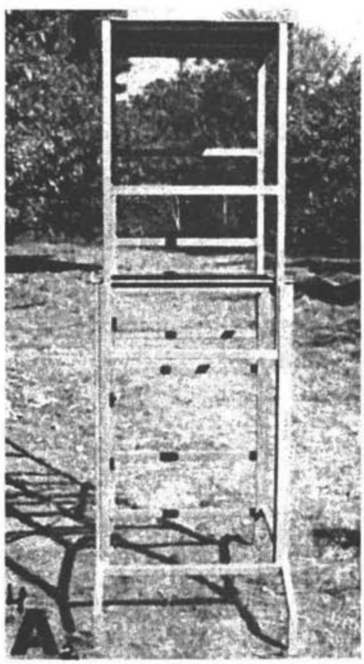

Fig. 4B : Flexible harvesting plate form for ber (RAU, SKNCOA, Jobner contribution): normal stage.

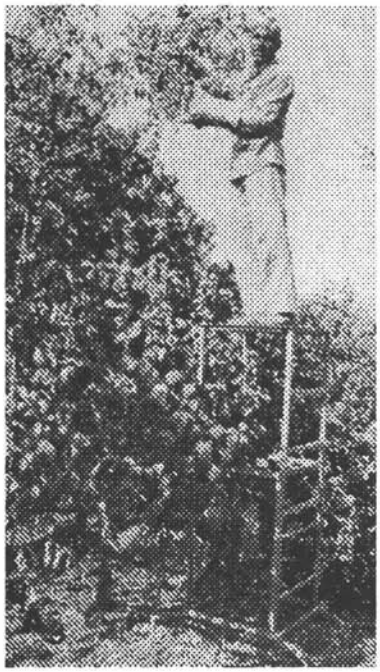

Fig. 4C : Flexible harvesting plate form for ber (RAU, SKNCOA Jobner contribution) Apparatus in working stage with manpower.

Fig. 5 : Usual fruit harvester better than manual simple harvesting.

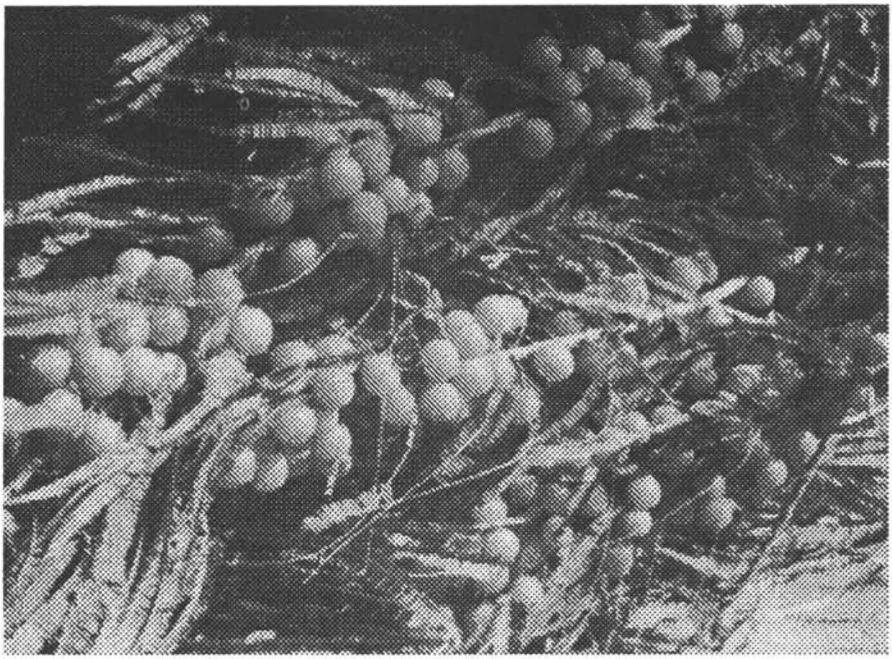

Fig. 6 : Aonla branch laden with physiologically mature fruits which have better processing quality.

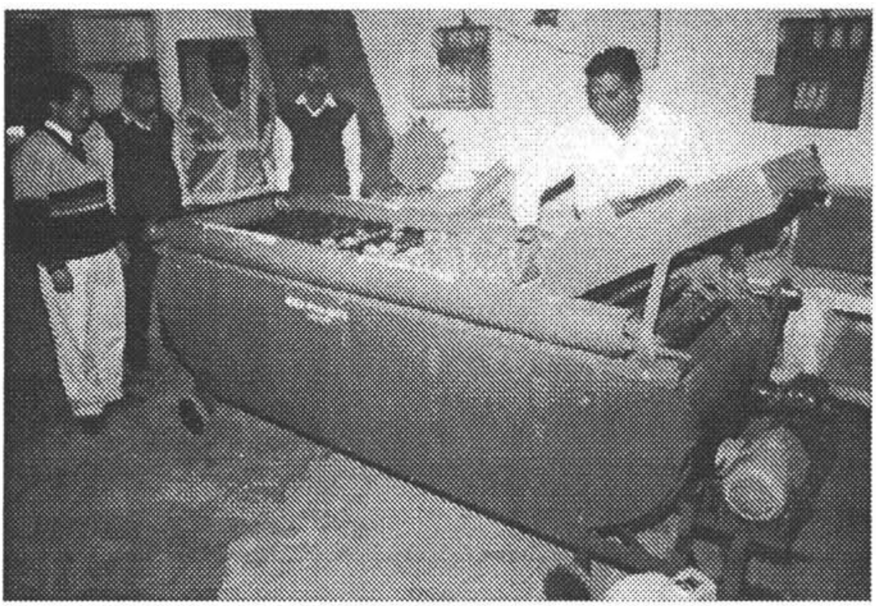

Fig. 7 : Improved vegetable/fruit grader.

Fig. 8 : Combine harvester for crops.

Fig. 9 : Power thresher for reducing post harvest losses.

Fig. 10 : Fruits packed in corrugated fibre board boxes.

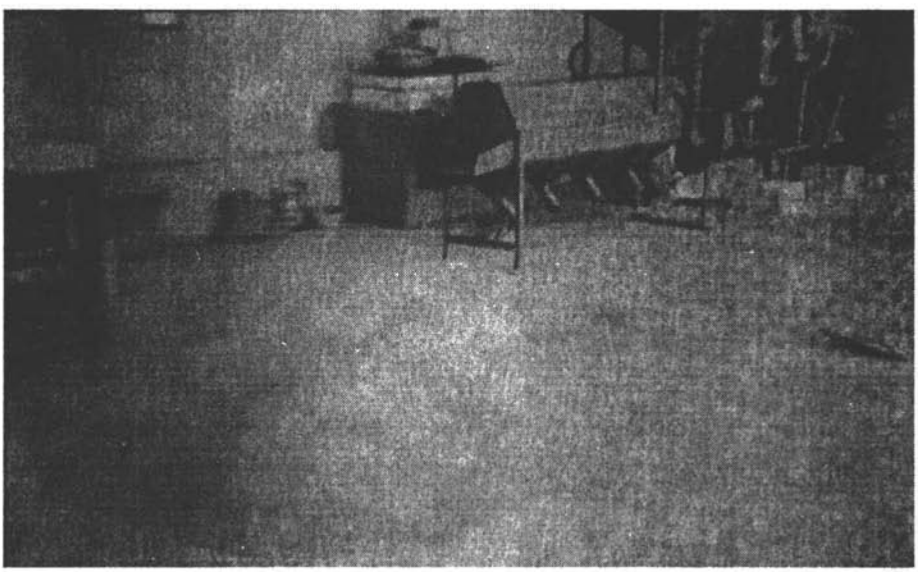

Fig. 11 : Improved dhal mill with processed product.

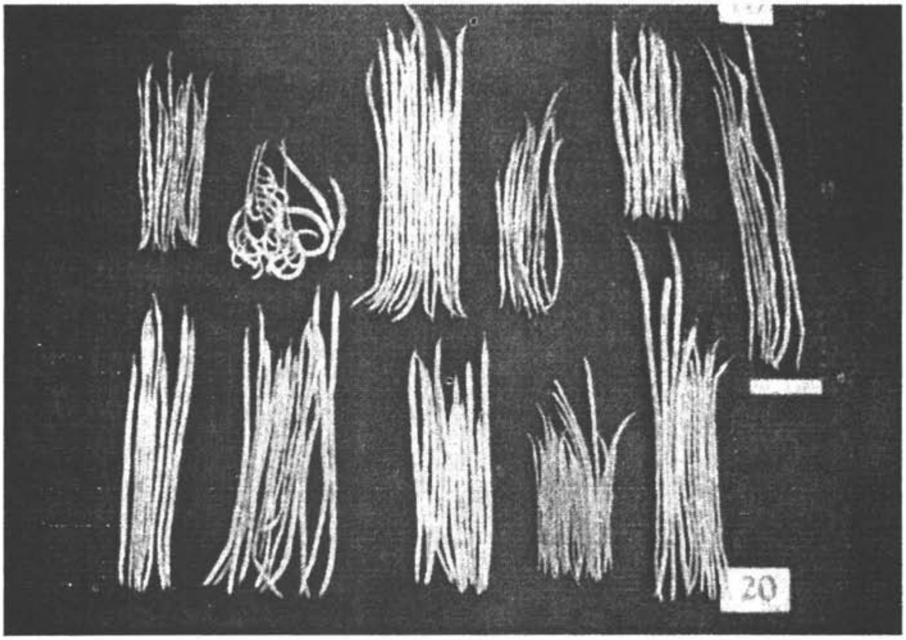

Fig. 12 : Variability in khejri pods with different processing quality.

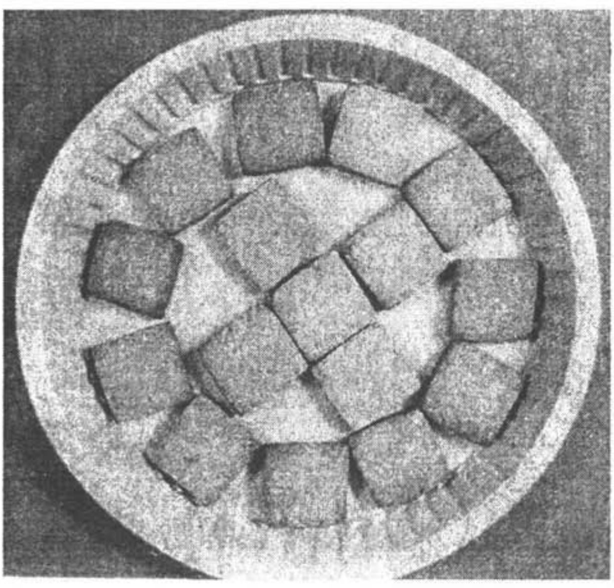

Fig. 12A : Biscuit prepared with floor of khokha (mature khejri pods).

Table 14-B : Some other harvest/post harvest equipment

1.	**Vegetable washing machine**	**2.**	**Ginger washing machine**
3.	**Fruit harvest net**	**4.**	**Solar cabinet drier**
5.	**Tomato juice extractor**	**6.**	**Green chickpea sheller**
7.	**Garlic bulb breaker**	**8.**	**Tamarind sheeting machine**
9.	**Tamarind De-seeding machine**	**10.**	**Radial honey extractor**
11.	**Multi crop threshers**		

Table 15-A : Additional income due to adoption of improved post harvest operations

S.No.	Crop	Post Harvest Operations		Additional income %
1	Fruits and vegetables	i.	Cleaning, grading and sorting	25.0
		ii.	Drying	30.0
		iii.	Preservation	15.5
2	Spices	i.	Milling	20.0
3	Maize	i.	Dehusking & shelling	12.5
		ii.	Cleaning	7.5
		iii.	Storage	15.5
4	Wheat	i.	Cleaning & grading	7.5
		ii.	Storage	15.0
		iii.	Milling	15.5
5	Paddy	i.	Cleaning & grading	7.5
		ii.	Storage	15.0
		iii.	Puffing	15.0
		iv.	Milling	15.0
6.	Pulses	i.	Splitting	10.0
		ii.	Dehusking	10.0
		iii.	Besan making	18.5
7	Oil seeds	i.	Milling	12.5

These technologies can be adopted in Rajasthan as such or after summary adaptive trials. Other technologies are at advance stage of commercialisation and use and may be tested for Rajasthan for subsequent adoption. In due course, new technologies suitable for Rajasthan may be developed / adopted.

Table : 15-B Technologies at advance stage of testing and release at National level

➢ Low cost grain infestation detector	➢ Solar drier-cum-green house
➢ Solar batch-in-bin drier	➢ Temporary crop covering devices
➢ Evaporative cooled storage structures for oranges	➢ Chittore store bin for safe storage of food grains
➢ Process for erogt-bajra separation	➢ Groundnut grader (power operated)

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- Rotary screen grain pre-cleaner
- Low cost seed storage bins
- Mango grader
- Safe storage of soybean seeds
- Storage technologies for pulses
- Natural air ventilated onion storage structure
- Trolley-cum-batch type drier
- Solar heat treatment machine for seeds/ grain
- Infrared seed treater
- Magnetic treater for seed
- Sun drying of chillies on different floors
- Packaging for mango
- Solar cabinet drier
- Sugarcane juice bottling process
- Groundnut stripper
- Tamarind kernel paste
- Pearler for coarse cereals
- Leaf grinder (to be adopted for mehandi)
- Oleoresin from ginger
- Puffing of coarse cereals
- Lime juice extractor
- Roofing tiles from soybean straw and cement
- Ginger and turmeric polisher
- Dehydrated pea processing technology
- Guava toffee

NETWORKING THE AGRO PROCESSING THROUGH PHT CENTRES AND KVKs : PROSPECTS IN RAJASTHAN

There are three major co-operative centres of AICRP on PHT in Rajasthan with specific mandate and crops and each district has a KVK either managed by ICAR or Agricultural University or NGO. These alongwith government functionaries (extension machinery of agriculture department) will play very important role in establishing and operating the network of model and district level agro-processing centres.

PHT centres, KVKs and other ICAR institutes to be involved in agro processing network are given in table 16A, B and C.

Table 16 A : Network for agro processing, value addition and marketing

S. No.	Name of locational institute	Contact person	Telephone No.	Priority Crops	Nodal place, model APC
1.	ARS, PHT Centre, Durgapura, Jaipur	Officer Incharge (OI) PHT	0141-2724075	Seed spices Clusterbean, henna, aonla, pomegranate, ber and aloe	Model APC, Durgapura
2.	PHT Centre, CAZRI, Jodhpur	OI, PHT		Under utilized fruits and vegetables of arid zone.	Model APC, Jodhpur
3.	PHT centre, CTAE Udaipur	OI, PHT		Maize etc.	Model APC, Udaipur

APC= Agro Processing Centres

Table 16-B : District level agro processing and value addition centres

S. No.	Name of locational institute	Contact person	Telephone No.	Priority crops	District APC
1.	KVK, Tabiji, Ajmer	Chief Scientist (CS/OI)	0145-2440023	Seed spices	DAPC
2.	KVK, Abusar, Jhunjhunu	CS/OI	01592-233420	Bajra, mustard, guar, moong, moth and wheat	DAPC
3.	KVK, Beechwal, Bikaner	CS/OI	0151-2250944	Bajra, moth and datepalm	DAPC
4.	KVK. Dholpur	CS/OI	05642-240457	Mustard and chickpea, Bajra	DAPC
5.	KVK, Fatehpur-Shekhawati	CS/OI	01571-222062	Bajra and guar	DAPC
6.	KVK, Dausa	CS/OI	01427-231083	Wheat, bajra, moong, groundnut and mango	DAPC
7.	KVK, Jaisalmer	CS/OI	02992-251359	Bajra and guar	DAPC
8.	KVK, Sawai Madhopur	CS/OI	07462-220870	Mustard, chickpea and guava	DAPC
9.	KVK, Keshwana, Jalore	CS/OI	02973-265648	Seed spices	DAPC
10.	KVK, Kumher, Bharatpur	CS/OI	05644-240691	Mustard, chickpea and bajra	DAPC
11.	KVK, Hindaun, Karauli	CS/OI	Not installed	Mustard, chickpea, bajra and wheat	DAPC
12.	KVK, Nagaur	CS/OI	01582-240902	Bajra and Seed spices	DAPC
13.	KVK, Navgaon, Alwar	CS/OI	01468-275276	Mustard and chickpea	DAPC
14.	KVK, Sriganganagar	CS/OI	0154-2440352	Cotton, kinnou, wheat and barley	DAPC
15.	KVK, Banswara	CS/OI	242771	Mango, orange, maize, rice, wheat and vegetables	DAPC

contd. ...

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S. No.	Name of locational institute	Contact person	Telephone No.	Priority crops	District APC
16.	KVK, Bhilwara	CS/OI	243850	Maize, wheat, moong and papaya	DAPC
17.	KVK, Bundi	CS/OI	2457815	Soyabean, guava and rice	DAPC
18.	KVK, Chittorgarh	CS/OI	241248	Maize, opium, ashwagandha, mustard, vegetable and guava	DAPC
19.	KVK Jhalawar	CS/OI	230504	Orange, lemon and rice	DAPC
20.	KVK, Kota	CS/OI	2326726	Soyabean, rice and seed spices	DAPC
21.	KVK, Baran	CS/OI	244862	Soybean, rice and seed spices	DAPC
22.	KVK, Sirohi	CS/OI	220708	Seed spices and isabgol	DAPC
23.	KVK, Dungarpur	CS/OI	231381	Fruits and vegetables	DAPC
24.	KVK, Rajsamand	CS/OI	220626	Vegetables and opium	DAPC
25.	KVK, Chomu (NGO) Jaipur	CS/OI	01425-235133	Vegetables and fruits	DAPC
26.	KVK, Sardarshahar (NGO), Churu	CS/OI	01564-221624	Bajra, moth, chickpea and guar	DAPC
27.	KVK (NGO), Barmer	CS/OI	0982-222865	Bajra and guar	DAPC
28.	KVK (NGO) Sangaria, Hanumangarh	CS/OI	01499-222762	Cotton and wheat	DAPC
29.	KVK (NGO) Vanasthali, Tonk	CS/OI	01438-228333	Mustard, chcikpea and bajra	DAPC
30.	KVK, Badgaon, Udaipur	CS/OI	0294-2451313	Opium, maize, wheat, fruits and vegetables	DAPC
31.	KVK, (ICAR), Pali	CS/OI	03229-256771	Mehandi	DAPC
32.	KVK, (ICAR),	CS/OI Jodhpur	Not available	Arid and under utilized fruits, vegetables, pearl millet etc.	DAPC

Table 16 C : Prospective locations/Institute for national agro processing activities

S. No.	Name of locational institute	Contact person	Telephone No.	Remarks – Lead/ Priority crops	National APC
1.	NRC on seed spices, Tabiji, Ajmer	Director	0145-2690711 0145-2443238	Seed spices	NAPC
2.	CIAH, Bikaner	Director	0151-2250147 0151-2250519	Arid fruits/vegetables	NAPC
3.	NRC on mustard & rape seed, Sewar, Bharatpur	Director	0564-260495 0564-260381	Mustard and rapeseed	NAPC

SUMMARY OF ACTIVITIES OF AGRO PROCESSING NETWORK

With the involvement of all the three PHT centres, KVKs and government functionaries, following activities (outline only no detailed description) may be taken up.

1. Agro processing centres establishment and operation
2. Processing technologies disseminated for agricultural, horticultural and other crops
3. Income generation and employment opportunities improvement
4. Value addition to crop product at producers, small entrepreneur and large processing industries levels
5. Operational research and village adoption
6. Techno economic feasibility and economic viability of process and equipments in Rajasthan's context
7. Utilization of minor agricultural produces, wastes and by products (biofuel/ biodiesel production)
8. Development of low cost PHT equipments/processes suitable for Rajasthan
9. Post harvest losses study and alleviation technique
10. Corporate, public and private partnership: Realistic strengthening
11. Involvement of farmers in activities
12. Cooperation with NARS, Agril. Universities and even other Universities
13. Strengthening the system of small industries
14. Cooperation with other AICRP and R&D projects
15. Cooperation with international agencies working for identical mandates

16. Cooperation with NGOs
17. Cooperation with financial institutions marketing board etc.

Once farmers and small industries (village level or block levels or Tehsil levels) are effectively convinced for the importance of agro processing and value addition, district level agro processing cooperative societies may be formally constituted.

MODUS OPERANDI OF THE NETWORK

All the three PHT centres working in the state will work as the nodal locations for model APCs and will run R & D activities (including HRD) relating to pH processing and value addition.

All the districts have KVK managed either by RAU or MPUAT or ICAR or some NGOs. These are having scientists with specialization. These may be given orientation training for PHT processing. Subsequently these will act as district agro processing centres (DAPCs) for educating farmers and grass root level agricultural officer's (AAOs, AAROs, Agricultural Supervisors etc.). Some monitory incentive to farmers may be further advantageous.

PERFORMANCE EVALUATION AND IMPACT ASSESSMENT

It should be the integral part of the network. Such team may includes Director (Research), Director (Extension Education), Director of Horticulture and Director of Agriculture.

QUALITY CONTROL

Quality standards for domestic market and export purpose should be certainly taken care of at all stages of processing, marketing and even the export.

RURAL SOCIOLOGICAL CONSIDERATIONS

There is the utmost need to make concerted efforts for changes in attitude and way of thinking of farmers. Such changes are, though difficult but if brought by any mechanism, will certainly lead to fruitful results.

STUDY OF VOLABILITY OF PRICES AND LACK OF REMUNERATIVE PRICES OF HORTICULTURAL CROPS

The production of various crops is concentrated in different pockets making different supply zones. For providing focused attention on marketing of these crops, some specific markets have been declared and project works are in progress as under:

Table 17: Important crops and project cost

S. No.	Name of KUMS	Commodity/Crop	Project cost (Rs. in Lakhs)
1.	Jodhpur	Cumin	174.50
2.	Sojat Road (Sub yard Sojat city)	Henna (Mehandi)	162.66

contd. ...

... contd.

S. No.	Name of KUMS	Commodity/Crop	Project cost (Rs. in Lakhs)
3.	Sub yard Pushkar	Flowers	91.00
4.	Ajmer	Flowers	102.75
5.	Chhabra (Sub yard Chhipa Barod)	Garlic	100.65
6.	Alwar (Phase I)	Onion	50.48
7.	Bhawanimandi	Orange	45.50
8.	Mertacity	Cumin	203.26
9.	Ramganjmandi	coriander	224.70
10.	Tonk	Chill	324.06
11.	Sawai Madhopur	Guawa	287.21
12.	Jaipur (F&V) Sub-yard Shahpura	Round Gourd (Tinda)	128.50
13.	Jaipur (F&V) Sub yard, Bassi	Tomato	179.20
14.	Chomu	Gooseberry (Amla)	216.10
15.	Sojat Road (Sub yard Sojat city)	Sonamukhi	
16.	Bhinmal	Isabgol	
17.	Jhalrapatan	Ashwganda	
18.	Sriganganagar	Kinno	
		Total	**2340.52**

POTENTIAL FOR AGRO EXPORT (OUTSIDE STATE AND COUNTRY)

There is immense potentiality of export of various commodities to other countries and to other states also. These may be enumerated as under:

A. Non Perishables:

Coriander	Whole seed and split, Powder
Cumin	Whole seed powder
Fenugreek	Whole seed powder
Chillies	Dried powder
Kalaunji	Seed
Soyabean	Milk by products
Pulses	Grain and split
Groundnut	Pod and kernel
Guar	Guargum and split
Bajra	Grain product
Barley	Malt

Wheat	Grain and flower
Paddy	Rice and bran oil
Malt	Corn flakes, Starch, Maize Cob, Poultry feed
Isabgol	husk and granules
Henna	Leaves and powder
Senna	Leaves and powder
Sowa	Gripe water (Chittor)
Ajowain	Seed, oil powder

B. Perishables:

Garlic	Dehydrated and power flakes
Onion	Dehydrated and power flakes
Flowers	Roses, flowers, dried leaves, gulkand, oil, rose water and essence merigold

C. Fruits:

Lemon	Juice, pickles and dehydrates
Orange	Fruit juice, squash, marina powders and concerate
Kinnow	Fruit and juice
Aonla	Fruit, candy, juices and appetizer
Ber	Fruit, chutney and sharbat
Custard apple	Fruit

D. Vegetables:

Tomatoes	Egg plants	Bitter gourd
Peas	Cluster beans	Carrot
Round gourd	Cucumber	Cauli flower
Cabbage		

ADDENDUM TO MARKETING ASPECTS

A. Present policy of agricultural produce, marketing, export and processing

- 125 regulated markets with 297 sub yards
- Scattered and scanty presence of yards in arid and semiarid region in western part of state
- Regulatory and less collecting
- Non-perishable centric
- Unsupportive to diversification and new ideas
- Non-lucrative in comparison to neighbouring state commodity specific markets.
- Prevalence of monopsony/biopsony/obligopsony market conditions
- Lack of specific infrastructure required for marketing of perishables and seed spices in yards

- Insufficient warehousing facility
- Absence of controlled atmospheric storage
- Little awareness about the various schemes implemented by APEDA, Spices Board, MOFPI
- Cumbersome & lengthy procedure of availing subsidy given for agro processing industries by MOFPI

B. Promotional role of APMCS

- Conducting awareness programmes on PHM practices and benefits accruing from them
- Offering better market intelligence services
- Suggesting best domestic consumption markets
- Publishing demand and supply variably for local and potential produced
- Inviting purchasers / processors for enhancing effective competition and avoid biopsony/oligopsony conditions
- Providing grading, sorting, lab testing facilities in yards
- Implementation of credit loan scheme
- Finding out the possibilities of value addition and attracting investment for same
- Have regular contacts with farmers/processors/exporters/consumers etc.
- Adopting latest information technology as a medium of effective mass communication
- Implementing Apni Mandi Scheme by each mandi for better farmer-consumer linkage and establishing direct market accessibility
- Provision for marketing of organic products, medicinal/herbal/aromatic produce and minor forest produce in mandi yard
- Exploring marketing channels for high-end produce

C. Promotional role of RSAMB

- Catalyst in improving the marketing efficiency
- Analysis of crop-wise and area wise demand & supply
- Exploring distant domestic markets
- Exploring overseas markets and their product standards
- Establishing export facilitation centres preferably region wise
- Use of mass media for creating awareness regarding production, planning and PHM practice in farmers
- Assessing infrastructural gaps and efforts to fulfill it through institutional and private sector support, viz., cold chains, warehousing
- Better liaison with Crop Research Stations, Processing and Engineering Institutions, Food/Bio-technology Centres
- Establishing close coordination with other institutions engaged in trade/export

promotion viz APEDA, Spices Board, MOFPI, SFAC

- Establishing State Chapter of SFAC and augment efforts to attain the objectives decided
- Building up strong and vibrant market intelligence system with or without help of private sector
- Promote future trading and evolving collateral warehousing receipt system
- Arranging farmers/traders/officers visit to high-tech farm, Seminar, Workshops, Conferences, Markets domestically and abroad
- Undertaking research and development projects on market oriented production and value addition
- Sharing the cost of weather insurance
- Developing human resources of APMCs and Marketing Board
- Develop and establish backward-forward market link agents
- Exploring avenues for public private partnership
- Attracting corporate investment in warehousing, cold chains, terminal markets and retail chains of agri produce
- Developing terminal markets for F&V, minor forest produce on hub & spoke model
- Establishing quality testing labs and subsidizing the cost of sample tests
- Promote marketing of organic produce to consolidate the gains of locational advantage
- Developing cargo-handling facilities at airport and sea ports
- Identification of big business houses/potential investors interested in diversification towards agriculture
- Promotional shows for recognition of exportable items though participation in trade fairs (brand promotion)
- Conglomerate the business of medicinal/herbal/aromatic plants
- Appointing/hiring the services of experts for project preparation
- Establishing overseas market linkages or hiring the services of consultants/ facilitators in overseas markets
- Setting up of retail stores in urban areas for fruit & vegetables
- Setting up of food processing training centres

Measures to reduce losses under post harvest operation in harvesting, threshing, packaging and transport from farm gate to market:

For grains

- Harvesting of crop at optimum moisture/time
- Adoption of improved harvesting tools/sickles
- Collection of crop at proper place/pucca floor

- Proper drying of crop to optimum moisture level
- Threshing with proper thresher at optimum m/c parameters
- Optimum drying, cleaning & grading of produce, introduction of improved gadgets
- Proper packaging and transport to market
- Training of farmers and extension officials

For Horticulture produce:

- Promotion of safe harvesting handling and hygienic production of quality products
- Creation of pre-cooling, sorting, grading and packaging facilities nearer to production site for improving shelf life & quality of the product
- Adoption of quality packaging technologies at competitive price
- Training of farmers and extension officials
- Adoption of zero energy evaporative cool storage structures

Compaignal Thematic Slogan

Produce	Protect	Process	Propser
Quality Production	Reduce losses due to abiotic/biotic factors	At farmers Small entrepreneurs Large processing units levels	Economic, Social, Cultural Prosperity

CONCLUSIONS

In view of prospective enhanced production of medicinal plants and spices, our efforts need to be leveraged to achieve economic and strategic objectives through exports. Agro processing and post harvest technology are broader terms and included all the processing action adopted at produce as well as industrial levels. In India unfortunately we process only 1.8-2.0% of vegetables and fruits produced in this country as compared to 80% processing in Brazil and 90% in UK and USA. This indicated about the scope of agro processing in India. The situation with other commodities with respect to processing in grim (only 15% fish, 0.0% egg, 2.0% fruits and vegetables, 27% cereals, 2.0% meat, 70% legumes, 75% oil seeds, 9.0% spices, 50.0% milk, 12% coffee, 1.0% tea and 100% cocoa are processed in India). Therefore, we must proceed for agroprocessing and post harvest processing without further delay (Chengappa 2004, Sananse *et al.*, 2003, Swaminathan 2006).

Swaminathan (2006), therefore, strongly recommended to add post harvest technology component at each Krishi Vigyan Kendra which may then act as extremely important locations for organisation of lab to land demonstrations in the area of post harvest technology, agro processing and value addition of primary products. AICRP on PHT centres will certain have a pivotal role in this network system.

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2

Post-Harvest Shelf-Life of Orange (A Medicinally Valuable Fruit): Effecacy of Neem Leaf Extract and Benzyladenine

R.L. Bhardwaj and N.L. Sen

Citrus is one of the most important fruit crop of India next only to mango and banana. The orange occpies nearly 50% of the total citrus area (0.64 million hectare) and maximum production (1.35 million tones). The high acceptability of orange among the citrus fruits is due to its attractive colour, distinctic flavour and their being rich source of vitamin 'C'. Mandrin orange is seasonal and perishable in nature, so 20-30 per cent of total fruits are lost at the post harvest stages. A number of post harvest treatments like waxing, fungicidal dip and polyethylene film etc. have been used to extend the shelf life of fruits. But the environmental consciousness among the scientists and general public has drawn attention towards increasing the use of chemicals on food staff and their deleterious effects on the environment and on human being. It is well known that the use of neem leaf extract and benzyladenine acts as antisenescent and arrest the metabolic break down deterioration caused by various bio-chemical activities in fruits. Neem leaf extract is residue free and safe for consuption point of view as compared to fungicides. Keeping in view the aforesaid facts this experiment was undertaken to observed the effect of neem leaf extract and benzyladenine on the self-life of mandarin orange.

EXPERIMENTIA

Freshly harvested, uniform fruits of orange cv. 'Nagpur santra' were purchased from the farmers field and brought to the laboratory in the department of Horticulture, R.C.A., Udaipur. Nine treatment combination consisting three levels of neem leaf extract (0, 10 and 20%) and three levels of benzyladenine (0, 50 and 100 ppm) were used for the experimentation. The treated fruits kept at room temperature i.e. 16.7 to 31.8°C with a relative humidity of 20-57 per cent. The above treatments were replicated thrice having 30 kg fruits in each treatment. Periodical observation with regard to physical characteristics (PLW, rotting per cent, juice content and reduction in diameter) and chemical characteristics (TSS, acidity, ascorbic acid, total sugar) were recorded on 6^{th}, 12^{th}, 24^{th} and 36^{th} day of storage. The total soluble solids content of the fruit juice was determined by using Zeiss Hand Refractometer and values corrected to 20°C. The titrable acidity was determined by using standard N/10 NaOH in the presence of phenolphthalein as an indicator (A.O.A.C., 1980). The vitamin 'C' content of the juice was determined by titration method (A.O.A.C., 1980). The sugar in the fruits was determined by the method of Lane and Eynon (1923), and the results were statistically analysed.

OBSERVATION AND INTERPRETATION

It is obvious from the data presented in Table-1 that the per cent PLW and rotting of fruits increased continuously with the advancement of storage period irrespective of any treatment. The increase in PLW and rotting was found to be very slow in fruits treated with 20 per cent neem leaf extract and 100 ppm benzyladenine as compared to control and other treatments. So the physiological loss in weight and rotting was significantly reduced by the treatment. This may be due to the fact that the neem leaf extract which checked the microbes growth and transpiration of fruits similar results were also recorded by Singh *et al.* (1993). The benzyladenine reduce senescence, rate of respiration, and ripening of fruits. The results conformity with Wade and Bradey (1971) in banana, Dhillon *et al.* (1985) in grape. The maximum retention of juice content (39.25%) and minimum reduction in fruit diameter (14.81%) on 36^{th} day of storage was found with 20 per cent neem leaf extract and 100 ppm benzyladenine treatment. A possible explanation for minimum reduction in juice content and diameter of fruits under this treatment was because of reduced moisture loss and maintaining proper shape of fruits. Similar results was reported by Garg *et al.* (1976) in guava, Bhowmick and Vardhan (1981). The maximum retention of acidity (0.466%) and ascorbic acid content (25.92 mg/100 ml fruit juice) on 36^{th} day of storage was found in fruits, those treated with 20 per cent neem leaf extract and 100 ppm benzyladenine. Decline in acidity during storage was due to the utilization of acids in respiration process and conversion in sugar and salts (Rutter *et al.*, 1975). Whereas, fruits treated with same treatment showed higher retention of acidity and ascorbic acid during storage. This could be due to the treatment delay in physiological ageing and alteration in metabolism which ultimately resulted in higher retention of acidity and ascorbic acid. Similar results were observed by Mitra *et al.* (1996), Kehri and Chandra (1986) in guava, Gautam and Chundawat (1989) in sapota. The total soluble solid and sugar content of fruits increased with advancement of storage period. But it was observed that the fruits treated with 20 per cent neem leaf extract and 100 ppm benzyladenine have minimum increase in TSS (12.48° Brix) and total sugars (7.21%) on 36th day of storage. The increase in TSS and sugar content of fruit might be due to same acid being converted into sugars, during respiration on the other hand the neem leaf extract and benzyladenine reduced respiration rate and delay ripening. The present findings are in conformity with the findings of Hooda *et al.* (1994) in tomato, Kehri and Chandra, 1986).

Table 1 : Effect of various treatments on the physico-chemical characteristics of orange

Treatments	PLW	Rotting (%)	Juice content (%)	Reduction in diam. %	TSS (⁰Brix)	Acidity (%)	Ascorbic acid (mg/100 ml juice)	Total sugars (%)
				After 6 days of storage				
N_0B_0	14.09 (5.928)	*	43.47 (47.33)	7.87 (1.88)	10.80	0.679	27.88	7.72
N_0B_1	13.38 (5.358)	*	43.74 (47.80)	7.49 (1.70)	10.67	0.680	28.51	7.39
N_0B_2	13.28 (5.278)	*	43.89 (48.07)	7.23 (1.58)	10.58	0.681	29.41	6.82
N_1B_0	12.55 (4.719)	*	43.68 (47.66)	6.57 (1.31)	10.63	0.678	28.84	7.46
N_1B_1	12.47 (4.660)	*	44.28 (48.75)	6.15 (1.15)	10.51	0.683	29.75	7.10
N_1B_2	11.93 (4.272)	*	44.50 (49.13)	5.30 (0.85)	10.37	0.684	30.55	6.52
N_2B_0	12.12 (4.410)	*	44.09 (48.41)	4.88 (0.73)	10.53	0.681	29.92	6.87
N_2B_1	10.87 (3.557)	*	44.80 (49.66)	4.45 (0.60)	10.40	0.686	31.53	6.49
N_2B_2	9.91 (2.966)	*	45.26 (50.46)	4.10 (0.51)	10.31	0.688	32.27	5.94
Sem±	0.163	-	0.230	0.058	0.096	0.003	0.498	0.094
				After 36 day of storage				
N_0B_0	27.32 (21.071)	27.25 (20.975)	35.15 (33.147)	18.66 (10.24)	13.45	0.426	21.32	8.51
N_0B_1	26.18 (19.466)	24.95 (17.79)	35.99 (34.544)	18.16 (9.72)	13.40	0.427	22.24	8.24
N_0B_2	26.04 (19.284)	23.85 (16.35)	36.60 (35.555)	17.58 (9.12)	13.34	0.430	23.55	7.99

contd. ...

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Treatments	After 6 days of storage							
	PLW	Rotting (%)	Juice content (%)	Reduction in diam. %	TSS (^{0}Brix)	Acidity (%)	Ascorbic acid (mg/100 ml juice)	Total sugars (%)
N_1B_0	24.81 (17.61)	22.57 (14.734)	36.80 (35.884)	17.12 (8.67)	13.28	0.425	21.99	8.28
N_1B_1	23.98 (16.52)	21.46 (13.387)	37.53 (37.109)	16.91 (8.46)	13.10	0.437	24.04	7.98
N_1B_2	23.27 (15.61)	20.01 (11.711)	38.29 (38.395)	16.58 (8.14)	12.85	0.459	24.39	7.57
N_2B_0	23.27 (15.61)	18.34 (9.902)	37.96 (37.837)	16.01 (7.61)	12.85	0.437	23.46	7.79
N_2B_1	21.93 (13.95)	17.00 (8.55)	38.66 (39.018)	15.50 (7.14)	12.87	0.464	25.85	7.51
N_2B_2	21.64 (13.60)	16.27 (7.853)	39.25 (40.039)	14.81 (6.54)	12.48	0.466	25.92	7.21
SEm±	0.163	0.107	0.179	0.106	0.133	0.008	0.211	0.109
0 days	0.00	0.00	51.25	0.00	10.15	0.695	36.65	5.65

N_0 = 0 % neem leaf extract B_0 = 0 ppm benzyladenin
N_1 = 10 % neem leaf extract B_1 = 50 ppm benezyladenin
N_2 = 20 % neem leaf extract B_2 = 100 ppm benezyladenin
Figures in parenthesis arc sine retransformed value
* No rotting was observed at 6 days storage in any treatments

These results indicated that after 36 days of storage a minimum PLW (21.64%), rotting (16.27%), reduction in diameter (14.81%) was recorded in 20 per cent neem leaf extract with 100 ppm benzyladenine treatment. The maximum juice content (39.25%) and highest organoleptic score was also recorded in the same treatment. The TSS and total sugar content were increased with the advancement of storage period. The rate of increase was slow in 20 per cent neem leaf extract with 100 ppm benzyladenine treatment. On 36th day at storage minimum TSS (12.48 ^{0}Brix) and total sugar content (7.21%) was recorded. The acidity and ascorbic acid content were decreased with the increase in storage period. The minimum decrease from 0.695 to 0.466 per cent acidity and from 34.65 to 25.92 mg/100 ml fruit juice, ascorbic acid was recorded in 20 per cent neem leaf extract with 100 ppm benzyladenine treatment after 36 days of storage.

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SECTION 2

PHYTOBIODIVERSITY AND CONSERVATION TECHNOLOGY

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3

Therapeutic and Global Diversities of Micro & Macrophytes : Sustainable Exploration, Conservation and Uses

Karan Singh, B.L. Kakralya and M.L. Jakhar

INTRODUCTION

The accelerating loss of plant biodiversity at global level is a matter of growing concern for scientific and political spheres and in some regions of the world where agricultural production has been intensified, such loss is very rapid (Edwards and Hilbeck, 2001, Singh, 2004 and Singh and Tyagi, 2004). This loss is much more alarming in case of therapeutically valuable microphytes and macrophytes primarily due to the fact that even today much of our requirements for pharmaceutical industries are met from wild resources and little scientific efforts have been made to domesticate and cultivate wild medicinal plants at commercial scale. This is largely due to the effects of selective focus of agricultural sciences which have hitherto neglected the domestication of a multitude of species, otherwise suitable for production under different ecological niches. Janick (2001) emphasized that there is tremendous scope for considering perennial plant species for such efforts but such action will require a realistically integrated approach involving both conventional and modern agrobiotechnologies, transparency of information and decision making, judicious exploration and exploitation genetic resources. Janick (2001) advocated to focus our attention to underutilized plant species but we have to be open mind for taking due care of genetically modified plants and organisms but environmental and biosafety concerns may not be overlooked. For such ventures, new phytocandidates include cereals and pseudocereals - their wild relatives, wild legumes, edible and industrial oils, fruits, nuts, vegetables, aromatics and therapeutics. Out of these phytocandidates for domestication, medicinal plants require immediate attention due to negligible or little ill-effects. Janick (2001) cited some hot candidates including Taxus, Hypericum, Panax, Echinacea, Hydrasius etc. for such purpose. Padulosi (2002), Sarin (2003), Jakhar *et al.* (2004), Singh (2004) and Singh and Tyagi (2004) reviewed the literature on biodiversity of medicinal plants in diverse groups of plants. Singh and Singh (2005), Jat (2005) and Mitharwal (2005) advocated to intensify scientific efforts for domestications and to bring more and more wild plants under cultivation web.

Screening the available/published literature, scientific communication with some national and global organizations and in-depth discussions with traditional experts and practically experienced people, clearly revealed that our understanding about therapeutic and global phytodiversity, its scientific exploitation / exploration and sustainable conservation is extremely meagre. Substantial part of our knowledge about this "science" remains undocumented which enunciates a critical gap between our traditional knowledge of surprisingly wonderful properties of several 'natural healers' and modern scientific interpretations. Some awakening in this regards has been noticed (Singh, 2004; Singh and Singh, 2005). Now phytodiversity and its judicious exploration and scientific exploitation in many phytotaxa requires immediate attention. This is especially factual about microphytes like many species of bacteria, fungi, lichens and algae, some bryophytes, many pteridophytes, several gymnosperms and hundreds of angiosperms. An effort has, therefore, been made to pinpoint some aspects of this other wise very complex problem.

THERAPEUTIC AND GLOBAL DIVERSITY IN BACTERIA

Bacteria are the best example in which a plant group is equally effective for and find of human being and his domestic animals. Dubey and Maheshwari (2003) comprehensively reviewed the literature on the subject citing both harmful and useful aspects of bacteriology. Many industrially useful bacteria are well known to produce household products and they have been in use for centuries. The list of therapeutically useful bacteria and their products is very long. A few of them have been summarized in Table 1. However, very few authors have compended antibiotics from bacterial source with other medicinal plants. Efforts made by Bhattacharjee and De (2005) recently are worth appreciation. It is evident that antibiotics from bacteria should be carefully used as side effects or harmful effects of some of them have been noted in many cases.

Table 1 : Important bacteria showing therapeutic and global diversity (Source – Bhattacharjee and De, 2005)

S.No.	Name of Bacteria	Therapeutic product
1.	*Streptomyces grireus*	*Streptomycin* (→ useful in Tuberculosis)
2.	*Bacillus subtilis*	*Bacitricin* (→ useful in wound dressing)
3.	*Streptomyces venzuele*	*Chloromycetin* (→ useful in haemophilus)
4.	*Bacillus polymyxa*	*Polymxin* (→ useful in pseudomonas infections)
5.	*Streptomyces aureofaciens*	*Aureomycin* (→ useful in protozoal infection)
6.	*Streptomyces fradiae*	*Neomycin* (→ useful in Wound dressing)
7.	*Streptomyces rimorus*	*Terramycin* (→ useful in ricketrrial infection)
8.	*Streptomyces erythreus*	*Erythromycin* (→ useful in streptococcal infection)
9.	*Streptomyces linocolnesis*	*Clindamycin* (→ useful in staphyloccal injection)
10.	*Streptomyces* sp.	*Caphamycin* (→ useful in bacterial infection)

THERAPEUTIC AND GLOBAL DIVERSITY IN FUNGI

Penicillin, a wonder antibiotic from *Penicillium notatum* and *P. chrysogonum* was originally discovered by 21 year old French medical student (Ernest Dochesne) in 1896 but his work was forgotten and was rediscovered by Scotish physician Alexander Fleming on September 28, 1928. This discovery initiated a lot of interest in beneficial and economically viable applications of fungal genera for human welfare. Besides Penicillin, many other therapeutically valuable secondary metabolites are produced from fungi. These include griseofulvin from *Penicillium griseofulvum*, aspergillin (but not commercially viable) from *Aspergillus* species, Ergot of rye from *Claviceps purpurea* which develop sclerotia in ovaries of flowers of many grasses including rye and anticancer drug calvatine from *Clavalia* species. Beside these medicinal application several fungi are industrially and agriculturally useful. These include various edible mushroom, yeasts, gibberella, agaricus, Ppolyporus, morchella etc. (Fig. 1)

Fig. 1A : Ergot (*Claviceps purpurea*) on ear of rye-medicinally valuable fungus.

Fig. 1B : Therapeutically valuable fungus *Morchella esculenta* (Morel).

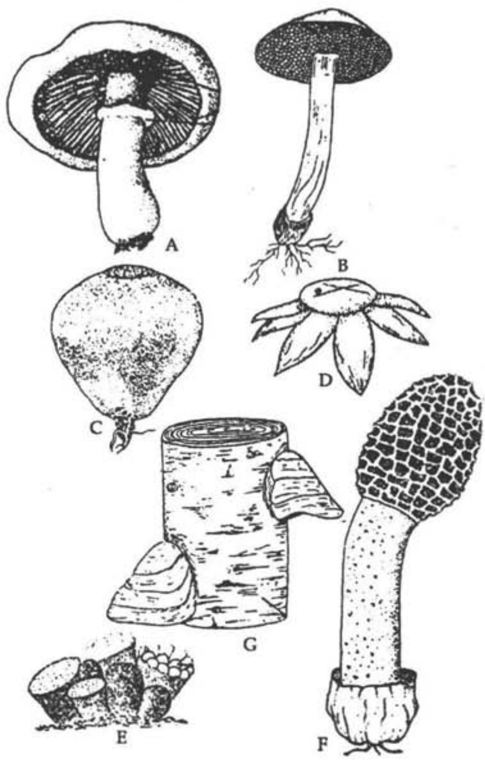

Fig. 1C : Some therapeutically valuable Agaricales, A. *Agaricus*, B. *Boletus*, C. *Lycoperdon*, D. *Geasier*, E. *Cyathus*, F. *Phallus*, G. *Fomea*.

THERAPEUTIC AND GLOBAL DIVERSITY IN LICHENS

Lichens are a small group of plants with about 16000 species. They are composites of dual organisms (Algae and fungi) called as phycobiont and mycobiont, respectively. Lichens grow in a wide variety of ecological conditions (walls, roofs of houses, leaves, trunk and bark of trees, on earth surface, barren lands, rocky surfaces, xeric environment (even sand dunes).

Some species of lichens are therapeutically valuable in ancient systems of medicine and have been prescribed for jaundice, fever, diarrhoea, epilepsy and some skin diseases (Fig. 2). However, scientific fortifications for such curative actions of lichens are still to be established. A broad spectrum antibiotic derived from *Usnea, Cladonia* etc. is a yellow substance and found very effective in various infections of skin and used as ointment. A mucillagenous substance obtained from *Cetrania islandica* (Iceland moss) is a potent luxative. Sweet scented thalli of a wide variety of lichens are use in the preparation of hup, hawan samagria and other perfumaries. *Oak moss* is commercially used as a fixative for perfumes. Some lichens are used to produce some acids which are medicinally useful. These therapeutic uses are besides the value of lichens in soil formation.

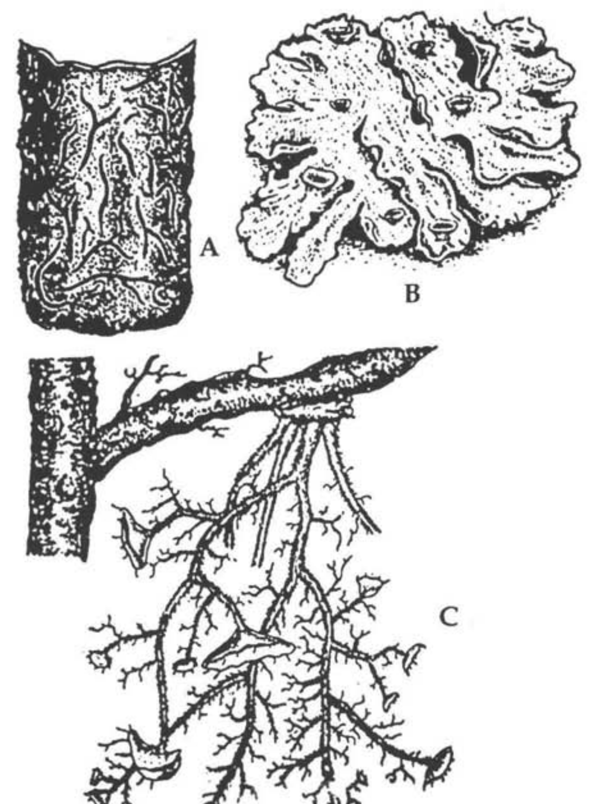

Fig. 2 : Some therapeutically valuable lichens,
A. *Crustosi lichen*, B. *Foliose lichen*, C. *Fruticose lichen*.

THERAPEUTIC AND GLOBAL DIVERSITY IN ALGAE

Algae is a very big group of plants, both microphytic and macrophytic thalophytic forms grown in different ecological niches, in fresh water, moist places, sea water, temperate, tropical and subtropical environments. These economic importance had been realized since the time immemorial. Porphyra (Red algae), Laminaria (brown algae), Undaria (brown algae), Aloria (brown algae), Rhodymenia (Red algae), Sargassum (Red algae), Chlorella (green algae), Enteromorpha, Ulva, Monostema are valuable food plants and some of them are cultivated in Japan, USA, Australia, Philippines etc. Some of them are used indirectly as food as these are used as feed by fishes and animals. Some are used as fertilizers and also to enhance soil fertility through nitrogen fixation and soil reclamination. Role of algae in soil formation, soil conservation and water purification is also well documented.

Role of algae as medicine is also known since ancient time. Use of sea weeds in the treatment of goitre in China and Japan is known since 1330. Sea weeds are used as vermifuge (*Alsidium, Digenia, Corallina* etc.). *Fucus, Ulva, Sargassum, Acetabularia* are commonly used against Scophula, Lymphotic and glandular disorder (Fig. 3; Table-2).

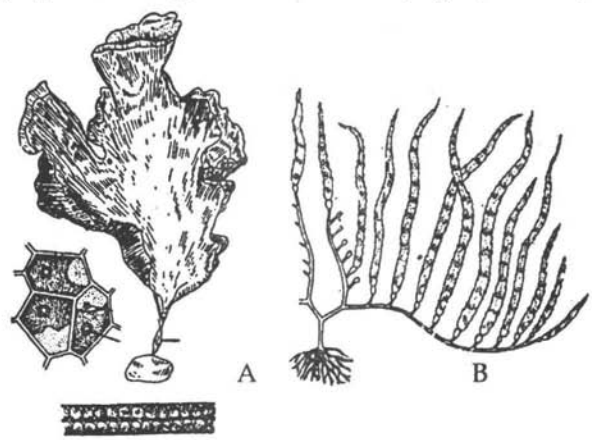

Fig. 3 : Some algae useful for treatment of human diseases. A. Ulva (*Green alga*), B. Macrocystis (*Brown alga*).

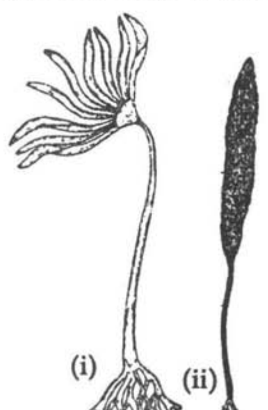

Fig. 3C : Some algae useful for treatment of human diseases. (i) Laminaria with divided lamina (ii) Laminaria with undivided lamina.

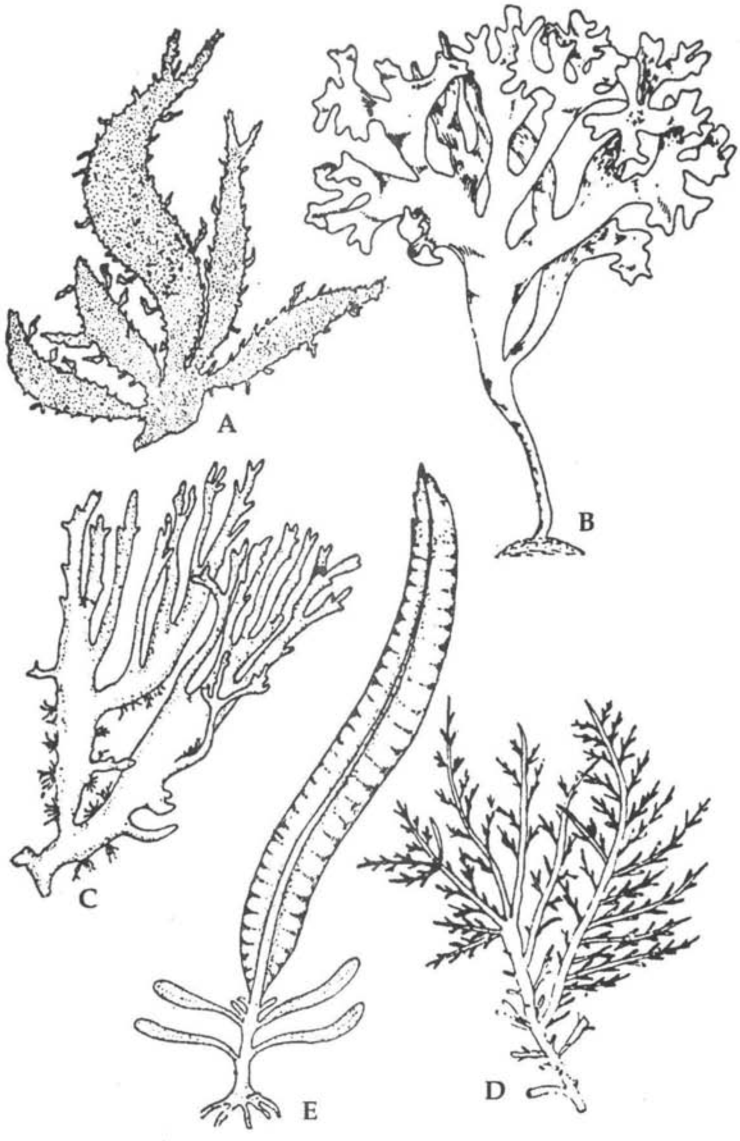

Fig. 3D : Some other seaweeds of medicinal value, A. *Gigartina*, B. *Chondrus*, C. *Rhodymenia*, D. *Gelidium*, E. *Alori*.

Irish moss (*Chondrus* and *Gigartina* in Scotland) is used in chest and stomach complaints. Besides these, many algae are used against hay fever in China and Japan. Many algae are used for the manufacture of therapeutically valuable biochemicals such as manitol, laminanin, algin. These are extracted or industrially produced from *Fucus, Ascophyllum, Macrocystis, Nereocystis, Alaria, Laminaria.* Agar is another medically valuable product (colloidal, water soluble gel). A number of red algae like *Gelidium, Pterocladia, Eucheuma, Glacilaria* are used to produce agar. However, most purified form of Agar is prepared from *Hypnum* and *Furcellaria*. Carrageenin is extremely important chemical produced from

Chondrus, Gigartina, Laminaria and *Chaetomorpha*. It is useful in pharmaceutical industry as stabilizer. It is a potent blood coagulant. Chlorellin is an antibiotic produced from various strains of *Chlorella* (a unicellular green alga). *Chlamydomonas, Dunaliella, Microcystis, Katadinium, Nitzschia* are some algae which possess considerable potential for the production of antibiotics. Extracts from *Ascophyllum, Laminaria, Polysiphonia* also have antibiotic properties. Some algae are used to prepare algal glue whereas others are important in space travel and also as diatomaceous earth.

Table 2 : Some Algae showing therapeutic diversity at global level

S.No.	Botanical Name	Family	Therapeutic Uses
1.	*Laminaria*	Laminariaceae	Used in the preparation of various Goiter medicines.
2.	*Chlorella*	Chlorella	Antibiotic *Chlorellin* is obtained from it inhibits the growth of other bacteria.
3.	*Fucus*	Fucaceae	Employed in Scrofulous disorder.
4.	*Ulva*	Ulvaceae	Employed in lymphatic disorder.
5.	*Chondrus*	Rhodophyceae	*Carrageenin* is obtained from *C. crirpus C. serves* as blood coagulant.
6.	*Gigartina*	Rhodophyceae	Agar – Agar is obtained form Gigartina which is used in Pills & Ointments.
7.	*Chlamydomonas*	Chlamydomonadaceae	Extracts of *Chlamydomonas* show inhibitory activities against several Microbes.
8.	*Microcystis*	Cyanophyceae	Inhibitory for *Staphylococcus clorteridium.*
9.	*Codium*	Codiaceal	Vermifuge is obtained from the extract of codium.
10.	*Sargassum*	Sargassaceae	*Alginates Alginic* acid is obtained from *Sargassum.* Pure Alginic acid is very effective blood coagulant serves as active ingradient *in* haemostatic preparations.
11.	*Cladophora*	Cladophoraceae	Extracts of *Cladophora* possess antiviral properties & pill strains of certain bacteria (*Pseudomonas* and *Mycobacterium*)
12.	*Ascophyllum*	Fucaeae	Extracts of *Ascophyllum* show antibiotical properties. Also used for manufacture of Algin.

THERAPEUTIC AND GLOBAL DIVERSITY IN BRYOPHYTES

Bryophytes are group of about 22000 species (5.5% of all the plants in the world). They are most neglected with reference to the investigations concerning therapeutic and global diversity. This is because of the fact that they are available in inadequate quantities for phytochemical and therapeutic investigations. Recent studies have, however, shown that these are treasure house of secondary metabolites which are medicinally very important (Zinsmeister and Mu, 1988; Chopra and Kumra, 1988; Vashistha, 1999; Jakhar *et al.* 2003). This group of plants is ecologically valuable due to their role as soil indicators, pollution indicators, soil erosion checkers, soil forming agents, seed beds, mineral indicators, biological nitrogen fixation agents, ornamentals, etc. *Marchantia, Jungermannia, Anthoceros, Riccia* have been found useful in pulmonary tuberculosis and liver problems. Extracts of *Marchantia polymorpha, M. stellata* and *Polytrichium commune* possess antitumour properties and diuretic actions (useful in stones of kidney and gall bladder). Extract of Sphagnum is useful in skin diseases.

Zinsmeister and Mue (1988) reported that bryophyta are rich in terpenoids, steroids, alkaloids, phenols, flavanoids. It was further emphasized that this class of plant is bound to attract the interest of biologists and pharmacists (Figs. 4-8).

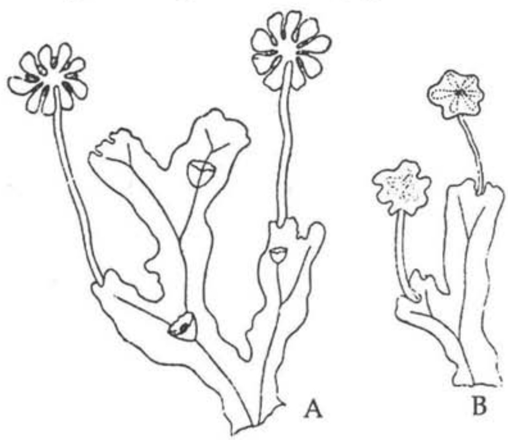

Fig. 4: ***Marchantia thallus*, A. Female plant, B. Male plant.**

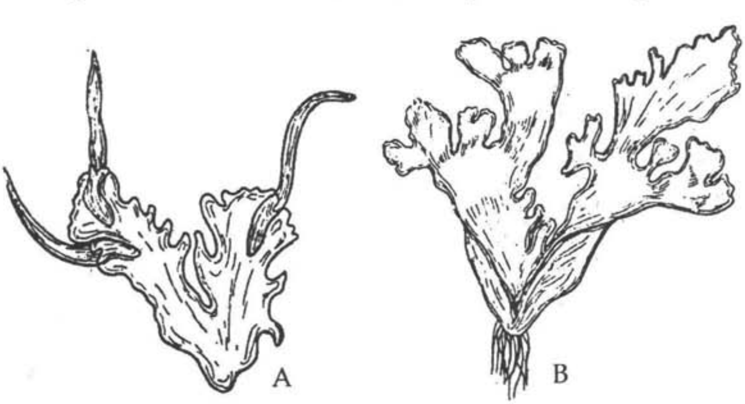

Fig. 5 : ***Anthoceros*, A. Fertile, B. Sterile.**

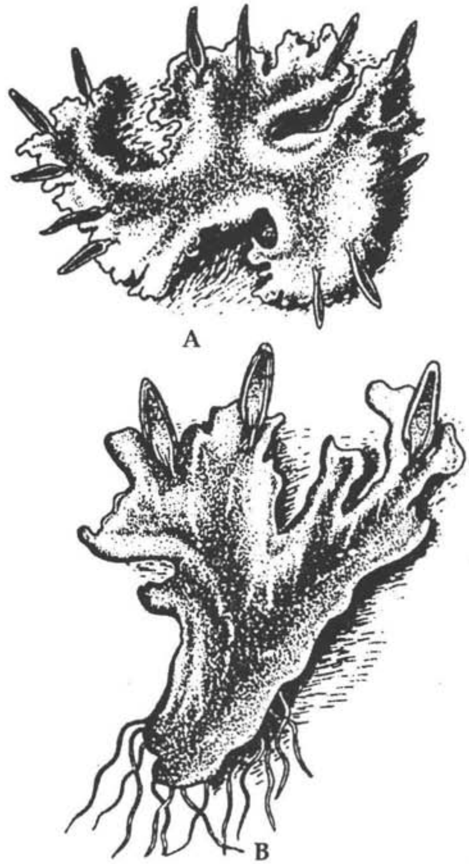

Fig. 6 : ***Notothylas*****—Sporangia bearing thalli.**

Fig. 7 : ***Sphagnum*****—A medicinally valuable bryophyte.**

Fig. 8 : *Funaria*—A medicinally valuable bryophyte.

Some bryophytes which require more attention of pharmacists and medical men includes *Riccia, Marchantia, Jangermannia, Pellia, Porella, Anthoceros, Notothylus, Funaria, Sphagnum* etc.

THERAPEUTIC AND GLOBAL DIVERSITY IN PTERIDOPHYTES

Pteridophytes constitute a very big group of vascular plants distributed throughout the world. The exact number of genera and species of this group of plants is controversial (Kramer and Green, 1999). Little attention has been given to their medicinal properties. Looking to their natural distribution in variety of climates, their medicinal properties are beyond doubt (Dixit and Singh, 2004). Out of 1200 species found in India, only a very few have been documented with medicinal point of view. Dixit and Singh (2004) have recently made a concerted effort to review the literature on therapeutically valuable Pteridophytes and compiled the information in tabular form (Table 3).

More than 100 such species have been given with therapeutic point of view. Out of these only 25 species have been selected for this article. Dixit and Singh (2004) described Pteridophytes with reference to their biodiversity and its conservation. However, it is, now established that Pteridophytes are therapeutically valuable in allopathic, homoeopathic, Unani and Ayurvedic systems of medicine but phytochemical and pharmaceutical information on plants of this group need to be further strengthened (Jakhar *et al.*, 2004). Ten species of *Adiantum* found in various part of India are important therapeutically. Three species of *Botrichium*, nine species of *Dryoptenia*, three species of *Equisetum*, one specie of *Lycopodium*, six species of *Lygodium*, one specie of *Lycopodium* have been described as medicinally important. Other such genera include *Marsilia, Nephrolipias, Ophioglossum, Osmund, Pelloea, Psilotum, Polypodium, Pteris, Pteridium, Sellaginella, Tectoria* and *Vittaria* (Figs. 9-17).

Table 3 : Some Pteridophytes with therapeutic and global diversity (Source–SRR Dixit and Singh, 2004)

S.No.	Botanical name	Family	Important uses
1.	*Actiniopteris radiata* (SW) Link)	Actinopteridaceae	Fronds chewed for sore throat. Rhizome styptic anthelminthic and its decoction used in cure of dandruff.
2.	*Adinatum caudatum* L.	Adiantaceae	Leaves externa remedy for skin disease, internally for diabetes.
3.	*Adiantum tenerum* SW.	Adiantaceae	Plants used for expectorant and demulcent.
4.	*Asplenium trichomanes* L.	Aspleniaceae	Plant bitter, laxative, expectorant used in pulmonary disease and in abscess of uterus.
5.	*Botrychium lunaria* (L.) SW	Botrychiaceae	Fronds are good vulnerary, used in dysentery ruptures for healing cuts and wounds.
6.	*Ceratopteris thalictroides* (L) Ad. Brongn.	Parkeriaceae	Whole plant used as toxic and styptic.
7.	*Diplazium esculentum* (Retz.) SW	Athyriaceae	Young tips of fronds are used as toxic for health. Decoction of rhizonic and young leaves are useful for haemoptysis and constipation.
8.	*Drymoglossum piloselloides* (L.) Press.	Polypodiaceae	Whole plant is useful against itching and relieving pain. Leaves are used as antiseptic.
9.	*Dryopteris barbigera* (Moore ex Hook.) O. Ktze	Dryopteridaceae	Rhizomes have anthelminthic properties substitute for the European male fern.
10.	*Equisetum arvense* L.	Equisetaceae	Dried plant is used in dropsy navel and kidney infections. Stem used for treatment of bone fracture.
11.	*Equisetum ramassissimum Desf. Sub sp. Debite* (Roxb ex vauch) *Hauke*	Equisetaceae	The plant is useful in cure of gonorrhoea and treatment of fracture.

contd. ...

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S.No.	Botanical name	Family	Important uses
12.	*Lycopodium clavatum* L.	Lycopodiaceae	Plant decoction is antispermatic useful in rheumatism, disease of lungs and kidneys.
13.	*Lygodium flexuosum* (L.) SW	Lygodiaceae	Fronds boiled with mustard oil useful as local application to carbuncles externally in rheumatism, sprains scabies ulcers and cut wounds. Spores cure high fever.
14.	*Lygodium japonicum* (Thunb.) SW	Lygodiaceae	Plant used as expectorant used in cure of haematuria and an amulet of this plant is tied round the neck of patient suffering from malaria.
15.	*Marsilea minuta* L.	Marsileaceae	Decoction of leaves mixed with ginger given in bronchitis, spastic condition of legs, cough sedative and insomnia.
16.	*Nephrolepis cordifolia* (L.) Presel	Nephrolepisaceae	Rhizomes and tubers are used in intestinal and kidney disorders. Extract of rhizome is used in permanent curing of sterility in women. Decoction used for cough.
17.	*Ophioglossum costatum* R. Br.	Ophioglassaceae	Dried tubers are crushed in the form of powder mixed with mustard oil used in skin disease.
18.	*Osmunda claytoniana L.*	Osmundaceae	Rhizome used as adulteration for male fern.
19.	*Psilotum nudum* (L.) P. Beauv.	Psilotaceae	Whole plant used as purgative.
20.	*Polypodium vulgare* L.	Polypodiaceae	Rhizomes are anthelmintic and purgative.
21.	*Pteris ensiformis* Burm. F.	Pteridaceae	Leaf juice used as an astringent to cure dysentery.
22.	*Pteridium aquilinum* (L.) Kuhn	Pteridiaceae	Rhizome have astringent and anthelminthic properties.
23.	*Selaginella bryopteris* (L.) Bak.	Selaginellaceae	Whole plant diuretic and anti gonorrhea. Dried plants with tobacco smoked for hallucination.

contd. ..

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S.No.	Botanical name	Family	Important uses
			Plants and leaves with sugar is taken in stomachache, inflammation of urinary tract and in some venereal diseases.
24.	*Tectaria cicutaria* (L.) Copel.	Aspidiaceae	10 gm rhizome along with seven fruits of black pepper, mixed with cow's milk given once daily as toxic and to purify blood and also in blood dysentery.
25.	*Vittaria elongated* SW.	Vittariaceae	Leaf juice used for curing rheumatic pain and stiffness.

Lycopodium voluble

Lycopodium phlegmaria

Fig. 9 : Medicinally valuable species of Lycopodium.

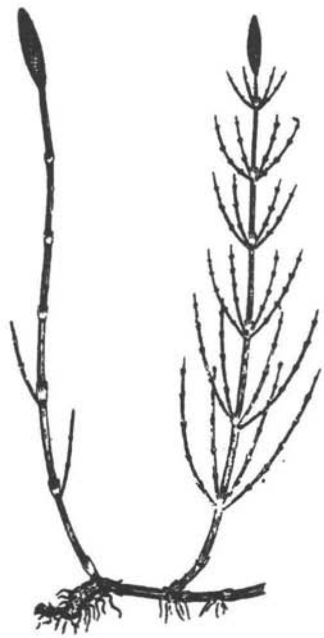

Fig. 10 : ***Equisetum diffusum*****—A medicinal pteridophyte.**

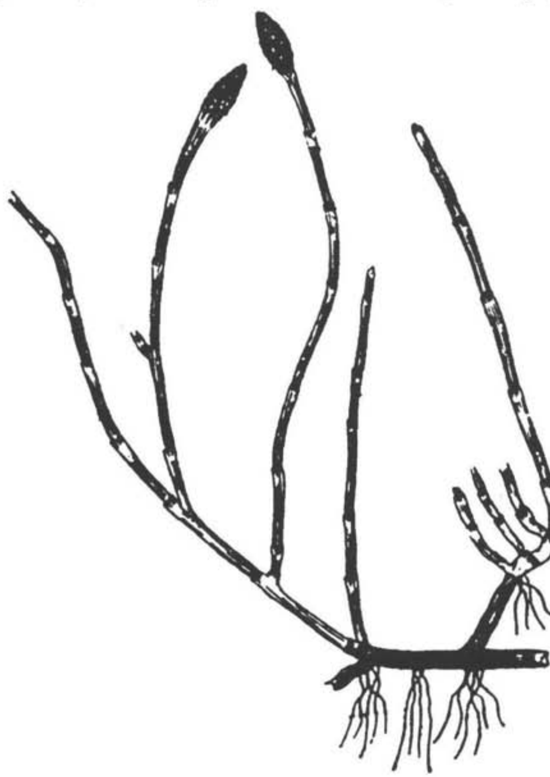

Fig. 11 : ***Equisetum debila*****—A medicinally valuable plenidophyte.**

Fig. 12 : ***Ophioglossum*****—A pteridophyte with medicinal value.**

Fig. 13 : ***Osmunda*****—A medicinally valuable pteridophyte.**

Fig. 14 : *Dryopteris*—A medicinally valuable pteridophyte.

Fig. 15 : *Pteridium*—A pteridophyte with therapeutic diversity.

Fig. 16 : *Adiantum*—A pteridophyte having medicinal value.

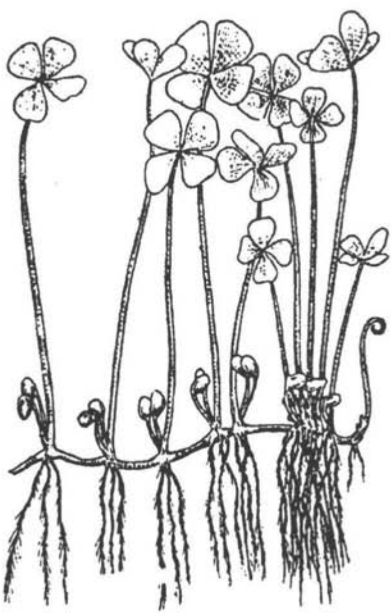

Fig. 17 : *Marsilea*—An aquatic pteridophyte with medicinal value.

THERAPEUTIC AND GLOBAL DIVERSITY IN GYMNOSPERMS

Gymnosperms are characterized by naked seeded plants in which ovule (the seed forming structure) is borne unprotected (without ovary wall) on megasporophyll. This small group of plants is represented by about 70 genera and 725 species (contrary to Angiosperms represented by 12500 genera and 250000 species). These are distributed throughout the world from temperate to tropical climates. Living gymnosperms in India are represented by 16 genera and 52 species. Gymnosperms exhibit great diversity in their therapeutic properties at national and international levels and have been described as medicinally important in all the modern systems of medicine (healing practices). Kramer and Green (1999) discussed families and genera of Gymnosperms in considerable details but little was described about their medicinal value. Many parts of *Cajcas, Zamia, Macrozamia* and *Dioon* are used medicinally. The Mexicans use a decoction of seeds of *Dioonedule* to cure neuralgia. Pollens of *Cycas circinalis* are narcotics, parts of bark and seeds is used as ointment, as poultice against sores and swellings. The juice is used against flatulence and vomiting. The resin of *Cycas revoluta, C. rumphii* is used in ulcers. Many species of *Ginkgo*, specially *G. biloba* (Bal Kunwari) in useful medicinally but are threatened and require intensive conservational strategies. Besides being used as timber source, many are source of resin which are used for making ointments (originally obtained from many species of *Pinus*). Copal is obtained from *Agathis* (green gum or candle gum). Sandarc obtained from Collitris is used for pilli varnish. Canada balsam (obtained from *Abies balsomea*) and Venice terpentine (obtained from *Larix decidua*) are used in human and veterinary medicine. Amber (a fossil resin obtained *Pinites*) is used as anticoagulant in blood banks. Essential oil (obtained from *Tsuga canadensis* and *Pinus glauca*) is used in bronchitis, tuberculosis, skin disease and also in gonorrhoea. Many kinds of rosin obtained from *Pinus roxburghii, P. wollichiana, P. insularis* and *P. merkussi* are pharmaceutically valuable. Leaves of *Taxus baccata* are useful in asthma, bronchitis, hiecough, epilepsy, indigestions. Seeds and leaves are being used for the extraction of many other drugs (especially effective in cancer) (Misra *et al.*, 2004). Plants are being over-exploited and needs conservation. Many species of *Ephedra* are used as a source of Ephedrine which a constituent of several drugs used in cough, asthma and bronchitis, as antibiotic, in siphilis and rheumatism. Seeds of *Gnetum ula* are useful in rheumatism. Stems and roots of *Gnetum contractum* and *G. latifolium* are effective antiperiodic agents. *Ephedra gerardian* contains good quantities of ephedrine. *Ephedra foliata* grows wild in drier part of Rajasthan. Tribals use it medicinally but modern systems of medicine should assign more research work on their plant which is rich source of pseudoephedrine. Medicinal importance of Thuja and Abies is well documented in homoeopathy. *Cupressus, Araucoria, Agathis, Tseuga, Cryptomeria, Callitris, Podocarpus, Juniperus* and *Cephalotaxus* are also medicinally valuable (Fig. 18-22).

Fig. 18 : Some *Cycadales* showing medicinal value, A. *Bowenia*, B. *Cycas*, C. *Dioon zamia*, E. *Stangeria*.

Fig. 19 : *Ginkgo biloba*—A medicinal plant, A. A profuse branch tree, B. Branch bearing mature seeds.

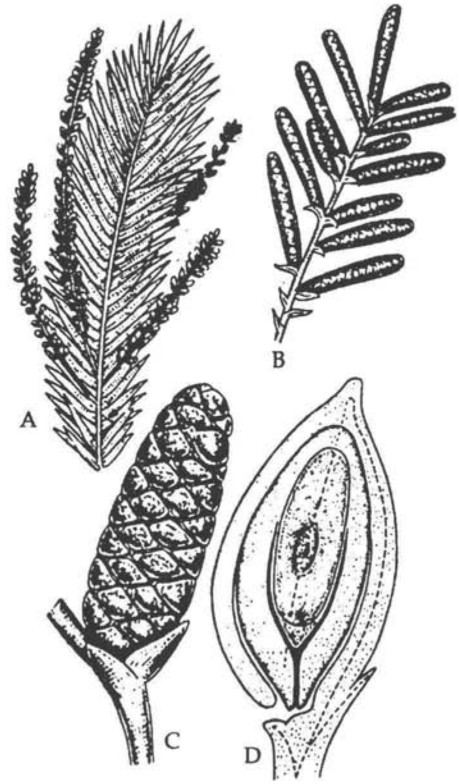

Fig. 20 : *Podocarpus,* A. shoot with male cone, B. A male branch, C. A single male cone, D. L.S. of ovule of *podocarpus.*

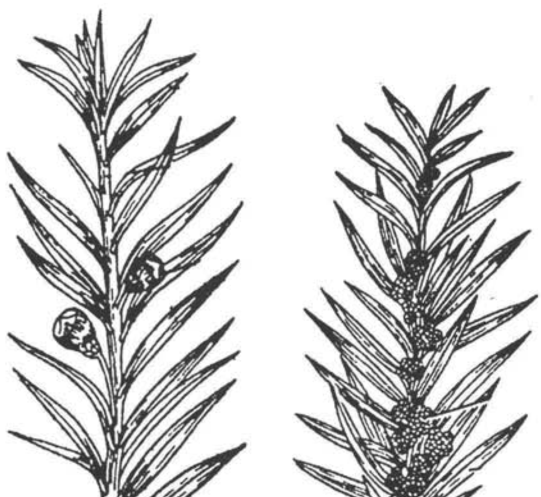

Fig. 21 : *Taxus baccata*—A gymnosperm with high potential of anti cancer drugs, A. Branch with seeds, B. Branch with staminate strobilii.

Fig. 22 : *Ephedra foliata*, A. A branch with male strobilii, B. A branch with leaves and young female strobilli.

THERAPEUTIC AND GLOBAL DIVERSITY IN ANGIOSPERMS

Angiosperms are represented by a wide diversity in forms including very simple, minute floating form and very gigantic trees. Out of about 400000 (four lacs) plants, about 286000 (two lacs eighty six thousand) on flowering plants. Out of these, the WHO has compiled a list of 21000 plant species of therapeutic value and used in different parts of the world. Out of these about 8000 species are used medicinally in India in Ayurvedic, Unani, Homoeopathic and Sidda systems of medicines (Bhattacharjee and De, 2005). However, our knowledge of medicinal plants has mostly been inherited traditionally. In modern medicine also plants occupy a very significant place being the raw material of many important drugs. The pharmaceutical industry is fairly advanced and sophisticated and more and more plants are being included in pharmacopoeia but still today, a large quantum of crude drugs (raw material) for the pharmacy comes from wild growth and need for bringing more and more plants under utilization web has been repeatedly by enunciated by many authors (Padulosi, 2002; Janick, 2001, Jakhar 2004; Singh and Tyagi, 2004).

Therapeutic and global diversity of angiospermic plants has been a subject of many recurrent reviews (Dorfler and Ressel, 1989; Cracker and Simon, 2002; Govil, 1998; Sarin, 2003a, b; Jakhar et al., 2003; Jakhar et al., 2004; Bhattacharjee, 2004; Singh and Tyagi, 2004; Bhattacharjee and De, 2005). Therefore, repeating the information in this review will be undesirable. For details of medicinal value and therapeutically useful metabolites - both secondary and primary, a reference of these reviews may be made.

On account of extraction of crude drug from wild plants, many important species have become 'threatened' and the biodiversity of many more is dwindling at an alarming rate and need of concerted efforts is being experienced globally for conservation and development of medicinal plants. Some results have indicated the fruitful results.

A new trend in the science and technology of medicinal and aromatic plants is emerging and this is to identify the therapeutic diversity of weeds which, otherwise, are harmful in crop production. Holm *et al.* (1997) presented the world literature on weeds of the world and also highlighted their therapeutic potential. Some of such weeds have been compiled in table 5 (Figs. 23-35).

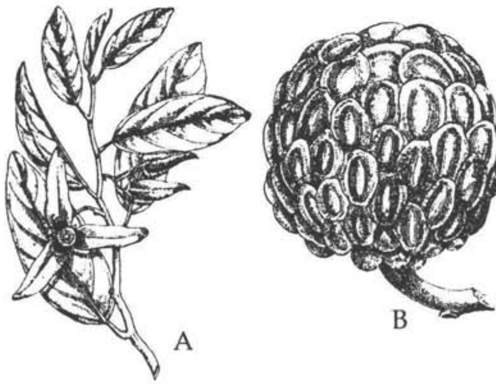

Fig. 23 : *Annona squamosa* L. (Annonaceae)—Sweet apple = sharifa—Edible fruits are medicinal and insecticidal in action, A. Flowering branch, B. A fruit.

Fig. 24 : *Rhus species* L. (Anacardiaceae)—A medicinally valuable angiosperm in Ayurvedic and Homoeopathic systems of medicine.

Fig. 25 : ***Terminalia bellerica*** **(Baheda) : A potent medicinal plant.**

Fig. 26 : ***Syzygium cumini*** **(Myrtaceae)—Medicinal angiosperm.**

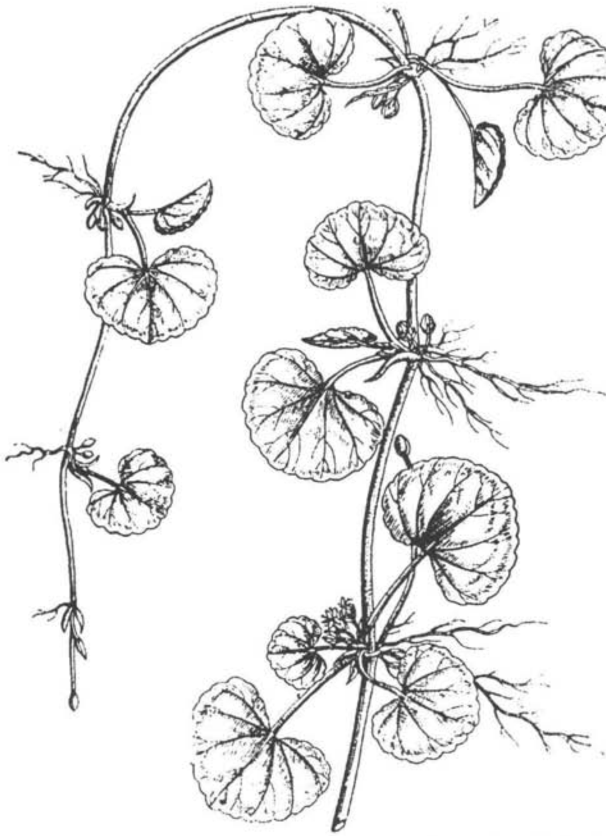

Fig. 27 : ***Centella asiatica*****—Hydrocotyle asiatica Brahmi (Medicinal angiosperm) a very important component of brain tonics.**

Fig. 28 : ***Pergularia daemia*** **(utran) (Asclepiadaceae)—A medicinal angiosperms.**

Fig. 29 : *Calotropis procera* (Asclipiadaaeae)—A medicinal angiosperm.

Fig. 30 : *Heliotropium strigosum* (Boraginaceae) A medicinal angiosperm.

Fig. 31 : *Adhatoda vasica* (Baansa)—A potent medicinal angiosperm.

Fig. 32 : *Vitex negundo* (Verbenaceae)—A medicinal angiosperm.

Fig. 33 : *Ocimum basilicum* **(Lamiaceae)—A highly medicinal plant, especially in Ayurveda and Homaeopathy.**

Fig. 34 : Smilax zelanica (Smilacaceae)—A medicinal angiosperm.

Fig. 35 : ***Sagitaria guayanensis*** **(Alistamaceae)—A potent medicinal angiosperm.**

Table 4 : Some genera of Gymnosperms showing therapeutic and global diversity

S.No.	Genus	Family
1.	Ginkgo	Ginkgoaceae
2.	Araucaria	Araucariaceae
3.	Agathis	Araucariaceae
4.	Cephalotaxus	Araucariaceae
5.	Amentotaxus	Araucariaceae
6.	Cupressus	Cupressaceae
7.	Juniperus	Cupressaceae
8.	Callitris	Cupressaceae
9.	Thuja	Cupressaceae
10.	Platycladus	Podcarpaceae
11.	Microbiota	Podocarpaceae
12.	Phyllocladus	Podocarpaceae
13.	Larix	Pinaceae
14.	Abies	Pinaceae
15.	Pseudotsuga	Pinaceae
16.	Tsuga	Pinaceae
17.	Cedrus	Pinaceae
18.	Picea	Pinaceae
19.	Pinus	Pinaceae

contd. ...

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S.No.	Genus	Family
20.	Podocarpus	Podocarpaceae
21.	Halocarpus	Podocarpaceae
22.	Taxus	Taxaceae
23.	Pseudotaxus	Taxaceae
24.	Taxodium	Taxodiaceae
25.	Cunninghamia	Taxodiaceae
26.	Cryptomeria	Taxodiaceae
27.	Sequoiadendron	Taxodiaceae
28.	Sequoia	Taxodiaceae
29.	Metasequoia	Taxodiaceae
30.	Cycas	Cycaceae
31.	Zamia	Cycaceae
32.	Microcycas	Cycaceae
33.	Ephedra	Ephedraceae
34.	Gnetum	Gnetaceae

Table 5 : Some world weeds having therapeutic and global diversity and potential as herbal medicine

S. No.	Botanical name	Family
1.	*Acanthospermum hispidum*	Asteraceae
2.	*Achyranthes aspere*	Amaranthaceae
3.	*Aeschynomene indica*	Papilionaceae
4.	*Alternanthero pheloxeroides*	Amaranthaceae
5.	*Alternanthero sessilis*	Amaranthaceae
6.	*Amaranthus viridis*	Amaranthaceae
7.	*Amaranthus retroflexus*	Amaranthaceae
8.	*Artemisia vulgaris*	Asteraceae
9.	*Asclepias curassavica*	Asclepiadaceae
10.	*Asphodelus tunifolius*	Liliaceae
11.	*Boerhaavia diffusa*	Nyctaginaceae
12.	*Boerhaavia erecta*	Nyctaginaceae
13.	*Borresia alata*	Rubiaceae
14.	*Brassica campestris*	Brassicaceae
15.	*B. kaber* var. *pinatifolia* (*Synapsis arvensis*)	Brassicaceae
16.	*Cardaria draba*	Brassicaceae
17.	*Carduus nutans*	Asteraceae
18.	*Cassia accidentoles*	Caesalpiniaceae
19.	*Cassia tora*	Caesalpiniaceae
20.	*Chenopodium ambrascides*	Chenopodiaceae

contd. ...

