



SOUVENIR

MUSHROOMS



**NATIONAL CENTRE FOR MUSHROOM
RESEARCH & TRAINING
SOLAN**

23rd September, 1986

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SOUVENIR – MUSHROOMS

released on 23rd September, 1986



***NATIONAL CENTRE FOR MUSHROOM
RESEARCH & TRAINING
CHAMBAGHAT, SOLAN-173 213 (INDIA)***

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NATIONAL CENTRE FOR MUSHROOM RESEARCH AND TRAINING — AN OVERVIEW

'What a lot of these funguses there are about here !' remarked brother Tom presently. 'I can't see what use they are in the world.'... 'I dessay they're sent for some wise purpose', said Mr. Coombes.

— H.G. Wells, *The Purple Pileus*, 1897

H.S. Sohi

Officer on Special Duty
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The Indian Council of Agricultural Research (ICAR) sanctioned the creation of National Centre for Mushroom Research and Training (NCMRT) during VI Plan on October 23, 1982 with the objectives of conducting research on problems of mushroom production, preservation and utilization and to impart training to scientists, teachers, extension workers and interested growers. It has also sanctioned an All India Co-ordinated Mushroom Improvement Project (AICMIP) at six centres in five states for multilocal testing of available technology. The Centre started functioning with effect from June 8, 1983. As per the Memorandum of Understanding signed between I.C.A.R. and H.P. Krishi Vishva Vidyalaya, Palampur, all buildings and adjoining land terraces at Chambaghat were to be transferred to the Centre by the University. Some buildings including spawn laboratory, cropping rooms and

mushroom house have not yet been transferred. The Director of the National Centre is also the Project Co-ordinator of AICMIP. The Centre functioned under the administrative control of the Director, Central Potato Research Institute, Shimla upto March, 31, 1986. The post of Director is still lying vacant. The work of the Centre is being supervised by Dr. H.S. Sohi, F.N.A., Officer on Special Duty as Scientist Incharge w.e.f July 19, 1984. The Centre had a sanctioned strength of nine scientists, eight administrative, two technical, seven supporting and one auxiliary staff during VI Plan. Fourteen more posts have been added during VII Plan.

OBJECTIVES

As mushroom growers face number of production and post harvest technology problems resulting in low economic returns, the main focus of research is devoted to develop new

technology for higher productivity based on recycling of agricultural waste materials. The priorities and new areas of thrust of research in VII Plan are as follow :

- (i) To undertake surveys, collect, identify and catalogue mushroom flora for building up a depository of germplasm.
- (ii) To identify various edible mushrooms for exploiting their cultivation.
- (iii) To select and evolve strains for tropic and sub tropics besides identify and exploit sources of resistance against pest and diseases.
- (iv) To develop cheaper compost based on locally available substrates for commercial cultivation of various edible fungi.
- (v) To study the ecological behaviour of growth of wild flora under natural conditions and explore the possibility of their planned cultivation.
- (vi) To investigate regional adaptability of strains and production technology.
- (vii) To evolve technology where different mushroom types can be grown in rotation throughout the year.

(viii) To undertake basic studies on growth and storage of mushrooms to achieve improved yield and better shelf life.

(ix) To study and develop methods of mushroom preservation.

(x) To train scientists, extension workers and growers in mushroom cultivation.

ACHIEVEMENTS

In order to meet the above objectives, necessary laboratory facilities have been created. Ten research projects have been undertaken in the disciplines of Mycology and Plant Pathology, Genetics, Physiology, Biochemistry and Nematology. The research work at this Centre is devoted to :

- (i) Survey and germplasm collection.
- (ii) Studies on breeding, compost, casing, diseases, nematodes, growth & morphogenesis and post harvest storage of *Agaricus bisporus*.
- (iii) Studies on substrates, cultivation, genetics, diseases, chemical sterilization of substrate, biochemical changes and post harvest storage of *Pleurotus* species.
- (iv) Exploitation of other edible fungi — *Auricularia* spp. and *Morchella* spp.

The salient research findings in various fields are given :

SURVEY & GERMPLASM

For collection and identification of fleshy fungi, hilly areas of Himachal Pradesh and Jammu & Kashmir were surveyed from time to time especially during rainy season in last two years. The large number of specimens collected include agarics, boletes, polypores, puffballs, earth-stars, tooth fungi, jelly fungi, morels etc. Out of these 50 have been identified. *Stropharia rugoso-annulata* and *Nolania sericae* are new reports from India while *Amanita caesarea*, *Auricularia polytricha* and *Coltricia cinnamonea* are new records from Himachal Pradesh. Out of 50 identified species, 5 were poisonous and 17 were edible. Two edible collections, *Auricularia polytricha* and a *Pleurotus* species have been successfully cultivated on wheat straw (details ahead).

During the course of surveys a number of interesting and rare agaricolous moulds were collected as mycoparasites on various fleshy fungi. Of these *Nyctalis asterophora* and *Mycogone perniciosa* were collected from *Lactarius* and *Russula* spp. and were found pathogenic on *Agaricus bisporus* on artificial inoculation. *Cladobotryum variospermum* was collected from fruit bodies of *Phomitopsis insulare* and *Polyporus versicolor* and it was pathogenic on *A.*

bisporus and *Pleurotus sajor-caju*. *Sepedonium chrysospermum* and its sexual stage *Hyphomyces chrysospermum* were collected from *Boletus* spp.

Besides culturing edible species (like *Morchella* spp., *Auricularia* spp., *Pleurotus* sp.) collected from nature, cultures of different edible fungi were procured from various sources. At present the Centre has 42 cultures of 14 different edible fungi. The collection is being maintained by periodic subculturing. Attempts are also being made to procure germplasm from abroad.

AGARICUS

Breeding

Efforts were made to evaluate and improve the available germplasm of *Agaricus bisporus*. Screening of available strains on composts prepared by long and short method of composting showed that the strains S11 and S310 are good yielders on both the compost preparations. Strain S649 gave good yield only on compost prepared by short method. Strain NC 7, though not among the best yielders, had desirable quality traits like tough fruit body and longer shelf life. The results of strain mixing on composts prepared by both long and short methods of composting showed that the mixture of spawn of any two strains out of the five tested could not

outyield either one or both the parents indicating little scope of strain improvement by this simple approach. From growers point of view this demonstrates the importance of using pure culture spawn and drawback of intermixing strains.

For achieving strain improvement through selection and hybridization, 48 fertile single spore isolates from three strains were evaluated and 14 isolates could outyield the parent strains. Promising isolates will be further evaluated at this Centre and co-ordinating Centres. A planned hybridization programme involving isolation of non-fertile single spore isolates and intermating the compatible isolates from different strains has been started for the first time in the country with the aim of combining wider adaptability of S11 and S310 with good quality and yields of other strains.

For spawn production of *A. bisporus* and of various other mushrooms, standard method using wheat grain was followed at the Centre and has given satisfactory results.

Compost

Efforts were made to reduce composting time, evaluate different compost formulations and determine optimum depth of compost in a bag. In the long method of composting it was found that there was good spawn run in samples taken after the 5th

turning from central and peripheral zones of heap; and compost from central zone after 5th turning gave as good yields as that obtained after 8th turning (28 days) indicating, thereby, the possibility of reducing the composting time. Out of four formulation the one consisting of wheat straw (300 Kg), chicken manure (125 Kg), wheat bran (15 kg), urea (15.4 Kg), and gypsum (20 Kg) with a nitrogen content of 1.56% gave the highest yield while compost made with cotton seed meal as nitrogen source gave poorest yield.

In an experiment with different depths of compost in polythene bags (keeping quantity of compost same), depth of 15 cm (6") and 23 cm (9") gave the maximum yields (13.58 and 13.72 Kg/qrtl compost respectively in 6 weeks) followed by 30 cm (12") and 38 cm (15"). In 46 cm (18") and 53 cm (21") depths there was decrease in the yield. In 15 cm (6") depth maximum number of fruit bodies (per kg compost) were obtained and 45% of total yield was obtained in the first week. In another experiment where bags containing 15 kg compost filled up to 46 cm (18") depth were reversed after two months of cropping and recased, a good flush of healthy mushrooms could be obtained in S310, S11 and NC7 indicating that some nutrition is left at the base of a bag and marginal farmers taking only single crop per year may benefit from this finding.

Casing

A new casing material for *A.bisporus* and optimum casing thickness have been determined. Moss is abundantly available in hilly areas of Himachal. This material in combination with garden soil (2 : 1) gave early pinning, even flushes, higher yield and heavier fruit bodies than the other treatments viz., garden soil, spent compost + soil (2 : 1), forest litter + soil (1 : 1) and standard casing material (FYM + soil 1 : 1). This (moss + soil 2 : 1) casing medium had desirable attributes like high water holding capacity, high porosity, low electrical conductivity and high pH. The casing thickness of 3.8 cm (1½") was considered best out of 2.5 cm (1"), 3.8 cm (1½"), 5.0 cm (2") while using standard casing material.

Diseases

Studies on diseases and competitors of *A. bisporus* revealed that *Trichoderma viride* was an important destructive agent as it competed with the mycelium of *A.bisporus* in compost (thus affecting spawn run) and also caused brown spots on sporophores. Bavistin could check the growth of this mould even at a low concentration of 25 ppm. During the course of experiments a number of other pathogenic fungi and competitor moulds were noticed in the compost

as well as on fruit body producing distinct symptoms. Besides *T.viride*, *Mycogone perniciososa* and *Papulaspora byssina* were found pathogenic and adversely affected the yields.

Nematodes

For control of nematodes infesting mushrooms, six commonly used pesticides were screened *in vitro* for their effect on mycelial growth of *A.bisporus* and *Pleurotus sajor-caju*; nematicidal activity against *Aphelenchoides composticola*, and fungicidal effects against various competitor and pathogenic fungi. Based on these results, *in vivo* trials were conducted and it was found that addition of carbofuran (400 ppm) at 4th turning during composting by long method is safe and can take care of nematodes, pathogens/competitor moulds and phorid and sciarid flies infesting mushrooms.

Plant extracts of castor and neem were highly effective against the nematode *A. composticola* both under *in vitro* and *in vivo* conditions and incorporation of these dried plant materials led to increase in yields up to 27 per cent. Neem extract inhibited the growth of 20 competitor/pathogenic fungi (15 of which were found to be the hosts of nematode) and encouraged the growth of various antibiotic producing and nematode trapping fungi.

Growth and Morphogenesis

While studying biochemical changes during fruit body development of *A. bisporus*, total protein and soluble protein contents increased initially but declined further till maturity. Total soluble sugars and phenols increased with size of the cap, the reducing sugar content being lowest in primordia and highest in fully mature cap with a decline in between.

Addition of 100 ppm of iron (Fe^{++}) in the soil significantly delayed pinhead formation and reduced the yields, there being no effect of 25 ppm iron.

Post harvest storage

White button mushrooms kept best at 5°C in non perforated polythene bags. Perforations and temperature above 5°C increased weight loss, blackening and veil opening. In an attempt to dehydrate *A. bisporus*, sliced mushrooms (3mm thick) dehydrated faster, contained less moisture in the finished product and rehydrated better than the whole mushroom. Blackening of mushroom could be reduced with 0.5% potassium metabisulphite - a concentration too high to be of significance.

PLEUROTUS

Substrates

A number of agricultural waste materials including wheat and paddy

straw, dried haulm of peas, brassica and methi, dried stem of *Euphorbia royleana* (Thor) were tried for *Pleurotus* cultivation. Good spawn run and fruit body formation were noticed in all cases showing their suitability for cultivation of oyster mushroom. Attempts on casing of *P. sajor-caju* during cultivation on wheat straw in trays gave poor results.

Cultivation

Seven *Pleurotus* species viz., *P. sajor-caju*, *P. ostreatus*, *P. flabellatus*, *P. sapidus*, *P. florida*, *P. eryngii* and *P. fossulatus* were cultivated on pasteurized wheat straw. *P. sajor-caju* gave best yields followed by *P. sapidus* and *P. flabellatus*. *P. sajor-caju* and *P. sapidus* gave maximum yields with 4 and 3 per cent rate of spawning (wet weight basis) respectively. A new *Pleurotus* species collected from Jammu on dried Thor stems (*Euphorbia royleana*) has been successfully cultivated on wheat straw like other *Pleurotus* species and has given 40% conversion. Yet another species *P. citrinopileatus* has also been cultivated on wheat straw.

Genetics

Observations on sporophore morphology of various *Pleurotus* species show that fruit body colour, shape, size, stipe length and its position etc. are greatly affected by the environment. So efforts are being made to see the

inter-relationships in *Pleurotus* species complex at genetic and morphological level. The intermating of single spore isolates of *P.sajor-caju* has revealed a tetrapolar mechanism of incompatibility in this species.

Diseases and Chemical sterilization

Present technique of cultivation of oyster mushroom on steam pasteurized wheat straw (80C for 2h) is cumbersome (especially for marginal farmers) and straw is easily colonized by different moulds especially *Trichoderma viride* resulting in decreased yield or even complete crop failure. Bavistin at a very low concentration (25ppm) could check the growth of this fungus under both *in vitro* and *in vivo* conditions. Its complete control could also be obtained by steeping the straw in Bavistin solution (25ppm) overnight followed by steam pasteurization.

A new and simple technique for cultivation of *Pleurotus* involving the use of chemicals only for sterilization of wheat straw has been standardized. This involves steeping of wheat straw in Formalin + Bavistin solution (500 + 75ppm) overnight (18h) and then spawning. Satisfactory yields of *P.sajor-caju* have been obtained using this technique. Out of 35 mould fungi isolated from various treatments their incidence was almost negligible in the treatments involving the use of Formalin, Bavistin and Blitox.

Biochemical changes

Biochemical studies of *P.citrinopileatus* show that total protein, free amino acids, total soluble sugars and dry weight decreased with the development of fruit body and there was no definite trend in reducing sugars and phenols.

Post harvest storage

For post harvest storage of *P.sajor-caju* oven drying at 55 and 90C temperature was not found suitable as it gave a brown product with very poor rehydration quality. Sun drying, especially after beading in the open on sunny (20-25C) and dry days was found suitable as it gave a product of acceptable colour and good rehydration quality.

OTHER EDIBLE FUNGI

Auricularia

This mushroom is collected by tribal and hilly people for consumption, but has not been cultivated in India till date. Tissue and multispore cultures from *Auricularia polytricha* and *A.tenuis* basidiocarps collected from nature were prepared. The *in vitro* studies on pH, rice bran supplementation, effect of chemicals on mycelial growth and evaluation of locally available substrates were undertaken and it was found that *A. polytricha* gave best mycelial growth in acidic pH

(5.5-6.5), low rice bran (2-5%) enhanced and high amounts (20%) retarded mycelial growth, and this fungus could colonize a wide variety of locally available substrates. Fruit body formation after casing the colonized substrate in petriplates could, however, be obtained in corn cobs, wheat straw and paddy straw only.

A.polytricha has been successfully cultivated both on composted and fresh wheat straw. Supplementation of straw with 4% rice bran gave better results. The fruit bodies appear as slightly hairy, pinkish primodia. With development a depression appears in the centre, margins thin out, and eccentric growth takes place and colour of fruit body changes from light pink to brown. The fruit bodies unlike other mushrooms did not decay easily on substrates and so could be allowed to grow for few days. Further, they can be easily sun dried where they shrivel significantly.

Morchella

Morchella collected from the forest areas is a prized mushroom in the International market. Attempts on its cultivation have not given much encouraging results. During various surveys in Himachal Pradesh it was found growing under all types of vegetation ranging from pines, oaks, deodar, barren land and field crops, in the months of March-April and

July-August. Fourteen cultures of *M.esculenta*, *M.conica*, *M.angusticeps* and *M.crassipes* were grown on seven synthetic media and Richard's medium was found to be the best for mycelial growth of all the cultures. The optimum pH for the growth of *Morchella* species ranged between 5.0 and 8.0. Spawn culture of *M.conica* was embedded in forest areas and no fructification appeared in or near the bags. However, the sclerotia remained viable for 10 months. Forest litter, wheat straw and their combination with moss and synthetic compost were also inoculated with above culture under *in vitro* conditions but despite good mycelial colonization no fructification was noticed.

EXTENSION

Training was imparted to growers in training programmes organised by Deptt. of Horticulture (H.P.). Sixty one sub-cultures of edible fungi were supplied to the mushroom scientists/extension workers and growers.

LIBRARY

A good library facility has also been established at the Centre. At present 50 journals from various disciplines are being subscribed and back volumes of important journals have been procured. There are about 300 books which include most of the important books on mushrooms and allied fields.

PUBLICATIONS

Bhandal, M.S. and K.B. Mehta. 1986. Natural occurrence of *Auricularia polytricha* (Mont.) Sacc. from Himachal Pradesh. Abstract. Presented at the annual meeting of Indian Phytopathological Society at Bhagalpur.

Bhandal, M.S. and K.B. Mehta. 1986. Cultivation of *Auricularia* in India. Abstract. Presented at the annual meeting of Indian Phytopathological Society at Bhagalpur.

Bhandal, M.S. and K.B. Mehta. 1986. Comparative evaluation of strains of *Agaricus bisporus* on compost prepared by long and short method. Abstract. Presented at the annual meeting of the Society of Mycology and Plant Pathology, at Coimbatore.

Bhandal, M.S. and K.B. Mehta. 1986. Strategies for breeding *Agaricus bisporus* (Lange) Sing. Abstract. International Symposium on Scientific and Technical aspects of cultivating Edible fungi, Pennsylvania.

