

Prospects of cultivation of oyster mushroom in eastern Uttar Pradesh, India

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As compared to other parts of India, eastern Uttar Pradesh lags behind in the production of oyster mushroom although there are bright prospects in this region because of suitable climatic conditions, availability of cheap raw materials and manpower in abundance. It is expected that the net profit in the cultivation of this mushroom on small scale shall be Rs. 4000/- per month. Moreover, the improved cultivation practices of mushroom in rural areas may accelerate the developmental programmes started by the Government of India in the five year plans. Besides, this vocation may help in uplifting the dietary and economic status of the poor people.

Key words : Oyster mushroom, cultivation, prospects

INTRODUCTION

It is now well established fact that mushrooms are one of the important sources of quality protein, vitamins and minerals. Mushrooms as a source of protein, can solve the problems of malnutrition and energy crisis upto certain level, particularly in developing countries like India, which has a mounting pressure of continuously expanding population.

Oyster mushroom is one of the best species among all the cultivated mushrooms. The name oyster mushroom is applied to *Pleurotus* spp. It is also commonly known as 'Dhingary'. It is a lignocellulolytic fleshy fungus which grows in nature in temperate and tropical forests preferably on wood or some times on decaying organic matters as saprophyte. Total 39 species of *Pleurotus* have been reported from all over the world (Singer, 1975) out of which 12 species are recorded from India (Manjula, 1983). Many of them have been cultured artificially on various lignocellulosic waste materials (Zadrazil and Kurtzman, 1982).

The oyster mushroom ranks second (24.2%) among cultivated mushrooms following *Agaricus bisporus* (37.8%) in the total world production (Chang and Miles, 1991). At present, 12 species of *Pleurotus* are being cultivated commercially on various lignocellulosic waste materials in different parts of the world (Jong and Birmingham, 1993). The leading countries producing these mushrooms are China, Korea, Japan, Taiwan, Italy, France, Thailand, Philippines and India. However, correct data on production of these mushrooms in India are not available. It is estimated that annual production may exceed 10 tonnes (Shanmugam, 1995).

Substrate for cultivation

The species of *Pleurotus*, commonly said as primary rot fungi are able to colonize different agricultural wastes as substrates. They are thus cultivated on cereal straws, sawdust, wood blocks, bagasse, coffee pulp, tea leaves and other lignocellulosic materials (Zadrazil and Kurtzman, 1982).

The choice and exploitation of substrates vary with species, strain and the technology of cultivation employed (Zadrazil, 1980).

For higher yield, different protein rich supplements like soyabean meal, cotton meal, wheat bran, alfa-alfa grass fodder, rice bran, chicken manure are added to the substrates (Zadrazil, 1980; Roysse and Bahler, 1988; Ertan, 1988).

Substrate pretreatment

To eliminate undesirable and harmful microbes from the substrate, sterilization, pasteurization, hot water treatment, aerobic and anaerobic fermentation of the substrate and chemical sterilization are the commercially exploited pretreatments before inoculation.

Environmental factors

Temperature and humidity are two cardinal factors which influence growth and yield of cultivated mushrooms. The species of *Pleurotus* have capacity to grow under wide range of temperature conditions i.e. 10-30°C (Zadrazil, 1976; Balas and Szabo, 1979; Sohi and Upadhyay, 1989). The moisture content of various substrates used for cultivation of *Pleurotus* varies and majority of *Pleurotus* species grow fairly well on various substrates at different water contents (65-90%), the optimum, however, being 70% (Zadrazil and Brunert, 1981). At higher moisture content increased aerial mycelial growth is observed (Zadrazil and Kurtzman, 1984).

Contrary to other cultivated mushrooms, light is necessary for initiation of primordia in *Pleurotus* (Eger *et al.*, 1974; Chang and Miles, 1989). It has also been shown that *Pleurotus* does not produce fruit bodies in complete darkness (Calleux *et al.*, 1973; Mehta and Jandaik, 1989). The tolerance of *Pleurotus* mycelium for carbon dioxide is rather strong, and it can grow luxuriantly at 15-22% concentration of CO₂. However, the growth rapidly decreases above 30% and ventilation is required (Zadrazil, 1975; Chang and Miles, 1989). The capacity of *Pleurotus* mycelia to grow under semi-anaerobic condition (Ginterova, 1973) may serve as a shield against other competing organisms under low oxygen and high carbon dioxide conditions.