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S. No.	Botanical name	Family
21.	*C. murale*	Chenopodiaceae
22.	*C. juncea*	Chenopodiaceae
23.	*C. album*	Chenopodiaceae
24.	*Chrysanthemum reucanthenum*	Asteraceae
25.	*Cichosium intybus*	Asteraceae
26.	*Cirsium vulgare*	Asteraceae
27.	*Cleome gynandra*	Capparidaceae
28.	*Erigeron canadensis*	Asteraceae
29.	*Corchorus olitorisu*	Tiliaceae
30.	*Coronopus didymus*	Brassicaceae
31.	*Cuscuta reflexa*	Cuscutaceae
32.	*Cyperus brevifolius*	Cyperaceae
33.	*Datusa stromonium*	Solonaceae
34.	*Davcus casata*	Apiaceae
35.	*Digitaria longiflora*	Poaceae
36.	*Drymosia cerdata*	Caryophyllaceae
37.	*Eleochaaris acicularis*	Gyperaceae
38.	*Emilia sonchifolia*	Asteraceae
39.	*Eragrostis pilora*	Poaceae
40.	*Euphorbia helioseopia*	Euphorbiaceae
41.	*Euphorbia heterophylla*	Euphorbiaceae
42.	*Euphorbia prunifolia*	Euphorbiaceae
43.	*Fumaria officinalis*	Fumariaceae
44.	*Heliotropium eurapaeum*	Boroginaceae
45.	*Heliotropium indica*	Boroginaceae
46.	*H. zeylanicum*	Boroginaceae
47.	*Hibiscus trianum*	Malvaceae
48.	*Hordeum murinum*	Poaceal
49.	*Hydrilla verticillata*	Hydrochanitaceae
50.	*Ipomoea aquatica*	Convoluulaceae
51.	*I. triloba*	Convoluulaceae
52.	*Lamium amplexicaule*	Lamiaceae
53.	*Lemna minor*	Lemnaceae
54.	*Ludwigia abbcendens*	Oxagraceae
55.	*L. hyssopifolia*	Oxagraceae
56.	*L. octovalvis*	Oxagraceae
57.	*Matricasia chamomilla*	Asteraceae
58.	*Mossordica charantia*	Cucurbitaceae
59.	*Myriophyllum spicatum*	Haloragaceae
60.	*Nicandra physolodes*	Solanaceae
61.	*Orobanche ramose*	Orobanchaceae
62.	*O. minar*	Orobanchaceae
63.	*Oryza sativa* + 5 Wild species	Poaceae
64.	*Oxalis latifolia*	Oxalidaceae
65.	*O. carniculata*	Oxalidaceae
66.	*Papavar rhoeas*	Papareraceae
67.	*Paspalum distichum*	Poaceae
68.	*Passiflora foetida*	Passifloraceae
69.	*Phyllanthus rirusi*	Euphorbiaceae
70.	*Poa annua*	Poaceae
71.	*Polygonum aviculosa*	Polygonaceae
72.	*P. hydropiper*	Polygonaceae
73.	*P. lapatxifolium*	Polygonaceae
74.	*P. persicasia*	Polygonaceae

contd. ...

contd. ...

S. No.	Botanical name	Family	S. No.	Botanical name	Family
75.	*Potamogeton pectinatus*	Potamogetonaceae	90.	*S. pallide fusca*	Poaceae
			91.	*Sida rhombifolia*	Malvaceae
76.	*P. crispus*	Potamogetonaceae	92.	*Sonchus arvensis*	Asteraceae
77.	*P. natans*	Potamogetonaceae	93.	*S. asper*	Asteraceae
78.	*Ranuncules rapans*	Ranunculaceae	94.	*Tagetus minuta*	Astiraceae
79.	*Raphanus naphanistrum*	Brassicaceae	95.	*Taraxacum officinale*	Asteraceae
			96.	*Tholapsi arvense*	Brassicaceae
80.	*Rumex acetosella*	Polygonaceae	97.	*Triantema portulaeastrum*	Portulacaceae
81.	*Saccharum & pontaneum*	Poaceae			
			98.	*Tridex procuombens*	Asteraceae
82.	*Sagitoria sagitatifolia*	Alismataceae	99.	*Typha angustifolia*	Tuphaceae
83.	*Salsola kall*	Chenopodiaceae	100.	*Ulex europaeus*	Papillonaceae
84.	*Scerpus maritimus*	Poaceae	101.	*Urtica urens*	Urticaceae
85.	*S. mucronatus*	Poaceae	102.	*Vallisnasia spiralis*	Hydrocharitaceae
86.	*Senecia vulgaris*	Asteraceae	103.	*Vernonia cinerea*	Asteraceae
87.	*Setaria geniculata*	Poaceae	105.	*Veronica arvensis*	Asteraceae
88.	*S. glauca*	Poaceae	106.	*V. persica*	Asteraceae
89.	*S. l;utescens*	Poaceae			

CONSERVATION, DOMESTICATION AND CULTIVATION OF THERAPEUTICALLY VALUABLE PLANTS

Therapeutic biodiversity has attracted the attention of all walks of life and awareness has been emerging fastly for conservation, scientific exploration, judicious utilization and further development of biodiversity. All kinds of biodiversity-genetic, species, ecosystem, agrobiodiversity is being looked into at global and national levels so as to eliminate threats to biodiversity. These efforts include both *in situ* and *ex-situ* biodiversity conservational strategies. These have the active involvement of many organizations (both governmental and non-governmental) and agencies. Domestication of wild growing medicinal plants is very important part of such efforts. Franz (1993) and Jakhar *et al.* (2003) reviewed world literature on the subject. It was emphasized that domestication is a tedious process and no specific and valid scheme exists for the purpose. However, roles of applied botanists, plant physiologists, plant breeders, agronomists and phytochemists are well founded (Singh and Tyagi, 2004). Production and distribution of good quality planting material is first step followed by area expansion, establishment of herbal gardens, upgrading technical know-how and other steps. Roles of gene banks have also been emphasized. Marketing and export and remunerative prices to cultivators may ensure farmers active participation in the programme.

CONCLUSION

At global level, a very wide range of diversities prevail in different groups of plants with respect to biosynthesis of therapeutically valuable products. Some of these products have been commercially exploited for human welfare including a wide range of antibiotics produced from bacteria and some fungi whereas others need to be systematically and commercially explored. Besides Penicillium, a number of fungi such as *Agaricus*, *Claviceps*, *Polyporus*, etc. have been in medical uses. A large number of Algae (both fresh water and marine), many lichens, several bryophytes are known to be therapeutically valuable in traditional and modern systems of therapeutic sciences. More than 100 Pteridophytes have been in use for treatment of many ailments. Likewise, several species of Gymnosperms are well documented as economically viable source of clinically useful secondary plant metabolites. The list of medicinally useful and economic plants belonging to Angiosperms is still larger but judicious use of these plant resources requires concerted efforts for their biodiversity conservation by involving private and public participation.

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4

Recent Technology for Conservation of Medicinal Plants

Shiv Narain, R. Sharma and M.L. Jakhar

INTRODUCTION

Plant products have been a source of medicinal agents since time immemorial. From the down of civilization, men have been utilizing the important biological properties of various plants for treatment of different diseases. India is one such country bestowed with rich natural resources diverse ecological conditions and long practice of traditional forming systems consistent with ethnic diversity and ancient civilization.

India has rich medicinal plant fora of over 2000 documented species having medicinal value. Out of these, 600-700 species are much in use in the country. Mostly by local peoples living in village as a household remedy in several diseases. About 150 species are used commercially many of these are exported to various countries of the world. In recent years, there has been an awakening all over the world for use of organic medicaments in place of synthetic and antibiotics and there has been consistent growth in demand of many of these plant based drugs and several plant products from diverse species (Anonymous, 1999).

With the increasing biotic pressure and human interventions the forests are getting degraded and in the process ground flora and shrubs which happen to provide bulk of the medicinal plants are also under strain. Reports are pouring in, which indicate that a number of plants are being endangered due to unsystematic and unscientific collection, over exploitation and destruction of habitat (A.K. Pandey and A.K. Bisana, 1998). In such condition of uncontrolled exploitation and unawareness it is of utmost importance to conserve these plants systematically and scientifically.

Global interest in IPR regime has further, necessitated enchancements in the systematic efforts for survey, inventronization, collection, evaluation, documentation and characterization of native plant biodiversity before it is eroded for ever. Above all, there is an urge to collect and conserve all available and useful genetic materials in view of the rapid habitat degradation, introduction of high yielding varieties and shifting land use patterns, which could eventually least to extinction of many traditional cultivars and useful wild plants including traditionally used medicinal plants. However, remaining neglected for long period collection and conservation of medicinal plants posses certain problem (Singh, 1982).

Problems regarding collection of Medicinal and Aromatic Plants from forests :

- Extinction of rare and endangered species.
- Depletion of resources due to large scale collection of plants.
- Unavailability of material in large quantities and throughout the year.
- Incorrect identification of plants.
- Possibility of adulteration.

Why to propagate/cultivate Medicinal and Aromatic plants :

- To conserve rare and endangered plants.
- To get large scale production of assured quality.
- To check unintentional adulteration.
- To meet requirement of domestic pharmaceutical companies.
- To save our forest resources from depletion.
- To utilize wastelands.
- To get maximum returns from a single piece of land by introducing multistoried plantation of suitable species of these plants.

Consideration for conservation : Basically three consideration are important:

i. **Crop:** Whether crop in annual, perennial and tree. In case of tree there is no need of elaborate effective conservation because they survive for long period.

ii. **Nature of flowering:** This is important for cross pollinated species where populations and gene frequencies need considerations.

iii. **Material:** The material is most important part for conservation purpose. Because some of the species have long period of dormancy but other have not. So conservation will depend on the nature of the material, objective and scope of activity.

In addition to these conservation strategy must also take into account the more considerations the time dimension, whether it is long time, medium time and short time storage and location.

CONSERVATION APPROACHES

i. ***Ex-situ* conservation of Medicinal Plants:** *Ex-situ* conservation maintains plant species outside their original habitats in facilities such as Botanical garden, seed gene banks, field repositories and *in vitro* gene banks etc. Seed storage is the cheapest and most reliable method of conserving germplasm of many Medicinal plants. It is desirable to harvest seeds at physiological maturity as germination and vigour were maximum at physiological maturity. *Ex-situ* conservation minimized the further evolutionary processes but ensures safe conservation of existing genetic variability and its sustainable use. The most common *ex-situ* conservation approach for orthodox seed species comprises their long term preservation in seed gene banks at -20^{0}C. other approaches namely cryopreservation (Conserving the samples of seeds, including recalcitrant seeds, embryos, embryonic axes and pollen grains in liquid nitrogen at -196°C). *In vitro* conservation in which tissue culture techniques for preservation of clonally propagated materials and field repositories for tree/vegetative propagated species are also adopted depending upon the characteristics of the species. Conservation of DNA fragments in genomic library is also attracting attention (Appa Rao,1997, Bhojwani and Razazan, 1996).

ii. ***In situ* conservation of Medicinal Plants:-** *In situ* conservation maintains plant in their original habitat. This is appropriate for many wild medicinal plant species. *In situ* conservation preserves evolution any processes and has low direct costs. *In situ* conservation approach simultaneously permits continued evolutionary development under natural selection pressures, thereby promoting the fitness of the species but cannot safeguard it in the face of unforeseen natural calamities. *In situ* conservation demands the establishment of nature or biosphere reserves, national parks, or banks and need special legislation to protect endangered species. As sustainability is the primary consideration *in situ* method should be effective for the conservation of genetic diversity in both cultivated and wild species. *In situ* conservation maintains genetic diversity at a dynamic state (Singh, 1982).

Many of the medicinal plants are habitat specific. They had grown vegetatively but the specific chemical to found in economic quantity only in certain climatic zone, specific soil and temperature. Therefore these species are to be conserved in their natural habitat. For conservation of these medicinal plants in their natural habitat, areas where these plants grow naturally will have to be selected and then these plants should be planted in those specified areas. The herbal gardens (Fig. 2), Arboreum, charak van etc. should be established by planting of medicinal Plants of different region or locality in one area for example Rajasthan forest Deptt. has developed one Arboreum in Jaipur by planting a number of species collected from the different parts of the country and from the different countries of the world.

Similarly, Herbal gardens at forest research farm Banki, Nal Sandol and Ogna of Udaipur district and similar gardens have also been developed by some of the Deptt. and agencies like Guggul Farm in Mangliawas (Ajmer) developed by Aurved Deptt. and Charak Van being developed by Ayurvedic College Udaipur. In southern Rajasthan, Forest Department has started planting some quantity of Medicinal plants in forest plantation for conserving these plants in their natural habitat (Siyol,2001).

Conservation Strategies

Artificial conservation → *Ex-situ* → Whole plant

- –Field gene bank
- –On farm conservation
- –Botanical/ Herbal garden
- –Arboreta

Parts of plant

- –Gene Bank/Seed Gene Bank
- –Pollen Bank
- –Tissue Culture Repository
- –DNA Library
- –Cryobank

Natural conservation → *In-situ*

- –Biosphere Reserve
- –National Parks
- –Wild life sanctuaries & National parks
- –Gene Sanctuary

Fig. 1 : Conservation schemes for medicinal plants.

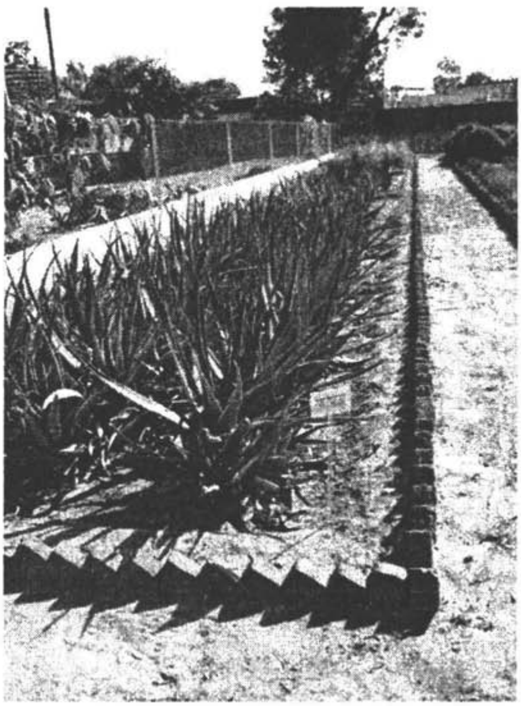

Fig. 2 : Conservation of *Aloe vera* in herbal garden.

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5

BIODIVERSITY CONSERVATIONAL STRATEGIES FOR THERAPEUTICALLY VALUABLE LEGUMES

KARAN SINGH AND S.J. SINGH

The scientific and systematic exploitation of plant biodiversity in general and of leguminous plants in particular is imperative for sustainable development (Conoor, 2001). Hence, it has attracted the attention of all walks of life. Due to new emerging threats to the quantitative and qualitative spectra of legume biodiversity, plant genetic resources and their biodiversity constitute enormously valuable asset for achieving the global objectives of food security, poverty alleviation, environmental production and subsequently the sustainable development. International Plant Genetic Resources Institute (IPGRI) has been the pivotal organization for making scientific efforts for biodiversity conservation at global level (Anonymous 2000). Recently, IPGRI has focussed its attention on *in situ* conservation of agrobiodiversity giving due weightage to farmers participation in such efforts (Nosberger *et al.*, 2001, Deb, 2002).

GENERAL VIEW

The biodiversity of legumes has following aspects worthmentioned here:

I. **Types of Legumes Biodiversity**—The biodiversity in legumes is classified as under:

(a) **Generic Diversity**—This includes biodiversity in form, functions and adaptability potentials of genera of family leguminosae. The family has been now trifurcated in three independent families—Papilionaceae (Fabaceae), Caesalpiniaceae and Minosaceae. These families have genera herbs, shrubs and trees. See Table-1 & Figure 1.

Table 1 : Tropical legumes (Pulses and Others) requiring immediate attention of scientific community

S. No.	Botanical Name	Common Name	Growth/ Habitat	Important Uses	Remarks
1	2	3	4	5	6
1.	Pachyrhizus tuberous (Lam.) Spreng	Yambean	Climbing vine, Amazen head water South America	Brownish tuberous roots (Similar to sugar beet) edible	Seed and tuber propagated wide diversity. Seeds remain viable for 3-4 years.
2.	Sphenostylis stenocarpa (Hochst) ex.A. Rich	African Yambean	Climbing vine twining, Central and Western Africa	Elongated tuber root but more proteins than sweet potato, seeds are edible.	International Inst Tropical Agril. Ibadan Nigeria did prelim work.
3.	Psophocarpus tetragonoloba (L)DC	Winged bean (Photo-graph)	Tuberous root edible, all parts (even Seeds) edible. Papua new guinea, South East Asia	Tubers are similar to early season potato but protein rich. Seeds with 20% protein.	Agronomic information not available.
4.	Vigna vexillata (L) A. Rich	Vexillate Vigna Wild Mung (M India)	Twining vine or prostrate herb, Tropical Africa, Asia, Australia	Large, thickened Tubers, edible (15% protein)	Promising crop for north/ eastern Himalaya (India)
5.	Vigna lanceolata Benth	–	Perennial legume. Tropical! sub-tropical Australia	Purnip Like roots edible	Vegetable
6.	Flemingia vestila Benth ex Bak	–	Partially cultivated in Meghalaya hills	Tuber roots	No further information

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1	2	3	4	5	6
7.	Psoralea patens lindl.	--	Tuber root Australia	Tuber roots	Vegetable purpose
8.	Voandzeia subterranea (L) Thouars	Bambara groundnut pulse crop	Similar to peanut (Seeds edible)	Seeds are with 24% protein	Needs attention of global Scientific community
9.	Canavalia ensifiormis (L)DC	Jackbean	Robust plant New World (Arizona, Mexico)	Seeds are protein rich	Drought hardy crp. No agro-nomic information published.
10.	Canavalia gladiata (Jacq.)DC	Swordbean (Horse bean)	Robust plant with sword shape pods old world Africa, Asia	Pods and Seeds are Edible	Physiological breeding and biochemical studies are needed.
11.	Tylosema esculentum (Burchell) A. Schreiber	Marama bean	Prostrate plant, wild in kalahari (South Africa)	Pods, seeds are edible. Rich in protein, good forage	All aspects of plant biology need research badely
12.	Vigna acontifolia (Jacq) Marechal	Moth bean	Erect, robust, most drought tolerant, mat forming across the soil, wild in rest of the world except india where it is cultivated in dry areas.	Seeds are edible, good forage	Ecophysiological, biotechnological research needed
13.	Vigna umbellata (Tumb.) Ohwi or Phaseolus calcaratus (Roxb.)	Rice bean	Erect or twining South and South East Asia. (Himalaya, China, Indinasia)	Highly nutritive seeds. Vegetable purpose	Poor pod/seed setting, low yield
14.	Lupinus mutabilis sweet	Tarwi	Erect, annual South America (Peru, Ecuador, Bolivia, Chile)	Seed, Pod nutritive	Seed propagated hardly, plants need physiolo-gical evaluation

contd. ...

contd. ...

1	2	3	4	5	6
15.	Phaseolus acutiformis A. Gray	Tepary bean	Shruby vine Mexico	Protein rich seeds	Highly tolerant, drought, high temp. dry air. Need introduction in India.
16.	Phaseolus lunatus L.	Tropical Lima bean	Erect, fast growing, Tropical America, low lying water logged soils	Seeds, pods are nutritive	Seed techno-logical breeding and ecophysiology
17.	Cordeuxia edulis Hemsi	Jehab nut	Hardy shrub, Somalia	Nutritive seeds, leaves, pods, fodder	Botanical, Agro-nomical studies
18.	Ceratonia siliqua L.	Carob	Tree, Greece, Italy, Egypt, Spain, Purtgal etc.	Usefid tree as forage, food industrial gum, shade and erosion control	All aspects of physiology and agronomy need to be studied.
19.	Tamarindus indica L.	Tamarind	Tree of hot climate, Native of tropical Africa but accli-mitized in India	Fresh or processed pods are edible	Neglected with research point of view.
20.	Cassia strutti L.	Australian Cassia	Forage tree, native of Australia, widely planted in Isreal.	Leaves are valuable, forage for browzing animals (Goats etc.)	Suitable for arid, semi-arid, hot desert areas, growth studies be initiated in variable niches.
21.	Desmodium discolor L.	Desmodium	Vigorous perennial shrub, Brazil Forage	Palatable, Good forage	No sytemetic research work carried.
22.	Gleditsia triacanthas L.	Honey-locust	Fodder tree eastern north America	Excellent livestock feed	Easily propagated by seeds, suckem cuttings, fast growth
23.	Leucaena leucocephala L.	Subabool	Fast growth bushy habit Australia, America (Now) in India	Protein rich leaves, seeds are palatable for domestic animals	Similar to alfalfa but need more research

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1	2	3	4	5	6
24.	Acacia tortilis (Forsk) Hayne	Isreali babool (umbrella thorne)	Medium size tree, Isreal, India etc.	Umbrell, good feed	Drought resistant, need basic, applied research
25.	Prosopis alba Griaebach	Arbol	Round crown tree, Argentina, Peru etc.	Valuable for wind break in arid regions	Biodiversity exploitation-needed
26.	Acacia auriculiformis A. Cum Benth	Australian phyllode Acacia	Fast growing tree, Papua new Guinee Australia	Colonising Tree, wide adaptation (Acidic, Saline, Alkaline soils)	Drought tolerant, forestry research paper
27.	Albizia falcatoria (L) Fosberg	Mollucca Albizia	Fastest growing tree of world, highly productive, phillipines	Wood, pulp, shade, forestry	PGRs effects
28.	Albizia lebbek L Berth	Black Siris	Fast growing tree, Asia, Australia, tropical parts	Timber, shade etc.	Medicinal preparation
29.	Sesbania grandiflora (L)	Dhaincha	Small tree, fast growth, All parts of tropics (India etc.)	Fuel, wood, green manure, forage, soil reclamation feed	Multiple uses but poorly exploited, researched
30.	Dulbergia siso L.	Sheesham	Tree, fast growth, Tropical Asia	Furniture/ Construction wood	No much research
31.	Crotolariauncea L.	Sunhemp	Herb, annual fast growth, Tropical Asia	Green Manure	Breeding Physiology
32.	Acacia senegal (L) Willd	Gum arabic	Tree, Native of hot, dry Afica, now grown in Asia	Commercial Gum arabic	Genetic improvement needed

(b) **Species Biodiversity**—This includes the variability existing in different species of the same genus. Leguminc. 40 species of *Cicer* and 26 species of *Arachis* embody species diversity in respect of growth habit, acclimation and tolerance to biotic and abiotic stresses (Witcombe and Erspine 1984). See Table-2 & Figure 2.

Table 2 : Cultivated species and their wild relatives of important pulses and some fabaceous oilseed plants

S. No.	Crop Name	Wild Relatives (Most Common)	Remarks (Distribution etc.)
1.	Chickpea (About 40 Species) Cicer arietinum L.	C.acanthophyllum (Boiss)	Afganistan, Pakistan, C.Asia, USSR
		C.anatolicum (Aleb)	Iran, Iraq, Turkey
		C.cuneatum (Hocht ex. Rich)	Egypt, Ethopia, Sudan
		C. incisum [(Willd) K. Maly]	India, Iraq, C. Asia (USSR)
		C.isauricum (Davis)	Turkey
		C.macracanthum (M.pop)	Afganistan, Spain, C.Asia (USSR)
		C.microphyllum (Benth)	Afganistan, India, Pakistan, C.Asia (USSR)
		C.oxyodon (Boiss)	Afganistan, Iran, Iraq, Turkey
		C. pinnatilidum (Iaub. & Spach)	Iraq, Syria, Turkey
		C.spiroceras (Iaub. & Spach)	Iran
		C.tragacanthoides (Iaub. & Spach)	Iran, C. Asia (USSR)
2.	Faba Bean (Vicia faba L.)	V.nerbonensis L.	Mediterranean region Near east
		V.ceratofolium	do
		V.johannis	do
		V.galilaea plit & Ioh	do
		V.melamops L.	Europe species
		V.birthynica L.	do
3.	Lentil (Lens esculenta L.Moench= L.Cullinaris L.)	L.orientalis Alef	Afganistan, India
		L. nigricans Alef.	do
		L. eroides Alef	Uganda
		L.mantbretti Alef.	Afganistan, India
4.	Pigeonpea [C.ajonus cajan (L)	C.volubilus L.	India, Pak, Nepal, Afganistan, Africa, Bangladesh
	C.indicus millsp spreng]	C. platycarpus L.	do
5.	Pea (Pisum sativum L.)	P.fulvam Sebth	India, America
		P.elutius bieb	
		P.humile Boiss	
		P.syricacum Noe.	

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S. No.	Crop Name	Wild Relatives (Most Common)	Remarks (Distribution etc.)
6.	Grasspea (Lathyrus sativus L.)	L.cicera L. L.marmoratus Boiss L.blepharocarpus Boiss L., seudocicera Pamp	India
7.	Fenugreek (Trigonella foenum graecum L.)	No wild species	India, USA
8.	Lupine (Lupinus albus L)	L.luteus L L.angustifolius L.	Tropical India
9.	Mothbean vigna acontifolius (Jacq) Marechal	V.trilobus L. Phaseolus trilobus L.	India Afganistan
10.	Cowpea Vigna anguiculata (L) Walp	x x x x	Cultivated in Africa, Greek, Romania, Spain, India
11.	Clusterbean Vigna cyamopsis tetragonoloba Taub.	C.senegelensis L.	India
12.	Horsegram Dolichus biflorus L.	x x	India
13.	Soybean Glycine max (L) Nerril= G.soja L.	G.arenaria Tind G.argyra Tind G.falcata Tind G.foliata Benths G.micropyla Benths	Tropical parts of the world
14.	Groundnut (Arachis hypogaea L.	A. batizoral Krap A.villosa Benths A.diogoi Hoechne A.belodes Krep A.nambyquare Hoechne A.monticola Rig A.tuberosa Benth A.quarentinica Chod A.martu Handro	Tropical World

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S. No.	Crop Name	Wild Relatives (Most Common)	Remarks (Distribution etc.)
		A. repens Hendro A. prostrate Benths	
15.	Garden Bean (Dolichos lab-lab) Var,Typicus Linn. (Sem)	D.bracteatus Baker D.hosei Taper D.falcatus Klein	India Africa, Australia America
16.	Field Bean (Dolichos lab.lab. var. lignosus L. Sem	No wild relative known	xxxx xxxx
17.	Frenchbean (Phaseolus vulgare L.)	No wild relative known	xxxx
18.	Three lobbed Kidneybean phaseolus trilobus L.	No wild relative known Forage crop in southern India	xxx xxx
19.	Sword bean (Cannavalia ensifoformis L.)	No wild relative	India, West Indies, Tropical Africa
20.	Lima bean (Phaseolus limensis L.)	No wild relative known	
21.	Green Gram = Mungbean (Vigna radiata (L) Willczek)	V.angularis Wild V.trilobata (L) Verdc	India East Africa, New Zealand
22.	Black gram (Vigna mungo (L) Hepper)	V.umbellata (Thumb) Ohwi Ohashi	Tropical Asia

(c) **Ecosystem Biodiversity**—Depending upon abiotic components, the biotic components exhibit great diversity as evident from fauna and flora of various ecosystems.

(d) **Agrobiodiversity**—When wild plants are domesticated, biodiversity is depicted in varieties, hybrids, clones and wild relatives (Edwards and Hilbeck 2001)

II. **Levels of Biodiversity In Legumes**—Biodiversity is also studied at various levels. These levels include global biodiversity, National biodiversity and regional biodiversity.

III. **Threats to Legumes Biodiversity**—The biodiversity of leguminous plants is under threats due to various biotic and abiotic pressures (Bunders et. al 1996).

These threats include overexploitation (such as medicinal plants), unscientific exploitation (Forest species both timbers and non-wood species), environmental degradation (Chickpea decline), human population (Plant biodiversity especially in fragile ecosystem- Rajasthan, India), intensive cultivation (excessive and indiscriminate uses of agrochemicals and chemical fertilizers) and GMOs etc. (Cassman, 2001, Kakraliya *et al.*, 2000, Killer and Carabias, 2001).

IV. **Threats to Legume Biodiversity In India**—Botanical survey of India (BSI), Man and Biosphere program (M&B), Department of Environment and Forest, DST, ICAR Institutes and SAUs have joined hands to quantify such threats which have led to identification of endangered (E) species, Vulnerable (V) species, Rare (R) species, Threatened (T) species, Out of Danger (O) species and Indeterminate (I) species of plants including leguminous plants. See Table-3.

Table 3 : Wild edible plants (Both legumes & non-legumes)

S. No.	Botanical Name	Local/Common Name	Family	Edible Parts
1.	Hibiscus crinitus G.Don		Malvaveae	Tuberous roots
2.	Dioscora bulbifera L.	Potato yaus/ Tatalu	Dioscoreaceae	Dull brownish tubers
3.	Eriosema chinense Vog.	Kandan	Fabaceae	Tubers
4.	Vigna vexilliata A.Richard	Kalanido	Fabaceae	Fusifirm roots
5.	Bryonopsis lacimioa Naud	Bilonja	Cucurbitaceae	Leaves
6.	Oxalis corniculte	Khatti Buti	Oxalidaceae	Leaves
7.	Baubinia variegata	Kachnar	Mimosaceae	Flower bud
8.	Aegle marmelos Linn.	Bael	Mimosaceae	Edible fruit

SEED-PROPAGULE BANKING SYSTEM AND LEGUME BIODIVERSITY

Seeds and propagules are the basic requirements for plant propagation, production and also for biodiversity management. This is imperative for natural and man made ecosystems as well. Other inputs and efforts revolve around this central biotic material (Singh et. al *1995;* McDonald and Copeland 1997). True seeds as well as vegetative propagating structures are constituents of this input. Synthetic seeds and other culture regeneraters are recent additions to this list (Deb, 2002). The banking system has following features of specific interest:

Seed And Propagule Quality in Legumes—Sufficient experimental evidences are available to enunciate that seed and propagule quality has the potential to enhance the primary productivity of the ecosystem (Singh et. al 2002). Various methods and procedures have been developed to improve and ensure seed and propagule quality (Seed testing, Certification, processing & storage etc.). This involves various national and international establishments and organizations (McDonald and Copeland, 1997; Anonymous 2000).

Organisational Setup of the System—A world wide non-formal seed- propagule banking system is operative having participatory and contributory roles by many nations and organizations (both governmental & NGOs). Looking to the importance of food security, environmental safety and sustainability of the development, a great awareness has been generated about such a system (Kumar & Sharma, 2001, Sankhla, 2002). However, conventionally this system is still termed as "Gene Banking System" (Boef et. al, 1996). Boef et. al (1996) emphasized that the efficacy of the system should be assured by the "by heart" participation of local people, farmers, academicians and scientists for both *ex-situ* and *in-situ* biodiversity conservation and also for further development of biodiversity in germplasm. Heide, Tripp and Boef (1996) used the term *Local Crop Development System* to include the effective partnership of farmers, tribals and scientific community for biodiversity conservation. They cited the examples of beans, peas, chickpeas, peanuts, lentils, lupins and cowpea crops and their locally available germplasm for sustainable crop biodiversity development. See Table-4.

Table 4 : List of the few partners in the banking system (Seeds and Propagules)

S.No.	Abbreviation, Name and Headquarters
1.	IPGRI—International Plant Genetic Resources Institute, Rome, Italy
2.	IPGRI—Regional Centre for South Asia, Pusa Campus, New Delhi, India
3.	IPGRI—Regional centre for Asia, the Pacific and Oceania (APO) Singapore
4.	IPGRI—Regional centre for East Asia, Beijing , China
5.	CPRO-DLO—Centre for Plant Breeding and Reproductive Research- Centre for Genetic Resources—Wageninger (Netherlands)
6.	ODI—Overseas Development Institute: London, U.K.
7.	USDA—United State Department of Agriculture, Douis California (USA)
8.	UPOV—Union for the Protection (New) Varieties of Plants
9.	IDRC—International Developmental Research Centre, Canada.
10.	ISTA—International Seed Testing Association, Zurich Switzerland
11.	SCST—Society of Commercial Seed Technologists, Coffey Rd. Columbus OH (USA)
12.	AOSA—Association of Official Seed Analysts, Coffey Columbus (USA)
13.	ICAR-CAU-SAU-NARS, New Delhi, India
14.	NBPGR—National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi, India
15.	ICFRE—Indian Council of Forestry Research & Education, Debradoon, India
16.	ISST—Indian Society of Seed Technology, New Delhi, India
17.	SAI—Seed Association of India, New Delhi, India
18.	FAO (UNO) Rome, Italy
19.	FIS—Federation of International Seed Trade.
20.	ISHI—International Seed Health Institute, Netherlands.
21.	OECD—Organization of Economic Cooperation and Development

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S.No.	Abbreviation, Name and Headquarters
22.	International/National Seed Companies like NSC, MAHYCO, MONSANTO, PIONEER, PGS, CIBAGEIGY
23.	ASTA—American Seed Trade Association (USA)
24.	APAFRI—Asia Pacific Association of Forestry Research Institution, Bangkok (Thailand)
25.	PGRFA—FAO Global System for Conservation and Utilization of PGRs for Food & Agriculture, Rome, Italy
26.	CGIAR—Consultative Group of International Agricultural Research, Washington, USA
27.	ICRISAT—International Centre for Research in Semi Arid Tropics, Hyderabad, India.
28.	CAZRI—Central Arid Zone Research Institute, Jodhpur, India
29.	ICARDA—International Centre for Agricultural Research in Areas, Aleppo, Syria.
30.	CAIT—Centro International de Agril. Tropical, Cali, Columbia
31.	CIMMYT—Centro International de Majoramiento de Maiz y Trigo, Apdo, Maxico, USA
32.	CIP—International Potato Centre, Limia, Peru
33.	ICRAF—International Council for Research in Agroforestry, Nairobi, Kenya
34.	IITA—International Institute of Tropical Agriculture, Ibadan, Nigeria
35.	IRRI—International Rice Research Institute, Manila, Phillipines
36.	ISNAR—International Service for National Agricultural Research, Hague, Netherlands
37.	AVRDC—The Asian Vegetable Research & Development Centre, Shanhua, Taiwan, China

International Rules For Germplasm Exchange: Seed and propagule material is exchanged between -nations and organizations for various purposes. Rules framed by I CCBD (Convention on Conservation of Bio-Diversity) and II CCBD *(1995)* in collaboration with FAO, CGIAR and CITES (Convention on International Trades in Endangered Species) are strictly followed alongwith plant quarantine and seeds -health rules (Anonymous, 2000).

Function and Activities of the System—Specifically documented procedures are followed for the activities relating to plant exploration, seed & propagule studies, germplasm evaluation, plant domestication/Introduction. Janick (2001) advocated the need of new crops to be brought under cultivation network as only 5 plant species still constitute the food component to the extent of more than 50% (Rice, Maize, Barley, Wheat & Potato). This indicates that pulses are still far away from this significant food web at global level. See Table-5 & Table-6

Role of the System—In all these activities seed and banking system plays a key role for biodiversity development and conservation, both conventional methods of crop improvement as well as modern methods are adopted. Varietal development is followed by breeder seed production, foundation seeds and other categories of seeds. These activities are fortified by scientific information generated by National and International seed science and technology researches.

CRYOBIOLOGY AND LEGUME BIODIVERSITY CONSERVATION

Applied aspects of cryobiology and plant biotechnology have now assumed very important status. These techniques have, now, become the integral part of seed and propagule banking system. Cryopreservation of germplasm is managed in storage at ultra low temperature in a cryogenic medium (such as liquid nitrogen). This technique has been found very effective (but costly) in long term storage of seeds and propagules (Kumar and Sharma, 2001). In India, excellent facilities have been developed at NBPGR, IARI campus, New Delhi for both orthodox as well as recalcitrant seeds and propagules (Chin, 1993, Chandel et. al 1993). Ways to develop and conserve legume biodiversity through tissue culture biotechnology (Synthetic seeds) is of recent commencement (Deb, 2002). See Table-5 & Table-6

Table 5 : Cryopreservation of orthodox seeds

Crop	Common Name	Scientific Name	Duration of storage (in months)	Storage temp (°C)
Millet	Pearl millet	*Pennisetum glaucum (2)*	41	-180.-20 RT
Minor Mullets	Little millet	*Panicum miliare (8)*	14	-180.-20 RT
	Barnyard millet	*Echinochloa frumentacea (21)*	14	-180.-20 RT
	Kodo millet	*Paspalum scrobiculatum (10)*	14	-180.-20 RT
	Finger millet	*Eleusine coracana (22)*	14	-180.-20 RT
	Foxtail millet	*Setaria italica (17)*	14	-180.-20 RT
	Proso millet	*Panicum miliaceaum (9)*	14	-180.-20 RT
Oil seed	Field mustard	*Brassica campestris (9)*	21	-180.-80.-20. RT
	Brassica	*Brassica carinata (1)*	27	-180. RT
	carinata	*Brassica carinata (10)*	21	-180.-80.-20 RT
	Indian	*Brassica juncea 4*	27	-180.-80. RT
	mustard	*Brassica juncea (10)*	21	-180.-80-20 RT
	Rape	*Brassica napus (5)*	27	-180.-80. RT
		Brassica napus (6)	21	-180.-80.-20 RT
	Taramira	*Eruca sativa (11)*	21	-180.-80.-20 RT
	Sunflower	*Helianthus annuzss (3)*	28	-180.-20 RT
	Til	*Sesamum indicum (50)*	18	-180.RT
Vegetable	Onion	*Allium cepa (2)*	42	-180.-20 RT
	Carrot	*Daucus carota (1)*	41	-180.-20 RT

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Crop	Common Name	Scientific Name	Duration of storage (in months)	Storage temp (°C)
	Chilli	*Capsicum annuum (1)*	17	-180.-80. RT
	Turnip	*Brassica rapa (1)*	17	-180.-80.-20 RT
	Radish	*Raphanus sativus (1)*	17	-180.-80.-20 RT
	Tometo	*Lycopersicon esculentum (1)*	17	-180.-80.-20 RT
Leafy vegetables	Amarnath	*Amaranthus cruentus (1)*	26	

Table 6 : Cryopreservation of dessication sensitive seeds

Crop	Scientific Name	Seed storage	Technique used	Explant used	Optimal MC% (f.wt.)	Success survival
Tea	*Camellia sinensis*	I	DFF*	EA	13.2-14.3	80-90
Jackfruit	*Artocarpus heterophyllus*	R	DFF	EA	14.5-14.8	25-30
			Vitrification	EA	-	30-35
Litchi	*Litchi chinensis*	R	DFF	EA	12.1-18.3	22-35
			Vitrification	EA	-	40-50
Trifoliate Orange	*Poncirus trifoliata*	R	DFF	EA	14.0-16.0	50-68
Citrus	*Citrus sp. (12 spp.)*	I	DFF	Seeds/EA	8.0-12.0	60-100
Oak	*Quercus leucotrichophora*	R	DFF	EA	13.0-14.0	15-25
Neem	*Azadirachta indica*	I	DFF	Seeds	4.0-13.5	50-75
			DFF	EA	4.0-8.0	90-100
			Vitrification	EA	-	90-100
Almond	*Prunus amygdalus*	I	DFF	EA	7.0-10.0	70-100
Black pepper	*Piper nigrum*	I	DFF	Seeds	6.0-12.0	60-70
Cardamom	*Elettaria cardamomum*	I	DFF	Seeds	7.0-14.0	70-80
Banana	*Musa balbisiana*	I	DFF	Seeds	13.2	90

DFF = Desiccation followed by fast freezing at -196°C; R = Recalcitrant; I = Intermediate; EA = Embryonic axes

PARTICIPATORY IMPACT

This aspect needs specific mention because efforts of scientific organisation will meet the real success only when local public (both farmers and non-farmers) is encouraged in the venture. IPGRI and NBPGR both have, now, realized this fact (Heide, Tripp and Boef, 1996; Bunders *et al.*, 1996, Kumar *et al.*, 2002).

EPILOGUE

It may be summarised that effort(s) of R&D agencies for biodiversity conservation and sustainable development in leguminous plant wealth would bear economically viable fruits only when seeds and propagules are made available in appropriate quantity with quality. Seeds and propagules are, therefore, in the centre of such activities. Hence, a system of seeds and propagules banking has been globally established. This system has been a potential tool for legume biodiversity conservation. This system is founded on sound, systematically operative, cooperative and coordinative actions of several organizations working under an umbrella of broad-spectrum objectivity. Alongwith conventional approach (Collection, identification, preservation, evaluation and utilization), cryobiology has offered a new dimension to such efforts. A concise and bird eye view of such activities is presented in this presentation (Over-view)

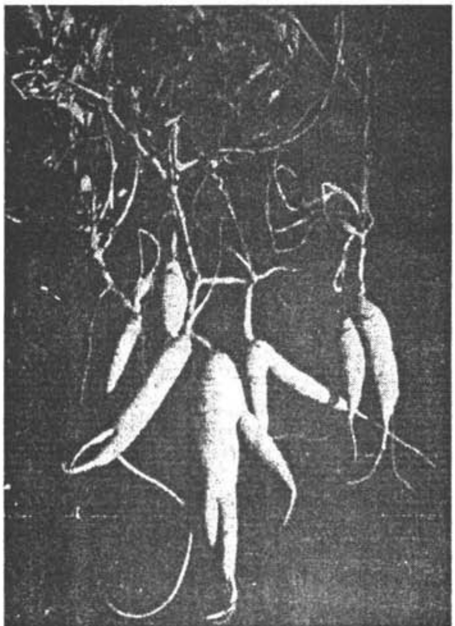

Fig. 1 : Protein rich tubers of *Vigna vexillata* (L) A. Richard.

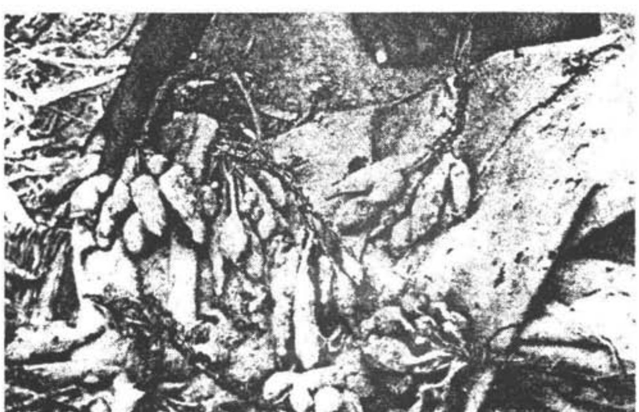

Fig. 2 : *Prosphocarpus tetragonolobus* (Winged bean) tuberous roots of *Chaudhari phali* are medicinally valuable.

Fig. 3 : *Psoralea esculenta* (Prairie turnip) = North American Babchi.

Fig. 4 : *Voandzia subterranea* (Barbara ground nut) : Edible beans are medicinally valuable.

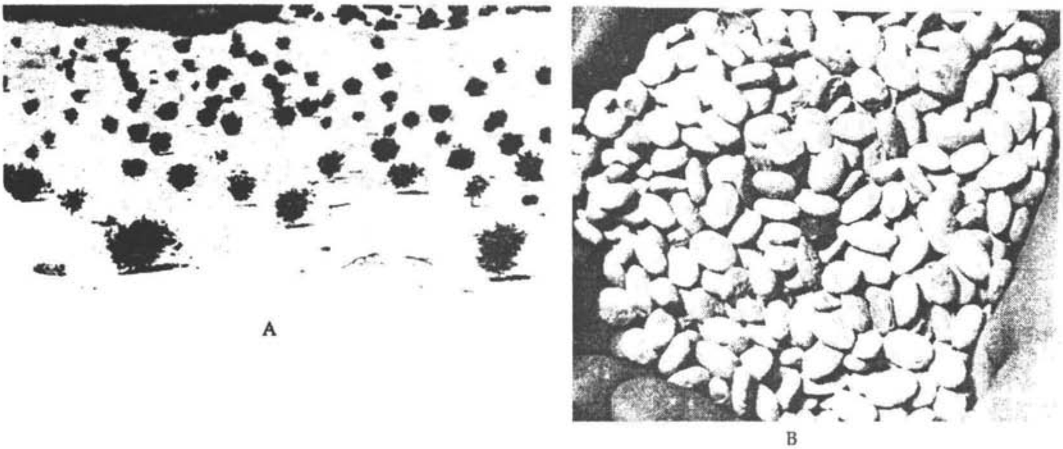

Fig. 5 : *Phaseolus acutifolius* (Tepary bean), A. Field grown plants in sandy soils, B. Seeds.

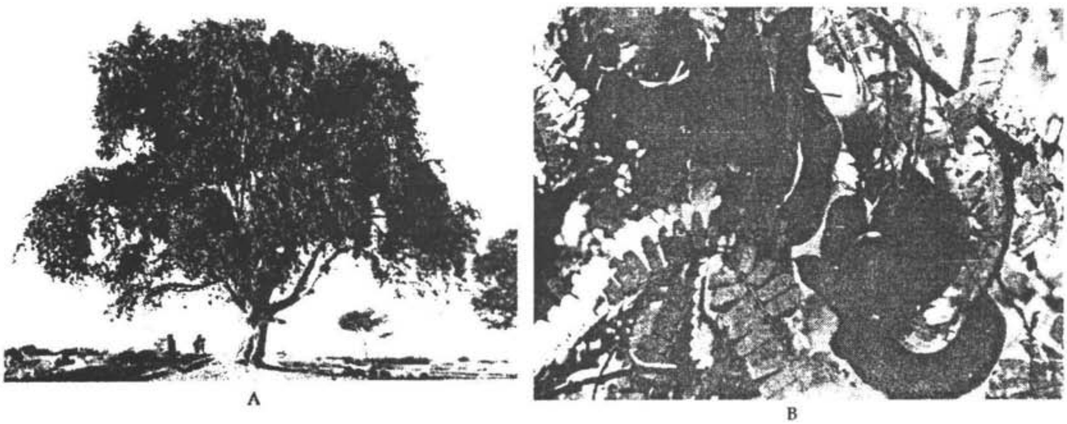

Fig. 6 : *Tamarindus indicus* (Tamarind = *Imoli*), A. Tree, B. Fruits.

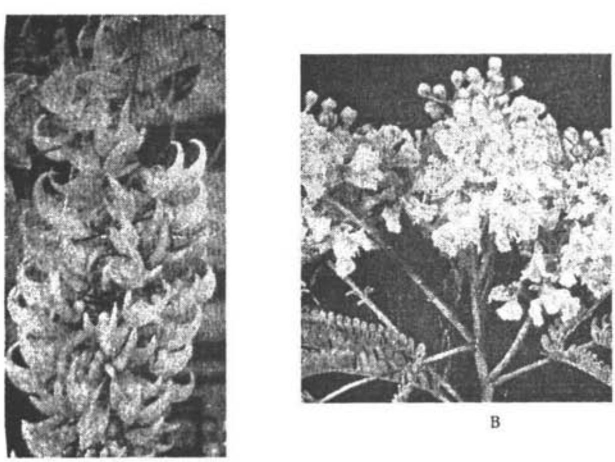

Fig. 7 : A. *Sophora microphylla*, B. *Peltophlorum africanum*.

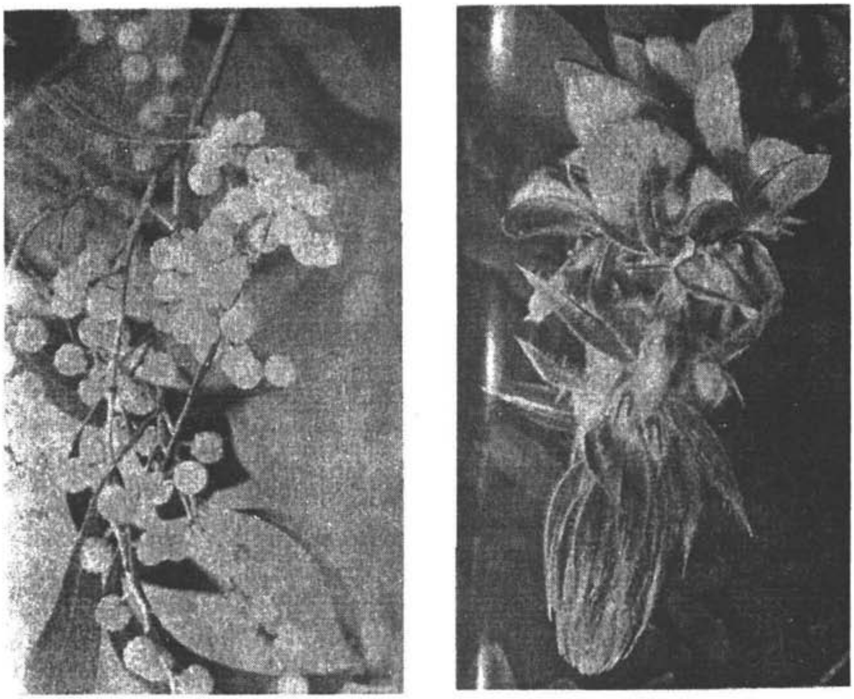

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Fig. 8 : A. *Berkiya syningifolia*, B. *Butea monosperma*.

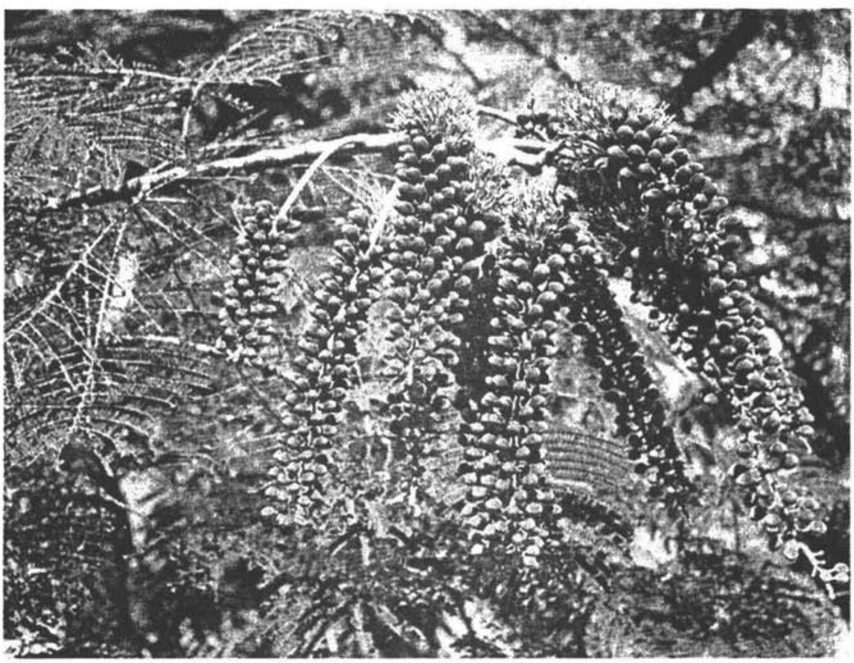

Fig. 9 : *Mucuna novoguineensis*.

Fig. 10 : *Cassia obtusifolia* **(Caesalpiniaceae).**

Fig. 11 : *Abrus precatorium* **(Fabaceae) Fruits & Twig.**

Fig. 12 : *Lathyrus odoratus* **(Papilionaceae = Fabaceae).**

Fig. 13 : *Acacia arabica* (Mimosaceae), A. Branch, B. Pod.

Fig. 14 : *Vicia sativa* (Fabaceae).

Fig. 15 : ***Lens esculenta*** **: A flowering branch.**

Fig. 16 : ***Lentil*** **: A fruiting branch : A medicinally legume.**

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SECTION 3

RURAL AND ECONOMIC DEVELOPMENT THROUGH HERBAL ECOFARMING

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Herbal Ecofarming in Fragile Ecozones: Potentials and Prospects of Co-operatives Movement

Karan Singh

Social and economic development of human societies has always been accelerated by the involvement of women. This fact is enunciatively true for the areas where multi adversity conditions exist. Such fragile agro-ecosystem is elaboratively existing in arid and semi-arid parts of the world. In India, Rajasthan is particularly influenced by such adversities. Therefore, there is a tremendous scope for the utilization of skill and power of women in this part of the world. On the basis of records, it is evident that women constitute the backbone of human resources associated with agriculture and are actively involved in utilization of conventional crops. Therefore, their practical experience may be effectively utilized for the cultivation of medicinal plants also. This non-conventional field of ecofarming has opened new vistas in developmental venture under diverse agroclimatic conditions(Schulze 2005). Schulze *et al.* (2005) emphasized that the cultivation of medicinal plants is the need of the day in all parts of the world.

Historical records are, now available to establish that the origin of human civilization was initiated by the forbidding of wildlife by human being and formation of small groups. This happening paralleled with the initiatives taken by women for domestication and cultivation few plants. This activity by women was undertaken as most of the time men used to go for hunting. Therefore, it is commonly believed that women played the key role in laying the foundation of agriculture. This foundation was fortified by the keen observation of women on plants and their suitability as food plants / sources. However, out of a very big number of wild plants known today, only a very few have been domesticated and are under cultivation. Out of these cultivated plants, food plants are dominant group under cultivation. These include cereals, millets, pulses, oil seeds, fruits, vegetables etc. With respect to number, cultivated medicinal plants are very few.

About 90% part of the raw material requirement of pharmaceutical industry is being met from wild resources. Consequently a large number of therapeutically valuable plant species are rapidly vanishing from forests and vegetational niches. The critical remedy of this situation is to identify plants of medicinal importance zone wise and scientific effort to domesticate and cultivate them be intensified. For this venture women organizations have to play important role.

World Health Organization (WHO) reports clearly indicate that for the production of medicines, plants are still the dominant components. This is applicable on Allopathy and alternative systems of medication (Majumdar, 2005). Besides Allopathy, Ayurvedic, Unani, Homoeopathy, Tibbi, Aromatherapy, Herbalism etc. system of medication, use medicines of plant origin all over the world. WHO has recently recognized about 20000 plant species having potential of therapeutic properties. Several scientific organizations have warned repeatedly that we must promptly take necessary steps for conservation and development of biodiversity of medicinal plants (Jakhar et al., 2004; Singh and Tyagi, 2004). Such steps are also crucial and unavoidable even for environmental protection (Podulosi, 2002, Lorcher 2003, Werner, 2004; Schulze, 2005). This is evident that the future of human civilization is closely related to conservation, scientific / judicious utilization and sustainable development of biodiversity of plants including medicinal plants. ***'Plants live - we live; plants die we die'*** is not just proverb but a reality and open reality (Schulze *et al.*, 2005).

Realizing this fact, an awareness has developed amongst human being across the world on biodiversity conservation and development. This awareness has resulted in activated involvement of several national and international organizations in conservation efforts of biodiversity of medicinal plants (Anonymous, 1998; Mitharwal, 2005; Jat, 2005). These include Central Medicinal Plants Board and State Medicinal Plants Boards in different states including the state of Rajasthan. These organizations will have to make concerted efforts to meet the targets laid for domestic industry and also to achieve the target of exports of medicinal plants, raw material upto 10000 crores of rupees upto 2010. Realizing the relevance and importance of such cultivational approaches, Indian Council of Agricultural Research (ICAR) New Delhi and National Academy of Agricultural Sciences, New Delhi, India, had joined hands for conservation, management and use of agricultural biodiversity including that of medicinal plants. The national workshop was organized for this purpose at CPRI Shimla in October 1997. The theme of the workshop was considered important in view of recent global developments which have far reaching consequences on policies, legislative measures and action plans of developing countries rich in biodiversity of genetic resources and medicinal plants (Anonymous, 1998). It was also noted that all biotic components of agro-ecosystems such as plants, animals, fish, reptiles, insects, birds and microbes are integral parts of agro biodiversity. India, being a very rich culture of agro biodiversity, it had been a centre of attraction for global players, especially due to the fact that the traditional farming systems of India are relatively stable and in equilibrium with nature. Human tribe, particularly women, have a long tradition of preserving plant species including medicinal plants and also the agro ecosystems. Therefore, there is a need to preserve the traditional practices and to learn from the available local wisdom (Anonymous, 1998; Singh and Purohit, 2000; Janick, 2001; Singh & Tyagi, 2004).

WHY TO GO FOR HERBAL ECOFARMING

Similar to other parts of India, farmers of Rajasthan have also established several milestones in production of traditional crops including wheat, barley, maize, pearl millet, chickpea, soybean, mustard, cotton, seed spices etc. and thereby contributed significantly in social and economic upliftment of the country but compliance is not in the interest of human being, neither this is the nature of otherwise very hard working farmers of Rajasthan. Hence, they have shown enormous interest in alternative agriculture in which cultivation of medicinal plants is utmost priority. Agroclimatic condition of Rajasthan is suitable for the undertaking herbal farming in a big way (Jobhar *et al.* 2004).

AGRO ECOLOGICAL ZONES (AEZ) OF RAJASTHAN (WITH MEDICINAL PLANTS POINT OF VIEW)

The therapeutic index (medicinal quality) of most of medicinal plants is determined by the accumulation of secondary metabolites in plant parts and this accumulation is profoundly influenced by agroclimatic components prevailing in the region where the medicinal plant is being cultivated /grown or naturally occurring. Ashwagandha Nagauri (*Withania somnifera* L.) naturally found in hot Indian desert (Parts of Barmer, Jodhpur, Nagaur, Bikaner etc.) is best example of effects of climatic condition on therapeutic quality (Singh and Tyagi, 2004). Therefore, knowledge of agroclimatic zone is must. Keeping in view this fact, Rajasthan state has been zonated into 10 agroclimatic zones (Table 1, Fig. 1).

Table 1 : Summary of agroclimatic zone of Rajasthan

Number of zone	Name of the Zone	Districts and their tehsils	ARS, ARSS KVK etc.
(1)	(2)	(3)	(4)
I-a	Arid Western Plain Zone	All tehsils of Barmer, Flaudi, Shergarh and Jodhpur tehsils of Jodhpur. Arid tehsils of Churu district	ARS Mandore, Jodhpur/ ARSS Samdari, KVKs of concerned districts.
I-b	North-Western Irrigated Plain Zone	All tehsils of Hanumangarh and Sriganganagar district.	ARS, Sriganganagar, ARSS Hanumangarh, KVK, SGNR
I-c	Hyper Arid, Partially	All tehsils of Bikaner, Jaisalmer, Dungargarh,	ARS, Beechhwal, Bikaner, KVK Bikaner KVK

contd. ...

contd. ...

(1)	(2)	(3)	(4)
	Irrigated Western Plain Zone	Sujangarh, Ratangarh, Sardarshar tehsils of Churu and some part of Churu tehsil of Churu district.	Sardarshahar.
II-a	Transitional Inland impeded Drainage Plain Zone	All tehsils of Nagaur, Sikar, Jhunjhunu districts, Tara-nagar, Rajgarh and some part of Churu Tehsil of Churu district.	ARS, Fatehpur K.V.K. Jhunjhunu, K.V.K. Sardarshahar.
II-b	Transitional Luni Basin Plain Zone	All tehsils of Jalore, Pali districts, Revdhar, Sirohi, Sheoganj tehsil of Sirohi district, Bilara and Bhopal-garh teshsils of Jodhpur	ARS Keshwana, ARSS Sumerpur, KVK Jalore.
III-a	Semi Arid Eastern Plain Zone	All tehsils of Ajmer, Jaipur, Tonk and Dausa districts.	ARS, Durgapura, Jaipur ARSS Diggi, ARSS, Tabiji, ARSS, Kotputli, KVK Dausa, KVK Chomu, KVK Tabiji, KVK Banasthali.
III-b	Flood Prune Eastern Plain Zone	All tehsils of Alwar Bharat-pur, Dholpur, Karauli districts, some parts of Sawai Madhopur district.	ARS Novagaon Alwar, ARSS, Bharatpur, KVK Hindon (Karauli) KVK Bharatpur.
IV-a	Sub Humid Southern Plains and Aravali Hill Zone	All tehsils of Bhilwara, Banswra, Tehsils of Udaipur district (Except Dhariawar, Salumber, Sarada tehsils) tehsils of Chittorgarh (except Chhotisadari, Pratapgarh, Arnod, and Bari Sadari) Pinwara, Aburoad tehsils of Sirohi district.	ARS Udaipur, ARS Argia Bhilwara, KVK Udaipur, KVK Bhilwara, KVK Rajsamand.
IV-b	Southern Humid Plain Zone	All tehsils of Dungarpur, Banswara, districts, Chjhoti Sadari, Barisadari, Pratap-garh and Arnod Tehsils of	ARS Banswara, ARSS Pratapgarh, KVK Banswara.

contd. ...

contd. ...

(1)	(2)	(3)	(4)
		Chittorgarh, Dhariawad, Salumber, Saroda tehsils of Udaipur district.	
V	Humid Southern Plain Zone	All tehsils of Kota, Bundi, Jhalawad, Baran district, Khandar and Sawai Madhopur tehsil of Sawai Madhopur district.	ARS Kota, ARSS Aklera, KVK Sawai Madhopur, KVK of Concerned districts.

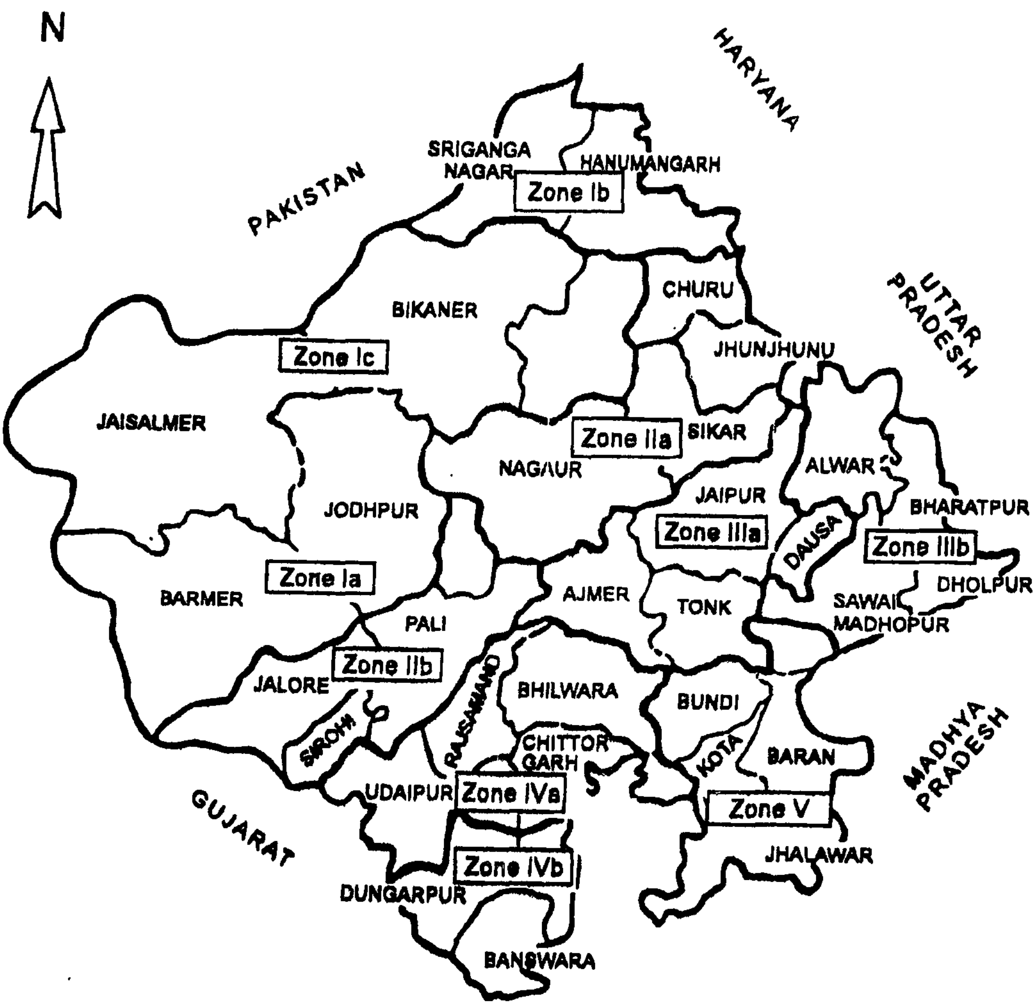

Fig. 1 : Agroclimatic zones of Rajasthan.

Now, all the districts have KVK from which farmers may get proper guidance about planting material of medicinal plants and other information about suitability of particular medicinal plants part zone.

Fig. 2 : Location of KVKs in Zone VI (Rajasthan and Gujarat).

To keep pace of research and extension activities being undertaken by Rajasthan Agricultural University (Bikaner) and Maharana Pratap University of Agriculture and Technology, Udaipur, Government of Rajasthan (Jaipur) has recently (September, 2005) reorganized divisions of state with agricultural production point of view. **Jodhpur** district includes Barmer, Jodhpur and Nagaur districts and the AEZ in I-A (Arid Western Plain Zone important crops are Methi, Chilli, Spices and Medicinal Plants etc. Sriganganagar division includes Sriganganagar and Hanumangarh districts and the AEZ in I-B (Irrigated North Western Plain Zone). Important crops are Kinnov and Cotton etc. **Bikaner** division includes Bikaner, Churu and Jaisalmer districts and the AEZ in I-C (Hyper Arid Partly Irrigated Western Plain Zone). Important crops are aonla, karonda etc. **Sikar** division include Sikar and Jhunjhunu districts and the AEZ in II-A (Transitional Plain Zone of Inland Impeded Drainage) Important crops are Barley and Onion etc. **Jalore** division includes Pali, Jalore and Sirohi districts and the AEZ in II-B (Transitional Plain of Luni Basin). Important crops are Saunf, Methi, Isabgol and Castor etc. **Jaipur** division includes Jaipur, Ajmer, Tonk and Dausa district and the AEZ in III-A (Semi Arid Eastern Plain Zone). Important crops are Barley and vegetables etc. **Bharatpur** division includes Bharatpur, Alwar, Karauli, Dholpur and Sawai Madhopur districts. The AEZ in III-B (Flood Prune Eastern Plain Zone). Important crops are Mustard, Pearlmillet and Pulses etc. **Bhilwara** division includes Bhilwara, Rajsamand and Chittorgarh districts. The AEZ in IV-A (Sub Humid Southern Plain Zone). Important crops are Maize, Soyabean, etc. **Udaipur** division includes Banswara, Dungarpur and Udaipur districts. The AEZ in IV-B (Humid Southern Plain Zone). Important crops are Maize etc. **Kota** division includes Kota, Baran, Bundi and Jhalawar districts. The AEZ in V (Southern Eastern Plain Zone). Important crops are oranges, coriander etc. Each division will be looked after by a joint director.

TIPS FOR HERBAL ECOFARMING

Domestication and cultivation of medicinal plants in different agroclimatic conditions requires some basic knowledge by farmers but such information are still scanty in the comparison of crops. The agrotechnology of only a few medicinal plants has been developed. These include isabgol, cinchona, opium etc. On the basis of in depth discussion and also on the basis of literature following guiding principles are tenable for herbal farming.

1. Small and marginal farmers should take the cultivation on a small area of their total cultivable land (about 5.0 %).
2. Get the training at suitable unit / establishment (example SKN COA Jobner)
3. Seeds/ Propagules be obtained from reliable/ authentic source.
4. Classify the plants as Rabi / Kharif / Summer crops.
5. Preparation of field is similar to other traditional crops.
6. Avoid the use of chemical pesticides and use FYM or Vermicompost avoiding chemical fertilizers.
7. Use life saving irrigation only and avoid excessive irrigation.
8. Hand weeding be preferred.
9. Intercultures be adopted according to the nature of crop (medicinal plants).
10. Harvest the crop at suitable maturity stage followed by shade drying, thresting winnowing, grading and processing (preliminary).

11. Partition the crop produce in leaves, stem, flower, fruits, seeds, roots etc. if needed and process /store/ transport accordingly in dry places and suitable containers.
12. For marketing take the help of local unit of DAO or state marketing board.
13. Each member of self help group of women/ men should plant atleast 5 trees, 10 shrubs, 15 climbers, medicinal plants at their own field so as to coin an example.
14. Each member should create an example by farming of herbs in their own fields.
15. In any non-concentrational work the difficulties are natural, have the patience and take the matter as challenge to create ideals before others.
16. Regular discussions and exchange of experience may solve many problems.
17. Once the experience is accumulated even such plants may be domesticated, introduced or cultivated which are new to the area.
18. Involvement of old and experienced persons of the village or area is very important. They may tell so many facts which are not even known to scientists or extension officers. If old persons are respected, they may happily contribute in the success of the venture.
19. Co-ordination and equilibration between traditional eco-technological knowledge (TEK) and modern agro-biotechniques is certainly the founding factor in such innovative step.
20. Though, any plant may be grown at any location, with respect to quality and productivity, specific species may be identified, earmarked location wise keeping in view the agroclimatic condition and industrial (Pharmaceutical requirements) needs.

WOMEN'S CO-OPERATIVES FOR HERBAL ECOFARMING

Indira Gandhi Panchayati Raj and Rural Development Institute (IGPR RDI) Government of Rajasthan, JLN Marg, Jaipur has been organizing trainings and orientation programmes involving women (and also men) from rural areas. These programmes have developed awareness and skill building up the enterprising attitude and also to inculcate the habit of entrepreneurship in human resources. Available records revealed that participants from all parts of the state have been benefited from such workshops and small training programmes. Hence women power of Rajasthan is well known about the procedure to establish and operate self help group and women co-operatives. For cultivation of medicinal plants in Rajasthan such co-operatives formation may be encouraged at Block / Tehsil/ District levels. Details guidelines about basic procedure, financial and technical help and constitutional provision may be obtained from the literature produced / published by ICPERDI Jaipur (Chaudhary, 2004).

The self help groups formed for women when entrusted with the cultivation of medicinal plants may be known as 'medicinal plants women co-operative (MPWC) on every 40 villages which have about 100 hectare non-cultivable fallow land. This land may be leased to MPWC for specific period and planting material along with technical know how many be made available by KVKs. The chairperson of the MPWC may act as 'Nodal Person (NP)' between producer, marketers and if needed even the processing unit or pharmaceutical unit. As the NP will have to devote considerable time and will have to utilize skill more judiciously, she (he) may be entitled for some **'honorarium'** or salary or commission on the total production of medicinal plants (brought to the market). In times to come, members of the society may be encouraged to undertake scientific and preliminary processing of the product for values addition. This activity may be coupled with raising of milk cattle, some dairy business, setting of gobar gas plant or production of vermicompost or even the biofertilizers. These activities will certainly improve the social and economic standard of the rural mass.

MEDICINAL PLANTS FOR FRAGILE AGROECOSYSTEM

If we critically analyse the agroclimate of Rajasthan it is evident that the climatic conditions are diverse with respect to soil characterization, temperature extremes, quantum and distribution of rain fall, availability of water, relative humidity, intensity of radiation. This agro climatic diversity has resulted in a vast biodiversity in floristic composition. At the same time, diverse genera of medicinal plants have potential for their cultivation in various parts of Rajasthan. At global level above 20000 species of plants are known to have medicinal properties (Cracker and Simon 2002, Hartmann *et al.* 2002, Jakhar *et al.* 2004, Mitharwal 2005). Out of these 2000 species have specific medicinal qualities but only 650 species show capability to work as raw material for the concerned industry. Out of these how many are found in Rajasthan is controversial with number point of view (Bhandari, 2004). But it is evident that the number is certainly higher than any other state of India. With reference to habit and growth characteristic, plants are classified as trees, climbers, shrubs and herbs (Table 2) (Summary Table)

Plants described in Table-2 are only a few selected once. Otherwise, the list may be long and plants belong to lower as well as higher plant groups (Kakralya and Singh, 2004) may be included.

Table 2 : Medicinal plants (selected) having potential for cultivation in Rajasthan

Vernacular name	English name	Botanical name and (Family)	Few very important medicinal uses
		A. Tree Species	
Khair = Kadira	Black Cutch	*Acacia catechu* (Mimosaceae)	Skin disease, blood purifier, teeth, carminative, expectorant
Bael	Bael (Aegle)	*Aegle marmelos* (Rutaceae)	Several ailments of digestive system
Ankol	Sage leaved Alangium	*Alangium salvifolium* (Alangiaceae)	Stimulant, blood purifier
Aonla	Indian goose berry	*Emblica officinalis* (Euphorbiaceae)	Multipurpose, blood purifier
Karanj	Pongam	*Pongamia pinnata* (Papilionaceae)	Leprosy, ulcer, skin disease
Arjun	Arjun	*Terminalia arjuna* (Combretaceae)	Ailments of heart, blood pressure

contd. ...

contd. ...

Vernacular name	English name	Botanical name and (Family)	Few very important medicinal uses
Kalpatru	Monkey breed tree	*Adansonia digitata* (Bombacaceae)	Diarrhoea, headache
Neem	Margosa tree	*Azadirachta indica* (Meliaceae)	Multipurpose medicinal plant
Kachnar	Mountain Ebony	*Bauhinia variegata* (Caesalpiniaceae)	Cough, expectorant worms
Rudrak	Ultrasum beed tree	*Elaeocorpus sphaericus* (Elaeocarpaceae)	Heart trouble, blood pressure
		B. Climbers	
Giloi	Moonseed	*Tinospora cordifolia* (Memispermaceae)	Dysentry, few skin troubles
Tamra bel	Tamrabel	*Argyreio nervoro* (Convolvulaceae)	Rheumatism
Satavari	Satawari	*Asparagus racemosus* (Liliaceae)	General tonic
Kant Karanj	Mollucobean	*Caesalpinia crista* (Caesalpiniaceae)	Seed for tonic fever, skin etc.
Malkangni	Malkangni	*Calastrus paniculata* (Celastraceae)	Stimulant, leprosy
Sikakai	Soap pod	*Acacia rugota* (Mimosaceae)	Hair tonic
Tumba	Colysynth	*Citrullus colosynth*	Fruit and roots are used in jaundice
		SHRUBY MEDICINAL PLANTS	
Kanghi ghas	Indian Abutilon	*Abutilon indicum* (Malvaceae)	Diuretic
Vasa	Malabar nut	*Adhatoda vesica* (Acanthaceae)	Cough, Asthma Bronchitis
Bajradanti	Barleria	*Barleria prionitis* (Acanthaceae)	Teeth, gums, bad breath
Tulsi	Basil	*Ocimum basilicum* (Lamiaceae)	Full of medicinal properties
Sarpgandha	Serpentine root	*Rauwolfia serpentina* (Apocynaceae)	Stimulant, eye trouble, mental tension

contd. ...

contd. ...

Vernacular name	English name	Botanical name and (Family)	Few very important medicinal uses
Gurmar = Merasingi	Gudmaar	*Gymnema sylvestre* (Asclepiadaceae)	Diabetes, caloric fat free, sweetener
Bidari Kand	Tuberaus bidary	*Peuraria tuberosa* (Papilionceae)	General weakness
Ratalu Types	Dioscorea	*Dioscorea delteroides* etc. (Diascoreaceae)	Source of steroids
Gudkshupa	Stewia	*Stevia rebaudiana* (Steviaceae)	Diabetic, calorie/ fat free sweetener
		HERBY MEDICINAL PLANTS	
Kirayata	Kalmegh	*Andrographis paniculata* (Acanthaceae)	Fever, malaria, jaundice
Babchi	Babchi	*Psoralea corylifolia* (Papilionaceae)	Diuretic, antiworms
Ashwa-gandha	Ashwa-gandha	*Withania somnifera* (Solanaceae)	Immunity regulator
Sonamukhi (Sanai)	Senna	*Cassia angustifolia* (Caesalpiniaceae)	Anti constipation
Apamarg	Chirchita	*Achyranthes aspera* (Amaranthaceae)	Cough, cold, asthma, bronchitis
Chitrak	Plumbago	*Plumbago zeylanica* (Plumbaginaceae)	Paralysis, leprosy, piles ulcer, ccabies
Guarpatha	Aloe	*Aloe vera* (Liliaceae)	Blood purifier, digestive, diuretic
Makoi	Black night shade	*Solanum nigrum* (Solanaceae)	anthrax
Brahmi	Brahmi	*Bacopa monniera* (Scrophulariaceae)	Many ailments of nervous systems
*(Brahami) Maanuuki	Asiatic pannywort	*Centella asiatica* (Hydrocotylaceae)	Brain tonic, many ailments of nervous system
Isabgal	Psillium	*Plantago ovata* (Plantaginaceae)	Anticonstipation
Gokhru	Gokharoo	*Tribulus terrestris* (Zygophyllaceae)	Polyureic, kidney trouble
Methi	Fennugreek	*Trigonella foenum graecum* (Papilionaceae)	Old cough Asthma
Dudhi	Dudhi	*Euphorbia hirta* (Euphorbiaceae)	Respiratory disorders

contd. ...

contd. ...

Vernacular name	English name	Botanical name and (Family)	Few very important medicinal uses
Harjora	Harjora	*Cissus quandrangularis* (Vitaceae)	Excellent wound healer, bone healer
Safed musli	Chloro-phytum	*Chlorophytum borivillianum* (Liliaceae)	General tonic, weakness
Mulehti	Sweet wood	*Glycirrhiza glabra* (Papilionaceae)	Expectorant, cough, asthma, Bronchitis
Jamun	Cumini	*Syzygium cumuni* (Myrtaceae)	Diabetes

* Vernacular 'Brahmi' is not used for *Centella asiatica in Ayurvedic literature* (Khare C.P. 2004).

SUMMARY OF ECOFARMING TECHNIQUES OF MEDICINAL PLANTS FOR FRAGILE AGRO ECOSYSTEM

Rajasthan is the largest state in India with respect to area and agroclimatic diversity. Therefore, a variety of medicinal plants many be cultivated here. A brief description of available information is as below :

1. AEZ 1-a

4.44 m hectare area, desert sandy soils. Temperatures 8°C – 44°C. Rainfall 100 mm 370 mm. Few wells are there. A very few distributaries of canals. Suitable medicinal plants include. Khair, Bael, Jojoba, Arjun, Neem, Kadamb, Imli, Vasa, Tulsi, Guggal, Castor, Tinospora, Satawari, Tumba, Kalmegh, Ashwagandha, Sanai, Titrak etc. For details of cultivation reference may be made from Sharma (2005), Hartmann *et al.* (2002) and Jakhar etc. (2005) (Table 3).

Table 3 : Preferential medicinal plants (PMP) for AEZ-1-a (AEZ 1-a)

Trees	Climbers	Shrubs	Herbs
Khair	Tinospora	Adhatoda	Kalmegh
Aegle	Asparagus	Catharanthus	Mimosa
Jojoba	Caesalpinia	Basil	Withania
Arjun	Malkangni	Nirgundi	Senna
Neema	Abrus	Phalsa	Achyranthus
Kadamba	Colocynth	Castor	Chitrak (Plumbago)
Peepal		Cappasin	
Tamarind		Stevia	
Bargad			
Bulberry			
Citrus			

Note : Kindly take case of Special Notes (SH) for PMP.

2. AEZ 1-b

Area about 2.1 m hectare, Irrigated by distributaries of Gang Canal, Bhakra Canal and Indira Gandhi Canal. Rain fall between 100 mm – 350 mm. Temp. 4.7° - 42-43°C. Good irrigation facility, economic condition is good. moderate soil fertility. Progressive farmers. Many medicinal plants may be successfully grown. Some of them are Khair, Anbol, Aonla, Anjeer, Putranjiva, Jojoba, Padal, Arjun, Neem, Kalpvriksh, Kachinar, Giloy, Tamarbel, Shatawari, Malkangni, Vasa, Vinca, Datura, Tulsi, Surpgandha, Akarkara, Lajvanti, Ashwagandha, Sonomuphi, Isabgol, Mulahati etc. Details information and planting material may be obtained with the help of ARS, ARSS and KVK working in the Zone (Table-4).

Table 4 : Preferential medicinal plants (PMP) for AEZ-1-b

Trees	Climbers	Shrubs	Herbs
Khair	Tinospora	Abutilon	Akarkata
Ankol	Kaunch	Adhatoda	Mimosa
Aonla	Tamarbel	Barleria	Babchi
Fig	Satavari	Catharanthus	Withania
Putranjiva	Malkangni	Datura	Senne
Jojoba	Aaral	Basil	Plumbago
Padal	Shikakai	Rauwolfia	Aloe
Arjun	Tylophora	Gurmaar	Solanum
Bahera		Bhurangi	Bacopa
Haritiki		Nirgundi	Centella
Neem		Capparis	Isabgol
Adassonia		Stevia	Mulahati
Havan			
Kateera			
Bauhinia			
Peepal			
Amaltaas			
Pomegranata			
Bargad			
Mulberry			
Lisaura			

Note : Kindly take case of Special Notes (SH) for PMP.

3. AEZ 1-c

7.71 m hectare, Hyper arid, Temperature extremes (upto 48-49°C). Some part in canal irrigated. Some areas suffer from salinity water logging. Head quarter of Rajasthan Agricultural University, Beechhwal Bikaner is there in this zone. ARS, ARSS, CAZRI, CIAH etc are located in this zone to help the farmers alongwith KVKs. Medicinal plants recommended for this zone included Khair, Bael, Ankol, Khirni, Jojoba, Padal, Arjun, Kalpatru, Kadamb, Neem, Eucalyptus. (For water logged areas only). Dhak, datepalm, Tinospora, Satawari, Aral, Aparjeet, Tumba, Kanghi ghas, Vinca, Vasa, Jamalghota, Nagdon Sarpgandha, Ashwagandha, Babchi, Kalmegh, Aloe, etc. Jawahar-20 genotype of *Withania somnifera* is specially suitable (Table-5).

Table 5 : Preferential medicinal plants (PMP) for AEZ-1-c

Trees	Climbers	Shrubs	Herbs
Aegle	Neemgiloi	Abutilon	Aswagandha
Khadira	Kaunch	Adhatoda	Babchi
Ankol	Tamarbel	Vajradanti	Lajvanti
Khirni	Satawari	Sadabahar	Kalmegh
Jojoba	Kantkaranj	Jamalghota	Dhamasa
Padal	Aaral	Basil (All types)	Sarphoka
Arjun	Abrus(All types)	Nagudan	Apamarg
Adansonia	Aparjeet	Sarpgandha	Chitrak (All types)
Kadamba	Tumba	Nirgundi	Aloe
Neem		Chuka	Makoi
Dhovan		Bhurangi	Kalihari
Kutbel		Phalsa	Gokhru
Havan		Castor	Harjora
Areetha		Capparis	
Pipal		Stevia	
Bargad			
Amaltaas			
Ashok			
Imli			
Sainjana			
Dhaak			
Maulasari			
Tetu			
Hingoth			

Note : Kindly take case of Special Notes (SH) for PMP.

4. AEZ II-a

3.69 m hectare area, low and erratic rain fall, shifting sand dunes low and impeded drainage by undulating topography, Soil salinity/ alkalinity prevails. Temperature between 5.3°C to 40°C. Rainfed agriculture. Many difficulties in herbal farming but farmers are hardworking and want to opt for medicinal plants cultivation. Plant which should be preferably cultivated in this zone include trees like Bael, Karary, Neem, Hawan, Areetha, Maulasri and Pomegranate, Climbers like Ephedra (a gymnosperm), Giloi, Tylophora, Reetha and Colosynth, shrubs include Abutilon, Datura, Jamalghota, basil, Phalsa and Gurmar.

Herbal medicinal plants which may preferably be tried in this zone and kalmegh, Babchi, Achyranthes, Tephrozia, Aloe, Tribulu, Senna, Calotropis, Evoluvulus etc. (Table-6).

Table 6 : Preferential medicinal plants (PMP) for AEZ-II-a

Trees	Climbers	Shrubs	Herbs
Aegle	Ephedra	Kanghighaas	Kalmegh
Acacia	Kaunch	Datura (All types)	Babachi
Ankol	Neemgiloi	Jamalghota	Apamarg
Pongamia	Anantmool	Basil (All Types)	Sarphoka
Paadal	Tamrabel	Chuka	Aloe
Neem	Kantkaranj	Phalsa	Gokhru
Kainth	Chauntali	Gudmaar	Harjora
Havan	Reetha	Capparis	Draunpushpi
Areetha	Tumba	Stevia	Sehand
Kachnar			Argemone
Pipal			Calotropis
Amaltas			Sankhapushpi
Imli			
Dhaak			
Maulasari			
Bargad			
Pomegranate			

Note : Kindly take case of Special Notes (SH) for PMP.

