Part III. Mushrooms Worldwide

Chapter 11

Mushrooms for the Tropics

GROWING PADDY STRAW MUSHROOMS

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Historical Overview

Figure 1. Paddy straw mushrooms at different development stages

Paddy straw mushroom (*Volvariella volvacea*) is the most popular mushroom in the rural areas of the Philippines and was commonly known to Filipinos even before the generation of a technology for its artificial cultivation was launched in the country. This mushroom is called kabuteng dayami or kabuteng saging by Filipinos since it naturally grows on paddy straw and decomposing piles of banana leaves and pseudostems.

Commercial mushroom growers, who were at the same time rice farmers used paddy straw and banana leaves. However, due to the intensification of rice production (i.e. from one cropping season to two) as a result of efficient irrigation practices and the availability of high-yielding but short duration rice varieties, most mushroom growers became full time rice growers.

Unlike the commercial production of paddy straw mushroom in neighboring countries such as China, Vietnam, Indonesia, and Thailand, production in the Philippines is still a backyard undertaking. Attempts to upgrade its production were made in the early part of the 1990's with financial assistance from international donors (Tharun, 1993; Ferchak and Croucher, 1993). Still, paddy straw mushroom production has been out paced by the newly introduced Pleurotus mushrooms, despite the abundance of substrates, availability of technology and high market demand. A rough estimate of paddy straw mushroom growers in the Philippines indicates the existence of approximately five hundred growers in the entire country.

A number of agencies scattered throughout the archipelago are actively involved in the promotion of paddy straw mushroom cultivation. The participation of these agencies in the dissemination of information varies from research, training, and extension services to spawn production. State colleges and universities are primarily involved in research, training, and the provision of starter cultures, while government and non-government agencies are active in the spreading of cultural technology, most particularly in the rural areas.

Production of paddy straw mushroom in the Philippines is still a hit and miss practice since growers lack necessary facilities for the maintenance of controlled physical conditions (temperature, light, relative humidity). Though indoor technology had already been introduced, most growers still adopt the traditional method due to its simplicity and low input. Maintenance of environmentally controlled conditions is one of the necessary factors to attain stable and relatively higher production, and would ultimately ensure the regular availability of paddy straw mushroom in the market.

Most of the paddy straw mushroom producers who are small scale growers are not sufficiently trained in business management. These traditional growers posses the technical skills for backyard paddy straw mushroom production which they acquired and developed from the seminars and trainings sponsored by the different agencies involved in the dissemination of the technology. Expansion of their small-scale paddy straw business undertakings is deterred by lack of funds and insufficient business skills. Moreover, unlike their counterparts in developed countries such as Japan, Filipino small-scale mushroom growers do not have a strong cooperative spirit that could assist their marketing and technical needs. Efforts are being made by some rural growers and various academic groups to create a vibrant rural-based mushroom industry. Rural-based mushroom growers have been assembled into groups in order to establish marketing linkages.

In order to increase the scale of production, the fabrication of equipment by local contractors is being encouraged. The local government units and individual entrepreneurs have now started to establish their own rural-based and practical laboratories utilizing this fabricated equipment.

Paddy Straw Mushroom Production Technology

The two production technologies for fruiting body production that are being adopted by the growers include outdoor and indoor techniques.

Outdoor cultivation of paddy straw mushrooms

The traditional outdoor method uses the bed-type approach and utilizes a number of agricultural wastes like dried paddy straw, rice stubbles, water lily, banana leaves, and stalks (Reyes and Abella, 1993). The use of these wastes as mushroom substrates depends on their local availability. The following is a description of the step by step procedure for the preparation of mushroom cultivation beds


Figure 2, 3. Bed-type production of paddy straw mushroom under the mango trees

Site selection and preparation

Growers should choose an area that is free from potential insect pests such as ants, termites and rodents. The selected site should preferably be under trees with a wide canopy. In order to ensure that the selected site is pest free, growers can spread rice hulls onto the area and burn them until they turn into ashes. This physical method of eliminating pests also reduces the occurrence of soil-borne pathogens.

Collection and preparation of bedding materials

The bedding materials collected from the field should be sun dried. Growers should trim and bundle the substrates into bundles twelve inches long with a diameter of two inches. The bundled substrates should be soaked for twelve hours and washed with clean water.