Proximate compositions of fruit body

Proximate analysis of *Pleurotus* spp. shows that they are constituted of carbohydrate (57-60%), protein (18-24%) containing all the essential amino acids, crude fibre (9-11%), vitamins (thiamin 1.16-4.8 mg, niacine 46-108 mg ascorbic acid 90-144 mg per 100g) and minerals (potassium 3260-4660 mg, phosphorus 760-1850 mg, magnesium 192-300 mg per 100 g mushroom) on dry weight basis. Calcium and iron are present in low concentrations in all the species of *Pleurotus* as compared to other minerals (FAO, 1972; Crisan and Sands, 1978; Bano and Rajarathnam, 1981).

Prospects of cultivation in eastern Uttar Pradesh

As regard to other states like Jammu and Kashmir, Himachal Pradesh, Punjab, Tamilnadu, Kerala and West Bengal, the eastern U.P. lags behind in production of mushrooms. The main reasons for the restricted cultivation in this area are lack of extensive knowledge of cultivation technology, non availability of quality spawn and the unawareness of the people about mushroom as such and its nutritive values (Singh, 1995). However, the basic requirements such as climatic conditions, substrates availability and manpower for production of oyster mushroom are plenty in this region. Therefore, in order to fulfil protein requirements of people the production of the mushrooms seems logical. The statistics of various factors prevailing in eastern Uttar Pradesh are as follows.

Climatic conditions

The eastern Uttar Pradesh has a vast area (85844 Square Km.) comprising 21 districts. The region lies between 23°45'N to 28°30'N latitude and 80°45'E to 84°30'E Longitude in the northern sub continental interior of the sub tropical climatic belt. The climate of the region is typically monsoonal with moderate annual rainfall (about 100 cms). The mean maximum temperature reaches about 38°C during April and exceeds in May. January is the coldest month with average temperature of 25°C. Eastern Uttar Pradesh has a vast agricultural livestock and population (>50 millions, 1991 census) resources. Million tonnes of agrowastes are produced annually. Such climatic condition with which eastern U.P. is endowed is an important aspect to the fact that the cultivation of oyster mushroom has a bright prospects.

Substrates availability

The chief raw material for cultivation of oyster mushroom is invariably cereal straw (paddy and wheat) which is available in abundance at the farmers doorstep. Presently, this vast resource of raw material is not being utilized scientifically at desired level and therefore, causes environmental pollution. Recycling of these organic residues as well as other wastes of agro-industrial origin through mushroom culture would provide not only ample proteinaceous food but also enough organic fertilizer in the form of spent materials. Besides, the load of accumulated organic debris in an environment could also be minimized. The quantity of straw produced from some principal crops in Uttat pradesh is given in Table 1.

Table 1. Estimated quantity of straw produced from some principal crops in Uttar Pradesh

Crop	Yield*(grain) (x 1000 M.T.)	Estimated straw production (x 1000 M. T.)
Wheat	18,356	27,534
Paddy	10,256	15,384
Sugarcance	1,03,562	1,35,800
Maize	1,700	2,100
	Total	1,80,818

* Source : Statistical Analysis, Directorate of Agriculture, U.P., 1991

Choice of species of *Pleurotus*

A number of species of *Pleurotus* have been brought under cultivation and they can be cultivated under wide range of temperature conditions. Some species require 20-30°C and are called high temperature species or summer species such as *P. flabellatus*, *P. sajor-caju*, *P. sapidus* and *P. membranaceous*. The other species which require 14-20°C for their growth viz., *P. florida*, *P. ostreatus*, *P. eryngii* and *P. fossulatus* can be grouped into category of low temperature species or winter species (Table 2). The suitable species cab be selected on the basis of its temperature requirement for cultivation.

