UTILIZATION OF WASTES OF PLANTATION INDUSTRY

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INTRODUCTION

Plantation crops cultivated in an area of nearly four million ha in the country have a unique role in the national economy as they earn the major share of export earnings of all agricultural commodities. The cultivation and processing of plantation crops results in the accumulation of large quantities of wastes which are lignocellulosic in nature. These waste materials accumulate in plantations and nearby processing units often causing disposal and pollution problems. Research work has been undertaken to develop suitable technologies for profitable utilization of wastes from plantation industry such as coffee pulp, tea factory wastes, rubber wood saw dust, coir pith, oilpalm mesocarp waste etc.and by-products from plantations such as coconut leaves, bunch wastes of arecanut and coconut, arecanut leaf sheath, oilpalm bunch refuse and cocoa pods. Mushroom cultivation is an economically feasible and ecofriendly process for bioconversion of these wastes into high quality protein food. These organic wastes can also be converted to good quality organic manure by composting methods and by vermicomposting.

MUSHROOMS

Mushrooms have been devoured by the mankind for its flavour and texture. Scientific investigations led to the recognition of their nutritional and medicinal attributes. In India, the cultivation of mushrooms is limited to three species viz., white button mushroom (*Agaricus bisporus*), paddy straw mushroom (*Volvariella volvacea*) and oyster mushroom (*Pleurotus* spp.). Oyster mushrooms are the ideal ones for the plantation sector due to its ability to utilize lignin rich plantation wastes and the climatic conditions prevailing in plantations is also ideal for its growth.

Oyster mushrooms:

Oyster mushrooms, known as wood fungi or Dhingri in North India are endowed with ligninolytic and cellulolytic properties to utilize a wide range of agricultural residues as substrates for growth and fruit body production. Paddy straw is the most widely used substrate for its cultivation. But its increasing cost and decreasing availability are factors which prompted research workers to look for alternate substrates for oyster mushroom cultivation. Conditions have been standardized for cultivation of oyster mushrooms using wastes of plantation industry such as rubber wood saw dust, mesocarp waste of oilpalm, coffee pulp, tea factory waste, arecanut leaf sheath and bunch waste, coconut leaf stalk and bunch waste, fermented coirpith etc.. The steps in OM mushroom cultivation include development of spawn, substrate preparation, spawning, incubation for spawn running and opening and maintenance of beds for cropping.

Spawn:

Spawn, the vegetative seed of the fungus, can be obtained either from research institutions or can be prepared with adequate training. An efficient and stable strain of *Pleurotus* isolated from sporocarps should be

used for spawn preparation using grains such as wheat, sorghum, maize, jowar or paddy straw as substrates.

Substrate preparation:

Pasteurization of substrates is necessary to avoid contamination and to obtain higher yield. Steam sterilization, hot water treatment and chemical sterilization are the effective methods. Steam sterilization at 1.02 kg/cm^2 pressure in an autoclave for one hour is an efficient method of sterilization. Hot water dip of the substrate at 80°C for 60-120 minutes is another method which can be easily adopted. Chemical sterilization method involves treatment with formalin (500 ppm) and bavistin (75 ppm) in substrate soaking water for 18 hours.

Spawning:

Polythene bag method is the commonly followed method of cultivation. Polythene bags (150-200 gauge) of 60 x 45 cm size are puncted to facilitate cross ventillation. Spawning is done by multilayered technique using 3% spawn.

Spawn running and cropping:

The filled up bags are incubated in cool dark place for spawn run. In 15 to 20 days white threadlike mycelium covers the entire substrate and the whole mass turns into a solid cylindrical structure. At this stage the polythene bags are ripped open and incubated for cropping by hanging or by stacking on the shelves of mushroom house with watering daily twice after two days of opening of beds.

Low cost mushroom house:

Low cost mushroom sheds can be built with coconut/areca stem and pleated coconut inside areca, oilpalm or coconut gardens or rubber plantations in between two rows of trees. Multilayer rack can be prepared with coconut/areca stem inside the shed to keep the spawned substrate for spawn running and cropping. Ventillators with insect proof nets are to be provided on all sides of the shed.

COCONUT WASTES

Coconut bunch waste, leaf stalk, mixtures of leafstalk + coir pith (1:1) and coir pith + bunch waste (1:1) are found to be suitable substrates (Thomas et al., 1997). Supplementation with 5% rice bran helps in the initial spread of mycelium. Mushroom yield of 531 and 453.8 g can be obtained from three kg. wet substrate of leaf stalk and bunch waste in an extended cropping period of 72.6 and 59.3 days, respectively (Table 1). Spraying the beds with a solution of 1% urea and 1% superphosphate helps to reduce interval between flushes.