5. AEZ 1I-b

About 3.0 m hectare area, Rainfall 300 mm – 500 mm, weak soil with low organic matter and poor fertility, salinity and alkalinity are also main problems. Trees suitable for this zone are Aonla, Lisora (Cordia), Bael, Khirnia Fig, Putranjiva, Padal, Arjun, Bahera, Haror, Kelpvrikgha, Neem, Kainth etc. Climbers include Tinospora, Kaunch, Tamrabel, Satmuti, Kantkaranj. Important shrubs are Adhatoda, Abuliton, Vajradanti, Datura, Bosil, Guggal, Phalso, Henna, Dioscorea etc. Among herbal species important for their zone are Kalmegh, Mimosa, Withania, Senna, Achyranthes, Plantago, Aloe, Isabgol, Fenugreek, *Euphorbia hirata*, chlorophytum, Glycirrhyza etc. Details of farming techniques and planting material source may be known from ARS, ARSS and KVK operative ir the zone (Table-7).

Table 7 : Preferential medicinal plants (PMP) for AEZ-II-b

Trees	Climbers	Shrubs	Herbs
Aonla	Kaunch	Henna	Akarkata
Lisaura	Neemgiloi	Adhatoda	Kalmegh
Aegle	Tamrobel	Abutilon	Lajvanti

contd. ...

contd. ...

Trees	Climbers	Shrubs	Herbs
Khirni	Satawari	Bajradanti	Ashwagandha
Anjir	Kanthkaranj	Datura	Saunamukhi
Putranjiva	Abrus	Jamalghota	Apamarg
Paadal		Basil	Chitrak
Arjun		Nagudan	Aloe
Bahera		Nirgundi	Kalihari
Haritiki		Guggal	Isabgol
Kalptaru		Chuka	Methi
Neem		Bhurangi	Dudhi
Dhovan		Phalsa	Safedmusli
Kainth		Bidarikand	Mulhati
Havan		Ratalu (All Types)	
Meethaneem		Capparis	
Pipal		Stevia	
Imli			
Dhaak			
Bargad			
Arlu			
Hingoth			
Rudrak			
Aanaar			
Anona			

Note : Kindly take case of Special Notes (SH) for PMP.

6. AEZ III-a

2.96 m hectare, 500 m – 600 m. Temperature 8.3 – 41°C. Very suitable for herbal farming suitable trees for this zone include Aonla, Ankol, Fig, Khirni, Jojoba, Arjuna, Bahera, Horitaki, Kalpatru, Neem, Kachnar, Pipal, Bargad, Mulberry, Jamun, Pomegronarte, Aonla, African Chirry – Climbers include Kaunch, Sadawosi, Kant Karanj, Malkangni, Abrees, Aparjeet, Shikakai, Shrubs include Abutilon, Vasa, Vajradanti, Datura, Vinca, Tulsi, Sarpgandha, Gurmar variety of herbal plants which should be recommended in the area are Andrographis, Achyranthes, Ashwagandha, Senna, Plantago, Yellow berry, Kateli, Chlorophytum, Sweet wood, root. Ipecac etc. (Table-8).

Table 8 : Preferential medicinal plants (PMP) for AEZ-III-a

Trees	Climbers	Shrubs	Herbs
Aonla	Kaunch	Kanghighaas	Aakarkata
Ankal	Satavari	Vasa	Kirayata

contd. ...

contd. ...

Trees	Climbers	Shrubs	Herbs
Anjeer	Karanj	Vajradanti	Lajvanti
Khirni	Malkangni	Sadabahar	Babachi
Jojoba	Aaral	Dhatura	Ashwagandha
Paadal	Ratti (All types)	Tulsi	Saunamukhi
Arjun	Shikakai	Sarpgandha	Apamarog
Bahera	Aparjeet	Nirgundi	Chitrak
Haritaki		Chuka	Aloe
Putranjeeva		Gudmaar	Makoi
Kalpatru		Stevia	Kanteli
Neem			Gokhru
Kainth			Dhudhi
Havan			Harijora
Meethaneem			Safedmusli
Kachnaar			Mulhati
Pipal			Karela
Bargad			Aconite
Shahtoot			Ipecac
Jaamun			Adiantum
Amaltaas			Pteridium
Ashok			
Sainjana			
Anaar			
Shareefa			
African Cherry			

Note : Kindly take case of Special Notes (SH) for PMP.

7. AEZ III-b

2.7 m hectare area, rainfall 500-700 mm but flood water originates from north eastern parts. Soil rich in moisture, Diversity in climate, sanctuaries like Sariska, Ghana and Ranthambore lies in the zone reflecting the types of vegetation suitable plants for the area include trees like Khair, Aegle, Ankol, Aonla, Fig, Kalpvriksh, Dhawan, Havan, Reetha, Kachnar, Pipal, Amaltas, Imli, Sainjara, Neem, African Cherry, Climbers like Tinospora, Kaunch, Tamrabel, Malkangni, Abrus, Shikakai, Shrubs like Abutilon, Vasa, Vince, Datura, Jamalghota. All kinds of Tulsi, Rauwolfia, Gulmohar; Herbs include Kalmegh, Mimosa, Babchi, Ashwagandha, Senna, Achyranthes, Plantago, Aloe, Bacopa, Methi, Safed Moosali, Glycirrhyza (Table-9).

Table 9 : Preferential medicinal plants (PMP) for AEZ-III-b

Trees	Climbers	Shrubs	Herbs
Khair	Neemgiloi	Abutilon	Andrographis
Aegle	Kaunch	Adhatoda	Mimosa
Ankol	Tamrabel	Vinca	Babchi
Aonla	Malkangni	Stramonium	Withania
Anjir	Abrus	Basils	Indian Senna
Paadal	Shikakai	Rauwolfia	Achyranthus
Kalptaru	Gokarni	Nirgundi	Plumbago
Dhovan	Amarbel	Chuka	Aloe
Havan		Bhurangi	Solanum
Reetha		Gurmaar	Kalihari
Kachnaar		Unga	Centella
Pipal		Arundo	Bacopa
Bargad		Stevia	Methi
Amaltaas			Safedmusli
Neem			Sweet wood (root)
Ashok			Boerhaavia
Imli			Barbari
Sainjana			Hanspadi
Dhaak			Isabgol
Hingoth			Turmeric
Anaar			Zinger
African Cherry			
Kaner			
Marorephal			
Arjun			
Baheda			
Haritaki			

Note : Kindly take case of Special Notes (SH) for PMP.

8. AEZ 1V-a

Geographical area about 3.36 m hectare, rainfall 500-700 m but about 900 mm in southern part of their zone. Temperature ranges between 24.2°C to 38.8°C. Medicinal plants of tree growth habit are Fig, Khair, Ankol, Khirni, Putranjiva, Padal, Arjun, Bhaero, Harar, Kalpatru, Kadamb, Neem, Pipal, Imli, Maulasari, Hingoth, Rudrak, Sandal, Sitaphal – Sharifa (Anona), African cherry (*Prunus africanum*); Medicinal plants of climber habit are Tinospora, Kaunch, Satawari, Malkangni, Aparjeet etc. Some shrubs for their zone are Abutilon, Adhatoda, Vajradanti, Catharanthus, Stramonium, Basil, Rauwolfia, Guggal, Tylophora, Gudmaar etc. Some herbal medicinal plants which may be grown in this area are Andrographis, Babchi, Withania, Opium, Tephrosia, Isabgol, Henna (Semi shrub), Achyranthus, Plantago, Aloe, Nightshade, Bacopa, Centell, Tribulus, Euphorbia, Chlorophytum and sweet root (Table-10).

Table 10 : Preferential medicinal plants (PMP) for AEZ-IV-a

Trees	Climbers	Shrubs	Herbs
Fig	Tinospora	Abutilon	Akarkata
Khair	Tylophora	Adhatoda	Kirayata
Ankol	Kaunch	Barleria	Babachi
Khirni	Satavari	Catharanthus	Withania
Putranjiva	Malkangni	Datura	Opium
Paadal	Aparjeet	Basils	Tephrosia
Arjun		Nagudan	Alhagi
Bahera		Sarpgandha	Isabgol
Haritaki		Guggal	Henna
Kalptaru		Castor	Achyranthus
Kadamba		Gurmaar	Plumbago
Neem		Gudkshupa (Stevia)	Aloe
Dhovan			Makoi
Havan			Kaleli
Murraya			Kalihaari
Imli			Centella
Pipal			Bacopa
Maulasari			Gokhru
Hingoth			Dudhi
Rudraksha			Safedmusli
Chandan			Mulhati
Sharifa			Calotropis
African cherry			
Aegle			
Pongamia			
Mahua			

Note : Kindly take case of Special Notes (SH) for PMP.

9. AEZ 1V-b

1.72 m hectare area, rainfall between 500-1100 mm, perennial rivers flow. Some canals are also there. Soil rich in organic matter. High relative humidity. Many plants which are otherwise grown in MP, AP, Karnataka, Kerala, TN and other southern parts may be successfully tried in their zone but no scientific efforts made so far. Most of the plants given in Table 2 may be successfully grown here. These include trees, small trees, climbers, shrubs and many herbs; some trees which should be tried on priority basis are Ankol, Fig, Khirni, Arjun, Kadamb, Kalptaru, Neem, Pipal, Bargad, African Cherry etc. Climbers include Tinospora, Kaunch, Ipecac, Satawari, Aaral, Malkangni, etc. Shrubs and herbs as quoted in AEZ IV-A (Table-11).

Table 11 : Preferential medicinal plants (PMP) for AEZ-IV-b

Trees	Climbers	Shrubs	Herbs
Khair = Khadira	Tinospora	Abutilon	Akarkata
Aegle	Tylophora	Adhatoda	Kiryata
Ankol	Tamrabel	Barleria	Mimosa
Aonla	Satavari	Sadabahar	Babachi
Anjir	Malkangni	Dhatura	Withania
Khirni	Aaral	Jamalghota	Senna
Almond	Ratti	Basils	Alhagi
Putrenjiva	Shikakai	Nagudan	Tephrosia
Paadal	Aparjeet	Sarpgandha	Achyranthus
Arjun	Tumba	Nirgundi	Aloe
Bahera		Guggal	Makai
Haritaki		Chuka	Suratense
Kalptaru		Jamalghota	Kalihari
Neem		Bhurangi	Centella
Dhovan		Phalsa	Becopa
Kainth		Castor	Isabgol
Havan		Gudmaar	Gokharu
Meethaneem		Bidarikand	Methi
Kachnaar		Ratalu (All Types)	Dudhi
Pipal		Henna	Hadjora
Amaltaas		Capparis	Safedmusli
Imali		Stevia	Mulhati
Tetu			
Rudraksha			
Annar			
Sandal			
Anona			
African cherry			

Note : Kindly take case of Special Notes (SH) for PMP.

10. AEZ - V

Geographical area about 2.7 m hectare, Rainfall 650-1000 mm or in some parts even more. Many perennial rivers flow. Canals are operative. Heavy block soil rich in organic matter, fertile. Temperature between 10.6°C and 42.6°C. A very diverse species of medicinal trees, shrubs, climbers and shrubs are recommendable for this area. These include trees like

Har, Bael, Ankol, Aonla, Fig, Khirni, Putranjiva, Jojoba, Arjun, Bahera, Haritaki, Semal, African Cherry, Kalpataru, Kadamb, Neem, Dhowan, Hawan, Kateera, Paras pipal, Kachnar, Pipal, Eucalyptus, Amaltas, Imli, Rudrak, Sandal, Anona Climbers like Tinospora. Tylophora, Kaunch, Ipecac, Tamrabel, Satawam etc. may also be tried. All the shrubs and herbs summarized in Table 2 may be recommended for this area (Table-12).

Table 12 : Preferential medicinal plants (PMP) for AEZ-V

Trees	Climbers	Shrubs	Herbs
Anona	Neemgiloi	Henna	Akarkata
Sandal	Kaunch	Ratalu	Kiryata
Baniyan	Ipecac	Bidarikand	Mimosa
Anjir	Aconite	Gudmaar	Babchi
Peepal	Ephedra	Castor	Withania
Rudraksha	Tamarbel	Phalsa	Saunamukhi
Sainjana	Satavari	Bhurangi	Apamaarg
Kachnaar	Anantmool	Chuka	Chitrak
Amaltaas	Abrus	Jamalghota	Aloe
Paraspeepal	Shikakai	Guggal	Makoi
Kateera	Aparjeet	Nirgundi	Chhotikateli
Havan	Colocynth	Sarpgandha	Kalihari
Dhovan	Aaral	Nagudan	Brahmi (Both Types)
Neem	Malkangni	Basils	Isabgol
Kadamba	Chirayata	Dhatura	Gokharu
Kalpatru		Sadabahar	Dudhi
African Cherry		Bajradanti	Hadjora
Saimal		Vaasa	Safedmusli
Haritaki		Kanghighaas	Mulhati
Arjun		Stevia (Gudkshupa)	Isabgol
Bahera			Dil
Paadal			Methi
Putranjiva			
Aonla			
Ankol			
Aegle			
Khadira			

Note : Kindly take case of Special Notes (SH) for PMP.

INVOLVEMENT OF CORPORATE AND OTHER ORGANIZATIONS

Plants, more particularly medicinal plants have good resilience with respect to their acclimation potential in diverse climatic conditions. Therefore, good seed, propagule and plating material if conditioned by suitable treatment may be successfully grown in different agroclimatic and soil conditions (Dorffer and Resell 1989; Cracker and Simon 2002; Govil, 1998, Singh and Purohit 2000; Sharma 2005; Singh and Tyagi 2004; Khare 2004; Desai 2005; Mitharwal, 2005; Jat 2005). Singh and Kakralya (2005) presented a comprehensive review of various methods of conditioning the seeds/propagules and other planting material to assure the better and uniform germination and crop stand establishment. These methods included osmoconditioning, hydropriming, thermoconditioning, ionopriming. Radiation conditioning and organochemo conditioning. Saravanan and Morimuthu (2005) also described some methods by which the planting material may be made relatively tolerant to diseases and insect pest infestations. But there is need to convey such innovative techniques to extension workmen associated with ARSS, ARSSs, KVKs, and even Medicinal plants, Board of centre and State Government. However agronomic management practice are to be followed carefully and judiciously. Looking to the abiotic stresses prevailing in different agroclimatic zones of Rajasthan, a coordinated and concerted approach is the only way to use herbal farming as the mean of social and economic upliftment. In this venture women (and men also) will certainly play a vital role packed by scientific, technical and financial inputs by both NGOs and Government Organizations and also autonomous /Corporate bodies like Agricultural Universities and their constituent to units operative in various agroclimatic zones. Role of such organization / establishments and their constituent units/ campuses/R&D foundation are summarized below :-

(a) National Agricultural Research System (NARS)

Under the umbrella and mandate of Indian Council of Agricultural Research (ICAR), New Delhi, different Research Institutes and Agricultural University are working collaboratively, co-ordinatively and co-operatively throughout the country. Many of such establishments are devoting considerable time and energy on developing research technologies for cultivation and domestication of medicinal plants. AICRP on medicinal plants, National Bureau of Plant Genetic Resources, Under Utilized Crops Project, Seed Technology Research Project, Post Harvest Technology Research Project. Details of these may be obtained from ICAR, Head-Quarter Krishi Bhawan, New Delhi or Krishi Anusandhan Bhawan-I and II, Pusa Campus, New Delhi (Anonymous 2004).

(b) Indian Council of Forestry Research and Education (ICFRE) Dehradun

Forests are very important habitants for medicinal plants resources. ICFRE units are, therefore, involved in exploration and scientific utilization of medicinal plants components of Indian Forests. In Rajasthan, Arid Forests Research Institutes (AFRI) Jodhpur has recently plants, especially trees, shrubs, climbing and herbs suitable for arid and semi-arid ecosystem. Women co-operatives may contact this institute and also CAZRI, Jodhpur for guidance and all possible helps.

(c) National Institute of Agricultural Marketing (NIAM) Jaipur

Marketing of produces obtained as a result of cultivation as medicinal plants, is an important problem. This is mainly due to the fact that local (general) traders are not still aware about the importance of medicinal plants and their trading procedure. NIAM is playing important roles in holding trainings / workshops on cultivation, seeds/ propagules and other planting materials of medicinal plants and subsequently the marketing procedures and pathways available for medicinal plants. This (Government of India, New Delhi)

Institute has shown effective co-ordination with (Rajasthan) State Medicinal Plants Board, Jaipur with respect to providing guidance to farmers who are interested in medicinal plants.

(d) National Medicinal Plants Board and State Medicinal Plants Boards in India

The National Medicinal Plants Board (NMPB) was established by GOI or 24 in November 2000. The objective was to establish a nodal agency for effective and realistic co-ordination on all matters relating to medicinal plants including R&D activities on medicinal plants. Subsequent to it, at least 25 State Governments of India have established State Medicinal Plant Boards (Summary Table-13, Rawat 2003). In Rajasthan, also Rajasthan State Medicinal Plants Board has been established and is playing key roles in encouraging forms for cultivation of medicinal plants, especially those species which can be successfully grown at marginal lands with low inputs and high outputs coupled with solving some of the problems of farmers such as seeds and marketing.

Table 13 : National and state medicinal plants boards in India

S.No.	State/ UT	Address
1	All India Scope	National Medicinal Plants Board GOI, New Delhi – 110 001
2.	Andman & Nicobar Islands (UT)	A&N Islands, Port Blair – 744 102 (A&N)
3.	Andhra Pradesh	AP Medicinal and Aromatic Plants Board, 205 Riviera Apartments, Punja Gutta, Hyderabad – 500082 AP
4.	Arunachal Pradesh	Arunachal Pradesh Medicinal Plants Board. Naharlagun, Itanagar (Arunachal Pradesh).
5.	Assam	Commissioner/ Secretary Health and Family Welfare Government of Assam, Dispur (Assam).
6.	Chandigarh (UT)	CEO Medicinal Plants Board, Old Architect Bld. Sector 19-B, Madhya Marg, Chandigarh – 160 019
7.	Daman, Div, Dadra and Nagar Haveli (UT)	Director, Medical and Health Services Secretariat, Moti Daman - 396220
8.	Gujarat	Director, ISM&H Secretariat GOG, Gandhi Nagar (Gujarat)
9.	Haryana	CCF Protection, GOH, Van Bhawan, Sector-6, Panchkula – 134109 (Haryana).
10.	HP	Ayurveda Bhawan SDA Complex, Block-26, Kasumpati, Shimla – 171 009 HP.
11.	J&K	JKSMPB, Near MLA Hostel, Indira Chowk, Jammu (J&K).
12.	Karnataka	Karnataka SMP Authority, Forest Campus Arakere. MICO Layout, Banne Ghatta Road, Bangalore – 560 076 (Karnataka)

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S.No.	State/ UT	Address
13.	Kerala	Kerala State MPB, Thrissur (Oushadhi – 680001)
14.	Lakshadweep (UT)	Lakshadweep State Medicinal Plants Board, Kavaratti (Lakshadweep)
15.	Madhya Pradesh	MP State Medicinal & Aromatic Plants Board, Khel Parisar, Indira Nikunj, 74 Bungalow, Bhopal (MP).
16.	Maharashtra	Director (Ayurveda) Khanna Construction House II, Flor, Dr. R.D. Thadani Road Worli, Mumbai – 400018 (Maharashtra)
17.	Mizoram	Secretary, Health and Family Welfare, Government of Mizoram, Aizawal (Mizoram)
18.	Nagaland	Programme Officer (ISM&H) Department of Health and Family Welfare, GON, Kohima (Nagaland)
19.	Orissa	Special Secretary, Forest and Environment Deptt., GOO. District Khurda, Bhubaneshwar – 751 001 (Orissa)
20.	Rajasthan	Member Secretary, Rajasthan State Medicinal Plants Board, Room No. 373, III Floor, Krishi Bhawan, Jaipur (Raj.)
21.	Sikkim	Principal CCF cum Secretary, Sikkim Medicinal Plants, Board, Govt. of Sikkim, Deorali 73710, Gangtok, Sikkim.
22.	Tamil Nadu	Commissioner, ISM&H AA, Govt. Hospital Campus, Arumbakkam, Chennai – 600 106 (TN)
23.	Tripura	Tripura Medicinal Plants Board, FRD, Aranya Bhawan, Nehru Complex, P.O. Kunjaban Agartala – 799 006 (Tripura)
24.	West Bengal	Joint Secretary, (ISM Branch) WCS (Exe) Govt. WB. Writers Building, Kolkatta 700 001 (WB)
25.	Uttaranchal	Director, Herbal Research & Development, Institute, Mandal Gopeshwar (Uttaranchal)
26.	Goa	Goa State Medicinal Plants Board, Panji, Goa
27.	Chattishgarh	Information not available
28.	Jharkhand	Information not available

(e) Central Institute of Medicinal and Aromatic Plants (CIMAP) Lucknow

CIMAP Near Kuprail Picnic Spot, Lucknow (founded on August 11th, 1978) has developed wonderful capabilities in Agro Techniques, Biotechnological Innovative and Phytomolecules developments against diseases. Recent example in malaria eradicating drug from *Artimissia* plant, an excellent alternatives of Chloroquin to which some species of mosquito have developed resistance. CIMAP has regional resource centres at Bangalore, Hyderabad, Pant Nagar, besides it head-quarter (Lucknow). All the wings of CIMAP are actively in research, training and extension activities and an equilibrated approach for farmer traders and pharmaceutical industries. Literature published by CIMAP is useful for farmers, traders and industrialists. The Directory of Crude Drugs and Aromatic Plants Dealers, Producers in Exporters and India has been revised and updated. It is very much helpful to all walks of life interested in different facets of medicinal plants.

(f) National Botanical Research Institute (NBRI) - Lucknow

It is a premier Institute involved in plant research and sustainable development (both basic and applied aspects). Established in 1963 has made remarkable contribution in medicinal plants and their domestication, scientific exploration and exploitation/ utilization. Herbal drugs, nutraceuticals, antiageing creams, face packs, anticigarette drugs, after shave lotions, herbal gulal, antioxidants (enzyme based). Farmers may seek the help from this institute about the new medicinal plants and their acclimation in fragile ecosystem.

Few other organization concerning the medicinal plants are :-

1. Indian council of Research in Ayurveda and Siddha.
2. Indian Council of Research in Unani/Tibbi Medicine.
3. Indian Council of Research in Homoeopathy.
4. National Council of Research in Naturopathy and Yogic Science.
5. National Institute of Ayurveda.

(g) Agricultural Universities and Their Roles in Ecofarming

There is a strong and well developed network of state agricultural universities (32), one Central Agricultural University, Imphal (Manipur) and two central universities (BHU Varanasi and AMU Aligarh) having reputed agricultural wings. All these Universities.

Besides these two CSIR Institutions (CIMAP and NBRI), this organization is engaged in medicinal plants R & D activities through some other centres (Regional Research Laboratories) located at Jammu, Almora, Palampur, Pantnagar etc.

Some multifaculty Universities and their Botany Departments, Biotechnology Departments and Environmental Science Departments are contributing towards medicinal plants. The Indian society should also remember the human resource development through some undergraduate and postgraduate colleges distributed throughout the nation. Some colleges have made remarkable contributions on applied and basic researcher on medicinal plants and their cultivational efforts teaching, researcher and extension units located in about 2/3 part of Rajasthan (Table 14) from where farmers may seek guidance/ help on matters relating to medicinal plants have established a widely spread system of regional agricultural research centre, agricultural research station, agricultural research substation, constituent agricultural colleges, research institutes and Krishi Vigyan Kendra and are effectively involved in R&D activities on crops, new crops and medicinal plants.

Table 14 : Constituent units of Rajasthan Agricultural University which may be helpful to farmer

S.No.	Name and location	Telephone (Office) number (if available)
A.	**Agricultural Colleges Constituent Units**	
1.	College of Agricultures, Bikaner (Raj.)	0151-2250292
2.	SKN College of Agriculture, Jobner (Jaipur)	01425-254022

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S.No.	Name and location	Telephone (Office) number (if available)
B.	**Agriculture Faculty, College (Affiliated to Raj. Agril. Univ.)**	
1.	SKMG Vidyapeeth, Sangaria	01499-220079
2.	PND College, Gajsinghpur	01505-230105
3.	B.B.D. Govt. College, Chimanpura (Shahpura)	01422-222062
4.	Govt. P.G. College, Sawai Madhopur	07462-220307
5.	Dayanand College, Ajmer	0145-2441574
C	**Directorate of Research and its constituent units**	
6.	Director Research (Ag.) RAU, Beechhwal, Bikaner	0151-2250576, 2250119
7.	Agricultural Research Station (ARS) Beechhwal, Bikaner	0151-2250870, 2250570
8.	ARS Durgapura, Jaipur	0141-2550229
9.	ARS, Fatehpur Shekhawati (Sikar)	01571-230226
10.	ARS, Keshwana (Jalore)	02973-265844
11.	ARS, Mandore (Jodhpur)	0291-2571813
12.	ARS, Navgaon (Alwar)	01458-275216
13.	ARS, Sriganganagar	0154-2435010, 2440619
14.	Agricultural Research Sub Station, (ARSS), Diggi (Tonk)	01437-227332
15.	ARSS, Hanumangarh Town	01552-222935
16.	ARSS Kumher, Bharatpur	05644-240531
17.	ARSS, Nagaur	01582-2343134
18.	ARSS, Tabiji (Ajmer)	0145-2440892
19.	ARSS, Sumerpur (Pali)	02933-252365
20.	ARSS, Gonera - Kotputli (Jaipur)	01421-286216
D.	**Directorate of Extension Education and Its Constituent Units**	
21.	Directorate of Extension Education RAU Beechhwal, Bikaner	0151-2251122
22.	Krishi Vigyan Kendra (KVK), Tabiji, Ajmer	0145-2440023
23.	KVK, Abusar, Jhunjhunu	01592-233420
24.	KVK, Beechhwal, Bikaner	0151-2250944
25.	KVK, Dholpur	05642-240457
26.	KVK, Fatehpur Shekhawati	01571-222062
27.	KVK, Dausa	01427-231083
28.	KVK, Jaisalmer	02992-251359

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S.No.	Name and location	Telephone (Office) number (if available)
29.	KVK, Sawai Madhopur	07462-220870
30.	KVK, Keshwana (Jalore)	02973-265648
31.	KVK, Kumher (Bharatpur)	05644-240691
32.	KVK, Hindon (Karauli)	Not Available
33.	KVK, Nagaur	01582-240902
34.	KVK, Navgaon (Alwar)	01468-275276
35.	KVK, Sriganganagar	0154-2440532

In the state of Rajasthan, two agricultural Universities with HQs at Bikaner and Udaipur are functioning for R&D efforts on medicinal plants. A brief introduction in given below :-

Maharana Pratap University of Agriculture and Technology, Udaipur (MPUAT, Udaipur)

The University also has adequate infrastructural facilities equipped with constituent colleges. Directorate of Research, Directorate of Extension Education, ARSs, ARSSs, KVKs, etc. and AICRPs including AICRP Centre on Medicinal Plants. A brief description is given below :-

Table 15 : Constituent units of MPUAT, Udaipur which may be helpful to farmers

S.No.	Name & location	Telephone numbers if available
A.	**Constituent Agricultural/ Allied Colleges**	
1.	Rajasthan College of Agriculture, Udaipur	0294-2417835
2.	College of Horticulture and Forestry Jhalawad	Not available at present
B.	**Directorate of Research and its constituent units**	
3.	Director Research, RCA, Udaipur	0294-2407334
4.	ARS, Udaipur	0294-2413625
5.	ARS, Kota	2844369
6.	ARS, Banswara	264073
7.	ARS, Bhilwara	Not Available
8.	ARSS, Pratapgarh	222326
9.	ARSS, Vallabh Nagar	240224
10.	ARSS, Aklera	Not Available
C	**Directorate of Extension Education and its constituent units**	
11.	Directorate of Ext. Education RCA, Udaipur	0294-2417697

contd. ...

contd. ...

S.No.	Name & location	Telephone numbers if available
12.	KVK, Banswara	242771
13.	KVK, Bhilwara	243850
14.	KVK, Bundi	2457815
15.	KVK, Chittorgarh	241248
16.	KVK, Jhalawad	230504
17.	KVK, Kota	2326726
18.	KVK, Baran	244862
19.	KVK, Sirohi	220708
20.	KVK, Dungarpur	231381
21.	KVK, Rajsamand	220626

Note : STD Codes of some ARSs, ARSSs and KVKs are not available.. Farmers may find these from BSNL sources. Further, there is no affiliated colleges with MPUAT at present.

There are few KVKs in Rajasthan which are being managed by NGOs/ deemed University. These are as below :-

Table 16 : Krishi Vigyan Kendra with NGOs in Rajasthan

S.No.	Name & location	Telephone numbers if available
1.	KVK, Chomu (Jaipur)	01425-235133
2.	KVK, Sardarshahar (Churu)	01564-221624
3.	KVK, Barmer	0982-222865
4.	KVK, Sangaria (Hanumangarh)	01499-222762
5.	KVK, Banasthali (Tonk)	01438-228333
6.	KVK, Badgaon (Udaipur)	Not available

TRANSFER OF TECHNOLOGY TO HERBAL FARMERS AND ROLE OF KVKs

National Agricultural Research System (NARS) conducts basic and strategic researches through the investment of ICAR, National Research Institutes, their regional research centres, State Agricultural Universities (SAVs) and their regional agricultural research centre / stations, some constituent college and research institute. However, to take that research to farmer, an effective system has been developed throughout the country in the farmer a network of KVKs (Krishi Vigyan Kendras) mostly working under the administrative control of agricultural universities but few KVKs are being managed by NGOs or deemed universities. The activities of KVKs include on farm testing of technologies to suite local agroclimatic and socioeconomic microsituation, frontline demonstrations, training to farmers and also the training to extension workers state government officer on frontier areas. Therefore, KVKs maintain effective linkage between technology development agencies and dissemination agencies. The first KVK was established in Pondicherry in 1974. Now, the number of KVKs has exceeded 276 and upto the end of X plan Government of India has decided to establish KVKs in all the 578 rural districts of India. At present (September 2005), 488 rural districts of India have been covered with KVKs network with the advancement of modern technologies, GATT regimes and globalization, the knowledge and information has become one of the most critical inputs in agriculture, in addition to soil, seeds, water, fertilizers, pesticides and farm implements etc. In the present agricultural scenario, farmers need to be judiciously linked with business systems (Marketing), research institution, public administration, other farmer.

Under such situations, some KVKs have started publishing news letters in English/ local languages and Hindi and have relevant information. With respect to domestication, cultivation and biodiversity conservation of medicinal plants, these KVKs have to intensify their activities.

SPECIAL NOTES (SP) FOR PREFERENTIAL MEDICINAL PLANTS (PMP) FOR DIFFERENT ECO ZONES IN FROGILE AGROECOSYSTEM

Plants generally show great adaptability and winder acclimation index. Hence any plant can be grown any where (except some very high altitude low temperature loving plants). Therefore, the list given in Table 3–12 should not be taken a final and strict document. A large number of other plants may also be grown in different zones. Some of them may be indicated here.

Adiantum, Pteris, Pteridium, Equisetum, Selaginella, Lycopodium, Lygodium, Salvinia, Cashew nut, Walnut, Pinus, Atriplex, Haloxylon, Salsola, Suaeda, Salicornia, Artemisia, Arnica, Atropa, Berberis, Cannabis, Ilaichi, Papaya, All species which have valuable medicinal properties may be tried (atleast 10 seed spices being acclimatized at NRC on seed species – Tabiji, Ajmer). Some more medicinal plants of therapeutic value are Leucus, Alstonia, Kulthi, Nagarmotha, Maessua, Woodfordia, Verbascum, Myristica, Kutki, Roheda, Viola, Piper longum, Acorus, Til, Nardostachys, Cassia species, Caesalpinia species, Ficus species, Strictus nux vomica, African Cherry (*Prunus africanum*) is a wonderful medicine of prostratic ailments. The agroecological condition of many parts of Rajasthan may be highly suitable for this plants. Therefore, efforts must be intensified for its introduction and cultivation.

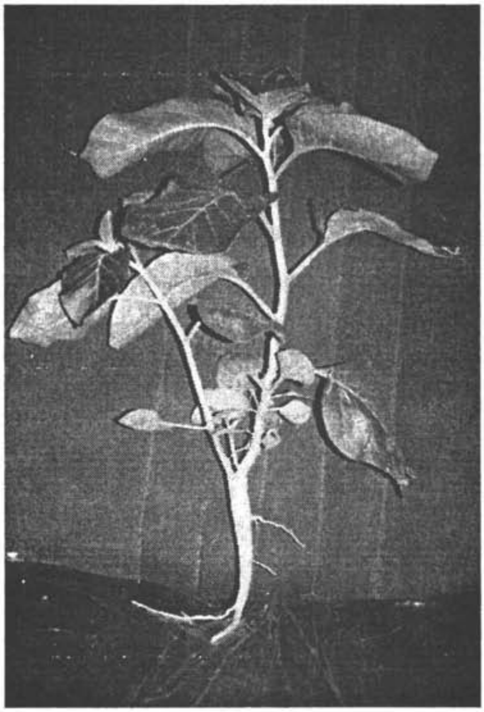
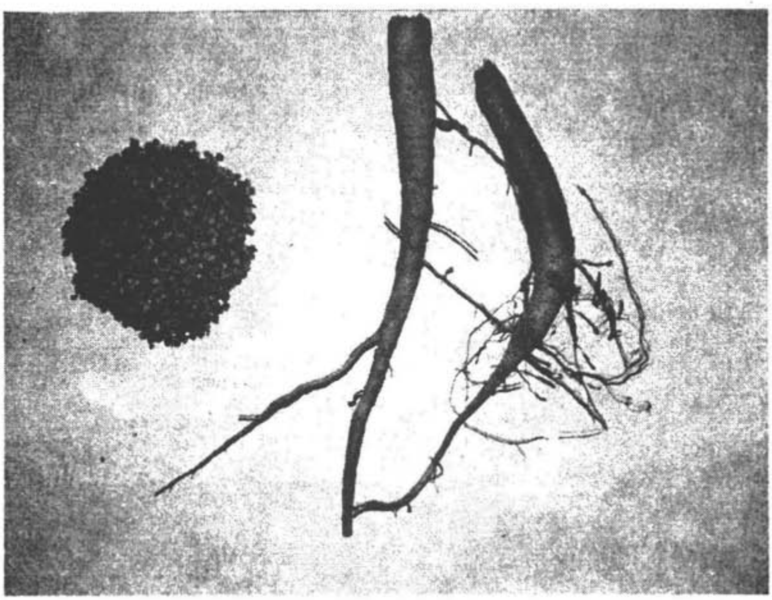
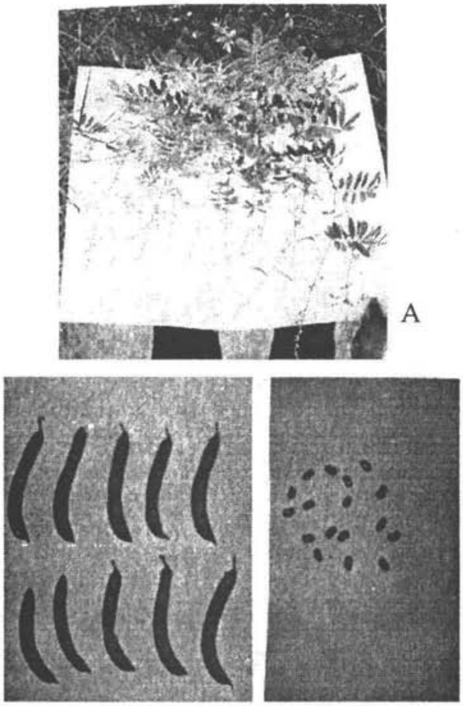


Fig. 3A : *Withania somnifera* (Solanaceae) : A single young plant.



B C

Fig. 3BC : *Withania somnifera* (Solanaceae) B. Seeds, C. Roots.



A

B C

Fig. 4 : ***Tephrosia purpurea*** **(Papilonaceae), A. Plant, B. Pods, C. Seeds.**

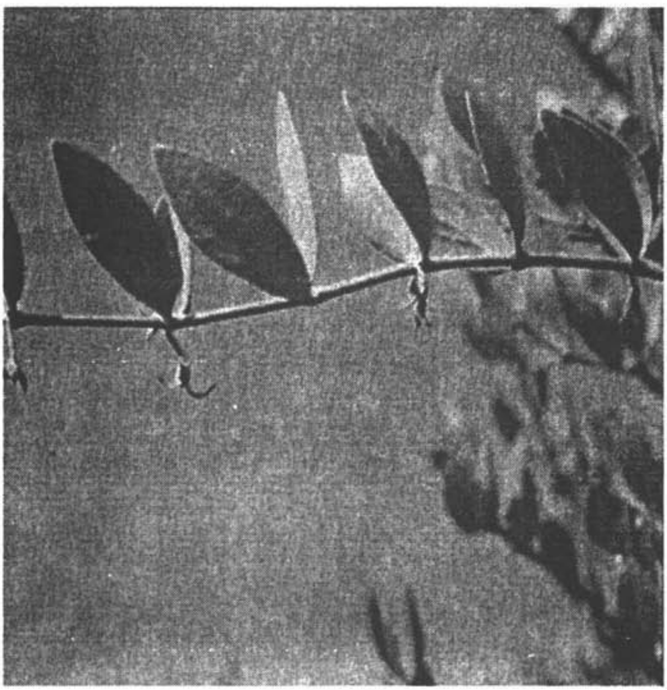


Fig. 5A : ***Simmondsia*** **(Jojoba) : Flower initiation.**

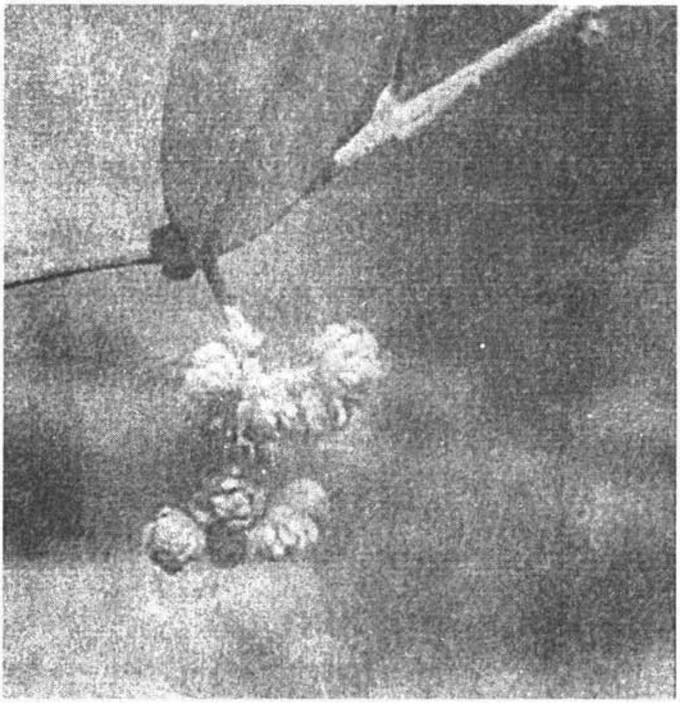


Fig. 5B : *Simmondsia* (Jojoba) : Male flowers.

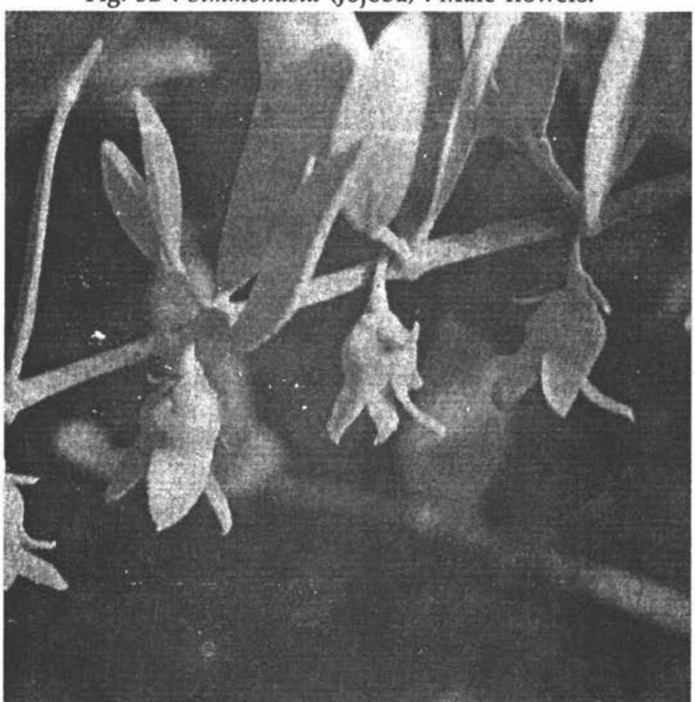


Fig. 5C : *Simmondsia* (Jojoba) : Female flowers.

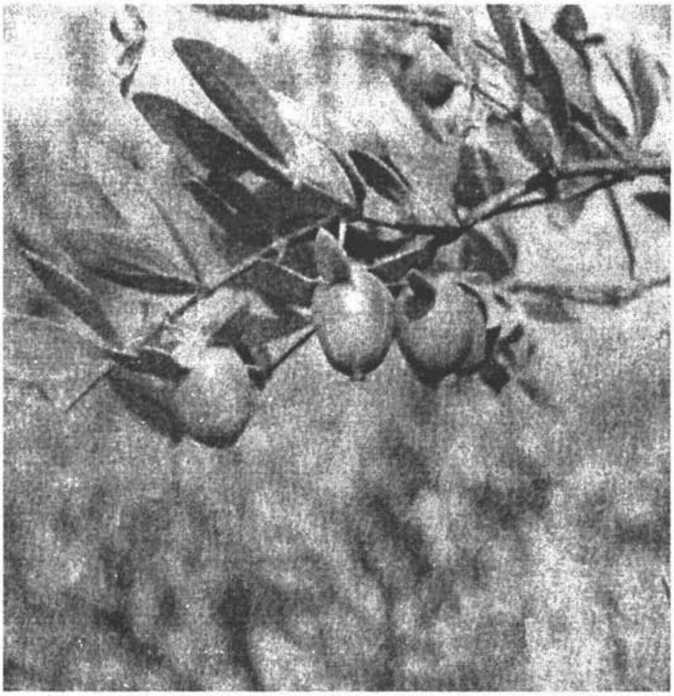


Fig. 5D : *Simmondsia* (Jojoba) : Developed fruits.

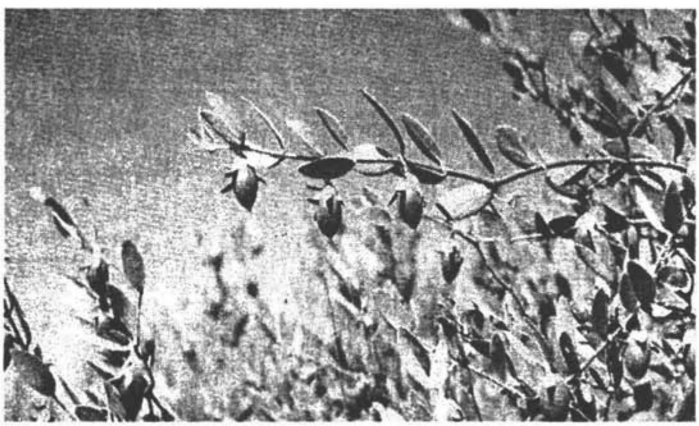


Fig. 5E : *Simmondsia chinensis* (Simmondsiaceae) : Jojoba plant in fruiting (in Rajasthan) : Ready to harvest (june).

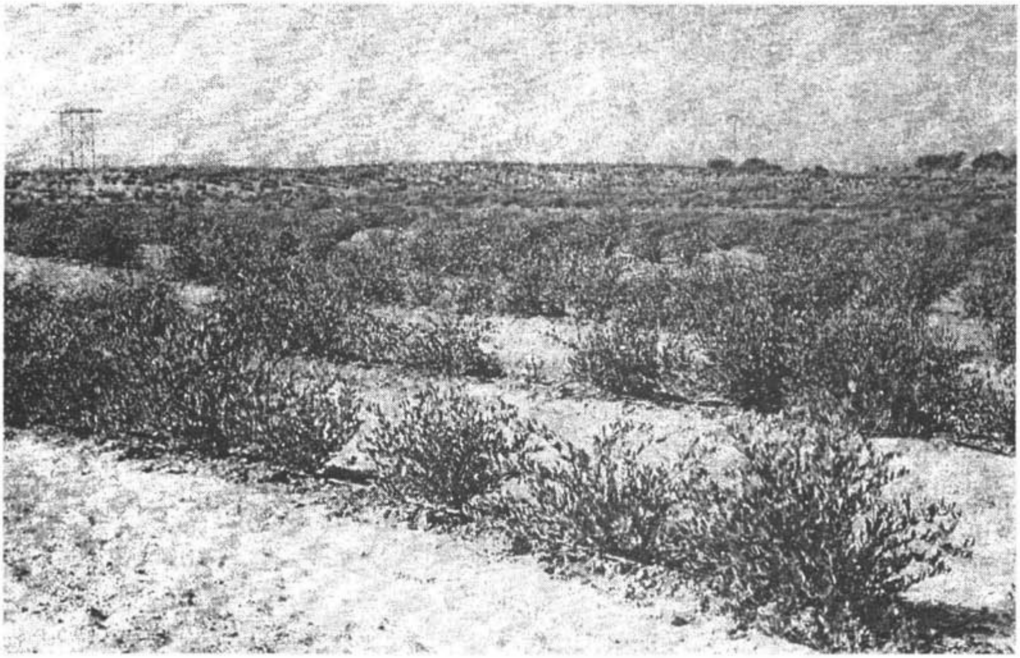


Fig. 5F : *Simmondsia* (jojoba) plantation in Fatehpur Sikar Rajasthan : Based on drip irrigation.

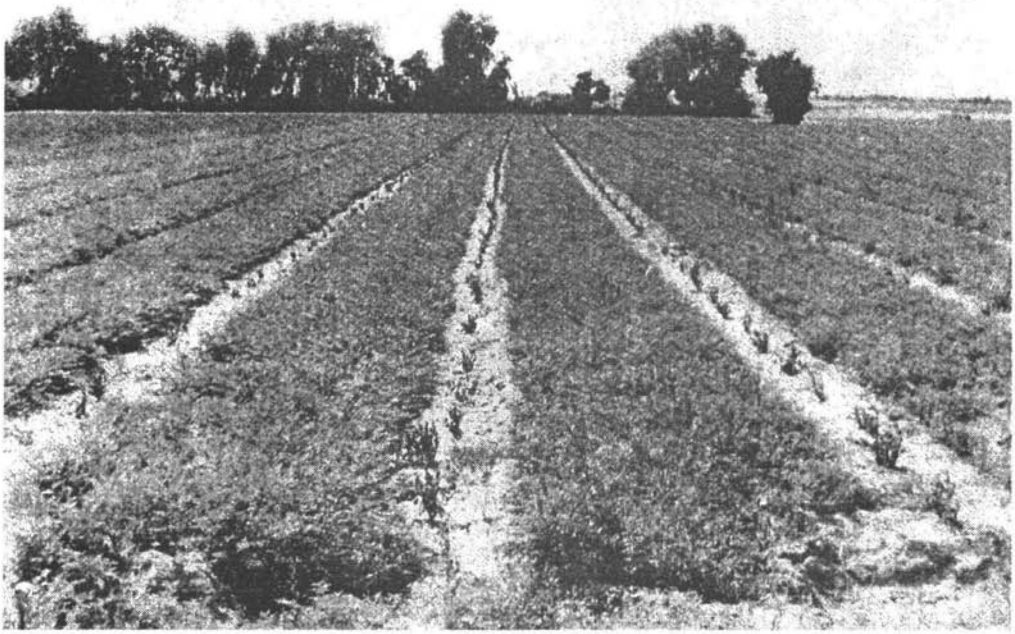


Fig. 5G : Raising of intercrops with jojoba in initial years of plantation upto 3 years provides additional return (Gram as intercrop).

Fig. 5H : Moong bean as an intercrop at 23 PTD Anoopgargh, Distt. Shriganganagar during 2nd year of Jojoba plantation.

Fig. 6 : *Adhotoda vasica* (Acanthaceae) under field condition.

Fig. 7 : *Azadirachta indica* (Meliaceae) A multhitherapic/multipurpose medicinal tree.

Fig. 8 : *Prosopis sinerasia* (Mimosacéae) : A medicinal tree of drier parts.

Fig. 9 : *Tecomella undulata* (Bignoniaceae) Reora = Royeda = Bohira.

Fig. 10 : *Ailanthus excelsa* (Simaroubaceae) A multipurpose medicinal tree.

Fig. 11 : *Cedrela toona* (Meliaceae).

Fig 12 : *Syzygium cuminii* (Myrtaceae)
A. Branch, B. Fruits.

Fig. 13 : *Eugenia jambolana* (Myrtaceae) :
A different clone.

Fig. 14 : *Santalum album* (Santalaceae).

Fig. 15 : *Madhuca indica* (Sapotaceae).

Fig. 16 : *Myristica fragrance* (Myristicaceae) A. Twig, B. L.S. of flower, B_1. L.S. of seed, C. L.S. of female flower, D. Fruit.

Fig. 17 : *Dalbergia sissoo* (Popilionaceae).

Fig. 18 : *Morus alba* (Moraceae).

Fig. 19 : *Morus alba* (Moraceae) An elite clone.

Fig. 20 : *Ficus religiosa* (Moraceae) A. Twig, B. Flower, C. Flower, D. C.S. of fruit.

Fig. 21 : *Mangifera indica* (Anacardiaceae).

Fig. 22 : A. *Cordia myxa*, B. *Cordia macleodii* (Cordiaceae).

Fig. 23 : ***Michelia champaca*** **(Magnoliaceae) A. Twig, B. Fruits.**

Fig. 24 : ***Michelia champaca*** **(Magnoliaceae) : An elite clone.**

Fig. 25 : ***Anona squamosa*** **(Anonaceae) A. Branch, B. Fruit, B_1. Seeds.**

Fig. 26 : ***Melia azadirechta*** **(Meliaceae) A. Branch, B. Fruits.**

Fig. 27 : *Mangifera indica* (Anacardiaceae).

Fig. 28 : *Bauhinia variegata* (Caesalpiniaceae)
A. Branch, B. Pod.

Fig. 29 : *Rhus parviflora* (Anacardiaceae)
A. Twig, B. Fruits,

Fig. 30 : *Terminalia bellerica* (Combretaceae)
A. Branch, B. Fruit,

Fig. 31 : *Woodfordia fruticosa* (Lythraceae).

Fig. 32 : *Nerium indicum* (Apocynaceae) A. Twig, B. Flowers, C. Fruits.

Fig. 33 : *Thevetia peruviana* (Apocynaceae). Poisonous plant but to be used only as per physician advice. A. Twig, B. Fruit.

Fig. 34 : *Ehretia laevis* (Boraginaceae).

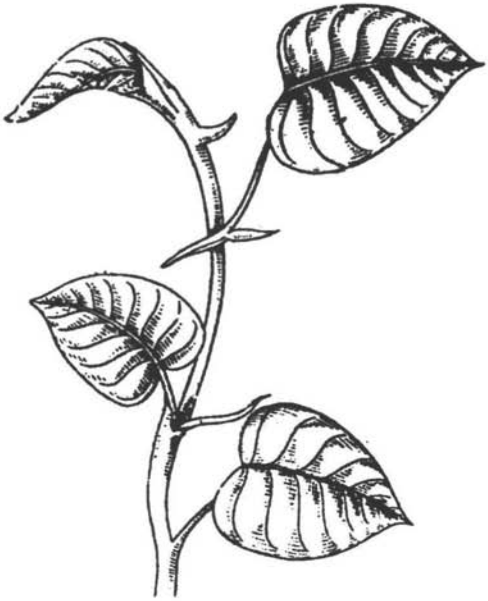


Fig. 35 : *Pothos aureus* : A multitherapic medicinal plant (Family Araceae).

Fig. 36 : *Colocasia esculenta* (Araceae) : Food cum medicinal plant.

Fig. 37 : *Leptadenia reticulata* (Asclepiadaceae).

Fig. 38 : *Hydrocotyle asiatica* (Apiaceae).

Fig. 39 : *Adhatoda vasica* (Acanthaceae).

Fig. 40 : *Euphorbia pulcherrima* (Euphorbiaceae).

Fig. 41 : *Amarnthus spinosus* (Amaranthaceae).

Fig. 42 : *Ocimum basilicum* (Lamiaceae).

Fig. 43 : *Vitex negundo* (Verbenaceae).

Fig. 44 : *Clerodendron indicum* (Verbenaceae).

Fig. 45 : *Sessamum indicum* (Pedialaceae).

Fig. 46 : *Campsis radicans* (Bignoniaceae).

Fig. 47 : *Nicandra physaloidea* (Solanaceae).

Fig. 48 : *Solanum nigrum* (Solanaceae)
A. Twig, B. Fruit.

Fig. 49 : *Ipomoea nil* (Convolvulaceae)
A. Twig, B. Fruit enclosed in persistent calyx.

Fig. 50 : *Heliotropium strigossum*
(Boraginaceae).

Fig. 51 : ***Calotropis procera*** **(Asclepiodaceae) A. Twig, B. Folicle.**

Fig. 52 : ***Pergularia daemia*** **(Asclepiadaceae) A. Twig, B_1. Flower, B_2. Folicle.**

Fig. 53 : ***Cyclanthera pedata*** **(Cucurbitaceae) A. Branch, B. Fruit.**

Fig. 54 : ***Vitis vinifera*** **(Vitaceae) A. Branch, B. Fruits.**

Fig. 55 : *Geranium occelatum* (Geraniaceae)
A. A branch, B. Fruit.

Fig. 56 : *Oxalis corniculata* (Oxalidaceae).

Fig. 57 : *Vaccaria pyramidata*
(Caryophyllaceae).

Fig. 58 : *Viola ordorata* (Violaceae)
A. Branch, B. Fruit.

Fig. 59 : *Cleome gynandra* (Capparidoceae)
A. Branch, B. Leaf, C. Flower.

Fig. 60 : *Papaver somniferum* (Papaveraceae)
A. Branch, B_1. Capsule, B_2. Seed.

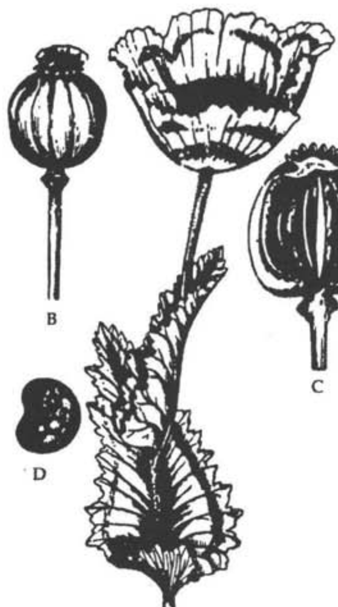


Fig. 61 : *Papaver somniferum* (Papaveraceae):
An elite genotype.

Fig. 62 : *Betavine* (Piper betel).

Fig. 63 : *Sarpgandha* (*Rauwolfia serpentina*).

Fig. 64 : *Echolabium* species.

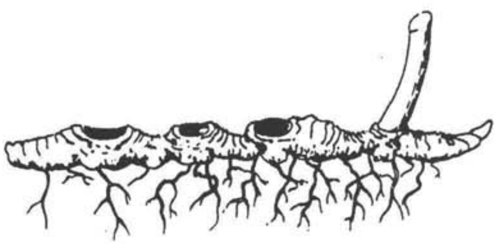


Fig. 65 : *Polygonatum biflorum* (Rhizome).

Fig. 66 : *Solanum rostratum* :
A medicinal weed.

Fig. 67 : *Solanum carolinense* : A medicinal weed.

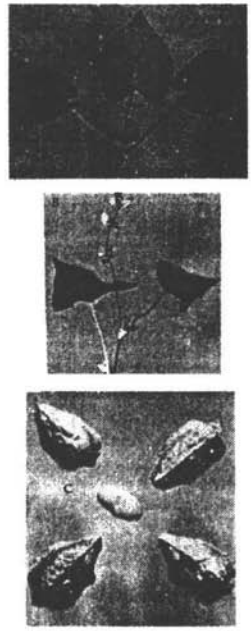


Fig. 68 : *Fagopyrum tataricum* : Tatary Buckwheat : A. Young seedling, B. Mature plant, C. Seeds.

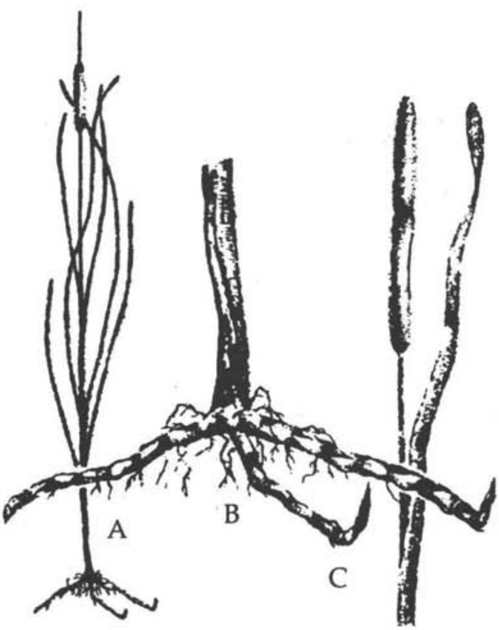


Fig. 69 : *Typha latifolia* : A. Plant, B. Rhizome, C. Flowering spike.

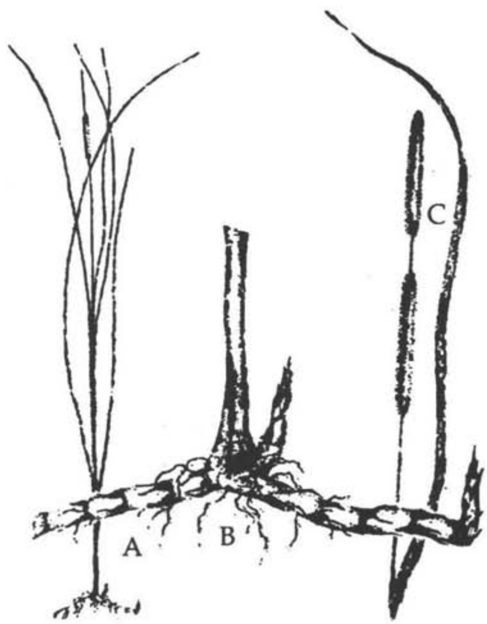


Fig. 70 : *Typha angustifolia* : A. Plant, B. Rhizome, C. spike.

Fig. 71 : *Ipomoea tropica* (Convolvulaceae).

Fig. 72 : *Convolvulus arvensis* (Convolvulaceae).

Fig. 73 : *Datura metel* : A Twig, B. Opened corolla, C. Fruit.

Fig. 74 : *Helianthus annuus* (Asteraceae).

Fig. 75 : *Asclepias curassavica* (Asclepiadaceae).

Fig. 76 : *Phyllanthus nirurii* (Euphorbiaceae).

Fig. 77 : *Catharanthus roseus* (Apocynaceae).

Fig. 78 : *Coccinia indica* (Cucurbitaceae).

Fig. 79 : *Viola tricolor* (Violaceae).

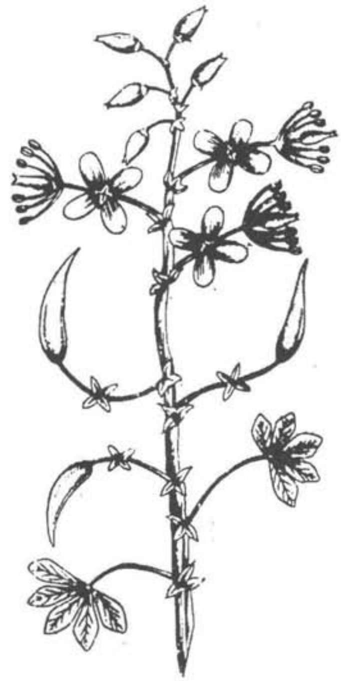


Fig. 80 : *Cleome gynandra* (Capparidaceae).

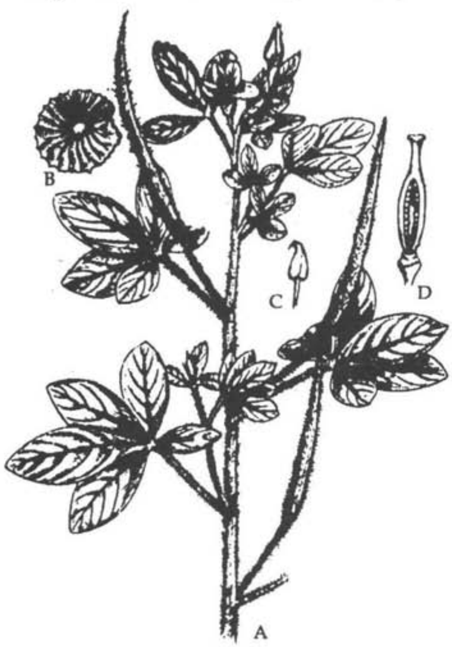


Fig. 81 : *Cleome viscosa* (Capparidaceae)
A. Twig, B. Seed, C. Stamen, D. Pistil.

Fig. 82 : *Mirabilis jalapa* (Nyctaginaceae)
A. Twig, B. Floral bud, C. L.S. of flower,
D. Fruit, E. L.S. of fruit.

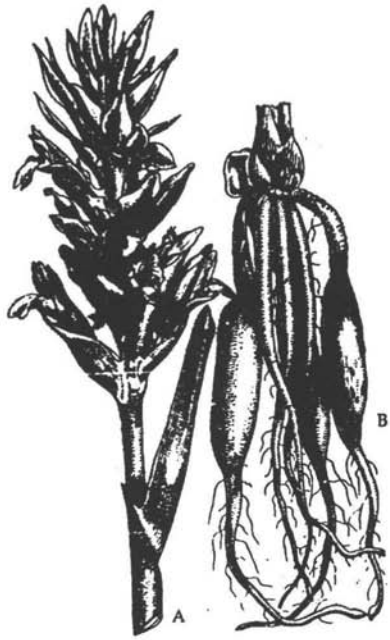


Fig. 83 : *Curcuma longa* (Zingiberaceae) A. Twig, B. Tuberous roots.

Fig. 84 : *Opuntia delinii* (Cactaceae).

Fig. 85 : *Zeuxine sulcata* (Orchidaceae).

Fig. 86 : A. *Orchis latifolia* (Orchidoceae), B. *Orchis muscula* (Orchidaceae).

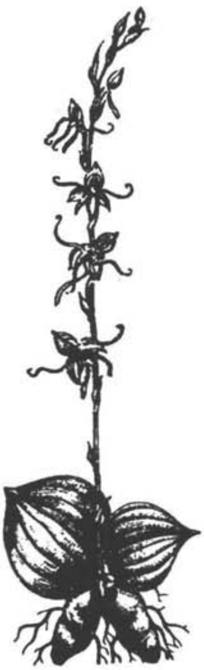


Fig. 87 : ***Habenaria diphylla*** **(Orchidaceae).**

Fig. 88 : *Vanda parviflora* **(Orchidaceae) :** *Jangli Rasna.*

Fig. 89 : ***Smilax zeylanica*** **(Liliaceae).**

Fig. 90 : ***Commelina benghalensis*** **(Commelinaceae).**

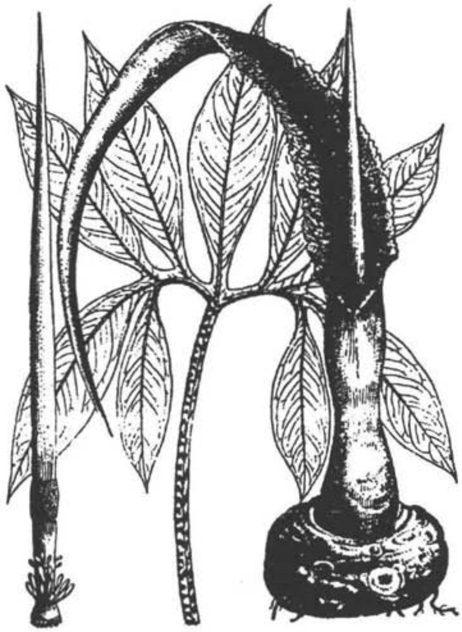


Fig. 91 : *Sauromatum guttatum* (Araceae) : A medicinal plant but must be used for external application only.

Fig. 92 : *Cyperus rotundus* (Cyperaceae).

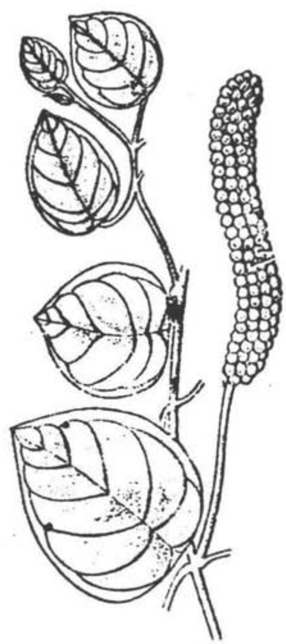


Fig. 93 : *Piper nigrum* (Piperaceae) : Medicinal spice.

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7

Domestication Oriented Study of Seeds of Medicinal Herbs

Karan Singh and M.L. Jat

The international market of medicinal plants is over 60 billion US dollars per annum. This trade is increasing at the rate of 7.0 per cent. India at present exports herbal materials and drugs to the tune of Rs 446.30 crore only per annum which can be raised upto 3000 crore by 2005 and upto 10,000 crore upto 2010 (estimated targets Sarin, 2003, Jakhar *et al.*, 2003 and Singh and Tyagi, 2004). However, this target can not be completed without concerted efforts of various scientific and administrative organizations. For such purpose we are bound to bring more and more plants of therapeutic value under cultivation web. For domestication studies environmental physiology or eco-physiological studies are of utmost important.

Seed is considered as the basic and most important requirement for domestication and cultivation of wild plants and consequently, the efficacy of the scientific efforts of agricultural scientists revolve round this basic input (Singh *et al.*, 1994, Singh and Singh, 1995). Although the therapeutically valuable plants mostly found wild and there is the marked scarcity in knowledge about their germination, growth and development and their adaptation and cultivational behaviours to the environment. Therefore, efforts to produce quality seeds and their timely supply to farmers and pharmaceutical industries and for further development in the domesticational approach of such therapeutically valuable medicinal plant species for pharmaceutical point of view. Seed treatment with quantified osmotic stress has furnished marked important in cultivars of few therapeutic valuable fabaceous crops (Singh *et al.*, 1994, Singh and Kakralya, 1995).

The scientific information on responses of some crop plants to water stress under laboratory condition are available with respect to germination and related parameters (Singh and Kakralya, 1995, Larcher, 2002). However, such studies on medicinal plants having potential to domesticate them, are very scanty whereas, this is well established that germination studies make the initial step for domestication (Sarin, 2003, Singh and Tyagi, 2004 and Jat *et al.* 2005). Therefore, an experiment was conducted to investigate the quantitative aspects of responses of selected medicinal plants to abiotic stress (water stress) with respect to germination and related parameters under laboratory conditions.

EXPERIMENTIA

Seeds of experimental therapeutically valuable medicinal plants species *viz.*, *Achyranthus aspera* L. (Amaranthaceae), *Andrographis paniculata* Brum. f. wall ex. Nees (Acanthaceae), *Plumbago zeylanica* L. (Plumbaginaceae) and *Amaranthus cruentus* L. (Amaranthaceae) were procured from the Medicinal Plant Project, Department of Plants Breeding and Genetics, S.K.N. College of Agriculture, Jobner (Rajasthan). Seeds were subjected to osmotic stress treatment by using carbowax (polyethylene glycol-6000). Osmotica of PEG-6000 were prepared by the method already described (Singh and Singh, 1995). Seed treatment included -0.0, -1 .0, -3.0, -5.0 and -7.0 bars osmotic potentials (PEG6000) in which seeds were put for 12 hrs. at room temperature later on seeds were dried to original moisture level (9.00%) by standard hot air circulation procedure. These seeds were tests for various seed parameters. Data were statistically analysed by using CRD method as described by Raghav (1983)

OBSERVATION AND INTERPRETATION

Seed treated with PEG-6000 and were tested for germination percentage, seedling length, seedling vigour and seedling dry weight. The effects of-1 .0, -3.0, -5.0 and-7.0 bars osmotica were compared with obtained data of seeds which had not been subjected to any treatment or treated with pure water (-0.0 bar) for all experiments.

Data presented in Table 1 revealed that germination percentage was significantly increased by osmotic stress treatment (PEG 6000) upto -5.0 bar level, in this experiment it was also showed that further increase in PEG-6000 (osmotic potential) level for osmotic stress decreased the germination percentage. The enhancement in germination percentage by increasing level (upto -5.0 bar) of PEG-6000 upto highest extent (30.09%) was found in *Andrographis* species and minimum extent (18.19%) was found in *Achyranthus* species over control among all the four medicinal plant species.

Table 1 : Effect of simulated water stress on Seed germination percentage of medicinal plant species under laboratory condition

Species	Water potential levels (bar)	Germination (%) *3 DAS/5 DAS	*5 DAS/10 DAS	Final count
Achyranthus	0 bar	0.00	26.67	73.33
aspera	-l bar	0.00	34.00	78.00

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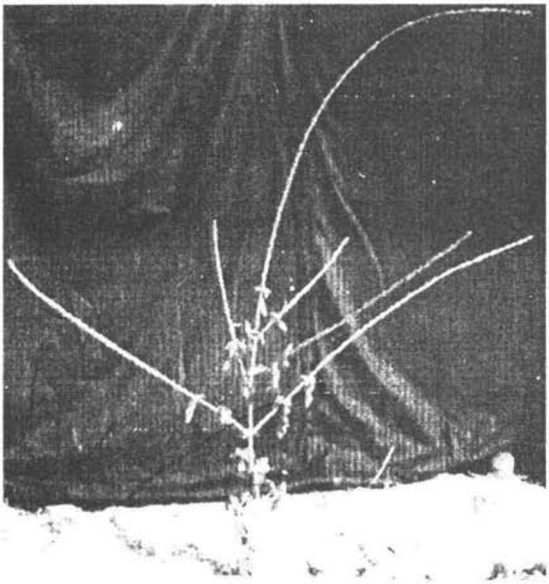
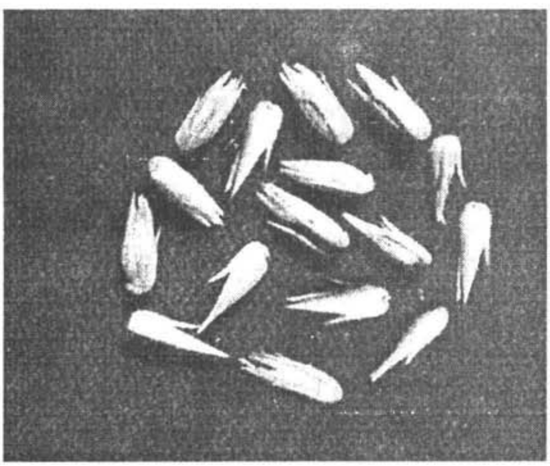
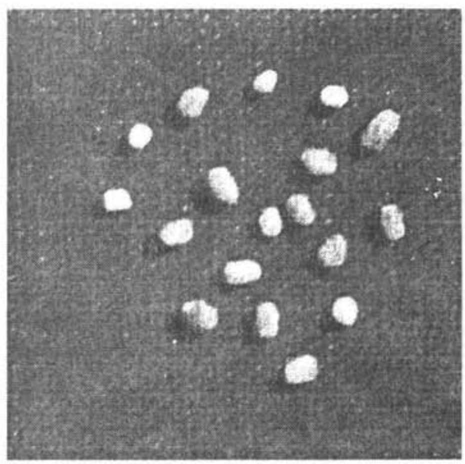


Achyranthus aspera

Andrographis paniculata

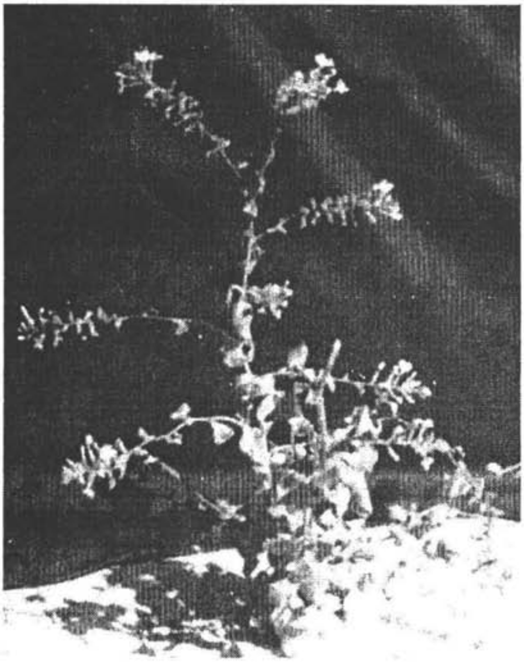


Seeds of *Achyranthus aspera*

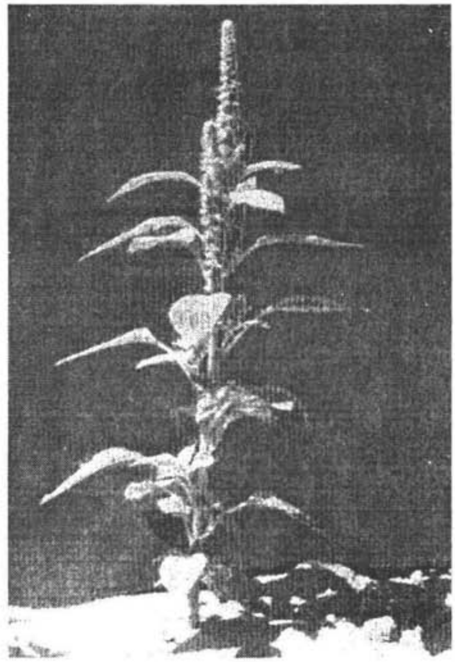


Seeds of *Andrographis paniculata*

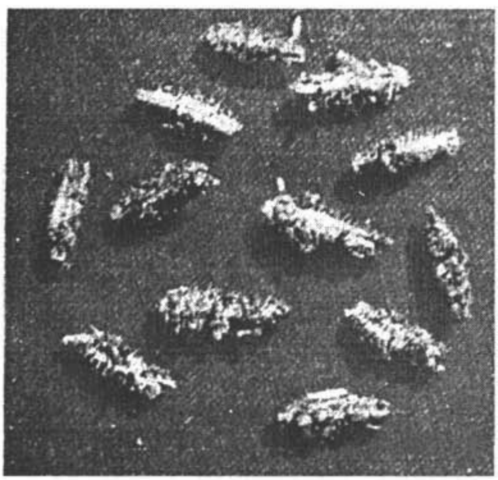
Fig. 1 : Plants and seeds of experimental material.



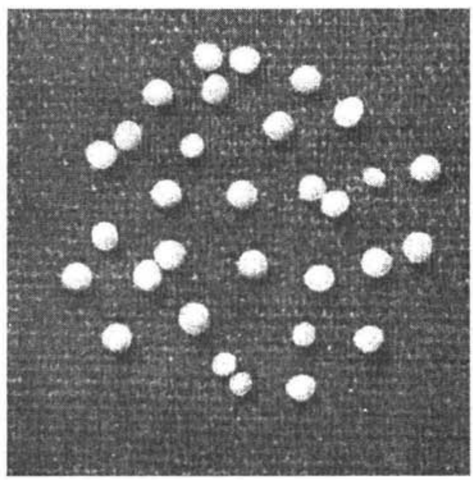
Plumbago zeylancia



Amaranthus cruentus



Seeds of *Plumbago zeylancia*



Seeds of *Amaranthus cruentus*

Fig. 2 : Plants and seeds of experimental material.

... contd.

Species	Water potential levels (bar)	*3 DAS/5 DAS	Germination (%) *5 DAS/10 DAS	Final count
	-3 bar	16.67	42.00	82.67
	-5 bar	28.00	51.33	86.67
	7 bar	22.67	42.00	78.67
Andrographis	0 bar	0.00	25.33	68.67
paniculata	-1 bar	0.00	35.33	73.33
	-3 bar	18.00	46.67	80.00
	-5 bar	23.33	62.00	89.33
	-7 bar	18.67	53.33	76.67
**Plumbago*	0 bar	0.00	56.67	68.00
zeylanica	-l bar	18.67	61.33	72.67
	-3 bar	33.33	70.67	76.67
	-5 bar	43.33	75.33	85.33
	-7 bar	35.33	65.33	76.67
**Amaranthus*	0 bar	23.33	66.67	76.00
cruentus	-l bar	33.33	75.33	79.33
	-3 bar	38.67	82.67	88.67
	-5 bar	42.00	88.67	92.67
	-7 bar	38.00	80.00	85.33
SEm±		2.00	2.96	3.35
C.D. (P = 0.05)		5.71	8.42	9.56

Fig 3 : *Achyranthes aspera* (Achyranthaceae).

Like seed germination the seedling length was increase by seed osmotic treatment with PEG-6000 osmotica (Table-2). The increasing trend was found upto -5.0 bar of osmotica however, the further increase in osmotic stress seedling length leads to decreasing order *i.e.* at -7.0 bar osmotica. At -5.0 bar level the highest per cent increase in seedling length was recorded in *Andrographis* species (14.36%) and was lowest per cent (10.71 %) in *Plumbago* species over control.

Table 2 : Effect of simulated water stress on seedling length , seedling vigour and seedling dry weight of medicinal plant species under laboratory condition

Species	Water potential levels (bar)	Seedling length (cm)	Seedling vigour	Seedling dry weight (g)
Achyranthus	0 bar	9.50	696.67	0.260
aspera	- 1 bar	10.00	780.00	0.270
	-3 bar	10.33	854.22	0.310
	-5 bar	10.33	895.56	0.360
	-7 bar	10.00	986.67	0.320
Andrographis	0 bar	9.33	640.89	0.200
paniculata	-1 bar	9.33	684.44	0.220
	-3 bar	10.00	800.00	0.260
	-5 bar	10.67	952.89	0.320
	-7 bar	10.33	792.22	0.280
Plumbago	0 bar	9.33	634.67	0.300
zeylanica	-1 bar	10.00	726.67	0.310
	-3 bar	10.33	792.22	0,350
	- 5 bar	10.33	881.78	0.410
	-7 bar	10.00	766.67	0.350
Amaranthus	0 bar	8.67	658.67	0.250
cruentus	-1 bar	8.67	687.56	0.260
	-3 bar	9.00	798.00	0.300
	-5 bar	9.67	895.78	0.360
	-7 bar	9.33	796.44	0.310
SEm±		0.68	59.80	0.014
C.D. (P =0.05)		1.94	170.41	0.039

The seedling vigour also increase with increasing levels of osmotica (PEG6000), the trend of increase *in* seedling vigour also found upto -5.0 bar level of osmotica and it was also recorded decreasing trend at -7.0 bar or further increase in PEG-6000 levels (Table 2). At -5.0 bar the maximum increase was recorded in *Andrographis paniculata* (48.68%) and lowest (28.55%) increase at -5.0 bar level was found in *Achyranthus aspera* species.

Table 2 also revealed that like seedling length and seedling vigour the seedling dry weight also increase with increasing orders of PEG-6000 osmotica (osmotic stress) levels upto -5.0 bar osmotica. However, further increase in osmotic stress (PEG-6000) levels the seedling dry weight leads to decreasing order. At -5.0 bar maximum per cent increase (60.0%) and lowest per cent, increase (36.37%) was recorded in *Andrographis* and *Plumbago* species, respectively.

It was interesting to note that osmotic stress as simulated by various osmotica of polyethylene glycol -6000, progressively increased the germination percentage in seeds of *Achyranthus aspera, Andrographis paniculata, Plumbago zeylanica* and *Amaranthus cruentus* species but this enhancement was noted upto -5.0 bar only and there after a decaling trend was observed. The promotory effect of simulated osmotic stress was also similarly recorded in case of other parameters including seedling length, seedling dry weight and seedling vigour. These result are inconformity with the findings of Some earlier workers who experimented with seeds of genotypes of cultivated plants. Bailly *et al.* (1998) conducted systematic experiments on sunflower seeds and reported time improvement in seed germenability and seedling growth. Such beneficial impacts have been described as osmopriming effects. However, the satisfactory scientific explanation of such beneficial responses is yet to be explored. Bailly (1998) interpreted that such responses are mediated through the restoration of anti-oxidant mechanism, specially the activities of catalase (CAT) and glutathione reductase (GR). These enzymes are known to control at least partly the rate of lipid, peroxidiation by scavenging H_2O_2 and by producing the potent anti oxidant glutathione. Similar, reports have also been furnished by Singh and Afria (1985) with chickpea, Singh amid Singh (1995) with microsperma and macrosperma grain, Singh and Kakralya (2001) with groundnut, Kakralya *et al.* (2000) with greengram. Kakralya *et al.* (2000) selecting four genotypes of green gram reported that the suitable level of osmotic stress for getting beneficial responses differs from variety to variety and also influenced by other environmental conditions. Singh and Kakralya (2001) mentioned that such levels of osmotic stress should be experimentally determined for each genotypes and species. Singh and Tyagi (2004) selecting *Withania somenifera* and *Tephrosia purpurea* as experimental material showed that such beneficial responses may be economically viable for medicinal plants but the level of osmotic stress and the time of treatment should be critically evaluated. It was further emphasized that the beneficial responses observed in primed seeds are not merely confined to germination and related parameters but they arc also reflected in yield and yield attributes of the crop raised from these osmoprimed seeds.

Seedling vigour is usually estimated on the basis of germination percentage and seedling length, therefore beneficial responses of plants to specific osmotic stress level are interpretable on the basis of results discussed earlier. Kakralya *et al.* (2000) and Mitharwal *et al.* (2002) selecting arid legumes as experimental materials further reported that the seedling vigour gave better index of the performance of primed seeds particularly when the seeds are subjected to adverse environmental conditions during subsequent storage and plantings. It may be summarised that laboratory experimcet was conducted on four species of therapeutically valuable medicinal plants (*Achyranthus, aspera, Andrographis paniculata, Plumbago zeylanica* and *Amarnthus cruentus*) to study the effect of osmotic stress on seed germination and seedling growth parameters. It was observed that the osmotic stress as simulated by different orders of polyethylene glycocl—6000 (PEG-6000) lmprovc the seed germination percentage, seedling growth and seedling vigour parameters up to -5.0 bar osmoticum. The experimental plant species indicated some quantitative differences in their responses to water stress under laboratory conditions. It was also observed that osmotic stress (at least upto -5.0 bar) proved to osmoconditioning treatment with respect to seed germination and seedling growth parameters.

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8

Prospects and Challenges of Rural Development in 21st Century through Herbal and Neofarming (Ecofarming)

Swami Om Poorna Swatantra and Karan Singh

India is a rural country. 70 percent of her population lives in villages with agriculture as its economic base. Thus rural India village + agriculture is real India which is under-developed. So the key to raise India to the status of a developed nation by the year 2020 as our President exhorts lies in developing the rural India.

For the last more than a year we have been endeavouring to move towards that end of developing rural India through a movement called as "Lab to Land" under the guidance and sponsorship of Indian Agricultural Research Institute, New Delhi. The Lab to Land Movement is a process of bringing the latest development knowledge, skill, technology in the premier research institutes in the country to the doorsteps of the rural people covering every aspect of their life agriculture, animal husbandary, health and education, bio or renewable sources of energy, herbal cultivation, water harvesting, cottage industries, harnessing natural resources etc. This movement serves twin-purposes of bringing the two ends together top knowledge and bottom action; most advanced seed and most backward field ; urban eyes, skill and spirit and rural hands, energy and body so that an integration could be achieved in national life, the knowledge could be applied and action could be modernized leading to the Economic Liberation of India through the awakening and upliftment of rural India.

The 21^{st} century is an era of economic liberation of the world, that is, freedom of mankind from want, hunger and disease and the world with the help of the mechanism of science and technology is moving fast in that direction, and India too is making a sound beginning. But India is in a peculiar situation and has a specific identity, so she will have to move and use technological mechanism keeping in view the uniqueness of her being.

The specific features of her personality are:

1. India is a rural country with vast treasures of natural resources, huge human capital and a variety of climatic zones. All this is in raw and potential state which awaits to the converted into actual power through processing and development. That is why it is said that India is a rich country inhabited by poor people. One spectacular example is that whereas cultivable land in India more than China but India's per capita income and per acre yield is far below China' s.
2. India's machinery of converting the potential into actual and processing the raw material into finished products, the science and technology apparatus is developing fast, in some of the areas such as information technology India has occupied a leading position in the world. Thus we have built an infrastructure for the economic development of the country.
3. India's one unique asset in modern world is her spiritual heritage which not only ensures the development of quality in her own life which is so essential in present circumstances but also assures for her a leading role in the composition of tomorrow's world wherein the establishment of a balance between power and wisdom is absolutely necessary for smooth and harmonious progress of mankind. Today's model of development emphasising exclusively on the advancement of the physical side of life is basically defective and unhealthy, it is proving counter productive: its immediate and superficial gains are being out-weighed by ultimate and fundamental losses and damages. Our modern development we are achieving at what cost : exploitation and pollution of Nature earth, water, air, ecological imbalance. disharmony and disorder in social relation, individual isolation, insulation, suffocation and ultimately threat to our civilizational structure. Recently some 1100 scientists from 95 countries concluded on the basis of 10 years' data that we are a mad people running a mad race leading to our own annihilation : maximum of world resources we shall consume ourselves and the rest we shall poison for our children. It means that even for our survival we shall have to reverse the order and evolve a new model of development based on symbiotic relationship with Nature. And this big change can he effected only with the help of spiritual vision and wisdom of which India is the repository and rural India the Gateway.