The yield is expressed in terms of biological efficiency, being per cent weight of mushroom on dry weight of substrate. The biological efficiency varies from 30-90% according to species/strain and substrate being used under optimum temperature and moisture conditions. The biological efficiency is also affected by shape of the bed (Eswarmurthy *et al.*, 1983) and the quantity of substrate used per bed (Singh, 1995). However, on the basis of study made by Singh (1995), the species of *P. flabellatus* and *P. sajor-caju* for summer and rainy seasons cultivation and *P. florida* and *P. ostreatus* for winter season cultivation are recommended for eastern Uttar Pradesh.

Table 2. Temperature requirements of various species of *Pleurotus* and their approximate yield performance

Species	Optimum temperature for spawn run(°C)	Optimum temperature for fruiting run(°C)	No. of days required for spawn run	No. of days required for fruiting	Biological efficiency (%)	References
Summer cultivated species						
<i>P. flabellatus</i>	25-30	26±2	12-14	18-22	60-90	Bano, 1967
<i>P. sajor-caju</i>	25-30	24±2	12-14	18-25	50-70	Jandaik and Kapoor, 1976
<i>P. sapidus</i>	25-30	24±2	16-18	22-25	40-75	Mehta, 1985
<i>P. membranaceus</i>	25-30	27±2	7-9	8-12	40-70	Sarwal <i>et al.</i> , 1982
<i>P. eous</i>	25-30	25±2	20-22	25-30	30-50	Gupta <i>et al.</i> , 1981
Winter cultivated species						
<i>P. ostreatus</i>	22-25	20±2	20-25	25-30	50-70	Trandaf <i>et al.</i> , 1981
<i>P. florida</i>	22-25	20±2	16-18	25-30	50-90	Zadrazil, 1976
<i>P. cornucopiae</i>	22-25	20±2	16-18	25-30	40-70	Delmas and Mamoun, 1983
<i>P. fossulatus</i>	18-22	18±2	50-55	65-70	30-40	Puri <i>et al.</i> , 1981
<i>P. eryngii</i>	18-22	16±2	55-60	70-75	25-30	Calleux and Diop, 1976

Economics of cultivation and recommendations

The economics of cultivation of oyster mushroom on small scale was worked out in Varanasi under east U.P. conditions (Singh, 1995). The cost of producing fresh oyster mushroom was calculated Rs. 14 per Kg with a net estimated profit of Rs. 11 per Kg. (Table 3). The economics of cultivation resembles, more or less, with other states of the country. Bhattacharya and Samajpati (1992) have stated the benefit of cultivation of oyster mushroom and its role in rural development while Savitri *et al.*, (1993) have reported that cultivation of oyster mushroom is an income generating activity for landless women.

Table 3. Economics of cultivation of *Pleurotus* spp. on small scale in Varanasi

A. Recurring expenditure of item	Amount (Rs.)
10 quintals wheat straw	1000
50% cost of 1500 polythene bags	500
Cost of 200 spawn bottles	2000
Cost of labour	3000
Rent of cropping room	1000
Miscellaneous expenses (For electricity, water, pesticides)	2000
	9,500
B. Depreciation and interest on "A"	1000
Total expenditure	10,500
C. Yield and Profit	
Expected yield under optimum conditions	750 Kg (fresh wt.)
Income from sale @ 25/Kg	18,750
Cost of cultivation per Kg mushroom	14
Net profit in two months	8250
Profit per Kg mushroom	11

A mushroom grower should have sufficient knowledge of technology and economics of cultivation. There is always a minimum size of a unit to be viable, a smaller unit than that may not be profitable. However, depending upon the man power and infrastructures available and availability of raw materials, one can have a small or large unit. Availability of ready market is also very important aspect in determining the size of mushroom farm.