Dhar, B.L., B. Vijay, R.C. Upadhyay and H.S. Sohi. 1985. Effect of compost depth on yield of *Agaricus bisporus*. Abstract. Presented at annual meeting of Society of Mycology and Plant Pathology at Pantnagar.

Dhar B.L., B. Vijay, R.C. Upadhyay and H.S. Sohi. 1985. Effect of casing thickness on yield of *Agaricus bisporus*.

Abstract. Presented at annual meeting of Society of Mycology and Plant Pathology at Pantnagar.

Dhar, B.L., B. Vijay, R.C. Upadhyay and H.S. Sohi. 1985. Effect of chicken manure supplementation in compost on yield of *Agaricus bisporus*. Abstract. Presented at annual meeting of the Society of Mycology and Plant Pathology at Pantnagar.

Grewal, P.S. 1986. 'Pests of mushroom and their control' in successful mushroom production, published by G.B. Pant University of Agriculture and Technology : 55-57.

Grewal, P.S. and H.S. Sohi. 1986. Integrated control of pests & diseases in mushroom cultivation. Paper presented for the "Pesticides India Award" competition at the annual meeting of the Society of Mycology and Plant Pathology, at Coimbatore.

Grewal, P.S. and H.S. Sohi. 1986. Studies on the effect of different pesticides on the growth of *Agaricus bisporus* (Lange) Singer and *Pleurotus sajor-caju* (Fr.) Singer. *Mushroom Journal for the Tropics* (Accepted).

Grewal, P.S. and H.S. Sohi. 1986. Integrated control of pests and diseases in mushroom cultivation. Paper accepted at the International Symposium on 'Technical and Scientific aspects of cultivation of Edible fungi' pp11 held at Pennsylvania.

- Grewal, P.S. and H.S. Sohi. 1986. Effect of different pesticides on the growth of *Pleurotus sajor-caju* (Fr.) Sing. and *Agaricus bisporus* (Lange) Sing. Abstract. Presented at the annual meeting of the Society of Mycology & Plant Pathology, at Coimbatore.
- Prasad. T., R.C. Upadhyay and B.L. Dhar. 1985. Observations on *Lycoriella* sp. (Diptera, Lycoridae) infesting button mushrooms. *J.Indian Soc. Soil Biol.*, Bangalore.
- Rai, R.D. and H.S. Sohi. 1985. Nutritive value of mushrooms — *Indian Horticulture*.
- Seth A., P.S. Grewal, N.K. Sharma and H.S. Sohi. 1986. Screening of some plant extracts against *Aphelenchoides composticola* infesting mushrooms. Submitted to the *Mushroom Journal for the Tropics*.
- Sohi, H.S. 1985. Diseases and competitor moulds associated with mushroom culture and their control. (Bulletin — 14 pages).
- Sohi, H.S. 1985. Know your edible and cultivated mushrooms (Folder).
- Sohi* H.S. and P.S. Grewal. 1985. Some interesting Agaricolous fungi from Himachal Pradesh. *Indian J. Mycol. and Pl. Pathology* (Accepted).
- Sohi, H.S., R.C. Upadhyay and P.S. Grewal. 1985. Rare Agaricolous fungi from Himachal Pradesh. Abstract. Presented at the annual meeting of Indian Phytopathological Society at Bhagalpur.
- Sohi, H.S., R.C. Upadhyay and P.S. Grewal. 1986. Some interesting edible fungi from Himachal Pradesh. Abstract. Presented at the annual meeting of the Society of Mycology and Plant Pathology, at Coimbatore.
- Sohi H.S., P.S. Grewal and A. Seth. 1986. Preliminary studies on the effect of plant extracts on the mycelial growth and yield of *Agaricus bisporus* (Lange) Singer and fungal flora in the compost. International Symposium on 'Technical & Scientific aspects of cultivation of Edible fungi' pp.6 held at Pennsylvania. (Accepted).
- Upadhyay R.C. and H.S. Sohi. 1986. *Strobilurus stepharocystis* (Hora) Singer, a new record from India. *Current Science* (Accepted).
- Vijay, B., and H.S. Sohi. 1986. Cultivation of oyster mushroom (*Pleurotus sajor-caju* (Fr.) Singer.) on chemically sterilized wheat straw. Communicated to *Mushroom Journal for the Tropics*.
- Vijay, B., H.S. Sohi and R.C. Upadhyay, 1986. Control of green mould (*Trichoderma viride*) by use of Bavistin in the cultivation of *Pleurotus sajor-caju* (Fr.) Singer. Abstract. Presented at the annual meeting of Indian Phytopathological Society at Bhagalpur.

STAFF

Name & qualification	Designation	Date of joining N.C.M.R.T.
A. Scientists		
I. Mycology & Plant Pathology.		
1. H.S. Sohi, F.N.A. M.Sc. (Hons), Ph. D. (IARI)	Officer on Special Duty	19.7.1984
2. R.C. Upadhyay., M.Sc.	Scientist S-1	7.12.1983
3. B.L. Dhar, M.Sc. (Agri.)	Scientist S-1	8.6.1983
4. B. Vijay, M. Sc.	Scientist S-1	31.10.1983
5. Yásh Gupta (Miss), M.Sc. (Agri.)	Scientist S-1	26.11.1984
6. Kiran B. Mehta (Miss), M.Sc., Ph.D.	Scientist S-1	26.11.1984
II. Genetics and Cytogenetics		
1. Manjit Singh M. Sc., Ph.D. (Genet).	Scientist S-1	6.3.1984.
III. Biochemistry and Plant Physiology		
1. R.D. Rai, M. Sc., Ph.D. (Biochem).	Scientist S-2	6.3.1984
2. Sanjeev Saxena, M.Sc.	Scientist S-1	23.1.1985
IV. Nematology and Entomology		
1. P.S. Grewal M.Sc. (Agri.)	Scientist S-1	13.3.1985
B. Technical		
1. Jia Lal	Mushroom Assistant	1.6.1983
C. Administrative Staff		
1. Lalit Kumar	Sr. Clerk	1.12.1983
2. Sita Ram Sharma	Sr. Clerk	5.7.1984
3. R.K. Bhatnagar	Jr. Clerk	19.3.1984
4. Rajinder Sharma	Jr. Clerk	10.6.1985
D. Supporting Staff		
1. Joginder Paul	Chowkidar	4.1.1984
2. Dhani Ram	Chowkidar	6.2.1984
3. Lekh Raj Rana	Lab Assistant	14.3.1986
4. Ram Sawroop	Lab Assistant	17.3.1986

ALL INDIA CO-ORDINATED MUSHROOM IMPROVEMENT PROJECT (AICMIP)

AICMIP started functioning in 1984 with Dr. H.S. Sohi, Officer on Special Duty N.C.M.R.T., Solan as its co-ordinator and includes six centres in Agricultural Universities at Coimbatore, Kalyani, Kanpur, Ludhiana, Pune and Pantnagar. (Kanpur centre is being replaced by a new centre at Jabalpur w.e.f. 1986).

The main objectives of these centres are : survey, collection and identification of mushroom flora; regional adaptability trials on promising strains; selection of cheap and locally available substrates for compost and casing and standardization of cultivation techniques for higher yields.

During surveys conducted by different centres, 19 edible fleshy fungi were identified. Cultures of *Auricularia polytricha*, *Pleurotus citrinopileatus*, *Pleurotus* sp. and *Tricholoma lobayense* were established to exploit them for cultivation.

Research work conducted on *Pleurotus sajor-caju* at various centres indicates that sorghum grains are suitable substrate for spawn; there is no effect of rate of spawning from 1 to 4 per cent; four complete layer

spawning gives good yields; waste cotton, cotton stalks, paddy straw etc. are suitable substrates for cultivation; supplementation of paddy straw with horse gram powder, cotton seed meal or fertilizers has no effect on yield; polythene bags are suitable containers, and 10 kg substrate per bag is optimum amount of substrate. Evaluation of 5 species of *Pleurotus* show *P.sajor-caju* to be superior over others and its strain M2 was reported to give better yields.

For cultivation of *A.bisporus* storing of spawn for 15 to 45 days at 25 C had no effect on yield. Experiments on casing using locally available materials revealed that mixture of rice husk + dung (1 : 3) gives good yields. Further sterilization of casing soil with Benlate also gave good results as compared to Formalin and Dithane M-45 treatments.

During the cultivation of paddy straw mushroom (*Volvariella* spp.) supplementation with neem leaves and cotton waste gave about 15% more yields. Further seriate beds made with paddy straw gave 20% more yield than square beds; and commonly used horse gram powder was best out of various supplements tried.



MUSHROOM CULTIVATION IN INDIA — HISTORY AND PROSPECTS

The first or superficial view which the observing mind takes of any object of knowledge is always an illusory view; all science, all true knowledge comes by going behind the superficialities and discovering the inner truth and hidden law.

— Sri Aurobindo, *Evolution*, 1921

P.K. Seth

Deptt. of Mycology and Plant Pathology
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In India cultivation of edible mushrooms is of recent origin, though methods of cultivation for some was known for many years. In 1886, some specimens of mushrooms were grown by N.W. Newton and exhibited at the Annual show of Agriculture — Horticultural Society of India. In 1908 a thorough search of edible mushrooms in India was instituted by Sir David Pain. During 1896-97, Dr. B.C. Roy of the Calcutta Medical College, carried out chemical analysis of the local mushrooms prevalent in caves or mines. Bose (1921) was successful in culturing two Agarics on a sterilized dung media, details of which were published in the Indian Science Congress at Nagpur during the year 1926. Bose advocated its cultivation for raising it as a daily food item and visualised its importance for becoming a major industry in India.

Experiments in cultivating the paddy straw mushroom (*Volvariella*) were

first undertaken in India during 1939-45 by the Deptt. of Agriculture, Madras, although these were discontinued later on. Padwick (1941) reported successful cultivation of *Agaricus bisporus* from various countries but without much success in India. He suggested the possibilities and difficulties in the cultivation in this country. Thomas *et al.*, (1943) mentioned details and gave full directions about cultivation of the paddy straw mushroom (*V. diplasia*) in Madras. Asthana (1947) obtained better yields of paddy straw by the addition of red powdered dal to the beds. He suggested April-June as the most suitable period for cultivating this mushroom in the Central Provinces and also carried out chemical analysis of this mushroom. Bano *et al.*, (1962) obtained increased yields of *Pleurotus* species on paddy straw. Subsequent work was undertaken with many modifications by various research workers in the country.

A serious attempt in the cultivation of edible mushroom, *A.bisporus* was carried out by the Deptt. of Agriculture, H.P. Solan, in collaboration with the I.C.A.R., during the year 1961, when it started a scheme entitled "Development of mushroom cultivation in H.P." Work was initiated in growing mushrooms on cow dung, which met with partial success. During 1964 the Deptt. succeeded in growing mushrooms on horse manure compost and thereafter the basis for scientific research work was established.

During 1965 Dr. E.F.K. Mantel, FAO Mushroom Expert guided and assisted the Deptt. of Agriculture for establishing spawn research and an experimental mushroom farm at Solan. He planned the construction of a modern spawn laboratory and a fully air-conditioned mushroom house for this purpose. Experiments for evaluating high yielding strains and use of various agricultural wastes and organic manures and fertilizers for preparing a synthetic compost were also worked out. Among the strains tested, No. 11 (White) was recommended for commercial adoption, whereas a compost programme using synthetic additives was finalized by the long method of compost making. The use of a new bin with nemagon for fumigation purposes was also finalized. This bin, however, met with various nematode problems and hence could not meet the requirements of the growers. Dr. Mantel's

consultancy concluded after a period of 7 years.

In 1974, the services of Dr. W.A. Hayes, FAO, Mushroom Expert were available for further improving the method of compost preparation, pasteurisation and management of important parameters in the mushroom house. A compost formulation consisting of chicken manure or horse manure or both was evolved which raised the yields of mushrooms from 7 to 14 kg/m² (Hayes and Shandilya, 1976). The use of farm yard manure + loam soil as a casing material was also finalized (Hayes *et al.*, 1975). Important parameters like nitrogen content in the compost, moisture in the casing soil, air movements and maintenance of proper environmental factors during casing and during cropping were also studied and released to the growers (Shandilya *et al.*, 1978). The mushroom house was also fully air-conditioned and made available for research work. The method of growing mushrooms was thus made sound and stable. Dr Hayes prior to leaving India made a number of recommendations for adoption in future research in the country, thereafter in 1977, the services of Mr. James Tunney were made available. He got a bulk pasteurisation chamber constructed, and made available ready made compost and casing soil to the growers of H.P. Thereafter a plan was initiated wherein mushroom growers were sold compost

and casing soil at subsidised rates and fresh mushrooms grown by them were purchased by the HPMC at a support price of Rs. 14/kg. In this manner problems of both technology and marketing were solved and only growing was handled by the farmers. Later mushrooms were collected at various focal points and these were transported to important marketing centres in Delhi under refrigerated conditions. A lot of work on various aspects has been done by other scientists in the country on *A.bisporus* since 1965, although many facilities were inadequately provided.

Due to work on mushrooms, a purely synthetic compost using straw and inorganic fertilizers and organic substrates was successfully chosen as an ideal medium for future commercial production (Seth, 1978). Later results revealed a break-through in the selection of spent compost (3 year old) as casing material (Munjal, 1978). The work on pathogens, competitors and pests of mushrooms was intensified (Seth, 1978) and methods to eradicate them were also finalized and released to the growers. The extension work for passing scientific information to growers/scientists was also stepped up.

On the basis of research work done by the scientists at Solan, I.C.A.R. established a National Centre for Mushroom Research & Training in 1982, with Solan as the main research centre and subcentres located in six

different stations all over the country. The objective was to handle problems of the mushroom industry at national level.

As a consequence of these efforts commercial mushroom growing was established at New Delhi, Srinagar, Jammu, Jalandhar, Amritsar, Patiala, Chandigarh, Ambala, Sonapat, Faridabad, Meerut, Hapur, Nainital, Jabalpur, Pune, Oatacamund, Coimbatore, Mysore etc.

Dr. Y.S. Parmar University of Horticulture and forestry at state level is now fully occupied in locating better high yielding strains, evaluating cheaper substrates for compost making, management of pathogens and pests and growing other edible mushrooms which can easily be cultivated all over the country. Besides supplying pure culture spawn to growers, training various growers/scientists of the country and on-the-spot-advise to the growers it also collaborates with the state Deptt. of Horticulture for training its growers.

Scientists in the country have successfully cultivated other edible mushrooms like *Pleurotus flabellatus*, *P.sajor-caju*, *P.eryngii*, *P.sapidus* and *Calocybe indica*. Attempts to cultivate *Flammulina velutipes*, *Agrocybe aegerita* and *Macrolepiota procera* on a small scale were also a success. Similarly many reports are available on the cultivation of paddy straw mushroom (*Volvariella* spp.).

As a consequence of the success achieved in cultivating *A.bisporus*, approximately 200-300 growers are now producing 1500 metric tonnes of fresh mushroom valued at 3 crores annually in the country. About 3500 persons are employed in the business of growing, whereas infrastructure and buildings worth Rs. 1.5 crores have come up. The total expenditure incurred on mushroom research since 1961 hardly touches one fourth of the total amount produced annually. Therefore, from a handful of important research achievements a sound and stable industry has been established in the country, providing employment for many and scope for the much needed foreign exchange for the country. Thus research has been well awarded.

Prospects and future outlook

Mushroom growing has been well established in the northern and to some extent in the southern regions of the country but it is yet to advance in other states. In order to keep with this rapid development, it is imperative that a quick followup plan be drawn up for extensive cultivation of mushrooms in other parts of the country. Since cheap raw material is available alongwith inexpensive labour and convenient environment, mushroom growing can flourish rapidly.

The UNDP Project should establish more bulk units in H.P. in order to meet the demand of compost. With the acceptance of this technology, the yields of mushrooms would be

enhanced and, therefore, marketing facilities shall have to be stepped up to keep pace with enhanced productions. A large number of canning units shall have to be established in the public and private sectors for handling enhanced production.

At present spawn is being supplied by the Mushroom Research Laboratory, Solan, as well as by some private laboratories. With the expected enhanced cultivation, the National Centre shall have to share this responsibility in order to meet the demands of additional spawn. The training programmes shall have to be reoriented in order to equip the growers with the latest growing techniques.

The University has come up with technology for growing other suitable edible mushrooms. As most growers are usually free for almost 6 months they must cultivate other edible mushrooms in order to make their financial position sound. Suitable types are *P.sajor-caju*, *P.ostreatus* or *P.flabellatus*. The cultivation of *A.bitorquis*, a temperature tolerant mushroom, also offers greater possibilities for cultivation during periods when *A.bisporus* cannot be grown. This mushroom has a number of advantages both for the table as well as for preservation. Therefore, the production of non-conventional foods can be stepped up so that the food habit of the people be changed in order to reduce the pressure on consumption of cereals and other vegetables.

APPROPRIATE MUSHROOM CULTIVATION TECHNOLOGY FOR INDIA

..... and scientific opinion is always a force both by its power of well-ascertained truth and its continued service to humanity

— Sri Aurobindo, *Evolution*, 1921

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The cultivation of paddy straw mushroom (*Volvariella* spp) was taken up on an experimental scale in several laboratories in India since 1940, yet even after four decades, its commercial cultivation has not taken roots so far.