   With these natural, spiritual and technological assets now we have to determine the tasks we have to perform and the goals we have to achieve in the context of the development of rural India.

(1) First of all the rural people must realize that they are the masters and makers of India in every respect : in democratic setup of the country they, being more than

70 percent, are the determinants of political authority; in the economic field they are the key-producers as Kisans in rural farms and as Mazdoors in urban factories, in defence and police force it is the rural youth who act as the national guards and finally spiritually too, being in direct touch with Nature, they carry the element of ancient value and wisdom. They perform all duties to the nation but enjoy no rights even on their labour and produce, — it is someone else who determines its value. Thus the country is divided into two parts : rural India has all duties and no rights and the urban has all rights and no duties. This is the grossest form of injustice. The rural India must awaken to this reality and act resolutely to establish justice and Truth in India: a harmonious and just social order in national life.

(2) Through appropriate legislation the Government of India must pave the way for decentralization of power political as well as economic : the Panchayat Raj system must be made more effective and efficient in its functioning through proper training and the planning for economic development must be brought nearer to the homes of the rural people, it must come down to the grassroots level village level planning or micro-planning as they call it should be introduced. Fundamentally, the agriculture should be given the status of an industry, so that the farmers get all the corresponding facilities and benefits. State barriers in the movement of agricultural goods should be removed and it should be given free hand to move, grow and develop. Most importantly, the Culture of Service must be developed in this country, that is, the bureaucracy from top to bottom must be taught and trained to approach the common men, the dignified citizens of this free nation with a sense of respect and service to them as the masters not to rule and boss over them as subjects as is the case today. But this is possible only then when the honourable members of legislatures and the governments themselves learn the lesson of humility by throwing away the ugly posture of arrogance that accompanies the power by gratefully recognizing the fact that their power is not theirs, it is people's who have so kindly delegated it to them. The government should genuinely serve the people, especially the deprived and downtrodden masses in rural India.

(3) The premier research institutes or the seats of higher learning like the Universities in the country must have a sense and element of social commitment in their working. The knowledge and expertise developed at the centres of learning must be linked to the ground realities of the nation the end users, the common men, the under-developed section of our society. If the upper and higher in knowledge. power and means does not feel obliged to serve and lift up the lower, then of what use is it to the nation ? It is a moral crime. If the light-houses of knowledge do not feel themselves to be an integral part of the surrounding community immediately and are not oriented to serve the national foundations, the last man ultimately, that is. they lack the spirit of moral responsibility to the society then by law they must be made to serve the higher cause and work for the ultimate ends. Otherwise these insulated white-houses become the black spots on the fair name of the nation which sustains and upholds them. Every Institute or University irrespective of the discipline must have a programme geared to the needs of the rural people. What we are doing today ? We are producing in these institutions of higher learning an army of youth with bulging

heads, shrinking hearts and paralysed hands who are fit to serve as cogs in the Western machinery but not the challenging and creative needs of national life. So our entire educational system must be overhauled to suit the needs of our people and our future the education must produce dynamic youth who could build a great nation out of the raw material human and natural available to us here.

(4) The uniqueness of the national life of India which distinguishes it from the rest of the world, is that it has been throughout history shaped by the spiritual forces, its ups and downs have been determined by the rise and decline in the spiritual content. Rama, Krishna, Buddha, Ashoka and the latest in the series Mahatma Gandhi all testify to this fact. Mahatma Gandhi is a singular example in modern history who demonstrated the effectiveness of spiritual force in materialistic and militaristic world : a naked Faqir with the spiritual weapon of Satya and Ahimsa single handedly defeated the British Empire and created a new history. Since Gandhi's times due to great decline in spiritual forces our development has become lop-sided and it has imbalanced life which is a cause for big alarm : a moral decay and disintegration has set in social structure. A spiritual regeneration alone can check this negative trend and bring the life back on rails running and moving smoothly and healthily which is essential in today's conflict ridden world. Our foolish approach of coercion, suppression and violent threat either through conventional or nuclear means to establish order and peace in the world is not going to work as has been amply demonstrated by the happenings in the recent past; it would only lead to further disorder, chaos and destruction. It is only the spiritual form which can save man and secure his future. And this is the prerogative of India to share this force with the world and in India it is the rural India where the conducive atmosphere prevails for the generation of this conscious energy. This is the most fundamental task assigned to India by her destiny which will make her a developed nation with a difference.

(5) After more than half a century of Independence now in the 21st century. which is considered to be a century of Asia and which we mean to make centrally a century of India. we must have a new generation of leadership which could build a new India a role model for the future world on the ancient foundations picking the thread of history from where Mahatma Gandhi had left it. The new leadership to play its role successfully must be equipped with certain basic qualifications which are as follows:

i) It must be the sons of the soil, emerging from the dust of this sacred land. so that they embody and manifest the soul of India, they are not aliens to its traditional culture and eternal spirit, the day the son of a Kisan from a poor village succeeds Mahatma Gandhi as the architect of New India, it would be the beginning of a golden era in India's history. Here I may mention, that is the only way to realize the destiny of the nation. To create such leaders is the prime task of rural India.

ii) The today's world has become so sophisticated and technologically oriented that remaining a simple, rustic farmer would not do, you must be well versed with the ways of the modern world, its structure and working, its functioning and dynamics to not only keep pace with it but to carve out a place of honour and respect for yourself in the international community, to become a dignified member of modern and materialistically developed world. So our 21st century leaders must be fully equipped with modern vision and mechanism and have a leading role in global affair&

iii) The third most vital qualification for future leadership is its spiritual vision and wisdom without which you cannot steer the ship of national life to the shore of success and glory in the complex structure of modern world. In fact, spirituality is going to be the compass for the future life of mankind. It is India's moral obligation to develop a spiritual technology which would shape the life 21st century world making constructive use of all the means developed by modern science today. A fundamental revolution in spiritual science must take place which would not only bring it at per with physical science but enable it to effect a synthesis between the two branches of science and evolve a new and integral Science of Life which would mark a turning point in human history. Simply said, our new leader must bear the stamp of divinity which is the result of a dimensional change in life.

After this exhaustive analysis of our national life with special focus on its rural section, its assets, prospects and challenges, the tasks to be performed, we come to this realization that India will have to act as the role model for future world in 21st century and the rural India will serve as its back-bone and power house supplying all energy, strength and wisdom necessary for the creation of a new life and a new world. With this we hail the march of rural India into the 21st century.

For this integrated development of rural India which in fact is the building up of a new India and the model of development for a new world along the above mentioned lines, we resolve to work tirelessly until the goal is reached irrespective of the time and energy to be put into it. At the same time we invite you all who share this vision and destination to come forward and join hands, so that we could achieve the goal in minimum possible time, since the realization of the End of destined. In this endeavour, replacement of conventional crops with herbal farming will certainly play a key role, Such medicinal plants may be trees, shrubs, climbers and herbs. There is a big list but selection of suitable species should be done carefully keeping in view the agroclimatic condition, export potential, domestic needs and marketing channels. Few diagrams shown here are just indications.

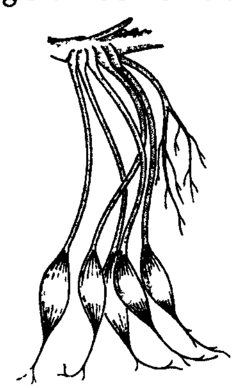

Fig. 1 : Roots of *Curcuma amada* = Ama haldi.

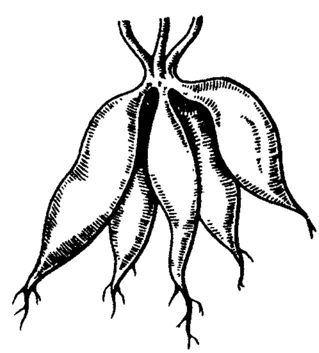

Fig. 2 : Roots of *Dahlia*.

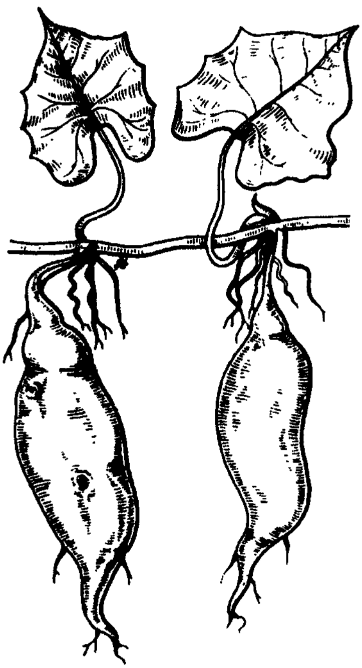

Fig. 3 : Roots of *Ipomoea batatus.*

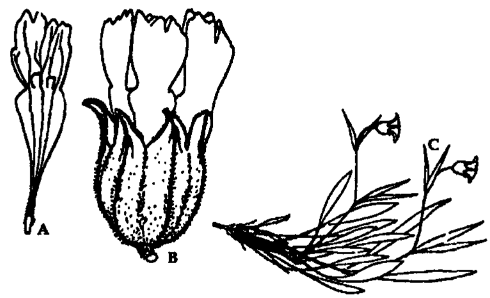

Fig. 4 : *Silena purli* A. Petals, B. Flower, C. Twig.

Fig. 5 : *Mesua floribunda.* Little known medicinal plant (Type of Nagkesor).

Fig. 6 : *Mesua assamica* (A type of Nagkesor).

Fig. 7 : *Mesua manii* (A type of Nagkesor).

Fig. 8 : *Mammea suriga* (Nagkesor type).

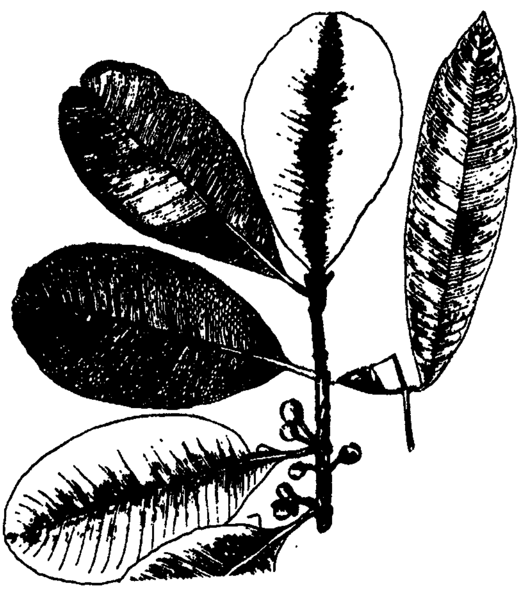

Fig. 9 : *Mammea americana* (Mammey Tree) : A potent medicinal plant.

Fig. 10 : Flowering twig of *Cinchona*.

Fig. 11 : ***Azadirechta indica*** **(Neem).**

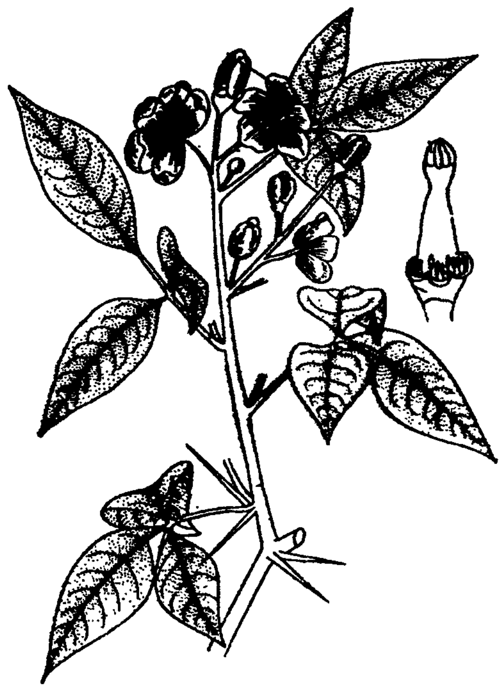

Fig. 12 : ***Aegle marmelos*** **(Bael tree).**

Fig. 13 : ***Casuarina equisetifolia.***

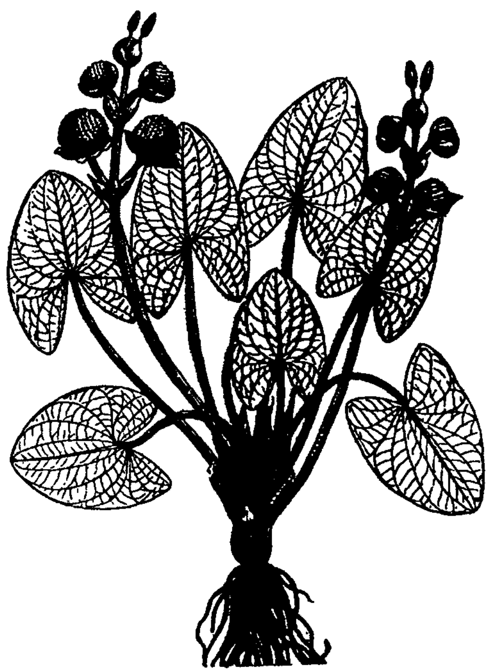

Fig. 14 : ***Sagitaria guayansis*** **(Alista maceae).**

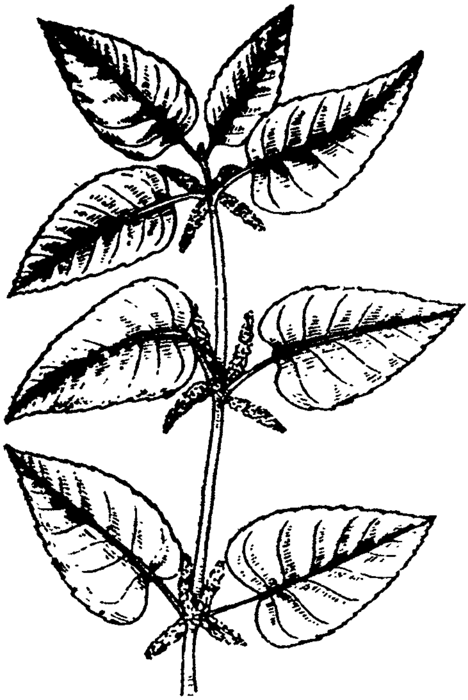

Fig. 15 : *Urtica dioica* (Urticaceae).

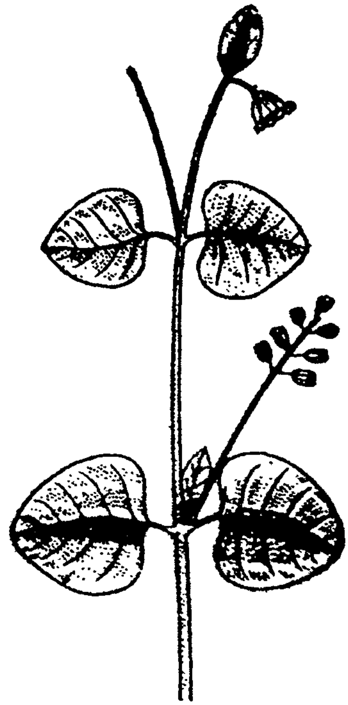

Fig. 16 : *Boerhaavia diffusa* (Nyctaginaceae).

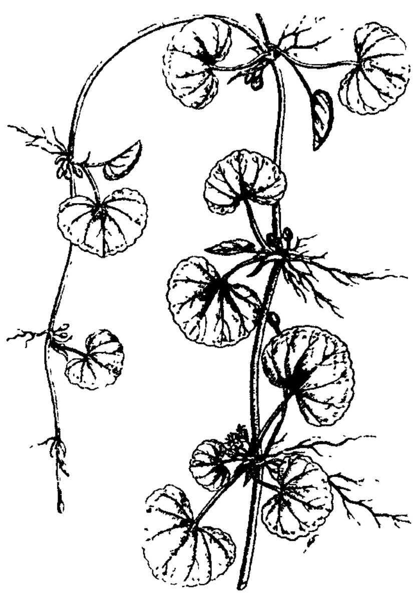

Fig. 17 : *Centella asiatica* (Hydrocotylaeceae).

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9

The Therapeutically Valuable Wonder Spices—Onion and Garlic

S.N. Sharma and R.S. Sain

Alliums are among the oldest cultivated plant species. Onion (*Allium cepa* L.) and garlic (*Allium sativum* L.) are the most important vegetable I medicinal crops have been grown in India. Both the crops introduced in India from Central Asia, the primary centre of origin. Onion and garlic must have been grown in India from very ancient times as their utility as medicinal herbs has been mentioned in the medicinal treaties like "*Charka Samhita*" dated to be around 600 B.C. (Ray and Gupta, 1980). Sanskrit language equivalent signifying Vedic period and Aryan uses, is available for onion as "*Palandu*" (Aiyar, 1956). Adoption of onion and garlic carried through from very early times before Chritians era originally native of Central Asia of temperate region with perennial/biennial habit and long day bulbing character, both have established well in India under tropical and short day photo-periodic conditions (Sheshadri and Chaterjee, 1996).

About 42.0 million tonnes of onion and 8.78 million tonnes of garlic are produced in the world from about 2.33 and 0.89 million hectares of land respectively. India ranks second in area of both the crops (0.42 million ha of onion and 0.11 million ha of garlic). In production, India ranks second in onion (4.43 million tonnes) the first being China (10.04 million tonnes) and third in garlic (0.45 million tonnes) the first being China (5.7 million tonnes). China, India, USA and Turkey are the major onion growing countries in the world contributing about 50% of the total production. China, India, Korea Rep and USA are the major garlic growing countries. In India per capita availability of onion and garlic is 4.51 kg and 455 g per year, respectively, which is quite low. Maharashtra is the leading state accounting for more than 16% of area and 25% production of onion with an average productivity of 19.20 t/ha in onion. Other major onion producing states are Gujarat, Karnataka, U.P., AP. and Orissa. In garlic MP is the leading state accounting for more than 35% of the total area and 36% of production with an average yield of 4.68 t/ha. Other major states are Gujarat, U.P., Orissa and Maharashtra. India is traditional exporter of onion. Onion alone accounts for more than 70% of export amongst fresh vegetables. India's share in the world trade is only 8-10%. Presently onion is mainly exported to Malaysia, Singapore, Dubai, Kuwait, Qatar, Bangladesh, Nepal and Sri Lanka. Garlic is exported to Qatar, Saudi Arabia, Jambia, U.A.E. Bahrain, Mauritius and Kuwait. The export is less than 1% of the total domestic production.

ONION

Onion as food, medicine and religious object was known as early as 3200 B.C. in Egypt and in India since 600 B.C. Onion is one of the few versatile vegetable crops that can be kept for a fairly long time and can safely withstand the hazards of rough handling including long distance transport. The edible portion is a modified stem, which is known as bulb and develops underground. Onion is a unique vegetable because its bulb and seeds are used through the years in the form of salad and condiments or for cooking with other vegetables. Onion seeds are also used in preparing soups, sauces, curries, and pickles and for flavoring or seasoning foods. Onion seeds lose its viability after the duration of one year, and then it's used as a substitute of 'Kalonji' *(Nigella sativa)*, which is a condiment and frequently used in making pickle, soups, sauces and curries.

Onion bulbs have many medicinal properties. It is recommended for the persons suffering from high cholesterol, weakness, lethargy and lack of vitality. It increases the appetite and suppresses the formation of gas. Its use against sunstroke is the best remedy during summer. It is also useful in fever, dropsy, catarrh and chronic bronchitis. Dehydrated bulbs or onion powder is in great demand, which reduces transport costs and storage losses. Raw onions have antiseptic value throughout the alimentary canal. It is also applied to eyes in dimness of vision and locally to allay the irritation of insect bites, scorpion stings and skin diseases. The pungency in onion is due to sulphur bearing compound in the volatile oil (Allylpropyl disulphide). The colour of the outer skin of onion bulbs is due to quercetin catechol, a phenolic factor present in onion, which has anti-fungal properties.

Two types of onions are common grown in India

i) Common onion type (*Allium cepa* var. *cepa*), which is the most important in commercial trade. The bulbs are large normally single and plant reproduce through seeds.

ii) Multiplier onion *(Allium cepa* var. *aggregatum)*, which produces the bulbs of smaller size and several in number to form an aggregated cluster. Propagation is almost exclusively vegetative by daughter bulbs.

COMPOSITION

Manjunath (1948) and Brahmachari and Augusti (1962) have reported that fresh onion contains about 86.8% moisture, 11.6% carbohydrates including 6-9% soluble sugars,

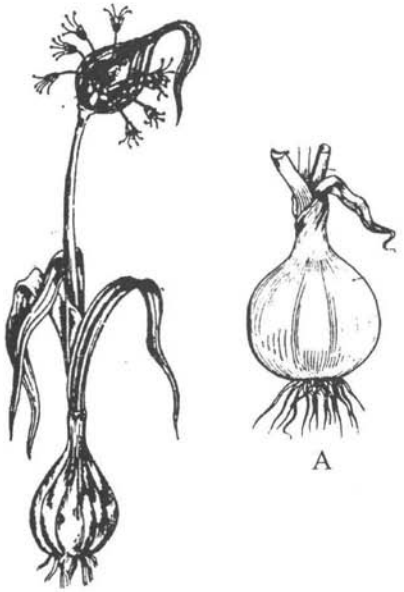

Fig. 1 : *Allium cepa* **(Onion) plant : A. A bulb (Diagramatic).**

Fig. 2 : *Allium cepa* **Seed crop.**

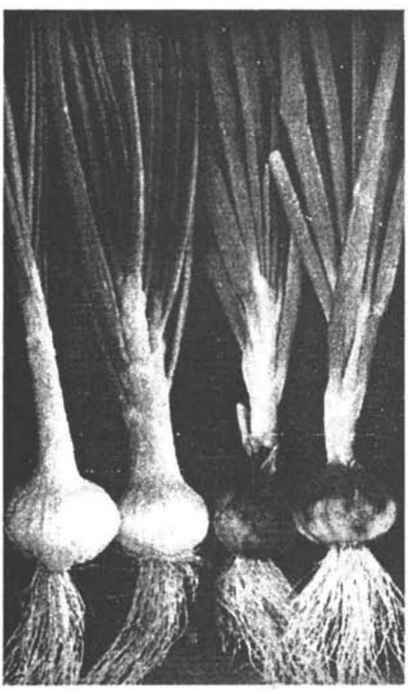

Fig. 3 : *Allium cepa.* **Freshly harvested plants.**

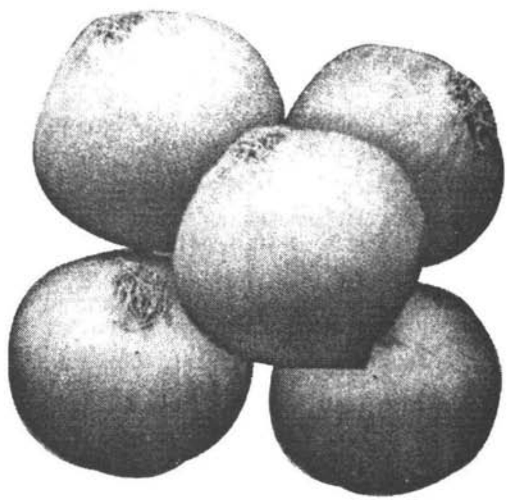

Fig. 4 : Onion bulbs.

1.2% protein, 0.1%, 0.2-0.5% calcium, 0.05% phosphorus and traces of Fe, Al, Cu, Zn, Mn and I. Vitamin A, B_1, B_2, C and nicotinic acid are present as 2.6 I.U., 64mg, 79 mg, 11mg, 0.77mg per 100 g onion, respectively. Roshania and Agrawal (1981) have also reported that onions to be thé richest in vanadium (682-750 μg 100 g^{-1} fresh weight) among variety of foodstuff examined.

In general, the nutritional of dry onion is low. The average nutritive value (ANV) is only 2.05. If the immature bulbs and crops are consumed, the nutritional value will be much higher and ANV may reach 3.96, with a vitamin C and calcium content. When used in raw in salads, the nutritional value is somewhat higher e.g. for onion 2.30 and green onions and tops 4.69 ANV. The ANV of onion (dry) is as follows:

Type of produce	Per 100 g of edible portion of onion
Waste (%)	6.0
DM (g)	11.4
Energy (Kcal)	38.0
Protein (g)	1.6
Fibre (g)	0.7
Calcium (mg)	30.0
Iron (mg)	1.0
Carotene (mg)	0.0
Thiamine (mg)	0.06
Riboflavin (mg)	0.04
Niacin (mg)	0.02
Vitamin C (mg)	9.0
ANV	2.05
ANV per 100 g dry matter	20.0

The pungency odour formed by enzyme reaction only when tissues are damaged. The enzyme alliinase hydrolyses the S-alk(en)yl cysteine sulphoxides to produce pyruvate, ammonia and many volatile sulphur compounds associated with flavour and odour. Both beneficial and unpleasant effects of onions and their extracts are due to sulphur compounds. They contain a large number of sulphur amino acid peptides and their derived products. Augusti (1976) explained that onion contains an acid volatile oil (0.05%) with a pungent smell. The oil is rich in sulphur contains a variety of aliphatic disulphides including allyl or propenyl propyl disulphide, dispropyl disulphide, methyl propyl disulphide and their trisulphides. However, the chief component is propenyl propyl disulphide, an isomer of allyl propyl disulphide. The precursors of onion oil are the cystein sulphoxide derivatives of methyl, allyl, propenyl and propyl groups. These amino acids are known as alliins. Onion contains an enzyme called alliinase, which is released on crushing the bulbs, and converts alliins to disulphide oxides. These oxides are allicin-type compound.

Flavour is influenced by varieties, stage of the bulbs, storage period, nutrition application etc. application of large dose of sulphur increases flavour strength. However, it depends on the sulphur content of the soil itself (Kumar and Sahay, 1954; Singh and Batra, 1972) Steady increase in the volatile sulphur towards the maturity stage and maximum just before the tops begin to fall over and reduction in volatile sulphur delay in harvesting and lifting from the field was noticed by Purewal (1957).

USES:

Domestic and industrial

Today *Alliums* are an important ingredient in several cooked vegetables and used for their flavour, aroma and taste in preparation of vegetables. Alliums are also used in the form of dehydrated, freezing, canning and pickling (in vinegar or brine). Onion oil is obtained by the distillation of minced onion, which possesses the flavouring strength. The oil is free from microbiological contamination and used in food manufacture. Onion salt is prepared by dehydration and used in flavouring.

Medicinal

According to traditional medical literature (Nadkarni, 1954), onions are source of many vitamins are useful in fever, dropsy, catarrh and chronic bronchitis. Raw onions have an antiseptic value throughout the alimentary canal. It is applied to eyes in dimness of vision and locally to allay the irritation of insect bite and scorpion instincts and skin diseases. Oil contain in the bulbs is a stimulant, diuretic and expectorants. Mixed with vinegar, onions are useful in cases of sore throat Cooked with vinegar, they are given in jaundice, spleen enlargement and dyspepsia. In malarial fever, they are eaten twice a day with remarkable relief The roasted onion mixed with cumin, sugar candy and butter oil are a demulcent of great benefit in piles. The essential oil (0.05% of bulbs) contains a heart stimulant, increases pulse volume and frequency of systolic pressure and coronary flow and stimulates the intestinal smooth musculature and the uterus. It promotes bile production and reduces blood sugar (Chopra *et al.*, 1956). Fresh onion juice is moderately bactericidal because of the action of allicin type compounds. Allicins and disulphides interact with —Sh (thiol) compounds like cysteine and prevent their incorporation into proteins. Such reactions inhibit the growth of bacteria.

Onion has blood sugar lowering effect. According to Augusti (1976), S-methyl cysteins sulphoxides and S-propyl cysteins sulphoxide, the precursors of disulphide and their oxides (allicins) are found. All these sulphur compounds can remove thiols, which inactivate insulin by oxidation or thiol disulphide exchange reactions. Onion has lipid-lowering effect. Augusti (1974) reported that regular use of onion by a diabetic patient lowered his insulin doses considerably. Sainani *et al.* (1979) reported that the people who consume 50-80 g onions they have significantly lower body fats and their serum level of cholesterol, triglycerides, β-lephotein and phospholipids are significantly lower than those who abstain from onion uses.

GARLIC

Garlic has higher nutritive value then other bulb crops. It is consumed as green as well as dried in the spice form and as an ingredient to flavour the various vegetarian, non-vegetarian dishes and pickles. A good tasty pickle is also prepared from garlic cloves. Recently, spray-dried garlic products are also available (Pruthi, 1979). The garlic is also used to disguise the smell and flavour of salted meat and fish Dehydrated garlic in powdered or granulated form is being used in place of fresh bulbs. (Fig. 5).

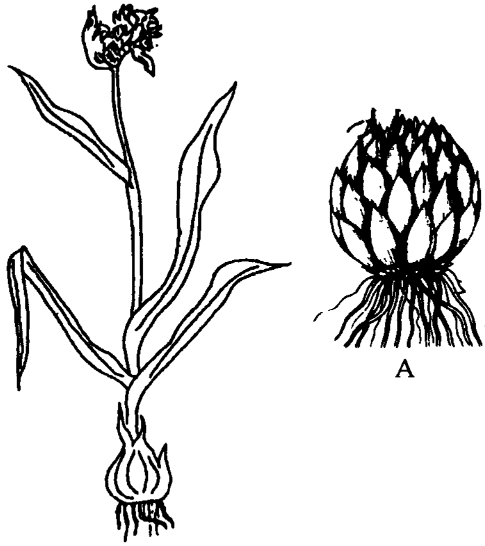

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Fig. 5 : *Allium sativum* (Garlic) plant. A. Bulb.

COMPOSITION

Garlic is a rich source of carbohydrates, proteins and phosphorus. Ascorbic acid content was reported to be very high in green garlic. Nutritive composition of fresh (green), dry garlic cloves and dehydrated garlic powdered are as follows reported by Manjunath (1948) and Pruthi (1979):

Nutrients	Fresh peeled garlic cloves	Dry garlic cloves	Dehydrated garlic powdered
Moisture %	62.80	62.00	5.20
Protein%	6.30	6.30	17.50
Fat %	0.10	0.10	0.60
Mineral matter%	1.00	1.00	3.20
Fibre%	0.80	0.80	1.90
Carbohydrate %	29.00	29.00	71.40
Calcium	0.03	0.03	0.10
Phosphorus %	0.31	0.31	0.42
Potassium%	-	-	1.10
Iron%	0.001	0.001	0.004
Sodium%	-	-	0.01
Vitamin A (I.U.)	0.00	0.40	175.00
Nicotinic acid (mg/100 g)	0.40	0.40	-
Vitamin C(mg/100 g)	13.00	13.00	12.00
Vitamin B(mg/100g)	-	0.16	0.68
Vitamin B_2 (mg/100 g)	-	0.23	0.08

Un-injured bulbs contains a colourless. odourless water soluble amino acid alliin on crushing the garlic bulb, the enzyme alliinase breaks down alliin to produce allicin of which the principle ingredient is the odoriferous diallyl sulphide. Shankaracharya (1974) reported that garlic contained about 0.1 % volatile oil. The chief constituents of oil are diallyl disulphide (60%), diallyl trisulphide (20%), ally-propyl disulphide (6%), a small quantity of disulphide and probably diallyl polysulphide. Diallyl disulphide is said to possess the true garlic colour. Garlic can yield 0.06-0.1% essential oil. The oil is made up of mainly disulphide and small amounts of allyl propyl disulphide (Nadkarni, 1954; Chopra *et al.*, 1956). This oil is founded from the decomposition of products of an alliin is called S-ally cysteine sulphoxide (SACS). Alliinase acts on SACS and produces allicin, ammonia and pyruvic acid. Later, allicin re-arranges to diallyl disulphide (DADS) and thiosulphonate. DADS may further arrange to tri-and polysulphides. Traces of methyl and propyl cysteine sulphoxide present in garlic may give rise to methyl disulphides and certain polysulphides e.g., methyl allyl trisulphide.

USES

Medicinal

Garlic is carminative and is a gastric stimulant and helps in digestion and absorption of food. Augusti (1977) reported that allicin, which has a hypocholesperolemic action, is present in aqueous extract of garlic and reduces the cholesterol concentration in human blood. Inhalation of garlic oil or garlic juice has generally been recommended by doctors in cases of pulmonary tuberculosis, rheumatism, sterility, impotency, cough and red eyes (Pruthi, 1979). Bordia *et al.* (1975) and Jain (1976) found that effect of feeding of raw garlic was better than onion in lowering down the serum cholesterol in the blood. Mahanta *et al.* (1980) observed a significant reduction in serum cholesterol level when 50 g of raw garlic was fed daily to ten human volunteers for one month. Augusti and Mathew (1973, 1974) and Bordia and Verma (1978, 1980) found that garlic lowered serum cholesterol. Blood sugar lowering effects by use of garlic were also reported by Brahmachari and Augusti (1962); Mathew and Augusti (1973) and Jain *et al.* (1973). Garlic oil and raw garlic reduced normal blood sugar significantly after two months of regular use (Mahanta *et al.*, 1980). The blood sugar lowering effect of garlic was ascribed to allicin and related disulphide containing compounds. All these findings supported the claim that garlic is beneficial to diabetics. The cloves of garlic are boiled in edible oil like mustard oil, coconut oil, groundnut oil, sesame oil etc., and its extract is dropped in earache. People's belief that eating more than 3 kg of garlic a year have 85% less incidence of stomach cancer than those eating less. Garlic can inhibit reproduction of toxic germs in the stomach, promote secretion of gastric acid juice and stop synthesis of a carcinogen named nitrosamine. Uncontrolled use of garlic may also lead to anemia. Therefore only customary amount of garlic of about 7-10 g per day is advised (Sainani *et al.*, 1979).

Industrial

Garlic possesses insecticidal action and repellant property. A formulation containing 1% garlic extract gave protection to persons against mosquitoes and black fly for eight hours. Deb-Kiotanya *et al.* (1980) found garlic extract possessing nematicidal and larvicidal properties, respectively. Singh *et al.* (1979) found marked fungicidal effect on new born fungi by applying leaf extract of garlic and suggested possible use of garlic leaf extract in controlling plant diseases under field conditions. The crude extract of garlic was to be quite effective against gram-negative as well as gram-positive bacteria. It inhibited growth of some bacterial cultures, which are resistant to commonly used antibiotics, (Sharma *et a!.*, 1977; Kumar and Sharma,, 1982) about 10% dilution of aqueous extract to garlic completely inhibited the growth of these bacteria in addition, report showed that garlic extract exhibited promising antibacterial activity against several clinical stains (Singh and Shukla, 1984).

GARLIC—A WONDER DRUG

Is garlic a spice or a medicine? Is it therapeutic for the major diseases of our times? Most of us know garlic as a favourite seasoning in salad dressings and as a staple of French, Italian, Greek, Middle Eastern, Indian and Chinese cooking. But garlic is also a medicine, an unusually powerful and versatile one that has been used since the dawn of medicine.

From epidemiological studies of cancer in China and Italy to clinical trails on high blood pressure and high cholesterol in the United States, Europe, and Japan, garlic has come under intensive scientific scrutiny in the last ten years as a potential wonder drug". Much of this research as investigated the effects of garlic on cardiovascular disease. This priority of research is probably inspired by the prominence of diseases, such as heart attack and stroke, the leading causes of death in the industrialized.

In 1944, scientists while reviewing a collection of previous clinical trials of garlic concluded that it lowers cholesterol and blood pressure, two important risk factors for cardiovascular disease. Notably, normal dietary amount of garlic did this without any side effects more serious than a garlic odor in a small percentage of participants. Conventional drugs for these diseases cause side effects such as dry mouth, insomnia, drowsiness, depression and impotence. In head-to-head trial comparing garlic against the cholesterol lowering drug bezafibrate, garlic was just as effective. This is good news for the 25% of men and women aged 25 to 59 in the United States who has high cholesterol levels.

Scientists have also recently investigated the possibility that garlic can prevent or treat some kinds of cancer. As early as 1981, scientists noted that populations in China eating more garlic had less incidence of stomach cancer than those eating less garlic. By *1985*, researchers experimenting with constituents of garlic had identified mechanisms that could inhibit tumors. Scientists neither have nor found evidence for the cancer preventing effects of garlic from such population research, from research on isolated cancer cells, and from animal research. Cancer is the second leading cause of death in the United States, and this research suggests that garlic may help prevent stomach, bladder, breast, colon and esophageal cancers. Besides it offers good remedy for respiratory, cardiovascular and skin disorders. Many of these uses come from the antibiotic and immune stimulating effects of garlic constituents. (As quoted in a book "Healing Powers of Garlic" by Paul Bergner)

The recent scientific studies indicate that many constituents of garlic have different functions as under. However, all constituents are not present in all forms of garlic.

I Antibiotic—ajoene, allicin, ally methyl thiosulfinate, diallyl trisulfied and methylallyl thiosullfinate.

II Inhibition of cancer—ajoene, allicin allixin, allyl mercapatan, allyl methyl trisulfide, diallyl disulfidee, diallylsulfidee, propylene sulfide & S-allyl cystein.

III Detoxification—ajoene, allicin aliin, allixin, allyl methyl trisulfide, diallyl disulfide, dimethyl disulfide, dimethyl trisulfide, dipropyl disulfide, methylajoene & S-allyl cystein.

IV Antioxidant—aliin, diallylhepta; hexa; peenta; tetra and trisulfide, Sallyl cysteine & selenium.

V Lowering blood sugar—allicin, allyl propyl disulfide.

VI Lowers cholesterol—Ajoenee, allicin S-allyl-cysteine, dially disulfide.

VII Liver protection—diallyltrisulfide

VIII Improvement in immune—diallyl trisulfide system against AIDS.

Garlic genotypes vary in chemical composition including pharmaceutical properties and flavouring compounds. Further, cultural practices and location of growing also exorcise great effect on these vulnerable chemicals. NRC for Onion and Garlic has started research on identification and improvement of varieties with high yield and rich in medicinal properties. Further evaluation of medicinal status of garlic genotypes through cultural management is also on.

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Section 4

Trade, Export and Marketing Scenario (Global and Domestic)

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10

Export Potential of Medicinal Plants in India

M.L. Jakhar and Shiv Narain

With the growing awareness to the problems arising from use of synthetic drugs—in the form of after effects and side reactions—there is perceptible tilt towards plant medicines as alternative or complimentary to modem drugs. It is generally accepted that herbal products with therapeutic value are less subjected to resistance and free from side effects. This is due to the presence in them of factors other than the biologically active ingredients with curative properties. This is in contrast to the single active ingredient of synthetic drugs that target the particular ailment, with no provision to counter the side effects. Such single-active ingredient based drugs, by their long term or excessive usage, result in development of resistance to them. The forest areas have been the traditional source of medicinal plants. Nearly 90% of the medicinal plants are harvested from the wild. Rapidly increasing population, urbanization, shrinking forests and unscientific harvesting of these plants causing damage to the genetic resource without realizing the magnitude of damage has brought several medicinal plants to the very brink of extinction. The changing concepts to healthcare all over the world, the alternate systems of medicine with less dependency on synthetic and chemical drugs are gaining more importance. Their cultivation should be developed in order to meet the entire demand of the domestic industries as also to exploit the bright prospects for export and providing high returns to the farmers. The commercial cultivation of medicinal plants will meet the demand of industry at reasonable price has also enable the producer to maintain the standards on quality, potency and chemical composition of the pharmaceuticals.

Commercial cultivation of medicinal plants has hardly taken place in the country while China has advanced far ahead in harnessing their potential agro-climatically; India is no way less than China. The need of the hour is to draw a road map by setting ambitious targets of production depending upon the potential in different zones. . Cultivation of medicinal plants permits production of uniform quality raw material whose properties are standardized and from which the crude drugs can be obtained unadulterated. There is immense scope for increasing the trade of medicinal plants and their products in India. India is blessed with a wide variety of climate and soil on which a wide range of such plant could be grown but we have not tapped our resources well. It will provide more employment opportunities since many crops are labour intensive. Their cultivation is more remunerative besides being export oriented. Several value added products derived from these crops have greater export potential. These groups of crops also provide ample scope for crop diversification and to create sustainable agriculture and can make an impact on the national economy in the years to come (Singh and Tyagi, 2004).

Medicinal plant includes trees, shrubs, herbs and climbers, are central resources for the traditional health system, as well as for pharmaceutical (or allopathic) medicines. Medicinal plants are accessible, affordable and culturally appropriate source of primary health care for more than 80% of Asia's population (Krishna *et al*, 2000). Medicinal plants are used at the household level by women taking care of their families, at the village level by medicine or tribal shamans, and by the practitioners of classical traditional system of medicine such as Ayurveda (Kumar, 1986 and Padulsoi *et al*, 2002) Marginalized people, who cannot afford or access from healthcare system, are especially dependent on these culturally familiar, technically simple, financially affordable and generally effective traditional medicines. Medicinal plants have the tremendous categories of treatment in healthcare system such as anti-dysentric (ipecac), cardiotonics (digitalis), cardiac depressants (cinchona), anti-hypertensive (rauwoulfia), anti-anginal (ammi), analgesic (opium), bitter tonic (nux vomica), anti-tussive (papver), expectorants (allium), bronchodilator (ephedra), anti-cancer (vinca), anti-rheumatic (colchicum), diuretic (gokhru), anti-malarial (cinchona), hallucinogenic (cannabis), anti-diabetic (gaur gum), anti-leprotic (chaulmoogra), anti-leucodermal (psoralea), liver protecting (kalmegh), adaptogens (aswagandha) etc.

In order to discover new medicines, which offer significant advantages over existing therapies, a key starting point is to identify novel biological targets that have a critical role in controlling diseases. The next step involves creating biological assays capable of detecting substance, which can modify the activity of the target and medicinal plants are the password of the lead compound which are amenable to chemical manipulation in order to optimize their bioactivity and bioavailability profile. Simvastatin (lipid lowering agent), enalapril (diuretic), clarithromycin (antibiotic), human insulin (anti-diabetic) and interferon (anticancer) are some of top-selling medicines, which are discovered from medicinal plants.

BIODIVERSITY OF INDIA

Biodiversity explore the global market to export-import of medicinal plants as the current global demand for them is worth Rs. 51,000 corers. India has 2.4 % of world's area with 8 % of global biodiversity. It have 12 mega-diversity hot spot of the world. Forest of India is estimated to 90 % of India's medicinal plant diversity in the wide range of forest types that occur (Conner, 2001). Only 10 % of the known medicinal plants of India are restricted to non-forest habitats. India is virtually herbarium of the world with a wide diversity of agro-climatic condition. India possesses all types of climatic conditions varying from temperature in the Himalayan to tropical in south India, dry in central India to humid and wet in Assam and Kerala. Thus providing condition favourable for the growth of varieties of medicinal and aromatic plants provided suitable strains and sites are selected for their commercial cultivation. Because of vast areas and varieties of agro-climates in India, a large number of medicinal plants are found growing wildly. India with its varied climatic conditions and topography has been considered as "Botanical Garden of the World" and this botanical wealth constitutes more than 2200 species of medicinal and aromatic plants (Bhattacharji, 2004) State wise natural habitats of prioritised species are as shown in Table 1.

Table 1 : State wise natural habitat of prioritised species

States	Name of Prioritised Species
Andaman & Nicobar Islands	Ashok
Andhra Pradesh	Chandan, Gudmar, Safed Musali
Bihar	Amla, Ashok, Bael, Bhumi amalaki, Brahmi, Gudmar, Kalihari, Kalmegh, Makoy, Safed musali, Pippali, Vai-vidang, Tulsi, Giole
Chandigarh	Aswagandha, Brahmi, Vai-vidang, Tulsi, Giole
Chhattisgarh	Amla, Aswagandha, Bael, Bhumi amalaki, Gudmar, Kalmegh
Delhi	Bhumi amalaki, Makoy, Mulethi, Ashwagandha, Bael
Goa	Kokum
Gujarat	Amla, Bael, Guggal, Isabgol, Safed musali, Senna
Haryana	Amla, Aswagandha, Brahmi, Mulethi
Himachal Pradesh	Atees, Chirata, Daruhaldi, Kuth, Kutki, Satawari, Vatsnabh
Jammu & Kashmir	Atees, Chirata, Daruhaldi, Kuth, Kutki, Kesar, Satawari,
Jharkhand	Amla, Ashok, Bael, Gudmar
Karnataka	Brahmi, Chandan, Kokum, Safed Musali, Patthar Chur, Pippali
Kerala	Brahmi, Kokum, Pippali
Madhya Pradesh	Amla, Ashwagandha, Bael, Bhumi amlaki, Brahmi, Gudmar, Guggal, Kalihari, Makoy, Safed Musali, Pathar Chur, Giloe, Sarpgandha, Senna, Satavari,
Maharashtra	Amla, Ashwagandha, Kalihari, Pathar Chur, Pippali
Orissa	Amla, Ashok, Gudmar, Kalmegh, Kokum, Vai Vidang
Punjab	Ashwagandha, Brahmi, Vai Vidang

contd. ...

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States	Name of Prioritised Species
Rajasthan	Amla, Ashwagandha, Bael, Guggal, Kalihari, Makoy, Giloe Mulethi, Pathar Chur, Seena, Satawari
North East States	Atees., Ashok, Aswagandha, Chirata, Giloe, Jatamansi, Kutki, Pippali, Sarpgandha, Vatsnabh, Vai vidang
Tamil Nadu	Brahmi, Chandan, Kalmegh, Safed Musali, Pippali
Uttar Pradesh	Amba, Bael, Bhumi ambaki, Brahmi, Gudmar, Kalihari, Kalmegh, Makoy, Mulethi, Safed Musali, Sarpgandha, Satavari, Tulsi, Giloe
Uttaranchal	Atees, Brahmi, Chirata, Daruhaldi, Jatamansi, Kesar, Kuth, Kutki, Satavari, Vatsnabh, Tubsi, Giloe
West Bengal	Ashok, Brahmi, Kokum, Pippali, Sarpgandha

GLOBAL TRADE VIEW

According to World Health Organization, over 80% of the world's population, or 4.3 billion people rely upon such traditional plant based system of medicine to provide them with primary healthcare. Recent estimates suggested that over 9,000 plants have known medicinal applications in various cultures and countries, and this is without having conducted comprehensive research amongst several indigenous and other communities (Purohit and Prajapati, 2003). There is now an ever increasing interest and demand for herbs and herbal products in the world over. The reason for this renewed interest of herbal products is attributed to the ever-increasing evidence of harmful side effect of modern synthetic products. The plant based products also referred as botanical, phytopharmaceutical or green pharmacy, herbal cosmetics, perfumes, condiments and confectioneries derived from natural products occupying a major share in the world trade and market.

The global market and industry both have been growing in recent years. Already the global OTC herbal market is more than US 50 billion dollars. Today, medicinal plants enjoy great potential for export. It is estimated that per annum, with an average market value of US $ 1 billion from Africa and Asia. France is second (116 billion) and the United Kingdom of botanical drug, Hong-Kong is at top followed by Japan, Germany and USA. Their assessment of international trade in medicinal plant including plant and their part like root, tubers, wood extract, bark, leaves, flowers, fruits and seeds. In 2002, the US imported over 200 million kilogram of medicinal and aromatic botanical raw material with a total import value of about $ 332 million. The leading supplies of botanical raw material to the US in 2002 were China and India, followed by Turkey, Maxico, Spain, Canada, Egypt and Germany.

INDIAN MARKET

The domestic market of Indian Systems of Medicine & Homoeopathy is of the order of Rs. 4000 crores (2000), which is expanding day by day. The Ayurveda drug market alone is of the order of Rs. 3500 crores (2000). Besides this, there is also a growing demand for natural products including items of medicinal value/pharmaceuticals, food supplements and cosmetics in both domestic and international markets. With export worth only Rs. 15 crores during 1978-79, the quantum of export has dropped to almost half of what it was in 1976-77, when India exported medicinal plants worth of Rs. 29 crores. During 1988-89, India exported crude drugs alone to the tune of about 62 crores. Presently India's export from Medicinal and Herbal plants is Rs. 446 crores (2000) only which would be raised to Rs. 3000 crores annually by 2005. India, with its diversified biodiversity has a tremendous potential and advantage in this emerging area.

According to a recent report from Secretariats of Convention on Biological Diversity (CBD), global sales of herbal medicines stood at $60 billion in 2002. Also, a new line of products called "functional food" containing medicinal plants as ingredients, is being developed. The functional food market is projected to reach $57 billion in 2004. Medicinal plants as a group comprise approximately 7,500 species and account for about 50 per cent of all the higher flowing plant species of India. The Indian system of medicines, including Ayurveda, Siddha and Unani, predominantly use medicinal plants for their preparations and formulations. The vast degree of biodiversity present in India is due to a highly divergent ecosystem and topographical variation. As a result, 70 per cent of India's medicinal plants are found in tropical areas, and 30 per cent in the temperate and alpine areas of higher altitudes.

The seed coat of isabgol (*Psyllium* husk) is used as a laxative, and also against irritation in the gastrointestinal tract. India is the sole exporter of isabgol husk and seed in the international market. During 2002-03, India's export was about 25,583 tonnes of *Psyllium* husk, worth Rs 2,40,228 lakh, and 404 tonnes of seed, worth Rs 216 lakhs. Aswagandha was exported 868 tonnes during 2001-02. Satavari too is known for its use in vital tonics. About 29 tonnes of the root, worth Rs 6 lakhs were exported and sold in the international market during the year 200 1-02. India is the second largest producer of castor seeds in the world producing about 1,25,000 tonnes per annum.

The Medicinal Plants Board at the national level is devoted for overall development of the medicinal plants sector as a whole in the country. However, for the development of the medicinal plants sector at the regional/state level, the National Board has initiated action and the respective state/Union Territories governments were requested to constitute the State Medicinal Plants Boards (SMPBs). So far (Sept. 2004) thirty two (32) SMPBs have been constituted. The EXIM bank of India, in its report (1997) has reported the value of medicinal plants rebated trade in India of the order of 5.5 billion US dollars and is growing rapidly. According to WHO, the international market of herbal products is estimated to be US $ 62 billion which is poised to grow to US $ 5 trillion by the year 2050. Ironically, India's share in the global export market of medicinal plants related trade is just 1.6 %.

Medicinal Plants Exported From India

India exports crude drug mainly to developed countries, viz. USA, Germany, France, Switzerland, UK and Japan, who share between them 75 to 80 % of the total export of the crude drug from India. The medicinal plants and their phytochemicals exported form India are:

1. Seed husk and seed of isabgol
2. Opium alkaloids
3. Leaves, pod and total sennosides concentrate of senna

4. Root and root alkaloids of Periwinkle
5. Quinine and quinidine alkaloids
6. Ipecac root alkaloids
7. Solasodine
8. Celery seed
9. Gudmar herbs
10. Mehdi leaves
11. Sindura fruit
12. Papin
13. *Podophyllum*
14. *Rauwolfia*
15. Vaberian
16. *Cassia tora*
17. Guar gum

Medicinal Plants Prohibited to Export From India

With development of phytochemical industry in India, domestic requirements for various medicinal plants grew considerably. Consequently, Government of India has adopted restrictive export policy in respect of those crude drugs, which were indiscriminately exploited in the forests. So, Ministry of Commerce, Government of India, New Delhi has prohibited the export of following medicinal plants, plant portions, their derivatives and extracts obtained from wild sources, since October 1998. These plants are as:

1. *Cycas beddomei*
2. *Vanda coerulea*
3. *Saussurea costus*
4. *Paphiopedilum species*
5. *Nepenthaes khasiana*
6. *Renathera imscootiana*
7. *Rauwolfia serpentina*
8. *Dioscorea deltoida*
9. *Podophyllum hexandrum*
10. *Euphoria species*
11. *Orchidaceae species*
12. *Ptercapous santalinus*
13. *Taxus wallichiana*
14. *Aconitum species*
15. *Gentiana kurroo*
16. *Picrorhiza kurrooa*
17. *Wertia chirata*
18. *Gnetum species*
19. *Panax pseudo-ginseng*
20. *Aquilaria malaccensis*
21. *Cyatheaceae species*
22. *Frerea indica*
23. *Cycadaceae species*
24. *Daciylorhiza hatagirea*
25. *Coptis teeta*
26. *Coscinium fenestratum*
27. *Kamphergia galenga*
28. *Ceropegia species*

Manufacturers/Sales/Exporters of Medicinal Plants

Exporters of medicinal plants are key of the export chain, which are all over India. Some of them are shown in table 2.

Table 2: Some manufacturers/sales/exporters of medicinal plants

Name of firm	Medicinal Plants	Address
Jeevan Herbs and Agro Farms	Aloe, Amba, Trifala powder, Aswagandha powder, Musli Sitaphal, Kanghi, Chandan	178, Keshav Ganj Sagar, M.P. 470 002
Fidelity Enterprises (P) Ltd.	Safed musli	G-4, 150, Habbibullah Road, T. Nagar, Chennai, T.N., 600 017

contd. ...

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Name of firm	Medicinal Plants	Address
Green Field Technologies	Aloe, Amla	402, Ratna Complex, Beside Image Hospital, Ameer Pet, Hyderabad, A.P., 500 038
Shrish Indomusk	Organic herbs, Senna tea, Herbal tea, Herbal tea	36, Shantinagar, Rahara, Kolkata, W.B, 700 118
Ishan Herbo Tech Innternational	Aswagandha, Phybanthus, Herbal extracts, Amla, Triphala, Brahmi	D-10, EPIP, Surajpur, Site-V, Greater Noida, U.P. 201 306
Advance Service Providers	Medicinal plants, roots, leaves, bark	N 204 A, Greater Kailash-I, New Delhi, 110 048
Vinayak Global Exports	Cassia angustifobia, Senna leaves, Cassia senna, Cassia acutifohia	172, Jwala Vihar, Jodhpur, Rajasthan, 342 008
Agro Project & Marketing	Aswagandha, Aloe, Safed mush, Jatropa, Mashroom	B/3, Bapujee Nagar, Regent Estate, Jadhavpur, Kolkata, W.B. 700 092
A and B Herbotex Private Limited	Safed musli, Aswagandha, Senna, Aloe	Herbal House, 76/4 Shipra path, Mansarovar, Jaipur, Rajasthan, 302020
Ganges Ayurvedic Private Limited	Senna, Gboriosa, Indigofera, Gymnema, Bacopa, Aloe, Boswebbia, Vaberian	23, Radhakrishan Nagar, Main Road, Thriuvanmiyur, Chennai, T.N. 600041
Sanjivini Herbals	Aswagandha, Lotus	No.1, 6th Cross, maravaneri, Salem, T.N., 636 007
Arna Planta Medica	Passiforia, Ipomoea, coleus, Gloriosa	392/96, Nethaji Street, Alagapuram, Salem, T.N., 636 016
Yash Exports	Henna, Isabgol, Reetha, Aswagandha, Basil	32, Uniara Garden, Near Police Memorial, Jaipur, Rajasthan, 302 004
Sanjivini Export and Import	Safed musli, Amla, Aswagandha	2-5-294, 1st floor, Nakkalagutta, Hanamkonda, Warangal, A.P., 530008
Siri Satya Agros	Bacopa, Aswagandha, Centelba	Plot No. 8, S.B.H. Officers Colony, Laxmi Nagar, Saidabad, Hyderabad, A.P. 500 059
Synergy Krishi Utpad Limited	Stevia, Safed musli	3/4, Central Park, City Centre, Durgapur, W.B., 713 216

contd. ...

contd. ...

Name of firm	Medicinal Plants	Address
Rajasthan Herbal Trade Centre Private Limited	Senna, Aswagandha, Isabgol, Chborophytum, Withania	18, Purohit Ji Ka Bagh, M.I. Road, Jaipur, Rajasthan, 302 001
Advance Impex	Aswagandha, Safed musli, Aloe, Ginger, Asparagus, Goosberry	36, Kothari Market, Opp. Hirabhai Market, D. B. Road, Kankaria, Ahmedabad, Gujarat 380 022
Mother Herbs	Henna, Neem, Ipecac, Amla, Vinca, Psyllium, Comiphora, Aloe, Safed musli, Butea, Citronella, Moms, Indigo	9/802, East End Apartment, Mayur Vihar, Phase 1 Ext., New Delhi, 110 096
Surajbala Exports Ptivite Limited	Amchoor powder, Cumin, Garlic, Aloe, Aswagandha, Shibajeet, Brahmi, Amla, Tulsi, Ablium, Neem	C-476, Narela Industrial Park, Dsidc, Narela, New Delhi 110 040
V.R. Medicinal and Aromatic Plantation Pvt. Ltd.	Abelmoschus, Embellica Dactylorrjiza, Boerhaavia, Zingiber, Nigebba	36-46-37, VR, Mansions, Kancharaporem, Visakhapatnam, A.P., 530 008
The Nenoba Agro-impex Company	Chorophytum, Safed musli	Shop No.A-7, Rohan Prarthana, S.No.36/2, Kothrud, Pune, M.H., 411 038
Herbs India	Coleus, Vinca, Neem	39, South Car Street, Sivakasi, T.N. 626 123
Cure Herbs	Eucalyptus, Tinospora, Arjuna, Lawsonia, Ginseng, Neem, Tnigonehla, Withania, Ipomoea, Terminalia, Vinca	WZ-435-A, Nangah Raya, New Delhi, 110 046
Bismibbah Trading Company	Senna, Vinca, Stevia	95, Devarpunam Road, Tuticorin, T.N., 628 003
P.S.S. Ganesan & Sons	Senna, Cumin, Gymnema, Vallerian	C-82-83, Sipcot Complex, Tuticonin, T.N., 628 008
Packiam Botanicabs	Gymnema, Senna	797/5, Natham Road, Reddiapatty, Dindigual T.N. 624 003

Agricultural Export Zone (AEZ)

To boost up the export of medicinal plants Agricultural Export Zone (AEZ) were formed with concept of:

1. "Market" as the key to produce what could be sold rather sells what is produced.

2. Identification of "interventions" in a project mode, identify one or a group of produce/products source from a geographically contiguous area.
3. Comprehensively address all the issues relating to each stage of the entire value chain from to ultimate consumer.
4. By making all central, State Government and local agencies to work under a single umbrella and reduce the time in the complete export process.

AEZ for medicinal and aromatic plant is Uttaranchal, for ginger and turmeric is Orissa, for seed and spices is Madhya Pradesh and for fresh and processed ginger is Assam.

Promotional and Commercial Scheme

The Medicinal Plants Board was set up a under a Government Resolution notified on 24th November, 2000 under the Chairmanship of Union Health and Family Welfare Minister. The objectives of establishing a Board is to establish an agency which would be responsible for co-ordination of all matters relating to medicinal plants, including drawing up policies and strategies for conservation, proper harvesting, cost-effective cultivation, research and development, processing, marketing of raw material in order to protect, sustain and develop this sector.

Project proposal could be submitted in the following designated areas of Promotional/Commercial schemes for overall development of medicinal plants in general and with special reference to 32 species, prioritised and identified by the Board viz:

1. Amla
2. Ashok
3. Ashwagandha
4. Atees
5. Bael
6. Bhumi ambaki
7. Brahmi
8. Chandan
9. Chirata
10. Daruhaldi
11. Giloe
12. Gudmar
13. Guggal
14. Isabgol
15. Jatamansi
16. Kalihari
17. Kalmegh
18. Kesar
19. Kokum
20. Kuth
21. Kutki
22. Makoy
23. Mulethi
24. Safed musali
25. Patther Chur
26. Pippabi
27. Sarpgandha
28. Senna
29. Satavari
30. Tulsi
31. Vai Vidang
32. Vatsnabh

Project proposal can be submitted by in the following areas

Promotional schemes

1. Survey and inventorisation of medicinal plants.
2. *In situ* conservation and *ex situ* cultivation of medicinal plants.

3. Production of quality planting material.
4. Extension activities—information, education and communication.
5. Study demand supply position and marketing.
6. Research and development.
7 .Strengthening capabilities NMPB.
8. Promote co-operative efforts among grower and collectors.
9. Value addition and semi-processing of products.
10. Undertake/assist or encourage scientific technological and economic research.

Commercial Schemes

1. Production and ensure supply of quality planting material in bulk.
2. Area expansion for selected species and cultivation in more than 2 hectare.
3. Value addition.
4. Develop innovative marketing mechanism.

CONCLUSION

Medicinal plants as potential source of therapeutic aids have attained a significant role in health system for both human and animal not only in the diseased condition but also as potential substances for maintaining good health. India has the knowledge and skill to develop its research and development capabilities. It is the second largest exporter of medicinal plants. Instead of exporting such a large amount of valuable resources with very low returns it can think about developing its own research and development capabilities and produce finished good in the form of modern medicines and health care products derived from plant origin and based on the knowledge of alternative system of medicine. Standardization of products in most essential to compete in the world market that India has to lay stress on. The development of Indian system of medicine and homeopathy has been specially dealing with the rules for the implementation of good manufacturing practices in herbals, which will not only help to make quality herbal product but also safeguard the adverse effects of the herbals. With all these, India has to take up the challenge of leading the drug and herbal market while conserving its heritage through proper planning and implementation of policies.

Thus, India with strong knowledge and vast natural resources is in a unique position to move very strong traditional knowledge base and large biodiversity and has the potential to emerge in international scene. Earnest efforts have to be put in place (i) consolidate the past gains of traditional knowledge base (ii) start developing entirely new herbal preparations base on India's biodiversity and (iii) make these products available to the international community.

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11

Applied Biology and Marketing of Medicinal Plants : Recent Trends

Ranveer Singh

Since the existence on this planet man has had to depend on nature for sustenance and survival. Instinctive urge, intuition and the accumulated knowledge has guided him to discover remedies for common ailments from natural resources even in the remote past. The Indian system of medicine itself is of great antiquity and is believed to be one of the most ancient. The Indian system of medicine (ISM) namely Aurveda, Unani, Sidha and also the homeopathic system predominantly use plant based raw materials in most of their preparations and formulations, the creditability of these systems, thus mainly depend upon the use of raw materials in manufacture of the drugs. In all about 1100 medicinal plants are estimated to find regular use in the Indian System of Medicine. Of these, 500 medicinal plants are commonly used in the preparation of ISM and homeopathic but among them about 100 plants are most commonly used and are traded in major drug markets in the world.

With the growing awareness to the problems arising from use of synthetic drugs—in the form of after effects and side reactions—there is perceptible tilt towards plant medicines as alternative or complimentary to modern drugs. It is generally accepted that herbal products with therapeutic value are less subjected to resistance and free from side effects. This is due to the presence in them of factors other than the biologically active ingredients with curative properties. This is in contrast to the single active ingredient of synthetic drugs that target the particular ailment, with no provision to counter the side effects. Such single-active ingredient –based drugs, by their long term or excessive usage, result in development of resistance to them. The forest areas have been the traditional source of medicinal plants. Nearly 90% of the medicinal plants are harvested from the wild. The increasing population, urbanization, shrinking forests, unscientific harvesting of these plants causing damage to the genetic resource without realizing the magnitude of damage has brought several medicinal plants to the very brink of extinction. The changing concepts to health care all over the world, the alternate systems of medicine with less dependency on synthetic and chemical drugs are gaining more importance. Their cultivation should be developed in order to meet the entire demand of the domestic industries as also to exploit the bright prospectus for export and providing high returns to the farmers. The commercial cultivation of medicinal plants will meet the demand of industry at reasonable price has also enable the producer to maintain the standards on quality potency and chemical composition of the pharmaceuticals.

Commercial cultivation of medicinal plants has hardly taken place in the country while china has advanced far ahead in harnessing their potential agro-climatically; India is no way less than china. The need of the hour is to draw a road map by setting ambitious targets of production depending upon the potential in different zones. There is also a need to create a structure for transmission and dissemination of information.There is immense scope for increasing the trade of medicinal plants and their products in India. India is blessed with a wide variety of climate and soil on which a wide range of such plant could be grown but we have not tapped our resources well. It will provide more employment opportunities since many crops are labour intensive. Their cultivation is more remunerative besides being export oriented. Several value added products derived from these crops have greater export potential. These groups of crops also provide ample scope for crop diversification and to create sustainable agriculture and can make an impact on the national economy in the years to come. The EXIM bank of India, in its report has reported the value of medicinal plants related trade in India of the order of 5.5 billion US dollar and is growing rapidly. According to WHO, the international market of herbal products is estimated to be US $ 62 billion which is poised to grow to US $ 5 trillion by the year 2050. India's share in the global export market of medicinal plants related trade is less than 0.5%.

Cultivation of medicinal plants permits production of uniform quality raw material whose properties are standardized and from which the crude drugs can be obtained unadulterated. Collection from wild versus cultivation of medicinal plants-

Features	Collection	Cultivation
Availability	Decreasing	Increasing
Fluctuation to supply	Unstable	More controlled & quality
Quality control	Poor	High
Botanical identification	Sometimes not reliable	Not questionable
Genetic improvement	No	Yes
Agronomic manipulation	No	Yes
Post harvest handling	Poor	Usually good
Adulteration	Likely	Relatively safe

MAJOR CONSTRAINTS

The systematic cultivation of medicinal plants is quite necessary to meet out the emerging demand of medicinal plants, but the pace of development is very slow due to following constraints-

1. There is lack of awareness among the farmers regarding commercial cultivation of medicinal plants. The dominant sector of cultivators in the country are conservative and are reluctant to abandon their time tested crops and turn to medicinal plants.
2. Lack of high yielding varieties and good quality planting material for getting higher yields and quality products.
3. Inefficient processing techniques in many medicinal plants resulted in low yields and poor quality products i.e. spoilage, contamination and short life of drugs.
4. Marketing of medicinal plants is inefficient, imperfect, informal and opportunistic. There is vast, secretive and largely unregulated trade in medicinal plants, mainly from the wild, which continues to grow dramatically in the absence of serious policy attention. There is no system of knowing the demand for a particular crop.
5. There is a fluctuation in the rate of medicinal plants. For example, The farmers took up muskdana for cultivation by paying a premium price of Rs. 100/-per kg for seeds, but after its cultivation the farmers were not getting even Rs. 10/- per kg. Large buyers like Dabur do not come to the places where only small quantities of raw material are available. Since about 90% of raw material is being collected from the wild, the industry hesitates to procure the same from the farmers. As a result, farmers are robbed for their rightful share.
6. Ayurvedic drug manufacturing calls for supply of more than one ingredient at a time and hence contract cultivation for one or few items may not be feasible in practical terms.
7. Lack of product diversification and development of other value added product like extracts, concentrates etc. for export market so as to sustain demand of raw materials rather than the dependence on classical formulation alone.
8. Cost of production for various medicinal plants at practical farm level is not known so as to make a realistic cost assessment between the supply from the wild and that from cultivation. Experimental cultivation has been carried out in several places, but the recommended commercial practices had been neither worked out nor tested on an industrial scale.
9. Improved cultural practices are not available so obtain high yields from unit area to make cultivation of the plants cost effective compared to wild collection.
10. Good manufacturing practices are not scrupulously adopted by the industry and hence raw material quality is not the prime concern compared to market rate.
11. Lack of coordination amongst various stakeholders such as State Govt. of India (Ministry of Agriculture, Environments and Forests, ISM&H, Science and Technology etc.), State Governments, Private traditional medicine sector, Research Institutes, NGOs, International network etc.

12. In the India most of the medicinal plants or crude drugs (roots, stems, leaves, flowers, fruits, seeds, whole plants etc.) are handed by the traditional herbal crude drugs dealers commonly known as *Pansaris* in the north and *Panchamarunna Kado* in the south, who sell crude drugs under *Ayurvedic, Unani* or local names. They have got their own traditional suppliers as local habitat of forests (mainly tribes). They supply the herbs even after the ban of government on harvesting of certain herbs, at very low cost on account of poverty. These herbs traders are holding more than 70% of market through all over the India.
13. Enefficient development of the infrastructure to process our material and produce finished goods. For example, India is having a very large growing area under garlic crop but we do not have garlic oil producing industries and a large demand of garlic oil is met by Mexico, Italy and Egypt in the world.

FUTURE STRATEGY TO BE ADOPTED FOR DEVELOPMENT

The National Medicinal Plants Board have been identified following 32 medicinal plants, which in great demand both in domestic and international market for cultivation, conservation and development for promotion and development of the sector:-

Amla (*Emblica officinalis* Gaertn); Ashoka (*Saraca asoca* (Roxb.) de Wilde); Ashwagandha (*Withania somnifera* (Linn.) Dunal); Atees (*Aconitum heterophyllum* Wall. Ex Royle); bael (*Aegle marmelos* (Linn) Corr.); Bhumi amlaki (*Phyllanthus amarus* Schum & Thonn.); Brahami (*Bacopa monnieri* (L.) pennell); Chandan (*Santtalum album* Linn.); Chirata (*Swertia chirata* Bunch –Ham.); Daruhaldi (*Berberis aristata* DC.); Giloe (*Tinospora cordifolia* Meirs.); Gudmar (*Gymnema sylvestre* R. Br.); Guggal (*Commiphora wightii* (Arn.) Bhandari); Isabgol (*Plantago ovata* Forsk.); Jatamansi (*Nardostachys jatamansi* DC.); Kalihari (*Gloriosa superba* Linn.); Kalmegh (*Andrographis paniculata* Wall. Ex Nees); Kesar (*Crocus sativus* Linn.); Kokum (*Garcinia indica* Chois.); Kuth (*Saussurea costus* C. Benth ex Royle); Makoy (*Solanum nigrum* Linn.); Mulethi (*Glycyrrhiza glabra* Linn.); Patterchur (Coleus) (*Coleus barbatus* Benth.); Pippli (*Piper longum* Linn.); Safed Musli (*Chlorophytum borivillianum* Sant.); Sarpgandha (*Rauwolfia serpentina* Benth. Ex Kurz); Senna (*Cassia angustifolia* Vahl.); Satavari (*Asparagus recemosus* Willd.); Tulsi (*Ocimum sanctum* Linn.); Vai Vidang (*Embelia ribes* Burm f.) and Vatsnabh (*Aconitum ferox* Wall.).

The emphasis should be given on the following aspects for boosting up the production of medicinal plants in India-

1. Quality Planting Material

a) Conservation of plants through herbal gardens

In order to develop the cultivation of genuine plant species, it is necessary to establish herbal gardens attached to the State Agriculture Universities functioning in the state. In addition to supply of basic planting materials of theses plant species, these gardens will also serve as centers for education, demonstration, references and service function to those entrepreneurs and individuals engaged in the pharmaceutical preparations and who volunteer to take-up the cultivation of medicinal plants. The herbals gardens already established may have to be maintained with the revenue realized by the sale of planting material produced.

b) Establishment / maintenance of nursery centers

For meeting the growing demand of various medicinal plants, the area under cultivation has to be increased and farmers encouraged to take up cultivation systematically. Non -availability of quality planting material of genuine plant species of medicinal plants at reasonable cost is the major constraints in taking up the area expansion programme. It is therefore proposed to set up nursery center that would be attached to each of the herbal gardens. The infrastructure required for the nursery centers such as land development, mist chamber, nursery sheds, irrigation systems will provided in the first year. The nursery centers will be set up by the second year of establishment of herbals garden and the nursery centers will be self supporting from the 3rd year onwards with the revenue realized by the planting materials produced.

2. Area expansion

a) Establishment of demonstration-cum-seed production centers at farmers field

As per the number of herbals gardens proposed to be established are very limited and are confined to autonomous/ voluntary organizations the benefits of these gardens will generally be available to the farmers in the nearby areas only. Therefore, in order to spread the message widely it is proposed to establish demonstration-cum-seed multiplication centers at the farmer's field. Each demonstration plot will cover an area of 0.05 ha. The medicinal plants suitable to the region and of good demand will be selected for planting and made available free of cost to the farmers from the nursery centers. Considering the additional expenditure required for establishment and maintenance of demonstration cum seed multiplication plots scientifically it is proposed to provide the vital inputs at 50% cost as an incentive to encourage the cultivation of medicinal plants. The plot owners are expected to make available maximum quantity of planting materials for distribution of the neighbouring interested farmers at reasonable cost.

b) Providing financial assistance in critical inputs like planting/sowing materials, fertilizers and plant protection chemicals etc.

c) Cultivation should be encouraged for short duration medicinal plants under farmers level and cultivation of trees and long duration plants in degraded forests, public lands etc.

3. Technology development and application

Develop suitable good agronomic practices for location specific medicinal plants based on local/export demand. Research should be also strengthened to modernize processing of raw drugs to avoid spoilage while storing, produce intermediary products such as extracts so as to keep uniform quality for starting materials etc. Selection of plants for each agro-climatic zone should be worked out based on adaptability, extensive market survey and industrial demand (local/export) by a committee for each zone consisting scientists from SAU, officials of state Agri/Hort Department, representative of Ayurvedic medicine manufactures and progressive farmers.

4. Upgrading technical know-how

Constant trainings, seminars, farmer's fare for the awareness generation on scientific cultivation, preservation and processing of raw drugs is to be given. Dissemination and sharing of information on medicinal plants through the electronic and print media through journals is also essential. State Agricultural Universities should be identified as the nodal agency to undertake extension work.

5. Establishment of analytical laboratories

The regional analytic laboratories should be established which will work as one of the agencies to provide quality evaluation support to the indigenous medicine manufacturing industries in the state.

6. Committee on demand and supply

A committee should be constituted under the National Medicinal Plants Board for regulating the demand and supply of medicinal plants in the country. The industries should feed back to the committee about their demand at least one year in advance for enabling its timely production. Similarly, state governments/ state medicinal plants board inform about the area undertaken under different medicinal plants in the state in each crop season to the committee. The committee also explore the existing potential of medicinal plants market abroad.

7. Standards and Quality control

Periodic assessment of quality of raw drug from the market may be undertaken at the Regional Analytical Laboratory including pesticide residues and heavy metal condemnation. In India, the single most important factor which standing in the way of wider acceptance of drugs based on medicinal plants is non-availability or inadequacy of standards to check or test the quality by modern instrumentation methods. A serious thought needs to be given to this aspect.

Declaration of sourcing of raw materials by drug manufactures may be made mandatory for each manufacturer to assess the market demand, rate of depletion of biodiversity, quality etc.

8. Minimum support price

If the deviation of the rate is wide, there should be government machinery to support the cultivation for initially 4-5 years period, during which time the cultivation medicinal plants mature commercially as any other agricultural crops. Due to fluctuation in the rate of medicinal plants, the farmers are hesitating to take up cultivation of medicinal plants. Minimum support price will protect the right of farmers.

9. Contractual farming

The government should encourage the growers and pharmaceutical industry for taking up cultivation of medicinal plants on contractual basis through MOU. They also fix minimum support price for medicinal plants. If the market prices are higher up, the farmer to be at liberty to sell it anywhere and if company agrees to pay prevailing market price, they get the first priority to purchase. Leading ayurvedic medicine manufacturers are willing to enter into a buy-back arrangement for specific medicinal plants, if realistic cost of production including reasonable margin of profit of selected plants are worked out scientifically and the cost does not deviate drastically over the prevailing rate.

10. Value addition for herbal products

The export potential of medicinal plants can be increased manifold by value addition. Statistical data shows that one ton of turmeric sells for Rs. 35000. However if it is converted to curcumin the value realized is Rs. 125000 for 60 Kg. of value added dye. This can be achieved by processing the medicinal plants into standardized herbals and formulated into neitraceuticals. In order to isolate the single active phyto-chemical present in the medicinal plant proper quantification of the activity marker compound is necessary. This can be achieved by using the advanced sophisticated technology like membrane filteration, supercritical CO_2 extraction, agitated thin film drying, spray drying etc. Use of sophisticated instruments like HPTLC, HPLC, GC, LCMS, GCMS and AAMS etc. are essential for the proper quality control of the active ingredients present in the value added product.

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12

Medicinal and Spiceal Plants : Export, Import and Trading Scenario : Indian & Global Status

Karan Singh

[A] MEDICINAL PLANTS

Plants which possess curative properties have been employed for human welfare since the dawn of the civilization. WHO has compiled a list of 2000 medicinal plants used in various parts of the world but over 100 species have a consistently large demand in world trade of medicinal plants. In the present context of *"back to nature"* in health care, it is pertinent to conserve, domesticate and cultivate the plants so as to meet the increasing demand and also to reduce over dependence on wild resources. The international market of medicinal plants in over US dollars 60 billion per annum. This trade is increasing at the rate of 7%. India at present exports herbal materials and drugs to the tune of Rs. 446.3 crores only per year which can be raised upto Rs. 3000 crores by 2005 and 10,000 crores of rupees upto 2010 (targeted estimates). China and India are two global giants with respects to medicinal plants having about 40% biodiversity. China besides meeting its domestic requirements is earning US $ 5 billion per year from herbal trade. Therefore, there is an enormous scope for India also to emerge as a major player in the global herbal market.

However, this needs a comprehensive strategic plan embodying a hollistic view of the entire situation to boost the export upto Rs. 10,000 crores by 2010 with simultaneous efforts to minimize the import of medicinal herbs (Anonymous, 2000).

Scientific efforts in this direction must therefore include on equilibrated and interdisciplinary approach. In this co-ordinated approach basic, application oriented basic and applied aspects of biology of therapeutically valuable plants must be investigated with the objective of domestication of plants, their cultural practices coupled with biodiversity conservation and developments. Some case studies reported in this book (treatise) are only a segment of the gamut Singh *et al.* (2003) Jakhar *et al.* (2003) and Sharma (2003) reviewed the literature on these aspects in reasonable details Cracker and Simon (2002) and Hartmann *et al.* (2003) also complied the literatures on propagational techniques for domestication and cultivation of medicinal plants. An outline of export, import and marketing of medicinal plants is described below:

EXPORT OF MEDICINAL PLANTS

The annual export of vegetable drugs is consistently increasing. Some data have been collected and presented in tables. However, figures available over the year have shown some degree of variations depending upon source. Table 1 indicates that export of Ayurvedic and Unani medicine was only Rs. 33.18 crores in 1991-92 which increased upto Rs. 54.74 crores in 1999-2000. The export of Homoeopathic medicines has shown a fluctuating trend.

Table 1 : Export of vegetable drugs and alkaloids from India

Year	Ayurvedic & unani medicines		Homeopathic medicines		Alkaloid	
	Quantity (in Tonnes)	Cost (Rs. lakhs)	Quantity (in Tonnes)	Cost (Rs. lakhs)	Quantity (in Tonnes)	Cost (Rs. lakhs)
1991-92	3360.56	3318.48	—	567.19	—	40.68
1992-93	4117.25	5022.43	—	164.56	—	68.17
1993-94	311234	5361.13	—	517.34	—	119.02
1994-95	4173.46	9338.94	—	180.02	—	115.01
1995-9 6	3716.29	9644.97	—	35251	—	402.95
1996-97	12986.70	15503.58	56.32	128.53	154.80	17939
1997-98	8939.52	6499.84	51.99	309.51	271.49	1989.65
1998-99	10898.79	7451.59	32.56	37.47	73.18	613.11
1999-2000	10399.20	5474.00	121.96	67.39	122.45	899.04

Source : Sharma, 2002.

The export of plant wise vegetable drugs has been summarized in Table 2 during 1995-96. The plant-wise export during 1999-2000 has been given in Table 3.

Table 2 : Export of medicinal plant commodities from India, during 1995-96

S. No.	Item (tonnes)	Quantity	Value (in lakhs Rs.)
	Vegetable drugs		
1.	Bellandonna		
	Leaves	3.162	0.993
	Roots	1.000	0268
2.	Galangal rhizomes arid roots including greater galangal	83.470	22.284
3.	Ginseng powder/chips	36.500	15.000
	Ginseng roots (others)	3072.110	1627.557
4.	Ipecac : dried rhizome and roots	3.866	4.347
5.	Liquorice roots	0.957	3.702
6.	Locust beans	7.200	48.551
7.	Poppy flowers and unripe dried heads poppy	6.551	4.577
	Poppy seeds	32.600	22.014
8.	Psyllium husk (lsabgul husk)	1686.230	14768.289
	Psyllium seed (Isabgul)	2258.230	672.720
9.	Sarsaparilla	1.100	0.305
10.	Senna leaves and pods	*6279.771*	1391 .611
11.	Serpentina roots	3.937	3.198
12.	Tukmaria	21 6.220	48.826
13.	Unnab (Indian Jujube or Chinese dates)	29.450	13.444
14.	*Vinca rosea* (herbs)	191.924	64.990
15.	Zedovary roots	30.000	3.740
16.	Neem oil	151.729	217.481
	Total	**14096.007**	**18930.877**

Several organizations establishments are contributing in enhancing the export of medicinal plants from Indian Central Institute *of* Medicine arid Aromatic Plants, Lucknow plays a pivotal role in boosting up the production of export oriented medicinal plants. Trade Development Authority of India regulates the qualitative and quantitative aspects of export of medicinal plants. National Medicinal Plants Board, New Delhi has been establish to intensify the production and export oriented R&D activities throughout the country (Rawat, 2003). The board has identified 32 species of medicinal plants to be cultivated on priority basis for the purpose of domestic market as well as export purpose. These include Withania, Amla, Ashok, Aconite, Bael, Brahmi *(Bacopa monnieri)*, Santalum, Swertia, Tinospora, Gudmar, Commiphora, Plantago, Jatamansi, Andrographis, Kolibari, Kokum, Kuth, Nightshade, Glycirrhyza safed musli *(Chlorophytum)*, *Piper longum*, Daru haldi *(Berberis aristata)*, Sarpgandha *(Rauwolfia)*, Senna *(Cassia angustifolia)*, Satawasi *(Asparagus racemosus)*, Basil, Via Vidang *(Embelia rides)* etc. 25 State Medicinal Plants Boards have also been founded throughout the country so as to corroburate the efforts of NMPB. The details of export, import and marketing of medicinal plants may be obtained from NMPB as addressed below:

The Chief Executive Officer

National Medicinal Plants Board, Department of Indian Systems of Medicine and Homoeopathic, Government of India

Chandralok Building

36, Janpath, New Delhi,

Telephones : (011) 23319360, 23319255, Fax : (011) 23319360,

E-mail: nmpb22@india times .com.

Table 3 : Export of medicinal plants during 1999-2000

S. No.	Plant Name	Export Quantity (tonnes)	Value (in lakhs Rs.)
1.	*Glycirrhiza glabra*	70.39	81.93
2.	*Rauwolfia serpentina*	09.03	05.73
3.	*Panas ginseng*	1379.46	1015.14
4.	*Atropa pelladona*	22.74	8.19
5.	*Plantago ovata*	15295.31	10815.18
6.	*Swertia chirayata*	50.29	37.74
7.	*Cassia angustifolia*	7466.33	2254.20
8.	*Catharanthus roseus*	541.54	213.39
9.	*Hemidesmus indicus*	14.71	6.22
10.	*Juniperus communis*	0.80	0.79
11.	*Santalum album*	260.97	1759.62
12.	*Eucalyptus globules*	108.44	377.48
13.	*Myristica fragrans*	28.49	278.02
14.	*Artemissia pallens*	3.85	638.63

(Figures of other plants during 1999-2000 not available.)

IMPORT OF MEDICINAL PLANTS

The pharmaceutical industry in India has been developed up-to the extent that medicinal plants produced in India are not able to meet the industrial requirement. Therefore, import of some vegetable drugs becomes unavoidable. Data given in Table 15.4 depicts that during a period of nine years (1991-92 to 1999-2000) the import in terms of quantity of vegetable drugs and amount in rupees *has* shown a fluctuating trend. In this period, 1992-93 witnessed the lowest quantity import (914.95 tonnes only). In 1999-2000 the highest import was observed (3934.49 tonnes). The critical appraisal of such data also indicated the active efforts being made at various levels are to yield satisfactory results so far. Some valuable information on import of medicinal plants have been summarized in Table 5 and 6. However, the share of plant material in terms of cultivated and that procured from wild resources in foreign countries (from where the import was materialized) is not known.

Table 4 : Import of vegetative drugs

Year	Ayurvedic & unani medicines		Homeopathic medicines		Alkaloid	
	Quantity (in Tonnes)	Cost (Rs. lakhs)	Quantity (in Tonnes)	Cost (Rs. lakhs)	Quantity (in Tonnes)	Cost (Rs. lakhs)
1991-92	1732.50	583.61	—	447.21	—	0.28
1992-93	914.95	442.83	—	427.53	—	
1993-94	2201.95	268.14	—	581.67	—	1.65
1994-95	1814.29	236.94	—	524.91	—	11.96
1995-96	1287.37	1270.26	—	485.61	—	3.34
1996-97	3640.05	3395.02	126.21	496.96	—	—
1997-98	1637.19	507.04	102.13	572.49	6.41	97.94
1998-99	3761.57	1863,54	171.63	936.42	0.63	53.99
1999-2000	3934.49	3956.77	146.06	799.69	007	0.27

Source : Sharma, 2002.