CONCLUSION

The cultivation of oyster mushroom in eastern part of Uttar Pradesh has bright prospects, inspite of some usual problems prevailing in this region (Singh, 1995). The mushroom cultivation is a labour oriented vocation and it can be done with a minimum of energy demand in a little space. It can provide opportunities for self employment to unemployed educated youths and landless workers (men and women both) besides fulfilling their protein requirement. The oyster mushroom has more potential in this region compared to other mushrooms because of the low-cost technology, direct use of different agro-wastes and appropriate climate for its cultivation. An easy availability of cereal straws substantially establishes that by improving and increasing cultivation of oyster mushrooms in rural areas, the rural development could possibly be promoted.

ACKNOWLEDGEMENTS

The authors are thankful to the Head, Department of Botany for laboratory facilities. ANS is thankful to the University Grants Commission, New Delhi for financial assistance in the form of Senior Research Fellowship.

REFERENCES

- Balazs, S. and Szabo, I. (1979). Temperature requirement studies on some new mushroom species in culture. *Mushroom Sci.* **10**(2), 421-427.
- Bano, Z. (1967). Studies on mushrooms with particular reference to cultivation and submerged propagation of *Pleurotus flabellatus*. Ph.D. Thesis, University of Mysore, India.
- Bano, Z. and Rajarathnam, S. (1981). *Pleurotus* mushroom as a nutritious food. In the *Tropical Mushroom Biological Nature and Cultivation Methods*, ed. S.T. Chang and T. H. Quimio, 363-380.
- Bhattacharya, M. K. and Samajpati, N. (1992). Economics of *Pleurotus sajor-caju* cultivation and rural development of West Bengal. *J. Mycopathol. Res.* **39**(1), 43-49.
- Calleux, R., Diop, A. and Macaya, L. A. (1973). Quelques varietion dur *Pleurotus ostreatus* (Jacq. ex. Fr.) Quelet precises par al culture. Completes rendus de l'Academic DAgriculture de France, Paris, **59**, 971-976.
- Calleux, R., and Diop, A. (1976). Researches Experimentals sur les condition d, ambience requises pour al fructification due *Pleurotus eryngii* et de l'Agrocycbe aegerita. *Mushroom Sci.* **9**(1), 607-619.
- Chang, S.T. and Miles, P.G. (1989). *Edible Mushrooms and their cultivation*. Boca, Raton CRC press, 345 pp.
- Chang, S.T. and Miles, P.G. (1991). Recent trend in world production of cultivated edible mushrooms. *Mush. Journal* **504**, 15-18.
- Crisan, E.V. and Sands, A. (1978). Nutritional value of edible mushrooms. In the *Biology and cultivation of Edible Mushrooms*, ed. S.T. Chang and W.A. Hayes, Academic press, New York, 137-168.
- Delmas, J. and Mamoun, M. (1983). *Pleurotus cornucopiae* a mushroom which can now be grown in France. *Revue horticole.* **240**, 39-46.
- Eger, G., Gottwald, H.D. and Von Netzer, U. (1974). The action of light and other factors on sporophores initiation in *P. ostrestus*. *Mushroom Sci.* **9**, 575-583.
- Ertan, O.O. (1988). Effect of some supplementary substrates on yield of *Pleurotus ostreatus* (Jacq. ex. Fr.) Kummer. *Doga Trunk. Botanik Dergise.* **12**, 234-238.
- Eswarmurthy, S., Ramraj, B. and Shanmugam, N. (1983). Studies on some factors influencing yield of oysters mushroom at Coimbatore. *Indian Mush. Sci.* **11**, 72-74.
- Food and Agriculture Organization (FAO) (1972). Food Composition Table for use in East Asia, part I Food Policy and Nutrition, Dry Food Agric. Organ, U.N., Rome.