Cultivation of white button mushroom was started under an ICAR : HP Govt. Scheme at Solan in 1961. Its preliminary success induced the Govt. of India to seek the services of an FAO expert to support this programme, which resulted in the commercial cultivation of this mushroom in 1965, through establishment of a spawn laboratory at Solan and a mushroom farm at Chail coupled with a few satellite growers in that area, largely due to the patronage of H.H. Maharaja Amarinder Singh of Patiala. This attracted the attention of others interested in mushroom cultivation which later spread to Kashmir and Punjab (initially at Patiala) in 1966. Since then, it extended to Delhi,

Haryana, Rajasthan and Western UP. Lately its cultivation has also been taken up in Maharashtra, Karnataka and Tamil Nadu. In most places, only one crop is taken during winter season except Kashmir valley, where it is grown during summer. Some people take two crops, which may occasionally overlap each other. However some mushroom farms at Shimla, Chail and Kasauli in Himachal Pradesh, at Ooty in Tamil Nadu, at Pune in Maharashtra, at Hoshiarpur in Punjab and at Ghaziabad in UP have started its cultivation round the year by providing environment control facilities. During the last two decades, the production of this mushroom had risen from 50-100 tonnes to about 1000 tonnes per year.

The third type of mushroom which has been successfully cultivated experimentally in some of the research laboratories in various parts of the country is *Pleurotus* species (Dhingri).

Some farmers have started its commercial cultivation but its large scale cultivation has not yet been taken up.

With the available inadequate financial support and research facilities, the scientists in India have done commendable work. They have to their credit some innovations such as use of spent compost and farm yard manure as casing soil, which is now catching the imagination of advanced countries.

Considering the facts that a large population in India is vegetarian, abundance of raw materials, vast market potential for home consumption and export, and that keenness of numerous persons to take up commercial mushroom cultivation, it is indeed a matter of great concern as to why the pace of its commercial exploitation has been so slow. I am of the opinion that mushroom cultivation technology needs improvement to suit our local conditions. The reason for this belief is that Taiwan which is an agricultural country like India with tropical and subtropical climate, has made a phenomenal progress in the past two and a half decades, and it has now become the third largest producer and the foremost exporter of edible mushrooms in the world. Korea, which took up mushroom cultivation about a decade back has also shown immense progress, whereas we remain at the bottom of the list among the

world mushroom growers, so far as production is concerned.

I define Technology, as technical knowledge including technical education for successful production.

In any agricultural production technology, seed is the primary input. Seed for mushrooms — spawn, prepared under dusty, high temperature conditions often gets contaminated thus adding considerably to the cost of production of commercial spawn. The spawn prepared in glass bottles in the cool hilly places, though pure, often gets contaminated through the rough packaging and transport methods, resulting from the breakage of glass bottles or loosening of the plugs during transit. If it were prepared in polypropylene packs and marketed in cardboard cartons, it will considerably bring down the cost of spawn for mushroom grower in the plains particularly. Grain spawn has replaced other types of spawn because it provides large number of foci of primary inoculum. Whereas in other countries, commercial spawn is prepared on small grain (millets), we in India still continue to prepare it on wheat or cholam (jowar) thus putting ourselves to much disadvantageous position.

The next important production component is substrate. For the cultivation of paddy straw mushroom, in

India we have concentrated only paddy straw as a substrate, which also happens to be very suitable food material for many competitors of this mushroom. Therefore if the environmental conditions during spawn run are not favourable, it results in failure of crops. Banana leaves are being successfully utilised for commercial cultivation of paddy straw mushroom in South East Asia, but this substrate has received scant attention in India, although banana leaves are available in abundance in certain parts of Gujrat and Maharashtra.

For the cultivation of white button mushroom, a few formulae have been devised, which result in successful crops. However, if large parts of northern plains, where conditions become suitable for successful cultivation of this mushroom during winter, long method of composting has been advocated. This technique of composting has been rejected all over the world except India. This is because we have developed a wrong feeling in our mind that the Indian farmer is too poor to adopt short method of composting, which involves the use of boilers. The reality is that the mushroom research scientists in India have been denied this facility except at Solan, where it became available in late seventies. Unless this facility becomes available to them, they cannot experiment and give their firm opinion regarding the economics on use of

boilers. The same applies to the bulk pasteurisation technique or in a broader sense the use of modern mechanization of mushroom cultivation in India. Earlier it was thought that mechanization of agriculture in India would result in unemployment but it has been proved wrong in at least 2 states in India namely Punjab and Haryana. The same might prove applicable at places where there is a very heavy demand for mushrooms. The use of boilers may also prove helpful for successful cultivation of paddy straw mushroom on pasteurised compost, as has been reported by Chang in Hong Kong. This will be especially useful for localities in India, where summers are hot and winters are mild, so that we can grow both straw mushroom and button mushroom successfully.

Last but the most important production component is growing conditions. This is our weakest link, which involves the design of cheap mushroom houses. At no stage we have involved engineers for their expert advice in providing suitable environmental conditions. Proper insulation of mushroom house, their resistance to steam pasteurisation, installation of cheap mechanical gadgets for providing required amount of air, water, steam, the spray machinery are important ingredients in which few mushroom scientists are competent to give expert advice. This lacuna needs to be filled immediately.

Regarding Technical Training we need to have a fresh look at our training programmes. A large number of training courses are held every year but an insignificant number actually adopt this vocation. Some with imperfect knowledge give it a trial and fail, which dampens the enthusiasm of others as well. I would suggest that we design different types of training courses to satisfy varied clientele. Some would like to take it up a hobby, others will like to make it as a commercial activity. In the latter category will be included those who have lot of money to invest, they would need basic information on cultivation techniques, its economics and trained personnel. If the training

centres do not have mechanized cultivation facilities, where will these technicians be trained; then we have smaller entrepreneurs, who would involve themselves in this vocation but have limited financial resources and cannot take risks, they would like to be trained for semi-mechanised or low cost mushroom houses with suitable limited environmental control, and courses for small farmers who would like it as subsidiary activity, for whom we must have the right type of structures simulating village houses.

Our development staff who are assigned mushroom extension work must have undergone rigorous training, so that they can render the right advice to mushroom growers.

WE LOST THEM FOREVER

Fred. C. Atkins OBE died in Peterborough on 23rd January 1983 at the age of 70. His contributions are well known to both mushroom growers and scientists. His death left a gap in mushroom growing.

Prof Dr. G. Eger Hummel died unexpectedly on 2nd April 1986 at the age of 58. She will always live through her contributions in mushroom research.

S. Mani Singh Project Director (Co-ordinator) Mushroom Project FAO/UNDP Department of Horticulture, Solan, Himachal Pradesh died in an accident on 1.5.1984 at the age of 56 years. He contributed significantly to the development of mushroom industry in Himachal Pradesh.

Dr. A.D. Sharma, Jr. Mycologist at Mushroom Research Laboratory, Solan, died on 10th February 1985 at the young age of 35. He, in his short career, contributed to taxonomy of fungi and *Pleurotus* cultivation.

PRESENT POSITION OF SPAWN PRODUCTION IN INDIA

*The E.Hauser spawn laboratories grow their own mycelium on rye grains ...
Today, infact, grain spawns are their greatest money maker ...*

— Beth Day, in Reader's Digests 1970

S. KUMAR

Mushroom Research Laboratory
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Solan-173 213 (H.P)

Cultivation of the edible mushrooms in India is of recent origin as compared with some other advanced countries of the world. The first serious and scientific effort on the cultivation of white button mushroom (*Agaricus bisporus*) was made by the Department of Agriculture, Himachal Pradesh and a scheme entitled "Development of mushroom cultivation in Himachal Pradesh" was started in collaboration with the Indian Council of Agricultural Research, New Delhi for the experimental cultivation of this mushroom at Solan in 1961. ICAR later strengthened this scheme by providing the services of a F.A.O. Mushroom expert, Dr.E.F.K. Mantel. This resulted in successful transfer of technology on composting, casing material and spawn production. As a consequence of the success in growing mushroom crop, a first commercial mushroom farm was established in a rented building at Solan in 1965 by Mrs. Madhu Kohli of New Delhi. In 1968 another mushroom farm was

established at Chail by Maharaja of Patiala under the technical guidance of Dr. E.F.K. Mantel, the F.A.O. Mushroom Expert. After that a number of commercial mushroom farms were established at Shimla and Kasauli. With the success of these mushroom farms to grow mushroom on a commercial scale, a number of mushroom farms have come up in Jammu & Kashmir, Uttar Pradesh, Punjab, Karnataka, Maharashtra, Delhi and other parts of the country.

Mushroom Research Laboratory located at Solan was only laboratory supplying the pure culture spawn on a commercial scale to mushroom growers of the country. This laboratory started supplying the spawn with 36 bottles in 1964-65 and in 1979-80 spawn supplied to mushroom growers of the country went upto 24000 bottles. U.N.D.P. Mushroom Development Project was started in 1977 in Himachal Pradesh at Solan and since then the mushroom industry is taking roots in India and

the demand for pure quality spawn increased many times. Keeping the above fact in mind, I was sent to The Netherlands, Italy and U.K. in 1980 to learn the latest techniques on breeding of new strains and spawn production of cultivated mushrooms on a large scale because the quality of spawn is determined by the biological value of the strain and to some extent by the technology applied in the multiplication of spawn. After my return I made a few suggestions in my report.

As the commercial production of pure spawn and its supply to the growers and research on spawn are two separate aspects, I suggested that multiplication of spawn on a commercial scale may be taken over by the Department of Horticulture, Govt. of Himachal Pradesh and spawn research may be retained with the Himachal Pradesh Krishi Vishva Vidyalya, College of Agriculture, Solan. Likewise a number of spawn multiplication laboratories may be established in various states of the country depending upon the number of mushroom growers and their demand of spawn.

Govt. of Jammu & Kashmir was quick to anticipate the problems of availability of pure quality spawn well in time due to the increasing number of mushroom growers in the State every year, two spawn laboratories were established in the state and mushroom growers of the state do not

have any problem of availability of spawn. No other state Government except J & K has established the spawn laboratories so far and the mushroom growers of the concerned states are facing the problems of non availability of spawn which is one of the biggest constraints in the development and expansion of mushroom industry in the country.

The exact estimates of spawn production in India are not available. At present, there are two private spawn laboratories established at Dochi near Chail and Saproon, Solan besides research laboratory at Chambaghat under the control of Dr. Y.S. Parmar University of Horticulture & Forestry, Solan in Himachal Pradesh which are supplying the spawn to the mushroom growers of Himachal Pradesh, Punjab, Haryana, Uttar Pradesh, Delhi and Chandigarh.

In 1984-85 roughly about 66600 bags/bottles of spawn were supplied to the mushroom growers of Himachal Pradesh and other states. In 1985-86 a number of new commercial mushroom farms have been set up in the neighbouring states and roughly 109500 bags/bottles of spawn were supplied only by the three laboratories established in Himachal Pradesh.

There is good scope for the development of mushroom industry in India due to the abundant availability

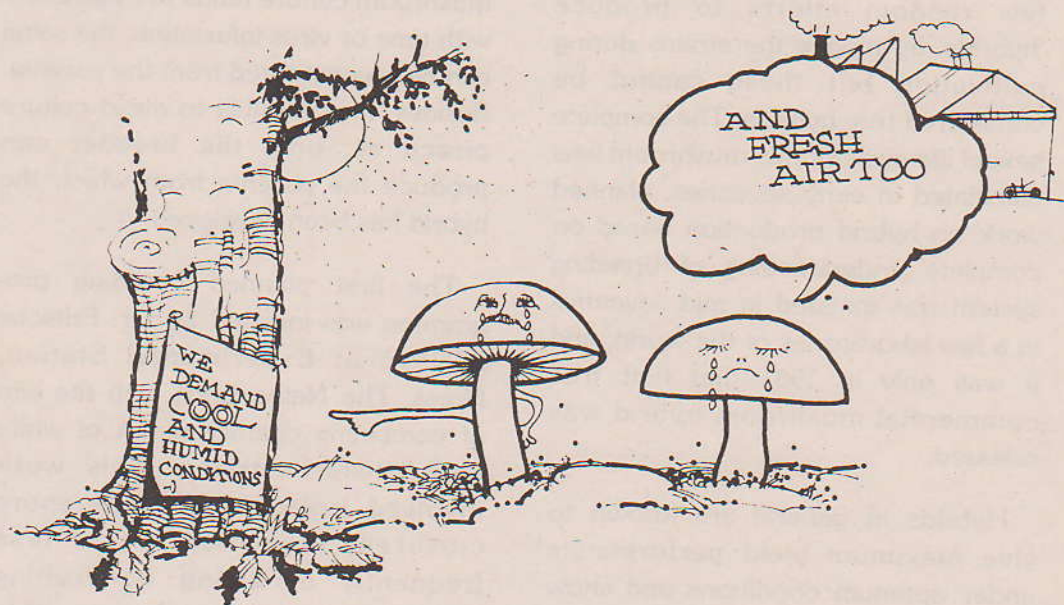
of raw materials, cheap labour, suitable environment to cultivate different edible mushroom throughout the year.

At present many mushroom scientists are engaged in teaching, commercial spawn supply and advisory services, with the result that they are unable to do justice to the research which is the back bone for the development and expansion of any industry. We are at a stage now where research on spawn and production of commercial spawn must be separated.

Technology for commercial spawn production under Indian conditions has been standardized and the same is

available for taking up production on a large scale. State Governments and private sectors may come forward to establish the spawn production laboratories.

Mushroom Research Laboratory located at Chambaghat, Solan has the limited facilities to produce spawn on a commercial scale and it will not be possible to meet the increasing spawn demand of mushroom growers of other states. State Governments must take action to establish the spawn production laboratories in each state to safe guard the interest of the mushroom growers of the country.



MUSHROOM HYBRIDS

"Top yield of today is the average of tomorrow"

— Slogan of Danish Mushroom Experiment Station in Sixties

Manjit S. Bhandal and Kiran B. Mehta

National Centre for Mushroom Research and Training
Chambaghat, Solan-173 213

Improvement in genetic pattern of a cultivar is one of the easiest ways of improving yield and quality. Use of hybrids in various crop plants was realized since long and has led to tremendous increase in crop productivity. However, in white button mushroom this approach was not exploited till recently, primarily due to lack of complete understanding of its breeding system. Earlier, there were few random efforts to produce 'hybrids' by mixing the strains during cultivation but these cannot be considered true hybrids. The complete sexual life cycle of this mushroom was elucidated in early seventies; planned work on hybrid production based on complete understanding of breeding system was initiated in mid seventies in a few laboratories of the world; and it was only in 1981 that first true commercial mushroom hybrid was released.

Hybrids in general are known to give maximum yield performance under optimum conditions and show phenotypic stability under stress. Besides, in hybrids joint improvement

of negatively associated traits without disturbing individual harmonious set of traits from diverse parents is possible. In mushroom also, the few hybrids developed till date have shown good yields and quality. Unlike many other crop plants where hybrid seed is to be produced afresh, in hybrid mushrooms the desired culture can be maintained and multiplied easily by further subculturing. Also, if the hybrid mushroom culture tends to degenerate with time or virus infestation, the same can be reconstituted from the parents. Besides, it is possible to avoid culture piracy as, only the breeder can produce the parents from which the hybrid has been developed.

The first planned breeding programme was initiated by Dr. Fritsche in 1975 at Experimental Station, Horst, The Netherlands with the aim of combining characteristics of white and offwhite strains. This work involved isolation of single spore cultures, identification of less frequently occurring non-fruiting isolates, intermating of compatible isolates from two parental strains

followed by evaluation and selections. Initial screening was carried out in small trays and selection was done on the basis of colour, size, shape, scaliness, firmness and total number of mushrooms. In this programme, from nearly 80 strains judged for yield, progress of flushes and quality in small trays, only three could reach the final phase of selection. Consequent upon these efforts, the Dutch hybrids were released in 1981 as U₁ (Horronondo) and U₃ (Horwitu). These were the first commercial hybrids and have lived upto expectations in both quality and productivity.

The other example of hybrid strain production is from Taiwan. The hybrid strain now being grown there is also the result of hybridization between an offwhite and snowwhite strain. Peng had mated 41 slow growing mycelia of offwhite strains with 47 of snowwhite and obtained 323 successful crosses. After initial screening only 19 cultures were retained out of which five could reach final evaluation trials and only one was selected for commercial exploitation.

From breeding point of view, the population size in both the above

experiments appears quite small. Therefore, for more improvements, it will be obligatory to produce, handle and evaluate larger number of cultures. But, even to produce a few hundred cultures it needs a good laboratory effort and thorough evaluation under controlled environmental conditions. Therefore, there is a necessity to devise simple and shorter procedures for hybridization as well as to identify parameters correlated with yield potential. The improved hybridization techniques will enable the breeder to produce strains with good yield, quality, pest resistance and phenotypic stability more efficiently.

In India, though a good deal of research has been carried out on various aspects of mushroom, the improvement of strains through hybridization still remains to be exploited. At National Centre for Mushroom Research and Training, Solan, work has been started on isolation of single spores, identification of non-fruiting types and their inter-mating, with the ultimate goal of producing mushroom hybrids suitable for Indian conditions. The only limitation at present is the availability of limited germplasm in the country.