Table 1. Mushroom production on different by-products of coconut

Substrate	Mushroom Yield g bed^{-1} (%)	Biol. Efficiency (days)	Cropping period
Leafstalk	531.0	53.0	72.6
Bunch waste	443.6	48.3	59.3
Coir pith + leaf stalk	356.0	60.3	75.0
Coir pith + bunch waste	326.0	43.0	53.4

ARECANUT WASTES

Arecanut bunch waste and leafstalk are pasteurized by soaking in a solution of 500 ppm formalin + 25 ppm bavistin (Chandramohan and Murthy, 1991). BE of mushroom production is 69% and 49.8% in a cropping period of 47 to 52 days in arecanut bunch waste and leaf sheath, respectively.

OILPALM WASTES

Mesocarp waste of oilpalm is found to be an ideal substrate for OM production. The availability of mesocarp waste is about 3 tonnes per ha in oilpalm plantations under irrigated condition. BE of 58.4% and 55.7 % are obtained with *P. florida* and *P. sajor caju*, respectively when mesocarp waste is used without pasteurization.

Other species such as *P. flabellatus* and *P. citrinopileatus* also gave better yield.

Table 2. Mushroom yield of *Pleurotus* spp. On oilpalm mesocarp waste

Mushroom	Weeks	Mushrom yield g bed $^{-1}$	BE (%)
P. pulmonarius	1-4	493.0	74.3
	5-9	181.0	25.7
P. ostreatus	1-4	275.8	41.4
	5-9	292.1	58.6
P. flabellatus	1-4	721.9	80.7
	5-9	123.1	19.3
P. citrinopileatus	1-4	817.0	72.0
	5-9	177.5	28.0
P. Sajor caju	1-4	8-00	75.8
	5-9	313.0	24.2
P. florida	1-4	851.7	86.3
	5-9	85.3	13.7

RUBBER WOOD SAW DUST

In a comparative study, rubber wood saw dust is found to be superior to paddy straw in yielding higher quantities of mushrooms. Higher BE of 88.8 % is obtained in rubber wood saw dust when cultivated in plastic containers with 5% spawn of *P. florida* by thorough spawning method.

COFFEE WASTE

Coffee pulp when mixed with 25,50 and 75% of paddy straw gave significantly higher yields as compared to pure straw. Maximum BE of 95 % is reported in a combination of 75% coffee pulp and 25% paddy straw.

TEA WASTE

When tea waste is mixed with paddy straw at different ratios of 25, 50 and 75%, there is decrease in yield with increase in the ratio of tea waste. Spraying with tea waste

extract at various concentrations significantly increased the yield of mushroom.

PADDY STRAW MUSHROOM ON OILPALM BUNCH REFUSE

The availability of bunch refuse from a hectare of oilpalm under irrigated condition is seven tonnes. For bulk utilization of bunch refuse, paddy straw mushroom (*Volvariella volvacea*) cultivation can be taken up in regions where the temperature ranges from 25 to 35°C. Its cultivation can be easily done in thatched sheds, varandas or corridors and under shade of trees. At a BE of 3%, about 30 kg of paddy straw mushroom can be produced from one tonne of bunch refuse (Kochu Babu, 1992).

COMPOSTING OF COIR PITH

The process of coir manufacturing from coconut husk results in the accumulation of coir pith as a waste material near coir processing units. Application of fresh coir pith as a manure to the crops is not advisable due to its higher C:N ratio of 112:1. Nagarajan et al. (1987) reported a process to convert coir pith to compost using the mushroom fungus, *Pleurotus sajor caju*. To compost one tonne of raw coir pith 5 kg of urea and five *Pleurotus* spawn bottles are required. By this process, coir pith compost with a C:N ratio of 24:1 is formed within a period of 35 days. Coir pith compost with low C:N ratio has been prepared by chemical method at CPCRI, Kasaragod.

Vermiculture:

Vermiculture technology involves the use of earthworms as versatile bioreactor for effective recycling of non-toxic organic wastes to produce manure of high quality for sustainable agriculture. The byproducts from coconut plantations are converted to vermicompost with a nutrient content of 1.8% nitrogen, 0.2% phosphorus and 0.2% potassium using a locally isolated earthworm species at CPCRI, Kasaragod. Vermicomposting of cocoa leaves, cocoa pod husk and areca leaves are done with the earthworm species *Eudrilus euginae*.

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