Layering of bundled substrates into bed and spawning

The bundled substrate should be drained of excess water to attain a 65% moisture content. Growers should pile the bundled substrates one after the other into the bed forms. On top of every layer, spawn should be sprinkled thinly over the bundled substrates. An ideal bed size consists of six layers and has a length of three meters.

Figure 4. Spawning

Incubation and fruiting

A plastic sheet should be used to cover the entire mushroom bed. This sheet maintains the appropriate temperature for the mycelial ramification (30-35℃) and fruiting body formation (28-30℃). It usually takes 10-14 days before the first flush of marketable fruiting bodies (button stage) come out from the edge of the mushroom bed.

Figure 5. Covering the mushroom bed of dried banana leaves

Figure 6. Paddy straw mushrooms in the rice straw bed

Harvesting

With bare hands, growers should harvest the button stages of *V. volvacea* by simply pulling the cluster out from the bed.

Indoor cultivation of paddy straw mushrooms

A more improved technology that is now gaining interest among potential growers is the indoor production technology. This method, which utilizes paddy straw as the main substrate, has three salient features: composting, pasteurization, and cultivation inside a mushroom house.

Composting is an important process that allows the microbial decomposers to loosen the tensile strength of paddy straw. This process also prepares the paddy straw to be easily colonized by mycelia of *V. volvacea* (Quimio, 1991). Pasteurization is a critical process that eliminates the undesirable microorganisms that may compete with *V. volvacea* during the production proper. This process also renders the composted paddy straw more easily able to be successfully permeated by the mushroom mycelia. The cultivation of mushrooms inside a growing house allows for the control of the fluctuations of temperature and relative humidity which may be hazardous to the mycelial growth and fruiting body production. In the Philippines, two methods of indoor cultivation have been developed and introduced. The key features of both are similar, but the manner by which spawn is inoculated into the substrates differs. The indoor cultivation of Quimio (1993) is a standard method that is also used abroad, and features the actual spawning on the mushroom beds. The other method promotes the use of wooden shelves or crates which facilitate the easy handling of substrates (Reyes and Abella, 1993). The following section describes the step by step procedures for the indoor cultivation of V. volvacea:

Soaking

Rice straw of any type can be used as substrate for the indoor cultivation of *V. volvacea*. Rice stubbles could also be used. The rice straw should be soaked for 12 hours in clean water. This procedure loosens the substrates as a prelude to composting.

Composting

The previously soaked substrates should be piled up and sprinkled with 1% molasses and 0.5% complete fertilizer. Growers should cover the pile of substrates with plastic sheets and compost the pile for 14 days. On the seventh day, the partially composted substrates should be turned with a spading fork in order to ensure even composting. At this stage, the population of thermophilic decomposers starts to pile up. Growers should now add 1% agricultural lime, replace the plastic sheets and continue the composting process until completing the required fourteen day composting period.

Figure 7. Composting of rice straw

Crating and steaming

Growers should dispense the composted substrates on 12 x 24 x 18 inches wooden crates that are open on all sides. Moisture content of the substrate should be 65% (no drippings of water when squeezed between fingers). Growers should make sure that the substrates are compactly placed inside the wooden crates, and should deliver the crated substrates into the steaming room by piling them one on top of the other. Growers should then start introducing the steam into the mushroom house. Steaming usually lasts from four to six hours, and the temperature should maintained at 60-80℃.

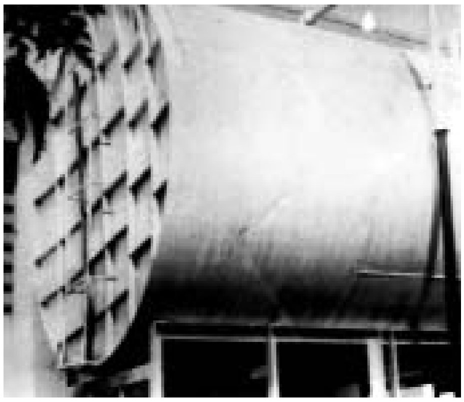

Figure 8. Steaming of rice straw

Spawning

The next morning after steaming the substrates, growers should check the temperature of the steamed substrates. The temperature should be 30℃ in order not to harm the mycelia of *V. volvacea*.

Incubation and fruiting

In order to encourage mycelial proliferation of *V. volvacea*, the mushroom house should be sealed. During this stage, it is very important to maintain the desirable temperature for mycelial ramification (30-35℃) with no ventilation and light. The spread of mycelia takes from seven to ten days after spawning. After this period, growers should check the status of the substrates. Fruiting initials should start to appear. At this point, the temperature should be lowered from 35 to 28℃. This can be done by sprinkling clean water on the floor of the mushroom growing house. Three to five days after the appearance of these fruiting initials, the first harvest of the button stages of *V. volvacea* can be performed.