DEVELOPMENT OF COMPOST AND COMPOSTING TECHNOLOGY IN INDIA

"It is one of the oldest and quite the most baffling of the Manural Laws that the longer you keep manure the shorter it becomes"

— Sellar and Yeatman 1936

T.R. Shandilya

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Compost is the substrate on which mushroom grows. This material is the result of decomposition process governed by a number of microorganisms which produce important chemical reactions there by making it selective for *Agaricus bisporus*. The nutrients for mushroom growth are provided in compost which traditionally was prepared from horse manure and wheat straw. Satisfactory development of spawn in unfermented horse manure is prevented by self generation of heat and competition from other microorganisms. It is therefore necessary to compost the manure in order to produce a medium which will remain stable and in which quantity of readily available nutrients for competing microorganisms is considerably reduced. Due to scarcity of horse manure efforts have been made by scientists since 1929 to develop alternatives based on vegetable origin.

Higher plants obtain nutrients from the soil and synthesize organic matter

in leaves through photosynthesis. However mushroom being heterotrophic organism has to get all nutritive elements from the substrate — the compost. Therefore compost plays a more comprehensive and important role in mushroom production than does soil in higher plant growth. What exactly happens in compost pile is not fully known but composting performs the following functions :

- It provides a selective medium for *A. bisporus*.
- Some of the food already present is made more acceptable.
- Avoids heating up tendency of composting materials.
- Improves the physical structure of the compost.

Production of *A. bisporus* to a greater extent depends upon quality of mushroom compost used. Abroad much attention has been paid to

evolve appropriate compost mix, and horse manure compost based on short method of composting (SMC) is the most common formulation used in many countries since its inception. Since horse manure is generally not available in our country especially in areas with cooler climatic conditions suited for growing this mushroom, a synthetic compost based on wheat straw and other inorganic fertilizers (CAN, Urea, Potash and Superphosphate) was recommended for commercial cultivation in 1964-65 totally dependent on outdoor composting (long method of composting — LMC) without pasteurization by Mantel et al., (1972). Later Seth and Shandilya (1975) used a formulation in which an inactive compost was prepared over a composting period of 28 days with nemagon incorporated as a chemical pasteurizing agent, a procedure which was practised on many mushroom farms in India before the introduction of pasteurization technique.

It has been conclusively proved that pasteurization of compost is a prerequisite as pasteurized compost gives better yield and insect pest, diseases, nematodes and moulds are effectively controlled. A new break-through was further ushered with switch from long method of composting to short method of composting based on wheat straw and chicken manure developed and standardized by Shandilya (1976) and Hayes and Shandilya (1977). They

outlined a procedure of composting in which anaerobic period of 4 days in the prestacking time, 8-10 days outdoor and 4-5 days indoor conditioning of compost under controlled environmental conditions was recommended. By adopting this new technique highest yield of 11-12 kg mushroom/sq.m. were achieved under Indian conditions not only at the Research Laboratory but at farmers level also when used in conjunction with new casing technique. This was the most significant contribution made by them in mushroom cultivation as the yields of mushroom were doubled through this technique.

As only few formulations were known for growing mushrooms under Indian conditions, it was felt necessary to use the local substrate for compost preparation. Keeping this in view, Shandilya (1979) developed six formulations based on short method of composting which were designated as MRC-F1 to MRC-F6 out of which first five (MRC-F1 to MRC-F5) have been recommended to mushroom growers, which have given better yields. Different ingredients used in these formulae were as follows :

MRC-F1 : Wheat straw, chicken manure, brewer's grain, urea and gypsum.

MRC-F2 : Horse manure, wheat straw, chicken manure, brewer's grain, urea and gypsum.

MRC-F3 :Wheat straw, chicken manure, brewer's grain, rice husk, urea, cotton seed meal and gypsum.

MRC-F4 :Paddy straw, maize leaves, molasses, urea, wheat bran and gypsum.

MRC-F5 :Wheat straw, maize leaves, molasses, urea, wheat bran and gypsum.

Though the yield obtained in horse manure compost was higher but due to its non availability, formulation based on wheat straw plus chicken manure has become the standard formulation and is being adopted by all the commercial mushroom units in the country. Various formulations have been developed by various workers from different regions of the country mainly based on locally available materials by long method of composting. In south, Tewari and Sohi (1976) reported the utility of maize stalks and paddy straw in equal proportion where 2.69 kg/tray (3'x2'x6") yield was achieved. Garcha *et al.*, (1981) developed seven formulations based on different agricultural wastes for making of compost for *A. bisporus* under Punjab conditions in which yield of 0.295 to 5.845 kg/sq.m was achieved. Kachroo *et al.*, (1979) recommended two synthetic formulations RRL-F1 and RRL-F2 based on wheat straw and paddy straw respectively. Shandilya (1986) have done

a more comprehensive and detail study on paddy straw compost formulations (PSC-F1 and F2) based on short method of composting in which yield of 220kg and 206kg/ton of paddy straw fresh weight could be achieved.

Supplementation of mushroom compost with various additives has been suggested by various workers. Hayes and Randle (1969) have found improvements in the productivity of the compost by use of molasses as a soluble carbohydrate supplement for the preparation of compost based on horse manure. Incorporation of molasses into MRC-F1 formulation have been suggested by Shandilya (1980) who reported the enhancement in yield upto 13.5 kg/sq.m. Sohi and Tewari (1984) have found increase in yield of mushroom to a level of 4.179 kg/tray by supplementing paddy straw with maize stalk prepared by long method of composting. Addition of yeast extract for enhancement of yield upto a maximum of 7.25 kg/sq.m has been suggested by Singh and Jain (1982).

Composting process being a fermentation process leads ultimately to the decomposition of plant residues by microbes. Quite a good amount of work has been done abroad in microbiology and chemistry of compost. In India, Munjal *et al.*, (1974) reported several fungi during the compost making

in long method of composting. Later, Dhar and Munjal (1976) have also reported the occurrence of micro-flora in long method of composting. Garcha and Kiran (1981) have also reported fungi and actinomycetes occurrence in different stacks under Punjab conditions. There is no report available on the microbiology of compost made by short method of composting except that of Shandilya (1986) who has reported a number of fungi, bacteria and actinomycetes during different processes of compost making.

Shandilaya and Munjal (1983) have studied the chemical characteristics of MRC—F1 formulation. Various parameters pertaining to quality of compost in this and C : N ratio were high at the start which later decreased with the progress of composting. Six organic acids were detected during compost making, whereas only four viz., citric, fumaric, malic and succinic acid were present at the spawning time. Shandilya and Munjal (1983) found that quantities of chicken manure, percentage of nitrogen at the start, pH and ammonia percentage of the compost at the time of filling for phase II, percentage of ammonia and pH at spawning affected the yield of mushrooms considerably. There was total

loss of mushroom yields when ammonia in the compost rose to 0.1% at spawning.

Bulk pasteurization was introduced in India in 1980-81 by the FAO/UNDP aided mushroom project with Mr. James Tunney as project manager at the central composting unit at Solan. Mr Tunney adopted the formula of the compost standardized by Mushroom Research Laboratory of the University. Extensive research on bulk pasteurization has been done abroad by Gerrits. In India, Tunney (1980) introduced Tunney Bulk Technology-TBT and yield of 12.98 to 13.60 Kg./sq.m was achieved during different cropping seasons. These yields were significantly better during first and fourth crop whereas second and third crop performance of traditionally pasteurized compost (TPC -12.84 to 13.3 Kg/sq.m) was better than TBT pasteurized compost (Shandilya 1985).

Recently Shandilya and Khurana (1985) and Shandilya *et. al.*, (1986) have suggested modified procedure for bulk pasteurization of compost through which it has been possible to achieve a record yield of 17 to 18 kg/sq.m bed area in a 60 days cropping period with 80 kg of compost under Indian conditions.

KNOWLEDGE

Knowledge is of two kinds. We know a subject ourselves or we know where we can find information.

— Samuel Johnson.

DEVELOPMENT OF CASING MEDIA IN INDIA

.....We, Diet on water, On crumbs of shadow, Bland-mannered, asking Little or nothing .

— Sylvia Plath, *Mushrooms* 1967

T.R. Shandilya

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Solan-173 213 (H.P.)

Casing layer in the culture of *Agaricus bisporus* is the medium in which the growth of cultivated mushroom switches from vegetative phase to reproductive phase. Despite the lack of definite information about casing materials, different media are capable of supporting fruit bodies, but the yield is not the only criterion which has importance; quality consideration are equally important. It is well recognised fact that varying compost influence the yield differently, but this fact has been ignored in respect of casing soils by the researchers and amateur growers. The functioning of the casing layer is known to be influenced by its water holding capacity, physical, chemical and biological characteristics.

Production of fruit bodies on uncased compost has been reported but their number is sparse. Thus casing layer is an important aspect in mushroom growing and under commercial cultivation a casing layer must be applied to obtain adequate mushroom yield. The way a casing material is made and managed after application has a

considerable bearing on its performance in terms of yield.

Mushroom growers in different countries have been using different type of casing material depending upon their availability (Table I.)

Table 1 : Casing materials used in different countries

Country	Type of casing material used (source-Chang & Hayes 1978)
Denmark	Peat/chalk
France	Local sub soil mixture
Holland	Black peat/moss peat/moss/sand
India	Farm yard manure + loam soil/ CaCO_3 . Farm yard manure + 3 years old spent compost (Shandilya and Agarwala, 1983)
Korea	Clay loam sub soil/hydrated lime
Taiwan	Clay loam sub soil/hydrated lime
U.K.	Moss peat/chalk
U.S.A.	Local subsoils, peat/ chalk

The aim of much of the recent researches which involve different casing types has been the commercial evaluation of possible casing media. In established mushroom growing countries research is being aimed at finding alternatives to peat or soil. In countries which are developing this industry, research is being done to find suitable local casing materials.

Since sphagnum peat or any material of good quality which can be used for casing the beds is lacking in India and materials available in India for casing differ markedly from those used in traditional mushroom growing countries, Mantel (1973) recommended and advised the use of one year old spent compost when properly treated for use as casing for Indian farms. Hayes *et al.*, (1976) and Shandilya (1978) reported a number of irregularities during the crop production as yields were poor with one year old spent compost. The flushes were in patches and there was high salt concentration. Hayes and Shandilya (1977) examined the suitability of a range of materials readily available in India as casing. F.Y.M. (farm yard manure-1½ years old), clay soil, loam soil, forest sub soil and one year old spent compost were compared. Mixture of F.Y.M. and loam soil (1 : 1, v/v) was adopted as a standard casing which helped in improving the yield of *A. bisporus* when used in conjunction with improved technique of composting (Shandilya, 1976).

Later, Amarinder Singh (1978) working at commercial farm has also found old cattle manure giving good results. Sehgal (1979) presented a paper at the National Mushroom Seminar held in New Delhi on Jan. 20-21 on the use of farm yard manure as the basic substrate for casing and its influence on increased mushroom yield. Later Garcha and Sekhon (1981) while studying 21 casing combinations have recommended the use of paper mulch + 2 years old spent compost giving highest yield of 8.78 kg/sq.m in 80 days cropping period under natural conditions of Punjab. Singh *et. al.*, (1985) have recently recommended the use of farm yard manure + apple garden soil. It seems from the foregoing account that farm yard manure has become the standard casing for Indian conditions and have always given better yields than any other material available commercially. F.Y.M. being rich in bacterial flora is capable of helping in pinning. Role of such biological factors has also been mentioned by Hayes *et. al.*, (1969) in Irish peat casing soil notably the *Pseudomonads*.

During the past 20 years in other countries much attention has been paid to research in various chemical, physical and microbiological aspects of casing but in India the research has been confined mainly to the development of substrates for casing. Keeping this in view, Shandilya (1982, 83)

carried comprehensive study on different casing materials viz. tree bark (fermented), tree bark (non-fermented), Kashmir peat, farmyard manure, loam soil, compost (1,2,3 years old) and Irish peat for their suitability as casing material. Aerated steam pasteurized farm yard manure in combination with tree bark has given the best production amongst all the media tested. This combination has proved superior in pilot scale trials even to the combination of Irish peat + chalk used by mushroom growers in U.K. These findings being new seems to have a bright future in India where good quality peat is not easily available. Other parameters taken into account were bacterial population, changes in colony types, salt concentration and pH changes taking place during cropping. There has been higher population of bacteria between + 14 to 21 days after casing coinciding with pinning. There has been inhibitory effect on bacterial population by a group of microorganisms which release some inhibitory substances that interfere with the mycelial growth. Since the implication of such inhibitory organisms in casing materials has not been reported from any country so far, it opens a new avenue of research to explain the vexed factors controlling the yield. The pH of casing media decreases and salt concentration increases with the progress of the crop which is detrimental to fruit body formation. Various ions responsible

for the salt accumulation have been identified by Shandilya and Hayes (1983).

Mantel (1973) recommended the treatment of casing material with formaldehyde which is still in vogue in many mushroom farms and research centres in the country but Shandilya *et al.*, (1976) recommended the treatment of farmyard manure + loam soil standard casing with live steam (60C for 1 hour) plus benlate which yielded better than formaldehyde treatment. It was noted by Shandilya (1978) that bacterial blotch (*Pseudomonas tolaasii*) and bacterial pit (cause unknown) occurred in fruit bodies from trays cased with farm yard manure. In order to get blotch free pilei, Shandilya and Munjal (1983) suggested the treatment of standard casing material with live steam at 65 C 4 hours. In case facilities for boiler are not available, Shandilya (1986) suggested drum method of steaming the casing material which is an improvised method of pasteurization. Singh *et al.*, (1981) have also suggested the sterilization of casing mixture with steam which was better than chemical treatment. Shandilya and Munjal (1983) have further suggested the exact time of casing, as the mycelium is active after a certain period and this critical period (CP) of mycelial activity in the compost is an important factor in deciding the time of casing. Garcha *et al.*, (1981) have suggested the supplementation

of casing with pyrite and zinc which resulted in increase of 72.7% and 50% respectively in mushroom yield under climatic conditions of Punjab.

In recent years there has been a rapid progress of mushroom cultivation in India especially after the adoption of

improved compost and casing technique developed and standardized by Shandilya (1976), Hayes and Shandilya (1977) and Shandilya and Hayes (1976) with which the yields of mushrooms have been increased by about 133%. Table 2 shows yields obtained under Indian conditions since its inception in 1962.

Table 2 : Yield levels of button mushrooms in India during different years

Year	Yield	
1964-65	2-3 kg/sq.m	Introduced improved compost technique
1970-71	5-6 kg/sq.m	based on short method of composting
1974-75	9-10 kg/sq.m	in conjunction with new casing technique
1980-81	12-13 kg/sq.m	with farmyard manure as basic substrate.
1982-83	13-14 kg/sq.m	Bulk Technology Introduced by Tunney-Tunney Bulk Technique —TBT
1985-86	17-18 kg/sq.m	Modified Bulk Technology (MBT) plus improved management of crop technology

Repeated trials have proved the importance of highly improved technology of compost, casing and management of crop in obtaining high yields under Indian conditions, Himachal Pradesh in particular. It is obvious from Table 2 that Bulk pasteurization techniques have led to higher yields. People in India do not have the

necessary structure, machinery and knowhow. Therefore opening of central community composting units (CCCU) in different regions of the country as such will contribute to the continuous improvement and in coming few years can make India the largest mushroom producing country of the world.

ADVICE TO GROWERS

You should study enough of technology and science to understand the results of research and development, not only to be able to take advantage of the new information but also to protect yourselves from it.

— J.W. Sinden, 1961.

DISEASES, COMPETITORS AND WEED FUNGI OF AGARICUS BISPORUS — THEIR PREVENTION AND CONTROL

Hygiene is a matter of priorities in that a spotlessly clean farm may glitter as being the model of hygiene standards but have great technical failings Simply sweeping the problems down the drain will not correct things.

— G. Ganney, 1983

B. Vijay, R.C. Upadhyay and Yash Gupta

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Hygiene is of utmost importance in mushroom cultivation. Unhygienic conditions in and around mushroom growing houses may cause infection of diseases and competitors, which may result in the crop losses and sometimes complete crop failure. Hence care should be taken to keep cleanliness in and around mushroom house.

Following precautionary measures should be taken :

— Compost should always be prepared on the cemented and roofed floor and the floor should be disinfected with 2% Formalin before the stacking.

— Spawning should be done in clean and well disinfected room and any contaminated spawn bottle should outrightly be rejected.

— Formalin (2%) should be sprayed in the growing room 24 hours in advance, before bags and trays are kept there for spawn running.

— Shoes should always be soaked in 2% Formalin solution before entering the growing room.

— Disinfected tools should be used for harvesting.

— Mushroom butts should not be left on the bags/trays and harvested portion should be cased immediately.

— Open and diseased mushrooms should immediately be harvested and dipped in Formalin solution.

— Proper preventive measures should always be taken against the spread of any pest/disease/competitor and its further dissemination in other trays or bags.

— Spent compost should not be kept in the vicinity of cropping rooms.

— After termination of the crop the trays should be thoroughly disinfected by dipping in 2% Formalin solution.

— The room should be disinfected with 2% Formalin spray after the termination of the crop.

Like other crops, mushroom crop also suffers from the ravages of nature, physiological disorders and diseases caused by other organisms. Diseases appear on the sporophore in general, while the competitors are present in the

compost and compete with *A.bisporus* mycelium for the substrate resulting in delay of crop, low yield or even complete crop failure. Weed fungi also draw nutrition from the compost and interfere in the normal growth of *A.bisporus*.

Following are the important diseases/competitors of mushroom (*A.bisporus*) and their control.