Table 5 : Import of medicinal plant commodities from India, during 1995-96

S. No.	Item (tonnes)	Quantity	Value (in lakhs Rs.)
1.	Agar Agar W/N modified	78.452	223.297
2.	Agarwood	12.089	11.889
3.	Ayurvedic and Unani NES	1287373	179.887
4.	Belladonna extracts	0.400	5.355
5.	Chirata	58.224	14.610
6.	Galangal rhizomes and roots including greater galangal	55.300	6344
7.	Ginseng extracts	5.764	323398
8.	Ginseng power/chips	1.150	19.913
9.	Ginseng roots	210.626	38.702
10.	Liquorice roots	581.150	49.030
11.	Mint (others)	816.106	182.230
12.	Mint including leaves (all spices)	0.750	0.693
13.	Other ginseng roots	324.298	24.103

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S. No.	Item (tonnes)	Quantity	Value (in lakhs Rs.)
14.	Pyrethrum	132.500	89.304
15.	Sap and extracts of liquorice	50.827	39.974
16.	Sarsaparilla	3.500	1.076
17.	Sweet flag rhizome	2.500	3.266
18.	Unab (Indian jujube or Chinese dates)	25.186	1.711
19.	Vegetable 'saps and extracts	182.419	695.463
	Total	3838.614	1910.445

Table 6 : Import of few medicinal plants in India during 1999-2000

S. No.	Plant Name	Export Quantity (tonnes)	Value (in lakhs Rs.)
1.	*Glycirrhiza glabra*	581.15	49.03
2.	*Rauwolfia serpentina*	—	—
3.	*Panas ginseng*	32430	14.69
4.	*Plantago ovata*	—	—
5.	*Swertia chirayata*	58.22	14.67
6.	*Cassia angustifolia*	—	—
7.	*Catharanthus roseus*	—	—
8.	*Hemidesmus indicus*	350	1.08
9.	*Myristica* fragrans	672.01	1225.00
10.	*Abelmoschus moschatus*	—	—
11.	*Santalum album*	—	—
12.	*Eucalyptus globules*	—	393.00

Plants indicated by blank (—) have been replaced by Indian vegetable drugs.

Trading

The cultivation of medicinal plants in India is getting momentum but speed is not satisfactory. Farmers are being encouraged by various R&D agencies for domestication and cultivation of medicinal plants. Seed and planting material is given to farmers alongwith technical know-how. Inensive training programme are being regularly conducted and farmers are also acquainted with marketing scenario. Such programmes will meet success only with *Bye Back Guarantee* or with contract farming system. The marketing of medicinal plants is being strengthened in Rajasthan by the efforts of Rajasthan State Medicinal Plants Board (II Floor, Pantkrishi Bhawan, Jaipur). Marketing of Medicinal Plants in Madhya Pradesh has gained momentum. Mandis of Neemach, Khandwa, Bhopal and Jabalpur are well developed with respect to medicinal plants.

The relevant information on such aspects are given in Table 7, 8 and 9. Latest information collected from Rajasthan State Medicinal Plants Board have indicated that about 68000 hectare are in under medicinal plant cultivation out of which major share goes to Isabgol (about 62000 hectares). Due to efforts of various organization, the area in increasing but marketing board should also come forward for this purpose. National Institute of Agricultural Marketing (NIAM), Jaipur has also takes some initiatives in this direction.

Table 7 : Estimated consumption of imported medicinal plants under cultivation

S. No.	Botanical Name	Vernacular Name	Parts Used	Estim-ated average consum-ption (kg)	% of Phar-macies cons-uming
1	2	3	4	5	6
1.	*Piper nigrum*	Kalimari	Fruits	55,200	43
2.	*Glycyrrhiza glabra*	Jethimadh	Roots	46,200	43
3.	*Swertia chirata*	Kariyatu	Whole plant	28,300	31
4.	*Berberis aristata*	Daru-Haldi	Bark	19,500	32
5.	*Picrorniza kurroa*	Kadu, Kutaki	Roots	19,000	32
6.	*Pluchea lancelata*	Rasna	Roots	13,200	24
7.	*Cinnamomum zeylanica*	Tamal patra	Leaves, Bark	10,700	46
8.	*Acorus calamus*	Ghoda vaj	Rhizomes	10,500	21
9.	*Ellataria cardamomum*	Elaichi	Seeds	8,600	21
10.	*Inula racemosa*	Pushkarmool	Roots	8,300	24
11.	*Hyoscyanus niger*	Khursaniajamo	Seeds		6,800 07
12.	*Saussurea lappa*	Kath, uplet	Roots, Whole Plant	6,200	12
13.	*Myristica fragrans*	Jaifal	Fruits, Flowers	5,200	24
14.	*Hedychium spicatum*	Kaupur kachali	Rhizomes		4,600 18
15.	*Valeriana jatamansi*	Tagarganth		Rhizonies	4,000 18
16.	*Nigella saliva*	Kalonji	Seeds	3,300	07
17.	*Eugettia caryophyllata*	Laying (Clove)	Flowers Bud	3,100	26

contd. ...

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1	2	3	4	5	6
18.	*Anacyclus pyrethrum*	Akkalkaro	Whole plant	2,800	18
19.	*Ferula narthrex*	Hing	Gum	2,750	19
20.	*Scindapsus officinails*	Gajpiper	Fruits	1,450	07
21.	*Jasminum auriculatum*	Jui, Chameli	Whole plant	1,970	03
22.	*Viola odorata*	Banfasa	Whole plant	965	06
23.	*Carum roxburghii*	Bodi ajmod	Fruits	900	02
24.	*Rosa centifolia*	Gulab	Flowers	850	10
25.	*Amomum suhulatum*	Elcho	Seeds	800	06
26.	*Citrus aurantifolia*	Santra	Fruits	755	02
27.	*Parmelia perfoliata*	Shaileyak	Whole Plant	750	06
28.	*Garcinia pendulata*	Amalvetas	Fruits	700	10
29.	*Croton tiglium*	Jamalgota	Fruits	400	06
30.	*Lilium poiyphylum*	Kshirkakoli	Bulbs	175	04
31.	*Polygonatum cirrhifolium*	Menda	Root stock	150	06
32.	*Cannabis sativa*	Bhang	Seeds	140	02
33.	*Polygonatum verticillatum*	Mahamenda	Root stock	115	04
34.	*Areca catechu*	Sopari	Seeds	110	03
35.	*Papaver somniferum*	Khaskhas	Seeds	105	02
36.	*Fritillaria roylei*	Kakoli	Bulbs	65	04
37.	*Eulopia campestris*	Salampanjo	Roots	40	03
38.	*Crocus satious*	Keshar	Stigma	35	04
39.	*Malaxis muscifera*	Rushbhak	Swollen stem	15	03
40.	*Malaxis accuminata*	*Jivak*	Swollen stem	15	04
41.	*Callicarpa macrophylla*	Priyanguful	Flowers	10	02

contd. ...

... contd.

1	2	3	4	5	6
42.	*Colchicum luteum*	Suranjan	Roots	10	02
43.	*Lubunga scandens*	Sugandhkokla	Fruits	10	02
44.	*Withania coagulence*	Kaknaj	Roots	10	02

Table 8 : Plants cultivated exclusively as medicinal crop

Plant	Part used	Areas where cultivated	Demand
Acorus calamus	RH	Karnataka*	High
Alpinia galanga	*RH*	Assam, W. Bengal, Karnataka and Kerala*	Med.
Aloe vera	LF (Juice)	Coastal areas of Saurashtra (Gujarat)	V. High
Ammi majus	FR	Jammu, Punjab and Western UP[4]	Med.
Andrographis paniculata	WP	UP, Bihar, WB, MP and Maharashtra	High
Asparagus racemosus	RT	Neemuch (MP), Bundelkhand (UP)*	High
Atropa belladonna	RT/ LF	Tangmarg and Kashmir Valley (J&K)	Low
Carum carvi	FR	Lahaul and Kinnaur (HP), Kumaon (UA)*	High
Cassia angustifolia	LF FR	Tirunelvelli, Ramnathpuram Distt. (TN)	High
Catharanthus roseus	RT HB	Peninsular and southern coastal region*	V. High
Cephaelis ipecacuanha	RT	Mungpo (WB)	Med.
Chiorophytum borivilianum	RTS	Udaipur, Sikar (Rajasthan), Jalgaon (Maharashtra)*	High
Claviceps purpurea	Scler-otia	Nilgiri Hills, Bangalore and Jammu	High
Cincnona sps.	STBK	Nungpo (W. Bengal), Nilgiri Hills (TN)	High
Digitalis Lanata	LF	Nilgiri and Pulriey hills (TN), Bangalore	Low

contd. ...

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Plant	Part used	Areas where cultivated	Demand
Dioscorea floribunda	RH	Goa, Bangalore, Nungpo (WB) and Tripura	High
Embica offieinalia	FR	Bundlekhand and Eastern UP, Nimar (MP) and Bihar*	V. High
Eucalyptus globulus	LF. OIL	Nilgiri hills (TN)	High
Gloriosa superba	RT/ SD	Tiruchirapalli (TN)	Med.
Inula racemosa	RT	Lahaul (HP)*	Low
Kaempferia galangal	RH	Karnataka, TN and Kerala*	Low
Matricaria chamomilla	FL	Kullu (HP)*	Low
Papavar somniferum	Latex	Ghazipur (UP), Mandsaur (MP)	V. High
Pimpinella anisum	FR	Haryana, UP and Punjab*	High
Piper longum	FR/ RT	Bihar, Guntur (AP), Tura and Shillong (Meghalaya)*	High
Plantago ovata	SD/ Husk	Mehsana and Banaskantha (Gujarat)	V. High
Rauvolfia serpentina	RT	Hazaribagh (Jharkhand)	High
Saussurea costus	RT	Lahaul (HP)	High
Withania somnifera	RT	Manasa (MP)	High

* Small holding over scattered areas.

Abbreviations same as in Tables 1, 4.

FUTURE PROSPECTS, OPPORTUNITIES AND CONSTRAINTS

The World Health Organization (WHO) has emphatically advocated to strengthen the indigenous system of medicine in all countries of the World. This system has attracted the attention of developed and developing countries both. Medicinal plants still play a major role in it. In several cases extracting the drug from medicinal plants in Cheaper than synthetic process (Farooqi and Sreeramu, 2001). The variability in agroclimatic conditions in India has been a major factor in founding a great biodiversity of medicinal plants and we should make all effort to harvest this gift of nature but in a judicious and scientific manner. The demand of vegetable drugs of Indian origin has tremendously increased in International market and we must promptly utilize this situation. Many advanced countries have shown reasonable interest in Ayurvedic and Siddha system of medicine and it in our turn to utilize this trend and it may boost up our earning of foreign exchange.

Table 9 : Classification of drug sources based on plant parts

Sl. No.	Parts used as drug source	No. of species used	% of species used	Annual consumption	% consumption of plant parts
1.	Whole Plant	48	15	789265	21
2.	Root	62	20	896200	24
3.	Leaf	24	08	254310	07
4.	Fruit arid Seed	95	30	1071351	·28
5.	Bark	36	12	265355	07
6.	Stem and Wood	18	06	297350	08
7.	Flower	16	05	34132	01
8.	Exudates (Gum resin)	11	04	147480	04
	Total	310	100	3755443	100

However some constraints are coming in the way. These constraints include derth of scientific manpower for undertaking research on medicinal plants, their genetic improvement, agronomic practices, quality seed availability and agricultural economics. In Indian market there are several crude drugs which have identical name (like Brahami, Safed Musli, Kanoj) in local language. Their specific plants must be properly marked and for meeting the problem of adulteration, proper steps must be taken (Pharmacognostic Studies). Many more plants which show extraordinary curative and healing properties are waiting for conservation, domestication and cultivation.

Foregoing discussion indicates that there are tremendous opportunities in India to become a world leader in medicinal plants trade due to its vast biodiversity of plants and indigenous knowledge we must exploit our plants but our climatic conditions also suits to the cultivation and introduction of several species of plants from temperate and tropical parts of the world.

[B] SPICEAL PLANTS

Spices constitute equally important group of agricultural commodities and play very important role in economy of India. They are almost in dispensable for domestic market and foreign trade. They are consumed for enhancing taste and flavour to food, whereas many of them are medicinally valuable. There are about 70 spices grown in different parts of the world. Many of these are grown in India (Fig. 1). The fame of Indian spices is older than recorded history. The Indian sub continent is known **'The Home of Spices'** all over the world.

Table 10 : Plants as sources of spices in India and World

S. No.	English/Common name and Hindi/Vernacular Name	Botanical name (Family)	Parts used	Trading status domestic/export (D/E)
(1)	(2)	(3)	(4)	(5)
1.	Bishop's weed = Ajowain	*Trachyspermum ammi* = *carum copticum* (Apiaceae)	Seeds oil of ajovain	D/E Highly medicinal (MU)
2.	Allspice = Pimenta	*Pimenta officinalis* = *Eugenia* = *pimenta* (Myrtaceae)	Dried unripe berries Berry oil	D/E Medicinally properties poorly explored.
3.	Amchur = Amchur	*Mangipera indica* (Amacordiaceae)	Kachho Aam Powder (dried)	D/E Medicinally useful (MU)
4.	Anardana = Anardana	*Punico granatum* (Punicaceae)	Dried seed with dried flesh	D/E Medicinally usefui (MU)
5.	Angelica = Angelica	*Angelica archengelica* = *Anchengelica officinalis* (Apiaceae)	Fruit, young stem roots	D/E (MU)
6.	Aniseed = Vilayati saunf	*Pimpinella anisum* = *Anisum vulgare* (Apiaceae)	Seed, Seed oil	D/E (MU)
7.	Asofoetida Heeng	*Ferula asafoetida* (Apiaceae)	Dried latex or oleoresin from living rhizome or root stock	D/E (MU)
8.	Balm = Lemon Balm = Bililotam	*Mellissa officinalis* (Lamiaceae)	Leaves or flowering top oil of Balm	D/E (MU)
9.	Basil = Sweet Basil = Babui Tulsi = Kali Tulsi = Marua	*Ocimum basilicum* (Lamiaceae)	Leaves Basil oil	D/E MU^{++}

contd. ...

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(1)	(2)	(3)	(4)	(5)	
10.	Bay = Laurel leaves (No Hindi name)	*Laurus nobilis* (Lauraceae)	Dried leaves Dried berries	Imported	MU
11.	Caper = Kabra	*Capparis spinosa* (Capparidaceae)	Flower buds	D/E	MU
12.	Chillies = La Mirch	*Capsicum annuum* (Solanaceae)	Dried ripe fruits	D/E	No comment
13.	Paprika = Sweet pepper	*Capsicum annuum* (Solonaceae)	Non pungent varieties of chilli fruit powder.	Imported	No comment
14.	Bird Chillies	*Capsicum frutescens* (Solanaceae)	Fruits	D/E	No comment
15.	Caraway = Shia zira	Carum carvi (Apiaceae)	Fruit oil of fruit (Seed)	D/E	MU
16.	Greater cardamom = Morang Elaichi = Bengal Cardamom	*Amomum aromaticum* (Zingiberaceae) = A. subalatum	Seeds/Fruits	D/E	MU
17.	Yesser Cardamom = Chhoti Elaichi	*Elettoria Cardamomum* (Zingiberaceae)	Dried fruits capsules	D/E	MU
18.	Cassia Darchini = Jangli Dalchini	Cinnamomum aromaticum (Lauraceae)	Dried inner bark of branches	D/E	MU
19.	Indian Cassia Tejpat	*Cinnamomum tamala* (Lauraceae)	Dried leaves	D/E	MU
20.	Celery Seed Shalari	*Apium graveolens* (Apiaceae)	Dried seeds (fruits)	D/E	MU
21.	Chervil = Baz Atrila	*Anthriseus cerefolium* (Apiaceae)	Yeoves	D/E	MU

contd. ...

contd. ...

(1)	(2)	(3)	(4)	(5)	
22.	Chives = Cives	*Allium schaenoparasum* (Liliaceae)	Green tpos	D/E	Not recorded
23.	Cinnamom = Dalchini	*Cinnamomum zeylanicum* (Lauraceae)	Bark, Bark oil	D/E	MU
24.	Clove = Laung	*Eugenia caryophyllata* (Myrtaceae)	Unexpaanded flower buds (dried) oil	D/E	MU
25.	Coriander = Dhania	*Coriandrum sativum* (Apiaceae)	Seed (fruit) All ponts, oil	D/E	MU
26.	Cumin Black Kalaunj= Kala zira	*Higella sativa* (Apiaceae)	Dried seed fruit	D/E	MU
27.	Curry Leaf = Mitha Neem	*Murraya koenigii* (Rutaceae)	Green leaves	D/E	MU^{++}
28.	Dill = Indian Dill Sowa	*Anethum sowa* (Apiaceae) *A. graveolens* (European Dill)	Seeds, oil	D/E	MU
29.	Fennel = Saunf	*Foeniculum vulgare* (Apiaceae)	Dried fruit (seed)	D/E	MU^{++}
30.	Fenugreek = Methi	*Trigonella foenum graecum* (Fabaceae)	Dried ripe fruit	D/E	MU^{++}
31.	Galangal = Kulanjan	*Alpinia galanga* (Zingiberaceae)	Dried rhizome Root, oil	D/E	MU
32.	Garlic = Lehasun	*Allium sativum* (Liliaceae)	Dried bulbs/bulbils	D/E	MU^{+++}
33.	Ginger = Adrak = Saunth	*Zingiber officinale* (Zingiberaceae)	Rhizome	D/E	MU^{+++}

contd. ...

contd. ...

(1)	(2)	(3)	(4)	(5)	
34.	Horse Radish (No Hindi name)	*Cochleuria armoracia* (Brassicaceae)	Roots/dried	—	MU
35.	Hyssop = Zufah	*Hyssopus officinalis* (Lamiaceae)	Aerial ports of plant	D/E	MU
36.	Juniper = Aaraur	*Juniperus communis* (Pinaceae)	Fruits/berries oil	D/E	MU
37.	Kokum = Kokam butter tree	*Garcinia indica* (Guttiferae)	Fruit	D/E	MU
38.	Welsh onion = vilayati lassan	*Allium fistulosum* (Liliaceae)	Bunching bulb	D	Nil
39.	Lovage = No Hindi name	*Levisticum officinale* (Apiaceae)	Root	D	MU
40.	Mace = Javitri = Jaiphal (Nutmug)	*Myristica fragrarnce* (Myristicaceae)	Mace = dried reticulated aril (Jaivitri); Nutmug = shell f seed (Jaiphal)	D/E	MU^{+}
41.	Marjoram = Marwa	*Majorana hortensis* (Lamiaceae)	Dried leaves, oil	D/E	MU
42.	Mint = Japanese Mint = Podina	*Mentha arvensis* (Lamiaceae)	Dried leaves	D/E	MU^{+}
43.	Peppermint = Piparmint	Metha piperita (Lamiaceae)	Distilation oil product of dried leaves Menthol	D/E (Imported too)	MU^{++}
44.	Mustard Black = True Mustard Kali Rai = Banarasi Rai	*Brassica nigra* (Brassicaceae)	Seed, Seed oil	D/E	MU^{++}

contd. ...

contd. ...

(1)	(2)	(3)	(4)	(5)
45.	White Mustard = Safed Rai	*Brassica alba* = *B. hirta* = *Synapsis alba* (Brassicaceae)	Seed = Seed oil (Gives mucilage with cold water)	Little Importance —
46.	Indian Mustard = Rai = Brown Mustard	*Brassica juncea* (Brassicoceae)	Seed oil (Preservation)	D/E MU^{+}
47.	Yellow Mustard = Pili sarso	*Brassica compestsis* (Brassicoceus)	Seed oil	D/E MU^{++}
48.	Onion = Pyaz	*Allium cepa* (Liliaceae)	Bulb	D/E MU^{+}
49.	Origanum = Sathra	*Origanum vulgare* (Lomiaceae)	Dried leaves	D/E MU
50.	Parsley = Ajmood	*Petroselinum crisbum* (Apiaceae)	Leaves, Roots, oil	D/E MU$^{(-)}$ (poisonous)
51.	Black pepper = Kali mirch	*Piper nigrum* (Piperaceae)	Dried mature unripe berries	D/E MU^{++}
52.	Long pepper = Pipali	*Piper longum* (Piperaceae)	Dried fruit	D/E MU^{++}
53.	Rose mary = Rose mary	*Rosimarinus officinalis* (Apiaceae)	Dried leaves volatile oil	D/E MU^{+}
54.	Saffron = Kesar	*Crocus sativus* (Iridaceae)	Dried stigmas	D/E MU^{+++}
55.	Saga = Salvia sefakuss	*Salvia officinalis* (Lamiaceae)	Dried leaves volatile oil	D/E MU^{+}

contd. ...

contd. ...

(1)	(2)	(3)	(4)	(5)
56.	Savory = Savori	*Satureia hortensis* (Lamiaceae)	Dried leaves, flowering tops	D/E MU
57.	Shallot = Ek kanda Lasun Gandana	*Allium asculanicum* (Liliaceae)	Bulbs/leaves	D/E MU
58.	Spearmint = Pahari Pudina	*Mentha spicata* = *M. viridis* (Lamiaceae)	Fresh/dried leaves	D/E MU
59.	Star Anise = Anasphal	*Illicium verum* (Apiaceae)	Dried fruit Volatile oil	Imported MU (Not grown in India)
60.	Sweet flag = Calamus Bach = Gorabach	*Acorus calamus* wild (Araceae)	Rhizome (Dried) (From forests)	D/E MU
61.	Tamarind = Imli	*Tamarindus indica* (Caesalpiniaceae)	Ripe fruit pulp	D/E MU
62.	Tarragon = Tarragon	*Artemisia dracunculus* (Asteraceae)	Dried leaves = Flowering tops volatile oil	D/E MU
63.	Thyme = Ban ajowain	*Thymus vulgaris* (Lamiaceae)	Dried leaves Flowering tops	D/E MU
64.	Turmeric = Haldi	*Curcuma longa* = *C. domestica* (Zingiberaceae)	Dried, boiled, cleoned, polished rhizomes	D/E MU++
65.	Vanilla = Vonilla	Vanilla fragrans = V. planifolia (Orchidaceae)	Cured fruits/ beans	D/E MU

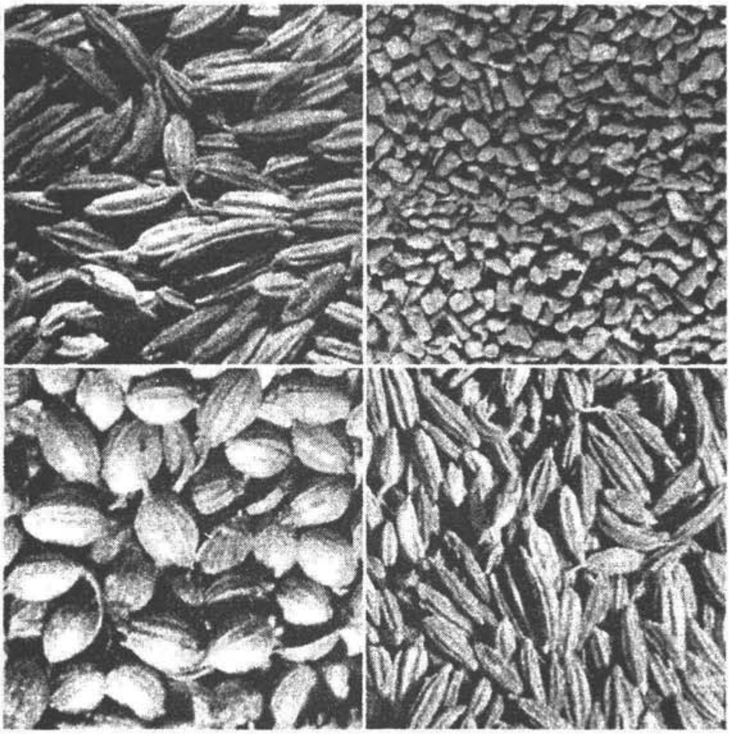

Fig. 1 : Seed spices : Primarily processed and in exportable form
1. Cumin, 2. Fenugreek, 3. Coriander, 4. Fennel.

Fig. 2 : Agri Export Zone (AEZ) for Cumin in Rajasthan State which topped in production.

Fig. 3 : Agri Export Zone (AEZ) for Coriander in Rajasthan State which topped in production.

At present spices are low volume high value and export oriented commodity crops. India produced about 2.6 million tonnes of spices during 1998-99 and earned Rs. 21013.00 lacs of rupees by export (Table 11). Onion and garlic are another group of spices exported from India (Table 12 and 13). With reference to spices. Rajasthan is very important state in India where coriander, cumin, fennel, fenugreek, chillies, ajovain, garlic and onion are produced. Accordingly agri export zones have been established in the state with proper infrastructure and facilities. (Fig. 1 from Rajasthan me masalon ka prasanskaran—cover page);Fig. 2 Agri export zone for cumin page 5; Fig. 3 Agri export zone for coriander page 6).

Table : 11 : Area, production, productivity & export of spices in India, 1997-98

Spices	Area '000ha	Production '000 t	Productivity kg/ha	Export 1998-99 Quantity (tonnes)	Value (Rs. Lakh)
Black pepper	181.55	57.27	315	35,100	634.67
Cardamom	96.37	7.15	74	355	2249.00
Large cardamom	26.358	5.39	200	1,150	970.50
Ginger	67.20	233.66	3477	9.550	4123.10
Turmeric	124.60	487.40	3912	27,750	10387.00
Coriander	521.60	308.10	590	18,500	4480.50
Cumin	307.046	117.122	381	11,000	5972.70
Fennel	25.107	28380	1130	5,300	1497.50
Fenugreek	38.485	49.968	1298	8,200	1521.00
Chillies	831.500	821 80	988	55,750	21013.00

Table 12 : Year-wise export of Onion from India

Years	Qty (M.T)	Value (Rs. Lakhs)	PUV (Rs./ton)
1990-91	289380.00	11803.00	4078.72
1991-92	406135.00	16296.86	4012.67
1992-93	395685.00	16256.06	4108.33
1993-94	448874.00	24411.11	5438.29
1994-95	496881.00	25675.55	5167.35
1995-96	434655.00	30873.81	7103.06
1996-97	512879.00	33163.40	6466.12
1997-98	446820.00	29525.72	6607.97
1998-99	298427.00	26436.32	8858.56
1999-00	318230.00	26703.64	8391.30
2000-01	330207.00	32361.93	9800.50
2001-02	506924.00	41140.53	8115.72
2002-03	545211.00	38718.70	7101.59

Source: NAFED, New Delhi and DGCI & S, Kolkata

Table 13 : Year-wise export of Garlic from India

Years	Qty. (M.T.)	Value (Rs. Lakhs)	PUV (Rs./ton)
1990-91	4073.00	257.00	6309.85
1991-92	10282.00	828.42	8056.99
1992-93	7441.00	710.00	9541.73
1993-94	2845.00	355.00	12478.03
1994-95	423.00	43.40	10260.05
1995-96	3523.00	333.00	9452.17
1996-97	3651.00	386.33	10581.48
1997-98	2436.00	219.63	9016.01
1998-99	3592.00	407.52	11345.21
1999-00	8067.00	1024.98	12705.84
2000-01	4443.00	516.30	11620.53
2001-02	657.00	159.94	24343.99
2002-03	570.00	132.11	23177.19

Source: NAFED, New Delhi and DGCI & S, Kolkata

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Section 5

Pharmaceutical/Industrial Aspects of Multitherapic Plants

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13

Impact of World Trade Organization (WTO) on Indian Pharmaceutical Industry

C.P. Malik and Bhavneet Kaur

The contemporary Indian Pharmaceutical Industry possessing wide ranging capabilities in the complex field of drug manufacturing and technology is at the pinnacle of the science-based industries and processes in India. It is a booming industry and has acquired a leadership position in the third world, in terms of technology, quality and range of medicines manufactured. The drug production in India has attained gigantic dimensions since independence. The total drug production in the country was around a meager Rs 10 crores in 1947. The Indian drug market was exploited under the Colonial Patent and Designs Act, 1911 by the then existing MNCs for import of drugs from their respective countries of origin. A total of 1704 drugs were produced during the period 1947-1957 and 99% of the pharmaceutical patents were held by foreign MNCs in the country which was practically illiterate in terms of patents. They contributed neither to the promotion of technological innovation nor the establishment of drug production centers in India. Consequently, the drug prices in India were among the highest in the world.

The establishment of two public sector units viz., **Hindustan Antibiotic Limited** (HAL) in 1954 and **The Indian Drugs and Pharmaceutical Limited** (IDPL) in 1961 combined with the enforcement of the Drug Policy of 1978 markedly alleviated the prices of drugs and medicines in India. The Patent Bill was first introduced in Parliament in 1967, but the Patent Act, 1970 came into force only in 1972. The Indian Patent Act 1970 which was in operation in our country did not allow product patents on medicines, agricultural products and atomic energy. The Patent Act classified all inventions satisfying the criteria of newness, non-obviousness and usefulness as a subject that can be considered for a patent. However, the government excluded pharmaceuticals and agrochemicals from eligibility for patents. For substances intended for use or capable of being used as food, drugs or medicines, government came up with the suggestion that patents are granted only for the process of manufacture of such substances and not for the substances themselves. Hence rather than implementing product patent, India went ahead with a process patent for pharmaceuticals and agrochemical products. This was necessary to protect the nascent industries of that time, and hence provided for development of a self-reliant indigenous industry. Resultant self-adequacy was achieved in the production of drugs after the Patent Act, 1970. Today the industry is at Rs. 45000 crores which has happened merely because of change of product to process patent vide Indian Patents Act 1970. This change gave a kick to the pharmaceutical sector enabling the industry with the growth of 19 per cent per annum (Table 1) against the global market growth of 6 to 7 per cent.

Table 1 : Growth of Indian pharmaceutical industry

Indications	1965-66	1994-1995	1997-1998
Investments	1400	12,000	18,400
R & D Expenditure	30	1400	2200
Formulation turnover	1500	79,350	1,20,680
Bulk drugs	180	15,180	26,230
Formulation exports	30	9240	28,050
Bulk drugs	30	12,607	21,730
No of manufacturers	2000	-	8250

The organized sector of the Pharmaceutical Industry has played a pivotal role in speedy development in this vital field of drug production. International and Indian companies associated with this sector have stimulated, assisted and spearheaded this dynamic development in the past fifty seven years and helped India to acquire a significant position on the pharmaceutical map of the world. Table 2 shows the key statistics pertaining to the Indian Pharmaceutical Industry followed by Tables 3 and 4 which highlight the top ten pharmaceutical companies and brands in India, respectively.

Table 2 : Indian pharmaceutical industry: fact sheet–2004

Annual Turnover:	Rs.269 billion; Growth 6.4%
Exports:	Rs.167 billion - Over 65 countries
Imports:	Rs.44 billion; Growth 10.2%

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Bulk Drugs Production:	Bulk Drugs Production: Rs.94 billion. Over 400 Bulk drugs manufactured
Future Market Size:	McKinsey Projection 2010 - U.S. $ 25 billion
Outsourcing Opportunities:	Excellent outsourcing opportunities for clinical trials, R&D, custom synthesis, technical services, e.g. Bioinformatics, etc.
Manufacturing Facilities:	Largest number of U.S. FDA approved Manufacturing facilities outside U.S.A.
No. of DMFs (Drug Master Files) filed with U.S. FDA:	197, largest DMF filed in U.S.
Per Capita Drug Expenditure:	Rs.250 per year
Share of World Pharma Market:	1.8% in value, 8% in volume terms
Global Ranking:	Volume terms – 4th, Value terms – 14th
Number of Formulations:	Over 60,000 in 60 therapeutic categories
Capital Investment:	Rs.52 billion; Growth 14.8%
R&D Expenditure:	Rs.11.8 billion, 4% of sales (However, some research based companies are spending over 6% of sales on R&D)
Ancillary Industry:	Extremely well developed. All the manufacturing equipment and machineries locally available
Number of Units:	About 10,000, out of which around 300 units are in the large and medium sectors
Intellectual Capital:	Third largest English speaking scientific and technical manpower in the world (highest intellectual capital per dollar)
Employment:	Direct—5,00,000 Indirect—25,00,000
Price Control:	3 tier control – on Bulk Drugs, Formulations And Overall Profitability. Currently, 74 drugs under price control (40% of retail market), Pharmaceutical Policy 2002 is currently under judicial review in Supreme Court. If cleared, likely to reduce number of drugs under price control from 74 to about 25
OTC Market:	Approx. Rs.42 billion, Growth 18-20%
Alternative Medicine:	Herbal, Ayurvedic, etc.– about Rs.44 billion
Biotech Market:	Total Biotech Market in India is estimated to be Rs.67 billion. About 60% of this market is accounted by Biopharmaceuticals
Health Infrastructure:	No. of Doctors—6,25,130; No. of Nurses—8,36,000; No. of Hospitals—16,000; No. of Retail Chemists—

contd. ...

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	5,00,000; Medical Colleges—171; Primary Health Centers—1,64,000; Medical Reps.—3,00,000
Fastest growing segments* :	Anti-diabetic, Cardiovascular, Central Nervous System

*based on retail sales

Reproduced from data by OPPI (Organization of Pharmaceutical Producers of India)

Table 3 : Top ten pharmaceutical companies in India

Rank	Name of Company*
1	Cipla
2	Glaxo Smith Kline
3	Ranbaxy
4	Nicholas Piramal
5	Sun Pharma
6	Pfizer
7	Dr. Reddy's
8	Zydus Cadila
9	Sanofi-Aventis
10	Aristo

* based on retail sales

Table 4 : Top 10 brands in India

Rank	Name of Brand*
1	Corex (Chlorpheniramine Maleate, Codeine Phosphate)
2	Human Mixtard (Insulin)
3	Voveran (Diclofenac Sodium)
4	Becosules (Vitamin B Complex, Vitamin C)
5	Taxim (Cefotaxime)
6	Asthalin (Salbutamol)
7	Sporidex (Cephalexin)
8	Digene (Aluminium hydroxide, Magnesium hydroxide)
9	Betnesol (Betamethasone)
10	Althrocin (Erythromycin)

* based on retail sales

Patent Laws

There has been an upsurge in the patenting activity in India during the last decade. India signed the **GATT (General Agreement on Tariffs and Trade)** agreement in 1994 and agreed to honor the **TRIPS (Trade Related Aspects of Intellectual Property Rights)** agreement which was part of GATT agreement, and included patents along with various other forms of intellectual property. India was given time up to 31 December 2004 to make its patent laws TRIPS consistent. After accession to **WTO (World Trade Organization** succeeded GATT later, established in 1995), India as a founder member was required to introduce TRIPS compliant IPR regime on 1st January 2005. The WTO was established in 1995 with one philanthropic objective of attainment of globalization i.e., achieving a single world market and economy. It views a world with no trade barriers of social, political, cultural and geographical nature. The Article 7 of the TRIPS agreement says: **The promotion and enforcement of intellectual property rights should contribute to promotion of technological innovation and to the transfer and dissemination of technology to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare, and to the balance of rights and obligations.** With the surfacing of WTO and India being a signed member of TRIPS, India would have to become TRIPS compliant by 1st of January 2005. This meant accepting a product patent regime. The Patent Act, 1970 was amended with effect from May 20, 2003 vide the Patent (Amendment) Act, 2002. The Patent Rules, 2003 thus replaced the Patent Rules, 1972 and were introduced to meet India's obligation under TRIPS.

India ushered in Product Patents Regime by introducing "**The Patents (Amendment) Ordinance, 2004**" on December 26, 2004. Later, amidst much disparate and confusing patchwork of views regarding the impact of product patent regime and debating the provisions of the Ordinance, the Parliament passed "**The Patents (Amendment) Bill, 2005**". It is envisaged this would have epoch-making implications on the Indian Pharmaceutical Industry in terms of R&D, Foreign Direct Investment and Improved healthcare.

The salient features of the Act are:

- After a gap of 35 years, product patent protection has been extended to pharmaceuticals, chemicals, biotechnology products and food for a period of 20 years
- Provisions relating to **Exclusive Marketing Rights (EMRs)** are deleted and a transitional provision is introduced for safeguarding EMRs already granted
- To meet emergent health situations (in accordance with the **Doha Declaration** on TRIPS and Public Health), a provision is made for enabling grant of **Compulsory License** for export of medicines to countries which have insufficient or no manufacturing capacity
- Provisions relating to opposition procedures, with a view to streamlining the system by having both Pre-grant and Post-grant opposition in the Patent Office, have been modified
- There is an addition of a new proviso to circumscribe rights in respect of mailbox applications shall be available only from the date of grant of patent and not retrospectively shall be available only from the date of grant of patent and not retrospectively from the date of publication
- The provisions relating to national security to guard against patenting abroad of dual use technologies have been strengthened

- Several provisions are included with a view to rationalizing time-lines, allowing flexibility and reducing the processing time for patent applications and simplifying procedures

Presently, the status of the Indian pharmaceutical industry is as follows:

1. Out of 470 bulk drugs used in India, all the essential bulk drugs, i.e. 350 which constitute 90% of the bulk drugs are produced in India.

2. 60,000 finished formulations which constitute 90% of the formulations and which is sufficient for domestic requirements are also made indigenously (Table 5). These formulations are like anti-TB, antibiotics, painkillers, cardiac drugs, etc.

Table 5 : Year wise status of formulations

Year		Status
1950	Formulations	Mostly imported MNC dominated
1960	Formulations	Domestic efforts on imported bulk drugs
1970	Formulations	Some imports
	Bulk drugs	Domestic companies manufacture drugs indigenously
1980	Formulations	Negligible imports
1990	Formulations	Significant exports and marginal imports

3. The exports are to the tune of Rs.12000 crores of bulk drugs and formulations, exported to nearly 60 countries of the world. Twenty five per cent of exports are to sophisticated western countries meeting their highest quality standards; significant portion of the production for exports comes from SSI/medium units and it will go a long way when we touch International Competitiveness.

4. The total production in value constitutes about 1.3% of the world market and 8% in terms of volume; this is because the prices of drugs in India are lowest in the world market.

5. It is the 5th largest producer after USA, Japan, Europe and China.

6. Of the 23,000 units, there are 25 large units and 3000 medium / SSI manufacturing units in the organized sector.

7. Two hundred units are with WHO GMP approved facilities.

8. Over 30 units have approved facilities of US FDA/TGA/MCA.

9. In regard to quality, India stands at par with the world market and our products are widely accepted even in a country like USA.

10. The total R&D expenses are over Rs.370 crores, which has risen from a modest space b/w Rs. and figure of Rs. 40 crores in the year 1983–1984.

11. About 200 R&D facilities are approved by Department of Science & Technology, but most of R&D efforts are limited to new process technology, process improvements, new drug formulations, new drug delivery system (NDDS) and clinical trials being important activities but not enough for global leadership. Recently, world market has started looking towards India as the cheapest market for clinical trials and other research purposes.

12. Total employment in the pharmaceutical industry is over 2 million.

13. Indian Pharma was 100% generic and remained 99% generic in 2005 also. This is a self achievement by the national sector without any financial or technological assistance from the developed world.

14. Nearly 12 companies are with turn over exceeding Rs.1000 crores.

15. There are research based companies supplying generic and branded drugs to North America and Europe, which are world's two largest pharmaceutical markets. They have manufacturing and market establishments in these countries also.

16. Present production is Rs.45,000 crores, of which one-third is exported.

17. Ranbaxy exported drugs worth Rs.2429 crores in 2003-04, which is 70% of their sales.

18. Dr. Reddy's Labs and Cipla exported drugs worth Rs.1000 crores each.

19. Drugs worth 50 billion will be off patent in US in the next few years.

Characteristics of Indian consumers

Before discussing the impact of WTO on Indian Pharmaceutical industry it is worthwhile to mention the present scenario related to the use of drugs and medicines in the country:

Low consumption—The per capita expenditure on drugs is very low in India, chiefly due to low purchasing power and poor health consciousness. Currently, the per capita expenditure on drugs is around only U.S. $ 3 in India, which is very less in comparison to U.S. $ 7 in Pakistan, U.S. $ 21 in Turkey, U.S. $ 97 in UK, U.S. $ 222 in Germany and U.S. $ 412 in Japan as shown in Table 6. No dramatic change is observed since January 2005. Clearly, process patent or product patent has no marked impact on this trend. Table 7 includes data on world drug production and percentage of world population in selected countries.

Table 6 : Annual drug consumption

Country	Per Capita Expenditure (In US Dollars)		Country
Japan	412	11	Philippines
Germany	222	10	Ghana
U.S.A.	191	7	China
Canada	124	7	Pakistan
U.K.	97	4	Indonesia
Norway	89	4	Kenya
Costa Rica	37	3	India
Chile	30	2	Bangladesh
Brazil	16	2	Mozambique

Table 7 : Percentages of drug production and world population in some countries

Country	World Drug Production (%)	World Population (%)
USA	28.2	4.7
Germany	7.7	1.5
France	7.1	1.1
U.K.	3.4	1.1
Brazil	1.7	2.8
India	1.2	16.1

Source: Business Standard, February 19, 1997

Poor Medical coverage—In Western countries, government or the insurance companies take up sizeable responsibility for healthcare funding. However, in India individuals have to fund their own medical bills. Considering the billion strong population the Government spends paltry amount on healthcare. Recently insurance companies have started medic-claims etc. However, this sector accounts for just 4% of the total spending in India against 50-80% in the Western countries. In India individuals have to foot doctor's bill and also pay for the medicines. No dramatic change has been noticed in this trend post January 2005.

Low prices of medicines—In India drugs are produced at very cheap price compared with rest of the world. The Indian Pharma manufacturers have four distinct advantages: cost is nearly 50% lower than in the West; infrastructure costs are nearly 45% lower, the prevalence of product patenting till December 2004 and lastly availability of enormous pool of talented chemists contributed to low prices of medicines although a rise in the prices have been recorded in the last few years.

Indian Pharmaceutical Industry Pre-2005

Comments an industry observer who prefers to remain anonymous, "So far, Indian scientists were preferring to go abroad as there were vast opportunities for them outside whereas, at home they would be asked to copy the foreign drugs by resorting to reverse engineering. Till now, the Indian industry did not bother about research particularly basic research. But the WTO prescription has brought a dramatic change in the thinking of the stalwarts of the Indian Pharmaceutical sector." WTO prescription since January 1, 2005, is the end of the process of reverse engineering, the core competence of the Indian Pharma sector as an organized industry; imported drugs and alternative (Ayurvedic, Homeopathic and Unani) medicines were the order of the day. In 1950, the total size of the Pharma industry was around Rs. 12 crore, which slowly and gradually went up to over Rs. 200 crore by 1970. At that time, the market share of foreign companies was over 85 per cent. But, during the last 30 years, the industry has made rapid strides, the main driving force being the process of reverse engineering. The Indian patent Act of 1970 accepted only process patents and this helped the Indian Pharma industry to introduce new patent products (developed after years of hard work and expenditure of millions of dollars by western Pharma companies) in the Indian market almost simultaneously with the innovator of the drug. Indian scientists, particularly those having an expertise in chemistry, have shown their intelligence and capability to develop an alternative process for almost every modern drug that is developed abroad. What is more, the cost of the Indian Pharma company in developing these products has been only a fraction of the cost incurred by the innovating company. The outcome was obvious: the most modern drugs developed by western multinationals after spending millions of dollars on basic research were produced through reverse engineering and were sold at almost one tenth of the price being charged in the western market. Further the Indian companies exported these drugs to several poor countries which happily lapped up Indian products as they were cheap as compared with the western products?

According to Mr. A.K. Jain, Managing Director of the Chandigarh based Ind Swift, besides reverse engineering, there are seven other factors which "contributed towards the phenomenal growth of the Indian Pharma industry". They are: (1) introduction of new molecules on a regular basis, (2) increase in the healthcare awareness, (3) aggressive marketing, (4) liberalized policies of the government allowing the import of almost all raw materials, (5) improved profitability which boosted funds, confidence and enthusiasm of the manufacturers to expand business, (6) gradual dilution of government control on drug prices and (7) liberal licensing policy, including the increase in the direct foreign investment in the Indian Pharma companies.

The western, particularly American pharmaceutical industry was in a rage against the Indian Pharmacy sector and brought on a pressure on the US government to twist the arm of Indian industry through New Delhi. But nothing could prevent the growth of the industry with people like Bhai Mohan Singh, Dr. Parvinder Singh, Dr. Reddy and Dr. Hamied, among others, striving hard to take the Indian pharmaceutical sector to new heights. Now the size of the Indian sector has gone up to 65 per cent, thus pushing down the share of the multinationals to just around 35 per cent from 85 per cent in 1970. Several MNCs like Nicholas and Roche had left the country, handing over their establishments here to local parties.

Scenario Post-2005

The days of reverse engineering have come to an end. After a prolonged struggle, the western Pharma industry succeeded in persuading the WTO to have product patent accepted throughout the world, particularly in the developing countries where it was not legally accepted. Now, under the GATT (General Agreement on Trade and Tariffs) accord reached in 1995, the entire Pharma industry in the world will be ruled by a uniform product patent. Developed countries accepted the product patent and under pressure from the US government (which was acting as per the request of the US Pharma industry), developing countries are following suit. To begin with, Korea and Czech and Slovak Republics accepted the product patent. They were followed by Mexico, Bulgaria, Indonesia, Chile, Belarus, Romania, Taiwan, Russia, Ukraine, Thailand, China, Yugoslavia, Philippines, Poland, Slovenia, Macedonia, and Hungary, among others. After the historic GATT accord, Brazil accepted the product patent in 1996 and Jordan in 2000. India was given a grace period up to 2004 end.

It was generally feared that enforcement of the product regime effective from 1st January 2005 would spell doom for the Indian Pharmaceutical industry. There are two areas of major concern as expressed by the anti-patent lobby in various quarters — apprehensions about rise in prices of medicine, and the possible impact of the new patent regime on the domestic pharmaceutical industry. Prices of drugs have increased by leaps and bounds along with the prices of other commodities in recent times (Table 8). The drug manufacturers are flouting the Drug Price Control Order (DPCO). The DPCO was first introduced in 1970. In 1970 most of the drugs were under price control. In 1987 this was diluted and the number of drugs which were restricted declined to 347, in 1987 it was brought down to 163 drugs and in 1994 only 73 drugs were under DPCO.

Further, it was advocated that under the WTO agreement and the imposition of a products patent regime, the prices of all new drugs (patented) will go up without any control of domestic law. The DPCO will become further irrelevant and Indian people's accessibility to newer drugs will be restricted only to the rich of the country. Table 9 shows the prices of certain new drugs.

Table 8 : Prices of twelve essential drugs before the liberal decontrol of Drug Price Control Order (DPCO)

Name of Drug	For Treatment	Packing	Price 1995	Price 1998	Increase (%)
Diazepam	Depression	10	3.13	9.50	204
Ampicillin	Antibiotic	4	12.85	23.15	80
Cephalexin	Antibiotic	10	45.07	113.15	151
Ethambutol	Anti T.B.drugs	10	5.92	33.00	457
Rifampicin	-do-	10	24.00	64.00	167
Pirazinamide	-do-	10	17.01	46.95	176
Lignocaine Hcl	Anaesthetic	30 ml.	4.16	12.40	198
Promethaxine Hcl	Anti allergic	10	1.25	3.23	158
Antacid liq.	Gastritis	200 ml.	13.00	23.00	77
Oxyfedrine Hcl	Angina pectoris	10	10.44	21.41	105
Discopyramide Phosphate	Cardiac problems	10	16.50	50.46	206
Dipyridamole	Anti angina	10	2.00	4.73	137

Table 9 : Prices of some of the new drugs introduced in 1997 in the Indian market

Drug	Company	Strength	Pack	Price (In Rupees)
Sporanox	Ethnor	100 mg	4 tablets	173.00
Lumicil	Novertis	250 mg	14 capsules	1247.00
Spariex	Sun Pharma	200 mg	6 tablets	154.00
Rispid	Panacea	50 ml	1 mg/ml capsule	141.00
Livial	Infar		28 tablets	1225.00
Pipracil	Cyanamid	2 g	Vial	215.78
Amate	Mesco Pharma	50 mg	12 tablets	180.00
Adnoject	Inca	3 mg	2 ml. vial	210.00
Roxisara	Sarabhai	300 mg	6 tablets	165.00
Celex	Glaxo	250 mg	4 tablets	140.00

Source: Paper of A. Guha, in the seminar held at Delhi in May, 1998

However, a dramatic change is witnessed. The clouds of gloom and despondency have dispersed and the atmosphere is filled with added hope and high expectations. On the issue of prices, Honorable Commerce Minister Shri Kamal Nath assured all stakeholders that there are enough safeguards built into the bill to protect the interests of consumers by ensuring availability of medicines at affordable prices and hence fears about drug prices rising after the introduction of product patent regime was "unfounded". "The prices of medicines will not shoot up due to patents, because of these strong safeguards, checks and balances," he asserted. The clear provisions in the amended Patents Act to protect the interests of domestic pharmaceuticals and chemical industry state that domestic companies can continue to manufacture patented products even after a patent is granted in respect of mailbox applications on payment of a reasonable royalty to the patent holder, provision for both pre grant and post grant opposition avenues as well as reduction in timeframe for grant of patents in a cost-effective manner are also provided, the pre grant opposition to patents has too been strengthened.

Further the Act also provides to prevent "ever-greening" of patents for pharmaceutical substances, provisions listing out exceptions to patentability have been suitably amended to remove ambiguity, the conditions for obtaining compulsory license have been clarified to facilitate export of patented pharmaceutical products by Indian companies, a reasonable period for negotiations between the patent holder and companies seeking compulsory license has been fixed at six months and research and development has been exempted from the ambit of patents. Undoubtedly, there will be a big shake up and number of pharmaceutical companies is likely to decrease to just 500 or so from the current 23,000. As far as non R&D companies are concerned they will either pull down their shutters or go in for mergers. The multinationals can capitalize on the huge reservoir of newly created opportunities. The new WTO prescription has concomitantly opened up significant new avenues for rapid growth of the Indian companies. In fact a huge $ 35 billion market for off-patent generic products awaits Indian companies. Novel Drug Delivery Systems (NDDS) research has assumed more significance. Consequently, hundreds of units have begun planning post-2005 strategies. They will have to fully utilize these opportunities to dominate the Pharma scene. Ten years ago when it was announced that the entire international pharmaceutical industry will be subjected to the new world trade organization prescription and process patents will be replaced by product patents, beginning 1st January 2005 it was believed that with the passage of time only the multinationals, would survive. But the campaigners have proved every one wrong substantially. Undoubtedly, 23,000 companies will not remain so but the ones which will survive shall have excellent future. The industry experts have concluded that the new WTO prescriptions pose formidable challenges but simultaneously offer invaluable new avenues for rapid growth. In fact the industry has confidently switched over from process patent to product patent.

Mr. Homi R. Khusrokhan, Managing Director of Glaxo (India), has stated that "I feel the Indian Pharmaceutical Industry has come of age in the past few years. We have begun to make a mark on the world scene and people are sitting up and taking note of us." "The future belongs to knowledge based industry sectors. After information technology, it is the pharmaceutical sector which is a highly knowledge driven industry. The world over, Indian engineers and scientists are being hailed as first rate intelligent people. How many Indian scientists are working in senior and responsible positions in USA?" asks Swati Piramal, Managing Director, Nicholas Piramal and continues, "Indian scientists can certainly take the Pharmaceutical Industry to new heights."

The WTO agreement includes a range of directives such as lifting of import restrictions, IPR regularization etc. Analyzing the pharmaceutical sector acutely, to gain a broader view of the issues besieging the Indian Industries in general, the following impacts of globalization are realized.

Closure of Industries on a large scale

Indian Pharma companies till date were earning their bread and butter by producing drugs quite similar to those patented by MNCs outside India, without paying them royalty. This was possible because India followed a regime of process patent unlike the product patent being followed by the western countries. India presently has around 23,000 small, big and medium factories producing drugs in India. The smaller and medium size factories have no other option but to close down their shutters because they lack the financial strength to pay any of the MNCs, a royalty fee for producing drugs. Apart from the factory workers the distribution workers are gradually being replaced by Cost & Freight agency system. In this system, the original company does not have any responsibility for the workers. They are employed by agents with more workload and lower wages. In the last decade around 15,000 distribution workers have lost their jobs in the pharmaceutical industry (Table 10). Moreover, through the agency system the Government is deprived of sales tax. Even a lot number of large firms have to close down their units which were involved in producing drugs similar to those patented by companies in the west resulting in a mass ending of jobs.

Table 10 : Mass ending of jobs in various pharmaceutical industries

Company	Year	Reduction of Work Force
Glaxo	1995	1564
Hoechst	1996	1049
Knoll Pharma (Boots)	1995	All 600 workers
Smith Kline Beecham	1995	208
E. Merck	1995	194
Rhone Poulenc	1996	700
Hindusthan Ciba Geigy	1993	907
Duphar Interfran	1996	154
Bayer	1996	590
Abbott	1996	All workers
Roche	1996	All 320 workers
Boehringer Mannheim	1997	All 335 workers
Park Davis	1997	All 650 workers
Pfizer	1995	215
Unichem	1997	All workers

Source: Annual reports of respective companies and interaction with the office bearers of Unions

Indian Firms concentrating on generic products

A lot of big firms have started concentrating on generic products as their primary source of revenue. There is a big market for generic products (products whose patents have expired) in the west and the Indian firms are eyeing to capture the market through our competency in low cost production. The generic market would witness intensive competition among all the left over firms.

Opening of R&D bases by foreign multinationals

Eyeing the huge human resource potential available in the country, Multi Nationals are going to flock down to create R&D bases, which would be used to launch new products in the international market. These bases would work as powerhouses to fuel the further growth of the company. The cheap availability of human beings for testing the new drugs and the low cost of infrastructure would add to the process of building bases.

Standardization of Products

With the regularization of products and patents, the market is witnessing one standard of products in every corner of it, in place of the variety of similar products found presently. Let us take an example of 'Cetrizine' drug, which had different versions of similar kind being circulated around, now has only one product being distributed by the patent owners, post January 1, 2005. This would help in removing the confusion which such multiple copies of same products create sometime.

Indian dominance in certain sectors

Not all on the gloomy side, certain segments of the Indian industries have benefited from the IPR regulations, such as textiles, spices, agro-business. ***The only issue here is, are Indians as conscious about patents like our competitors in the west?*** We have got to understand, respect and start using IPR's to our advantage to take back the battle to their court.

There was a hue and cry in the Indian pharmaceutical sector as the product bomb created a scare at that time. While the multinationals were jubilant, the Indian companies were in a disarray fearing extinction. And such fears were quite understandable, as the new WTO prescription for product patent clearly implies that:

(a) The emphasis would now be on **basic research**. The days of reverse engineering, which was responsible for the rapid growth of the Indian Pharma sector, will be over. Now the companies without patents for new products will be unable to offer newer drugs to customers.

(b) Indian companies are too poor to conduct basic research. So far they have neither the inclination, nor the will to conduct research and wait for years for the outcome. While the Western countries spend about 15 to 20 per cent of their turnover on research, their Indian counter parts don't spend more than 2 per cent of their sales. There aren't even half a dozen companies out of a total of 23,000 which pay some attention to basic research.

Fearing extinction the Indian Pharma companies initially tried hard to prevent the government from accepting the GATT agreement. But, as the whole world was moving in one direction, India too has accepted the goal of globalization, the acceptance of the WTO prescription was inevitable, and which ever party was in power in New Delhi. Now that product patent is operative, the industry has started thinking as to what should be done. Interestingly, it was soon realized that there is life beyond 2005. If the acceptance of the product patent regime posed so many challenges and would create many problems leading to closure of many units, it also offered several new opportunities for growth, it is realized.

(1) Block buster drugs worth over US $ 30 billion (Rs. 1, 35,000 crore) have gone off patent.

(2) At present, MNCs do not outsource bulk drugs from Indian companies for products under patent protection as they are apprehensive that this might lead to transfer of technology to a country which does not provide them patent protection. Hence their outsourcing of bulk drugs from India is limited for products that are off patent. This situation has changed after 2005 as MNCs have started outsourcing bulk drugs for patented as well as off patent products from India since the latter has accepted the product patent regime.

(3) As in the case of bulk drugs, MNCs prefer outsourcing even for formulations. According to International Medical Statistics (IMS), half of the big pharmaceutical companies worldwide have moved towards outsourcing through long term strategic alliances, while 9 per cent of the companies outsource moderately. Only 31 per cent went for in house capacity expansion, Glaxo, Welcome American Home Products, Upjohn, Pharmacia, Briston and Makers Squib are some of the MNCs that outsource extensively. India has emerged as a world class manufacturer of pharmaceutical products and many MNCs are coming to India for contract manufacturing.

(4) The world over, it has been recognized that Indian Pharma companies have superior chemical synthesis skills, backed by a quality conscious manufacturing infrastructure. What is more, labor costs are cheap in India as compared to the Western world. Thus, after 2005, India has become an important sourcing base, for research for new drugs by multinationals.

The European patent Law has been tightened with the adoption of **Supplementary Protection Certificate (SPC)** clause along with the Bolor clause which allows Pharma companies to develop samples for regulatory filling. The proposed Indian Patents Act includes this Bolor clause. Hence, this has given the Indian companies a head start for their entry into the highly competitive international market for generics after 2005. The obvious conclusion is that Pharma sector is not affected.

Mr. Purushottam Agarwal, Managing Director of Ajanata Pharmacy says, "If the new era will pose severe challenges, at the same time, it will also offer several opportunities." The Indian pharmaceutical market, is expected to cross the Rs. 50000 crore mark by 2010, i.e., within five years of the implementation of the product patent. However, it will not be possible for over 23,000, existing companies to remain in operation. The companies which depend on reverse engineering and have not adopted strategies to succeed in the new patent era, will have to close down. While the Pharma market will expand to Rs. 50000 crore by 2010, the number of companies will come down to just around 2000. Even this number may decline further in the subsequent years, and one should not be surprised if the total number of companies went down to just 500 by 2020, with only 100 companies ruling the roost. But what strategies should be adopted by Pharma companies excluding foreign companies with 100 per cent equity ownership by overseas proprietor, to tap the vast opportunities thrown open in the post-2005 era?

According to Mr. Pankaj Patel, Managing Director of Cadila Healthcare, to meet the post-2005 challenges, the Indian Pharma companies need to adopt a strategic game plan that should include emphasis on R&D, reinforcement of marketing strengths, and backward integration of Pharma business and aggressive marketing of generics in high margin export markets. "Research and development will be the prime engine for growth in the coming years." Mr. Sursh Kare, Chairman and Managing Director of Indoco Remedies opines, "Indian scientists who have excelled in the 'short cut' of reverse engineering can certainly do extremely well in basic research also. But the path is too costly and too risky. According to a study undertaken by Tuffs Center, a new molecule topically takes at least 7 to 8 years to reach the market after pre clinical trails, and costs between $ 150 million and $ 300 million to develop and commercialize. Out of 500 molecules that are commercially launched most will recover their research and development costs. With such high levels of risk and cost, not even the biggest of Indian Pharma companies can afford to conduct R&D on their own, from start to finish. Suggests a SSKI sector strategy study for pharmaceuticals, "In our opinion, given the access to low cost talent, the Indian companies should concentrate on less risky (through admittedly low return) areas of R&D like analogue research, novel drug delivery system (NDDS) research and choral research."

Analogues

Analogues are modifications of original molecules and thus exhibit similar activity. In fact, they are improved, superior versions of existing drugs. A good analogue molecule may even become a bigger money spinner than the original that inspired it. Take the success of ciprofloxacin (analogue) over nalidixic acid (original) and Ranitidine over Famotidine. Several Indian companies, including Ranbaxy, Dr. Reddy's Laboratories, Cipla, Wockhardt, SunPharma and Torrent have already started working on analogue research. Analogue research is clearly cheaper and less risky than basic research, as clinical data for the original molecule are already available. Given the prohibitive cost associated with basic research, analogue research would definitely be a better bet for Indian companies. Given the high cost of clinical trails and the lack of past experience in this area, it would make sense for Indian companies to license out their analogue molecules to MNCs. Dr. Reddy's has already done this once, when it licensed its two anti-diabetes molecules to Novo Norkisk. Since January 1, 2005 pricing advantage has proved to be a boom for the Indian Pharma industry due to its effective competitive ability in the world markets. However, this course is highly capital intensive and has a long gestation period. In order to tide over these problems some Indian companies e.g. Cipla, Lupin, Morepen Lab have linked with ANDA owner local company, to supply the bulk active from India. "This ensure a quick entry into new markets, but the downside is that it increases their dependence on alliance partner, who are, by and large, interested only in the small window of opportunity (12 to 18 months) when a product is generics," warns a study. Another strategy is to establish a base in Western countries. Consequently, some companies like Ranbaxy, Wockhardt and Sun Pharma have acquired manufacturing facilities in overseas markets and have started filling their own ANDAs. Many more Indian companies are following this route, which demands a capital investment of nearly U.S. $ 50 million to $ 75 million and has a gestation period of 3 to 4 years. Consequently, it also provides these players with better bargaining power, especially if they manage to get exhaustively right. More and more Indian companies have started going global in order to survive and succeed in the new patent era. In these circumstances, it is certain as Mr. Pankaj Patel says, "The patent regime is not the end of the road for the Indian Pharma industry." But as, Mr. Ajay Piramal maintains, "in the post-2005 era, Indian Pharma sector will have to focus on basic research or collaborate with patent holders to launch new products in the market. Globalization will become increasingly important for Indian companies in the post-2005 era. The criteria for success in this era will depend on skills of new product development, product portfolio leadership, competitive pricing, superior brand management skills and a strong distribution network. The watchwords in the post-2005 era are innovative research, marketing strategies and cost leadership."

Patent Amendment Ordinance

Mr. Ranjit Shahani, President of OPPI in a recent interview to Pharmabiz has expressed his optimism regarding implementation of product patenting and its implications on Indian pharmaceutical industry. Indeed some of the changes proposed in the **Patent Amendment Ordinance** matched OPPI's expectations. For instance the ordinance includes several provisions aimed at rationalizing timelines, allowing flexibility and reducing processing time for patent applications. This step will boost R&D and will help to bring in foreign direct investment in industry and hence helping improving healthcare. However, India was likely to lag behind in ushering in World Class IPB standards: India should join other leading countries and progressive nations in moving away from pre-grant opposition. In fact Ordinance has a provision representation by third parties and lengthens time for grant of Patent. Another area of concern pertains to **Compulsory Licensing (CL)** provisions that extend beyond emergency and extreme urgent situations, public health crisis and anti-trust situations. Unfortunately broadening the scope of CL can cause unfair commercial gains to favored companies. Yet another concern is pertaining to research based manufacturers since a new provision has been added in the Ordinance that treat patent holders in respect of mailbox applications on a discriminatory footing as they are denied the rights from the date of publication retrospectively. The happiness is that Ordinance has been converted into a full-fledged law by the parliament. Once a suitable climate is provided for world-class patent protection there is tremendous scope to attract fresh investments, focus on R&D, clinical trials and productive collaboration between Indian and international companies. MNCs shall have immense opportunities for improving their growth by launching patented new products. This must accompany TRIPS compliant law for monitoring the implementation in a fair and transparent manner. MNCs are also seeking provision for data protection to the safety and efficacy data developed by them through expensive and time consuming clinical trials. Incidentally data protection act is in force in countries like USA, China, Europe, Korea, Singapore, etc. OPPI has demanded from the government at least 5-year of data protection from the time of marketing approval. It is essential for the government to provide environment of IPR protection that promotes innovations and stimulates launch of patented molecules. In turn this will result in better healthcare for all.

Against the general apprehension that Patent Amendment shall cause serious problems to the Indian Pharmaceutical firms, and accelerate costs of essential drugs, the amendment has opened several new opportunities for the Indian pharmaceutical firms. Big companies like Ranbaxy, Dr Reddy's, Nicholas Piramal, Lupin, Wockhardt are investing huge amounts in R&D and very shortly they should be launching their own patented molecules all the world over. India is one of the countries, having largest number of US FDA approved manufacturing facilities outside USA. Therefore, India is bound to emerge as a significant player in the area of generics. Unfortunately some sections of the Pharma industry have propagated a myth that with the product patent regime, the prices of medicines will increase. A perusal of available information will show that 97% of the drugs in the WHO list of the essential drugs are already out of patent and shall continue to be available at current prices. For the rest, several therapeutics alternatives are available. Moreover, the **National Pharmaceutical Pricing Authority (NPPA)** will monitor drug prices. It may be stated, that as mentioned earlier, medicines contribute to only about 15% of healthcare expenditure. Most of the expenditure comes from diagnostic test, hospitalization, consultation fee of the doctor, etc. Hence this kind of propaganda is not warranted.

From the above discussion it is evident that India is bound to emerge as a leading country in the world pharmaceutical market. As stated earlier India is ranked 4^{th} in volume terms and 14^{th} in value terms and in the next coming decade we are bound to improve upon these figures. Many Indian companies are proceeding to build international operations which will add to their turnover. These companies include Ranbaxy, Dr. Reddy's, Lupin, Sunpharma, Wockhardt, etc. We believe that **Post Product Patent Era** will result in major thrust in exports. Further due to low costs of inputs the manufacturing costs for formulations would be reduced to half compared with the developed world. In fact MNCs may make the Indian manufacturing facilities as "**centers of excellence**" for shipping to other countries. Further making alliances for developing MNCs by outsourcing to India has enormous cost advantages without sacrificing quality. The biopharmaceuticals market is evolving very fast and the Indian market is flooded with biogenerics like TPA, interferon, human insulin, vaccines, and erythropoietin. In the coming years India is surely on the path to emerge as one of the largest producers of vaccines in the world. Mr. Habil Khorakiwala, the group chairman of Wockhardt opines that acquisitions of overseas rights are proceeding in a creditable way. His firm has acquired three medicines companies in Europe. Armed with a war chest of nearly Rs 3,570 crore it is combing the US for a fresh acquisition target. Since January 2005, Indian drug firms have collectively bought more than 30 overseas companies for over Rs 5,802 crores. Since most deal sizes are not declared hence actual investments may be higher.

Alliances, Linkages and Acquisitions

MNCs could also build linkages or alliances with domestic Companies for generic drugs sourcing for use by their overseas formulations plants. Here again the local manufacturing units of MNCs can be utilized for manufacturing bulk drugs and formulations for global supply to other affiliates .There is immense pressure on global pharmaceuticals to reduce costs of the drugs. It is interesting to note that drug discovery cost has enhanced tremendously in USA and is touching US $ 1 billion per new chemical entity (NCE). Consequently, the global industry is contemplating cost reduction through outsourcing and India offers enormous opportunity in the area of contract R&D manufacturing, clinical trials, bioinformatics, custom synthesis, technical services, etc.

On March 4, this year Dr Reddy's Laboratories napped up Germany's fourth largest generics company Betapharm for $ 572 million. On 29 March, 06 Ranbaxy, India's largest Pharma company and among the global top 10, wrapped up the largest Romanian generics firm, Terapia for $324 million (Fig. 1). The question is why these companies are gobbling up targets in rapid fashion. The intent is to dominate the global generics space. Through the process of mergers, acquisitions and takeovers (Table 11) MNCs will gradually perpetuate their grip on the Indian industry by the creation of a limited number of mega companies having monopoly control and domination world wide. In the absence of competition people will have to pay any price as it happens in the sellers market.

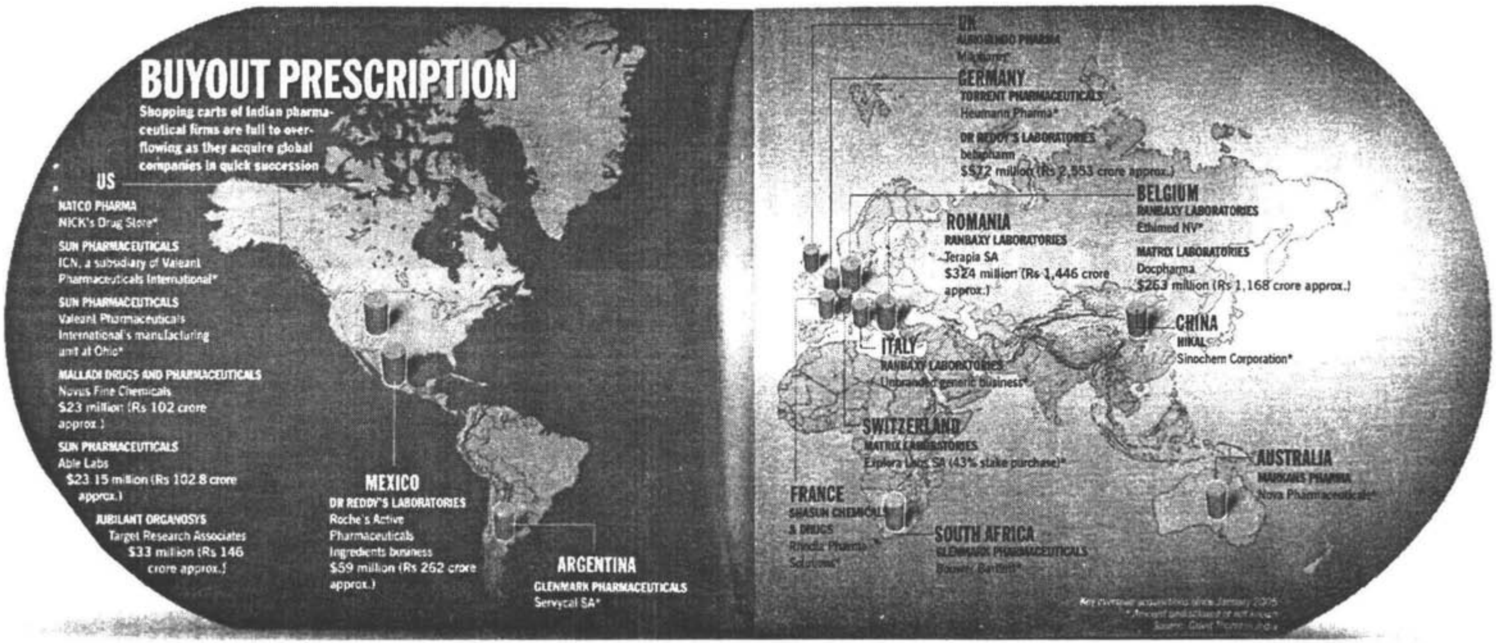

Fig. 1 : Mergers & acquisitions (Source : India Today, 2006)

Table 11 : Top pharma company mergers in the world

Company	Merger	Year of Merger	Value of Merged Company (in Billion US Dollars)
Dow Chemicals	Marion Labs	1986	6.21
Bristol Myers	Squibb Corp	1989	12.09
Beecham group	Smith, Kline & French	1989	7.9
American Home Products	American Cynamide	1994	9.7
Hoffman La Roche	Syntex Lab.	1994	5.3
Eli Lyly	PCS Health System	1994	4
Sandoz	Gerber	1994	3.7
Smith Kline Beecham	Sterling	1994	2.9
Glaxo	Burroughs Wellcome	1995	14.2
Hoechst	MMD Roussel	1995	7.2
Pharmacia	Upjohn	1995	7
Rhone-Poulenc Rorers	Fison	1995	2.7
BASF	Boots	1995	1.3
Ciba Geigy	Sandoz	1996	30.1
Hoffman la Roche	Comage Ltd.	1997	11
Hoechst A.G.	Rhone Poulenc	1998	
Astra	Zeneca	1998	67

Source: Compilation from reports published in various news papers at different times

India manufactures more than 20 per cent of the world's generics, with 60% of its factories bearing the US Food and Drug Administration's (FDA) stamp of approval. As discussed earlier more than 200 drugs are scheduled to go off patents in the next three years, hence opening the flood gates to a global generics opportunity worth $50 billion. Indian Pharma persons are out to grab it. It may be stated that generics is based purely on pricing as the same product is replicated by every competitor in the field, affording very little space for slips in quality. A law enacted in 1972 permitted production of drugs still under patent, using alternate process and Indian Pharma companies fully exploited this for more than three decades. On the way they gained expertise in reverse engineering of novel drugs and launched copied versions. Advantage of low cost was also there. In fact a new drug factory could be set up in India at a cost far below that of the West. Obviously acquisition will boost expansion in lucrative markets as happened a few years ago. DRL's first take over was UK's BMS Labs LTD and Meridian Healthcare for $12 million in 2002. Since then, DRL's generic sales in the UK have doubled to $19 million. Then Docpharma was acquired in May-June last year. Matrix experts expect the share of international business in its revenue to go from 50% to 80% in 2007-08. Accordingly revenues will increase from $ 142 million to nearly $ 452 million. Moreover, acquisitions will give access to approved products lines and marketing set-ups. Again most markets require generic drugs to be registered before sale. Due to the clearances enjoyed by the firms they are acquiring, Indian Parma companies will be able to sell the drugs produced cheap here in the fast growing overseas markets. For example, Ranbaxy has acquired tenth largest Belgian generic company which will provide access to over 20 registered products. The company is looking at three broad streams for its overall strategic direction for M & AS. In USA which constitutes critical market, it is seeking acquisitions to secure dominance and scale. Thus it is seeking opportunities which provide technology advantages or diversification into a new segment. It also intends to invest in markets such as Japan which holds long-term promise and potential. CEO and MD of Ranbaxy, Malvinder Singh feels, that acquisitions mark the beginning of an explosive phase of inorganic growth. They intend to seek and look for opportunities in Europe, the USDA and India. Gone are days when Indian drug firms were regarded as good copycats.

According to Goldman Sachs during 2004, Indian firms have spent nearly Rs 631 crore on R & D. Most of this amount was spent on developing new formulations, the real gold mines since companies can sell during the patent period. One estimate according to Pricewaterhouse Coopers, suggests that there are nearly 37 drug candidates in the pipeline. Both DRL and Ranbaxy have developed about 10 molecules each. Further, Nicholas Piramal has just completed preclinical studies for a diabetes compound. In any case Indian companies find it hard to bear the cost of launching a new drug. From development to marketing a drug costs `nearly 4,442.5 crore on an average. Incidentally most of the Indian companies do not have this much annual turnover. Incidentally for every formulation that is launched, nearly 20 fall. That is one reason why Indian firms out-license to multinationals for co-development. Thus, Wockhardt is ready to take India's first antibacterial drug to Phase-II clinical trials. Chairman of the company feels that they can take to the final stages for launch within India but shall need some global partner for launching. It must be mentioned that generics experienced a squeeze during 2005 and so brands worth Rs 44,425 crore during 2005 descended from 66,635.5 crore during 2004. Indian companies gained only 22%. However, there was intense competition in base products since new products sought approval in very few cases but existing products sought approval increasingly. Top Pharma companies also experienced such a drop but they captured market share in noted launches. Even though Indian companies do not match US and European firms yet we have broken into the top three Pharma industries of the world. Right now the chief motto of the industry is 'Go west and take your medicine chest with you'. Says Mr. Pankaj Patel, Managing Director of Zydus Cadila, the fifth largest Pharma company in the country, "I don't believe that the patent regime is the end of the road for the Indian Pharma industry in fact, I think the opportunities for growth were never better."

The research in novel drug delivery system (NDDS) in India has assumed increased significance post-2005 era. The attempt is to introduce a more user friendly dosage form of medicine to enhance patient compliance and efficacy of tolerability to drugs. Research in this area is chiefly concerned with improving existing delivery mechanisms e.g. oral and transdermal. There is a tremendous scope for research in this area post 2005 era as MNCs are in search of novel delivery systems for drugs going off patent. There is vast scope for Indian companies in the market for off patent generic products as well. By 2005, the size of this market will grow to $ 30 billion in the US and to over $5 billion in European Union according Mr. A.K. Jain. From 2005, drugs worth US $ 30 billion have gone off patent. Indian companies are endeavoring to grab this opportunity due to their strong process re-engineering skills and low cost of development. To mention a few Ranbaxy, Cipla and Wockhardt are doing extremely well in this field.

CONCLUSION

In summary it can be propounded from the foregoing account that the new WTO patent regime has provided multiple advantages for Indian pharmaceutical industry like, increase in R&D activities, larger exports and a boost to contract manufacturing. The process patent regime which existed till January 2005 has really helped Indian industry to grow by leaps and bound to become very cost effective producer of bulk drugs and medicines. The time has now come for the Indian industry to establish a global foot print by taking advantage of the **Intellectual Property Rights (IPR)** regime. There is every reason to believe that the industry is going to be benefited in the near future. According to OPPI estimates, over the next few years around $60 billion worth of generics market will be created in the developed world due to patent expiry. India is now part of the global village and the new patent regime will encourage research and development in India – it has the potential to make India an international hub for pharmaceutical research. Indian producers will be able to continue to export drugs currently on the Indian market, even after product patents are introduced, due to the non-retroactive nature of product patents under the Act. Large investment flows have and likely to continue to pour into its economy from pharmaceutical industries around the world due to the certainty engendered by the TRIPS implementation. It will also provide the adequate incentive for the development of a local research-based pharmaceutical industry and other innovative sectors of the economy. Indeed, as **Dr. Raghunath A. Mashelkar, has noted, "in anticipation of the new challenges that will follow in the wake of TRIPS implementation Indian drug and pharmaceutical industries have increased their R&D spending by 400% in the past 4 years, and they are now looking to hire hundreds of Ph.D.s reducing the dramatic brain drain which India is currently experiencing".** Increased investment in the country and the likelihood that Indian scientists and researchers will remain at home instead of seeking jobs in the United States and elsewhere is certain. The prospect of better patent protection has already attracted foreign pharmaceutical firms anticipating to take advantage of research costs that by some estimates are one seventh of those in the United States.

In the long run the social purpose of intellectual property is to foster innovation by encouraging creation and allowing creators to reap the rewards of their innovation. Providing protection for the results of investment in the development of new technology gives the incentive and means to finance research and development activities. Such incentives will also support innovations in India, for the benefit of patients in India and around the world. In conclusion, TRIPS implementation in a country such as India should have no major negative repercussions and reports of the "death" of the Indian local pharmaceutical industry "post-2005" are, therefore, greatly exaggerated.

Indian Pharma market has special characteristics: low consumption, poor medical coverage and low prices of medicines. Even then Indian Pharma sector has grown from Rs 12 crore (1950) to Rs 200 crore (1970) to Rs 165 billion currently. It employs large number of persons directly and indirectly. Several factors have contributed to its enormous growth (23,000 Units) and these are: reverse engineering, introduction of new molecules regularly, increased health care awareness; aggressive marketing, liberalized government policies to import raw material, enhanced profitability, gradual relaxation of government control on drugs prices and liberal licensing policy.

With the coming in force of product patent regime since January 2005, it was apprehended that gloom and despondency, shall descend on Indian Pharmaceutical Industry. The situation post-2005 is the theme of the present article. A huge US $ 35 billion market for off patent generic products is a reassuring factor for Indian companies. Most Pharma companies have started planning strategies in order to dominate the Pharma scene. The captains of various industries especially OPPI India opine optimistically. The future shall lie with this knowledge driven industry.

Tremendous hopes are pinned on Indian engineers and scientists who can certainly take the Pharma industry to new heights. Added emphasis shall be needed on basic research to discover new molecules; outsourcing of bulk drugs and formulations of off patent block buster drugs by MNCs. Several MNCs are coming to India for contract manufacturing; recognition that India Pharma Company have superior skills for chemical synthesis; quality conscious manufacturing infrastructure; maintaining low labor costs; reinforcement of marketing strengths, backward integration of Pharma business and aggressive marketing generics in high margin export markets; discovering novel drug delivery systems; R &D on analog research; establishing a base in Western countries; globalization philosophy; tapping ancient Indian system of medicine, Ayurvedic for new drugs, to build a golden triangle between traditional medicine, modern medicine and modern science. The criteria for success in post-2005 era demands skills of new product development, product portfolio leadership, competitive prices, superior brand management skills and strong distribution network.

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14

Recent Trends in the Use of Herbal Drugs in the Development of Formulations for Pharmaceutical Industry

C.P. Malik

Herbs have been used since time immemorial to alleviate human suffering. 80% of the world population, mostly in developing countries of Asia, Africa and Latin America use medicinal plants for their primary healthcare. These plants constitute the major component of traditional and herbal medicine, more recently called as herbal medicinal products.

In 1994, global market for herbal medicine was US $ 12.46 billion and has touched US $ 24.2 billion in 2002. Europe is the global leader in retail sales of herbal medicine. On the contrary USA is the world's fastest growing market for herbal products. With the categories of health foods, natural cosmetics and personal hygiene products having been constituted, demand for medicinal and aromatic plants has enhanced enormously in the global market. The international demand for medicinal plants and herbal products is calculated to be over US $ 60 billion during 2002 and is surmised to increase to 4 trillion by

2050. China and India are the major suppliers to the world market. The recent trends in the use of herbal drugs can be classified into the following four major user groups :

- Phytopharmaceuticals
- Herbal Medicines
- Natural Health products
- Phyto-cosmetic and personal hygiene products

PHYTOPHARMACEUTICALS

Several important drugs molecules of modern therapeutics are being obtained from herbal drugs. Currently nearly 50% of the total prescriptions of the plant derived products arise from single entities. The sale of these plant drugs in USA approximates to nearly US $ 4.5 billion (1980) and US $ 15.5 billion in 1990. With increasing demand of herbal medicines and increased interest of pharmaceutical companies in the discovery of new molecules the share of plant prescription drug is expected to increase to 30% in the coming years. Alkaloids are third most significant category of plant derived drugs as regard sales, the most significant are those related to neural, respiratory, digestive and skin problems as well as pain and cancer.

HERBAL MEDICINES

These are oldest form of the health care products familiar to mankind and constitute an integral part of modern civilization. Medicinal plants are predominantly used in indigenous or alternative system of medicine. They are commonly employed in different systems of medicine e.g. Ayurvedic, Homoeopathic, naturopathic, Oriental and Native American Indian medicine, etc. WHO reports indicate that nearly three fourth of the herbal drugs correlated directly with their traditional uses in native culture.

In the following we summarize various plant spp. and plant products used for different ailments :

ESSENTIAL OILS

- Treatment of dental caries with Neem oil as an alternative medicine replaces antibiotics.
- The essential oils used as fumigants exhibit complete protection of stored wheat samples from fungal as well as insect invasions without showing phytotoxicity.
- *Marijuana hortensis* or sweet Marforam or Murwa is useful in treating asthma, hysteria, paralysis. Fresh and dried leaves are highly valued as a condiment for seasoning of food. Considered to be carminative, expectorant and tonic, leaves and seeds used as astringent. Infusion of the plants is used as stimulant, sudofric, emmenagogue and galactogogue.
- *Artemisias niligirica* : Used as a substitute for cinchona in fever. It has antilithica and alexipharmic properties and assists perturbation. Decoction is given to children suffering from measles. Infusion of leaves and flowering top is given in nervous and spasmodic infections and asthma.
- *Artemisia maritime* : Oil is very efficient in action on round worms.

- *Matricaria chamomile :* Essential oil is used in alcoholic and non-alcoholic beverages, ice cream, baked goods, chewing gums and in high class perfumes. It acts as expectorant, carminative, anthelminitic, deductive, diuretic, etc.
- *Origanum vulgare :* Oil has carminative, stomachic, diuretic, diaphoretic and functions.
- *Lantana camera :* Leaves and seed essential oil is antimicrobial against *Bacillus subtilis, Escherichia coli, Shigella boyedii* and *Salmonella typhimurium.*

General :

- *Munrovia pumilla* effective against high fever as in Malaria.
- *Psoralea corylifolia* against skin diseases.
- Artemisin from *Artemisia annua* against Malaria (in insect and bacterial infections).
- *Barleria lupulian* and *Aloe vera* for burns.
- *Curcuma longa* for indigestion.
- *Andrographis paniculata* for fever.
- *Morinda citrifolia* for nausea.
- *Copitatita* against fever.
- *Aconitum heterophyllum* against stomach disorders.

AGAINST CANCER

- *Camptothecin* (CPT) from stem bark of *Camptotheca acuminata* (tree native to China) has efficacy against solid tumours, breast, lung and colorectal cancers which are unaffected by many other cancer chemotherapeutic agents. This tree has got abundant source of CPT.

  Three anti-tumour alkaloids CPT, 9-methoxy CPT and 20-O-acetyl CPT were isolated from *Nothapodytes foetida.*

  CPT is isolated from *Ophiorhiza rugosa* var. *decumbens, O. erianth, Tabernaemontana heyneana, Merilliodendron megacarpum.*
- Vinblastine and Vincristine from Periwinkle (*Catharanthus roseus*) is used against cancer.
- Sulphorapane (acts as a strongly protective agent against cancerous growths) is isolated from most cruciferous vegetables such as Brussels sprouts, Cabbage and Cauliflowers and Brocoli. This compound is not destroyed in cooking. Similar properties have been found in limorine from citrus fruits, *Allium* compounds in garlic and onions, Isoflavones in beans and allergic acid in grapes.
- *Taxus baccata* which yields Taxol used against cancer.
- Some other cancer curing plants are : *Aconitum heterophyllum, Allium sativum, Bauhinia variegata, Boerhaavia diffusa, Calotropis procera, Curcuma longa, Haolarrhena antidysenterica, Melia azadirachta, Ocimum gratissimum, Plumbago zeylanica, Tecoma undulata, Catharanthus roseus, Tinospora cordifolia, Withania somnifera.*

AGAINST AIDS

- The Bitangor (*Calophyllum, Lanigerum austrocoriacum*) extract from the twigs and branches contains a compound Castonolide A which has proved potentially useful against – AIDS. Other species *C. teysmaniiinophylloide* also contains a more abundant but less potent compound called costanolide.
- Some other AIDS curing plants are : *Allium sativa, Aloe vera, Asparagus racemosus, Curcuma longa, Emblica officinalis, Glycyrrhiza glabra, Ocimum sanctum, Terminalia chebula, Tinospora cordifolia, Tribulus terrestris,Withania somnifera, Zingiber officinale.*
- Some blood purifying plants are : *Adhatoda vesica, Bambusa arundinacea, Berberis aristate, Curucuma longa, Hemidesmus indicus, Melia azadirachta, Piper nigrum, Psoralea corylifolia, Pterocarpuas santolina, Rubia cordifolia, Vitis vinifera, Withania somnifera.*

AGAINST INSECTS

- In a study against tobacco caterpillar (*Spodoptera litura*) though the mean weight of larvae treated with extracts of seven different medicinal plants, *Gymnema sylvestre, Curcuma amada, Piper longum, Andrographis paniculata, Withania somnifera, Clerodendron phlomidis* and *Aristolochia bracteolata* were statistically at par (0.265 to 0.398 g) but *G. sylvestre* was found best among all even better than the established antifeedant *Azadirachta indica.*
- Neem (*Azadirachta indica*) controls more than 200 species of insects, mites, nematodes including major pests such as locust, rice and maize borers, pulse beetles and rice weevils, yet it does not harm birds, mammals and beneficial insects such as bees. Also it is used as a contraceptive agent. Neem is also reported to have fungicidal, antibacterial and even anti viral properties.