- Gintérova, A. (1973). Dedikaryotization of higher fungi in submerged culture, *Folia Microbiol.* **18**, 277-280.
- Gupta, S., Mishra, P.S., Pathak, N.C. and Singh, M.S. (1982). Cultivation and nutritive value of pink mushroom (*Pleurotus eous*). *Fitoterapia* **53**(3), 57-61.
- Jong, S.C. and Birmingham, J.M. (1993). Edible mushroom in Biotechnology. American Type Culture Collection, Rockville, Maryland 20852 USA.
- Manjula, B. (1983). A revised list of the Agaricoid and Boletoid Basidiomycetes from India and Nepal. *Proc. Indian Acad. Sci. (Plant Sci.)*, **92**, 81-213.
- Mehta, K.B. (1985). Studies on physiology and cultivation of *Pleurotus sapidus* (Schulzer Kalch). Ph.D. Thesis, Himachal Pradesh Krishi Vishwa Vidyalaya, India.
- Mehta, K.B. and Jandaik, C.L. (1989). Cultivation of *Pleurotus Fr. sapidus* (Schulzer) Kalchbr. in India. *Mushroom Sci.* **12**(2), 179-186.
- Puri, Y.N., Rehill, P.S. and Singh, B. (1981). Cultivation trials of *Pleurotus fossulatus*. *Mushroom Journal* **102**, 211-214.
- Royse, D.J. and Bahler, B.D. (1988). The effect of alfa-alfa hay and delayed release nutrients on biological efficiency of *Pleurotus sajor-caju*. *Mushroom. J. Tropics*. **8**, 59-65.
- Sarwal, B. M., Jasmeet, K.S. and Singh, R. (1982). Comparative physiological account of two wood-rot fungi. *Bio-vigyanam* **8**(2), 141-143.
- Savitri, A., Soundararadjane, S. and Shanta Kumar, Hopper, R.S. (1993). Mushroom production-an income generating activity for land less women. *Mushroom Res.* **2**(2), 91-94.
- Shanmugam, N. (1995). Biology and cultivation of *Pleurotus* spp. in India. In the *Beneficial fungi and their utilization*, 2nd ed M.C. Nair and S. Balkrishnan, Scientific Publisher, Jodhpur.
- Singer, R. (1975). The Agaricales in modern taxonomy, J. Cramer Vaduz.
- Singh, A. N. (1995). Problems and prospects of Cultivation of Edible Mushrooms in eastern Uttar Pradesh. Ph.D. Thesis, Banaras Hindu University, Varanasi, India.
- Sohi, H.S. and Upadhyay, R.C. (1989). Effect of temperature on mycelial growth of *Pleurotus* sp. and their yield performance on selected substrates. *Mushroom Sci.* **12**, 49-54.
- Trandaf, F., Partenie, S., Bengulescu, I., Harasim, I and Trandaf, V. (1974). Intensive culture of the mushroom of the genus *Pleurotus* *Productia Vegetatra* **23**(12), 3-6.
- Vijay, B. and Sohi, H.S. (1987). *Mushroom J. Tropics* **7**, 67-75.
- Zadrazil, F. (1975). Influence of carbon dioxide concentration on the mycelial growth of three *Pleurotus* species. *Europ. J. Appl. Microbiol.* **1**, 237-335.
- Zadrazil, F. (1976). The ecology and industrial production of *P. ostreatus*, *P. florida*, *P. comucopiae* and *Peryngii*. *Mushroom Sci.* **9**, 621-652.
- Zadrazil, F. (1980). Conversion of different plant wastes into feed by basidiomycetes *Europ. J. Appl. Microbiol. Biotechnol.* **9**, 243-248.
- Zadrazil, F. and Brunnert, H. (1981) Investigation on physical parameters important for solid state fermentation of straw by white rot fungi. *Europ. J. Appl. Microbiol. Biotechnol.* **11**, 183-188.
- Zadrazil, F. and Kurtzman, R. H. Jr. (1982). The Biology of *Pleurotus* cultivation in the tropics. In *Tropical Mushroom, Biological Nature and Cultivation methods*, ed. S.T. Chang and T. H. Quimio, 277-298. The Chinese University Press, Hong Kong.
- Zadrazil, F. and Kurtzman, R. H. (1984). The biology of *Pleurotus* cultivation in the tropics. in *Tropical Mushrooms, Biological nature and Cultivation Methods*, ed. S.T. Chang, T. H. Quimio, 277-298, Hong Kong, Chinese University Press, 493 pp.

(Accepted for publication 11 December 1996)