Name of the disease/competitor	Causal organism	Symptoms	Control
Dry bubble	<i>Verticillium fungicola</i>	Light brown spots on the cap and downward splitting of stem resulting in shattered appearance.	Spray Benlate @ 0.05% at 10 days interval.
Wet bubble	<i>Mycogone pernicioso</i>	Whitish mouldy growth on sporophore followed by oozing of brown liquid with unpleasant smell.	Spray 0.05% Benlate or Bavistin.
Cobweb disease	<i>Dactylium dendroides</i>	Cottony white mycelial patches on the casing soil and on sporophore.	Spray Dithane M-45 @ 0.2% and reduce humidity to 80%.
Bacterial blotch	<i>Pseudomonas tolaasii</i>	Circular yellow to brown sunken spots on the cap.	Reduce humidity, run fan after spraying of water and spray 150ppm chlorine water.
Brown plaster mould	<i>Papulaspora byssina</i>	Whitish patches on the compost in the initial stages, later on light brown to rust brown.	Treat infected patches with 2% formalin and regulate moisture in the compost (70%).

Olive green mould	<i>Chaetomium olivaceum</i>	Grayish white mycelium in the compost along with <i>A.bisporus</i> mycelium	Proper pasteurization of compost along with ample supply of air during peak heating. Spray with 0.2% Dithane M-45.
Green mould	<i>Trichoderma viride</i>	Small blue green cushions on spawned and cased trays. Also grows around the dead butts of mushroom. spawn run is affected, dry sunken brown spots on the stem and cap.	Spray Bavistin @ 0.05% at 7 days interval. Dead mushroom butts should not be left on the trays.
White mould	<i>Cephalothecium roseum</i>	White mouldy growth turns pink in due course in compost or casing soil.	Spray 0.04% Captan at 7-10 days interval.
White plaster mould	<i>Scopulariopsis fimicola</i>	Dense white patches of mycelium on compost and casing soil giving flour like appearance.	Compost should be properly prepared with less than 8 pH.
Lipstick mould	<i>Geotrichum sp.</i>	White mycelial growth on compost or casing soil changing to pink and buff colour.	Maintain good farm hygiene.
False truffle	<i>Diehliomyces microsporus</i>	White creamy mycelium on compost turning to thick, solid wrinkled mass resembling brain like structure.	Maintain proper hygiene and lower down the temperature to 15-18C.
Inky caps	<i>Coprinus spp.</i>	Sporophores develop rapidly often before actual mushroom appears. At maturity disintegrate into black slimy mass of spores.	Eliminate ammonia from compost at the time of filling of trays and rougue out the caps.

MITES IN MUSHROOMS

Life creates in its environment the conditions favouring its existence.

— V.I. Vernadsky, 1965

C.D. Thapa

Mushroom Research Laboratory
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Solan-173 213 (H.P)

Different types of mites have been found to be associated with the mushroom crop. Some of them are known to be harmless but they are potentially dangerous distributors of diseases whereas others have been found to be serious pests of edible mushrooms such as white button mushroom, paddy straw mushroom and others. The mites are small, sub-microscopic, with white, yellowish brown or reddish brown colourations. These are different from insects and belong to the class Arachnida and order Acarina. The body of a mite is sac-like with piercing and sucking type mouthparts and the cephalothorax and abdomen being broadly joined without any distinct segmentation. In some cases they have glistening bodies. They bear developed palps on the head and possess four pairs of legs.

Several species of mites belonging to different genera such as *Tyrophagus*, *Tarsonemus*, *Tyroglyphus*, *Caloglyphus*, *Rhizoglyphus*, *Oppia*, *Linopodes*, *Pygmephorus*, *Siteroptes*, *Brennanda-*

nia, *Parasitus*, *Digamesellus*, *Arctoseius* and *Gamasus* have been reported to be associated with the mushroom crop in different parts of the world.

These tiny creatures create nuisance in the mushroom house in various ways. The harmful mites like species of *Tarsonemus*, *Tyroglyphus*, *Tyrophagus*, *Oppia* etc. damage the crop directly by feeding on the spawn and mycelium, nibbling holes in mushroom caps and stalks.

Sometimes they chew the mycelial strands around the bases of the stalks leaving them rounded and rust coloured. *Tyrophagus putrescentiae* has been reported to be the most common and serious pest among mites in the mushroom growing countries including India, and causes small, irregular pits in stalks and caps which become slimy with bacterial decomposition and the buttons are completely hollowed out. Other mites belonging to the genera *Pygmephorus*, *Parasitus*, *Digamasellus*, *Arctoseious*, *Gamasus* etc. do not damage the crop directly.

Almost all of them feed on the weed moulds only but may create difficulty for workers as they crawl all over the body parts. They are also reported to carry disease spores on their bodies and sometimes mushroom viruses also.

Mites are generally attracted by the mycoflora like *Trichoderma*, *Chaetomium*, *Sepedonium*, *Aspergillus* etc. developed in a substandard compost in which they feed and reproduce readily. Phoretic behaviour of mites with mushroom flies like sciarids and phorids have been reported. Improperly pasteurized compost, casing soil, older infested beds, spent compost lying nearby, contaminated implements and mushroom flies are the common sources of mite infestation in the new mushroom beds.

The mites generally complete their life cycle in four stages i.e. egg, larva, nymph and the adult stage. Eggs are laid in batches which hatch and six legged larvae come out of eggs. They feed on the mycelium and undergo moulting into eight legged nymphs which are similar to the adults in morphology but are smaller in size and lack genital pore. A generation generally takes 4 days at 77F, 5 days at 68 F and 7.5 days at 60 F. The humid atmosphere and 15-20 C temperature in the mushroom house have been

found to be favourable for the growth and reproduction of these mites.

Proper hygienic conditions all around the mushroom farm and a properly peak heated, good quality compost will not encourage the other weed moulds to grow in it and as a result the growth of mites also gets discouraged. Similarly proper sterilization of casing soil, timely spray of diazinon 20 E.C. (Ditaf) @ 30 ppm in the compost at the time of filling or kelthane 18 E.C. (Dicofal @ .01-.02%) on the mushroom beds, drenching of mushroom houses from time to time with endosulfan, diazinon and dicofal followed by cook out of the beds at the end of the crop at 71 C for 10-12 hours have been found to be the most effective control measures against mites. Spraying of other chemicals like Birlame, Sumithion, Lebaycid, EPN, Trithion or Metasystox @ 1 g/m² (on a.i. basis) on the beds immediately after spawning and before casing was found to give good control of mites without any crop reduction (Han et al., 1977). Szudyga (1978) also recommended treatment with DDVP in the form of aerosol sprays against the attack of mites on *Stropharia rugoso-annulata* whereas Delmas (1978) recommended addition of lindane dust at first turning and diazinon at each turning of compost and on the beds before and after casing.

BIO-CONTROL OF MUSHROOM NEMATODES : A PROMISING PROPOSITION

Large red mites hanging on the legs of some adult female Sciariids gave me some encouragement that biological control was following natural selection.

— G. Ganney, 1984

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Nematodes are the most dreadful pests of mushroom, being incipient and difficult to control once infestation occurs in the mushroom beds. They have a tremendous rate of multiplication and cause 26-100% losses depending upon the initial inoculum, nematode species involved and time of entry into the compost. The source of infestation are variable including almost every ingredient, implement or organism associated with the mushroom culture. Nematodes can also manage to escape the heat of pasteurization or the toxic effect of chemicals used against them. They can even survive in the absence of the main host (mushroom) in soil or on organic decay fungi, thus perpetuating for longer durations.

The use of pesticides is generally recommended for the control of mushroom nematodes but, the potential pathogenic ability of the nematode, the safe concentration of the pesticide, the degree of control achieved and

the duration of the crop points out for some appropriate and economical alternative. Studies carried out at this Centre reveal that pesticides cannot be safe, viable, appropriate and economical in controlling these tiny but inimical organisms. In view of these facts, biological control seems to be one of the promising possibilities besides proper pasteurization.

Attempts are being made to control the nematodes by the use of plant extracts. Out of the various plant extracts tried against *Aphelenchoides composticola*, seven have showed promising results. The plant extracts besides being toxic to the nematodes, increased the mycelial growth of *Agaricus bisporus* by 17-125 per cent. The incorporation of dried plant materials in the compost before spawning also gave 6-27 per cent increase in yields. In addition, these extracts have an added advantage of being selectively fungicidal. Out of 20

commonly occurring competitor moulds the neem extract was effective against most of them. The incorporation of this extract in the compost also changed the mycoflora. It encouraged the growth of some desirable fungi including nematode trapping and antibiotic producing fungi and inhibited the growth and sporulation of most of the unwanted competitor and pathogenic fungi. Further studies revealed that the fungal extracts were toxic to the nematodes and none of the fungi were potential competitor of *A. bisporus*.

These studies indicate towards the development of a balanced ecological system in which the incorporation of the dried plant materials in the compost increased the yields of mushrooms on one hand and suppressed nematode population by way of their direct toxicity and indirectly by encouraging the mycoflora inhibitory to nematode and other fungi. However, these aspects need further study so as to confirm the possibility of above approach on a larger scale.

PARASOL ANTS

The food of Attine ants are the Basidiomycetous fungi especially *Agaricus* and other genera of mushrooms. They gather leaf material into their subterranean nests and use it as a substrate for growing these fungi. The larger ants cut the large leaf pieces into smaller fragments and pulp it by continuous licking and pressing with the margins of their mandibles. The tiny ants tend the fungi in the fungus garden and as the fungus grows on its substrate, it produces short aerial hyphae which terminate in swollen, cytoplasm-filled organism called gonglydia. These nutrient rich cells are eaten by the ants and fed to their larvae. Whenever new leaf fragments are added these are inoculated with minute tufts of hyphae picked up by the worker ants from the fungus garden. The food fungi convert the indigestible substrate especially cellulose into proteins and carbohydrates and form the gonglydia for the ants. This fungus surprisingly does not fruit within the nests and cannot exist naturally in the free living state outside the nests although they can be cultured in laboratories. Thus the fungus is given shelter and nutrients in the form of carbon rich leaves and nitrogen rich anal droplets by the ants. As, only one species of fungus grows in the nests of any particular ant, the maintenance of pure culture of this food fungus by the ants is the most remarkable achievement of nature.

— K.B.M

MUSHROOM — A PERFECT FOOD

Is a mushroom a fruit or a vegetable ? I know it is fungus. But, "Eat more fungus" makes poor reading.

— F.C. Atkins, 1945

R.D. Rai

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Mushrooms have been devoured since time immemorial for their flavour, texture and taste but their nutritive value was recognized recently. Knowledge of nutritive value of any food item increases its consumption and helps formulate balanced diets, correct inadequacies through judicious use of available food stuffs and plan agricultural policies. Elite and common man alike are quite conscious about health and nutrition.

It is now fully recognized that mushrooms are highly nutritive — a good source of good quality protein, vitamins and minerals. Average Indian diet is primarily cereal-based and abundant in calories but it is highly deficient in protein. Widespread protein malnutrition (kwashiorkor, marasmus, anemia) particularly in children and women of the vulnerable groups is the biggest nutritional problem in our country. Requirement of protein is more of quality than of quantity. Based on the contents of the essential amino acids, the proteins

have been classified as good, intermediate and poor quality proteins. In general, as single source, plant proteins (cereals & pulses etc.) are of poorer quality than animal proteins (milk, egg, fish, meat). It has been recommended that one third of total protein intake should be of good quality protein i.e. of animal origin. Deficient intake of protein, particularly 'first class' protein is the main dietary defect in India. Mushrooms contain 20-35% protein (dry weight basis) which is higher than in vegetables and fruits and mushroom protein is of very good quality and, as per recent studies, are as good as animal protein. Cereals, the staple constituents in Indian diet, are deficient in two essential amino acids namely, lysine and tryptophan; mushrooms are very rich in lysine and tryptophan and can effectively supplement cereals in our diet. Keeping in view the declining per capita availability of pulses, mushrooms fit in very well in the diet of predominantly vegetarian population of our country for bridging the 'protein

gap'. Mushrooms have been recognized by the F.A.O. as food contribution to the protein nutrition of the countries depending largely on cereals.

In addition to good quality protein, mushrooms contain fairly good amounts of vitamin C and vitamins of B complex group particularly thiamine, riboflavine and niacin. Folic acid and vitamin B₁₂ which are so much needed by the pregnant and lactating women and are almost absent in vegetable food, are present in mushrooms. They contain high quantities of potassium, sodium and phosphorus but comparatively deficient in calcium. Though iron is in low quantity but it is present in 'available' form and has been shown to maintain blood haemoglobin level. As compared to other food substances potassium : sodium ratio in mushrooms is very high which is desirable for the patients of hyper-tension.

Mushrooms are a low calorie food with very little fat and are highly suitable for obese persons. With no starch and very low sugars, they are the 'delight of the diabetic'. Fat content of mushrooms though low is rich in linoleic acid, an essential fatty acid. Cholesterol, the dreaded sterol of the heart patient, is absent and instead ergosterol is present which could be converted by body to vitamin D. They have also been reported to contain specific blood cholesterol reducing substances. Mushrooms with low fat which is rich in linoleic acid and is free

of cholesterol are the 'dieticians diet' for the heart patients. Mushrooms due to alkaline ash (high sodium and potassium) and high fibre content are highly suited to the patients with hyperacidity and constipation.

There is a wrong notion, primarily due to higher price, that white button mushroom is more nutritious than other mushrooms. *Pleurotus* and *Volvariella* are as nutritious as *Agaricus*. It is generally thought that mushrooms are beyond the reach of poor malnourished people due to prohibitive prices but this notion has crept in when the poor are thought to be the only consumers. In India, more than 90% of the people below poverty line live in villages where consumers are producers also so far as food is concerned. Moreover, mushrooms can be cultivated by landless workers also as it does not require land, can be cultivated indoor on a variety of agricultural wastes which are abundant in rural India. *Pleurotus* and *Volvariella* should particularly be recommended in this regard. Small farmers and landless workers should be motivated to produce and consume *Pleurotus* and *Volvariella* due to simplicity of cultivation.

Owing to the nutritive value and their capability to produce one of highest amounts of good quality protein per unit area and time from worthless agricultural waste, production and consumption of mushrooms ought to increase.

COOKING WITH MUSHROOMS

"Of course mushrooms contain no additives"

— N. Dickie in 'Mushrooms as a Food'

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Owing to recent commercialization and introduction of mushrooms in Indian markets, the housewives are hesitant to cook it. Besides possessing good nutritive value mushrooms have appreciable culinary quality and are easy to cook. Looking into the vegetarian food habit of Indians there appears to be a tremendous scope of mushrooms finding a place on table menu. In fact, in marriages or other important ceremonies mushroom dishes have occupied a prestigious place. Mushrooms can be cooked into a variety of dishes like salad, sandwich, omelette, soups, stew, souffle, sauces, pizza, vegetable stuffings and curries in combination with other vegetables, rice pulao, pakoras and pickle.

Mushroom being a new vegetable has often led to various misconceptions in the consumers mind. The mushrooms cultivated commercially are neither poisonous nor they turn poisonous on storage. Besides, open mushrooms with exposed brown

coloured gills are also consumable. In fact, for some recipes in Europe, only open (cup mushrooms) are used as they have stronger mushroom flavour. However, care should be taken to purchase fresh and healthy mushrooms which can be ascertained by absence of rotten smell. Insect larvae also damage the mushroom by boring tunnels into it which can be clearly seen by cutting open the mushrooms. These are very simple tips which become clear with little experience.

Before cooking, mushrooms should be cleaned gently with running tap water to remove sticking debris. Mushrooms are never peeled; instead, are cut, preferably vertically, into 2 to 4 pieces. Mushrooms unlike other vegetables, retain their shape and do not dissolve into the curry while cooking. Hence a single steam pressure is enough to retain the nutrients as well. Mushrooms can be cooked in curry or non curry recipes alongwith a variety of vegetables like green peas,

capsicum, tomato, cottage-cheese etc., the pea mushroom being the most common recipe. Cooking can be done in the traditional Indian style and mushrooms are added only after frying the 'masala' (normally containing onion, garlic, ginger and other condiments and spices as per taste). The mushroom can be fried a little (they tend to leave surplus water on frying) which is followed by addition of vegetable and water (if desired) as per normal cooking procedures. Mushrooms grounded finely in a mixer (with little water) can be added to thicken the gravy and to incorporate extra flavour.

Mushrooms can also be grated or sliced into a stuffing for sandwich, omelette, pizza, souffle, sauce, vegetables (like capsicum) patty, hotdog, hamburger or even dosa or may be used for garnishing rice, vegetables, dessert etc. The finely cut slices can be used for decorating salad or added into rice for preparing rice mushroom pulao.

For preparation of soup, mushroom pieces are fried lightly alongwith onion

and boiled for 5 minutes with water and milk. The soup can be thickened by further cooking with little corn flour. For preparing pakoras whole or sliced button mushrooms can be used. The paste of gram flour with necessary spices should be thick enough to stick properly around the mushrooms.

For making pickle, cut mushrooms are fried in mustard oil till brown and cooked. Various condiments including onion, garlic, ginger, methi, ajwaen, zeera, kalonji, chillies, salt etc., are fried in sufficient oil separately and added to the fried mushrooms. Like other pickle preparations, the oil cum masala should be sufficient to soak the mushrooms. The pickle can be kept in sun for a few days for curing. Vinegar and potassium metabisulphite can be added for longer storage.

The mushroom recipes available in foreign books are more suitable for European taste but looking into the diversity of pattern of cooking, it will not be at all difficult to blend them into any of our Indian recipes.