HERBAL DRINK

- Mulberry Herbal Tea has been produced in Thailand. Two types are : Green Tea and Chinese Tea. It has flavor, colour and solubility in hot water according to the industrial standard for tea. It has 200 times less caffeine than ordinary tea, which is 0.01%. Gamma amino butyric acid present in mulberry tea has the property of reducing blood cholesterol. Phytosterol in mulberry tea has the property of reducing blood cholesterol. Moreover, it also has deoxynojiuimycin which is effective in reducing sugar level in the blood. The mulberry leaf extract has been found to contain chemicals which inhibit cancer. The Chinese traditional medicine describes the therapeutic use of Mulberry tea in lowering blood pressure.

SWEETENER

- Jubilee (*Pentadiplandra brazzein*) berries found in Gibbon in West Africa, contains a protein (brazzein) which is 2000 times sweeter than sugar. Being a protein (natural substance) it does not lose its sweet taste when heated. Today top biotechnology companies are engaged in Africa battling to tap and control the undiscovered plant based pharmaceutical wealth (valued more than $ 147 billion) available in the tropical forests alone. Likewise the sales of drugs from Indian plant Periwinkel and *Rauwolfia serpentina* is more than $ 260 million every year.

TAXOL

- It is Isolated from *Taxus brivifolia* by bioassay directed fractionation. Thus, isolation of 1 g of taxol requires bark from 3 mature yew trees. The interest in taxol drug discovery followed by crystallized compound and showed high activity in case of ovarian cancer. Taxol stabilized the microtubule assembly by inhibiting back polymerization of tubulin, an important protein present during mitotic phase of cell cycle. In 1994 successfull clinical trials were done, though the amount of taxol from natural source (0.01%) was a limiting factor since more quantity is required for clinical trials. This difficulty was resolved through its semisynthesis, which involved isolation of biosynthetic precursors of paclitaxel from renewable source of *T. baccata* which contains about 1% of Baccatin III and 10-DAB III. The precursors are converted into taxol by reacting with taxol side chain.

CAMPTOTHECIN

- This is isolated from *Camptotheca accuminata* (Nysaceae) and is found to be active in L1210 & P388 mouse leukemia life prolongation assay; 10-Hydroxy CPT was more active than CPT (Camptothecin). Camptothecin is shown to inhibit selectively topo-isomerase-I enzyme. Topotecan and CPT-11 are clinically used derivatives .

ARTEMISIN

- It is a sesquiterpene lactone isolated from *Artemisia annua* and is used to treat malaria. It is effective against multi-drug resistant strains of malarial parasite. The compound kills malarial parasite by getting activated itself in the presence of iron and converted into a free radical, which binds with malarial parasite protein and stops the growth of the parasite.

ARTEETHER

- Arteether (ether derivatives), artesunate ester derivative and dihydroartemisin are used in the form of oily injections for intramuscular use and oral tablets, for the treatment of malaria.

  Proper identification of the drug is desired since local names may be misleading e.g. 'Haritaki' (fruit of *Terminalia chebula*) has seven varieties originating from different parts of the country and are attributed with different therapeutic properties (Table 1).

Table 1 : Anomalies in nomenclature of herbs

Local name	Botanical origin
Brahmi	*Bacopa monieri* or *Centella asiatica*
Babuna	*Matricaria chamomilla* or *Corchorus depressus*
Rasna	*Vanda roxburghii* or *Pluchea lanceolata*
Vadarikhand	*Pueraria tuberosa* or *Ipomoea digitata*
Varahikand	*Dioscorea bulbifera* or *Tacca aspera*

IDENTIFICATION OF ADULTERANTS

- The genuine herb drug is admixed with the adulterant. For example *Selinium vaginatum* with those of *Nardosstachys jatamansi* (Jatamansi); *Calotropis procera* with *Rauwolfia serpentina*, etc.

  Earlier the herbs were collected by local people from the wild; but their ever increasing demand and urbanization has depleted some of the sources, hence possibilities of adulteration or substandard supply has increased. The Pharmacognocist plays an important role to ensure a standard, specification consistent herb supply by undertaking the studies for proper identification of the herb through proper techniques (Macroscopy; Microscopy; Flourescence studies and qualitative test). A proper identification must be followed by checking the quality of the herb.

Table 2 : Leading herbals in USA in 1998

Herbals	Botanical name	Sale value (million US $)	Growth (%)(1996-98)
Ginkgo	*Ginkgo biloba*	138	140
St. John's Wort	*Hypericum perforatum*	121	2801
Ginseng	*Panax sps.*	98	26
Garlic	*Allium sativum*	84	27
Echinacea	*Echinacea sps.*	33	151
Saw palmetto	*Serenoa repens*	27	138
Grape seed	*Vitis vinifera*	11	38
Kava kava	*Piper methysticum*	8	473
Evening primrose	*Oenothera biennis*	8	104
Goldenseal	*Hydrastis canadensis*	8	80
Cranberry	*Vaccinium macrocarpon*	8	75
Valerian	*Valeriana spp.*	8	35
Others	—	31	—

Table 3 : Some values of herbals in 9 regions of the world

Region	Sale value (billion US $)			
	1994	1997	1999	2002
Europe	6.00	7.00	7.00	8.90
North America	1.50	1.60	3.80	4.50
Japan	1.80	2.40	2.20	2.90
Asia	2.70	2.20	5.10	6.00
Austral-Asia	—	—	0.12	0.14
Africa & Middle East	—	—	0.19	0.21
Latin America	—	—	0.60	0.83
Eastern Europe	—	—	0.37	0.80
Rest of World	0.50	0.80	0.20	0.30
Total	**12.40**	**14.00**	**19.58**	**24.18**

NUTRACEUTICALS

Herbs are used as nutraceuticals. The USA, Europe and Japan are the major producers and consumers of health food products. On the other hand, the increasing interest and popularity of health product in the Asia, Latin America, Africa and Middle East is creating more opportunities at international level than at the domestic level. Health foods are known with different names throughout the world i.e. functional food in oriental and nutraceuticals in western region. As per the literature both are synonyms for health food products.

'Nutraceuticals' is the latest term for health foods which are more correctly defined as a part of a food or a whole food that have medical and health benefit, including the prevention and treatment of diseases. The three main constituents which make the nutraceuticals are herbal and related extracts, vitamins and minerals, and nutrients.

DIFFERENT TYPES OF NUTRACEUTICAL PRODUCTS

The major nutraceuticals include dietary supplements such as food supplements, drinks, herbal extracts, vitamins and essential oils; fortified food such as high carotenoids, tomatoes and vegetable oils modified to improve their fatty acid profiles, foods and beverages with added bio-active ingredients such as Ginseng, Tea or cholesterol lowering phytosterols and entire food regimens.

PHYTOCOSMETICS AND PERSONAL HYGIENE PRODUCTS

The following are the major cosmeceutical products being formulated having ingredients from natural origin :

- Hair tonic for the growth stimulation and retardation of greying.
- Skin caring.
- Facial preparations to improve the appearance, facial implants and chemical peels, etc.

- Hair conditioner.
- Herbal soaps and shampoos.

FUNCTIONAL AND MEDICINAL FOODS

It is mainly connected with mainstream of plant biotechnology and molecular biology. Functional foods are produced by fortification such as orange juice with calcium, health plant oils from modified oil crops, edible vaccines and plants with increased levels of essential vitamins and nutrients.

The current health related goals of plant oil seed engineering is to increase the content of healthy fatty acids (trans unsaturated fatty acid) and ratio between omega-6 and omega-3. Unsaturated fatty acids in some vegetable oils thus reduce the risk of heart disease.

Other recent advances in functional plant foods include increasing vitamin E contents in plants – *Arabidopsis*.

- Selecting high lycopene or vitamin C tomatoes;
- Metabolic engineering of legumes and tomatoes from high contents of bioflavonoid (known for their antioxidants, anticancer and estrogenic properties) and possible use of thioredoxin to decrease allergenicity of foods.

Plant produced oral vaccines were recently shown to be highly effective as boosters that have increased the immunity of mice to measles and humans to hepatitis.

The future of plant based functional foods seems bright and as a result, grocery and drug store might eventually look alike.

RECOMBINANT PROTEINS

Recombinant proteins, such as antibodies, vaccines, regulatory proteins and enzymes, represent one of the most rapidly growing segments of the pharmaceutical industry. With dozens of proteins in clinical development today there is a substantial shortage of industrial capacity to manufacture future recombinant drugs. During the past decade, plants have emerged as promising biopharming systems for commercial production of pharmaceutical proteins. Tobacco was the first plant to express a recombinant antibody in 1988, with further confirmation in 1989.

Plants are generally considered to be low-cost, safe and relatively fast alternatives to many existing manufacturing systems, particularly when large quantities of multimeric recombinant proteins (i.e. antibodies) are required. Most major groups of human pharmaceutical proteins have been produced successfully in a diverse variety of crops and model systems (e.g. maize, rice, wheat, soybean, tomato, potato, mustard, oil seed rape, turnip, alfalfa, banana, tobacco and *Arabidopsis*) using stable; nuclear and plastid transformations, as well as transient expression systems such as viruses.

Secondary metabolites are produced as a consequence of morphogenesis including metabolic and cyto-differentiation. In some situations secondary metabolites are synthesized following stress (abiotic or biotic) and activation of some gene.

A large number of secondary plant metabolites are produced following differentiation. These are flavour, pigments, tannins, fragrance. In poppy alkaloids are produced in laticifers. Similarly vinblastine and vincristine are produced in cultures where there is shoot formation. In *Mentha piperata*, cell culture with shoot formation synthesize menthol in mint. Several factors regulate secondary metabolite synthesis and these are : hormones (cytokinins); cytodifferentiation, stimulate accumulation of secondary metabolites. Several types of stress e.g. osmotic stress; UV-radiation, biotic and abiotic stress stimulate alkaloid synthesis and accumulation in plant cell cultures.

Recently mutagenesis and/or breeding is used to increase the production of intended product. More recently recombinant DNA technology is employed to modify the genomes of organisms directly. The new technology has overcome several hurdles posed by traditional genetics. Consequently it has been possible to construct novel organisms with novel metabolites through new reactions. There are several aspects which are sought in transgenic plants to synthesize novel chemicals through : accomplishment of partial pathways; stimulation of existing pathways; blockage of undesired pathways, revising metabolic regulation; minimizing response cascades.

STRATEGIES TO IMPROVE YIELD/END PRODUCT BIOTECHNOLOGICALLY

In the following we shall briefly describe the strategies for improving secondary metabolite production with high yield.

A combination of biotechnological methods and cultural conditions are required to enhance production of secondary metabolites. Nearly 20000 organic compounds are listed as secondary metabolites. Some of the strategies exploited for increasing metabolic production include : selection of elite source material; selecting superior cell lines; optimizing cultural conditions; induction of stress; scale-up-the process; use of rDNA technique; genetic transformation; cryo-preservation of elite types, and micropropagation.

SELECTION OF ELITE SOURCE MATERIAL

Species and plants having abundant quantities of secondary metabolites are used as starting material. Thus, for a given specific natural product, explants are secured from diverse sources/species. Then different parts are used as explants from different cultivars. Finally, yield of secondary products in individual explant is evaluated (Debnath *et al.*, 2006).

SELECTING SUPERIOR CELL LINES

Following screening and selection process, high yielding cell lines are identified. The technique is best suited for visual characterization e.g. pigments (*Beta vulgaris, Vitis vinifera*), flavours as vanilla. RIA and ELISA tests are also employed. If non-destructive analysis is desired, it is ideal to use NMR. Generally chromatographic methods are used to screen plant compounds. Shoot tip meristem, seedling, embryo explants are highly productive. For terpenoids, leaves perfumes and for nicotine, roots are preferred.

OPTIMIZING CULTURAL CONDITIONS

For this several conditions are altered and these include, light, culture medium, stimulation of synthesis of metabolites, immobilization. Different spectra of light have profound effect on production of secondary compounds. For instance light stimulates production of metabolites is in leaves (essential oils in glands), but interferes with paclitaxel formation in *Taxas* spp.; napthaquinones in *Lithospermum*. Visible light close to UV for vinblastine production in *Catharanthus* has a profound effect.

Growth of cells *in vitro* and production of secondary metabolites depends on the nutritional status of each species, different genotypes and even cultivars. Different culture media are tried to achieve optimal biomass, secondary metabolites by using mineral salts, vitamins, organic supplements, carbohydrate, hormones, etc. Thus for alkaloids (serpentine) and naphthaquinones, shikonin is used. Generally auxin and nitrate are decreased and ammonium salts and carbohydrate levels are enhanced.

The addition of hormone(s) also determines the quality and quantity of secondary metabolites. Supplementing the culture medium with substantial amount of precursor, causes increase in yields of metabolites. It is desired to ensure that cells have the tolerance to withstand the concentration of metabolites. It is required to find out degree of tolerance (1 g L^{-1}/2 g L^{-1}). Caution is observed to avoid production of unknown or undesired compounds.

The induction and stimulation of metabolites by elicitation is also practiced but type of elicitation, its application to cultural conditions must be standardized. Jasmonate induces production of secondary metabolites. Generally 5 mðl of an ethanol solution of Jasmonic acid or Methyl Jasmonate per 1 ml of cell suspension is used. Immobilization of aggregate cells in a tissue like manner is continuously exposed to culture medium *in vitro* yields high metabolites production. Different types of matrices are used to entrap cells. Some of the matrices used are hollow fibres, polyacrylamide gels, carrageenan, agarose, alginate, reticulate polyurethane foam in stainless steel screen.

GENETIC TRANSFORMATION

In many plant species roots are induced at the point of infection by *Agrobacterium rhizogens*. The transformed roots accumulate secondary products. In fact transformed roots exhibit high degree of genetic stability and show biosynthetic activity for extended periods. The roots show enormous growth and generally grow fast in a medium lacking growth regulators. Table 4 shows examples of phytochemicals produced by hairy roots.

Table 4 : Instances of phytochemicals produced by hairy roots

Compound	Culture
Ajmalicine; Catharanthine	*Catharanthus roseus*
Hyoscyamine	*Datura stramonium*
Nicotine	*Nicotiana tabacum*
Saponin	*Panax ginseng*
Shikonins	*Listhospermum erythrhizon*
Quinine	*Cinchona ledgeriana*
Thiophenes	*Tagetes patula*
Arabasine; scopolamine	*Atropa belladonna*
Serotonin	*Peganum harmala*

PRODUCT RELEASE AND ADSORPTION

Cell cultures in descending phase of growth, will mature and often show signs of decline and lysis. As a result, secondary metabolites are leached in the nutrient medium which can be subjected to downstream processing. Future studies will seek to manipulate *in vitro* system to check release of metabolites. One of the approaches is adsorption of metabolites from the medium, release of products from vacuoles without damaging cells. The metabolites may be released through passive diffusion, enhanced by permiabilization with DMSO on chemicals and subsequent adsorption of metabolites. This also essentially requires procedures which will suppress, enzymatic or non-enzymatic metabolisms of extracellular products. Hence non-toxic, non-interactive adsorbants are used.

Cells, tissues or organs of medicinal plants have been successfully cryopreserved. The cells or tissues are stored at ultra low temperature (-190 °C) and on demand retrieved without genetic alteration.

Additionally, plants regenerated from elite *in vitro* grown cells, tissue or micropropagation of elite plants are used to raise high yielding genotypes. The elite clones once identified are repeatedly micropropagated.

STANDARDIZATION OF DIETARY SUPPLEMENTS

Official standards are absolutely essential to ensure the quality, reliability, and homogeneity of herbal products for consumers standardized products are paramount to those in health care planning to conduct clinical research with these products.

In 1995, the USP commissioned an advisory panel on natural products whose aim was to propose standards and develop information concerning herbal or 'dietary' supplements. Supplement monographs created by this mission address various issues linked with the standardization of individual herbals. The following list of section headings outlines the information found in each of the monographs :

1. **Title** – identifies the most commonly accepted name of the entity.
2. **Definition** – describes plant parts used, (genus, species, authority, and family) of the botanical material.
3. **Packaging and storage-** appropriate packaging and storing conditions designed to promote integrity of the product.
4. **Labelling** – states requirements for label nomenclature.
5. **Reference standards :** identifies appropriate reference standards.
6. **Botanic characteristics** – describes visible and microscopic shape and structure characteristics of the whole plant or plant parts.
7. **Identification** – describes pharmacognostic tests for the identification of the entity.
8. **Total ash** – for the amount of inorganic residue remaining after incineration.
9. **Acid**-insoluble ash –for the amount of foreign inorganic residue remaining after boiling the total ash with 3N hydrochloric acid.
10. **Water soluble ash** – for the residue remaining after boiling the total ash with water.
11. **Foreign organic matter** – the amount of non drug containing matter.
12. **Loss on drying** – criteria for loss limits of water, volatile oils, or other volatile chemical compounds.

13. **Water content** – variation in the water content of dried botanicals.
14. **Alcohol soluble/water soluble extractives** – thresholds for minimum acceptable amount of aqueous, alcohol, or aqueous alcohol-soluble extractives.
15. **Volatile oil** – the quantity of volatile oil present in the botanical.
16. **Heavy metals** – heavy metals present in the botanical.
17. **Pesticide residue** – strict limits of pesticide content.
18. **Microbial limits** – of total bacteria and mold count.
19. **Marker substances and content test** – standards for quantitative chemical analysis of plant products for the presence of certain marker substances that aid in proper identification.

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15

Medicinal and Spiceal Plants for Human Welfare through Different Therapeutics

Karan Singh and S.M. Husain Zafri

PREAMBLE (INTRODUCTORY ANCIENT HISTORY)

Human being is considered as most precious creature of the Almighty who always blesses him a life with happiness and pleasure. However, due to some known and some unknown reasons (spiritual or adhyatmic), he/she is caught by different kinds and intersities of sufferings. Among such suffering, ailments of human body (diseases) are most common. As a results of multiplicity of such problems, intellectuals in all part of the world have developed different systems to keep the human being normal and healthy. The objectives of all these systems of health sciences is common-to alliviate the human pains and illness. The methods of achieving the objectives, are however, different. If we look into the past, it will be evident that health sciences across the world have evolved as a splendid blend of science, art, philosophy and mythology. We have made considerable advancement in physical, mathematical, mechanical and electronic sciences, but still today, much of the healing art is a myth wrapped in mystery inside an enigma. And honestly realizing, a practicing healer (doctor) is very much a child of his time.

Scientists, practitioners, doctors, vaidyas, haqeems and others who made valuable contributions in health sciences have honour and enormous respect in society. There number is almost non countable and to quote their names in this overview as such is very difficult. In orthodox system of medicine (Allopathy) names of Nicholeas Culpeper, Vesalius, Simpson, Flemish Lister, Dioscorides, Alexander Fleming, Sydenham, Birhmingham are regarded. Hippocratus (460-377 BC) the father of medicines, wrote about 50 books. His famous oath is still used today by medical students (Hippocratic Oath—'I will use treatment to help the sick according to my ability and judgement). Paracelsus (1493-1541), a Swiss physician also made significant contributions.

Homoeopathy system of medicine was founded by famous physician Dr. Samuel Hahnemann who advocated that minute doses of medicines (prepared from plants, animals or minerals) are able to stimulate the body's defense mechanisms. Others who made valuable contributions in Homoeopathy include many names. The Ayurvedic system of medicine is very old and parallel to the progress of civilization. In this system, medicines of plant origin are very important. In ancient India, Atreya, Charak, Susrata, Dhanvantri, Chavyan etc. made valuable contributions through Vedas. This system is older than Allopathy and Homoeopathy and is very comprehensive.

Unani-Tibbi system of medicine arrived India with mughal empire. It was based on the work of Avicenna, the renowned physician of Persia, Unani is the arabic word for 'of the Greeks' whereas 'Tibb' is arabic for medicine and healing. In India, the admixture of Graeco-Roman and Arabian medicine is known as 'Unani' medicine often linked with Tibbi. Haqeems (Unani physicians) who made valuable contributions include many names. The alternative systems of medicines include a diverse group of treatments including Acupressure, Acupuncture, Moxi Bustion, Aroma-therapy, Herbalism, Hypnosis, Massage, Osteopathy, Reflaxology, Yoga-Naturopathy, Meditation, Shiastu Taichu, Chiropractice, Bioenergetics, Juice therapy, Fruit therapy, Magnet therapy, Hypnosis, Reiki etc.

BASIC PRINCIPLES OF DIFFERENT PATHIES

There are some basic principles of different pathies which treat the patient through a blend of science and art. However the relations between a doctor and patient are important.

Allopathic system of medicine has progressed a lot in all parts of the world. The basic requirement is to make a proper diagnosis which leads to proper prescription and administration of medicines. The drugs contain active substance/s alone or in combinations and should be taken in prescribed dose at specific intervals. Antibiotics, vaccines, analgesics, anaesthetics and anti-histamine are important groups. This system believes that symptoms are a part of disease. The large part of the conventional treatment is, therefore, symptomatic. Little consideration for the temperament of the patient. The diagnosis of the problem is based on various modern methods including blood test, urine test, stool test etc.

The basic principle of Homoeopathy is *'like cures like'*. Medicines are given in very-very minute doses (potentized/triturized). The principle is based on common observation that strong dose proves injurious and minute dose of the same medicine cures the symptom. Medicines are developed based on systematic experiment performed on volunteers. It is further believed that any medicine cures that disease, which this medicine can produce when given to healthy person. (Law of similar—Similia—Similibus curantur). Homoeopathy gives high importance to symptoms (physical, mental, temperamental etc.). Originally single dose/

single medicine properly selected was prescribed but now-a-days combinations are also prescribed, Psora, Siphilis and Sycosis are three basic considerations.

The Ayurveda, the science of life, follows holistic approach. This system views health as a balance between a person and environment. It lays equal emphasis on exercises, good habit of eating, work climate, emotions, spirituality and even sexual activities. It also recognises a life force (vital force) which is known as 'Prana'. 'OM' symbol denotes life force. It is commonly believed that in a healthy person, the Vaat, Pitt and Cough (Kaff) are in balanced and equilibrated state (Homoestosis) and a disturbance in any of these three becomes the causal factor for illness. Panch-bhoot system is followed.

Unani-Tibbi system believes that most illnesses arise solely from long continuous errors of diet and regimen. Thus, the Unani medicine rests on the principles of harmony and balance, uniting the physical, mental and spiritual realms. This system divided the main elements of body into seven categories—1. Aarkan, 2. Mijaj, 3. Akhlat, 4. Aja, 5. Aarva, 6. Kuva, 7. Aafal. These are collectively known as 'Um ure Tabia'. Unani Haqeems (Hakeems) believe that a good health depends on healthy food, drink, muscle movement, rest, sleep, early walking, defaction and restrained sex.

Alternative systems of medicine are diverse and have variable principles including herbal application, colour, aroma, vital energy, hypnotic practice etc.

There is a critical need to examine common features of all the system of medicine and their integrated uses for human welfare.

PLANTS AND AYURVEDIC DRUGS/FORMULATIONS

Ayurvedic drugs prepared from plants are considered as potent agents to improve the health through ameliorative actions on *'vital force'* of the human body. As per the principle of Ayurvedic system of Medicine, an imbalance of 'Vaat', 'Kafa' and 'Pitta' reduces the vital force of the body and this reduction leads to lowering down of body resistance to biotic (and even abiotic) factors responsible for all ailments. In Ayurvedic system of Medicine, drugs are predominantly prepared/extracted from plants, plant parts (trees, shrubs, herbs, climbers etc.) These plants are still (more or less) obtained from *wild resources.* This has led to over exploitation of certain wonderful vegetable drugs. Due to this over exploitation, some plants have extincted completely and few are at the verge of extinction. Hence, some *'Ayruvedic Medicines'* are in great scarcity. Due to this situation, some traders are misusing the situation by saling fictition or furious or false drugs or adulterated drugs.

In Ayurveda, plants are used in different forms including powder, tablets, juice, water extract, decoction, concentrate, chutney, aasava, distillates. Some other methods of preparation of drugs from plants are named as (No English version) Avaleh, Paak, Aasava, Arishta, Sharbat, Murrobba, Ghee Sidda, Tel Sidda, Faant, Putpaack, Ras Kriya Dhan, Manth, Kshaar etc.

Under the guidance of vaiddyas, the medicine should be used in morning (churna), with meal or after meal, just before sleep, twice a day etc.

Recently Brahm Varchas (2005) has described various aspects of therapeutically valuable plants. These aspects include common name (English name), Hindi name (Varnicular name), Botanical name, family, part/s used, growth habit, taste, chemical constituents (phytochemical status), major actions on body, major disease controlled by the drug, properties, applications with anupaan (such water or milk or honey or alcohol etc.). For details of each plant, an authentic reference of this book may be made. In all, 304 plants have been described. These plants include Abrus, Abutilon, different species of Acacia, Achyranthes, Acalypha, Aconitum, Acorus, Adansonia, Adhatoda, Adiantum, Aegle, Agave, Ailanthus, Albizzia, Allium (two species), Alocasia, Aloe, Alpinia, Altonia, Althea, Amaranthus, Amaryllis, Amomum, Amorphophallus, Anacardium, Andrographis, Annona, Aralia, Artemissia, Asclepias, Asparagus, Bacopa, Barleria, Bauhinia, Berberis, Boerhaavia, Brassica (different species). Caesalpinia, Calotropis, Carica, Cassia, Catharanthus, Centella, Chenopodium, Chlorophytum, Cinnamomum, Citrus, Clerodendron, Commiphora, Curcuma, Datura, Daucus, Digitalis, Dioscorea, Emblica, Eriobotrya, Ferula, Ficus, Glycirrhiyza, Gymnema, Jatropha, Lawsonia, Leptadenia, Melia, Mentha, Mimosops, Momordica, Myristica, Ocimum, Papaver, Phyllanthus, Piper, Plumbago, Plantago, Psoralea, Punica, Santalum, Sessamum, Solanun, Swertia, Syzygium, Tephrosia, Terminalia, Thuja, Tinospora, Tylophora, Vitex, Withania and Zingiber etc.

The number of pharmacies preparing and marketing Ayurvedic medicines is very large. Most of them have their centre of origin in India and few of them have attained international reputation. Few of such pharmacies may be named as Dabar, Baidyanaath, Uunjha, Zhandu, Himalayan Drug Co., Gurukul Kangri, Shantikunj, Divya Pharmacy (Patanjali Yog Vidyapeeth) etc. The Pharmaceutical Laboratory for Indian Medicine (Government of India), Ghaziabad (U.P.) has described some important medicinal plants with formulations point of view. These are as below in tabular form (Table 1).

Table 1 : Medicinal plants with common formulations (only very few are selectively given). There are many more which may be referred in Indian Pharmacopia (Ayurvedic)

S. No.	Botanical Name and family	Hindi/ Indian Name	Important Formulation	Therapeutically Uses
1	2	3	4	5
1.	*Hibiscus sabdariffa* (Malvaceae) : Root	Ambastaki	Pusyanuga churna	Pakvatisara
2.	*Clitoria teranatea* (Papilionaceae) : Leaf, root	Aparajita= Gokarni	Vataraktan-takaras, Misraka sneha	Kushta, Mutra, Vrana Aamsoth
3.	*Withania somnifera* (Solonaceae) : Root	Ashwagandha	Ashwagandha-rista Ashwagandha-lepa Balaswa	Ksya, Daurbalya vata roga, sotha, klaibya
4.	*Ficus religiosa* (Moraceae) : Stem bark	Asvattha	Nyagrodadhi Kwatha, Churna	Prameha, Raktapitta, Vatarakata, Vrana, Yonidosh

contd. ...

contd. ...

1	2	3	4	5
5.	*Ailanthus excelsa* (Simarubaceae) : Stem bark	Araluka	Pusyanuga churna, Brahtgagadhar churna	Twakurga, Apasmara, Pravahika, Atisara, Grahni Arsa Bhagandhara Raktapitta, Prameha, Prador
6.	*Cassia fistula* (Caesalpiniaceae): Stem bardk, Endosperm Seed, Leaf, Fruit pulp	Aragvadha	Nyagrodhadhi Churna, Mahatikta ka Ghrita, Kushtha raksasa, Taila, Somraj Taila, Brahmi Ghrita	Vibandha, Udavavtta Gulma Sula Udara roga Prameh, Hridya roga
7.	*Calotropis procera* (Asclepiadaceae) : Root Leaf, Latex	Arka = Aakaro	Dhanvantri Ghrita, Kasisadi Tail, Arka, Lavana, Vjra Ksaro	Kandu, Kusth, Krimirogo Gulma, Udara rog, Urana, Swasha shotha, Slesma Udar-roga Pliha Arsa.
8.	*Abutilon indicum* (Malvaceae) : Root	Atibala = Kanghi ghas	Mahavisa-grabha Taila	Meh, Vatarakta Raktapitta
9.	*Mimosops elangi* (Sapotoceae) : Seed	Bakula	Varisosan Rasa	Sweta Kushta, Danta Roga, Krimiroga
10.	*Eclipta alba* (Asteraceae) : Whole plant	Bhrangaraja	Puga Khanda	Krimi roga, swas roga, Kasa roga, Sotha, Pandu
11.	*Coccinia indica* (Cucurbitaceae) Whole plant	Bimbi = Kanduri	Vatsyana-mayantaka Ghrita	Kapha, Kasa, Sotha, Swas, Agnimandya, Kamala, Raktavikar Prameha, Carma roga, Fever.

contd. ...

contd. ...

1	2	3	4	5
12.	*Aegle marmelos* (Rutaceae) : Root, Leaf Fruit pulp	Bilva = Bael = Beil	Amritarista Vacalasunadi Taila, Suta-sebharo Raja	Provahika, Agni-mand, Grahani roga
13.	*Bacopa monnieri* (Scrophulariaceae) : Leaf, Stem, Root, Whole plant	Brahmi	Sarasa vata-rista, Brahmi-ghrita	Kushta, Pandu, Meha, Sotha, Jwara
14.	*Punica granatum* (Punicaceae) : Stem bark, Fruit pulp, Dried seed, Fruit rind	Dadima= Anaar	Mrtasonjivani sura, Kalyanaka Ghrita, Dadimadi Ghrita, Dadhika Ghrita	Daho Jwar, Rakt atisar Guda roga Trishna
15.	*Ricinus communis* (Euphorbiaceae) : Root, Seed, Oil, Leaf	Eranda	Rasnadi Kwatha, Churna, Simhanda Guggulu, Catur-bhujaras	Aamvata, Sotha, Satisula, Jwar, Katisula Udar roga
16.	*Tribulus terrestris* (Zygophyllaceae) : Root and fruit	Goksura	Amrita rista, Sukramatrka voti	Kasa, Swas, Sula roga, Vata roga, Heart ailments, Asmani, Arsa, Prameha, Weakness
17.	*Tinospora cordifolia* (Menispermaceae) : Stem	Amrito= Giloi= Guduchi	Amarita rista	Jwar, Kushta, Vatarakta, Kamala Pandu, Prameha
18.	*Syzygium cumini* (Myrtaceae) : Stem bark, Seed, Endosperm, Fruit pulp	Jaamun	Usirasava Pusyanuga Churna	Atisara, Madhumeha, Atisarakta, Vadakameha
19.	*Nelumbo nucifera* (Nymphaeaceae) : Flower, Stem, Androecium, Seed, Root	Kamala	Arvindasava Madukasava Nilikadya Taila	Trishna, Dahasava visa, Kaphapitta sara, Daha Bhrama
20.	*Musa paradisiaca* (Musaceae) : Rhizome	Kadali	Kadalikasara Vasanta Kusuma Kor Rasa	Rakta vikar, Unmaad, Atisar Grahani

contd. ...

contd. ...

1	2	3	4	5
21.	*Anthocephalus cadamba* (Rubiaceae) : Stem bark	Kadamba	Grahani-mihira Taila	Jwar, Atisara, Sukradosa
22.	*Momordica charantia* (Cucurbitaceae) : Fruit	Karela= Karavalli	Mah Visagrabha Taila	Krimi roga, Prameha, Pandu roga, Rakta vikara Madhumeaha.
23.	*Carissa carandus* (Apocynaceae) : Stem bark, Fruit	Karinkara = Karaunda	Marma Gutika	Aruchi, Trishna Visa roga
24.	*Gossypium herbacus* (Malvaceae) : Endosperm Seed, Flower	Karkasa = kapasa	Karpasa Taila, Gorokanadivati	Daha, Sroma Bhranti Moorcha
25.	*Nerium indicum* (Apocynaceae) : Root, Leaf, Root bark	Karvira = Lal Kaner	Kasisadi Taila, Vajraka Taila	Jwar, Sotha, Vrona Netra roga, Swas roga, Ashmani, Agni mandya
26.	*Zizyphus jujuba* (Rhomnaceae)	Kola = Jangli Ber	Dhanvantara Taila	Vaata roga, Swas, Kaas
27.	*Luffa acutangula* (Cucurbitaceae) : Whole plant	Kosa taki	Abhaya lavana	Prameha, Jwar Kushta, Gulma, Swas, Kaas
28.	*Mimosa pudica* (Mimosaceae) : Whole plant	Lajjalu = Lajvanti= Chhui-Mui	Mrtasanjivani sura	Yoni roga, Atisar Kushta
29.	*Caeselpinia crista* (Caeselpiniaceae) : Seed Seed oil	Lata karanja = Karanju = Nakta mala	Ayashkriti Visamjavar gani Vati = Visam jwar ghani Taila	Inter mittent fever kasa, Swasha
30.	*Cannabis sativa* (Cannabinaceae) Seed, Leaf	Charas = Bhang, Ganja	Resinous Exudates of Leaves, Flower Inflorscence	Drugs but to be used strictly on the advise of a vaidya.
31.	*Melia azedirach* (Meliaceae) Stem bark	Bakajan = Mahanimba	Brahma-manjisthadi	Kaphapitta Roga Krimi rog

contd. ...

contd. ...

1	2	3	4	5
			Kwatha = Churna	Rakta rog
32.	*Centella asiatica* (Hydrocotylaceae) Whole plant	Mandukaparni (Confused with Brahmi)	Brahma-Rava yoga	Soth, Kushta, Pandhu, Prameha Kasa, Tonic for brain
33.	*Cyperus rotundus* (Cyperaceae) : Rhizome	Naagur motha = Nusta	Asokarista	Kapha, Pitta vikar, Aruchi, Ajeerna, Krimi roga
34.	*Azadirechta indica* (Meliaceae) : Stem bark, Leaf, Seed oil	Neem	Punarnava Aasva, Kasisadi Ghrita	Multi purpose medicine
35.	*Boerhaavia diffusa* (Nyctaginaceae) : Whole plant	Rakta punarnava	Punarnava stoka Kwatho/churna, Punarnavo aasava Punarnavo vati, Mandura Sukumaro Ghrita Sothaghan lepa	Paandu Roga Sotha
36.	*Alstonia scholaris* (Apocynaceae) Stem bark	Saptaparno = Sapta patti	Aragvadhadi Kwath churna, Amrita-rista, vajraka Taila	Sula Gulma Krimi-roga, Kustha, Jwar
37.	*Moringa pterygasperma* (Moringaceae) : Root bark Stem bark, Leaf, Seed	Sigru	Vastya maya-ntaka, Ghrita visatin duka Tail Sothghan Tail = Lepa Saraspadi Pralepa	Sirsula Krimi Apasmar Gulma Pliha Gandavrana
38.	*Sesamum indicum* (Pedaliaceae) : Seed	Til	Eladyamodaka	Vajaj, Gulma, Yosishula, Gulma Kushtha Pliha
39.	*Ocimum sanctum* (Lamiaceae) : Whole plant Leaf, seed, flower	Tulsi	Dasmula Ghrita, Abharak Bhasma	Kasa, Swas Aruchi, Krimi rog.

contd. ...

contd. ...

1	2	3	4	5
40.	*Adhatoda vasica* (Acanthaceae) : Whole plant, Leaf, Root	Vasa =Adusa	Vasaarista Vasavleh, Dasmula Kwath = Churna	Swas, Kasa Raktapitta Prameha Kshya rog, Kamala, Kustha
41.	*Terminalia arjuna* (Combretaceae) : Stem bark	Arjuna	Arjunarista	Heart problem
42.	*Vitis vinifera* (Vitaceae) : Dried fruits	Draksha = Angur = Kishmish	Drakshaasove	Swas, Kaas Aruchi, Agni mandya

PLANTS AND HOMOEOPATHIC REMEDIES/FORMULATIONS

Contrary to the principle of contraria contraris—the basic principle of allopathy, the Homoeopathy treatments are guided by the fundamental doctorine of *Similia similibus curantuve.* According to this philosophy the medicine which develops the symptoms of a specific disease in a healthy body, the same medicine has a potential to cure the symptoms (of disease) if provided/administered in potenlized/extremely diluted form. In this system mediums are developed by *'proving'* on healthy persons (volunteers), by potenlizations, by diluations (systematic), Mother tincture (Alcoholic extracts); by Attenuation (decimal attenuation, centesimal attenuation), by proper selections of potenlized drug based on a detailed study (analytical and critical) of symptoms. Names of disease are not so important herein. The symptoms include mental, head, nose, male/female parts, urinary, eyes, ears, mouth, stomach, abdomen, respiratory, extremeties, skin, sleep, fever, modalities etc. This system gives importance to dreams, psychological conditions, past and present history, allopathic treatments taken by the patient in past and also the 'psora', 'psychosis' and 'siphilis' conditions. If compared critically, Homoeopathic treatments are closer to naturopathy than allopathy. Some of the medicines of this system have centrifugal actions and try to extcrete the impurities and morbids from body (Siddhantalankar, 1995, 96).

Voluminous literature has been published on various aspects of Homoeopathy (Boericke, 1997; Dhama, 1996). Plants have been the important source of Homoeopathic medicines. However, the exact number of plants used as source of such medicine is obscure. Many MNCs are now preparing medicines from plants. German homoeopathic medicines still dominate in quantity and quality both. Such pharmacies include Dr. Willmar Schwabe (Germany) and its Indian Allie-Willmar Schwabe India Ltd. and Dr. Reckweg & Co. Germany, Dr. Willmar Schwabe (Germany) and Dr. Reckewag & Co. Germany are marketing homoeopathic preparations in more than 40 countries of the world. (Table 2, 2-A, Table 3, Table 4).

In India, HL Kolkatta, SBL (I) Ltd. etc. are preparing plants used homoeopathic medicines but we have to take quality and purity standards into consideration because a minute negligence may be dangerous for human health. Some medicines based on plants are summarized here.

Table 2 : Some common homoeopathic remedies prepared from plants (World Materia Medica)

S. No.	Medicinal Plant and Medicine/Name	Potency/ Potencies	Most Common Ailment/s
1	2	3	4
1.	*Abies canadensis* (Abies)	1-3	Mucus membranes
2.	*Abies nigra* (Nigra Abies)	1-60	Gastric disturbances
3.	*Acalypha indica* (Acalypha)	3-6	Alimentory canal and respiratory disorder
4.	*Aconitum napeleus* (Aconite)	1-3 or 6	Physical and mental restlessness
5.	*Actea spicata* (Actea)	3	Rheumatic remedy
6.	*Aethusa cynapium* (Aethusa)	3-30	Nervous system
7.	*Agaricus muscarius* (Mushroom) (Todds stool)	3-30-200	Neuralgia
8.	*Medicago sativa* (Alfalfa) = Leucerne	Mother T.	Digestive disorder
9.	*Allium cepa* (Red onion)	3	Coryza
10.	*Allium sativum* (Garlic)	3-6	Intestinal mucous membrane
11.	*Aloe* (Socotrine aloe)	6-above	Distrubance in physiological equilibrium
12.	*Anarcardium* (Marketing nut)	6-200	Nervous dyspepsia
13.	*Apium graveolens* (Common celery)	1-30	Urine problem, Headache, Heartburn
14.	*Aralia recemosa* (American spikenord)	Tincture-3 potency	Asthmatic ailments
15.	*Arnia* (Leopard's bane)	3-30 Tincture for local application	Injury, Fall, blow
16.	*Artemisia vulgaris* (Mugwort)	1-3	Epileptic condition convulsive condition of children
17.	*Ferula asafoetida* (Asafoetida)	3-6	Digestive disorder
18.	*Asclepias tuberosa* (Pleurisy root)	Tincture-1	Dyspepsia, chest pain (muscular)

contd. ...

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1	2	3	4
19.	*Asparagus officinalis* (Common garden asparagus)	6	Urinary secretion problems
20.	*Avena sativa* (common oat)	Tincture	Brain/Nervous system problem
21.	*Azadirechta indica* (Margosa bark = Neem)	Tincture	Afternoon fever Rheumatic pains.
22.	*Baptisia* (Wild Indigo)	1-6	Asthmatic condition Septic condition of blood
23.	*Atropa belladonna* (Belladona = Deadly nightshade)	1-30 and Higher P	Nervous systems ailmentss
24.	*Berberis vulgaris* (Barberry)	Tincture-3	Hepatic/Rheumatic affections
25.	*Bryonia* (Wild Hops)	1-12	Servous pains
26.	*Calendula officinalis* (Marigold)	Tincture-3	Wound healing agent
27.	*Cannabis indica* (Hashish)	Tincture and lower attenuation	Nervous ailments
28.	*Cannobis sativa* (Hemp)	Tincture 3	Urinary, Sexual problems
29.	*Capsicum annuum* (Red pepper)	3-6	General uncleaniness of body
30.	*Chenopodium anthelminticum* (Jerusalem oak)	6-30	Sudden vertigo, Ear problems.
31.	*Cina* (Worm seed)	3	Children problems
32.	*Cinchona officinalis* (Peruvian bark = china)	Tincture-30	Debility, Chronic gout
33.	*Cineraria* (Dusty Miller)	Tinctue	External use for cataract and other eye problems
34.	*Erythroxylon cocao* (Coca)	Tincture-3	Mountaineers remedy
35.	*Cocculus* (Indian cockle)	3-30	Spasmodic affections
36.	*Coffea cruda* (Unroasted coffee)	3-200	General nervous & vascular stimulant
37.	*Colocynth* (Bitter cucumber)	6-30	Ailments originating by seasonal changes.

contd. ...

contd. ...

1	2	3	4
38.	*Crocus sativa* (Safron)	Tincture-30	Haemorrhages
39.	*Digitalis* (Foxglove)	3-30 (but potency is cautiously variable)	Heart problems
40.	*Dioscorea villosa* (Wild yam)	Tincture-3	Colic pains, gall stonic pains
41.	*Drosera* (Sundew)	1-12	Whooping cough
42.	*Equisetum* (Scouring rush)	Tincture-6	Enuresis, Dysuria
43.	*Eucalyptus globulus* (Blue gum tree)	Tincture-3	Antiseptic expectorant, diaphoretic
44.	*Eugenia jambos* (Blue apple)	Tincture	Nausea
45.	*Eupatorium perfoliatum* (Thorough wort)	Tincture-3	Malaria, influenza
46.	*Euphorbia tathyris* (Gopher plant)	3-30	Rheumatic pains
47.	*Fagopyrum* (Bluckwheat)	3-12	Pruitus senilis
48.	*Gelsimium* (Yellow Jasmine)	Tincture-30	Motor paralysis
49.	*Panax jinseng* (Ginsing)	Tincture-3	Paralytic weakness
50.	*Guaiacum* (Resin of lignum vitae)	Tincture-6	Arthritic diathesis
51.	*Hyoscymus niger* (Henbane)	6-200	Nervous disorder
52.	*Ipecacuanha* (Ipeaca root)	3-200	Nausea/vomiting
53.	*Jatropha curcus* (Purging nut)	3-30	Cholera/diarrhoea
54.	*Justicia adhatoda* (Adhatoda vasica)	3-higher	Catarrhual condition
55.	*Lilium tigrinum* (Tiger lily)	Middle to higher potency	Pelvic problem
56.	*Lycopodium* (Club moss)	Lowest as well as highest potency effective	Urinary and digestive distrubence
57.	*Nux moschata* (Nut meg)	1-6	Heart attacks
58.	*Nux vomica* (Poison nut)	1-30	Polychrestic remedy
59.	*Papaver somniferum* (opium) poppy	3-30	Depression, painless sluggishness
60.	*Physostigma* (Calabar bean)	3	Heart stimulant
61.	*Phytolacca* (Poke root)	Tincture-3	Restlessness prostration

contd. ...

contd. ...

1	2	3	4
62.	*Piper nigrum* (Black pepper)	Low attenuation	Sensation of burning
63.	*Plantago major* (Plaintain)	Tincture	Earache, toothache, Enuresis
64.	*Pothos foetidus* (Slunk cabbage)	Tincture-4	Asthamatic due to dust/pollution
65.	*Pulsatilla* (Wind Flower)	3-30	Weather cock remedy Female
66.	*Rhus toxicodendron* (Poison Ivy)	6-30	Skin, Rheumatic pain joints pain, strain
67.	*Ruta graveolens* (Rue bitterwort)	1-6	Eye problems
68.	*Secale cornutum* Claviceps purpurea (Ergot)	1-30	Old age problems (Anaemic etc.)
69.	*Solanum nigrum* (Block nightshade)	2-30	Ergotion Mcningitis
70.	*Datura stramonium* (Stramonium = Thorn apple)	30 and lower	Brainy remedy = parkinsonsism
71.	*Nicotiana tabacûm* (Tobacco)	3-30-Higher	Nausea, Giddiness
72.	*Thea sinensis* (Tea)	3-30	Nervous sleeplessness Heart troubles
73.	*Thuja occidentalis* (Arbor vitae)	Tincture	Gastro-intestinal kidney brain problems
74.	*Urtica urens* (Stinging Nettle)	Tincture-3	Agalatia, Lithioss
75.	*Verbascum thapsus* (Mullein)	3-30	Crinal nerve problem Cattarrha
76.	*Zingiber officinalis*	1-6	Digestive disorder Sexual, Respiratory Troubles

Table 2A : Some Indian homoeopathic remedies from plants

S.No.	Botanical Name	S.No.	Botanical Name
1.	*Abroma augusta*	2.	*Achyranthes aspera*
3.	*Aegle marmelos*	4.	*Andrographis paniculata*
5.	*Azadirechta indica*	6.	*Boerhaavia diffusa*
7.	*Calotropis gigantia*	8.	*Calotropis lactum*
9.	*Carica papaya*	10.	*Cynodon dactylon*

contd. ...

contd. ...

S.No.	Botanical Name	S.No.	Botanical Name
11.	*Desmodium gangeticum*	12.	*Ficus religiosa*
13.	*Ficus benghalensis*	14.	*Swertia chirata*
15.	*Gymnema sylvestre*	16.	*Hydrocotyle asiatica*
17.	*Saraca indica*	18.	*Adhatoda vasica*
19.	*Leucus aspera*	20.	*Nyctanthes arbor tristis*
21.	*Ocimum sanctum*	22.	*Rauwolfia serpentina*
23.	*Solonum xanthocarpum*	24.	*Eugenia commoni*
25.	*Terminalia arjuna*	26.	*Terminalia chebula*
27.	*Tinospora cordifolia*		

Table 3 : Some rare and uncommon homoeopathic remedies from plants

S.No.	Botanical Name	S.No.	Botanical Name
1.	*Aconitum ferox*	2.	*Agrostis species*
3.	*Alstonia contricta*	4.	*Ampelopsis trifolia*
5.	*Androsace lactea*	6.	*Aralia hispida*
7.	*Arundo donax*	8.	*Brassica napus*
9.	*Capparis coriaccea*	10.	*Cicer arietinum*
11.	*Coffea tosta*	12.	*Cupressus australis*
13.	*Convolvulus duartinus*	14.	*Derris pinnata*
15	*Ephedra species*	16.	*Eucatyplus rostra*
17.	*Euphorbia prostata*	18.	*Ficus carica*
19.	*Gentiana cruciata*	20.	*Heliotropium indicum*
21.	*Ilex paraguayensis*	22.	*Jatropha urens*
23.	*Juniperus virgini*	24.	*Linum catharti*
25.	*Macrozamia spiralis*	26.	*Mangifera indica*
27.	*Mentha viridis*	28.	*Mimosa pudica*
29.	*Momrdica charantia*	30.	*Sinapsis nigra* (Mustard oil)
31.	*Nepeta cataria*	32.	*Oenotheva biennis*
33.	*Oxalis corniculata*	34.	*Plumbago littoralis*
35.	*Plumenia cellinus*	36.	*Polygonum species*
37.	*Prunus species*	38.	*Psoralea species*
39.	*Rhus radicans*	40.	*Rosmarinus species*
41.	*Rumex acetosa*	42.	*Salvia sclerata*
43.	*Sambucus con*	44.	*Santalum album*
45.	*Selaginella species*	46.	*Senecio species*
47.	*Sinopsis alba*	48.	*Solanum carolina*

contd. ...

contd. ...

S.No.	Botanical Name	S.No.	Botanical Name
49.	*Solanum tuberosum*	50.	*Trifolium repens*
51.	*Typha latifolia*	52.	*Vitex nugando*
53.	*Xanthium spinosum*	54.	*Zea italica*

Table 4 : Some active principles and useful products from medicinal plants and spices

S. No.	Source/Botanical Name	Product/s Group	Active principle Action/ Multitherapic
1	2	3	4
1.	Cereals & Millets—Rice, wheat, barley, sorghum, corn, bajra etc.	Starch	Alcohol
2.	Tuber crops—Tapioca, beet roots, potato, sweet potato	Starch	Alcohol and other
3.	*Modhuca indica*	Oil (non-edible) and starch	Diesel/some medicine
4.	*Vitis vinifera*	Vinegar	Beverages (medicinal)
5.	*Artocarpus lakoocba*	Beverage	RTS drinks
6.	*Cucurbita pepo*	Cosmatics	Skin soother
7.	*Zanthoxylum armatum*	Oily extrocts of plant	Skin soother
8.	*Simmondsia chinensis*	Leaf oil, Seed oil	Refined cosmatics
9.	*Aloe vera*	Fleshy leaf pulp	Mucilage
10.	*Cedrus deodara*	Leaves	Dye, Vegetable
11.	*Eucalyptus glabulus*	Leaves	Yellow Dye C
12.	*Morus nigra*	Fruits/pulp	Bioflavonoids
13.	*Gossypium arboreum* *G. hirsutum, G. barbadense* *G. herbaceum*	Seed oil	Some medicines
14.	*Hibiscus cannabinus*	Kenaf	Medicines
15.	*Fagopyrum esculentum*	Starch	Antidiabetis
16.	*Caryota urens*	Toddy	Protein producing yeast
17.	*Mangifera indica*	Kernel	Multipurpose = Mangiferina
18.	*Cyphomandra betace* (Tamarilla)	Vitamins	Ascorbic acid

contd. ...

contd. ...

1	2	3	4
19.	*Cichorium intybus*	Root Roasted powder	Coffee blends
20.	*Anacardium occidentale*	Gum from stem bark	Pharmaceutical
21.	*Averrboea carambola*	Vitamins (fruits)	Vitamins
22.	*Chenopodium anhelminticum*	Antihelmintics	Oral dose for lambs
23.	*Glycine max*	Soy protein	Choestrol reducing property
24.	*Simarouba glauca*	Tree of Heaven	Medicinal oil
25.	*Podophyllum hexandrum*	Rhizome extract	Antioxident, Radio protectant
26.	*Piper longum*	Water extract	Anti cancer properties
27.	*Zingiber officinalis*	Water extract	Anti cancer properties
28.	*Ferula asafoetida*	Water extract	Anti cancer properties
29.	*Thea chinensis* (Tea)	Green tea (unfermented)	Medicinal
30.	*Acacia sinnata* (Shikakai)	Natural medicine	For hairs
31.	*Helichrysum bracteatum*	Flowers	Analgesic, Anti-inflammatory
32.	*Tribulus terrestris*	Fruit decoction	Steroid alglycosides
33.	*Rhus cotinus*	Dried arial parts	Anti cancer
34.	*Theabroma cacao*	Seed powder	Anti cancer
35.	*Semecarpus anacardium*	Nut extract	Anti stress drug
36.	*Croton oblongifolius*	Stem extract	Gastric ulcer, Gastric cancer
37.	*Achyranthes aspera*	Root extract	Oligosachharide Potential anti cancer
38.	*Barleria prionitis* (Vajradanti)	Leaf, root, stem	Antidiabetic
39.	*Ipomoea batatus*	Tuberous roots	Antidiabetics (Glycoprotein)
40.	*Boerhaavia diffusa*	All parts extract	Anti jaundice
41.	*Berberis asiatica*	All parts extract	Strong antibiotic (Berberine)

contd. ...

contd. ...

1	2	3	4
42.	*Eclipta alba*	All parts extract	Hepato protective Cardiac problem
43.	*Peperomia pellucida*	All aerial parts	Analgesic
44.	*Silybum marianum*	Seed extract	Hepatoprotective
45.	*Chulrasia tabularis*	Leaf extract	Strong herbal antibiotic
46.	*Cyperus articulatus*	Rhizome decoction	Multi purpose Multi-therapeutic drugs
47.	*Mucuna prurita*	L. DOPA	Anti Parkinson's disease
48.	*Musa paradisiaca*	L. DOPA	Anti Parkinson's disease
49.	*Chromolaena odorata*	Leaf extract	Anti malaria
50.	*Myristica fragrans*	Kernal	Anti inflammatory
51.	*Cucurma longa*	Rhizome dried	Anti-allergic
52.	*Eugenia uniflora*	Leaf extract	Multi therapic
53.	*Hibiscus rosa*—chinensis	Leaf extract	Anti diabetics
54.	*Punica granatum*	Cold water Extract of flower	Anti hypertensive
55.	*Polyalthia cerasoides*	Stem bark extract	Antistress
56.	*Aegle marmelos*	Leaf extract	Anti diabetics
57.	*Daucus carota*	Seed oil	Analgesic, anti inflammatory
58.	*Terminalia chebula*	Unripe, dried fruit extract	Multipurpose multitherapic
59.	*Tridax procumbens*	Leaf extract	Hepatoprotective
60.	*Aegle marmelos*	Fruit extract	Wound healing principle
61.	*Coculus hirsutus*	Root extract	Cardio tonic
62.	*Ocimum grassimum*	Leaf extract	Multitherapic
63.	*Momordica charantia*	Fruit extract	Anti diabetics
64.	*Syzygium cuminii*	Seed extract	Anti diabetics
65.	*Mangifera indica*	Bark of stem	Analgesic anti inflammatory
66.	*Terminalia arjuna*	Stem bark extract	Coronary heart disease
67.	*Peristrophe bicalycalata*	Dried plant extract	Multipurpose Multitherapic
68.	*Panax ginsing*	Root extract	Multitherapic drugs
69.	*Cydonia oblonga*	Fruit extract seed extract	Wound healer

PLANTS AND UNANI DRUGS/FORMULATIONS

Similar to Ayurveda, the Unani System of Medicine lays emphasis on the fact that majority of human ailments originates from imbalance of human physiological functions and pure medicines prepared from plants (wild as well as cultivated) have wonderful curative properties. The name Unani has its base in the nation Unan (Greek) from where this system of medicine has gained popularity throughout the world. This system gives high priority to proper diagnosis of the ailment by pulse (Nabja), temperament etc. Unani medicines are used in developing as well as developed countries.

In India Hamdard (Waqf) Laboratories, Rex (USA) Remedies Pvt. Ltd., Dawakhana Tibbiy a College—AMU-Aligarh, Mohammedia Products are some of the pharmacies preparing Unani medicines from plants. Directorate of Indian System of Medicine (ISM) Government of India has developed a system of maintenance of quality control for pharmaceutical formulations through GMP Certificate (Good Manufacturing Practice Certificate). This certificate is issued after thorough and critical evaluation of quality standards as laid downs by World Health Organization (WHO). The GMP system of certification for plant based drugs and formulations is, now, adopted in more than 70 countries. GMP has specified 10 strictly followed conditions for preparing Unani (and other categories of medicines including Ayurveda and Allopathy) medicines.

However, systematic and scientific information on the exact number of plants used in Unani as the raw material for drugs is still obscure. Some patent formulations are available in market. There is a very long list of such effective formulations in which herbal plants are the principle ingredients. For the sake of examplifying the system, few are being summarized here—

- Rogan Banfasha (Headache)
- Rogan Gul (Headache, Heat stroke) Arka Gulab
- Khamira Gojwain (Brain tonic)
- Maajun Brahmi (Brain tonic)
- Rogan Baadaam Shiri (Brain tonic)
- Maajoon Nisyan (For forgetfulness)
- Rogan Khaskhas (For Insomnia)
- Sharbat Rooh Afza (For Heat stroke)
- Khameera Govajaban Ambari Jadvar Udsafeeb vala
- Maazon Jograaj Guggal
- Rogan Dhatoora (For paralytic conditions)
- Ikaseer Shifa (For madness)
- Sharbat Ahmadshah (For madness and confusiveness)
- Rogan Samaayat Kusha (For deafness), Saafi (For ear problem)
- Rogan Anaf (Nasal foul smell)
- Joshanda syrup (Cold and influenza, corryza)
- Joshina (Cold, cough, influenza, corryza)
- Nazali (Cold, cough, influenza)
- Lauuk Sapista (Cold, cough, influenza, Bronctitis-expectorant)

- Kushta karanuallayyal (Puring and rib pain)
- Lauuk Abe Tarbooj wala (Cough)
- Sadoori (A preparation of Ephedra, Adhatoda, Basil etc. for old cough, bronchitis etc.)
- Swalline (All types of cough)
- Habbe Magza Baddam (cough)
- Mazoon Rahul Moninin (Asthma)
- Lauuk Rabvi (Spasmodic asthma)
- Lauuk Zeepunnphax (Expectorant)
- Lauuk katan (Expectorant)
- Sharbat Rabvi (Asthmatic attacks)
- Arka Ilaichi (Heart problem)
- Arka Gobjaba (Heart and brain weakness)
- Arka Gulaab (Heart and digestive disorder)
- Sharbat Aonla (Heart, brain and digestive problems)
- Sharbat Annar Shiri (Heart-liver tonic)
- Sharbat Angoor Shiri (Heart tonic, mild purgative)
- Arka Ajwain (Various digestive problems)
- Arka Badyan (Digestive problems)
- Kurs Pudina (Digestive stimulant)
- Jawarish janjbeel (Pancreatic stimulant)
- Jawarish Udashiri (Stomachache problem)
- Pachnol (Digestive stimulant)
- Sharbat janjabeel (Digestive stimulant)
- Habbe papeeta (Peplic ulcer)
- Arka Naana (Dyspepsia)
- Arka Pudina (Vomiting)
- Sikanj been leemu (Digestive disorder)
- Sharbat Bajoori Motidil (Problems of liver, pancreas and spleen)
- Arka Kasni (Liver enlargement and swelling)
- Arka Maullaham Makohakasni (Different disorder of stomach and liver)
- Arka Makoha (All internal organs including alimentary canal, liver, even uterus)
- Rogan Afasanteen (Swellings in stomach and liver)
- Sharbat Kaasani (Swelling of intestine, liver and stomach, jaundice, liver, malfunctioning)
- Maazoon Hizrulyahood (Good remedy for removing kidney, bladder stones)
- Sharbat Baelgiri (Intestine problems)
- Khameera Banfasa (Mild purgative and useful in all kinds of fevers, cold, corryza, influenza, cough, asthma and bronchitis)
- Maazoon Inzeer (Old constipation)

- Sharbat Arjani (Old constipation)
- Itariphal Mukil (All kinds of piles)
- Kushta Baiza Murg (Diabetes)
- Dolabi (Diabetes, Polyury, Kidney problem)
- Maazoon suparipaak (Useful in pregency establishment)
- Arka Dashmool (Ladies problems after delivery)
- Naunihaal Baby Tonic (Child weakness)
- Maazoon chobchini (Rheumatism and fathrities)
- Rogan Kuchala (Arthritis)
- Rogan Hena (Arthritis)
- Helawa Gheekwar (An aloe preparation—useful in Arthritis and backache)
- Arka Zeera (Obesities)
- Arka Chirayata (Blood purifier)
- Sharbat Unnab (Blood purifier)
- Saafi (Blood purifier and related problems)
- Gaaza Husna Afza (Skin problem)
- Zauhar Munakka (Rheumatic problems)
- Barseena (Leucoderma)
- Rogan Babchi (Leucoderma)
- Zulamala (A formulation of Aonla, shikakai, Mustard etc. for hair problems)
- Rogan Amala Khas (Hair oil)
- Cinkara (General tonic based on herbal drugs and minerals)
- Kalaungi oil (Multipurpose)

Dr. S.M. Hussain Zafri (Principal, Rajputana Unani Medical College, Hospital and Research Centre) Jaipur and also Dean, Faculty Chairman of Unani System of Medicine of Rajasthan Ayurvedic University, Jodhpur has made valuable contributions in preparaing several formulations of Unani Medicines based on medicinal plants. He has founded a good pharmacy of Unani Medicines in the College campus. For details of these medicines he may be contacted. He has been actively involved in the development of a herbal farm (Gardens) in outer areas of Jaipur. He is also working hard on the development of drugs for some types of cancer. These medicines are based on plants and have shown encouraging results under trials.

Besides Hamdard, Rex, AMU and Mohammedia Products, other pharmacies in India preparing herbal unani medicines include Hindustan Dawa Khana Delhi, Rajputana Unani Dawa Pharmacy (Unani College, Jaipur), Johar (Unani) Products Aurangabad, Bulandshahar (UP) etc. As per discussions with Dr. S.M.H. Zafri more than 3000 plants are used as raw materials for the production of Unani Medicines but only 100 plants are suitable for cultivation in different parts of India. Out of these 100 plants, Government of India has issued a list of only 29 plants which are at present under cultivation and efforts should be made for domestication, cultivation and conservation of other therapeutically valuable plants.

PLANTS AND ALLOPATHIC DRUGS/FORMULATIONS

Thinking of medicinal plants generally biased towards Ayurvedic system of medicines followed by other pathies like Unani (Tibbi), Homoeopathy etc. and Allopathy generally become the last thought with medicinal plants points of view. However, the factual position is different and plants as sources of allopathic medicines are equally important. Antibiotics are extremely valuable remedies is Allopathy and majority of antibiotics are commercially produced from plants of lower order (microbes—like bacteria and fungi). Giving the list of antibiotics of microbial origin here will be an undesirable repitition because such information are easily, voluminously and systematically available elsewhere.

Plants belonging to Pteridophyta and Spermatophyta (Gymnosperm and Angiosperms) are very rich sources of Allopathic drugs individually or in various commercial formulations and combinations. More than 20000 plants are known to possess therapeutic properties but the number of plants which have been practically explored with curative principles point of view is limited. The phytochemical analysis of different plant part revealed that secondary plant metabolities are the major constituents of medicinal plants for preparing drugs. These phytochemicals are grouped into classes like (1) Enzymes (2) Hormones (3) Steroids (4) Glycosides (5) Alkaloids (6) Vitamins etc.

These secondary metabolities are produced from plants by various methods. These methods are grouped into two—

(A) Conventional methods such as solvent extraction, partial fermentation, fermentation distillation and crystallization.

(B) Modern Methods. These methods include induced production of specific metabolities in cell/protoplast culture under controlled environmental conditions.

Plant tissue culture was originally developed as a research tool to study the physiology and biochemistry of plants but now, the technique is in commercial applications for the production of pharmaceutically valuable products and has taken the shape of an industry producing millions of plants per annum. (Micropropagation).

For few years, plant based drugs faced a competition with their synthetic analogs but complex structure of drugs of plant origin and their superiority over synthetics have again resumed the value of plants as source of allopathic drug preparation. The tissue culture technique has hastened the procedure of production at lower cost and short time. *Digitalis, Disocorea Papaver, Cinchona, Taxus* etc. are few examples which indicated that's plants (either field cultured/cultivated or tissue/cell culture) will remain the principal raw material for allopathic drugs too.

Plants used for the preparation of pharmaceuticals are grown in plantations. As these plantations are affected by climatic changes, the yield and quality are variable. Therefore, the culture cells are now-a-days used to produce specific pharmaceuticals under controlled conditions. The large scale culture of plant cell is practiced by (1) suspension culture (2) immobilized culture (3) organized culture (4) hairy root culture. Specifically designed and developed bioreactors have been developed for such applications (Berlin 1988; Shargool and Ngo 1994; Scragg 2002). Some examples of such applications are evident from tables (Table 5, 6 and 7).

Table 5 : Some higher plant cell cultured for pharmaceutical purpose

S.No.	Plant	Remarks/Products etc.
1.	*Coleus blumei*	Rosmarinic acid
2.	*Morinda citrifolia*	Anthrequinones
3.	*Lithospermum erythrorrhizon*	Shikonin
4.	*Thalictrum minus*	Berberine
5.	*Perilla frutescens*	Antho cyanin
6.	*Dioscorea deltoidea*	Diosgenin
7.	*Papaver somniferum*	Morphine
8.	*P. somniferum*	Sanguinarine
9.	*Taxus bravifolia*	Taxol
10.	*Catharanthus roseus*	Vincristine
11.	*Coptis japonica*	Berberine
12.	*Atropa belladonna*	Tropane alkaloids

Table 6 : Large scale production of drugs by root and shoot culture

S.No.	Plant	Remarks/Products etc.
	A. Root culture	
1.	*Atropa belladonna*	Tropina alkaloids (Atropine etc.)
2.	*Catharanthus roseus*	Ajamalicine
3.	*Papaver bracteatum*	Thebone
4.	*Papaver somniferum*	Codeine
5.	*Senecio sativus*	Pyrrodizidine alka
	B. Shoot culture	
6.	*Atropa belladonna*	Tropane alkaloids
7.	*Rauwolfia serpentina*	Ajamalicine
8.	*Digitalis purpurea*	Digitoxin
9.	*Pelargonium fragrans*	Pinorine
10.	*Cinchona ledgeriana*	Quinine
11.	*Centranthus macrosiphon*	Valpotritine
12.	*Linum flavum*	Coniferin
13.	*Coleus forskohii*	Forskolin

Table 7 : Some pharmaceuticals produced form hairy roots

S.No.	Plant	Product
1.	*Lithospermum erythrorrhizon*	Shikonin
2.	*Cinchona ledgeriana*	Quinine
3.	*Nicotiana tabacum*	Nicotine
4.	*Catharanthus roseus*	Ajamalicine
5.	*Datura stramonium*	Hyoscyamine
6.	*Panax ginseng*	Saponin

Some other plants which produce pharmaceuticals through cell culture include *Glycine max, Solanum demissum, Echinacea purpurea, Rauwolfia serpentina, Trisptergium species, Digitalis lanata, Berberis wilsonea, Helianthus annuus, Beta vulgaris, Thalictrum rugosum, Vitis vinifera, Solanum tuberosum, Picrosma quassoides, Cinchona robusta, Daucus carota, Capsicum frutescens, Madicago sativa, Artemisia annua, Glodiolus speices, Euphorbia pulcherima, Musa, Cordyline, Nephrolepis, Colystegia septum* etc (Table 5, 6, 7).

Therapeutically active principles summarized in Table 4 are being also used by Allopathic Drug Manufacturing companies (some of which are given in table 9) to prepare drugs (either singly or in various combinations) by different brand names. However, the standards of these finished and marketable products are maintained as per Indian Pharmacopoia norms. Such standards are to be maintained as per World Health Organization (WHO) norms. WHO plays an important role in observing the uniform quality standards in all parts of the world. Due to WTO regime and liberal import policies, some formulations follow the quality standards described by British Pharmacopoia or by United States Pharmacopoia. Accordingly the *Materia Medica* (Allopathic) are followed. Such Materia Medicas have also been published to describe Ayurvedic drug pictures. Homoeopathic Drug pictures and Unani Drug pictures. (Table 8).

Table 8 : Some allopathic drugs/formulations from plants

S.No.	Drug Name	Remarks/Effects/Disease
1.	Atropine	Anticholinergic
2.	Hyoscine	Anticholinergic
3.	Hicotine	Autonomic ganglia
4.	Lobeline	Autonomic ganglia
5.	Piperazine	Antihelmintheic
6.	Cocaine	Adrenergic drug
7.	Reserpine	Adrenergic drug
8.	Ephedrine	Adrenergic drug
9.	Guanethidine	Adrenergic drug
10.	Sailbutamol	Anti asthmatic
11.	Ergotamine	Antiadrenergic drug
12.	Erogotoxine	Antiadrenergic drug
13.	Dihydro ergotamine	Antiadrenergic drug
14.	Dihydro ergotoxine	Antiadrenergic drug
15.	Quinine	Skeletal muscle relaxants
16.	Quinidine	Skeletal muscle relaxants
17.	Cinchocaine	Local anaesthetic
18.	Lignocaine	Local anaesthetic
19.	Codeine	Cough and asthma
20.	Morphine	Cough and asthma
21.	Narcotine	Cough and asthma

contd. ...

contd. ...

S.No.	Drug Name	Remarks/Effects/Disease
22.	Esthaline expectorant	Anti tissue expectorant
23.	Benadryl expectorant	Anti tissue expectorant
24.	Terbutaline	Anti tissue expectorant
25.	Ergo novine	For uterus problems
26.	Berberine	Sedative
27.	Opium alkaloids	Analgesics
28.	Digitoxin	Cardiac problems
29.	Digoxin	Cardiac problems
30.	Strophanthin K	Cardiac problems
31.	Quabain	C H F drug
32.	Proscilaridin	C H F drug
33.	Thevetin	C H F drug
34.	Convallotoxin	Cardiac glycoside
35.	Mexilatine	Anti rhythmic
36.	Xanthine	Diuretics
37.	Theophylline	Diuretics
38.	Psyllium (Isabgol)	Anti constipation
39.	Senna	Anti constipation
40.	Castor oil	Anti constipation
41.	Chloroquine	Anti malarial drug
42.	Artemisinin	Anti malarial drug
43.	Emetine	Anti-amoebic drug
44.	Vincristine	Anti cancer drug
45.	Taxol	Anti cancer drug
46.	Epipodophylla toxin	Anti cancer drug
47.	Gum acacia	Skin problems
48.	Gum tragacanth	Skin problems
49.	Glycirrhiza (Natural steroids in roots)	Skin problems
50.	Clove oil	Counter irritant
51.	Eucalyptus oil	Counter irritant
52.	Thymol	Counter irritant
53.	Menthol	Counter irritant
54.	Mustard seed oil (Sinigrin)	Counter irritant
55.	Capsicum (Capsicin)	Counter irritant
56.	Methyl solycylate (Wintergreen oil)	Muscle/joint pain

contd. ...

contd. ...

S.No.	Drug Name	Remarks/Effects/Disease
57.	Purpurin (Tephrosia)	Digestive stimulant
58.	Tephrosin (Tephrosia)	Digestive stimulant
59.	Somniferon, Withaminon (Withania roots)	Rejuvenator, Diuretic
60.	Nergundin, Hydrocotylon (Vitex)	General tonic, Analgesic
61.	Violene alkaloid (Viola)	Patent, safe expectorant
62.	Tylophorine alkaloid (Tylophora)	Expectorant
63.	Trigonelline, Colline (Trigonella) Seed	Carminative, Diuretic

Table 9 : Some Indian pharmaceutical companies using plants for preparing allopathic drugs/formulations

1.	Alembic Chemical Works, Baroda.
2.	Alta Lab Pvt. Ltd., Dadar, Mumbai.
3.	The Anglo-French Drug Co., Mumbai.
4.	Bayer (India) Ltd., Mumbai.
5.	Bengal Chemicals and Pharmaceuticals Work, Kolkatta.
6.	Indian Drugs and Pharmaceuticals Ltd. (IDPL), New Delhi.
7.	Boehringer Knoll Ltd., Mumbai.
8.	Cadila Laboratories, Ahmedabad.
9.	CIPLA (The Chemical, Industrial & Pharmaceuticals Lab) Ltd. Mumbai.
10.	CIBA Geigy India Ltd., Mumbai.
11.	Geoffrey Monnere Co. Ltd., Mumbai.
12.	German Remedies Ltd., Mumbai.
13.	Glaxo Laboratories Ltd., Mumbai.
14.	Hindustan Antibiotics Ltd., Pune.
15.	Hoechst Pharmaceuticals Ltd., Mumbai.
16.	May and Baker Ltd., Mumbai.
17.	Byers Laboratories Ltd., Mumbai.
18.	Pfizer Ltd., Mumbai.
19.	Ranbaxy Laboratories Ltd., Mumbai.
20.	Sandoz (India) Ltd., Mumbai.
21.	Uni Chem Laboratories Ltd., Mumbai.

There are many more and some have attained MNC dimensions.

The drug formulations based on plant products are developed as per specific procedure laid down by competent authority (Mittal, 1984). These formulations are marketed in the form of tablets, capsules, powder, syrups, liquids, concentrates, baams, pastes and also the injectable preparations. Such preparations are made by using certain carriers (such as inert material-talc, alcohol, water, oil etc.) Some adhesives plant of origin (such as gum arabic, gum tragacanth) are also used for this purpose. As capsules composed of Nifedipine (soft gelatin) are the most common mean of drug utilization, the quality of Nifedipine must be carefully evaluated before filling the actual drug in the capsule (Sharma and Gupta 2006). (Table 9).

LIVESTOCK AND VETERINARY MEDICINES FROM PLANTS/ FORMULATIONS

Like allopathy, ayurveda and other systems, plants are excellent sources of medicines for domestic animals. These plants based drugs are used for large animals as well as pets (Prasad, 2003; Roy, 2001; Dudi, 2004). Plant based medicines have been used in ethnoveterinary as well as in modern veterinary sciences. The list of plant based medicines for animals' treatments is very large. The systems of classifying such medicines are variable but broadly these may be grouped as antiseptic, antibiotic, anaesthetics, analgesics, absorbents, alteratives, anodynes, antacids, antagonistics, antihelminthic, antidotes, antipyretics, antispasmodics, antirheumatics, antiprotozoaics, diuretic, aromatic, astringent, antihistaminic, caustic detergents, deodorants, antidiuretic, disinfectants, skin pests killers, expectorants, emetics, electrolytes, galatagogues, laxatives, narcotics, parasiticides, purgatives, sedatives, stimulants, tonics, vermicides, ophthalmics, coccidiostate, haematinics etc. Veterinary medicines as mentioned above are broad groups and plants are important components in all these medicines with few exceptions.

All the antibiotics recommended for animals are basically produced from plants (mostly lower plants—bacteria, fungi etc.). Some medicinal plants useful as veterinary medicines are described in Table 10 given here in this section (Table 10, 11).

Table 10 : Some veterinary medicine in which plants/plant products are used as an important components

S.No. No.	Common/Hindi Botanical Name & Family	Therapeutic Action	Ailments of Animals
1	2	3	4
1.	Asafoetida = Heing : Ferula asafoetida Apiaceae	Carminative	Stomachache, Flutalence Cough, Gastric Troubles
2.	Aniseed = Saunf, Foeniculum vulgare, Apiaceae	Appetizer, digestive, carminative	Digestive stimulant, Digestive fodder for animals
3.	Belladonna = Angur shefa Atropa belladonna	Astrigent	Extract of leaves/fruits, stimulant, sedative,

contd. ...

contd. ...

1	2	3	4
	Solanaceae		antispasmodic, Antidote of poisons, ophthalmic uses.
4.	Catachac = Katlha Acacia catechu Mimosaceae	Astrigent	Useful in diarrhoea, dysentery
5.	Castor oil = Arandi Tel Ricinus communis Euphorbiaceae	Purgative	Stomach problem, Insecticide
6.	Ginger = Saunth Zingiber officinalis Zingiberaceae	Carminative Stimulant	Digestive disorders
7.	Nux vomica = Kuchala Strychnos nuxvomica Strychnaceae	Tonic, Stimulant Epectorant	General medicine for various problems but to be given only on the advice of physician
8.	Opium = Afeem Papaver somniferum Papaveroceae	Astrigent, sedative Antiemetic, Narcotic Anti-diabetic	Many problems of Horses, Cows, Sheep, Goat
9.	Linseed oil = Alsi Linum ussitatisimum Linaceae	Antispasmadic Flalulent mild purgative	Dogs, Horse, Goats, Sheeps Cow, etc.
10.	Chiretta = Chirayata Swertia chirayata Gentianaceae	Tonic, stimulant	General weakness of cow, buffalo, horse (Powder of dried plant)
11.	Eucalyptus = Eucalyptus Myrtaceae	Antiseptic, Disinfectant, Parasiticide, Carminative Anodyne, Expectorant Diuretic	Oil in Massages, cold, cough flatulence with linseed oil
12.	Digitalis = Digitalis Digitales lanata Scrophulariaceae	Cardiac stimulant tonic	For general debility of many domestic animals
13.	Sweet wood = Mulahati Glycyrrhiya glabra Fabaceae	Demulscent Expectorant	General tonic, digestive disorders of animals

Besides these plants, several other plant species are in common use as household remedies for domestic animals. These include *Panex ginseng, Ruta graveolens, Aloe vera, Exogonium purga, Olea europea, Mentha piperita, Cinnamomum zeylanicum, Cinnamomum camphora, Acacia tragacanth* etc. (Roy 2001, Dudi 2004). These plants are used alone or in combinations with others. Some plant based patent medicines are also available in pharmaceutical formulations and preparations.

Some homoeopathic medicines are also being prescribed by some veterinary medical practitioners. But their potency, dose and durations are very carefully selected as sometimes they may cause adverse effects if not selected properly on the basis of detailed symptoms analysis.

Table 11 : Few plant based homoeopathic medicines for animals

S.No.	Plant/s	Common ailments
1.	Arnica, Aconitum	Abcess
2.	Arnica, Rhus, Secale, China, Pulsatila, Aconitum	Abortion
3.	Bone spavin	Rhus lotion
4.	Broken knee	Arnica lotion
5.	Bronchitis	Aconitum, Belladonna
6.	Coryza	Aconitum
7.	Constipation	Nux vomica
8.	Cough	Aconitum, Belladonna
9.	Cutting Brushing	Arnica lotion
10.	Diarrhoea	Aconitum, Nux
11.	Dropsy	China
12.	Fever	Aconitum
13.	Jaundice	Aconitum
14.	Milk fever	Belladonna, Nux
15.	Pneumonia	Aconitum
16.	Rheumatism	Aconitum

MULTITHERAPIC PLANTS AND AGEING PROCESS : SOME PRACTICAL ASPECTS

Ageing is a complex biological phenomenon and has been a subject of investigation under different pathies due to its multiferous implications. Everybody wants to live longer and this 'desire' can be fulfilled only if the process is delayed by anti-ageing interventions (Rattan, 2006). The biological aspects of ageing and strategies to delay the process has therefore, been the subject of several studies by gerontologists throughout the world.

Anti ageing therapy or treatments involve several factors. According to Rattan (2006) ageing should not be considered as a 'disease' and scientific and rational anti-ageing strategies should concentrate on ageing delaying treatments. (Rattan 2006, 2005, Boia 2004). Plants and plant products form very important components of such strategies (Ferrori, 2004) and many plants have been claimed to contain potent anti ageing principles. Ayurvedic, Homoeopathic, Unani and Allopathic literature has frequently described such plants (Brahmvarchas, 2005). No specific plant is being listed here due to their limitations. But it is evident that such plants are good supplements only. Purification of body and removal of morbids from body enhance the efficacy of such plant based supplements by way of improving the basic vital force of body and ameliorating the resistance of the body against biotic, abiotic and psychological stresses. Various naturopathic treatments, physical excercises, yogasanas and pranayams have been found very effective in such 'purification process'. These include some hydrotherapic activities like Kunjal, Jalaneti, Sutraneti, Vashtradhauti, Anema, Sankha prakshalan, Surya Pranaam, Sukhma, Vyayaam, various Aasans, Morning walk, morning water uptake, massages etc. Some spritual rituals if practiced patiently, regularly and systematically further improve the efficacy of all such treatments. The Ayurvedic preparations (named *Triphala*) (balanced mixtures of Aonla, Haritaki and Bahira) if used scientifically and systematically for longer duration, has been found very effective in delaying the ageing process and further improving the body vital forces but such chemical must be used only on the advise of experienced physician.

PLANTS AND OTHER LITTLE KNOWN THERAPIES

Besides commonly acknowledged system of health management there are few other systems where plants play important roles. These pathies are, though in practice sporadically in various parts of the world, have yet to get official recognition in few nations. On account of limitations of orthodox and conventional therapies, a large number societal elements are attracted towards them. Acupressure, Acupuncture, Aroma therapy, Chromotherapy, Naturopathy, Yogic system of treatments, Suzok, Cosmotherapy, Hypnotherapy, Ethnotherapy (folk medicine) are few examples. Plants are directly or indirectly involved in these system. Sharma (2006), Malik (2006), Patil (2006) and Sharma and Kumar (2006) reviewed literatures on such aspects.

Commercial exploitation of herbs based on Indian system of medicine (Ayurveda, Siddha and Unani) is a Rs. 1500.00 crore industry today with about 30% annual growth. This substantial growth phenomenon is attributed to the minimal or lock of their ill/toxic/ side effects (Malik, 2006). In so called developed countries like USA, plant based drugs occupy very important place. This is evident from growth rate of 140% of *Ginakgo* and 2801% of *Hypericum* in that country. Menthol, Vanillin, Taxol, Vinblastin, Onion, Garlic, Citrus and Sanguinarine are some other examples for Allopathic uses of plants. Patil (2006) described more than 50 plants commonly used in Indian Folklore and have attracted the attention of Government of India. Brahm Varcha (2005) has made valuable contribution and described more authentically about 304 plants (Table 12 and Table 13).