Figure 9. Mushroom growing house

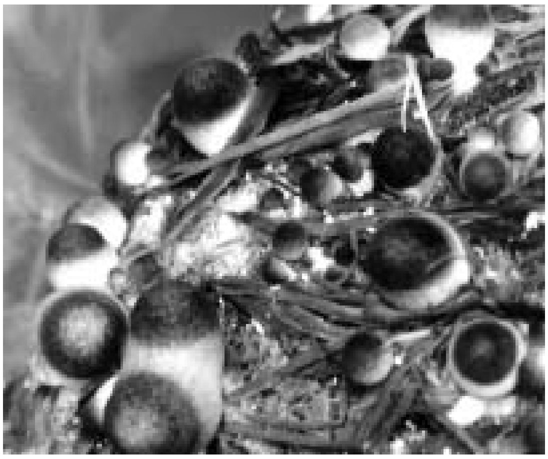

Figure 10. Fruiting bodies

Production of Spawn

A number of locally available substrates are being used as spawning material for paddy straw mushroom. In Northern Luzon for instance, tobacco midrib, a waste product of the cigar industry, is being used by the spawn producer of Pangasinan in Northern Luzon. Tobacco midrib that has been soaked in water for three days and later washed and air dried is mixed with sawdust. The mixed formulation is then placed in empty mayonnaise bottles and sterilized by autoclaving. In Central Luzon, the Center for Tropical Mushroom Research and Development at the Central Luzon State University developed and introduced the use of rice hull, a waste material from rice milling. Rice hull is moistened and mixed with 10% of either corn meal or rice bran and dispensed in heat resistant polypropylene bags and microwaveable plastic trays. In other areas of the country where leaves of leguminous trees like *Gliricidia* and *Leucaena* are abundant, dried leaves of these trees are soaked for three days and later air dried. The leaves are then mixed with sawdust and rice bran at a rate of seven parts leaves, three parts sawdust and one part rice bran. Coffee hulls are also being used in areas where coffee is grown. Moisture content of all the preparations is 65%.

Figure 11. Tobacco midribs in glass bottles

Figure 12. Tobacco midribs in polypropylene bags

Figure 13. Autoclave for large scale preparation of culture media

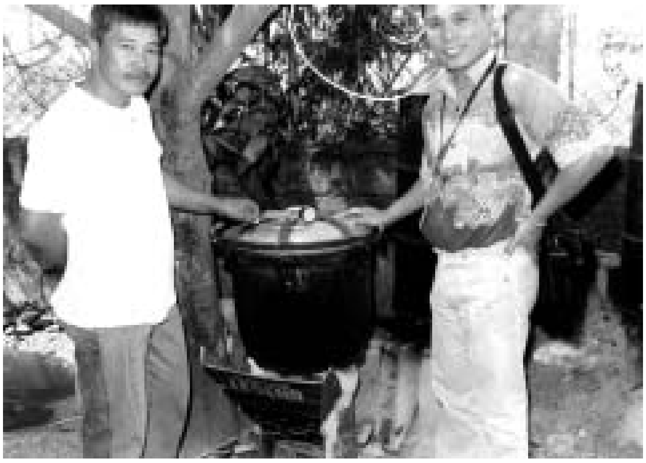

Figure 14. Simple autoclave and Mr. Eduardo Matic, a mushroom grower cum innovator and the author

Feasibility of Paddy Straw Mushroom Production

Economic potential

The supply of fresh paddy straw mushroom in the domestic market is still lacking since this commodity is generally preferred by the Filipino consuming public. Its availability in the market is still erratic which makes it a luxury food. A kilogram of fresh mushroom fruits sells at 150-180 pesos (i.e. USD3-3.5).

Technical and environmental feasibility

The Philippines are a tropical country and have a maximum temperature ranging from 30 to 35℃ and a rainfall ranging from 55 to 225mm (Philippine Statistical Yearbook, 1996). The prevailing temperatures and rainfall in its three major islands of Luzon, Visayas and Mindanao are relatively the same, and this makes the management of environmental conditions favorable for paddy straw mushroom country wide. Mushroom substrates such as paddy straw, water lilies and banana leaves are abundant throughout the year.