IMPRESSIONS

We judge ourselves by what we feel capable of doing, while others judge us by what we have already done.

— H.W. Longfellow.

MUSHROOM CULTIVATION AND RURAL DEVELOPMENT

Why are the villages so important ? One of the obvious reason, of course, is that the vast majority of the people of our country live their lives out in the villages. If there were no other reasons, this single one should have been sufficient for the villages to receive our utmost possible attention.

— Jaya Prakash Narayan

Mira Madan

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As this title goes, one should not understand that mushroom cultivation is synonymous to rural development. However, one should recall to oneself that Government of India is concerned with poverty alleviation. Poverty is lurking in India, mostly in the villages, because of unemployment, underemployment, and below sustaining levels of living. There are large number of people who are landless, marginal and small farmers. Artisan families cannot make their both ends meet. Government of India is utilizing various means and methods to improve the lot of villagers in multifaceted dimensions.

Any new technology, improved methods in anything related to agriculture is bound to give boost to the rural economy. If one thinks of poorest of the poor and also seeks the development of women in vocation, which

has income generating potential is really talking of rural development, in that sense, one can say mushroom cultivation for development, without hesitation.

Anything which does not demand too much land, costly seeds, fertilizer, irrigation input should be the choicest approach in the village. Less time consumption, no drudgery, in-door or nearby space availability are the advantages of mushroom cultivation. This activity can bring money in abundance when marketed to elite and city dwellers. Hence pursuance of this vocation increase the family income and purchasing power of the family. Food problems in our country are of varied kind. Mushroom plays an important role to enrich human diet. Mushroom is good source of protein, vitamins and minerals and hence is an

important alternate source of energy, human development and growth and nutrition well being. One should reach that large majority of Indian population which are vegetarian and mushroom can fill in the gap for protein and other essential vitamins and micronutrients. The protein of edible mushroom is also known for its nutritive and biological value. The starch content of mushrooms is very low and therefore, the same becomes ideal food for diabetic patients. Mushroom continue to be a delicacy with the rich and thus spins lot of money on marketing. The food value being good, promotion of mushroom consumption can be done for the poor families. This will go a long way to combat malnourishment as prevalent in the villages. The cost and effort of mushroom growing is very low as straw, dried leaves, some weeds, dung and waste from food and cottage industries needed for mushroom cultivation is available in plenty. The above named materials remain unused except for a limited amount which is used as cattle feed.

Mushroom growing as a matter of fact, is the process of recycling these waste products efficiently and has various advantages like :

- conserves available national resources;
- recovers useful products like food (microbial protein);

- post harvest waste of mushroom residues becomes fuel to be used in biogas production;
- the spent residue is fertilizer (rich in nitrogen when *Pleurotus* spp. are grown) in form of slurry or as such;
- the spent residue (*Pleurotus* spp.) is useful as cattle feed.

At present three edible mushrooms *Agaricus bisporus*, *Pleurotus* spp. and *Volvariella* spp. are commercially cultivated in our country and the technique for their cultivation has been standardised suiting the local Indian conditions.

More essentially, mushroom cultivation should be adopted by rural women because with this part-time activity they can look after home related chores. This technique in terms of equipment and skills are within her reach and can have reasonable return for labour. Mushroom growing is a labour intensive activity as approximately 30 per cent of cost of production is spent towards manual picking of mushrooms. The advanced countries are concentrating their energies to develop labour saving devices through mechanisation. On the other hand, in India, we are looking for additional avenues of employment for the under employed in rural areas. This income generating activity fits very well in our present scheme of rural development.

The professionals and the scientists should explore avenues in supplying technology for various types of edible mushrooms and promote large scale cultivation. There is considerable need of training at intermediary and grass root levels with focus on women. This challenge be accepted and be given highest priority, community awareness and community participation in mushroom cultivation appears the key. Voluntary agencies of various types can make in-roads in these efforts.

Highest priority for mushroom cultivation should be given to tribal areas (wherein forest resources and biomass are surplus) followed by areas having scheduled caste population and other backward regions.

As of now, heavy dependence continues for spawn procurement on few laboratories, which are sparsely available and distantly located. This situation becomes an obstacle. Hence, it is high time that private ventures come forward to make the mushroom seeds widely available.

WOMEN — HERE TOO !

When a conference of French mushroom growers was convened in Paris in 1968, there was a ripple of surprised murmuring as the principal speaker ascended the rostrum. "This is Dr. E. Hauser", asked one mushroom farmer. "I had no idea Dr. Hauser was a woman"..... so starts the article written by Beth Day in Reader's Digest, October 1970. There are many more such names like G. Eger-Hummel, G. Fritsche, D.G. Gandy, T.A., Quimio, C.A. Raper. This by no means is a complete list. There may be many more women contributing directly and indirectly to the mushroom development all over the world.

— M.S.B.

ROLE OF BANKS IN FINANCING MUSHROOM PROJECTS

It is possible to fail in many ways while to succeed is possible only in one way.

— Artistotle

H. Bharath Kumar

Do (Tech) NABARD, Bombay

The institutional finance has a significant role to play in promoting mushroom production in India. Cultivation of mushroom helps the small and marginal farmers to raise their income, diversify economic activity, and to create gainful employment especially for unemployed youths, weaker sections of the society, women folk etc. It also increases food production from unused resources raising nutritional standards and also create export potential.

Keeping in view the above points the National Bank for Agriculture and Rural Development as an apex institute for refinancing agricultural and allied activities has taken initiation in popularising mushroom cultivation through credit. In this direction, NABARD has prepared a model scheme on mushroom development and circulated to all the Banks advising them to prepare technically feasible and economically viable project and implement in both traditional and non-traditional areas. NABARD has considered mushroom development on commercial scale as one of the

innovative field of investment. As a result of NABARD's involvement, several banks have formulated and are implementing mushroom schemes all over the country.

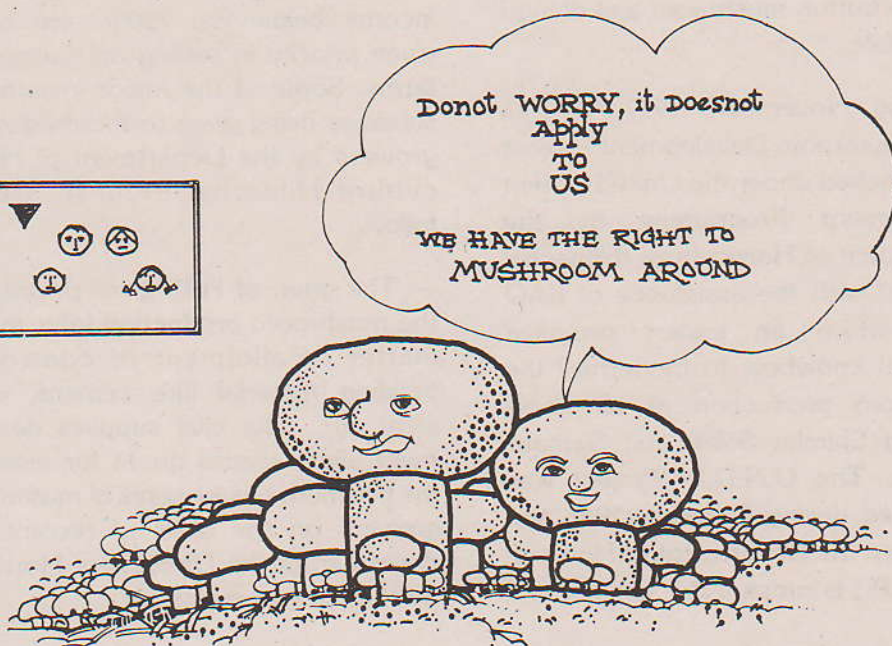
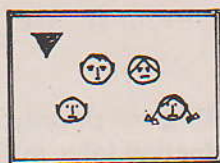
The commercial banks and other financial institutions provide long term loan for mushroom production to the extent of 85 to 90% of the total project cost and charge interest at the rate of 10% to small and marginal farmers and 12.5% to big farmers. The terms and conditions of the loan will be at par with the other agricultural credit. In turn commercial banks get refinance from NABARD. Apart from the normal lending, in traditional areas of mushroom cultivation where the small and marginal farmer cultivates mushroom under open conditions, this activity could be included under integrated rural development programme. In this case the loan component will be reduced because the government provides subsidy to the tune of 50% to scheduled tribes and 33.3% to others of the total project cost.

The various activities of mushroom production for which banks provide loan are :

- commercial cultivation of mushroom—*Agaricus* as well as *Pleurotus*
- mushroom production and setting up of canning units
- spawn production unit
- compost production unit.

Commercial production of mushroom under controlled conditions need a huge capital investment in a planned manner. This necessitates the grower to go for bank loan. As this is an innovative type of activity with lot of potential for internal consumption and export, banks have no constraints in considering technically feasible and economically viable mushroom projects.

NABARD has sanctioned about 22 schemes (7 each in H.P. and Punjab, 2 in Tamil Nadu, one each in Kerala, Bihar, Meghalaya, Haryana, Chandigarh and Jammu & Kashmir) and disbursed refinance to commercial banks to the tune of 27 lakhs as on June 1985. Many more projects are in the pipeline. With the active participation of other research and extension agencies combined with bank financing one can hope that the consumption of mushroom will reach the common man. Recently NABARD has commissioned a study on prospects of Mushroom Development in Western and Southern parts of the country in collaboration with FAO and report of the same is expected.



ROLE OF UNDP/HORTICULTURE DEPARTMENT IN POPULARIZING MUSHROOMS IN HIMACHAL PRADESH

There is no doubt that the scientist should have communion with the grower and the grower access to the laboratory, but it should be in a spirit of mutual understanding, each respecting the position and needs of the other.

— J.W. Sinden 1961

H.L. Kochhar

Project Director,
Mushroom Project, Deptt. of Horticulture, Chambaghat, Solan

The agroclimatic conditions prevailing in Himachal Pradesh are very congenial for the development of mushroom industry. This climate has been greatly exploited by setting up a nucleus infrastructure for the supply of high quality spawn, compost and other facilities for encouraging the cultivation of white button mushroom and dhingri in the state.

During November, 1977, a 1.27 crore Mushroom Development Project was launched under the United Nation Development Programme by the Department of Horticulture (Himachal Pradesh) with the assistance of FAO under which an expert provided technical knowhow to modernise the mushroom production at all levels covering Shimla, Solan and Sirmaur districts. The U.N.D.P. Project was concluded during October, 1982 and since then the Department of Horticulture (H.P.) is running this project and

providing all the facilities and incentives for the development of mushroom industry in Himachal Pradesh which were available to the growers under the U.N.D.P. Project.

The scheduled castes/scheduled tribes, small and marginal farmers and unemployed graduates having annual income below Rs. 7500/- are being given priority in setting up mushroom farms. Some of the major incentives/subsidies being given to the mushroom growers by the Department of Horticulture Himachal Pradesh are as follow.

— The govt. of H.P. gives priority to the mushroom production units in the matter of allotment of controlled building material like cement, iron, steel, etc. The civil supplies department allots special quota for meeting the minimum requirements of mushroom growers on the basis of recommendations from the Director of Horticulture or his representative.

— A maximum subsidy to the tune of Rs. 2500/- is provided on capital investment.

— The cases of mushroom cultivators are sponsored to the commercial banks for providing loan on capital investments up to a maximum of Rs. 2500/- and subsidy of 3% is provided on the rate of bank interest.

— The quality compost is supplied on 50% subsidy to the scheduled caste and scheduled tribe and 25% subsidy to small/marginal farmers and poor unemployed graduates up to 400 trays. Casing soil is supplied free of cost to all the categories of growers.

— Since compost is the major material in the production of mushroom, there is provision of freight subsidy to the growers of the eligible categories. The subsidy on freight of compost and casing soil is 100% upto 400 trays and is borne by the Department of Horticulture (H.P.). The growers taking compost from the department on full cost are provided transportation facilities on departmental rates.

— During training a subsistence allowance of Rs. 8/- per day and to and fro fare is provided to the candidates of Himachal Pradesh belonging to eligible categories.

During 1981, three bulk pasteurization chambers having total capacity of about 80 tonnes/month were

constructed to provide pasteurized compost to the growers of Himachal Pradesh. Previously this unit was run by hpnc but recently it has been transferred to the Department of Horticulture, (H.P.).

A mushroom training-cum-demonstration centre has been set up to provide practical training to the persons interested in mushroom cultivation and the Department of Horticulture (H.P.) with the assistance of scientists of University of Horticulture and Forestry and National Centre for Mushroom Research and Training have organised training camps in which 1260 persons have been provided practical training out of which 1067 belong to Himachal Pradesh.

Before this project came into existence the annual production of mushroom was estimated to the order of 50 tonnes which during the year 1985-86 was estimated to be 500 tonnes as against a total annual production of 1500 tonnes in the country. During the year 1986-87 a total budget of Rs. 16,14,000/- has been ear marked for this project for the development of mushroom industry in the state. With the Dutch assistance a mushroom project is being established at Palampur which is to be started during the current year. With the establishment of this project the growers in Kangra district will get incentives for mushroom cultivation.

DEVELOPMENT OF MUSHROOM INDUSTRY IN JAMMU & KASHMIR

"The Kashmir Valley is probably one of the few ideal climates for mushroom cultivation in the world.....The favourable climate, the general availability of straw-main raw material required for mushroom production, and the large number of unemployed justify its establishment".

— Dr. W.A. Hayes

T.N. Kaul

Head, Regional Research Laboratory (Branch),
Sanat Nagar, Srinagar - 190 005

Though cultivation of mushroom has been common in many countries of west and some countries in the east for nearly three centuries, yet it was non-existent in India till about two decades back. India, being a vast country with varied climatic conditions and diverse vegetation, always possessed abundant natural mushroom wealth. In many regions of the country these are collected locally and used as food. However, these collections from wild sources are not always dependable and are subject to fluctuations in climatic conditions. Also sometimes due to the existence of poisonous species in the market collections, they pose a health hazard.

Cultivation of *Agaricus bisporus* (white button mushroom) in Jammu and Kashmir was started on an experimental basis in 1964 by Regional Research Laboratory, Jammu. With initial success in experimental pro-

duction, some entrepreneurs in Srinagar city started cultivation on a small scale in 1967 with technical guidance of Regional Research Laboratory (Branch), Srinagar. This activity extended slowly to the rural sector and by 1973 about twenty-five people mainly school teachers in rural areas were engaged in the activity. A major breakthrough occurred in 1975, when ninety growers having about 7,000 trays were engaged in this activity in rural areas alone. This activity caught the imagination of rural people so much that in some villages like Inder (Pulwama Tehsil) and Batahar (Badgam Tehsil) practically everybody was involved in this activity in 1976.

The sale of spawn from Regional Research Laboratory over a decade increased from 111 bottles in 1969 to 1880 in 1974, 9,000 in 1976 and 30,000 in 1979. Besides, Regional Research Laboratory, the Department of Agri-

culture, J&K Govt. also sold spawn to the growers. About 200 tonnes of fresh mushrooms were produced in the peak year of 1979 in Kashmir Valley. The production since then has not gone up. It has been fluctuating with the market demands. The activity got extended to the Jammu province subsequently. The current year's (1986) estimate of production in Jammu district alone has been put at 100 q fresh mushrooms, by J&K Agriculture Department.

Dr. W.A. Hayes, FAO Consultant in his report on mushroom industry in Jammu and Kashmir observed that :

"This laboratory (RRL) together with the State Government, Department of Agriculture, Laboratory at Lal-Mandi, have pioneered a unique and highly successful mushroom industry, involving the villagers of the Kashmir Valley. These laboratories have manufactured and supplied spawn to the villagers of the valley and provided guidance and technical advice on the cultivation of mushroom in primitive situations".

Factors responsible for the phenomenal success of mushroom industry in Kashmir are : (i) easy availability of raw materials i.e. paddy or wheat straw (ii) well developed canning industry (iii) significant economic gains as a motivating force (iv) cooperation of banking institutions and (v) promotional efforts of SFDA (Small Farmers'

Development Agency) and MFDA (Marginal Farmers Development Agency).

Cultivation mostly has been as contract growing for canners. These canners have determined the volume of annual production in the valley. However people in rural areas are now fully aware of cultivation technology and market potentials. With suitable incentives from appropriate agencies, the mushroom industry can produce a crop worth 20-30 crore rupees annually.

Besides the development work for promotion of white button mushroom industry in the region, investigations were also started in 1964 for locating other edible mushroom species and to bring them under cultivation. We collected a species of *Pleurotus* (later identified on *P. flabellatus*) growing on stumps of *Euphorbia royleana* in 1965 from Katra region of Jammu province. Technology for its cultivation on paddy straw was perfected and released to the growers in 1980. In view of its ease of production and preservation, it has now become popular with the growers in Jammu and Kashmir with an annual production of 5 tonnes.

In conclusion one would say that firm foundations of mushroom industry has been laid in Jammu and Kashmir. With suitable promotional efforts, the industry has a great future in the region.

MUSHROOM CULTIVATION AROUND DELHI

Today it is no longer a question of producing a luxury food reserved for the few only, but to produce an important food stuff, a source of important nutrition, which will probably in the not too distant future have a comprehensive influence on the menu of the ordinary family.

— Dr. C. Treschow, 1959

Nita Bahl

Division of Mycology & Plant Pathology,
Indian Agricultural Research Institute,
New Delhi - 110 012.