Table 12 : Some medicinal and spiceal plant in demand for pharmaceutical purpose

S.No.	Botanical Name	Hindi Name	Family
1	2	3	4
1)	*Abrus precatoius*	गुंजा	Leguminosae (Fabaceae)
2)	*Abutilon indicum*	अतिबला	Malvaceae
3)	*Acacia catechu*	खदिर	Leguminosae (Mimosae)
4)	*Acacia concinna*	शिकाकाई	Leguminosae (Mimosae)
5)	*Acacia nilotica*	बबूल	Leguminosae (Mimosae)
6)	*Acalypha htspida*	सुलतान	Euphorbiaceae
7)	*Achyranthes aspera*	अपामार्ग	Amaranthaceae
8)	*Aconitum heterophyllum*	अतिविषा	Ranunculaceae
9)	*Acorus calamus.*	वचा	Araceae
10)	*Adansonia digitata*	गोरक्षी	Bombacaceae
11)	*Adhatoda vasica*. (Nees)	अडूसा	Acanthacae
12)	*Adiantum lunulatum* (Burm)	हँसपादी	Polypodiaceae
13)	*Aegle marmelos* (Corr)	बिल्व	Rutaceae
14)	*Agave americana* (Linn)	कंटाला	Agavaceae
15)	*Ailanthus excelsa* (Roxb)	अरलवो	Simarubaceae
16)	*Albizzia lebbek* (Benth)	शिरीष	Leguminosae (Mimosae)
17)	*Allium cepa* (Linn)	पलाण्डु	Liliaceae
18)	*Allium sativum* (Linn)	लसुन	Liliaceae
19)	*Alocasia indica* (Roxb)	मानकंद	Araceae
20)	*Aloe barbadensis* (Mill)	घृतकुमारी	Liliaceae

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1	2	3	4
21)	*Alpinia galanga* (Willd)	महाभरीवच	Zingiberaceae
22)	*Alstonia scholaris* (R.Br)	सप्तवर्ण	Apocyanaceae
23)	*Althea officinalis* (Linn)	खेरु	Malvaceae
24)	*Amaranthus spinosus* (Linn)	तण्डुलीय	Amaranthaceae
25)	*Amaryllis belladonna* (Linn)	बैलाडोना लिली	Amarryllidaceae
26)	*Amomum subulatum* (Roxb)	बृहदेला	Zingiberaceae
27)	*Amorphophallus campanulatus* (Blume)	सूरनकंद	Araceae
28)	*Anacardium occidentales* (Linn)	बताड़	Anacardiaceae
29)	*Anacyclus pyrethrum* (D.C)	आकार करम	Asteraceae (Compositeae)
30)	*Ananas cosmosum* (Merr)	अन्नानास	Bromeliaceae
31)	*Andrographis paniculata* (Nees)	भूनिम्ब	Acanthaceae
32)	*Annona squamosa* (Linn)	सीताफल	Annonaceae
33)	*Anthocephalus cadarmba* (Miq)	कदम्ब	Rubiaceae
34)	*Apium graveolens* (Linn)	अजमोत	Umbelliferae
35)	*Aralia nudicaulis* (Linn)	लक्ष्मणा	Araliaceae
36)	*Areca catechu* (Linn)	पूगीफल	Palmae
37)	*Argemone mexicana* (Linn)	कटुपर्णी	Papavaraceae
38)	*Argyreia speciosa* (Sweet Syn)	वृद्धदारक	Convolvulaceae
39)	*Aristolochia indica.* (Linn)	ईश्वरी	Aristolochiaceae
40)	*Artemissia vulgaris* (Linn)	दमनक	Asteraceae (Compositae)
41)	*Artocarpus integrifolia* (Linn)	पनश	Moraceae

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1	2	3	4
42)	*Asclepias curassavica* (Linn)	काकनासा	Asclepiadacfae
43)	*Asparagus adscendens* (Roxb)	श्वेतमुशली	Liliaceae
44)	*Asparagus recemosus* (Willd)	शतावर	Liliaceae
45)	*Asteracantha longifolia* (Nees)	कोकिलाक्ष	Acanthaceae
46)	*Averrhoa carambola.*	कमरख	Oxalidaceae
47)	*Azadiraclita indica.*	नीम	Meliaceae
48)	*Bacopa nionieri* (Linn)	जलनीम	Scrophulariaceae
49)	*Balanites roxburghii* (Planch).	इंगुदी	Simarubaceae
50)	*Bombusa arundinacia* (Willd)	वंशलोचन	Poaceae (Graminae)
51)	*Barlezia prionitis* (Linn)	पीलावासा	Acanthaceae
52)	*Basella alba* (Linn)	पूतिका	Chenopodiaceae
53)	*Bauhinia purpurea* (Linn)	कोविदार (लाल)	Leguminosae (Caesalpinaceae)
54)	*Bauhinia variegata* (Linn)	कचनार	Leguminosae (Caesalpinaceae)
55)	*Berberis aristata* (D.C)	दारुहल्दी	Berberidaceae
56)	*Biophyturn sensitivum* (Linn)	अलम्बुषा	Geranjaceae (Oxalidaceae)
57)	*Boerhaavia diffusa* (Linn)	लाल पुनर्नवा	Nyctaginaceae
58)	*Brassica campestris.*	सरसों	Cruciferae (Brassicaceae)
59)	*Brassica Juncea* (Linn)	लालराई	Brassicaceae (Cruciferae)
60)	*Brassica oleracea* (Linn)	पत्ता गोभी	Brassicaceae (Cruciferae)
61)	*Bryopliyllum calycinurn Salib*	पत्थरचूर	Crassulaceae
62)	*Butea frondosa koenex* (Roxb)	पलाश	Leguminosae (Fabaceae)

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1	2	3	4
63)	*Caesalpinia bonducela Fleming.*	पूति करंज	Leguminosae (Caesalpinaceae)
64)	*Callicarpa maerophylla* (Linn)	प्रियंगु	Verbenaceae
65)	*Calotropis procera* (Aif)	अलर्क	Asclepiadaceae
66)	*Cannabis indica* (Linn)	देवकिली	Cannabinaceae
67)	*Cannabis Sativa* (Linn)	भांग	Cannabinaceae
68)	*Capsicum annum* (Linn)	मिरचा	Solanaceae
69)	*Carica papaya* (Linn)	पपीता	Caricaceae
70)	*Carum copticum* (Benth & Hook)	अजवायन	Umbelliferae
71)	*Cassa auriculata* (Linn)	अर्बूर	Caesalpinaceae
72)	*Cassia absus* (Linn)	चक्षुष्या	Leguminosae (Caesalpinaceae)
73)	*Cassia angustifolia* (Vahl)	सनाय	Leguminosae (Caesalpinaceae)
74)	*Cassia fistula* (Linn).Cassia rhombifolia	अमलतास	Leguminosae (Caesalpinaceae)
75)	*Cassia occidentalis* (Linn)	कासमर्द	Leguminosae (Caesalpinaceae)
76)	*Cassiatora* (Linn)	चक्रमर्द	Leguminosae (Caesalpinaceae)
77)	*Catharanthes roseus* (L.) *vincarosea.*	सदाबहार	Apocyanaceae
78)	*Cedrela toona* (Roxb Syn) *toona ciliata roem.*	तून	Meliaceae
79)	*Cedrus deodara.* (Roxb) Loud.	देवदार	Pinaceae
80)	*Celastrus paniculatus* (Wi lid)	माल कांगनी	Celastraceae
81)	*Celosia argentea.* (Linn)	शितिवार	Amaranthaceae
82)	*Centella asiatica* (Linn) (Hydrocotyle asiatica)	मंडूकपर्णी	Umbelliferae
83)	*Cestrum diurnum* (Linn)	दिन का राजा	Solanaceae

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1	2	3	4
84)	*Cestrum nocturnum* (Linn)	रातरानी	Solanaceae
85)	*Chenopodium albu* (Linn)	बथुआ	Chenopodiaceae
86)	*Chlorophytum borivilianum* (Sant & Ferm)	सफेद मूसली	Liliaceae
87)	*Cicer arietinum* (Linn)	चना	Leguminosae (Fabaceae)
88)	*Cinnarnomum camphora* (Nees & Eberm)	चीनक कर्पूर	Lauraceae
89)	*Cinnarnomum tamala* (Nces & Eberrm)	तेजपात	Lauraceae 144
90)	*Cinnamomum zeylanicum* (Blume Syn)	दाल चीनी	Lauraceae 145
91)	*Cissampelos pareira* (Linn)	पाठा	Menispermaceae
92)	*Cissus quadrangularis* (Linn)	हड़जोड़	Vitaceae 149
93)	*Citrullus colocyntliis* (Sehrader)	इन्द्रायण	Cucurbitaceae
94)	*Citrus mediea* var. *acida* (watt.)	कागजी नींबू	Rutaceae 153
95)	*Citrus medica* (Liiin)	बिजोरा	Rutaceae 155
96)	*Cleome viscosa* (Linn Syn)	पीला हुरहुर	Capparidaceae
97)	*Clerodendron inerme* (Linn)	छोटा अरनी	Verbenaceae
98)	*Clerodendron plilomidis* (Linn)	अरनी	Verbenaceae
99)	*Clerodendron serratum* (Spreng)	भारङ्गी	Verbenaceae
100)	*Clitoria ternatea* (Linn)	अपराजिता	Fabaceae (Leguminosae)
101)	*Coccinia indica* (W & A)	कुन्दरू	Cucurbitaceae
102)	*Coleus aromaticus* (Benth)	पत्थरचूर	Labiatae
103)	*Commiphora mukul* (Hook & Exstocks)	गुग्गुल	Burseraceae
104)	*Convolvulus pluricaulis* (Choisy)	शंखपुष्पी	Convolvulaceae

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1	2	3	4
105)	*Cordia myxa* (RoxbSyn) *Cordia dichotoma*	लिसोड़ा	Boraginaceae
106)	*Coriandrum sativum* (Linn)	धनिया	Umbelliferae
107)	*Costus speciosus* (Koen) smith	केवुक कन्द	Zingiberaceae
108)	*Crataeva nurvala* (Buch-Ham)	बरुण	Capparidaceae
109)	*Crinum asiaticum* (Linn)	सुदर्शन	Amaryllidaceae
110)	*Croton tiglium* (Linn)	जमालगोटा	Euphorbiaceae
111)	*Cuminum cyminum* (Linn)	सफेद जीरा	Umbelliferae
112)	*Curculigo orchioides* (Gaertn.)	काली मूसली	Amaryllidaceae
113)	*Curcuma amada* (Roxb)	आमा हल्दी	Zingiberaceae
114)	*Curcuma domestica* (Valsyn) *longa*	हल्दी	Zingiberaceae
115)	*Cuscuta reflexa* (Roxb)	अमरवेल	Convolvulaceae
116)	*Cymbopogonaa citratus* (Andropogon citratus)	भूतृण	Poaceae (Graminae)
117)	*Cymbopogon schoenanthus* (Linn)	रोहिष घास	Poaceae (Graminae)
118)	*Cynodon dactylon* (Linn) *Pers.*	हरी दूब	Poaceae (Graminae)
119)	*Cypcrus rotundus* (Linn)	मोथा	Cyperaceae
120)	*Dalbergia sissoo* (Roxb)	शीसम	Fabaceae (Leguminosae)
121)	*Datura metal* (Linn. Syn) *Datura innoxia*	काला धतूरा	Solanaceae
122)	*Datura stramonium* (Linn)	कनक धतूरा	Solanaceae
123)	*Daucus Carota* L. Var. *Sativa* D. C.	गाजर	Umbelliferae
124)	*Desmodium gangeticum* (D.C.)	शालपर्णी	Fabaceae (Leguminosae)
125)	*Digitalis purpurea* (Linn)	तिलपत्री	Scrophulariaceae

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1	2	3	4
126)	*Dillenia indica* (Linn)	चिल्टा	Dilleniaceae
127)	*Dioscorea bulbifera* (Linn)	वाराही कंद	Dioscoriaceae
128)	*Eclipta alba* (Hassk.)	भृंगराज	Asteraceae (Compositae)
129)	*Elettaria Cardamomum* (Maton.)	छोटी इलायची	Zingiberaceae
130)	*Embelia ribes* (Burm. F.)	वायविडङ्ग	Myrsinaceae
131)	*Emblica officinalis* (Geartn.)	आमलकी	Euphorbiaceae
132)	*Erioborya Japoniea* (Linn)	लौकाट	Rosaceae
133)	*Ervatamia Coronaria* (Jacq. Syn)		
	Tabernaemontana divaricata	चांदनी	Apocyanaceae
134)	*Erythrina indica* (Lam)	पारिभद्र	Fabaceae (Leguminosae)
135)	*Euphorbia antiquorum* (Linn)	वज्रकण्टक	Euphorbiaceae
136)	*Euphorbia hirta* (Linn) *E. pilulifera* (Linn)	दुग्धिका	Euphorbiaceae
137)	*Euphorbia neriifolia* (Linn)	सेंहुड	Euphorbiaceae
138)	*Eupliorbia tirucalli* (Linn)	शातला	Euphorbiaceae
139)	*Euryale ferox* (Salisb)	मखाना	Nymphaeaceae
140)	*Evolvulus alsinoides* (Liiin)	नील शंखपुष्पी	Convolvulaceae
141)	*Feronia elephantum* (Correa)	कपित्थ	Rutaceae
142)	*Ferula foetida* (Reed. Syn) *Feruala narthex* (Boiss)	हींग	Umbelliferae
143)	*Ficus bengalensis* (Linn)	वट	Moraceae
144)	*Ficus Carica* (Linn)	अंजीर	Moraceae227
145)	*Ficus glomerata* (Roxb. Syn) *F. recemosa*	गूलर	Moraceae

contd. ...

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1	2	3	4
146)	*Ficus religiosa* (Linn)	पीपल	Moraceae 230
147)	*Foeniculum vulgare* (Mill)	सौंफ	Umbelliferae
148)	*Fumaria indica* (Pugsley)	पित्त पापड़ा	Fumariaceae
149)	*Gardenia gummifera* (Linn)	डीकामाली	Rubiaceae
150)	*Gloriosa superba.* (Linn)	कलिहारी	Liliaceae
151)	*Glycyrrhiza glabra* (Bois)	मधुयेष्ठी	Fabaceae (Leguminosae)
152)	*Gmelina arborea* (Roxb)	गम्हार	Verbinaceae
153)	*Gossypium herbaceum* (Linn)	कपास	Malvaceae
154)	*Grewia subinacqualis* (D.c.Syn) *gasiatica*	फालसा	Tiliaceae
155)	*Grevillea robusta.* (A.Cunn.)	सिल्वर ऑक	Proteaceae
156)	*Gymnema Sylvestre* (R. Br.)	गुड़मार	Asclepiadaceae
157)	*Gynandropsis pentaphylla.* (D.C.)	श्वेत हुर-हुर	Capparidaceae
158)	*Hedychium spicatum* (Llanicx. smith)	गंध पलाशी	Zingiberaceae
159)	*Helianthus Annuus* (Linn)	सूर्यमुखी	Asteraceae (Compositae)
160)	*Hemidesmus indicus* (R.Br.)	सारिवा	Asclepiadaceae
161)	*Hibiscus rosa-sinesis* (Linn)	गुड़हल	Malvaceae
162)	*Holarrhena antidysenterica* (Wall)	कुटज	Apocyanaceae
163)	*Jasminum grandiflorum* (Linn)	चमेली	Oleaceae
164)	*Jasminum Sambac* (Alt.)	मोगरा	Oleaceae
165)	*Jatropha Curcas* (Linn)	व्याध्र एरण्ड	Euphorbtaceae

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1	2	3	4
166)	*Jatropha gossypifolia* (Linn)	रतनजोत	Euphorbiaceae
167)	*Juniperus communis* (Linn)	हपुषा	Cupressaceae
168)	*Lagerstroemia speciosa* (Pers. Syn.)	जारूल	Lythraceae
169)	*Lantana camara* (Linn)	वन तुलसी	Verbinaceae
170)	*Lawsonia inermis* Linn. *L. alba*.	मेन्दिका	Lyturaceae
171)	*Lepidium Sativum* Linn	चर्महन्त्री	Brassicaceae (Cruciferae)
172)	*Leptadenia reticulata*. W & A	जीवनी	Asclepiadaceae
173)	*Leucas Cephalotes* spreng.	द्रोणपुष्पी	Lamiaceae (Labiatae)
174)	*Linum usitatissimum* (Linn)	अलसी	Linaceae
175)	*Litchi chinensis* Syn. *Ncphelium litchi* comb.	लिची	Sapindaceae
176)	*Loranthus longiflorus* Desrsyn. *Dendropthoe falcala*.	वांदा	Loranthaceae
177)	*Luffa acutangula* (Linn) Roxb Var. *amaralark*	कड़वी तोरई	Cucurbitaceae
178)	*Lycopersicon esculentum* Mill	टमाटर	Solanaceae
179)	*Mallotus phillippinensis* Muell Arg	कपीला	Euphorbiaceae
180)	*Mangifera indica*. (Linn)	आम	Anacardiaceae
181)	*Melia azedarach*. (Linn)	वकायन	Meliaceae
182)	*Mentha piperata* (Linn)	पिपरमिन्ट	Lamiaceae
183)	*Mentha spicata* (Linn)	पुदीना	Lamiaceae (Labiatae)
184)	*Mesua ferrea*	नागकेशर	Guttiferae
185)	*Michelia champaca* (Linn)	सोनचम्पा	Mangnoliaceae

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1	2	3	4
186)	*Mimosa pudica* (Linn)	लज्जावन्ती	Mimosae (Leguminosae)
187)	*Mimusops elengi* (Linn)	बकुल	Sapotaceae
188)	*Mirabilis jalapa* (Linn)	गुलवास	Nyctaginaceae
189)	*Momordica charantia* (Linn)	करेला	Cucurbitaceae
190)	*Momordica dioica* (Roxb)	कर्कोटकी	Cucurbitaceae
191)	*Moringa pterygosperma* (Gaertn)	सहिंजना	Moringaceae
192)	*Morus indica* (Cuff.)	सहतूत	Moraceae
193)	*Mucuna Pruriens* (Bek.)	कौंच	Fabaceae (Leguminosae)
194)	*Murraya koenigii*. Spreng	मीठी नीम	Rutaceae
195)	*Murraya paniculata* Jack Syn. *M. exotica*	कामिनी	Rutaceae
196)	*Musa sapientum* (Linn) *M. paradisiaca.*	केला	Musaceae
197)	*Myrica nagi* Thunb. *M. eseulanta*	कायफल	Myricaceae
198)	*Myristica fragrans* Houtt.	जायफल	Myristicaceae
199)	*Myristica fragrans* Houtt	जावित्री	Myristicaceae
200)	*Nardostacliys jatamansi*	जटामांसी	Valerianaceae
201)	*Nelurnbium speciosum* (Willd).	कमल	Nymphaeaceae
202)	*Nerium odorum* Soland.	कनेर	Apocyanaceae
203)	*Nigella Sativa* Linn	कलौंजी	Ranunculaceae
204)	*Nyctanthes arbor-tristis* (Linn)	हरसिंगार	Oleaceae
205)	*Ocimum basilicum* (Linn)	कूपर तुलसी	Lamiaceae (Labiatae)

contd. ...

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1	2	3	4
206)	*Ocimum canum* sines. *O. americanum*	वन तुलसी	Lamiaceae (Labiatae)
207)	*Ocimum gratisiimum* (Linn)	राम तुलसी	Lamiaceae (Labiatae)
208)	*Ocimum sanctum* (Linn)	गौरी तुलसी	Lamiaceae (Labiatae)
209)	*Oldenlandia corymbosa* (Litin)	क्षेत्र पर्पट	Rubiaceae
210)	*Opcrculina terpthum* Silva Manso. *Ipomoea terpethum*	निशोथ	Convolvulaceae
211)	*Oroxylum indicum* Vent.	सोना पाठा	Bignoniaceae
2 12)	*Oxalis corniculata* (Linn)	चांगेरी	Oxalidaceae
213)	*Pandanus odoratissimus* Roxb	केवड़ा	Pandanaceae
214)	*Papaver sornniferum* (Linn)	अफीम	Papavaraceae
215)	*Pedalium murex* (Linn)	बड़ा गोखरु	Pedaliaceae
216)	*Peucedonum graveolens* (Linn)	शतपुष्पा	Umblliferae
217)	*Phaseolus trilobus.* Ait	वन मूंग	Fabaceae (Leguminosae)
218)	*Phyllanthus niruri* (Linn) *P. asperulatus*	भुँई आँवला	Euphorbiaceae
219)	*Physalis niinima* (Linn)	टंकारी	Solanaceae
220)	*Phyla nodiflora.* Lippia nodiflora Rich.	जल पीपल	Verbenaceae
221)	*Picrorrhiza kurroa.* Royle exbenth.	कटुकी	Scrophulariaceae
222)	*Pinus lotigifolia* Roxb.	चीड़	Pinaceae
223)	*Piper betle* Linn.	पान	Piperaceae
224)	*Piper longum* (Linn)	पिप्पली	Piperaceae

contd. ...

contd. ...

1	2	3	4
225)	*Piper nigrum* (Linn)	काली मरिच	Piperaceae
226)	*Piper Sylvaticum* Roxb	पहाड़ी पीपल	Piperaceae
227)	*Pluchea lanceolata* oliver & Hiern.	कृत्रिम अशोक	Compositae (Asteraceae)
228)	*Plumbago zeylanica* Linn.	चित्रक	Plumbaginaceae
229)	*Plumeria acutifolia* Poir.	रासना	Apocyanceae
230)	*Pluchea lanceolata* oliver & Hiern.	खेर चम्पा	Compositae (Asteraceae)
231)	*Pongamia pinnata* Syn. *P. glabra*. Vent	करंज	Fabaceae (Leguminosae)
232)	*Portulaca oleracea* (Linn)	बड़ी लोणा	Portulaceae
233)	*Portulaca quadrifida* (Linii)	लघु लोणा	Portulaceae
234)	*Prosopis spicigera*	शमी	Mimosae (Leguminosae)
235)	*Prunus amygdalus* Batsch.	बादाम	Rosaceae
236)	*Prunus persica* Batsch.	आड़ू	Rosaceae
237)	*Psoralea corylifolia* (Linn)	बाकुची	Fabaceae (Leguminosae)
238)	*Psidium guajava* (Linn)	अमरूद	Myrtaceae
239)	*Pterocarpus marsupium*. Roxb.	असन	Fabaceae (Papilionaceae)
240)	*Pueraria tuberosa* D.C.	विदारी कंद	Fabaceae (Leguminosae)
241)	*Punica granatum* (Linn)	अनार	Punicaceae
242)	*Putranjiva roxburghii*. Wall	पितौंजिया	Euphorbiaceae
243)	*Pyrus malus* (Ltnn)	सेव	Rosaceae
244)	*Quisqualis indica* (Linn)	मधुमालती	Combretaceae

contd. ...

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1	2	3	4
245)	*Randia durnetorum* Lam.	मदन	Rubiaceae
246)	*Raphanus sativus* Linn	मूली	Brasicaceae (Cruciferae)
247)	*Rauwolfia serpentina* Benth. ex. kurz.	सर्प गंधा	Apocyanaceae
248)	*Ricinus communis* Linn	एरण्ड	Euphorbiaceae
249)	*Rosa centifolia* (Linn)	गुलाब	Rosaseae
250)	*Rubia cordifolia* Linn	मंजिष्ठा	Rubiaceae
251)	*Saccharum officinarum* Linn.	ईख	Poaceae (Graminae)
252)	*Salmalia malbarica*	सेमल	Bombaceae
253)	*Santalum album* Linn.	सफेद चन्दन	Santalaceae
254)	*Sanseriena roxburghina* Schult.	नागदमन	Haemodoraceae
255)	*Sapindus infolialus* (Linn)	रीठा	Sapindaceae
256)	*Saraca indica*	अशोक	Caesalpinaceae (Leguminosae)
257)	*Sarifraga ligulata* Wall	पाषाणभेद	Saxifragaceae
258)	*Sesamum indicum* Linn.	तिल	Pedaliaceae
259)	*Shorea robusia* gaemm.	शाल	Dipterocappaceae
260)	*Sida cordifolia* (Linn)	बला	Malvaceae
261)	*Sida rhombifolia* (Linn)	महाबला	Malvaceae
262)	*Smilex china* (Linn)	चोप चीनी	Liliaceae
263)	*Solanum indicum* (Linn)	बृहती	Solanaceae
264)	*Solanium melohgena* (Linn)	बैंगुन	Solanaceae

contd. ...

contd. ...

1	2	3	4
265)	*Solanum nigrum* (Linn)	मकोय	Solanceae
266)	*Soianum surattcnse* Brumt. *S. xanthoearpum.*	कंटकारिका (लघु)	Solanaceae
267)	*Soymida febrifuga* A. Juss	रोहिनी	Meliaceae
268)	*Spinacia oleracea* (Linn)	पालक शाक	Chenopodiaceae
269)	*Strychnos nux vomica* (Linn)	कुचला	Loganiaceae
270)	*Swertia chirayata* Roxb. Syn. .	चिरायता	Gentianaceae
271)	*Symplocos racemosa* Roxb. Syn.	लोध्र	Symplocaceae
272)	*Syzygium aromatica*. Meril & Perry.	लौंग	Myrtaceae
273)	*Syzvgium cumini* Skeels Syn.	बड़ी जामुन	Myrtaceae
274)	*Tagetes erecta* (Linn)	गेंदा	Asteraceae
275)	*Tamarindus indica* (Linn)	इमली	Caesalpinaceae (Leguminoceae)
276)	*Tamarix articulata*. Vahl.	छोटी पत्रवास	Tamaricaceae
277)	*Tamarix gallica* (Linii)	बड़ी पत्रवास	Tamaricaceae
278)	*Tectona grandis* (Linn)	सागवान	Verbinaceae
279)	*Tephrosia purpurea* Linn	शरपुंख	Fabaceae (Leguminosae)
280)	*Teramnus labialis* spreng	माषपर्णी	Fabaceae (Leguminosae)
281)	*Terminalia arjuna*. Bedd.	अर्जुन	Combretaceae
282)	*Terminalia belerica* Roxb.	विभीतक	Combretaceae
283)	*Terminalia chebula* Retz.	हरीतकी (बड़ी)	Combretaceae
284)	*Terminalia tomentosa*. W & A.	असन	Combretaceae

contd. ...

contd. ...

1	2	3	4
285)	*Thevetia neriifolia* Juss.	पीला कनेर	Apocyanceae
286)	*Thuja orientalis*	मयूर पंख	Cupressaceae
287)	*Tinospora cordifolia* (Wilid) Miers.	गिलोय	Menispermaceae
288)	*Trapa natats* (Linn)	सिंघाड़ा	Trapaceae
289)	*Tribulus terrestris* (Linn)	गोक्षुर	Zygophyllaceae
290)	*Trichosanthes dioica*. Roxb.	परवल	Cucurbitaceae
291)	*Trigonella foenum graecum* (Linn)	मेथिका	Fabaceae (Leguminosae)
292)	*Tylophora indica* (Burmf.) Merr.	अर्कपर्णी	Asclepiadaceae
293)	*Uraria picta*. Desv.	पृश्निपर्णी	Fabaceae (Leguminosae)
294)	*Virginia indica*. kunth.	जंगली प्याज	Liliaceae
295)	*Vernonia anthelmintica* (Willd)	वन जीरा	Asteraceae (Compositae)
296)	*Vernonia cinerea* Less.	सहदेवी	Asteraceae (Compositae)
297)	*Vetiveria zizanioides* (Linn) Nash.	वीरणमूल	Poaceae (Graminae)
298)	*Viola odorata* Linn	गुलबनफ्शा	Violaceae
299)	*Vitex negundo* (Linn)	निर्गुण्डी	Verbenaceae
300)	*Vitis vinifera* (Linn)	द्राक्षा	Vitaceae
301)	*Withania somnifera* Dunal.	अश्वगंधा	Solanaceae
302)	*Wrightia tinctoria* R. Br. Syn.	मीठा इन्द्रजव	Apocyanaceae
303)	*Zingiber officinale* Roscoe.	अदरख	Zingiberaceae
304)	*Zizyphus vulgaris* Lam.	राज बदर	Rhamnaceae

Table 13 : Common name of medicinal and spiceal plants as known in world trade

1)	Ailanthus	37)	Black Musale
2)	Ajova Seeds	38)	Black Night shade
3)	Almonda	39)	Black pepper
4)	Apple Tree	40)	Black Plum
5)	Arbian Jasmine	41)	Blue shankhpushpi
6)	Arjune Tree	42)	Bondac Nut
7)	Asfoetida	43)	Box Myrtle
8)	Asoka Tree	44)	Brinjal
9)	Asiatic Grawia	45)	Broom Jute sida
10)	Asporagus	46)	Bushy Gardenia
11)	Bacopa	47)	Bus Tard
12)	Bael Tree	48)	Cabbage
13)	Balanite	49)	Camphor Plant
14)	Bambo	50)	Capsicum
15)	Banana Plant	51)	Cardamom major
16)	Banyan Tree	52)	Cardamom fruit
17)	Baobad	53)	Carambola
18)	Barbados Aloe	54)	Carrot
19)	Barbreng	55)	Cashew Nut Tree
20)	Bedda Nut	56)	Caster oil Plant
21)	Beleric Myrobalans	57)	Cat-tail
22)	Belladona Lily	58)	Celeryfruit
23)	Bellyache bush	59)	Celosia
24)	Bengal Gramm	60)	Century Plant
25)	Bengal Quince	61)	Chebulic Myrabalans
26)	Betal Leat	62)	China-Root
27)	Beta Nut Palm	63)	Chireta
28)	Bhuianvla	64)	Chir Pine
29)	Bitter Apple	65)	Cinnamom Bark
30)	Bitter Gourd	66)	Citron
31)	Bitter Luffa	67)	Clerodendron
32)	Black Basil	68)	Clove Tree
33)	Black Catechu	69)	Cobras Saffron
34)	Black Cumin	70)	Colocynth
35)	Black hellebore	71)	Common Cress
36)	Black kurchi	72)	Common Jasmine

contd. ...

contd. ...

73)	Common Purslane	110)	Garden Quinine
74)	Common Sweet Basil	111)	Garland Flower
75)	Coral Tree	112)	Garlic
76)	Coriander	113)	Giant Alocasia
77)	Country Mallow	114)	Ginseng
78)	Creeping Cynodon	115)	Gorgon Fruit
79)	Crinum	116)	Grape Plant
80)	Crotan oil Seed	117)	Greater Galangal
81)	Cumin Seed	118)	Guava Tree
82)	Cuptard Apple Tree	119)	Gummy Gardenia
83)	Curry Leaf Tree	120)	Henna plant
84)	Cuscus Grass	121)	Himalyan Cedar
85)	Datura	122)	Hog Weed
86)	Deilenia	123)	Holy Besil
87)	Devil's Tree	124)	Hollyhock
88)	Doddar	125)	Indian Atees
89)	Dodi	126)	Indian Beach
90)	Drum stick Tree	127)	Indian Bedellium Tree
91)	East Indian Walnut	128)	Indian Berberry
92)	Edible Stammed Vine	129)	Indian Birth wortlt
93)	Egg Plant	130)	Indian Atees
94)	Elephant Creeper	131)	Indian Beach
95)	Emblic Myrobalan	132)	Indian Bedellium Tree
96)	Emetic Nut	133)	IndianBerberry134) Indian Birth worth
97)	False Jalap		
98)	Fennel fruit	135)	Indian Cotton
99)	Fenu Greek	136)	Indian dill fruit
100)	Fever Nut	137)	Indian Gum Tree
101)	Fig Tree	138)	Indian Ipeca Caunha
102)	Fine Leaved Fumiteric	139)	Indian Jack fruite
103)	Flame of the Forest	140)	Indian Jalap
104)	Fleabanc	141)	Indian kino Tree
105)	Flowers Priyangu	142)	Indian Madder
106)	Four Leaved Cassia	143)	Indian Mallow
107)	Four 'O' Clock Plant	144)	Indian Mustard
108)	Fox Glove	145)	Indian Night
109)	Gardenmint	146)	Indian Penny wort

contd. ...

contd. ...

147) Indian Privet
148) Indian Rock Foil
149) Indian Sarsaprilla
150) Indian Senna
151) IndianSnot
152) Indian Sorret
153) Indian Spinach
154) Indian Squill
155) Indian Teak Tree
156) Indian Trumpet flower
157) Indian Worm wood
158) Ivy Gourd
159) Iyrisp
160) Java Apple
161) Jequirity
162) Jonesia Ashoka
163) Jujub
164) Juniper Berry
165) Kadamba
166) Kantkari
167) Kosht
168) Large Caltrops
169) Lamb mint
170) Lemon Grass
171) LifePlant
172) Lime Plant
173) Line seed
174) Liquoric Root
175) Litchi
176) Locket
177) Long Leaved Barleria
178) Long Pepper
179) Loranthus
180) Love Apple
181) Lucky Nut
182) Luster Fig
183) Lyon Bean
184) Madder Tree
185) Maiden hair
186) Malaya Tea
187) Malbar Nut
188) Mango Ginger
189) Mango Tree
190) Margosa Tree
191) Marigold
192) Mast Tree
193) Mexican Poppy
194) Milk Bush
195) Milk Hedge
196) Milk Weed
197) Monkey Bread Tree
198) Monkey face Tree
199) Moon Been Plant
200) Mountain Ebony
201) Mulberry
202) Negro Coffee
203) Night blooming Jasmine
204) Nut Grass
205) Nut meg
206) Onion
207) Opium
208) Orange Jasmine
209) Oriental Arbor vitae
210) PagodaTree
211) Pandari Tilwan
212) PapwaTree
213) Peach
214) Pepper Mint
215) Periwinkle
216) Persion Lilac
217) Physic Nut
218) Pine Apple
219) Plantain

contd. ...

contd. ...

220) Plum
221) Poison Nut
222) Pomegranate The
223) Pongarue Oil Tree
224) Poppy Plant
225) Poppular Leaved Fig Tree
226) Prickly Amaranthus
227) Prickly Chaff Flower
228) Pride of India
229) PrishnaParni
230) Pudding Pipe Tree
231) Purging Nut
232) Purple Fleabane
233) Purple Lippia
234) Putanjiva
235) Radish
236) Ran-Goose Berry
237) Rangoon Creeper
238) Rape Seed
239) Rape Seed Plant
240) Rasna
241) Red Cedar
242) Red Ebony
243) Red Silk Cotton Tree
244) Red wood Tree
245) Ring worm Plant
246) Rose
247) Rosha Grass
248) Sacred Lotus
249) Sandal Wood
250) Sansevieria
251) Saral
252) Sarivan
253) Screw Pine
254) Sebestan
255) Sensitive Plant
256) Serpentine
257) Sesame
258) Sespadula
259) Shankhpuhpi
260) Shallow wort
261) Shikakai Acasia
262) Shivan
263) Shoe Flower
264) Silver Oak
265) Sisso Tree
266) Small Caltrops
267) Small Indian Ipeca Caunha
268) Small Pepper
269) Small Purslane
270) Soap Nut tree
271) Sponish Pellitory
272) Spikenard
273) Spinach
274) Spiny Yellow Borleria
275) Sun Flower
276) Suppermint
277) Spinous kino Tree
278) Sponge Tree
279) Staff Tree
280) Sugar Cane
281) Surinam Madler
282) Sweet Flag
283) Sweet Scented Oleander
284) Sweet Viola
285) Swinum Cherry
286) Symplocos Bark
287) Tamrind
288) Tamrinsk
289) Tamrix (Red)
290) Tamba
291) Tamla Tree
292) Tanners Cassia
293) Tillicheny Bark

contd. ...

contd. ...

294)	The Creat	308)	Water Chest Nut
295)	The Day Jasmine	309)	White Goose Foot
296)	The Sal Tree	310)	WhiteLealdwort
297)	Thome Apple	311)	White Musale
298)	Tinospora	312)	Wild Besil
299)	Tiutun	313)	Wild indigo
300)	Touch me not	314)	Wild Mung
301)	Trailing Eclipta	315)	Wild Sage
302)	Turk's Turbon	316)	Wild Udad
303)	Turmeric	317)	Winged Leaved chiforia
304)	Varuna	318)	Winter Cherry
305)	Vasaka	319)	Yam
306)	Vegetable Corn	320)	Yellow Cleome
307)	Velvet Leaf	321)	Zinger Plant

EPILOGUE

The objectives of all the systems of treatment prevailing in different societies of the world are similar—To make human life more pleasuring for which health is wealth and for this wealth to achieve, there is need to follow an holistic approach in which the integration of different concepts and practices is a primary requirement. This integration needs to shed the opinion of differences and to make concerted and co-ordinated efforts. In this venture, we must take timely action to bring more and more plants (medicinal and otherwise useful) under domestication and cultivation web. It is envisaged that this treatise shall pave the way for these efforts. This will certainly have a bearing biodiversity conservation, environmental protection, climatic amelioration and societal/economic upliftment.

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16

Phytoeatables, Food Adjuncts and their Therapeutic Potential

Karan Singh and O.P. Gill

Food is the basic and primary requirement of a healthy body of all living being as it provides necessary energy of all the metabolic actions which lead to growth and development. Successful metabolism is the base of growth of body of animals and plants (both lower and higher phyla). Life and human body is an excellent gift of all mighty. To remain healthy is the natural characteristic of the body.

To stay healthy (and happy also) good food in appropriate amount at proper time is foremost need. Good food indicates the pure tasty digestible and balanced diet to be taken by human body. Good foods also embody such characteristics which renders the food items as medicinal properties (Mehta, 2005; Chauhan 2006). It is an established fact that a patient is better treated in a kitchen than in a hospital. Therefore, we should prefer health maintaining and nutritive food in our daily life.

We can increase our life span substantially only by improving our food habits and food quality. Modern researches by medical experts have proved that more men die of over eating rather than hunger. We should eat less to prolong the working conditions of our digestive system. More and more scientists are now recommending to become closer to nature which implies that food of wholesome nature preserves our health and beauty. Naturopathy favours only *'Satvik'* foods. This grand science and art believes that food is medicine and medicine is food. Natural food activates our inner resistance power (immunity system = vital force). Good amount of literature is available on good food, nutritive food, digestive food and healthy retentive food coupled with proper eating habits including timings of eating and periodicity of eating. Information are also available on roles of vitamins and calorific, value of fruits and vegetables, food spices (food adjuncts and condiments) and their therapeutic status for our health.

According to Health Bulletin No. 23, Government of India, New Delhi, we should eat such food which contains **proteins** (including pulses, cereals, milk, dry fruits etc.), **fats** (including curd, ghee, milk, almonds, walnuts, cashew nut, groundnut etc.), **minerals** (including vegetables, fruits, etc.), **carbohydrates** (including rice, wheat, millets, sugar cane, dates etc.), water, calcium, iron, vitamins etc. This is also believed that constipation is the root cause of so many ailments of human body. Therefore, fibres in food are essential alongwith proper amount of water. However, hectic life style, restless work and lack of systematic physical exercises are essentially the another causes of constipation, blood pressure, diabeties etc. Systematic physical exercises certainly improve the efficiency of treatment through medicines, food etc.

Chauhan (2006) comprehensively described the treatment of constipation through food. Eating the food items that stimulate the natural action of bowel is the best way to keep the constipation away. These include sprouted beans, cooked pulses, boiled vegetables and leafy greens, spinach juice, melon juice, beal juice, oranges, mangos, papaya, guava etc. To supplement the efficacy of such items Haritaki powder, mustard oil, carrot, fenugreek (leaf and grain powder), aniseed, tomato, amla, turnip, apple, large raisins, dried dates are also beneficial.

Therapeutic potentials of some eatables of plant origin are discussed here in brief—

CEREALIC EATABLES AND THEIR THERAPEUTIC POTENTIAL

Cereals are the most important eatables, act as staple food, belong to graminaceous group (Family Poaciar). These are herbaceous annuals with tillering habit. Wheat, rice, maize, barley, oat and rye are six most important cereals. Utilization of their grains as food in various forms is well known but their therapeutic potential is less explored and very few references are available on the medicinal uses of cereals. Few medicinal uses are summarized as below—

Wheat (Triticum)—There are 14 species of *Triticum* out of which *T. aestium* (common wheat) and *T. durum* (durum wheat = Macaroni wheat) are most common.

Wheat grain alone or in combination with certain other plant products provide a good management of various disease (disorders) of human body. If used systematically this is useful in semen flow with urine, dysentry, wound healer, swelling, bone fracture exzema, scabies, cough, kidney stone and impotency.

According to Vigmor (1990), an eminent naturopath, wheat grass juice therapy is effective in ageing, in cancer, in blood pressure, in kidney stones.

Rice (Oryza sativa) —Out of 23 species of Oryza, *Oryza sativa* and *Oryza glaberrima* are cultivated. Out of these two species, *Oryza sativa* is widely distributed in tropical and subtropical parts.

Rice grain is useful in diarrhoea, dysentry and loose motions. The left out water (after rice cooking) which is called *maand* is given at hourly intervals. Rice is useful in heat stroke, urinary problem, vomiting (in pregnant ladies), in nutralizing the effect of bhaang, charas, ganja, opium etc. Khichadi of rice with mung is beneficial in constipation. Some liver problems are removed by taking raw (uncooked) rice with water.

Maize = Corn (*Zea mays*) — Cultivated maize comes from *Zea mays* which monoecious plant bearing male flowers (inflorescence) on terminal portion and female flowers (inflorescence) on exillary positions. Maize grains boiled in water are effective tonic. The processed food prepared from corn (corn flakes) are nutritive and very digestive. Corn oil is a good massage medium for child. Un ripe cobe of maize partially roasted are beneficial for whooping cough, urinary problems, kidney stone, rheumatic fever, leucorrhoea and obesity.

Barley (*Hordeum vulgare*) —Barley is grown in tropical, sub tropical, semi arid and temperate climates. Out of three species of *Hordeum, H. vulgare* is most common.

The grain is used in the preparation of beverages like beer, whiskey, brandy etc. This is due to the quality of grain. Barley grains are used to prepare *'Aatta'* which is used for several medicinal purposes. It is used with sessame and honey, to prevent abortion. Also useful for burns etc. Ash of grain with sugar cubes is used for asthma. Barley water is effective in kidney and bladder stones. Useful in the swelling of internal organs.

Oat (*Avena sativa*)—Oat is a crop of humid, temperate region. It is hardy and tolerant to abiotic stresses. It is nutritious and easily digestable. Useful in few veterinary medicines.

Rye (*Secale cereale*) —It is a tufted annual but tends to be perennial. The plant flourishes well in cool-non-humid climate and is tolerant to low temperature and drought.

Rye is used for preparing therapeutically valuable beverages including whisky, gin, beer. Rye, oat and barley (alongwith millets) are also cultivated for specific purpose of *'ergot'* production. The ergot is the source of several Allopathic drugs.

Rye plant is also used to produce an intergeneric hybrid *Triticale (Triticose Cole)* which is the result of cross between wheat and rye.

MILLETIC EATABLES AND THEIR THERAPEUTIC POTENTIAL

Millet is a general term used to describe the group of grasses producing small grains (coarse grains). They are staple food for poorer regions of the world. They are used for preparing alcoholic beverages in many parts of the world. Most of them are tolerant to adverse agroclimatic conditions. Common millets include pearl millet, foxtail millet (Italian millet), proso millet (common millet), finger millet (ragi), kodo millet, japanese burnyard millet, shama millet, taff, black fonio, Adlay Job's tion etc. Their medicinal value is described in some indian literature. *Sorgum* is also described with millets in majority of references.

Sorghum (*Sorghum vulgare*) —Sorghum (Jawar) is basically a fodder plant. All the 10 species found in India are source of fodder. The grain of Sorghum is used for beverages preparation. The grain of sorghum is beneficial in piles and wound healing. The bread of sorghum with curd water (Chhachha = mattha) is prescribed for hyper thrustic condition. Roasted grain of sorghum is useful in digestive disorders.

Pearlmillet (Pennisetum typhoides)—This millet is much adopted to arid and semi arid environment. The bread of bajra is liked in rural areas of Rajasthan. The grain of this millet in some combinations is useful for constipation. Beneficial for asthmatic mode and reduces the formation of mucusic secretion (sputum = balgam).

Italian millet (Foxtail millet) = **Setaria italica** = Kangni is a good diuretic, astingent and also used as external application for rheumatic problems.

Proso millet = common millet (**Panicum miliaceum** = Chin = Morho) is used as fodder and some medicines.

Finger millet = ragi *(Eleusine corcanna)*, Kodo millet *(Paspalum scrobiculatum)*, Japanese burnyard millet *(Echinochloa frumentacea)*, Shama millet *Echinochloa colona*, and jobs tear *(coix arundinacea)* are also the rapeutically valuable and are used by tribes for various ailments.

Besides cultivated cereals and millets, there are some other grasses which are medicinally valuable including species of *Eragrostis (E.Tef), Digitaria iburua, D. exilis, Cynodon dactylon*, etc. Stem and roots of Bermuda grass (Doob-Cynodon) are ground with water and mixed with sugar cubes (Mishri) and taken to remove / dissolve stone of blcdder. Doob is also useful in more bleeding, abscesse, wound healing, eye sight weakness and scabies in combination with some other medicines.

PULSES, SOME OTHER LEGUMES AND THEIR THERAPEUTIC POTENTIAL

Pulses are second to cereals as the source of human food and provide proteins which are essential for balanced diet of vegetarian society. All pulses are member of grand taxonomic group family - Leguminaceae which has now, been split into three families — Fabaceae, Caesalpiniaceae and Mimosacease. Pulses are members of first family Fabaceae (earlier name Papilionaceae). Pulses include lentils, chickpea, common pea, grass pea = khesari dhal, broad bean = horse bean, ground nut, soybean, lab lab bean, common bean, cowpea, pigeonpea, horse gram, ground bean, sword bean, jack bean, cluster bean, green gram, black gram, kulthi etc. The nutritive value of these pulses have been well explored but they are equally important in medicine. Few medicinal potentials are given below —

(1) Pigeonpea = Redgram = Congo pea (*Cajanus cajan*)—An annual crop but tend to become perennial, is grown in tropical and subtropical parts of the world. Very nutritive and often used as dhal.

Paste of dhal in water is applied externally for hydrocele in children. Useful in bodypain. Excess of dhal if taken without ginger stimulates flatulence. Mouth burns and boils of buccal cavity are removed by the water of pigeonpea dhal. Intoxication of cannabis is nutralized by dhal water. Also useful in scabies, exzema and alopecia, nasal bleeding and skin abscesses.

Common Pea (*Pisum sativum*) —Common Pea (*Pisum sativum*) is an annual herb grown in rabi season in many parts of the world. This is known as a vegetable crop.

In winter, the swelling of fingers is relieved by warning the fingers with luke worm water mixed with pea grain and sessame seeds. It also improves skin beauty. Green pea if pasted on skin removes the body pain. Green pea removes constipation. Green mater is beneficial for pregnant ladies.

Chickpea (*Cicer arietinum*)—Chickpea is a crop of arid and semi arid regions. All the aerial parts are medicinally valuable. There is a long list of human problems which are relieved by chickpea seed, leaves and stem etc. But these must be used under the guidance of an Ayurvedic physician (Mehta, 2005). Sprouted chickpea is beneficial in leprosy. Chickpea seeds soaked in water, boiled in water are good tonic. Excessive hunger is relieved by chickpea seeds. Water accumulation in body cavity, dysentry, cold (common), blooding piles, constipation, headache, bronchitis, jaundice, body pain, exema, small pox, vomiting, leucoderma, leucorrhoea, polyuria, abortion, diabetes, urticaria, maddness, kidney/bladder stones and some problems of heart are ameliorated by chickpea in some processed form or in combination with some other medicines of plant origin.

Lentils (*Lens esculanta*)—Lentils are chemotaxonomically related with chickpea. These are winter annuals and are cultivated in semi-arid and arid parts of the world. Lentil dhal is of nature, increases blood formation, improve the blood viscosity. This dhal is beneficial for dysentry, polyuria, leucorrhoea, constipation, eye sight, all types of bleeding, various digestive problems, abscesses, piles etc.

Green gram (*Phaseolus aureus*)—It is an annual herb and is grown in kharif season as well as in summer season in hotter parts and arid and semi arid parts of the world. Dhal of greengram (moong) is medicinally useful for all types of fevers. It is a good tonic for weak persons. It regulates excessive sweating, relieves constipation, relieves burns pains, exema and scabies.

Black gram (*Phaseolus radiatus*) —Black gram (Urd) is a kharif crop and also grown as additional crop in summer season. Properly prepared and cooked dhal is useful in plies, arthritis, rheumatism, paralytic conditions and asthmatic problem. But dhal of Urd should be well cooked ajuncted with asafoetida and ginger because persons with weak digestion may be in trouble by taking Urd Dhal. Whole grain of Urd if poured on burning coal and inhale this smoke, the condition of hiccough may be relieved. The nasal epistaxis, headache, Hemi piegia, abscesses, baldness, leucoderma and forgetfulness may be relieved.

Mothbean (*Vigna aconitifolia*)—Mothbean is a crop of hot arid environment. It is an annual kharif crop. Moth grain and dhal is a potent wormifuge (wormicide). It relieves fever, excessive sweating, uterous purifier and appetiser.

Atylosia = Kulthi (*Atylosia scarabeoides*)—This is an annual herb, semi cultivated or wild. This is a good remedy for obesity, leucoderma and rheumatic fever but the most important in its capability to remove (dissolve) kidney and bladder stones of various sizes. For this purpose, the cleaned and washed grains are soaked over night in water (200 gm seed in 3 litre of water). This whole content (grain + water) are boiled to the extent of 1/3. This content is filtered and mixed with common salt, black pepper, cumin, and turmaric. This water is taken daily till the kidney and bladder stones are removed. This is the experience of eminent physicians that stones are passed out without pain and surgical operation. Taking this water for even longer period does not cause any ill effect.

Other pulses which have good therapeutic potential include cowpea *(Vigna unguiculata)*, french bean (common bean, *Phaseolus vulgaris)*, grass pea *(Lathyrus satium)*, hyacinth bean *(Dolichos lab-lab)*, horse bean *(Dolichos uniflorus)*, clustur bean (Cyamopsis tetragonoloba) *Vicia feba, Lathyrus aphaca* etc.

Besides pulses, other members of legume group are therapeutically potent in Allopathic, Homoeopathic Unani Siddha and Ayurvedic systems of medicine. These include *Abrus precatorius, Acacia catechu, Acacia concina, Acacia nelotica, Albizzia lebbeck, Bauhinia purpure, Bauhinia variegata, Butea frondosa, caesalpiria bonducela, Cassia absus, Cassia angustifolia, Cassia fistula, Cassia occidentalis, Cassia tora, Clitoria ternatea, Dalbergia sisso, Deomodium gangeticum, Erythrina indica, Glycirrhiza glabra, Mimora pudica, Mucuno prurims, Phaseolus trilobus, Prosopis spicigira, Pongamia pinnata, Psoraleo corylifolia, Pterocorpus marsupium, Pueraria tuberosa, Saraca* *indica, Tamarindus indicus, Tephrosia purpurea, Trigonella foenum graecum, Urasia picto.* The medicinal preparations of these legumes have been described by Brahm Varchas (2005).

EDIBLE OIL YIELDING PLANTS AND THEIR THERAPEUTIC POTENTIAL

Edible oils and fats of plant origin constitute a very important component of eatables all over the world. But these plants have attracted little exploratory attention. Diverse taxonomic groups form the raw material for vegetable oils and fats. Plants which provide edible oils include soybean, groundnut, sunflower, rapeseed and mustard, sessame, linseed, safflower, cottonseed, olive, coconuts, tung oil, palm kernel oil, palm oil, castor oil etc. All these oils have high calorific value and make an important part of vegetarian diet. Medicinal properties of these plants are briefed as below —

Groundnut (*Arachis hypogea*) — Groundnut or pea nut is a crop of kharif season. Nuts are used for preparing peanut butter, vanaspati ghee. Groundnut is rich in vitamins and proteins. Groundnut oil is equal to olive oil (Jaitoon ka Tel) in medicinal properties. It is useful in cough in winter. strengthen the stomach and lung functioning. Groundnut is beneficial in rheumatic problems. In small amount beneficial for pregnant women. It enhances lactation in women. It removes skin dryness. Groundnut oil is beneficial for ruptured lips.

Soybean (*Glycine max*) —Soybean and soybean oil is nutritious and is used in the preparation several products of medical significance. These products include margarine, linoleum, disinfectants, insecticides, lecthin, phospholipids, cosmetics, pharmaceutic plastic, lipoxidase etc. Germinated soybean is used as a good and natural breakfast.

Mustard and Allied Oils—*Brassica* and allied genera are good sources of edible oils. These constitute potent remedies for various health problem in different systems of medicine. The genun *Brassica* include more than 150 species of annuals, biennials and rarely perennials. All are medicinally important. There are some confusions / overlapping in nomenclature. But according to Indian Council of Agricultural Research, New Delhi (Singh et al, 1983) the nomenclature has been authenticated. *Brassica compestris L* var. *dichotoma* Watt be quoted as *Brassica Chinensis* guslen non Duthie & Fuller (Kalisorson). *Brassica compestris* var. *sarson Prain (Synonym - B compestris* var. *glauca)* be quoted as *B. napus* L var. *Glauca (Roxb)* Schulz = Yellow sorson) *B. Compestris* var. Toria Duthie & Full be quoted as *B. napus* L var. *napus* (Toria) *B. juncea* (Syn. *B. juncia = B. lanceolata = B. synopsis alba*) be quoted as *B. juncea (L) Czern & Co.s sub. sp. juncio (Rai.). B. juncea* (L) Czern & Coss var. *Cuncifolia* Roxb = Synonym *B. rugosa* Prain var. *cuncifolia grain be quoted as B. Juncea (L) czern & coss sub species integrifolia (west) (Raj = sabaji). B. napus* L be quoted as *B. napus* var. *napus* (Toriya). Besides these other species of *Brassica* include. *B. alba = B. hirta = Synapsis alba* Safed Rai, *B. nigra* Kali Rai. etc. *Eruca sativa* (Tara mira) is also closely related to *Brassica.*

All kinds of mustard (Sarson) are medicinally valuable. Seeds contain alkaloids like Cinapene, myrocene, cinigrin, inosyte etc. Albumins, volatile oil, erucic acid and protein. Seeds and leaves are antipuritic. Seeds alleviate kafha. These are carminative and increase appetize. Scrorbutic, spermatorrheal, Antiwormic. Useful in leuco derma, leprosy, epilepsy, insonnia and dental disorder. Mustard oil (pure and without adulteration) is beneficial in toothache, useful as massage medium of whole body. For ticks, earache, cold (common) asthma, cough, for burm, for naabhi related problems, constipation, heart problems, flatulence and headache etc. In ayurvedic and Unani Systems of medicine, sarson (usually means yellow mustard) oil is used for various disease but its combination with other medicines are used in dyspepsia, leprosy, skin disease. Seed cake, leaves are also useful. Bari Rai (Indian mustard) = Lal Rai is also useful in swellings body pain, rheumatism. It seeds, their powder and oil are used in medicine.

Coconut (*Cocos nucifera*) —Coconut palm is one of the greatest gift to mankind by the nature. All part are useful. Coconut kernel (green seed) and it water, coconut oil etc. are medicinally applied for variety of human oilments. Coconut water and unriped coconut kernal is good vermifuge. Coconut oil is good hair retainer. The oil is used for headache, skin problems, epistaxis, eye problems, tongue problems, dehydration, tuberclosis, fever, blooding piles, obesity, easy delivery, whooping cough, kidney and bladder stones. This is also prescribed for small pox, metorrhagia, stomatitis etc. cooking medium of coconut oil has medicinal properties including digestive problems. Dried coconut kernel power mixed with fennel and sweet cubes are good digestive stimulants.

Sessame (*Sesamum indicum*)—The plant is an erect bushy annual and is grown in many parts of the world. In India, it is a kharif crop. The seed oil finds medicinal uses in a number of problems besides being a nutritive and digestive oil. Seeds are good expectorant, diuretic, astringent, carminative aphrodissiac lectogogue, wound healer, useful in disurea, skin disease, hair growth, spermopoitic, anthelmintic, anti dysentryic. Good for relieving the arthritis, hair loss, piles etc. In combination with some plant products sessame seed and their oil is given in cold (common / constipation, cough, burns, polyuria, dend-rugh, toothache, etc. Improves body resistance to some biotic and abiotic stresses.

Castor (*Ricinus communis*)—Castor as a crop is raised in some parts of the world. The seed oil is useful in constipation, piles, pyorrhoea, roughness of skin, nales, backache, wound healing, skin problems, flatulence, arthritis, bed urining of children, swelling, sciatica, feet burning (pain), hernia and asthma, Leaves, roots and other parts of the plant are also medicinally useful. These are purgative, anti-inflamatory, carminative, alterative, febrifuge, stomachic, aphrodisiac. If used in proper dose and combinations (or the advise of physician), the plant is considered a potent medicine for many other problems of human and his domestic animals. These problems of health may be related to digestion, breathing, urination, ophthalmic and blood morbids.

Linseed (*Linum usitatissimum*)—Linseed is a dual purpose crop (fibre and oil seed crop). The plant is a small herb grown in *rabi* season. It is cultivated in few states of India.

The raw linseed oil is used in pharmaceuticals as an emollicent, demulcent, expectorant and diuretic. The whole seed is used as a laxative due to mucillage nous nature. The extracted mucillage is used in safe cosmatics. There are some poisonous elements also so the seed and oil should be used with a care on the advise of a physician only. It is a good laxative for cattle. The crushed linseed is used in the form of a paultice for inflamation, ulcers and boils. In case of dry sputum in lungs the linseed oil is a good remedy but should be used with care. The seed contains about 30-40% oil, gum, protein, wax, resin, sugars, phosphate and linamarin (a glucoside). Un riped seeds and flowers, contain hydro cyonic acid and also an alkalaid - liparine.

Seeds are oily, tonic, diuretic, carminative, analgesic and good wound healing agent. Linseed oil with sulpher is effective in some skin diseases.

Besides above quoted oil seed crops, oil palm = African oil palm (*Elecis guinensis*) is also medicinally important. The tree produces two distinct oils - palm oil (from fleshy mesocorp of fruit) and palm kernel oil (from the kernel = endocorp) Both are medicinally important.

Other medicinally valuable oil yielding plants include common olive *(Olea europaea)*, cotton seed *(Gossypium* species - 4 species), Tung and relatives *(Aleurites* species - *A. fordii* - Tung tel; *A. moloceana* - Jangli Akhrot; *A. montana* - kashtha Tel Taru). Aleuritu is a member of family Euphorbiaceae.

SUGARS, STARCHES AND CELLULOSES YIELDING PLANTS AND THEIR PHARMACEUTICAL POTENTIAL

Sugars, starches and celluloses are important parts of human life. These are used as eatables in many form and are equally valuable in pharmaceutical industry and therapeutics. All these are photosynthetic products. These are essential foods. Some of them are food preservatives, raw materials for beverages and bakery industry.

Sugar Cane is the major source of sugars followed by others (Beet, date palm etc.). Few therapeutic potentials are given below —

Sugar Cane (*Saccharum officinarum*)—The cultivated sugar cane is a crop of humid tropics. Brazil is the leading sugar cane producer. Sugercane juice, jaggery (Gur), Khandsari, Boora, Khand, Crystalline Sugar, raab and sheera (mollases) are some products. All these products find their uses in therapeutics either directly or in some processed form.

Cane juice (fresh) is a good tonic and resistance / immunity modulator. Useful in whooping cough, dry cough, blood impurity, kidney and bladder stones, fever, liver problems, hiccough, jaundice etc.

Gur (Jaggery) is beneficial for blood purification, flatulance, migraine, body weakness, heart weakness, asthma, dry cough, common cold, hiccough, worms etc.

Mollases of sugar cane industry and sugar beet industry is good medium for microbial culture (in pharmaceutical industrial).

Beet = Sugar beet = Parsnip (*Beta vulgaris*) —Sugar beet (and even the vegetable beet) is a good tonic. It is beneficial in lactation, joint pains, liver problems, forgetfulness, stones, it is a good expectorant, piles, tumours and leucorrhoea. The sugar beet and its juice are taken in combination with some other medicines.

Besides these sagopalm, rice starch (Maand), potato starch etc. are used in pharmaceutical and beverage industry. Date palm is also used to prepare jaggery in some places and this is evident that the medicinal properties of this product are better than jaggery of sugarcane.

FRUIT PLANTS AND THEIR THERAPEUTIC POTENTIAL

Fruits are integral and oldest part of human food and their history is as old as Adam. There are records to mention that date palm, pomegranate, grapes, figs, olive and apple were known to humankind as early as 7000 B.C. Ancient Ayurvedic literature contain some information on medicinal value of fruits like Aonla, Bael, Citrus, Wild dates, Figs, grapes, hog, plum, jack fruit, monkey jack, jamun, ber, karonda, khirni, lemon, lime, mango, mulberry, orange, phalsa, banana, pomegranate, walnut, almonds, pista and wood apple (Singh, 1969). In this chapter however the medicinal value of some fruits, plant parts of fruit yielding trees, shrubs, vines, etc. is being indicated in brief—

(A) Tropical Fruit Plants—These fruit plants have a good acclimation index and potential for growing in hot climates. Few are given below.

Mango (*Mangifera indica*)—Mango (*Mangifera indica* = Aam) is a national fruit of India. The plant is a tree and can tolerate a variety of soil and climatic conditions. All parts of plant are medicinally valuable. Mango fruits should be cooled by cold water wash / freeze before use. Taking mango with milk is very healthful.

Ripened mango is very useful in xerophthalmia and night blindness. Mango seed (dried and powdered) effective against worms. Mango seed powder is effective against dysentry (pasting on naabhi or intake with chhachh).

Powder of leaves of mango with hot water is good for stones. Mango leaf powder is effective for teeth problem, tuberculoses (mango juice with honey). Mango is a good blood purifier, brain tonic good in cholera, piles, digesting disorders, liver problem, dry cough, tastes problems, diabetes. Marasmus Raw mango fruit is good for heat stroke. Scorpian bites, impotency, burns, insomnia are also relieved by mango. Further the mango is prescribed in epilepsy, vomiting, cannobis intoxication, leucorrhoea and bleeding piles.

Banana (*Musa paradisiaca*)—Banana is one of the oldest fruits of the world. Names like Adam's Fig = Apple of Paradise = Musa paradiaca are the indications of its antiquity. Unlike other fruits, the plant is herbaceous. The fruit is seedless. All parts of plant are medicinally used. For tri-oilments (Tridosh-Ayurvedic term), banana with sugar is beneficial, useful in eye problems. Increases semen and sperms in the fluid. It is Kapha and Rakta pitta reliever. Dried powder of banana is available with the name *'Banalona'* in Allopathie drug shops. Banana is given in typhoids. Banana with other combination is applied for problems like exema, scabies, baldness, swellings, skin injury, digestive problems, acidity, leucorrhoea, peptic ulcer, diarrhoea, tongue boils, epistaxis etc. Some physician prescribe it in snake bites, high blood pressure, excess collasterol. Probibited for asthmatic patients. Powder of specially prepared ash of leaf is useful for all types of cough. Jaundice, dysentry, T.B. are also relieved by this leaf powder.

Citrus Fruits (*Citrus species*)—Citrus fruits are members of family *Rutaceae*. These include *Citrus limon* (Lemon - Bara Nimbu = Pahari Nimbu), *C. aurantifolia* (Kaghji Nimbu), *C. medica* var. limetta (Mitha Nimbu), *C. aurantium* (Khatta), *C. decumana* (Chakotra), *Citrus limones* (Khatta), *C. medica* (Bijaura), *C. paradisi* (Grape fruit), *C. reticulata* (Santara), *C.sinensis* (Mausombi - Malto) etc. All are full of medicinal properties. Lemon (Nimbu) is prescribed as a tonic, source of vitamin C, good antiageing agent, in digestive problems, worms, acidity, hiccough, headaches, piles, fevers, flue, cough, asthma, syphilis, epistaxis, teeth problems, frecples, heart problems, skin problems high blood pressure, diphtheria, dendruff, blood purifier, exzema, TB, Cholera, Diabetes etc. Oranges, mausambi also have similar medicinal uses. Some species of citrus are given in kidney and bladder stones.

Guava (*Psidium guajava*)—A small tree cultivated in many parts of the world. Some clones flower and fruit twice a year. Fruits (green as well as ripened) and leaves are medicinally useful. These are prescribed in various oilments including Manla, Boils, Abscesse, Blood Morbidity, Old Diarrhoea/Dysentry, Cough, Toothache, Constipation, piles Whooping cough etc. It is beneficial in arthritis, intoxication etc.

Papaya (*Carica papaya*)— This is a wonderful fruit as it is a remedy in Allopathy, Homoeopathy, Unani, Ayurveda etc. The fruit is used in green form as vegetable but as a fruit after ripening. Leaves one also medicinally useful. Latex of green fruit is very good remedy for old exzema (external application). Very useful for spleen problems, pancreas, liver, jaundice, diarrhoea, skin roughness, constipation, dyspepsia, worms. Some physician prescribe it as effective safe abortifacient. Effective in Diphtheria and kidney stones.

Grapes (*Vitis vinifera*)—This is a vine and berries are produced in bunches. Fresh ripened fruits and raisins are medicinally prescribed. It is a nice tonic and also relieves common cold, arthrites, cancer, small pox, migraine, cough, asthma, heart beat, toothache, kidney pain, polyuria leucorrhoea and irregular mansuration, epistaxis, lung problem, wound healing, intoxication. Dried grapes seeded varieties -(Munnakka) are good for constipation and dyspepsia, Kishmish (seedless dried grapes) are good tonic.

Minor Tropical and Sub Tropical Fruits—These are minor with reference to area and cultivation but not with respect to therapeutic potential. These include custard apple (Anona sqamoso-shariffa), jack fruit (*Artocarpus heterophylla*), pine apple (*Ananas comosus*), sapota (*Achrus sapota*), Litchi (*Litchi chinensis*), jujube (*Ziziphus maunitiana*), pomegranate (*Punica granatum*), lauquat (*Erio botrya japonica*), fig (*Ficus Carica*), Phalsa (*Grewia asiatica*) etc.

B. Temperate Fruits—These are fruit plants grown in cold climate but some of them have now been adopted in some other climates. Few of them are as below —

Apple (*Malus sylvestris = Pyrus malus*) —This is most important temperate fruit with good keeping quality. Excellent and safe tonic for brain and liver. Both fresh fruit as well as juice is good for health, especially in mental tension, skin diseases, arthritis and joint swellings and pain, many problems of respiratory system, toothache, common cold, cough, typhoid, heart weakness, high blood pressure, forgetfulness, kidney and bladder stones etc. Some preparations of apple fruits are recommended for polyuria, insomnia, flatulence, peptic ulcer, constipation, worms, warts, dry cough and dyspepsia.

Pear (*Pyrus communis*)—These are grown in hilly areas. Small much branched trees. Vegetatively propogated. It relieves flatulence, sperm improver, cold reliever and removes constipational problems. Enhance the strength of heart, brain, stomach and liver.

Peaches (*Prunus persico*)—Similar properties as pears but should be used on the prescription of an experienced physician. Medicinal properties of other fruits have been described in Dry Fruits / Nuts (Table-1).

Singh (1969) comprehensively described fruits and compiled the list of 183 plant species which are sources of fruits. It was interesting to note that many of such species have wild relatives and may be used as basic bioresource for domestication. Cultivation and genetic improvement. Most of them have been discussed in Ayurvedic literature indicating their therapeutic potential but little scientific work has been conducted on further exploration of their medicinal properties and almost insignificant research was reported on post harvest management and processing of such wonderful bio-resources. Many of these may be systematically and scientifically processed to provide drugs of plant origin and may be used in multitherapic systems.

DRY FRUITS AND THEIR THERAPEUTIC POTENTIAL

Dry fruits (more commonly called 'Nuts') are important part of our food. Many of them are full of medicinally valuable metabolites (both primary as well as secondary metabolites). Few are briefly described here.

Table 1 : Wild and cultivated fruits found in India having ample therapeutic potential

Botanical name	Family	Country of origin	Common names including Indian names	Remarks
1	2	3	4	5
Actinidia chinensis Planch.	Actinidiaceae	China	Chinese gooseberry	A recent introduction; the oval fruits have flavour of gooseberry.
Aegle marmelos Correa	Rutaceae	North India	Bengal quince, bael, bel, bilva, shul, bil, maredu, vilvam, bilpatre	Distribution—Semi-wild all over India; one form not commonly found has more numerous and smaller leaflets.
Acsculus indica Colebr (*A. glabra*)	Hippocastanaceae		Indian horse chestnut, pangar, bankhor, torjaga, kanur, ravi-gun, hane hanudun	Found in Kashmir.
Ampelocissus latifolia	—		—	Vines like grapes; found wild in Bihar.
Anacardium occidentale L.	Anacardiaceae	Tropical America	Cashew, kaju, kaju badam, hijle badam, jidi-mamidi, munthama-midi, mindiri, geru bija	Found in Kerala, Madras, Andhra, Mysore and Assam.
Ananas comosus Merr. (*Ananas sativus*)	Bromeliaceae	Brazil	Pineapple, ananas, anaras, kazhudhachakka	Found in Kerala and Assam.
**Annona atemoya* Hort.	*Annonaceae	A man-made hybrid found in	Atemoya, lakshman phal	Found in Andhra Pradesh.

contd. ...

*Annona and Annonaceae are sometimes spelt with a single 'n'.

contd. ...

1	2	3	4	5
		Israel, Florida, Egypt and India		
Annona cherimola Mill. (*A. tripetala*)	Annonaceae	Tropical America	Cherimoya, hanuman phal, cherimoyer	A recent introduction; a few trees are found in Central & South India.
Annona diversifolia Safford	Annonaceae	Tropical America	Ilama, white anona	Introduced into South India.
Annona muricata L.	Annonaceae	America—West Indies	Soursop, mamphal, guanabana, durian blanda	Found in some parts of Maharastra and Madras.
Annona reticulata L.	Annonaceae	Tropical America	Bullock's heart, bull's heart, Ramphal, nona	Found in South India and Assam.
Annona squamosa L.	Annonaceae	Tropical America	Sweet sop, custard apple, sugar apple, sharifa, sitaphal, ata	Found wild in the eastern parts of Andhra Pradesh and near Hyderabad.
Artocarpus altilis Fosberg = *A. communis* (*A. incisu, A. incisa*)	Moraceae	Malaya, Pacific Islands	Bread fruit, vilayati phanas, seema panasa, seemapila	Found in Madras, Assam, Maharashtra; not a common fruit.
Artocarpus heterophyllus Lam. (*A. intergra, A. intergrifolius, A. intergrifolia*)	Moraceae	India	Jack-fruit, kathal, panasa,, kanthal, pilapalam, halasu, chakka	Found on Western Ghats and is Assam, Bengal and Bihar.
Artocarpus hirsula Lam.	Moraceae	Probably India	Aini, hebbhalasu, anjili, pejata, pat phanas	Found in Western Ghats and Deccan Peninsula.

contd. ...

contd. ...

1	2	3	4	5
Artocarpus lakoocha Roxb.	Moraceae	India to Malacca	Monkey jack, barhal, dephal, wotomba, kammaregu, vatehuli, daua	Found in wild Assam, Bengal and U.P., in the sub-Himalayan areas and on the Western Ghats.
Averrhoa carambola L.	Oxialidaceae	India-China	Carambola, kamrakh	Found in all frost-free areas of India.
Averrhoa bilimbi L.	Oxialidaceae	India-Malaya	Bilimbi, tree sorrel, cucumber tree	An introduced plant found in a few gardens in South India.
Baccaurea sapida Muell.-Arg.	Euphorbiaceae		Latka, Lateku, kanazo	Fruit of the size of a large gooseberry, edible; seeds with pulpy aril; found in North Bengal, Assam and Andamans.
Carica candamarcensis Hook f.	Caricaceae	Ecuador	Mountain pappaya, kondapapaya	Semi-wild stray trees found in the Nilgiris above 1500 metres.
Carica papaya L.	Caricaceae	Tropical America	Papaya, papita, arind-kharbuza, pappaiya, pappali, pappayi, boppayi, parangimara	Found all over India in frost free areas.
Carissa carandas L.	Apocynaceae	India-Java	Karonda, caronda, karamcha, karavanda, karamarda, vaka, kalakkay, karekayi	Found throughout India.

contd. ...

contd. ...

1	2	3	4	5
Carissa grandiflora A.D.C.	Apocynaceae	South Africa	Natal plum	An introduced plant cultivated around Baroda.
Carissa inermis Vahl (*C. macrophylla*)	Apocynaceae	Probably South India		Found wild throughout Deccan Peninsula.
Carissa spinarum L.	Apocynaceae	India	Karmadika, karaunda, kalivi, chiru, kila, anka, kol, gan, garaunda	Found throughout India, especially in Kashmir and Punjab.
Carya illinoensis Koch (*Carya pecan, Hicoria pecan*)	Juglandaceae	Southern U.S.	Pecan, Pecan nut	Tried in India but not yet proved a success.
Casimirao edulis Llav. & Lex.	Rutaceae	Mexico	White sapote, Cochil, sapota	A sub-tropical edible fruit found in some gardens in India; belongs to the family of citrus fruits.
Castanea sativa Mill = *C. vulgaris* Lam (*C. vesca*)	Fagaceae	North Africa-Asia Minor	Chestnut, sweet, Spanish or European chestnut, Punjabi geer	Cultivated in Kashmir, Assam and other Himalayan areas, not grown commercially.
Chrysophyllum cainito L.	Sapotaceae	West Indies and Central America	Butter lime, cainito, West Indian star apple	Grown in warmer parts of India, especially Baroda and Bombay.
Citrus assamensis Bhattacharya and Dutta	Rutaceae	India	Ada-Jamir	Found semi-wild in Assam. It is similar to be gajanimma. or badvapulli of South India and should be treated as a

contd. ...

contd. ...

1	2	3	4	5
				botanical variety of C. *pennivesiculata*.
Citrus aurantifolia Swingle (*C. medica* var. *acida*)	Rutaceae	Probably India	Key lime, Mexican lime, sour lime, khata limbu, elumichai, nimma, limbe, kagdi, kagzi, nimbu, nimbuka, pattinebu, erumichinarakam	Grown all over India.
Citrus aurantium L. (*C. aurantium* var. *bigaradia*)	Rutaceae	India	Sour orange, Seville orange, bitter orange, soh-than, karun jamir, naranji, khatta, narangam, narattai, mallik narangi, heralay, heralle	Not a common tree in India.
Citrus grandis Osbeck (*C. maxima*, *C. decumana*)	Rutaceae	South-East Asia	Pummelo, pomelo, shad-dock, chakotra, betabi, mahatabi, obakotru, pains, papnasa, sakkota, pamparamasam, pambalipi-masu, pampalamasam, rabab-tenga, soh-myngor	Found all over India in the humid regions.
Citrus indica Tanaka	Rutaceae	India	Indian wild orange, humitia-tenga	Found wild at high altitudes in Assam. Does not survive in the plains.

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Citrus jambhiri Lush.	Rutaceae	India	Rough lemon, Florida Rough Mazoe lemon, Citronelle, jambheri, jamburi, soh-myndong, khatti, jattikhatti, madhul, kada narangi	A common rootstock found all over India.
Citrus karna Raf.	Rutaceae	India	Id-lemon, karna orange, karna, karna khatta, id-nimbu, soh-sarkar	Found all over India. Useful rootstock for citrus in heavy soils especially for grapefruit.
Citrus latipes Tanaka	Rutaceae	Eastern part of India	Khasi papeda, soh-khymphorshreih, soh-shyrkhoit	Found in Assam.
C. *limettioides* Tanaka	Rutaceae	India	Indian sweet lime, Palestine sweet lime, limun helw, mitha nimbu, sharbati, mitha, mitha kagzi, moumuri, nenupandu, kolumin-changai, nenumapandu, mou-muri, soh-bakhlein, shinimbu, sakkar limbu	Grown in Central and Northern India.
Citrus limon Burm. (C. *medica* var. *limon*, C. *limonimedica*, C. *limonia*)	Rutaceae	East Asia	Lemon, lebu, baranimbu, perya yelumichai, nimbu, jambira, nemu, pahari	The true lemons are tree lemons like the varieties Lisbon and Villa Franca

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1	2	3	4	5
			kaghzi, goranebu, motulimbu, idalimbu thoralimbu, bijapura, bijori, bijapuram	and are rearely found in India. The bush type of lemones found in India are hybrids between citron and lemons and should be designated as C. *medica* var. *limonum* (Lush.).
Citrus limonia Osbeck	Rutaceae	Probably India	Canton lemon, rangpur (lime), mandarin lime, cravo lemon, marmalade orange, Kusai lime, modulli, sindhuri nemu-tenga, moognimbe, surkh nimbu, Sylhet lime	Found in the lower Hima-layas and hills in India; an important rootstock; a mandarin-like fruit, which should not be confused with lime or lemon.
Citrus macroptera var. *annamensis* Tanaka (C. *combara* Raf.)	Rutaceae	Probably India-Burma region	Anam papeda, satkara, soh-kwit, hampur-arong, chamarbaphang	A common plant in Khasi Hills in Assam.
Citrus maderaspatana Tanaka	Rutaceae	South India	Kichili, vadlapudi, Guntur sour orange	This fruit resembling the sour orange is found in Guntur area of Andhra Pradesh; not found in North India.
Citrus madurensis Lour. (C. *mitis*)	Rutaceae	China	Calamondin, Hazara, China orange, orange-	Grown as an ornamental or hedge plant; the fruits hang

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1	2	3	4	5
			quat	on the tree after the next crop has been set.
Citrus medica L.	Rutaceae	India	Citron, turanj, madhu-kankar, mokri, begpura, bijoru, mahalunga, mavalung, gilam, rusa-kam, matalanarakam, mahaphala, lungamu, madala kadaranorathai	Found all over India
C. *megaloxycarpa* Lush.	Rutaceae	India	Sour pummelo, amilbed, desi kalamba, bor-tenga, jamir-tenga, holong-tenga, hukma-tenga	Grows luxuriantly in lower ranges of Eastern Hima-layas.
Citrus paradisi Macf. (C. *maxima* var. *wacarpa*)	Rutaceae	West Indies	Grapefruit	Cultivated in North India, Gujarat and Maharashtra.
Citrus pennivesiculata Tanaka	Rutaceae	India	Gajanimma, baduvapulli, attara, sinderum	Found mostly in South India.
**Citrus pseudolimon* Tanaka	Rutaceae	India	Hill lemon, kumaon lemon, galgal, kilkil, pahari nimbu, soh-long	Found commonly in lower Himalayas.
Citrus reliculata Blanco (C. *nobilis*, C. *chrysocarpa*)	Rutaceae	Southern China and Cohin-China	Mandarin, kidglove orange, loose-skinned orange, tangerine,	The name orange is often used in India for this species, but the English word orange

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*It would be more appropriate to treat the hill lemon as a botanical variety (var. *decumana*) under C. *limon*.

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1	2	3	4	5
			kamla, khasi orange, santara, sangtara, pulli, soh-niamtara, sumthira	denotes a tight-skinned orange (*C. sinensis*).
Citrus rugulosa Tanaka	Rutaceae	India	Indian grapefruit, attani, attoni	Found in the submontane areas.
Citrus semperflorens Lush.	Rutaceae	India	Sadaphal, nardaba	Found all over India, but not a common plant.
Gitrus sinensis Osbeck (*C. aurantium* var. *sinensis)*	Rutaccae	China	Swcet orange, orange, malta, Sathgudi, Chini, Batavian, tight-skinned orange (Mosambi is a variety of this fruit grown mostly in Maha. rashtra.)	Found in Punjab, Rajasthan, U.P., Maharashtra and Andlira Pradesh. All.varieties of this fruit have been introduced from abroad.
Clausena indica Oliver	Rutaceae	India		Found in evergreen forests of Western Ghats; the fruits are half-inch across and edible; aromatic leaves are used for flavouring curries.
Clausena lansium (Lour.) Skeels (*Cookia wampee, Clauserta wampi)*	Rutaceae	South China	Wampee	Introduced into India; a small tree with yellow fruits looking like small sour limes; can be used for making a jam; not cultivated muchi

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1	2	3	4	5
Cydonia oblonga Mill. *(CydQnia vulgaris)*	Rosaceae	South Asia (uncertain)	Quince, beh, bihi, amrit. phala, safarjab, bum-chunth, sbimaimathala, simadanimma, simeda. limbe, bamsutu, barn-tsuntu	Cultivated in Kashmir.
Cyphomandra beiacea (Cav.) Sendt.	Solanaceae	Peru	Tree tomato	Cultivated on the hills in tropical regions.
Dillenia indica L. (*D. speciosa*)	Dilleniaceae	East India	Chalta, karambel, karinal, peddakalinga, uvu, uva, betta kanigala, chalita, punna, outenga	Occurs as a wild plain mostly in Assam and Bengal, where a clniiney is macif from the round ball. shaped calyx of the fruit; grows in moist places near ptrearns all over India.
Diospyros discolor Willd. —*D. mabola* Roxb.	Ebenaccae	Philippines	Mabola persimmon, butter fruit, vilayati gab	Found in Assam, Bihar and extreme south; the quince. like fruits are edible.
Diospyros kaki L. *(D. chinensis)*	Ebenaccae	China	Persimmon, Japani phal, halwa tendu, dieng-iong, soh-tang-jong	Cultivated in the Kulu valley in H.P. and at Coonoor in Nilgiri Hills.
Diospyros lotus I..	Ebenaccae	West Asia—Himalayas—China	Date-plum, persimmon, amlok	Found wild in the Hima-layas.

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1	2	3	4	5
Diospyros peregrina (Gaertn.) Gurke= *D. embryopteris* Pers. *(D. malabarica)*	Ebenaccae	India-Malaya region	Gaub, kalatendu, makurkendi, timburi, temburni, tinduki, gabu, kavikattai, tumbi, hole-tupare, kusharta, panachi, vananji, kendu, dhusaro-kendu, kattati	Found all over India near streams; the small dark fruits are edible.
Diospyros tomentosa Roxb.	Ebenaccae	India	Ebony persimmon, tendu, kendu, temru kend, kyon, cittatumiki, mancitumiki, tumiki, tumbi, tindura, tumari, timburani, kinnu, tumri, tumid	Found wild in North and Central India; the small fruits are edible.
Durio zibethinus L.	Bombaceaceae	East Indies-Malaya	Durian, civet fruit	A few trees are grown at the foot of the Nilgiris in South India.
Elaeocarpus floribundus Bl. *(E. serratus)*	Elaeocarpaceae	India-Malaya	Jalpai, ulangkarei, uttrachham, perinkara, avil, nallakara, valiya-kara, karmava; jolopari	Grows wild in Asaam and Bengal and on the Western Ghats; fruits resemble the olive; cooked or pickled.
Emblica-officinalis Gaertn. *(Phyllo.tzthus emblicczL.)*	Eupharbiaceae	Tropical Asia	Myrobalan, emblicmyro-balan, Indian goaseberry, amla, aonla, amlika,	Cultivated mostly in UP, but found all over India.

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1	2	3	4	5
			amali, ambala, amala-kamu, usirikai, nelli, amalka	
Eriobotrya bengalensis Hook. f.	Rosaceae	India-Matacca	Maya, dieng-signerei, larubandlia, bol.anchin	Found in Eastern H.imala-yas upto 5000 feet; used for timber, shuttles; fruit inedible.
Eriobotrya japoniea Lindl. *(Photinia japonica)*	Rosaceae	China	Loquat, Japan plum, Japanese medlar, lakotte, ilakotta, nokkota	Cultivated at the foot of the Himalayas,
Eugetzia kurzii Duthie	Myrtaceae	India	Jaman, sunom, bagijamuk	Found in Assam, Sikkim, at upto 5000 feet; also in Martaban, and the Anda mans; fruit .is edible.
Eugetuia uniflora L.	Myrtaceae	Tropical South America	Surinam cherry, Brazil cherry, Pitanga	Found in gardens in Bang.a-lore, Bombay and Baroda.
Euphoria longan Steud *(E. longana, Nephtlium longana, Dimocarpus longan)*	Sapindaceae	India-Burma	Longan, lungan, ashphal, tokra, wumb, puvatti, shemnpuvan, kanakindeli, malakcota, pasakota, shempuna, poripüná, mulei, naglichi	Found in Assam, Bengal; a few trees at the foot of the Nilgiri Hills in South India.
Fejoa sellowiana Bcrg.	Myrtaceae	Brazil	Pineapple gu;va, feijoa, Newzealand banana	Not grown commercially, found, on hills at elevations

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				upto 3500 teet.
Feronia limonia (L.) Swing. *(Limonia acidissima)*	Rutaceae	India	Wood apple, elephant apple, kaith, kaitha, kapith, Indian wood apple, bilin, kait, katbel, kavit, kotha, kothum, velaga, bela, vilanga, vila, vilatti	Occurs wild all over India.
Ficus auriculata Lour. =*F. roxburghii* Wall *(F. macrophylla)*	Moraccae	India	Timla, tirmal	Grows mostly on the lower Himalayas; the leaves and fruits are large; fruit is edible but insipid.
Ficus carica L.	Moraccae	West Asia	Fig, anjir, dumar, anjuru, manjrnedi, slmayatti. tennatt, anjura	Cultivated around Poona, Mysore and Lucknow.
Ficus glomerala Roxb. =*F. racemosa* L. *(F. vesca)*	Moraccae	East Indies to Australia	Gular, umar, dumar, jagyadumbar, umbar, atti, bodda, paidi, udum baramü, athi, dimri	Fruits borne in clusters on trunk and main branches; found all over India near streams, etc.; fruit is not edible but can be grniud into flour.
Ficus hispida L. f.	Moraceae	South Asia to Australia	Jangli anjir, bodamamidi, brammadi, daduri, dagu-nfl, gobla, kagsha,	Found in shady places all over India; the leaves are opposite and the fruits

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1	2	3	4	5
			katgularia, dumoar, kakodumar, bhokada, boknia, kalaumber, kharoti, dhedaümaro	often borne in pairs are of poor quality.
Ficus palmata Forsk.	Moraceae	India to Egypt	Phagwara, anjiri, bedu, khemri, pepri, manjimedi	Found in N.-W. India, U.P. and Rajasthan; the fruits are of fairly good quality, especially on hills; leaves are used as fodder.
Flacourlia indica Merr. *(F. ramaontchi)*	Flacourtiaceae	India and Tropical Africa	Governor's plum, Batoko plum, Madagskar plum, ramontchi, kandregu, katukala, sottaikala, hattari mullu, hunmunki, bilangra, baichi, kanju, binja, katai, kankod, bhekal, kaker, paker	Found in Assam, Bengal, and Maharashtra.
Flacourtia jangomas Raeusch. .=*F. cataphracta* Roxb.	Flacourtiaceae	India	Puneala plum, paniala, talispatra, tambat, kura-gayi, saralu, vayangarai, chankali, goraji, kanji, talisam, vayankatha, baincha, baichi	Found at foot of the Hinia-layas and in South India; fruit is inedible.
Fortunella japonica	Rutaceac	South China	Kumquat (Maroomi and	The small evergreen shrub

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and *F. margariüa* Swingle (*Citrus japonica)*			Nagazni)	can withstand cold wcather and is cultivated as an ornamental plant.
Fragaria chiloensis x *F. virginia*	Rosaceae		Strawberry, garden strawberry, ishtabar	Cultivated in Kashmir, Dehradun valley in U.P., at Mahabaleshwar near Poona and on a small scale near Delhi.
Fragaria daltoniana Gay (*F. sikkimensis)*	Rosaceae	Eastern Himalayas	Bhumla	Native of Eastern Himalayas; found above 9000 feet.
Fragaria indica Andr. (*Duchesnea indica* Focke.)	Rosaceae	India	Indian or mock strawberry	Occurs wild in the Himalayas and hills of South India; fruit insipid.
Fragaria nilgerrensis Schlecht.	Rosaceae	India and China	Nilgini strawberry	Fruit of inferior quality; found in South India and in Eastern India, above 5000 feet.
Garcinia cowa Roxb (G. *kydia)*	Guttiferae	India	Cowphal, cowa, kau, kaphal, kujithekera, kauthekara	Grows in Assam, Bengal and. Orissa, fruit edible; bark yields a yellow dye.
Garcinia indka Choicy	Guttiferae	India	Kokum, kokam butter tree, mangosteen oil tree, brindonia tallow tree, kokam, kokan, amsol,	Found on the Western Chats and the Nilgiris; seeds used for making butter and fruits for culinary purposes;

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1	2	3	4	5
			bhirand, katambi, ratamba, murgal, punampuli	cultivated around Bombay.
Garcinia mazzgostana L.	Guttiferae	Malaya-Peninsula	Mangosteen, mangusta, mangustan	A most delicious fruit; only a few trees are grown at the foot of the Nilgiris and in Tinnevelly in Madras State.
Garcinia xanthochymus Hook. f. = G. *tinctoria* Dunn.	Guttifcrae	India-Burma	Dampel, tamal, chalata, karamala, ota, chunyel, jharambi, ivarumedi, tamalamu, kulavi, malaippachai, mukki, tamalam, devaganige, anavaya, cheoro, sitarnbu	Found wild in lower Eastern Himalayas and Maharashtra, Mysore, Madras and Kerala.
Grewia elastica Royle G. *vestita* Wall. (G. *asiatica* var. *vest ita)*	Tiliaceae	India	Pharsia, dhaman, bimla, dhamni, mirgichara, manbijal	Found in sub-Himalayan tract from Garhwal to Sikkim, Central India, the Western Chats, and Malabar; a tall tree with edible fruit.
Grewia subinaequalis D.C. .=G. *asiatica* Mast.	Tiliaceae	India	Phalsa, falsa, dhamin, parusha, shukri, jana, nallajana, phutiki, palisa, tadachi, buttiyudippe, tadasala, pharasakoli	Cultivated especially around Baroda.