Nutriceutical benefits

Though paddy straw mushroom is known primarily for table consumption due to its nutritional content, its use as a functional food has started to be recognized. A number of studies on its immunobiological activities have been reported (Kishida *et al*., 1992; Kishida *et al*., 1989; Misaki *et al*., 1986 and Sone *et al*., 1994). Thus, its additional use as a nutriceutical could be an additional factor in marketing this type of mushroom.

Zero farm wastes technology

Paddy straw mushroom cultivation utilizes large volumes of paddy straw as substrates for fruiting body production. Hence, tons of mushroom spent are also generated which results in the accumulation of wastes in the form of mushroom spent. If improperly disposed, these wastes might pose environmental hazards. Traditionally, the mushroom spent of paddy straw mushroom is burned in order to get rid of contaminants. The spent from paddy straw mushroom production can further be efficiently utilized to harness its full potential for food production. It has shown promising results as potential substrates for *Pleurotus, Auricularia*, *Ganoderma* and *Collybia*, fishpond fertilizer for tilapia (*Oreochromis niloticus*) and feed for broiler chickens (Reyes and Abella, 1997; Abella *et al*., 1996; Divina *et al*., 1996a and b; Reyes and Abella, 1993).

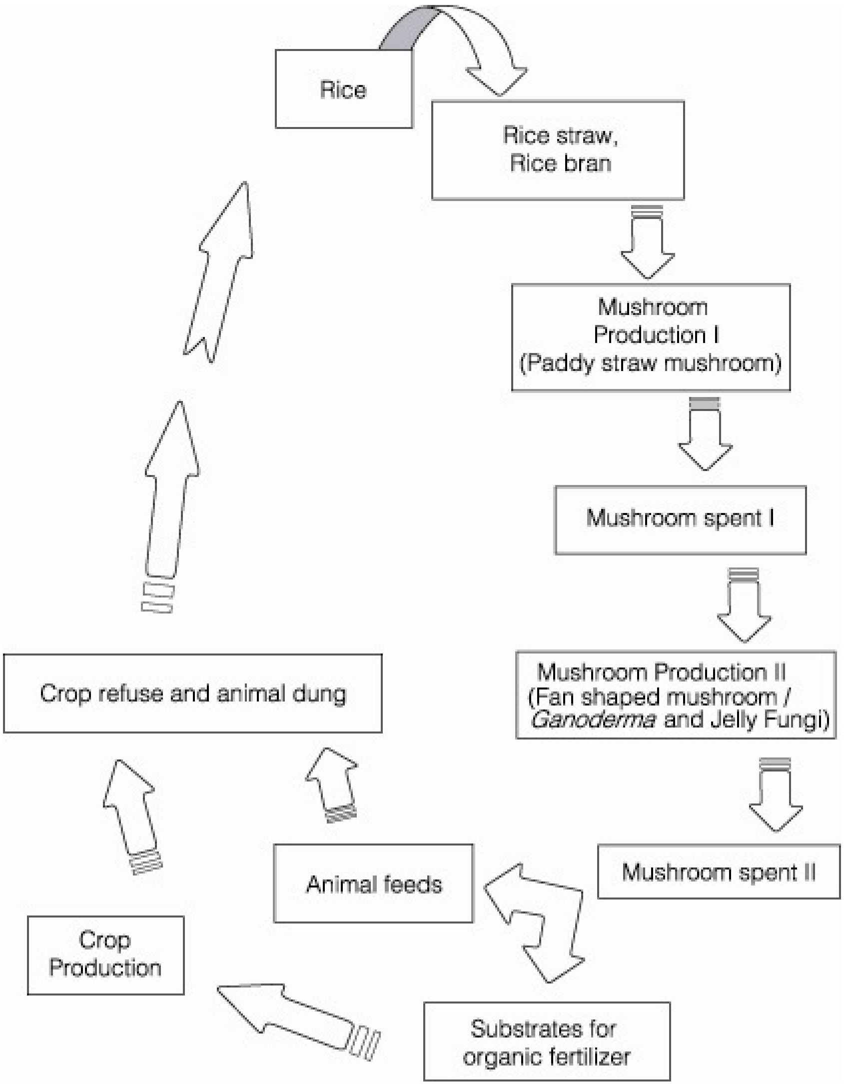

Figure 15. Efficient utilization of agricultural wastes for mushroom, crop and animal production

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