Mushroom farming is becoming successful because of its very low inputs. It is estimated that about 300 million tonnes of mushroom can be produced in the world from just one fourth of annual yield of straw (2,235 million tonnes) providing 4,100 million people with 250 g fresh mushrooms daily.

Around Delhi mushroom growing can be highly rewarding because of a good market. The technology can be profitably considered in areas, where land is a limiting factor and agricultural residues such as straw, sugarcane bagasse and wastes of fruit industry are abundantly available. Three types of mushrooms (*Agaricus bisporus*, *Volvariella* spp. and *Pleurotus* spp.) can be cultivated without much temperature and humidity control throughout the year: mid November to mid March - button mushroom (*A.bisporus*); February to mid April and September to November - Dhingri (*P. sajor-caju*); and mid June to mid

September - paddy straw mushroom (*Volvariella* spp.).

Button mushroom cultivation in Delhi was first started around 1965 by Mrs. Madhu Kohli. She improvised the techniques for home growing and was able to do so in a garage at her residence. She used to sell her produce to foreign diplomats at a high price, since she was the only grower at that time. Later, other people with good financial background like Capt. Sood and Sardar Paul undertook this venture and yields obtained were 5 kg/m². By 1970 the mushroom research became well organized in Department of Mycology and Plant Pathology, I.A.R.I., New Delhi, devoting more time to practical problems in mushroom cultivation. At the same time a progressive farmer Mr. Mohan Singh started growing mushrooms at Chattarpur village in the suburb of Delhi. Gradually the impetus was caught by other small farmers and hobbyists. Today; mushroom growing

has become so popular, particularly in Chattarpur village that it is known as "Mushroom Village" or "Khumbi gaon".

In villages around Delhi mushrooms are being cultivated in mud houses, which are built by digging 1-3 meters lower than the ground level. Such mushroom houses are made of mud bricks and plastered with mud and have thatched roof top which keeps the cost nominal. The compost is made of horse dung and poultry manure. This operation is carried out on a co-operative basis in groups, which saves the cost of labour also. To catch the early market they start cultivation operations by mid-August and the crop is ready by mid-October, when the rates are quite high as the crop that comes from hills (Nainital, Kasauli, etc.) does not fetch good market due to quality deterioration during transportation. At present mushroom cultivation in rural areas is suffering from certain problems.

- In rural areas people are making compost on Kacha floor, with a high risk of nematode infestation.
- Mud houses are also the sources of several diseases that affect mushroom cultivation.
- Thatched roof does not maintain proper humidity.
- For commercial production growers have to depend on Mushroom

Research Laboratory at Solan or private agencies for getting spawn. Since spawn is not always free from contamination, growers have to suffer as the season for mushroom growing is lost.

- Growers start cultivation operations when the temperature is high. To obtain low temperature for cropping they put ice blocks in the room. The result is that floor gets muddy and becomes the source of nematode infection.

In urban areas mushroom cultivation is better organized since people are educated and have financial resources. The major constraint is lack of space. Rented rooms for cultivation makes the mushroom production expensive. Garages and attics are used for cultivation on a small scale which are sufficient to meet the demand of a small family. The drawbacks of urban cultivation are :

- The obnoxious smell of ammonia during compost preparation causes neighbour's displeasure.
- Difficulties are faced for obtaining boxes for cultivation. Though wooden fruit cartons can be a cheap substitute but the variable sizes do not allow shelving which saves space.
- To maintain humidity water has to be sprayed on the walls and floor and this may result in seepage.

Delhi has a potential market for button mushrooms. Hotels and vegetable shops in posh colonies are the main buyers. In and around Delhi the period of button mushroom is 4-5 months under natural environment. The main problem is that most of the sale is handled by middle man, who buys it from growers at nominal price and sells it to consumers at very high rates. Often the middle man gets supply from the hills and local growers are exploited. If local growers can keep a regular supply, the produce from hills need not be sold in Delhi markets and hence, the profit earned by middle man may be reduced. By improved technology in cultivation, mushroom can be made a year round crop and price variation may be reduced.

At present mushrooms are grown by enterprising people mostly in and around Delhi to cater the need of the city elite. Mushroom cultivation involving simple methodology coupled with low risk technology have a great promise for adoption in villages around Delhi as a kitchen garden activity or a cottage industry. Besides utilizing the farm wastes it will also be a source of part time or full time employment for the poor farmers, under employed and unemployed youth. With more consumption of mushrooms there will also be an

improvement in the nutritional standard of our rural population.

For popularising mushroom farming, it is essential to remove some of the present constraints that limit large scale cultivation in rural areas. Mushroom growing must be encouraged under closed structure with cemented construction instead of mud houses. Pasteurization of compost is also essential.

Government agencies should take the responsibility for preparation of high quality compost and spawn and supply it to small growers at subsidized rates. The problems concerning packing and marketing are not well organized at present, thus a good deal of the produce does not fetch a high price. Better facilities need to be strengthened in this direction too. If cold store facilities are provided during marketing the shelf life of mushroom will increase.

It will also be very befitting to induce both rural and urban women to take up mushroom growing as a part time business cum hobby. The understanding of techniques is within their reach and the time spent will bring economic returns to the family. Thus by intensifying mushroom cultivation with improved methods, it can reach the common man and we may look forward to avail this one time delicacy as a part of our everyday meal.

MUSHROOMS GAINING POPULARITY IN SOUTH INDIA

India is a large country with a variety of languages and faiths adopted and accepted by the people. Each part has made an impressive contribution to the development of Indian culture, literature and art.

— Dr. Rajinder Prasad, 1959

K. Sivaprakasam and R. Jeyarajan

Tamil Nadu Agriculture University, Coimbatore

Edible mushrooms hold a unique place in the world today and they are in great demand everywhere for their flavour and nutritional value. The total world production of fresh edible mushrooms was about 13.6 lakh tonnes. When the annual production of edible mushroom ranges from 90,000 to 1,65,000 tonnes in countries like USA, France and Taiwan, it is awfully low namely just 1500 tonnes in India which includes 80% under *Agaricus*, 10% under *Volvariella* and 5% under *Pleurotus*.

Mushrooms can be grown successfully on a wide variety of inexpensive substrates such as agricultural and industrial by-products and residues. In India, the amount of cellulosic waste amount to about 25 million tonnes and obviously they pose problems of disposal. By the cultivation of suitable mushroom fungi, these wastes can be converted into an asset and recycled thereby preventing environmental pollution also. In Tamil Nadu, the

amount of paddy straw available amounts to about 84 lakh tonnes per year. In parts of Tamil Nadu like Thanjavur and Thiruchirappalli districts considerable quantity of paddy straw is wasted and obviously it poses problems of disposal. Mushrooms can be obtained all the year round throughout Tamil Nadu with the cultivation of straw mushroom during severe summer and oyster mushroom during the remaining period. It is possible that if only one-tenth of annual yield of straw is utilised to grow mushroom, about 2.1 lakh tonnes of fresh mushrooms could be produced. Such an amount would provide a net income of Rs. 105 crore per annum.

Types suitable for cultivation

Paddy straw mushroom : In India cultivation of straw mushroom was first standardised by the Agricultural College, Coimbatore in 1943 by Thomas and co-workers. Since then, research on cultivation technology of straw mushroom (*Volvariella* spp.) was

continued on a small scale with distribution of spawn bottles. However, the yields were low and hence its cultivation was not taken up on a commercial scale. Besides, it requires an optimum temperature of 30-35C and not below 25C for its growth. Therefore it is not possible to cultivate this mushroom in hilly regions as well as during winter season in plains of Tamil Nadu.

European mushroom : The possibilities of growing *Agaricus bisporus* in temperate areas of Tamil Nadu like Kodaikanal and Ootacamund have been explored since 1970. This mushroom has subsequently established its roots in Tamil Nadu where commercial mushroom farms have come up in places like Ootacamund. However, it requires extensive care and great skill besides the proper environmental conditions. It is not possible to cultivate this mushroom in plains under natural environmental conditions.

Oyster mushroom : During 1974 the cultivation of oyster mushroom, *Pleurotus sajor-caju* was introduced in Tamil Nadu and since then it is becoming popular. Comparative growth and yield of *P.sajor-caju*, *P.flabellatus* and *P.ostreatus* were studied to select a suitable fungus for mushroom cultivation in southern states by Kandaswamy and Sivaprakasam in 1980. Among the three fungi tested, *P. sajor-caju* gave rapid growth and

found to be suitable for the tropical temperature 32C, when compared to the other two *Pleurotus* species. It also consistently recorded high yields with more number of flushes.

Pleurotus citrinopileatus Singer a new edible mushroom has recently been brought into cultivation and released by the Tamil Nadu Agricultural University in 1986. This mushroom was collected from the stumps of forest trees in Lower Palneys by Mr. W.P.A.R. Rajaram, a progressive mushroom grower from Pattiveeranpatti, Tamil Nadu. Production technology was developed in the department of Plant Pathology, Coimbatore. It grows well and yield of 414g per bed of 500g of paddy straw substrate was obtained which works out to 13 per cent increased yield over *P.sajor-caju* in poly-bag method of cultivation. This species produces white mushrooms compared to grey mushrooms of *P.sajor-caju*. They are larger in size than *P.sajor-caju* and suit mushroom growers. This is the first record of this mushroom in India.

Prospects of oyster mushroom

The oyster mushroom can be grown under a temperature range of 15 to 31C and relative humidity of above 75% and therefore it is suitable for cultivation in different parts of the country. The phenomenal interest in cultivation of oyster mushroom in different parts of the country is

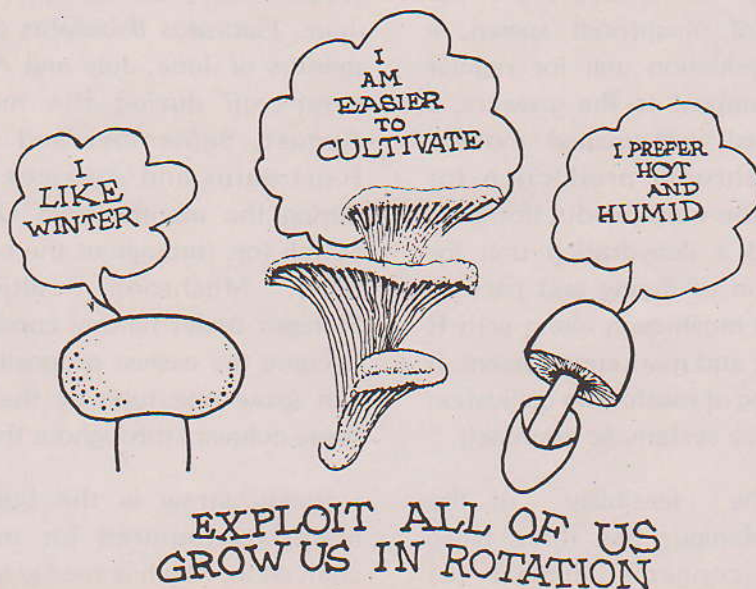
evidenced from the steep increase in demand for spawn bottles from the University by mushroom growers in Tamil Nadu, Kerala, Andhra Pradesh, Karnataka, Gujarat, Maharashtra and West Bengal as indicated by supply of 4514 bottles in 1985 as compared to only 1031 in 1976.

Growing edible mushrooms is gaining momentum in recent years. The University took active steps to create awareness amongst the people on the cultivation and usefulness of mushroom through the agency of press and radio. Practical training in techniques of mushroom cultivation including spawn preparation was imparted in the University to several persons from Tamil Nadu and other States. The response from the farmers was tremendous and enquiries poured

in from all parts of the State and other States enquiring about the spawn supply and techniques of mushroom cultivation.

The State Bank of India looking into the potential of mushroom cultivation in rural areas requested our University to train the Rural Development Officers in mushroom cultivation. The Bank has come forward to finance mushroom cultivation and our University has prepared a report on tentative cost economics for the cultivation of oyster mushroom and supplied the same to the Bank.

Due to impact of technology oyster mushroom cultivation has been taken up as a commercial venture by 23 progressive mushroom growers in Tamil Nadu, Kerala and Andhra Pradesh.



MUSHROOM CULTIVATION IN MANIPUR

"The entire meaning of human experience resides in the interminable conquest of the unknown, in the eternal quest for new knowledge...."

— Emile Zola

R. Ibotombi Singh and S. Mema Devi

Department of Agriculture, Imphal, Manipur-795 001

In Manipur the earliest attempts to cultivate mushroom was made by the State Agricultural Department during the early seventies. Spectacular result was achieved by Dr. R.N. Verma at I.C.A.R. Research Complex, Imphal in the year 1978. In the year 1984, Manipur Tribal Development Corporation (M.T.D.C.) ventured a mushroom project towards an objective of establishing a management system by way of creating skilled man-power through training and demonstration, establishing a laboratory for production of mushroom spawn, a compost production unit for regular supply of compost to the growers, a medium sized well-equipped mother-unit of mushroom production for demonstration-cum-production programme and a dehydration unit for demonstration of drying and packing of *Pleurotus* mushroom along with R & D support and marketing system. It is the begining of mushroom cultivation in Manipur in a systematic approach.

As for the feasibility of the approach, Manipur has three basic things, (a) congenial climate (b)

sufficient raw-materials and (c) man-power. Manipur has a subtropical to temperate climate depending on the location and elevation. The rains usually start from middle of March and continue to October and the temperature varies from 3 C to 45 C according to location. Manipur has, therefore a salubrious climate for growing *Volvariella*, *Pleurotus* and *Agaricus* in different pockets in different seasons of the year. As for example, *Volvariella* spp. can be grown in Manipur valley (850m M.S.L.) during April, May and June, *Pleurotus flabellatus* during the months of June, July and August, *P. sajor-caju* during the months of August, September and October, *P. ostreatus* and *Agaricus bisporus* during the months from October to March (or, throughout the year in the hills). Mushroom cultivation in Manipur under natural conditions has become the easiest proposition as we can grow one type or the other of these cultivars throughout the year.

Paddy straw is the bulk of the materials required for mushroom cultivation, which is readily available in

Manipur as it is a paddy growing state. Cattle feed competition is almost negligible in hill areas where big pasture lands are available. Paddy cultivation being the main-stay for both the hill and plain areas of Manipur, this bulk resource of agricultural waste will be maintained for decades together and there is no likelihood that the proposed venture may disturb the social synergy in the long run.

By and large, Manipur is a traditional area for mushrooms which are found growing wild in both the valley and the hills. Of these, twelve varieties available in the local market as fresh mushrooms during rainy season are : *Agaricus*, *Auricularia*, *Clitocybe*, *Lentinus edodes*, *Lactarius*, *Pleurotus*, *Podosypha*, *Ramaria*, *Schizophyllum commune*, *Termitomyces*, *Tricholoma*, and *Volvariella*.

The natural production of mushroom is, however, not substantial to meet the requirement. There is a long gap during winter when no mushroom appear naturally. This shortfall can be made up by the cultivation of hitherto standardised species of *Pleurotus*, *Volvariella* and *Agaricus* varieties.

This prospect has been engaging the attention of the Govt. of India and

the State. Under the Govt. of India, M.T.D.C. has started a training programme for the tribal and scheduled castes. A production base has already been developed by training prospective farmers, setting up a nucleus laboratory with the technology transferred from I.C.A.R., Imphal branch and Horticulture Department, Solari.

Traditionally, valley is the main local market of mushrooms produced in the hills. Agencies like NERAMAC, NAFED and Star Hotels in Calcutta have already shown their interest to utilise mushrooms produced in Manipur. Once a production base is maintained, programmes for large scale production industry would be tied up with the programmes of the institutions like NABARD etc. Until the farmers are taken to this stage they are required to be looked after both technically and financially.

All these at hand, Manipur is marching ahead with mushroom industry. We start with the available technology, the adaptability of the selected cultivars and the available aptitude and enhanced skill of the trained hands. We have to have a start with the foolproof bulk pasteurization of compost to boost up the industry.



COMMERCIAL CULTIVATION OF WHITE BUTTON MUSHROOM IN BADHANA AREA OF HARYANA

I deem a single experiment to be of greater value than a thousand opinions born of the imagination alone.

— Nikhailo Lomonosov

H.S. Sohi, R.C. Upadhyay and B. Vijay

National Centre for Mushroom Research and Training
Chambaghat, Solan-173 213

Cultivation of button mushroom (*Agricus bisporus*) is gaining popularity in the plains of North India due to ready availability of various agricultural waste materials like wheat and paddy straw and low temperature during winter months. One of the enterprising farmer, Master Jagdev Singh of village Badhana took mushroom cultivation training at Solan in 1980. Afterwards he started cultivation of white button mushroom in his village on a small scale. The success achieved by him during the following year promoted many others to undertake training and mushroom cultivation. This led to the establishment of about two dozen mushroom units in that village in 1985-86. Most of the growers prepared the synthetic compost by long method using various ingredients in the following proportions :-

Wheat straw	65 q
Chicken manure	20 q
CAN	50 kg
Urea	50 kg

Murate of potash	50 kg
Wheat bran	200 kg
Single super phosphate	50 kg
Molasses	150 kg
Furadan	5 kg
BHC	5 kg
Gypsum	200 kg (at third turning).

Mushroom crop is raised in thatched huts made of mud bricks and sarkanda (*Saccharum* sp.). Wooden trays are no more in use and have been replaced either by shelves or polythene bags. The number of shelves varies from 3 to 6 according to the height of the hut. For casing soil a mixture of decomposed FYM and garden soil (1:1) or (2:1) is used. The compost is generally prepared during October and complete spawn run is achieved by the end of November and the crop comes by 1st or 2nd week of December, after casing.