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1	2	3	4	5
Grewia tillifolia Vahl	Tiliaceae	Eastern Tropical Africa	Dhamni, dhamin, pharsa, daman, dalmon, charachi, etllttada, sadachi, unnu, thadsal, butale, chadicha, dhamuro	A large tree found at foot of the Himalayas, down to South India; fruit is edible.
Juglans regia L.	Juglandaceae	South-East Europe	Walnut, English walnut, Persian walnut, akhrot, akhor, knot, doon	Grows semi-wild in Kashmir and Himachal Pradesh.
Lansium domesticum Correa	Meliaceae	Malaya	Langsat, daku, lansa	Cultivated in South India in a few places.
Litchi chincsis Son. (*Nephelium litchi* Cambess.)	Sapindaccae	China	Litchi, lecchee, lychee	Cultivated mostly in Bihar; also in U.P., Punjab and Bengal.
Macadamia ternifolia F. Muell	Proteaceae		Macadamia nut, Queensland nut, Australian nut	Being tried in the Himalayas and on the hills in South India.
Madhuka indica J.F. Gmel. (*Madhuka latifolia* Macbride, *Bassia latifolia*)	Sapotaceae	India	Mohwa, mahua, maul, mahula, mahudaippa illupei, elupa, hippe, poonam, ilupa, mohula, moha, madgi	Fruits very inferior; flowers used as food and for making liquor; seeds give an oil; grows wild mostly in Central India.
Malpighia glabra L.	Malpighiaceae	South America	Barbados cherry	Very recently introduced into India; a few bushes cultivated in gardens; richest

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				source of vitamin C.
Malpighia punicifolia L.	Malpighiaceae	South America	West Indian cherry, vallari, simeyara nelli	Plants up to 8 metres tall.
Malus baccata var. *himalacca* (Maxim) Schneid.	Rosaceae	Himalayas	Himalayan crab apple, ban mehal, gwalam, baror, katsab, liu, lhizo, soh-shur-um; all wild apples are called 'Trel' in Kashmir	Found wild in the Himalayas.
Malus pumila Mill. *(Malass communis, Pyrus malus, Malus domestica)*	Rosaceae	Asia Minor to Western Himalayas	Apple, seb, sea, sebu, kushu, chunth	Cultivated in the Himalayas and to some extent in the Nilgini Hills.
Malus sikkamensis Hook. f.	Rosaceae	North India		Allied to *M. accata*, but more woolly and much larger red fruits; wild in Sikkim and Bhutan from 7,000 to 10,000 feet.
Mangifera indica L.	Anacardiaceae	India-Burma	Mango, am, amba, amb, amni, rnamidi, mavi, manga, mau, amram, mavu, cutam, mangkay	Cultivated all over India.
Mangifera sylvatica Roxb.	Anacardiaceae	India	Ban-am, chuchi-am, kathorkung	Occurs wild from Nepal to Assam in the lower H.imalayas.

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1	2	3	4	5
Manilkara hexandra (Roxb.) Dubard (*Mimusops hexandra*)	Sapotaceae	Probably India	Khirnee, kirni, khirkhe-jur, ranjana, rayan, raini, manjipala, pala, palla, pallai, bakula; khiri, khirakuli	Used as a rootstock tar sapota; its thin white date-like fruits are edible; found mostly in Central and South India.
Monstera deliciosa Liebm.	Araceae	Mexico-Guate-mala	Ceriman	Not grown in India for fruit; cultivated only as an ornamental plant in gardens.
Morus alba L.	Moraceae	China	White mulberry, silk mul-berry, tut, tutri, ambat, shetur, shehtoot, reshmi chattu, pippali pandu chettu, musukette, kambli chedi, hipnerle, tuticcli, tul, shatul	Grows all over the plains and on the lower Himalayas; cultivated in Kashmir and. Mysore for rearing silk worms.
Morus indica Linn. (*M. cuspidaia* Wall. *M. alba* var. *cuspidata* Bureau)	Muraccae	China		Found from Kashmir to Sikkim; used for rearing silkworms.
Morus laevigata Wall. ex Brandis	Muraccae	North India	Wild mulberry	Found wild in the outer Himalayas from Kashmir to Assam up to 4,000 feet.
Morus nigra L.	Muraccae	West Asia (Iran)	Black mulberry (verna-cular names same as for *M. alba*)	Grown all over India for black fruits; the leaves are coarse and not good for

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1	2	3	4	5
				rearing silk worms.
Morus serrata Roxb.	Muraccae	North India	Himalayan mulberry, karum, kimu, himu, tuti, dieng-soh-tungkhar	Grows wild in the Himalayas mostly in the Western region.
Musa acuminala Colla	Muraccae	South-East Asia	Wild banana, kattu vazhai	A wild species found in Assam and on hills of South India; a fewcultivated types also come under this species.
Musa balbisiana Colla (*M. sapienturn* var. pruinosa)	Muraccae	South-East Asia	Leaf banana, bonkera, kait dewsan, chungbi anguoba, athiya kel	Found wild in Assam, Sikkim and South India; some varieties cultivated for leaves, such as Elavazhai, Ginjaliarati or kaliubale, belong to this species.
Musa nepalensis Wall.	Muraccae	Probably India		Found on lower hills of Nepal; has the habit of *Ensete stiperbum*.
Musa paradisiaca L. [1]covcrs almosl all edible bananas)	Musaceae	Malaysia-India	Banana, kela, vazhai, bale, arati, vazha, rambha, anati	South India and East India are the main centres of cultivation. The dwarf bananas are also included under this species.
Musa sanguinea Hook. f. (*M. assamica)*	Muraccae	Assam	-	About three-foot tall ornamental plant found in

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1	2	3	4	5
				Assam, fruit small variegated red and yellowish green.
Musa sapientum L.	Muraccae		Plantain; most of the cooking types come under this species	This name is now used for varieties which have origi nated as hybrids between *M. acuminata* and *M. balbisiana*. There are only a few varieties under this species.
Nephelium lappaceurn L.	Sapindaccae	Malaya	Rambutan	Grown in the Nilgiris on a limited scale.
Olea europaea L.	Oleaceac	Mediterranean region	Olive, zaitun, zeitoun	Important oil crop of the Mediterranean region; only a few trees are found in orchard collections.
Olea ferruginea Royle (*O. cuspidata*)	Oleaceac	N. W. Himalayas—Baluchistan	Indian olive, kahu, kan, kao, bairbanj	Found in the Western Hima layas; the fruit is edible and yields an oil.
Passiflora edulis Sims.	Passifloraceae	Brazil (Tropical America)	Passion fruit, purple granadilla, purple passion fruit India.	Found on nills in South
P. edulis var. *flavicarpa*	Passifloraceae	Tropical America	Yellow-fruited passion fruit	Found in plains in South India.
P. quadrangularis L.	Passifloraceae	Tropical America	Giant granadilla	Found in garden collections only.

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1	2	3	4	5
Persea americana Mill. (*P. gratissima*)	Lauraceae	Mexico and West Indies	Avocado, Avocado Pear, alligator pear	Bangalore and lower ranges of the Niligiri Hills; introduc -ed into India in recent times.
P. drymifolia Schlecht.	Lauraceae	Mexico and West Indies	Mexican race of avocado	A low, often almost stemless
Phoenix acaulis Buch & Roxb.	Palmae	North-Eastern and Central India	Dwarf date-palm, khajuri, Janglikhajur, schap, lepcha chindi, jhari gond, funo, kurku; pindkhajur, biochind	palm; commonly met with in dry ground from the sub-Himalayan tract to Central India. It flowers in cold season, and ripens its fruit in April and May.
Phoenix dactylifera L.	Palmae	West Asia & Arabia	Date-palm, khurma, chu-hara, kukyan, pind chirwi, jarikha, tamara, perich-chankay, somblonzi khaj-ur, kasser, mach, karmah, pind chirdi, tar, perita, swonpalwon	Not cultivated commercially much in India due to damage to fruit from rain at the time of ripening.
phoenix humilis Royle	Palmae	China to Cochin-china		Found wild from Kumanon to Burma and down to Malabar; it is similar to *P. sylvestris*.
Phoenix rupicola T. Anders.	Palmae	India	Schiap	In Assam and Sikkim at 400 to 1400 feet; a beautiful palm of the lower hills of Darjeel

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				-ing and Bhutan.
Phoenix sylvestris Roxb.	Palmae	India-Madagascar	Wild date, date-sugar palm, East Indian wine palm, sendhi, kejur, salma, boichand, kharak, sandoleka-nar, itchum-pannay, ita, ichal, pindakharjura, Kharjura	Found all over India near . streams; most abundant in Bengal, Bihar, on the Coroma -ndel coast and in Gujarat; forms extensive forests in Rohilkhand; on the low ground along the Ramg-anga river, and on the plateau of Mysor between Shimoga and Tumkur.
Phyllanthus acidus Skeels (*Averrhoa acida, Phyllanthus distichus*)	Euphorbiaceae	India	Star gooseberry, Otaheite gooseberry, noar, hariphal narkuli, cherambola, arunelli, rachausirike, kirnelli, nelli, lavani	A close relative of the anola, found all over India; common in gardens of South India, Burma and Andaman Islands.
Physalis ixocarpa Brat	Solanaceae	Mexico-Southern	Tomatillo, jamberry	
Physalis perwana L. (*P. edulis*, Sims)	Solanaceae	Tropics	Capegooseberry, tepari, tiparee, rasbhari (not to be confused with respberry)	Cultivated all over India on a small scale.
Pistacia integerrima Stewart	Anacardiaceae	Western Himalayas	Kakra, galls, Kakra singi, mar, guj, karkala sringi	Found wild on warm slopes of Western Himalayas.
Pistacia vera L.	Anacardiaceae	West Asia	Pistachio, pista, pistalik, Pistachio nut	Limited cultivation in kash-mir; the species *P. indica* has

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1	2	3	4	5
				been mentioned to occur in the for citrus in Japan.
Poncirus frifoliata Raf. (Citrus trifoliata)	Rutaceae	China	Trifoliate orange	Grown in India as a hedge plant. Used as a rootstock for citrus in Japan.
Prunus amygdalus Batsch. *(Amygdalus communits, P. communis)*	Rosaceae	Persia-Afghanistan	Almond, badam, badum, bilati-badam, vadam-kottai, badam-vittulu.	Cultivated in Kashmir and Himachal Pradesh on a limited scale.
Pruns armeniaca L. (*Armeniaca vnlgaris*)	Rosaceae	China	Apricot, khurmani, Khubani, cheare, zardalu, sadhi	Found at the lower elevations of Western Himalayas.
Prunus armeniaca var.	Rosaceae		Black-fruited apircot	Cultivated in Kashmir; probably a hybrid *P. armeniaca* x *P. cerasifera.*
Prunus aviam L.	Rosaceae	Europe-West Asia	Sweet cherry, gilas, shal	Cultivated in Kashmir, Himachal Pradesh and the Kumaon Hills.
Prunus cerasus L.	Rosaceae	Europe-West Asia	Sour cherry, aclche	
Prunus domestica L.	Rosaceae	Europe-West Asia	Plum, alubokhara, European plum	Grown at high elevations
Prunus jacquemontii Hook. f.	Rosaceae	Probably India		Related to *P. humilis*, but taller, flowers bright rose pink; found in Western Himalayes, Tibet and Afghanistan.

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1	2	3	4	5
Prunus nepalensis Ser.	Rosaceae	North India		Difficult to distinguish from *P. padus* except that it has larger fruit; related to *P. cornuta;* inflorescence hairy, fruit 3/5" across found from Kumano to the Khasi Hills at elevations of 4000-7000 feet.
Prunus padus L.	Rosaceae	Europe	Bird cherry, jamana, likh-ar-u, holsa, hlot-kung, bombaksing, zamb-chule, paras, kalakat, gidar-dak bart, zum	Found at high altitudes in the Himalayas and west-ward upto Great Britain.
Prunus persia Batsch. (*Amygdalus persica*)	Rosaceae	China	Peach, aru, takpo, rek, sunnu, chimnanu, bem beini, aroo, chunun, man-data, shaftalu, ghwareshtai	Grown in India on the lower Himalayas and the foothill areas.
Prunus puddum Roxb. (*Prunus corasoides*)	Rosaceae	Himalyas	Paddam, paya, padmaksh	Found from Garhwal to Butan and Burma at altitudes of 3000 to 6000 feet.
Prunus rufa Wall.	Rosaceae	Himalyas		Leaves narrow, flowers pink, solitary or in small clusters, fruit broadly clliptic, fieshy, red; found in Nepal and Bhutan at 10000 to 12000 ft.

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1	2	3	4	5
Prunus salicina Lindl. (*P. triflora*)	Rosaceae	China	Japanese plum, alucha	More common in India; also grows at the foot of the Himalayas.
Psidium cattleianum Sab.	Myrtaceae	Brazil	Purple guava, strawberry guava	var. *lucidum* has yellow fruit.
Psidium guajava L.	Myrtaceae	West Indies to Peru	Guava, amrood, amrut, amrud, aim	Cultivated mostly in UP., but found all over India.
Pwsica granalum L.	Punicaceae	South-East Europe to Himalayas	Pomegranate, anar, dalimb, deum; the wild type in the Himalayas is called daru	Cultivated mostly in Maharashtra and Gujarat.
Eyrus commuois L.	Rosaceae	Europe	Pear, nashpati, French pear, tang, baghugosha	Cultivated on the hills in South India and on the Himalayas.
Pyrus khasiana Dcnc.	Rosaceae			Found wild in the Khasi Hills; fruit similartc: that of *P. pashia*.
P. pashia	Rosaceae	North India	Wild Himalayan pear, kainth, kenth	Found wild all over the Himalayas.
P. pyrifolia (*P. serotina*)	Rosaceae	China	Shiara, wild Himalayan pear, batang, teng	Found semi-wild in the Himalayas.
P. pyrifolia var. *culta* Nakai	Rosaceae	China	Nakh, desi nakh, Chinese sand pear	Cultivated at the foot of the Himalayas.
Rubus biflorus Ham.	Rosaceae	Probably Himalayas	Whitewashed bramble, chanch, kantanch,	With yellow roundish fruit; found wild in the Hima-

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1	2	3	4	5
			khariara, akhreri, karer, ankren, bumbal, insra, batang, knlikalin, dhen	layas from Nahan to Bhutan at 7000 to 9000 ft.
R.cllipicus Smith	Rcuaceac	Probably Yunan	Orange raspberry	Found on hills in South India, the Himalayas from Himachal to Khasi mountains at 2000 to 7000 ft.
Rubus frutscosus L.	Rcuaceac	West Asia	Brambles, blackberry, chhanch	Found in Kashmir at 3000 to 7000 feet.
Rubus gracilis Roxb. (*R. niveus* Wall.)	Rcuaceac	Himalayas-China		Fruit blue-black, small, found wild in the Himalayas from Kashmir to Bhutan at 5000 to 11000 ft.
Rubtts lineatus Reinw. (*R. pulcherrimus* Hook.)	Rcuaceac		Gempe aselu	Fruit small, red or yellow, leaves with parallel veins and beautiful silvery sheen below; wild in Sikkim at 6000 to 9000 ft.
Rubus nutatu Wall.	Rcuaceac	Himalayas	Sinjang	Fruit purple, glabose edible; makes a gao ground cover; wild in the Himalayas in U.P. at 8000 to 10000 ft.
Rubus rosaefolius Smith	Rcuaceac	Himalayas		Small evergreen shrub;

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1	2	3	4	5
		East Indies		fruits 7/8" long, red, insipid; wild in the Himalayas from Kumaon to Khasi Hills at 3000-7000 ft. Fruit is frequently collected and sold in Darjeeling.
Spondias cythara Sonn. (S. *dulcir* Wild)	Anacardiaceae	Polynesia	Hog plum, Otaheitc plum or apple, atora, ambrella	Introduced into India from West Indies.
Spondias pirnnata Kurz. *(Spondias mangjfera)*	Anacardiaceae	Tropical Asia	Indian hog-plum, amara, ambodha, ambra	Cultivated in Bengal, Assam and Maliarashtra, but found all over India; a small deciduous tree.
Syzygium cuminii Skeels *(Eugenia jambolana)*	Myrtaceae	East India-Malaya	Jambolan, jaman, Java plum	Grows all over India.
Syzygium fruticosum D.C.	Myrtaceae	-do-	Wild jaman, jamoa	Found mostly at the foot of the Himalayas.
Syzygium jambos Alston	Myrtaceae	East Indies	Rose apple, gulab jaman	Cultivated on a small scale in Bengal, Bihar, Assam, Orissa, Bombay and South India.
Tamarindus indica L.	Leguminosae	Tropical Africa-India	Tamarind, tamaranda, imli, tintul, puli, amli, tintiri, koya, chinta,	Grows all over. India; an important condiment for cooking in South India;

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1	2	3	4	5
			jajo, chinch, neddi, shenta, sitta, karangi, bunasc, magyl	not cultivated in planta-dons.
Terminalia catappa L.	Combretaceae	India (Tropical Asia)	Indian almond, tropical almond, deal badarn, bangala badam, jangli badam, nat vadorn, tad katappa	Cultivated primarily as an ornamental tree.
Vitis barbata Wall. *(V. latjfolia, V. lanata)*	Vitaceae			Found in the Khasi moun-tainn in Assam.
Vitis discolor Dalz.	Vitaceae			Fruits' reddish purple, dry; found in Sikkim and the Khasi Hills.
Vitis lanata Roxb.	Vitaceae	China. Himalayas	Kolo, kolonari, farila-lara, mikrum-rik, asan-jiyaor, asoja, paharphuta, purain	Fruit black, round, found in the Himalayas from 1000 to 7000 feet.
Vitis parviflora Roxb.	Vitaceae		Barain	Found in Kashmir to Nepal, also in Eastern Bengal.
Vitis quadrangularis Wall.	Vitaceae		Har-jora, hadjora, nallar, harsankar, asthisanhara Hills to Ceylon, Java, East Africa.	Berries very acidic; founu from foot of the Kumaon

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1	2	3	4	5
Vitis rotundifolia Michx.	Vitaceae	South and Central United States	Muscadine grapes	Not commonly found in India.
Vitis rumcisperma Laws.	Vitaceae			Wild species, found from Khasi Hills to Nepal.
Vitis vinifera L.	Vitaceae	Caucasus region	Grapes, angoor, drakshi, dusch	Cultivated in Maliarashtra, Hyderabad, Madurai in Madras and Punjab, etc.
Vitis labruscana Bailey	Vitaceac	North America		Cultivated around Banga. lore.
Ziziphus glabrata Heyne (*Z. triflervia*)	Rhamnaceae		Karukata, karakattam, carukuva, vata dalla	A tree of Eastern Bengal, Bhutan and the Western Peninsula.
Ziziphus mauritiana Lam. (*Z. vulgaris, Z. sativa*)	Rhamnaceae	India	Jujube, ber, bar	Found in all dry areas of India; the large trees mature fruits late in winter.
Ziziphus jujuba Lamk.	Rhamnaceae	China	Chinese date, jujube	Not common in India.

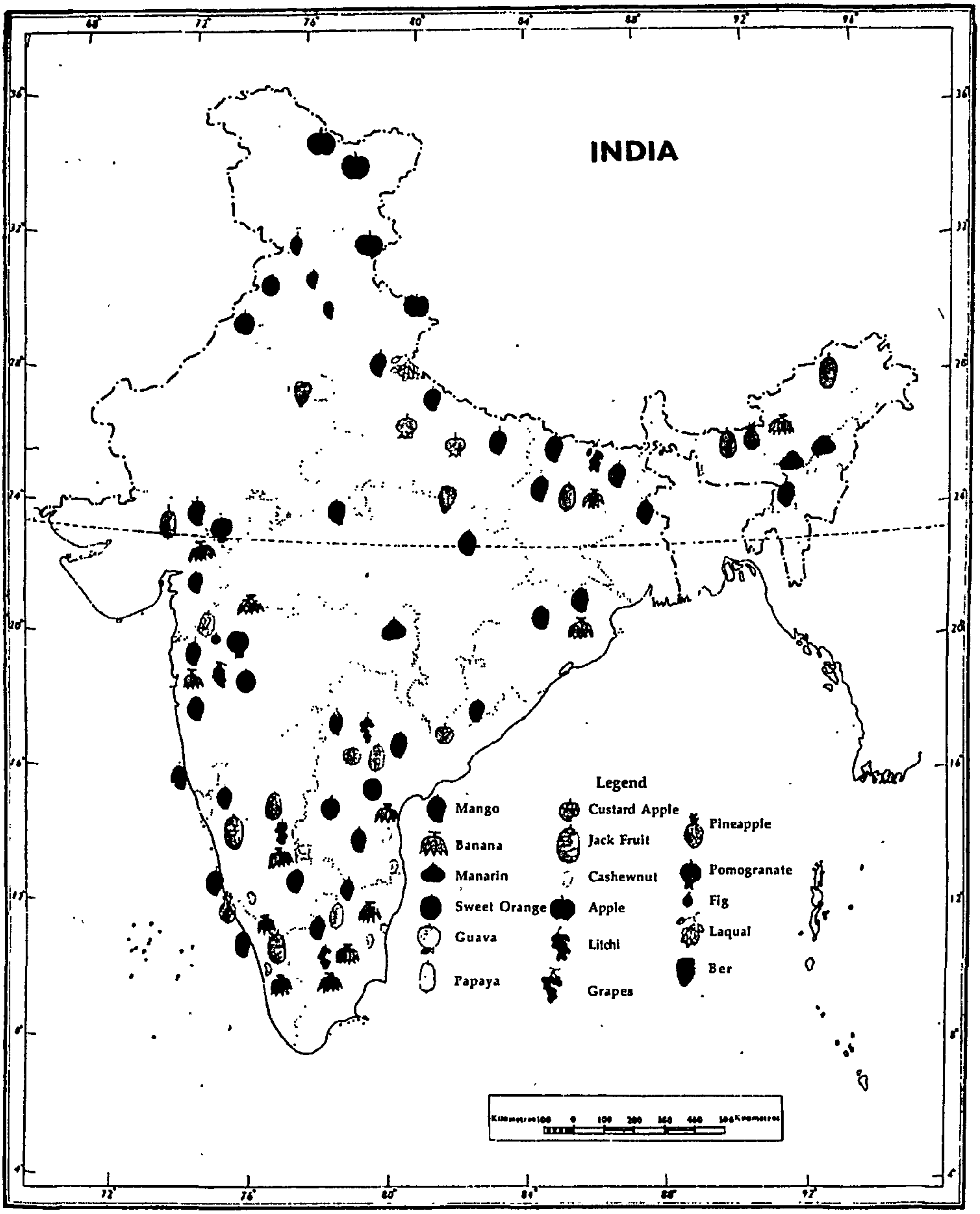

Fig. 1 : Distribution of therapeutically valuable fruits in India

Walnut (*Juglans regia*)—A cold climate preferring tree, few plantations in upper parts of Kashmir. Moderate size tree. Kernel is medicinally useful. A good tonic for old age with almonds, raisins and milk. A good vermifuge for children. Good for memory. The whole fruit powder given with water removes stones within few days. Also beneficial in dysentry, vomiting, TB, boils, abscesses and leucoderma.

Almonds (*Prunus amygalus*)—A slow growing tree. Few plantations but full of medicinal properties. Kernels soaked in water overnight and then after removal of brown seed coat, should be eaten after chewing or ground wet followed by milk uptake. This treatment is very good for memory and eyesight Kernels are also effective in urine burn, deficient mansuration and few other problems of women. Good for small pox, teeth, dry cough, weakness and low body weight. Almonds are also recommended for stammering, semen ejaculation, jaundice, warts and some other skin problems.

Fig (*Ficus carica*)—Dried figs are excellent remedy for old and long prevailing constipation. Good for common cold and weakness. Removes many oilments of lungs. Good expectorant and alleviate the arthmatic condition.

Edible Pine = Chilgozah (*Pinus gerordiana = P. edulis*)—A slow growing medium height tree of cold climate (north western Himalayas). Fruits produced in female cones are edible. If eaten properly enhance the body power and some problems of males.

Pista (*Pistacio vera*) —Four species of *Pistacio* are found in India. These are *P. integerrima, P.khinjuk, P. lentiscus* and *P. vera. Pistacia vera* (Green almonds = Pistachio = Pista) is found in many parts of Asia. The species is cultivated in North India for edible fruits. The high cost of the fruit is attributed to slow growth and low productivity. The fruit is warm and hydrous in nature. Very rich in vitamin E which improves semen production. Pista alleviate the brain weakness and irregular heart beats.

Cashewnut (*Anncordium occidentale*)—Cashewnut (Kaju) is a small evergreen tree cultivated in humid tropics of southern India including parts of Malabar, Kerala, Karnataka, TN, AP, Maharashtra, Goa, Orissa and W.B. Seeds are slouro of cashewnut. All the parts are economically useful. Besides the nutritive and food value of nuts, they are good source of some medicines for various systems of medicine. The fleshy swollen pedicel (cashew apple) is also medicinally valuable. Cashew oil (from shells = pericarp) is used for feet cracks. The cashew apple juice is fermented and useful medicine for various problems (Astingent). Leaves are also useful in medicine. Cashewnut (Kaju) contain polysaccharides, galactouronic acid, leaves contain many glycosides and alkaloides (Brahma Varchas 2006). They are aphrodisiac, diuretic, demulcent and astingent. They are useful in haemorrhagic diseases, kidney troubles. They are spermatopoitic, antibacterial, anti diarrhoeal, antiscorbutic, emulcient. The bark is applied externally in leprosy. Root is purgative. The fruit (kernel) is also useful in dropsy, dyspepsia, fever, piles and sprue. Also used for skin disease. Seed cooked with milk (kheer) is given for feet/skin infections in rainy season.

Other dry fruits having ample therapeutic potential include fresh and processed date palm fruits, dried date palm, sagopalm (Saabudana-*Cycas revoluts*), raisins (Kishmish, Munakka), Coconut Kernel Powder, dried, roasted peanut, trapa (Singhada), Makhana (Gorgan nut = *Euryal ferox - Euryalaceae*)

VEGETABLES AND THEIR THERAPEUTIC POTENTIAL

Vegetables include diverse group of plants that reserve food in roots, shoots, leaves and fruits. Some of them are medicinally valuable as below —

(A) Earth vegetables with therapeutic potential

These are plants which store food in under ground parts. These are regarded as easily digestable. Few are as below—

I. Roots

Beets (*Beta vulgaris*)—Therapeutic potential of this vegetable has been described Sugars / Starches. However, vegetable types of beets differ from sugar beet. It is a biennial crops grown in many parts of the world. *Beta vulgaris* var. *rapa,* the vegetable beet is medicinally valuable in rheumatic condition blood/ haemoglobin improver, liver tonic, brain tonic, kidney stone, expectorant and tumours.

Carrots (*Daucus carota*)—The root juice is excellent remedy for blood purification, anaemia etc. Carrot juice (fresh and filtered) is good tonic for brain. It relieves mansuration disorders. Good for eye sight, digestive problems, cancer, liver, jaundice, spleen problems, diarrhoea, worms, acidity, skin problems, exzema, chest pain, wound healing, rheumatism, stones (kidney, bladder and gall bladder, adenoids, throat problems, teeth troubles, bad breaths, asthma etc.

Radish (*Raphanus sativus*) —Properly washed and juiced root are prescribed for kidney and urinary problems. Good for piles, stomaches, scorpions, exzema, throat problems, hieccough, diabetes, dyspepsia. Radish eaten raw daily relieves jaundice, acidity and mansurational disorders but it should be followed by jaggery uptake. For kidney and urinary bladder stones, seeds of radish (boiled in water and filtered water) are effective. Its relative *Brassica rapa* = Turnip Shaljam has similar medicinal potential.

Sweet Potato (*Ipomoea batatus*)—Thoroughly washed fresh roots are good for health. Boiled in water and cooled roots are effective in relieving anaemia, improves bodyweight. Also good for sexual weaknesses in man,

Other root vegetables include *Brassica nepabrassica,* (Rutabagas), elephant foot (Yam), Oyster plant, paranips, common yams and cassava.

II. Underground stems

Potato (*Solanum tuberosum*)—This is the most important vegetables of the world. Potent source of starch. But more importantly tuberous stem, stem, leaves, flowers and fruits are also medicinally important in almost all the systems of medicine. Raw potato juice is good for beri beri. Recommended for scurvy. Raw potato is good for burns, heart burns, acidity, gout, rhumatism, arthritis, lumhago, knee problem (synovitis), erysepalas, renal (kidney) stones, obesity, high BP, swellings and skin wrinkles.

Taro and Dasheens (*Colocasia antiquorum* and *C. esculenta* = *Kachalu* and *Arvi*)—Both these rhizomatic stems have similar medicinal properties. Many problems of kidney are relieved by Dasheens. Skin dryness and heart troubles one relieved by taro and dasheen uptake.

Onion (*Allium cepa*)—The bulb and leaves of onion are good remedy for a number of health problems. Problems which may be taken care of by proper uptake of onion include ensomnia, eye problems, worts, epilepcy, heart stroke, earache, baldness, digestive disorder, hieccough, constipation, worms, dysentry, diarrhoea, vomiting, jaundice, piles, stones, bronchitis, asthma etc. This medicine is also prescribed in abscesse, rheumatic condition, headache, cholera, touch problems, heart troubles, intoxication, corn, sexual weakness, dropsy, common cold, skin problems, epistaxis, TB, anaemia etc.

Garlic (*Allium sativum*)—Garlic is reputed as a wonderful remedy for many problems. Various pharmaceutical preparations are marketed. These medicines are recommended by Allopathy, Homoeopaths, Unani Haquims, Siddas, Ayurvedacharyas and even in ethno medical systems. It is a very lengthy topic. Only a summary is possible in this section. In brief garlic is a good appetiser. Recommended in asthma, pleuricy, bronchitis TB (of different organs), common cold, soar throat, pneumonia, cough, whooping cough, scabies, exzema, teeth problems, baldness, ticks, nipple looseness, headache, earache, diphtheria, hysteria, cholera, worms, fever, malaria, paralysis, bones, B.P. etc. Garlic (fresh, powdered or processed) is a good remedy of different heart problems. This also relieves ageing impotency, jaundice etc. Some types of cancer are also relieved. Peptic ulcer, gastric ulcer, tonsilitis and leucoderma are also relieved by proper use of garlic (alone or in combination with certain other medicinal herbal remedies).

Other underground stems (vegetables) useful as medicines include leek *(Allium porrum)*, jerusalem artichoke *(Helianthus tuberosus)*, Oca *(Oxalis tuberosa)*, Ullucu *(Ullucus tuberosus)*, Anu *(Tropaeolum tuberosum)*, Yoution *(Xanthosoma angustifolia)* and Arracocha *(Arracacia Xanthorrhiza)*.

B. Herbage vegetables

These are usually leafy vegetables and tender aboveground stems / shoots. Many of then are medicinally valuable.

Asparagus (*Asparagus officinalis* = Shatawari) —Greek and Roman had been well acquainted with medicinal value of **Shatawari** which includes tender shoots (Spears). Many processed products are conned, frozena and also marketed. Fleshy roots and Cladode are also medicinally valuable. *Asparagun officinalis* (*A. racemosus*) flesh roots, clododes, tender shoots, and even whitish flowers contain mucilage, saponin, diosgenin, shatavarin, glycosides etc. A good rejuvenator, nervous tonic, astingent, galactogogue, spermatopoltic, heart tonic and diuretic. Useful in threatened abortion, leucoderma, seminal debility, general debility, agatactio, headache, hysteria. The extract of Cladode is rich in anticancer factors.

A close relative of *Asparagus racemosus* is *A. adscendens* (Musali = Swet musali = Taal musali) and has similar medicinal values. It should not be confused with *Chlorophytum borywilli* (Safed Moosali).

Other herbage vegetables which are rich in medicinal properties include cabbage and its different allies, (*Brassica oleracea*) celery (*Apium graveolens*), lettuce *(Lactuca sativa)* spinach *(Spinacea oleracea)*, fenugreek *(Trigonella foenum graceum)* - both leaves and seeds are equally effective), mustard *(Brassica compestris)*, Amaranth *(Amaranthus blitum)*, bathua *(Chenopodium album)* etc. For information on their specific medicinal efficacy, a reference may be made from Dr. Ganesh Narayan Chauhan's wonderful book (kindly see the reference).

C. Fruits vegetables

Many fruit are used as vegetables but their medicinal properties are given here in brief —

Tomato (*Lycopersicum esculentum*)—Most important fruit vegetable of the world, tomato has tremendous therapeutic value. Fruits, leaves, stem etc. are useful. Green as well as ripened fruits are used as medicine. Many processed products of tomato are marketed. Tomato fruits are rich in vitamines (A,B and C) and minerals (Calcium, Iron etc.) Raw tomato (unripened) is good for constipation. It is a digestive stimulant. Useful in appendicites, worms, good tonic, reduces obesity. Recommended in weakness, fever, jaundice, skin problems, scabies, night blindness, gout, diabetes and teeth problems.

Cucumber (*Cucumis sativus - Khira*) —Effective in constipation, jaundice, fever, skin diseases, stones and diabetes. Also relieves joint pains.

Bottle Gourd (*Lagenaria siceroria - Lauki = Ghiya = Ghiya Kaddu*)—Good in scorpion bites, dysentry, diarrhoea, renal pains, feet burns, teeth problems, TB, piles, and jaundice, Lauki juice relieves obesity and lever problem.

Pumpkin and Squashes (*Cucurbeta moschata - Sitaphal*), *C. pepo*-Chhappun Kaddu, *C. maxima* - Vilayati Kaddu)—All these are related species and are used in digestive disorders.

Bitter Gourd (*Momordica Charantia - Karela*) —A potent multitherapic medicinal plant. Fruits are used in different preparations (juice, powder etc.) against diabetes. It has been found effective in paralysis, stones, asthma, flatulance, digestive disorder, cholera, liver problems, spleen disorder, worms, blood purification, bleeding piles, jaundice, gout and constipation.

Other vegetables of family cucurbitaceae are also medicinally valuable. These include sponge gourd (*Luffa cylindrica* - Ghiya tori), ridge gourd (*Luffa acutangula* - Kali tori), ash gourd (*Benincasa hispida* = petha), snake gourd (*Trichosanthes anguina* - chichinda), pointed gourd (*Trichosonthes dioica* = Parwal), little gourd (*Coccinia indica* - kandoori) etc.

Brinjal (*Solanum melongena*) —Good remedy for flatulance and feet pains. Effective in baola = Naaru disease. Good for heart weakness, piles, etc.

Okra (*Hibiscus exculenta*)— Rich in vitamines and minerals, proteins and mucilage. This is a good remedy for urine burns and dysentry.

Other fruit vegetables of medicinal value include cucumber (*Cucumis melo* var. *utilisimus*), kathhal = Jack fruit (*Artocorpus edulis = A. heterophylla),* musk melon (*Cucumis melo* = kharbooja), water melon (*Citrullus vulgaris* = Tarbooj) etc.

PLANT BEVERAGES AND THEIR THERAPEUTIC POTENTIAL

Beverages are part and partial of human civilization and our culture is closely associated with use of beverages in some form or the other. These are palatable and refreshing. More than 1000 species are used but only a very few are commercially exploited (Hill 1952)

(A) Non alcoholic beverages

These beverages contain coffeine which is on alkaloid and has good medicinal properties such as diuretic and nerve stimulant but harmful in large quantities. These are as below —

Coffee (*Coffea arabica*)— It is a beautiful shrub or small tree. Fruits are small berries. Other species are *C. robusta, C. liberica.* Fruits are harvested, graded, dried and powdered (roasted or unrosted). Coffee powder is consumed in various ways. Coffee is a medicine in Homoeopathy and Ayurved. It relieves pain in body, diuretic. It is a good broncheodialator and relieves cough, asthma, brain fatigue. It is a digestive stimulant. Beneficial for easy delivery. More suitable in humid climate.

Tea (*Camellia theo*) —Tea is the plant product of dried and partially fermented (cured) leaves. It is a medicine but not for daily use and should be taken with a great caution. In regulated uptake it is good nervous stimulant, cold, pain, fever, cough and sinusitis. It is diuretic. Useful in burns, piles, dysentry, It is a homoeopathic medicine also.

Cocoa (*Theobroma cacao*)—Cocoa and chocolate are prepared from seeds of Cocoa. It is a tropical plant grown all over the world. Numerous varieties have been developed. Cocoa beans (seeds) are marketed in raw or processed form. Theobromine, an alkaloid and caffeine are action principles. These are nerve stimulant. Cocoa butter (obtained from seed) is used for the preparation of chocolate. It is a massage medium (butter), ointment. Shells of fruits are used to prepare Theobromine which an Allopathic medicine for urine problems, myocardial problems and also as a muscle relaxant.

Mate (*Ilex paraguariensis*)—Mate is next to coffee, tea and cocoa in uses throughout the world. The beverage is a leafy product. Leave contain theine, a volatile oil and a tonnin. Medicinal exploitation is moderate in South Amrica. Fruits of *Ilex* are purgative, emetic and also diuretic.

Pragya (Ayurvedic Non Alcoholic Drink)—In view of popularity and ill effects of excessive uses of common tea, some Ayurvedic pharmacies (Registered) are preparing / marketing a nice-non-alcoholic drink (beverage) with the name 'Pragya'. It is a safe drink and medicinally valuable. It is the balanced mixture of pure herbs including Brahmi, Sankhapushpi, Nagar motha, Dalchini, Saunf, Lal Chandan, Arjun bark, Aagya ghas, Tulsi, Madu Jesthi, Tejpat and Sarpunkha. These herbal medicines are properly dried and mixed in the preparation. According to literature, pragya is a safe drink (boiled with water, cow milk and added some sugar). Even it used daily after meal, it has no ill effects. It is said to be good digestive stimulant, nerve stimulant, expectorant, diuretic and beneficial in cough, common cold, general debilities. This is also claimed to improve heart and brain functions. It may be a good substitute of common tea.

Cola (*Cola nitido*)—Cola nuts = Seeds of the plant are used or beverage which is prepared by boiling seeds in water. Nuts are rich in caffeine (2.0%) which is a good medicine for many problems.

Other non alcoholic beverages which have therapeutic potential include. Guarano *(Paullinia cupana)*, Khart *(Catha edulis)*, Cassine *(Ilex comiltoria)*, yoco *(Paullinia yoco)*, fruit juices of many fruits (now available in bottled form). Some malt beverages include ginger ale, sarsaparilla, root beer, near bear and cola beverage (coco cola).

(B) Alcoholic beverages

Uses and abuses of alcoholic beverages have paralleled the entire history of mankind, all civilizations, all cultures, all countries on this earths (Kochhar, 1998). Alcohol is a well documented poison if taken in excess and evels of excessive drinking, their ill effects and alcoholism are perfectly obvious to every one. But in prescribed doses and limited uptake, these are helpful in some remediation process.

I. Fermented Alcoholic Beverages

Wine (*Vitis vinifera*)—Except specifically mentioned, wine is fermented juice of grapes (*vitis vinifera*). Wines are named differently in various countries. In France (Modoc Red Wine), Champanges are famous. Germany, Italy, Hungory, Spain, Portugal, USA, Russia, India have different brand names. In tropical countries like India, wines are injurious to health. Medicinal properties are to little to describe here.

Beer (Barley bear starch is fermented)—By malting and brewing process, beer is produced. Alcohol content is very low (3-5% v/v). Other fermented beverages are Hand Cider (Apple), Root Beer (Sarsaparilla, ginger, winter green), spruce beer (Spruce leaves), birch beer (birch), Mead (honey fermented in Africa) - word *honeymoon* originated from this, Saka (Rice - Japan), Palm Wine (Inflorescence of many palms), Pulgue(fermented juice of Agove atro cinera - Mexico), Chicha (Maize in Peru), other plants used for this fermentations are banana, sugar cane, sorghum, cassava, algaroha, sweet potato and pine apple. No scientific information on medicinal uses could be available.

II. Distilled Alcoholic Beverages— Whisky is distilled from a fermented mash of malted or unmalted cereals and potato. Low wine whisky, High Wine whisky, *Scotch whisky* (only barley malt is used) are some kinds of whisky. Other distilled alcoholic beverages are *Brandy* (distilled from wine), *Rum* (distilled from unrefined products of sugar cane - (juice and molasses), *Gin* (Distilled from barley and rye malts). Some other liqueurs and cordials are also prepared from plants. In these various essential oils are added for flavour and taste but their medicinal properties are not well documented and are being avoided here.

PLANT FUMITORIES AND PLANT MASTICATORIES AND THEIR THERAPEUTIC POTENTIAL

Habit of chewing and smoking is so wide spread that it appears to be the part of our food (though, their nutritius value is negligible). These are the part of an attempt to seek flight from reality. Some of these smoking and chewing substances of plant origin have little medicinal value while most of them are harmful.

Tobacco (*Nicotiana tobacum*)—Leaves of this solanaceous plant contains Nicotine, some essential oils and few aromatic substances. The 'cured' tobacco is used as blends, snuff, chewing, smoking, cigars, cigarettes, bidis etc.

Nicotiana rustica is the source of "nicotine" which is a good insecticide. Tobacco is also the source of Rutin. Nicotine is the raw material for many Allopathic medicines. The norms and ill effects of tobacco dominate over few medicinal values.

Betel Nut (*Areca catechu*)—Betel nuts (areca nuts) are the seeds of betel nut palm, a long unbranched palm. Important component of 'Paan', an important Asian masticatory. Roots, leaves and seeds are used as medicine. Seeds contain Aracaidine, Arecoline, Guvacine, Isoguacine alkaloids and few minerals. Supari is antimicrobial, antifertilily, cooling, astingent, anthelmintic and general stimutant. Useful in Diarrhoea, Urine disorder, small pox, veneral sores, cholera, syphlis, Dysentry and fractured bone.

Betel leaf (*Piper betle*)—Leaves and fruits of this root climber are medicinally used. Leaves are used as 'Paan'. Therapeutically these leaves contain an aromatic volatile oil, starch, sugar, tanin distase, chavicol cadenine, chavi betol, eugenol. Leoves are good digestive stimulant, carminative, anti inflamatory, wound healing, anthelmintic, astringent, aphrodisiac, and expectorant. These are medicinally useful in a number of body problem including rhiritis, bronchitis, asthma, larynx-swellings, cough, cold, diphtheria, inflamation, ulcer, birth control, conjectivitis, night blineness, leprosy, oetalgio, obesity. The root is used in snakebites. Fruits are used common cold, birth control. Excess chewing of paon is harmful and may lead to mouth cancer.

Cola (*Cola nitida*) —Cola seeds are non alcoholic beverage but are also used as masticatory (unprocess) after roasting and powdering. It is an important commodity in life of African people. These are general stimulant and lower down the general debility, hunger and fatigue. Caffeine content is about 2.0% which is high enough. The *kolanine* is a good heart stimulant. Old nuts are less effective. Fresh should be used. Long term chewing of colanut has no ill effect in long run so they are safely used in all families of African people.

Other fumitories and masticatories of plant origin are true narcotics and equally harmful with very high negative effects on human body. These include coca *(Erythroxylon cocoa)*, opium *(Papaver somniferum)*, cannabis *(Cannabis sativa)*, peyote *(Lopho phora willinissib)* - a cactus, fly agaric (*Amonita muscaria*), oloninqui (*Rivea corymbosa*), caapi (*Banisteriopsis caapi*), Datura (*Datura stromonium* - very limitted doses), Hanebone (*Hyoscymur niger*) etc. Datura and Hanebane are potent hypnotic agents. Kava kava (*Piper methysticum*) is a potent narcotic with sedative effects and sweat dreams.

PLANT GUMS & RESINS AND THEIR THERAPEUTIC POTENTIAL

True gums are the products of disintegration of internal tissue (celluloses) through 'gummosis'. These are important adhesives in pharmaceutical industry. *Gum arabic* (*Acacia sevegal*) is a good demulcent. *Gum tragacanth* (*Astragalus gummifer*). This is one of the oldest drugs and frequently used for adhesive in the preparation of pills, trouches and insoluble powders. Karoyogum *(Stercutia urem)* is also medicinally useful. Other gums include gum ghatti *(Anogeissus latifolia)*, *Feronia* gum, *Cochlospermum gum*, *Cycas gum*, Ceratonia gum and *prosopis* gum. Many of these gums are used in India, especially rural masses for preparing nutritive dry tonics for ladies who have delivered newly. All parts of *Acacia arbica* are medicinally valuable. The gum is used as a medicine. It contains galactose, arabic acid and minerals. The gum is astringent, anthelmintic, antidotal, anti inflamatory, antileprotic, emolient and good demulcent. Gum is a good tonic, useful in urine problems, diabetes, digestive disorder. It is chewed slowly for digestive stimulation. Gum is also useful in cough and soar throat and also in semenal disorder but the gum for this purpose is first roasted, broken in to small pieces and mixed with khand, boora, and cow ghee.

Resins are very important plant products for pharmaceutical industry. These are rarely used as direct medicines. These are often called minor forest products. Copals, Damara, Ambers, Lacquirs, Shellac, Acaroids, Oleoresins, Balsams are important resins of plant origin and of good importance in pharmaceutical industry.

FOOD ADJUNCTS (SPICES AND CONDIMENTS) AND THEIR THERAPEUTIC POTENTIAL

Therapeutic potential of all the 70 spices of plant origin has been documented in considerable details in different chapters of a treatise (Singh et al 2006). Describing them here again will be a wasteful repitition. Pruthi (1976), Mehta (2005), Chauhan (2005), Chauhan (2006) and Brahma Varchas (2005) have also given comprehensive discussion of spices in details. Central Food Technological Research Institute (CFTRI). Mysore and other laboratories of CSIR are in active progress to point out changes in medicinal value of spices which are being variedly processed. Various national and international organisations which make R&D efforts in this direction include International Organisation of Standardization (ISO), FAO, WHO, Indian Bureau of Standards, Spices Export Promotion Council of India, Cochin, ICAR-New Delhi, Indian Institute of Spices Research Calicut, National Research Centre on Seed Spices (ICAR) Tabiji - Ajmer, Central Plantation Crops Research Institute, Kasargod, American Spices Trade Association, New York etc.

EPILOGUE

Subject covered in this chapter is very vast and therefore, only a brief description of therapeutic potential of different economic groups of plant eatables has been given. These economic plant groups include cereals (grains), millets, pulses, tropical and sub tropical legumes of herbs, shrubs, climbers and tree nature, sugars, starches, celluloses, fruits, nuts, vegetables, edible oils, chewing and smoking plants, beverages of plant origin, gums, resins and spices. Efforts have been made to include medicinal uses (and some abuses also) but it is a clear caution that no medicine should be taken without the advise of a physician. Further, the therapeutic impacts are general and indicative only and these may vary with the age of the patient, physique, intensity of ailments. Control of diet (Parhej = patya and Apathya) is an integral part of medication. Purity, freshness, dose and medium of uptake are also equally important.

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SECTION 6

PROPAGATION AND NUTRIENTS MANAGEMENT

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17

Propagation and Nutrients' Management in Therapeutically Valuable Seedy Spices

Karan Singh and Yogendra Kumar Sinsinwar

INTRODUCTION

Spices constitute an important group of agricultural commodities, which are virtually indispensable to the culinary art. They also play a significant role in national economy of several countries including India (Pruthi, 1976, 1993). Out of about 70 species of spice yielding plants which are grown all over the world, many constitute the components of Indian Agro ecosystem (Arya, 2000). The spices may comprise floral parts (clove, saffron etc), fruits (cardamom, chilies etc) berries (all spice, black pepper, juniper etc), seeds (aniseeds, caraway, celery, coriander etc), rhizomes (ginger, turmeric etc), roots (angelica, horse radish, lovege etc), leaves (hay leaves, mint, majoram, tispat etc), kernel (nutmeg etc), aril (mace), bark (cinnomom), bulbs (garlic, onion etc) and some other parts of plant.

Out of 70 species, more than 20 are obtained from seeds or seedy fruits (seeds fused within fruit wall). All these are part and partial of drug industry and provide valuable raw materials for pharmaceutical industry all over the world (Sharma, 2005). Out of these medicinally important seedy spices, some are important sources of foreign currency through tremendous export potential (Nehara *et al* 2006).

Indian spices had gained reputation in world trade due to their quality but now face a tough competition with other countries due to changing scenario of marketing, WTO and more and more emphasis on quality standards. India exports spices to more than 70 countries in raw form, value added item and (upto limited extent) in processed form.

Usefulness of seedy spices as medicine was realized in the very beginning (Singh and Tyagi, 2004) and at present many pharmaceutical formulations are based on components or extracts of spices. All the twenty seedy spices have now been established as important raw material for pharmaceutical industry (Bhattacharjee, 2004) and some of them are being used as the source of clinically valuable active principles.

The productivity of seedy spices in India is one of the lowest (545 to 1113 kg /ha) compared to other spices growing countries of the world and the production is only fraction of the potentially realizable yield with available knowledge and inputs (Reithinam and Sadanandan, 1994). The nutrient management of seedy spices (like all the other crops) occupies a key place in the packages of production technology. This includes soil condition, (more suitable for better productivity), fertilizer recommendation and soil preparation. Basic aspects like nutrient uptake mechanism of individual essential macronutrient and micronutrient is being avoided to discuss here more on applied aspects of nutrient management (Table 1).

Table 1 : Therapeutically valuable seedy spices at a glance

S.No.	Common name/ Hindi name	Botanical name/ Family	Part/s used	Medicinally important metabolism & uses
(1)	(2)	(3)	(4)	(5)
1.	Bishop's weed: Ajvain	*Trachyspermum ammi / Carum copticum*: Apiaceae	Seeds	Volatile oil thymol stearoptin cymon, Terpene, Diarrhoea, Stomachic Anthelmintic Heart tonic
2.	Allspice= Pimmetta Pimmeta Pimmenta	*Pimenta officinalis= P. dioica = Eugenia pimenta*: (Myrtaceae)	Seedy berry	Ascorbic acid, essential oil, quarcitanic acid, digestive stimulant, flatulence diarrhoea neuralgia
3.	Aniseed Valaiti Saunf= Muhuni	*Pimpinella anisum*: Apiaceae	Seeds	Choline Essential oils, Carminative Diuretic Diaphoretic Expectorant Emenagogue
4.	Pomegranate = Anardana	*Punica granatum*: Punicaceae	Seeds with dried seeds	Oxalic acid carotene Thiamine vit. C etc cardiac and digestive stimulant

contd. ...

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(1)	(2)	(3)	(4)	(5)
5.	Carawa Shia Zira	*Carum carvi, Apium carvi*: Apiaceae	Seeds	Essential oil – Carvone Carveola Thiamine Niacine Carminative Digestive Stimulant, Anthelmintic
6.	Celery Shalari = Karas	Apium graveolens Apiaceae	Seeds	d. limonene, d. selenine, Sedamolide, Glucosides, Multipurpose medicine for digestive disorder
7.	Coriander= Dhania	*Coriandrum sativum*: Apiaceae	Seeds	Essential oil kinene, dipentine, p.cymene geraniol carminative cooling agent digestive disorder
8.	Cumin = Zira	*Cuminum cyminum*: Apiaceae	Seeds cum fruits	Cumic aldehyde Thymol, Pentason Vit A, B & D Stimulant, Analgesic, carminative digestive, Disuria
9.	Cumin black= Kalaunji =Kala Zira	*Nigella sativa*: Apiaceae	Seeds cum fruit	Volatile oil – Carvone cymone Nigellone Carminative Diuretic Emenagogue
10.	Dill = Dill Indian Dill European Dill Sowa	*Anethum sowa A. graveolens*: Apiaceae	Fruits cum seeds	Essential oil – carvinone, terpene carminative, in flatulence colic
11.	White mustard = Safed Rai	*Brassica alba B. hirta Sinopsis alba*: Brassicaceae	Seeds	Glucosides – Sinoblin Myrosine, Carminative, Digestive stimulant
12.	Black Mustard = Banarasi Rai	*Brassica nigra*	Seeds	Glucoside – Sinigrin, Myrosine, many medicines – both useful in ayurvedic & naturopathic systems
13.	Indian mustard: Brown mustard = Sarason	*Brassica juncea*: Brassicaceae	Seeds	Volatile oil safe preservative, very useful in ayurvedic & naturopathic systems

contd. ...

... contd.

(1)	(2)	(3)	(4)	(5)
14.	Black pepper= Kali Mirch	*Piper nigrum*: Piperaceae	Dried seedy fruits	steroids, alkaloids, glycosides, stimulant carminative digestive, throat, liver piles, leucoderma
15.	Long pepper= Pipal / Pipalli	*Piper longum* Piperaceae	Seeds cum fruits	Sylavitin seramine Tonic, Alternative Reijuvantor expectorant, cough, Bronchitis cold, Lumbago Asthama
16.	Poppy seeds= Kash Kash = Khus Khus	*Papaver somniferum*: Papaveraceae	Dried seeds	Triglyceride esters, Somniferine, Tonic Expectorant, Aphrodisiae, Polyuric cough, Rheumatic problems
17.	Fennel= saunf	*Foeniculum vulgare*: Apiaceae	Seeds	Ascorbic acid, niacin, riboflavin ticophenol, amethol, foeniculin Stomachic carminative stimulant, kidney problems
18.	Fenugreek= Methidana	*Trigonella foenum-gracecum:* Fabaceae	Seeds	Alkaloids – Trigoneline, Coline, Glycosides, Saponin, Seeds are diuretic carminative
19.	Greater Indian Cardamom = Bara Ilaichi	*Amomum subulatum*: Zingiberaceae	Fruits & seeds	Seeds aroma flavour, flavanoids, stimulant laxative, astringent Appetizer Heart + liver tonic
20.	Cardamom = Chhoti Elaichi	*Elletaria cardamomum*: Zingiberaceae	Fruits & seeds	Essential oil – Cineol, Terpineol, Limonene Stimulant Carminative Analgesic Diuretic
21.	Hill Parsley= Ajmoond	*Petroselinum crisbum*: Apiaceae	Seeds	Glycoside – Aptin Essential oil Diuretic Stimulant Diophoretic Urinary problems

RESPONSES TO SOIL CONDITION AND NUTRIENT MANAGEMENT PRACTICES

As common with other crops, seedy spices are grown under a wide range of agroclimatic conditions. As soil is a medium of plant growth, physical characteristics and chemical conditions of oil considerably affect the productivity, production, quality and processibility of all the seedy spices. Compared to other groups of crops, very little work has been done on the responses of seedy spices to soil conditions, macronutrient application, micronutrient effects, farmyard manure, vermicompost and biofertilizers etc. (Singh and Tyagi, 2004; Sharma, 2006). A brief of available information on these aspects are summarized here.

Bishop's weed: Ajovain

(*Trachyspermum ammi* = *Carum copticum*: Apiaceae)

Annual herbaceous herb is a Rabi crop sown in October – November and harvested in May-June in Iran, Egypt, and Afghanistan. In India, U.P., Bihar, M.P., Punjab, Rajasthan, Bengal, Tamilnadu and Andhra Pradesh are ajovain-growing areas. Genotypes GA1, AA-01-19, AA-01-27 and AA-01-61 responded well to fertilizers under rainfed as well as irrigated conditions of sandy loam soil. 25 t FYM/ ha. Sowing 4 kg seeds/ ha at spacing 45x20 cm. With 75 kg N, 20 kg P_2O_5 and 20 kg /ha K_2O produced average yield of 10.5 q/ha under Rajasthan conditions (NRC SS-Tabiji, Ajmer – ICAR). However, more research work on responses to organic manure and biofertilizers is required (Anonymous 2005).

Allspice: Pimmetta, Pimmeta, Pimmenta

(*Pimenta officinalis* = *P. dioica* = *Eugenia pimenta*: Myrtaceae)

This is a bushy evergreen tree (8-9 meters) high and indigenous to West Indies and Tropical Central America. Found wild in Jamaica. In India, it is cultivated in gardens in Bengal, Bihar, Orissa, Karnataka and Kerala. The tree is in great demand in world market. The cultivation of the spice should be encouraged in India. Practically scientific data on soil/ climatic condition and fertilizer needs of the spices are lacking. However, compost mixed with sandy loam soil enhanced the yield (Bhattacharjee, 2004).

Aniseed = Valaiti Saunf = Muhuni

(*Pimpinella anisum*: Apiaceae)

An annual herb native of Mediterranean region, widely cultivated in Bulgaria, Cyprus, France, Germany, Italy, Mexico, South America, Syria, Turkey and Russia. In India, it is grown as a garden plant upto limited extent in Rajasthan, Punjab, U.P. and Orissa as a Rabi crop. The crop remains in the field for about six months. Seeds are sown in October-November (45 x 45 cm). About 10 tonnes of FYM /ha are applied during land preparation. 50 kg N, 25 kg P_2O_5 and 25 kg K_2O per hectares gave higher seed yield. Crop matures in March-April within 7-8 q/ha yield.

Pomegranate = Anardana

(*Punica granatum:* Punicaceae)

Dried seeds of pomegranate with flesh are obtained from the tree (5-8 meter high) which is a native of Iran, Afghanistan and Baluchistan. It is cultivated in warmer parts of

India. It is considered as a semi arid fruit tree. The plant requires well-drained rich soil (with moderate organic matter). Long hot dry summer and cool winter are suitable. Propagation by seeds as well as by cutting of shoot. Specific data on responses of plants to inorgamic fertilizers could not be available. Some work is being conducted at SKN COA, Jobner (Raj.) under AICRP on Arid Fruits.

Caraway = Shiazira

(*Carum carvi* = *Apium carvi* : Apiaceae)

It is a hardy, thick rooted biennial plant, about 60 cm tall. The species is cultivated in cool climate. Native to North and Central Europe and extensively cultivated in Holland, Russia, Poland, Bulgaria, Romania, Syria and Morocco. In India, the plant is grown as a Rabi crop in hills of Jammu & Kashmir and Uttranchal. The yield of this crop in well prepared rich soil is upto 20 q/ha. Sowing of seeds (rate 6-8 kg/ha seed rate) in mid October at spacing 30 x 20 cm. With fertilizer at the rate of 60 kg/N, 40 kg P_2O_5 and 20 kg K_2O gave an average yield of 4-5 q/ha.

Celery = Shalari = Karas

(*Apium graveolens*: Apiaceae)

An annual herb, the native of Europe, India, North and South Africa, is grown in various parts of India including Indogangetic Plains and also some parts of Rajasthan. It is a rabi crop. Direct seed sowing or through seedling transplants. Rich loamy soil with moderate soil moisture retention capacity is preferred. Seedlings spaced 20 cm x 45 cm give better yield. 25 tonnes FYM is incorporated in soil during land preparation. A fertilizer dose of 150 kg N, 100 kg P_2O_5 and 100 kg K_2O per hectare is recommended. Crop matures up to 90-120 days after transplant. Experiments conducted on A Cel 01-01 at Ajmer (Raj.) showed that under semi arid rich sowing in October (1.0 kg seed per hectare) spaced 30 cm x 20 cm with 60kg N, 40 kg P_2O_5 and 20 kg K_2O gave better yield (1.5 q/ha).

Coriander = Dhania

(*Coriandrum sativum*: Apiaceae)

An annual herb, Rabi crop, native of Mediterranean region. India, Morocco, Russia, Hungary, Poland, Romania, Czechoslovakia, Guatemala, Mexico and USA are important coriander growing countries. India produces coriander in states like Andhra Pradesh, Tamilnadu, Maharashtra, Punjab, Rajasthan, Uttar Pradesh, Himachal Pradesh, Assam, Madhya Pradesh etc. It may be cultivated in ordinary soil with proper drainage. Seed are sown at 1 cm depth and 30 cm x 30 cm distance. FYM 10-25 tonnes per hectare is recommended. NPK dose differs from state to state and also on soil test basis. NPK (60:40:20 in Bihar, 15:20:15 in Gujrat and 50 kg N in 20 + 30 split doses in Rajasthan) recommendations are variable. Studies on micronutrients application are in preliminary stage (Rethinam and Sadanandan, 1994). Integrated nutrient management coupled with water and soil management is preferable (Anonymous, 2005). Improved varieties with higher yield under nutrient management have been developed under AICRP on Seed Spies (ICAR) collaborative centres including SKN COA, Jobner (Rajasthan). NRCSS, Tabiji (Rajasthan) is also actively involved in production technology development.

Cumin = Zira

(*Cuminum cyminum* : Apiaceae)

Cumin (Safaid Zira), native of Egypt and Syria, is an annual herb grown as rabi crop. Seed propagated crop is grown in Uttar Pradesh, Punjab, Rajasthan, Gujarat and Tamilnadu. The plant thrives better under sandy loam soils with good drainage. 30 cm row spacing is achieved by 10-12 kg seed rate/ha. Better results are obtained by seed sowing during November 22 – December 15. Cumin responds to NPK (25:20:20) in Rajasthan. In Gujrat FYM (15-20 t/ha) as basal dose was recommendable. In this state N (30 kg/ha), P (15 kg/ha) and K 30 kg/ha gave higher seed yield. Application of macronutrients (N, P&K) also affected the medicinal index of cumin seed.

Cumin black (Kalunji = Kala Zira)

(*Nigella sativa*: Apiaceae)

It is a small herb (45 cm height). Native of Eastern Mediterranean. Cultivated upto limited extent in Punjab, Himachal Pradesh, Bihar and Assam. Varietal improvement programme is in progress at NRCSS, Tabiji (Ajmer). Genotypes AN 01-1 gave higher yield on sowing between October 1-15 (seed rate 07.0 kg/ha) with row spacing 30-15 cm. The FYM and vermicompost also improved seed yield. 40 kg N, 20 kg P_2O_5 and 15 kg K_2O per hectare gave higher seed yield (7.8 q/ha).

Dill = Indian Dill = Sowa

European Dill (*Anethum gaveolens*)

Indian dill (*Anethum sowa*: Apiaceae)

Both the spices are medicinally valuable. Dill is cultivated in England, Germany, Romania, Turkey, USA and Russia. In India, efforts to cultivate have yielded fruitful results and the sowing is limitedly cultivated in many parts including Jammu & Kashmir, Punjab, Himachal Pradesh and Rajasthan. Herbaceous annual rabi season crop is acclimatized in variety of soils. European dill AD 01-44 genotype and Indian dill genotypes – AD-01-43 and AD-01-06 showed good performance at NRCSS, Tabiji, Ajmer under irrigated as well as rainfed conditions. The suitable time of sowing for dill is mid October with a seed rate of 4.0 kg (45 cm x 20 cm spacing). 75 kg N, 30 kg P_2O_5 and 20 kg K_2O per hectare gave better yield (13.0 q/ha).

White Mustard = Safed Rai (*Brassica alba = B. hirta = Sinapsis alba*): Brassicaceae

Black Mustard = Banarasi Rai (*Brassica nigra*) : Brassicaceae

Indian Mustard = Brown Mustard = Sarason (*Brassica juncea*) : Brassicaceae

The genus Brassica (to which these wonderful seed cum medicinal spices belong) consists of about 150 species. Mustard is an annual herbaceous Rabi crop grown in various parts of India including parts of Himachal Pradesh, Uttar Pradesh, Punjab, Haryana, Rajasthan, Gujrat, Madhya Pradesh, Assam, Orissa, Bihar, and West Bengal. October sowing (30cm x 20 cm) is preferred. The recommended dose of N, P, K for mustard (in Kanpur) is

60:40:20: kg/ha under irrigated conditions in loamy soil. FYM, vermicompost and biofertilizers give economically viable results. Several improved varieties have been developed and are being successfully grown at farmers field. First fortnight of October always preferred as delayed sowing is disadvantageous. Seed rate is about 5.0 kg/ha. Thinning should be practiced at 15-20 days after sowing. Micronutrients like Zn and B are also recommended. It is always better to apply fertilizers (micronutrients as well as macronutrients) on soil test basis.

Black pepper = Kali Mirch

(*Piper nigrum:* Piperaceae)

The genus Piper consists of about 200 species and about 50 are found in India, including *Piper betle* (betal vine), *P. brachystachyum* (hilly pipalmul), *P.cubeba* (cubeb), *P. longum* (Pippali = Pippal), *P. nigrum* (Black pepper). Black pepper is native of Western Ghats of India, which is a major producer but now, Indonesia, Malaysia and Brazil have entered the global market. The vine (climbing, perennial tropical plant) thrives best on virgin well-drained red lateritic or alluvial soil rich in humus with moderate soil fertility. As black pepper is an exhaustive crop, fertilizers (micronutrient as well as macronutrients) are essential. Many experiments have been conducted and doses vary according to soil conditions. Sandanandan (1994) studied the nutrient requirements of black pepper (12 varieties) and found that N, P, K, Ca, Mg (macronutrients) and Fe, Mn, N, Cu, Mo, B are essential for normal growth. Organic manures give distinct advantage. N (50 kg), P_2O_5 (100 kg), K_2O (200 kg) per hectare were found optimum in Panniyur-1 pepper variety for adult vine.

Long pepper (Pipalli)

(*Piper Longum*: Piperaceae)

A creeping herb is grown in tropical zones and also distributed wild in Central Himalaya, Khasi, Mikir hills, Western Ghats, lower hills of Assam and West Bengal. The main areas cultivating the long pepper include Assam, Tamilnadu and Cherrapunji. It grown on rich soils having moderate organic matter. Therefore, FYM is often recommended. Specific studies on the NPK and micronutrient need furtherance.

Poppy seed: Kash Kash = Khus Khus

(*Papaver somniferum*: Papaveraceae)

Papaver is a genus of about 100 species out of which 7 are native to India. Opium poppy seeds are important spice. Seeds contain about 50% oil (which is edible) and protein with medicinally important amino acids. Seeds are generally free from narcotic properties. The plant is an erect annual herb cultivated for the purpose of latex (opium) in countries like India, Iran, Turkey, Russia, Yugoslavia, Bulgaria, Australia, Poland, Belgium, France and Spain. In India, opium poppy is cultivated as annual rabi season crop in few districts of Madhya Pradesh, Uttar Pradesh and Rajasthan under licence by Narçotic Department GOI New Delhi, MOP 3, MOP 16, Dhota, Chota Ghotia, Telia and Ranjhotak are improved varieties. The crop thrives better on well-drained rich soil. About 15 tones/ha FYM is added to soil during land preparation. Green Manuring is also beneficial. Neem cake, vermicompost and biofertilizers have been recently experimented and gave advantage of yield and quality both. On soil test basis, 90 kg N, 50 kg P_2O_5 and 40 kg K_2O are recommended. Zinc deficiency symptoms are observed in some areas and Zinc sulphate (15.0 kg/ha) is recommended.

Fennel = Saunf

(*Foeniculum vulgare*: Apiaceae)

An hardy annual (in some niches biennial herb) originated from Western Asia and Mediterrnean Europe. Now, under cultivation in various parts of the world. In India the crop is grown in Rabi season in many states including Maharashtra, Gujrat, Karnataka, Punjab, Haryana, Uttar Pradesh and Rajasthan. The crop is raised in well-drained loamy black or sandy soils containing sufficient limes. Direct seed sowing as well as transplanting is practiced. Moderate organic matter is beneficial. FYM is therefore, recommended. Doses of NPK vary according to soil type. Afridi (1983) (Aligarh) recommended 90 kg N, 60 kg P_2O_5 and 30 kg K_2O per hectare. Micronutrient like Zinc and Boron are also required but more research work is needed (Arya, 2000). Experiments conducted on new genotypes (AF-01-119; AF-01-87) showed that a line-to-line spacing of 60 cm gives better yield at NRCSS, Ajmer (Rajasthan) India (Anonymous, 2005). First week of October is preferred for seed sowing. In Punjab, 50 kg N /ha was recommended. In Rajasthan, 45 kg N and 50 kg K_2O was recommended. No deficiency of K was noted in soil of Jobner (Raj.). Application of zinc and boron was also recommended.

Fenugreek =Methi

(*Trigonella foenum gracecum* : Fabaceae)

Annual hardy Rabi crop, native of Eastern Europe & Ethiopia. In India, grown in all the states. Well-drained loamy soils are more suitable. Seed are sown in Mid-October to November. 10.0 tonnes/ha FYM is recommended during land preparation. Rajasthan, Gujrat and Uttar Pradesh are major states for fenugreek cultivation. Many improved varieties have been developed. Crop is fairly tolerant to salinity. All varieties are responsive to fertilizer application. NPK (25:25:50) is recommended. In Rajasthan N 20 and P 40 kg /ha is recommended. At NRCSS, Tabiji, Ajmer genotypes AM-01-25 and AM-01-10 gave higher seed yield with 30 kg and 20 kg K_2O per hectare dose. Nehara *et al* (2006) with RMt1 cultivar reported that N upto 20 kg /ha (recommended earlier). P upto 50 kg /ha and S upto 50 kg /ha gave higher yield under Jobner conditions. NAA (PGR) 20 ppm, Triacontonol 2.0 ppm and Ethephon 100 ppm also enhanced the yield in combination with macronutrients. Sheep manure (7.5 t/ha), vermicompost 4.0 t/ha also gave higher yield. Use of rhizobium also gave advantageous results.

Greater Indian Cardamom (Bara Ilaichi)

(*Amomum subulatum*: Zingiberaceae)

The species is cultivated in swampy places along the sides of mountain streams in Nepal, Bengal, Sikkim and Assam and forms the important cash crop in Eastern India. It is a perennial shrubby herb (upto 2.0m height). Native of Eastern Himalaya (India), now also grown in parts of Uttaranchal. The plant thrives better on sandy loam soil with adequate drainage potential. Ramse, Sawani, Gose, Ramla, Chibe, Ramnog, Madhu and Mongni are important cultivar. Seed and slips propagated crop. FYM (8-10 kg per pit) is added to soil during land preparation. Seeds are sown 10-15 cm apart & 8-30 kg N, 20-25 kg P_2O_5 and 35 kg K_2O per acre are recommended. Micronutrients like Zinc, Boron and Mo are also required (exact dose not mentioned (Sharma, 2005).

Cardamom (Chhoti Ilaichi)

(*Elletaria cardamomum* : Zingiberaceae)

The true cardamom of commerce is called 'queen of spices'. India, Srilanka, Guatemala, Thailand are major producer. The largest area is in India. Kerala, Karnataka and Tamilnadu are major states producing cardamom. The crop is mostly raised under canopy of evergreen forests (warm-humid tropics). The perennial herbaceous plant with erect stem (upto 3 m tall) is native to India, Srilanka, Guatemala and El Salvador. Plants are propagated by seeds and suckers. Well-drained rich loamy soil with plenty of humus is more suitable. FYM 10 kg per pit is added to the soil. Fertilizer dose 150 kg urea, 200 kg super phosphate and 150 kg muriate of potash per hectare is recommended. Micronutrients like Zinc. Boron and Mo have also been experimented (Bhattacharjee, 2004).

Hill Parsley = Ajmood

(*Petroselinum crispum*: Apiaceae)

It is hardy biennial aromatic herb, native to Europe and Mediterranean region and now, extensively grown in America and Mediterranean region. It is a cool weather crop grown in rich moist soil. The crop is grown upto-limited extent in India at (preferably) higher hilly altitudes. Sowing is done in March – May on hills and in August – November in plain (foot hills). No systematic work seems to have been undertaken on fertilizer requirement of the crop.

SOME TIPS FOR PROPAGATION AND NUTRIENT MANAGEMENT

1. Bishop's weed, Ajovain (*Trachyspermum ammi*)

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers Macronutrients	Chemical Fertilizers Micronutrients	Remarks
Sandy loam	FYM 25 t/ha	N 75 kg/ha	SINA*	Nil
		P 20 kg/ha	SINA	Nil
		K 20 kg/ha	SINA	Nil

* Scientific information not available

2. All spice = Pimmento (*Pimenta officinalis*)

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers Macronutrients	Chemical Fertilizers Micronutrients	Remarks
Sandy loam	FYM 05 t/ha	SINA	SINA	Nil
		SINA	SINA	Nil
		SINA	SINA	Nil

3. Aniseed (*Pimpenella anisum*)

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers Macronutrients	Micronutrients	Remarks
Sandy loam	FYM 10 t/ha	N 50 kg/ha	SINA	Nil
		P 25 kg/ha	SINA	Nil
		K kg/ha	SINA	Nil

4. Pomegranate, Anardana (*Punica granatum*)

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers Macronutrients	Micronutrients	Remarks
Well drained	FYM 15 kg/pit	SINA	SINA	Nil
Rich soil		SINA	SINA	Nil
		SINA	SINA	Nil

5. Caraway, Shia Zira (*Carum carvi*)

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers Macronutrients	Micronutrients	Remarks
Cool organically rich hill soil	FYM 10 t/ha	N 60 kg/ha	SINA	Nil
		P 40 kg/ha	SINA	Nil
		K 20 kg/ha	SINA	Nil

6. Celery, Shalari = Karas (*Apium graveolens*)

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers Macronutrients	Micronutrients	Remarks
Rich loamy with moderate soil moisture retain capacity	FYM 25 t/ha	N 150 kg/ha	SINA	Nil
		P 100 kg/ha	SINA	Nil
		K 100 kg/ha	SINA	Nil
		At Ajmer lower doses		

7. Coriander = Dhania (*Coriandrum sativum*)

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers Macronutrients	Micronutrients	Remarks
Sandy loam	FYM 10-25 t/ha	N 60 kg/ha	SINA	Nil
		P 40 kg/ha	SINA	Nil
		K 20 kg/ha	SINA	Nil
		Lower doses are needed in Rajasthan		

8. **Cumin = Zira (*Cuminum cyminum*)**

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers Macronutrients	Chemical Fertilizers Micronutrients	Remarks
Sandy loam with moderate organic matter proper drainage	FYM 10-20 kg/ha	N 30 kg/ha P 20 kg/ha K 20 kg/ha	SINA SINA SINA	Nil Nil Nil

9. **Cumin black = Kalaenji, Kala Zira (*Nigella sativa*)**

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers Macronutrients	Chemical Fertilizers Micronutrients	Remarks
Loamy soil Irrigated crop	FYM Vermi-compost are given but close dose not mentioned	N 60 kg/ha P 20 kg/ha K 15 kg/ha	SINA SINA SINA	Nil Nil Nil

10. **Dill= Dill,Indian Dill European Dill, Sowa (*Anethum sowa*)**

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers Macronutrients	Chemical Fertilizers Micronutrients	Remarks
All light soil without water logging	FYM response not specially known	N 75 kg/ha P 30 kg/ha K 20 kg/ha	SINA SINA SINA	Nil Nil Nil

11. **White mustard = Safed Rai (*Brassica alba*)**

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers Macronutrients	Chemical Fertilizers Micronutrients	Remarks
Sandy loam soils	FYM Vermi-compost Bio-fertilizer (dose not known)	N 40 kg/ha P 20 kg/ha K 20 kg/ha	Zn (dose not known) B (dose not known)	Excess N reduced seed yield

12. **Black mustard = Banarasi rai (*Brassica nigra*)**

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers Macronutrients	Chemical Fertilizers Micronutrients	Remarks
Sandy loam soils	FYM Vermi-compost Bio-fertilizer (dose not known)	N 46 kg/ha P 20 kg/ha K 20 kg/ha	Zn (dose not known) B (dose not known)	Excess N reduced seed yield

13. Indian mustard = Brown mustard, Sarason
(Brassica juncea)

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers Macronutrients	Chemical Fertilizers Micronutrients	Remarks
Sandy loam soils	FYM Vermi-compost Bio-fertilizer (dose not known)	N 40 kg/ha P 20 kg/ha K 20 kg/ha	Zn (dose not known) B (dose not known)	Excess N reduced seed yield

14. Black pepper = Kali Mirch (*Piper nigrum)*

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers Macronutrients	Chemical Fertilizers Micronutrients	Remarks
Well drained rich red, lateritic or alluvial soil	Organic (FYM) Manure 20 t/ha	N 50 kg/ha P 100 kg/ha K 200 kg/ha Ca (dose not given) Mg (dose not given)	Fe, Zn, Mn, Mo, B, Cu (dose are not known)	Excess N reduced seed yield

15. Long pepper = Pipal/ Pipalli
(Piper longum)

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers Macronutrients	Chemical Fertilizers Micronutrients	Remarks
Well drained rich red, lateritic or alluvial soil with high organic matter	FYM 15 t/ha	N dose not clear P dose not clear K dose not clear	SINA SINA SINA	These doses are for Pannijur 1 variety

16. Poppy seeds = Kash Kash, Khus Khus
(Papaver somniferum)

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers Macronutrients	Chemical Fertilizers Micronutrients	Remarks
Well drained rich soil	FYM 15 t/ha	N 90 kg/ha P 50 kg/ha K 40 kg/ha	$ZnSO_4$-15 kg/ha	Nil Nil Nil

17. Fennel = Saunf
(Foeniculum vulgare)

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers		Remarks
		Macronutrients	Micronutrients	
Well drained loamy black or sandy loam soils	FYM 15-20 t/ha	N 90 kg/ha P 60 kg/ha K 30 kg/ha In UP (Aligarh). At Ajmer lower doses	Zn recommended, B recommended, but doses are not mentioned	Nil Nil Nil

18. Fenugreek = Methi dana
(Trigonella foenum gracecum)

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers		Remarks
		Macronutrients	Micronutrients	
Well drained loamy soils	FYM 10 t/ha	N 20 kg/ha P 25 kg/ha K 90 kg/ha (In UP) N 20 kg/ha P 40 kg/ha K (not needed) (In Rajasthan)	Micronutrients need to studied	Vermicompost & Bio-fertilizers beneficial Sheep manure 7.5 t/ha in Ajmer, PGRs are also studied

19. Greater Indian Cardamom = Bara ilaichi
(Amomum subulatum)

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers		Remarks
		Macronutrients	Micronutrients	
Sandy loam soils (well drained)	FYM 8-10 kg/pit	N 28-30 kg/acre P 20-25 kg/acre K 35 kg/acre	Zn beneficial B beneficial Mo beneficial (doses not quoted)	Nil Nil Nil

20. **Cardamom = Chhoti ilaichi (*Elletaria cardamomum*)**

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers Macronutrients	Micronutrients	Remarks
Well drained rich forest soils (loamy)	FYM 10 t/pit	Urea 150 kg/ha Super phosphate 200 kg/ha Muriate of potash 150 kg/ha	Zn, B, Mo (dose not mentioned)	Nil Nil Nil

21. **Hill parsley = Ajmood (*Petroselinum crispum*)**

Preferable Soil Type/Condition	Organic Manuring Requirement	Chemical Fertilizers Macronutrients	Micronutrients	Remarks
Hilly soils,	SINA on FYM	N (No study)	SINA	Nil
well drained,	and other organic	P (No study)	SINA	Nil
High humus	manure	K (No study)	SINA	Nil

NUTRIENT MANAGEMENT IN RELATION TO THERAPEUTIC QUALITY OF SEEDY SPICES

Abiotic stresses like water deficit (soil as well as atmospheric drought), water logging, temperature extreme, light stress etc. have been studied in relation to their effects on productivity of crop plants and upto very limited to quality of plant products. Such studies on medicinally valuable seedy spices are extremely scanty (Sadanandan, 1994, Singh and Tyagi, 2004). Further, the effects of nutrients excess and nutrient deficiency on quality of plant products of medicinal value have been rarely studied. Available traditional knowledge specifically mentions that quality of plant drugs are influenced by environmental factors / stresses (Singh and Tyagi 2004). But experimental investigations are limited to few medicinal plants (Sharma, 2005). Studies with the effects of excess and deficiency of macronutrients and micronutrients on therapeutic quality is still more grim. In this era of globalization and WTO, such information has gained much more importance. Sadanandan *et al* (2001) reviewed the literature on the relationship of potassium management/ nutrient ion with quality of spices. It was emphasized that K is often described as an element of quality. It indirectly improves the utilization of N and P and protein formation, oil content, oleoresin in several spices. Further studies are required.

CONCLUSION

It is evident that effects of FYM, vermicompost, biofertilizers, green manure on productivity and quality are pronounced but quantitative studies need elaboration Some advancements have been made on effects of N, P and K but very little work on other macronutrients and almost all micronutrient has been conducted. Both basic and applied work needs to be taken up.

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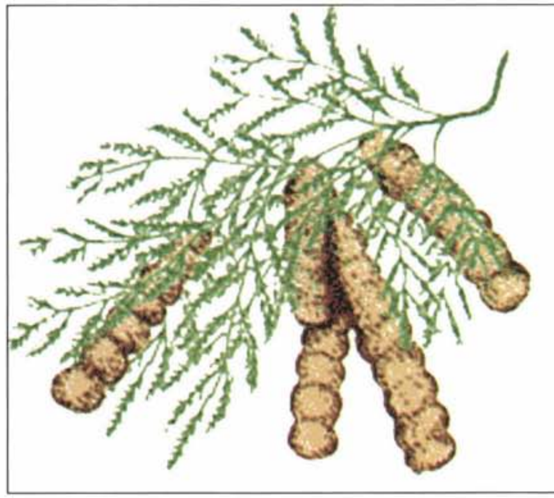
Abutilon indicum



Acacia concinna

Achyranthes aspera

Acorus calamus

Adhatoda vasica

Aegle marmelos

Ailanthus excelsa

Aloe barbadensis

Alpinia galanga

Athaea officinalis

Amaryllis belladonna

Amomum subulatum

Amorphophallus campanulatus

Anethum sowa

Anethum graveolens

Andrographis paniculata

Anona squamosa

Apium graveolens

Bauhinia variegata

Brassica alba

Brassica juncea

Brassica nigra

Carum carvi

Cassia angustifolia

Cassia fistula

Centella asiatica

Chlorophytum borivilianum

Clerodendron indicum

Colocasia esculenta

Cordia myxa

Coriandrum sativum

Cuscuta reflexa

Datura metal

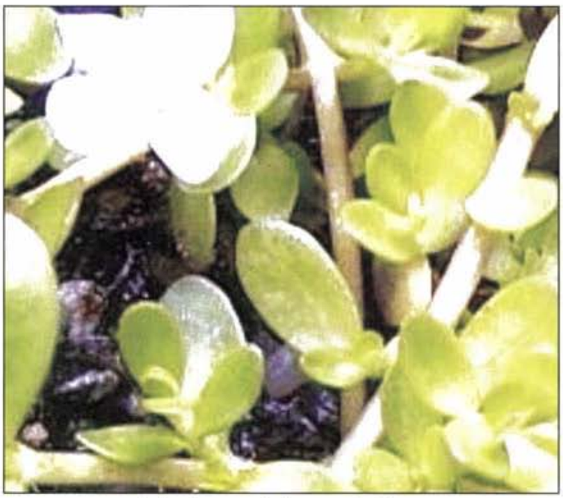
Elletaria cardamomum

Euphorbia hirta

Ficus carica


Ficus religiosa


Glycyrrhiza glabra


Hydrocotyle asiatica


Lantana camara


Mentha piperata


Mimosa pudica

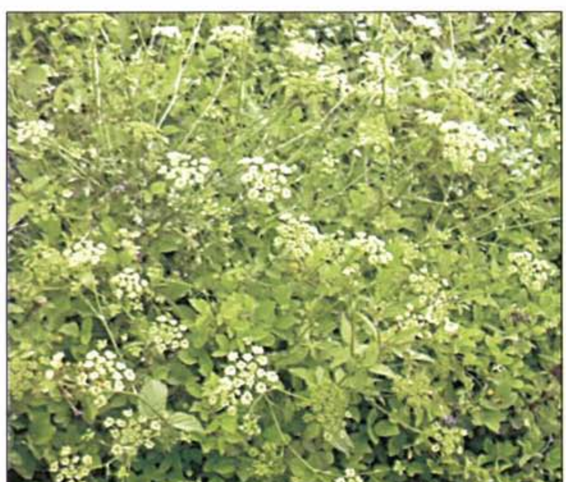
Mucuna pruriens

Myristica fragrans

Nigella sativa

Ocimum basilicum

Papaver somniferum



Petroselinum crispum


Phyllanthus niruri


Pimpenella anisum


Piper longum


Piper nigrum


Palmarosa


Pongamia pinnata

Psyllium seeds

Punica granatum

Putranjiva roxburghii

Rauwolfia serpentina

Sida cordifolia

Simmondsia chinensis

Swertia chirayata

Tephrosia purpurea

Terminalia belerica

Thevetia peruviana

Tribulus terrestris

Trigonella foenum-graecum

Trigonella foenum-graecum seeds

Vetiveria zizanioides

Vitis vinifera

Vitex negundo

Withania somnifera

Zizyphus vulgaris

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