As per the information collected from the growers of the village, 80-90

tonnes of fresh mushroom was produced during 1985. The produce was sold in Delhi market at Rs. 20/- to 25/- per kg. It is interesting that almost all the growers made 50 to 100% profit (Table 1).

During 1986 a production of 300 to 350 tonnes is expected from the area since about 25000 spawn bottles have already been reserved by the growers with various spawn producing units. Recently the growers have formed a co-operative society of mushroom

growers for strengthening mushroom culture in the region. The State Govt. has also started giving some incentive through D.R.D.A. project.

In order to reap maximum benefit of mushroom culture in the North Indian plains there is a need to create facilities for preparation and supply of pasteurized compost to the growers, supply of quality spawn at the site and proper marketing of produce so that more and more farmers undertake this venture.

Table 1 : Mushroom yields of three farms in Badhana during 1985 -86

Approx. wt. of compost (q)	Total mushroom yield (q) in $\approx$ 90 days	Av mushroom yield (Kg/q compost)	Net profit (Rs.)
320	36	11.3	35,000
450	32	7.1	23,000
400	40	10.0	44,000

VALUE OF RESEARCH

Growers sometimes ask as whether research has really contributed very much of value to the mushroom industry No one can take seriously the suggestion sometimes heard that any grower has real doubts as to the value of research.

— F.C. Atkins 1979.

TAKE PRIDE IN GROWING MUSHROOMS

People who have not succeeded in any other job can always become a gardener. I am quite sure that you can't say the same about mushroom growers.

— E.F. Nielsen, 1959.

MUSHROOM PRODUCTION IN INDIA AND ABROAD

Had Marx been never there, the world would never have cared for the poor. As a saint I revere him. But as political prophet he was defeated by technology.

— Baba Amte

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Mushroom cultivation is of recent origin in India. The first mushroom cultivated in world as also in India was paddy straw mushroom (*Volvariella spp.*) followed by Shiitake (*Lentinus edodes*) and button mushroom (*Agaricus bisporus*). Today about 20 species of mushrooms are cultivated all over the world. Of these, button mushroom, Shiitake and paddy straw mushroom contribute 75, 14 and 4 per cent, respectively. The remaining 7 per cent is contributed by others (Table.1.).

In U.S.A., the highest mushroom producer, mushroom production was 255,000 tonnes during 1983-84 showing 9% increase over 1981-82. Of this 50% was produced in Pennsylvania State alone. Fresh mushroom sales in U.S.A. accounted for 69% of country's production. Despite huge local production, the country imported mushrooms from Asian countries. In West Germany the mushroom production in 1984 was 34,200 tonnes as against 34,500 tonnes in 1983. This accounted for 22.5 per cent of total consumption in the country and imports worth 42,419 tonnes of fresh

mushrooms and 1,14,800 tonnes of canned mushroom were made by the country. Western Europe produced 41300 tonnes (47% of the world production) in 1980 and remains the principal production region inspite of a decrease in its relative predominance. The Far East produced 1,67,000 tonnes (19% of total production of the world) in the year 1983-84.

China, Holland, Taiwan, France and South Korea are the principal exporting countries, contributing 96% of the export in 1980. Except for France where home market consumes 2/3 of the output, other countries do not have significant home consumption and they are export specialists. Taiwan and South Korea which dominate the international market are facing a strong competition from China. The export figures of China also include those of Hong Kong, whose operation is largely reprocessing and exporting mushrooms originally from China and Taiwan. Chief mushroom importing country is West Germany followed by U.S.A.

Table 1. World production of different cultivated edible mushrooms in 1975 (Delcaire, 1978. Mushroom J. No.96)

Name/species of Mushroom	Production (tonnes)
White button mushroom (<i>Agaricus bisporus</i>)	6,70,000
Shiitake mushroom (<i>Lentinus edodes</i>)	1,30,000
Straw mushroom (<i>Volvariella volvacea</i>)	42,000
Enokitake (<i>Flammulina velutipes</i>)	38,000
Nameko (<i>Pholiota nameko</i>)	15,000
Oyster mushroom (<i>Pleurotus ostreatus</i> <i>P. abalonus</i> and <i>P. cornucopiae</i>)	12,000
Jew's Ear (<i>Auricularia auricula</i> and <i>A. polytricha</i>)	5,700
Tremella (<i>Tremella fusiformis</i>)	1,800
Stropharia (<i>Stropharia rugoso-annulata</i>)	1,300
Black Truffle (<i>Tuber melanosporum</i>)	200
Total production	9,16,000

Situation in India

The production of cultivated mushrooms in India is about 2,000 tonnes (est.), besides the wild mushrooms which are collected from the forests of northern India, dried and marketed. The common dried mushrooms available in the market are Dhingri and Gucchi, the latter fetching a price between 800 and 1000 rupees per kg of dried product. India has been the traditional exporter of these mushrooms to European countries.

Commercial cultivation of button mushroom was undertaken at Solan in H.P. during the year 1961-62, under an ICAR project. This led to establishment of a number of mushroom growing units in temperate area of H.P. and J & K. Subsequently its cultivation was

extended to South India (Bangalore, Ooty, Marcara and Pune). In the plains of North India it is at present cultivated during the winter months. The produce is mostly sold fresh for immediate use as vegetable. Some of the progressive growers however process the produce during the period when there is a glut in the market and the prices are low. The technique for the cultivation of paddy straw mushroom is known since 1943. Inspite of the fact that the base material i.e. paddy straw is available in plenty, its cultivation has not been taken up on a large scale in the country. Technique for cultivation of Dhingri has been standardized in our country and good strains are available. Its cultivation is picking up almost throughout the country and has bright future.

Table 2 : Yearwise world production of *Agaricus bisporus*

Country	Production in tonnes in the years				
	1939 ¹	1960 ¹	1970 ¹	1980 ²	1983-84 ³
U.S.A.	17,000	50,000	88,000	2,13,300	2,55,000
UK	6,800	21,000	40,400	61,800	84,000
France	20,000	35,000	68,000	1,31,700	—
Hungary	800	1,000	2,000	—	—
Denmark	400	2,500	6,500	6,600	—
West Germany	300	3,000	20,000	35,000	34,200
Italy	—	2,000	20,000	44,000	—
The Netherlands	—	3,000	29,500	60,000	80,000
China	—	—	2,000	66,800	—
India	—	—	—	1,500 (est)	2,000 (est)
Japan	—	2,000	4,800	5,500	—
Taiwan	—	700	39,000	64,400	—
South Korea	—	—	6,000	25,600	—
Total world production	46,000	1,36,300	3,81,100	8,12,200	

1. Delcaire, 1978. Mushroom J. No.96.

2. P.B.Flegg, D.M.Spencer & D.A.Wood 1985. The Biology and Technology of the Cultivated Mushroom.

3. M.Courvoisier 1984. Mushroom J. No.143.

The consumption of mushroom in India is confined to the elite of the society and in the star hotels. As compared to the world production and consumption, India is lagging far behind. There is a great potential for export of mushrooms from India provided the cost of production is brought down and these are produced all the year round to have a continuous supply. This is possible only

when the production is taken up on a large scale using the modern technology to its fullest advantage. The labour and raw materials are cheaper in India as compared to the developed nations which could go a long way in bringing down the cost of production. This would not only popularize mushrooms among the Indian folks but also help fight the protein malnutrition in the country.

SCOPE OF AGARICUS BITORQUIS (QUEL.) SACC. IN INDIA

It is advisable for tropical and sub-tropical countries to focus more on local Agaricus species.....

— P.Bels, 1981

D.S. Guleria

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Cultivation of *Agaricus bisporus* has been practised in India as well as abroad for the past many years. Being a temperate mushroom, its cultivation has been restricted to hilly areas only or cultivation extended only during the winter months. This constraint of cultivation has been a limiting factor in the establishment of a strong mushroom industry in the country throughout the year. Unfortunately, all research of interest for the growers has been restricted to *A. bisporus* with limited or scarce research on other cultivated species of this genus.

A new species *A. bitorquis* which possesses a number of clearly distinct and marked qualities from those normally grown, has now been introduced for cultivation in warmer areas. This mushroom is often referred to as *Psalliota bitorquis* Quel., *Agaricus rodmanii* Peck, *Agaricus campestris* var. *edulis* Vitt., *Psalliota edulis* (Vitt.) Schaffer & Moller, *Agaricus peronatus* Richon and Roze, *Psalliota bivela* Vel., and *Chitonia*

edulis (Vitt.) Hurrfurth. It is closely related to the cultivated white mushroom and its properties as an edible species are very similar and in many regards rather better than those of *A. bisporus*. The first strain of *A. bitorquis* was introduced commercially in 1973 by a French firm Somycel as strain No. 2017 and later by Le Lion under the name "*Psalliota edulis*". Unlike, the two spored *A. bisporus*, generally four spores per basidium are formed in *A. bitorquis*.

One of the promising qualities of this mushroom is that it grows at higher temperature (25-28°C) and requires a higher concentration of carbondioxide and is specifically resistant to virus diseases. It could be kept for a few days longer than the normal mushroom and does not appreciably decline in quality. The fruit bodies tend to be larger and more solid. In general it possesses a rather coarse and short stalk. The caps are smooth and silky and sometimes a little dented. Some canners appreciate

its firmness and suitability for preservation while others like its taste.

Farms facing serious and persistent attacks due to die-back virus disease could, temporarily switch over to cultivation of this species. It may be realized, however, that resistance applies only to virus diseases and not to others. It is, therefore, essential that such growers must pay equal attention to the avoidance and control of diseases and pests as they would practice while cultivating *A.bisporus*.

A number of mushroom growers in The Netherlands and in other well developed countries having ample experience, have switched over to the cultivation of *A.bitorquis* because of low production costs, resistance to dieback attacks, and are now generally quite satisfied. There are growers in Europe who cultivate *A.bitorquis* only during the summer months because cultivation of *A.bisporus* poses problems due to high costs of airconditioning. Possibly *A. bitorquis* may offer new and interesting avenues for those countries possessing mild tropical climates which is prevalent in our country during most of the period in a year.

Cultivation of *A.bitorquis* has not been taken up commercially in India because of lack of sufficient information

about its cultivation under Indian conditions and the incidence of certain diseases which usually develop at high growing temperatures. Since the problems in cultivation are of different nature, detailed studies on various aspects are needed under the conditions prevailing in India. Cultivation trials conducted at Mushroom Research Laboratory, Solan have clearly demonstrated that this mushroom can be successfully cultivated on similar type of compost as for *A.bisporus* during warmer climate when cultivation of *A.bisporus* is not possible or uneconomical.

Since cultivation of *A.bisporus* during summer months (April to August) is not possible due to high temperature or cultivation costs are exceedingly high, species like *A. bitorquis* which can tolerate higher temperatures can be introduced and growers can take two additional crops. This would not only help mushroom growers to cultivate mushrooms round the year (thus keeping machinery and labour busy) but will also enhance the economy of growers, for, during summer months, this species would fetch comparatively better prices in the market. Moreover, introduction of *A.bitorquis* would reduce the chances of introduction and spread of virus diseases.



SCOPE OF PLEUROTUS CULTIVATION IN INDIA

New opinions are always suspected, and usually opposed, without any other reason but because they are not already common.

— John Locke

C.L. Jandaik

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The history of man is the record of a hungry creature in search of food. Mushrooms are undoubtedly one of Man's earliest food and history sings high praises for virtues of edible fungi (mushrooms). It is clear that mushrooms can be marshaled to aid in solving many important global problems including food shortages, resource recovery and reuse, energy shortages and pollution.

Species of *Pleurotus* are well known edible fungi and are popularly known as 'Dhingri'. These include mainly *Pleurotus ostreatus*, *P. sajor-caju*, *P. eryngii*, *P. flabellatus*, *P. cystidiosus*, *P. tuber-regium*, *P. fossulatus* and *P. pulmonarius*. In India, many species of *Pleurotus* are collected from wild sources in different parts of the country and form an important item of local dishes and in certain areas constitute an article of commerce.

The very interesting fact in cultivating *Pleurotus* species is that this mushroom can be produced successfully on both fermented as well as non fermented

types of substrates. Rapid growth of mycelium and so, speedy penetration of the substratum by *Pleurotus* species simplifies the cultivation process as a whole. For cultivation, waste materials such as cereal straws, shelled corn cobs, maize stalks, waste newspaper, wood shavings, saw dust, treebark, coffee pulp, vegetable and food industry wastes are cheaply and easily available. Presently more than half of the agriculture plant products remain unused as waste matter and with suitable method of substrate preparation, these wastes can be utilised with advantage for successful cultivation of *Pleurotus* species and this would also help in easy disposal of these wastes which otherwise may cause environmental pollution and health hazards.

Pleurotus species can easily be cultivated on cereal straws, which should be treated either with hot water or steam at 70°C for 1 hour. After spawning and throughout the cropping period, temperature should be in between 20-30°C which is

available in most of areas in the country during maximum period of the year. Secondly, in genus *Pleurotus* both high and low temperature requiring strains are known, cultivation of *Pleurotus* throughout the year would be a worthwhile proposition. The unique advantage in cultivation of *Pleurotus* species is that it can easily be dried either in the sun or mechanical dehydrators (50C) and revived after remoistening without any loss in the flavour. This would not only reduce the canning costs but also minimise the labour cost.

From nutrition point of view, *Pleurotus* species are also of special interest. They contain about 10% dry matter and 90% water (similar to vegetables). The dry matter consists of approximately 20-35% protein (containing all essential amino acids) 1-2% fat and 5 to 10% ash (which contains many minerals). The *in vitro* digestibility of protein varies from 70 to 90%. Among vitamins, thiamine, niacin and ascorbic acid are present in remarkable proportions. As such, incorporation of fruit bodies of *Pleurotus* in the human diet as protein rich supplement, would help in overcoming protein malnutrition problem, which has attracted the attention of the world. The gastronomical delights and nutritional benefits of *Pleurotus* species certainly justify attempts to make it more widely available.

Nowadays, there is a need to promote the cultivation of mushrooms,

especially to introduce more varieties for choice. Because of increasing world population as well as more interest in renewable energy has been realised with rise in prices of fuel, it is imperative to produce food in a cheaper and simpler way and this is of utmost significance in rural areas for which "*Pleurotus* cultivation is the answer".

For the growth of *Pleurotus* industry in India, cultivation of this mushroom should be organised on Taiwanese model i.e. in small farmer's unit with very little capital investment. Since cultivation of *Pleurotus* does not require that much exacting conditions as *Agaricus bisporus*, cultivation of *Pleurotus* in ordinary built house on farmer's unit will go a long way in establishing *Pleurotus* industry in India on a sound footing. *Pleurotus* certainly has a distinct advantage over *Agaricus* as it can grow on variety of substrates, does not need composting and casing and can easily be dehydrated.

Biologically, *Pleurotus* species have the ability to efficiently utilise its substrate, to fruit on a single component substratum, to colonise the substrate rapidly while tolerating high carbondioxide levels (lethal to competitive microflora) and to produce abundant crops (about hundred per cent biological efficiency) relatively within a short period (two months). All this makes *Pleurotus* species ideal for cultivation in the rural areas of the country.

SCOPE OF VOLVARIELLA CULTIVATION IN INDIA

The cultivation of tropical mushrooms dates back a long time, but research in this field is still rather young.

P.J. Bels, 1981.

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The development of Indian economy is not progressing due to the lack in development of rural economy. The Indian Science Congress has to be congratulated for introducing the idea of focal theme in its deliberations since 1976 i.e., 63rd Session. In the said year the focal theme was "Science and Integrated Rural Development". Even in 1977, 1978, 1979, 1980 and onwards, the recommendations of 64th, 65th, 66th and 67th Sessions of the Indian Science Congress include the ideas for the development of rural people.

The rural population of India is about 80 per cent of the total population (Table 1). It is needless to mention that until and unless the economic standard of this 80 per cent rural people are uplifted there is no way to better the present Indian economy.

The development of a modern commercial white button mushroom (*Agaricus* sp.) farm in India will require about 5-6 lakh Rupees for 2000 trays with 1000 sq.m. cropping area capacity. Under the present technological

knowhow yield of such a farm will be about 22 tonnes per annum. It is obvious to realise that how difficult and expensive it is to develop such farms in India. For this reason development of mushroom industry in India should be small scale cottage industry based. The real development of mushroom industry can be possible only by utilizing the opportunities and facilities of small scale cottage industry, resources of the Government and at the same time the human and natural resources of rural India.

The best way to develop the industry in rural areas is to utilise the rural population. This will not only help the industry to flourish but at the same time will help the rural people to come out of their poverty line. Moreover this will also help to secure the necessary finance from the Government. The potential of mushroom (*Volvariella*) production utilizing the rural manpower has been estimated to be about 1.57 crore tonnes per annum which will fetch a price of about 15.76 crore

Table 1. Potential of *Volvariella* cultivation on the basis of rural manpower in India

Total rural population	52.54 crores
Total rural household on the basis of average 6 persons/household	8.76 crores
Total no. of mushroom beds (@60 beds/household)	525.44 crores
Total amount of mushroom yield (@ 3 kg/bed)	1.576 crore tonnes
Total value of mushroom products (@ 10.00/kg)	15.763 crores

Data are from Statistical Abstract. 1982.

Rupees (Table 1). On the other hand main constituents of mushroom compost in Indian condition is wheat or paddy straw. As these straws are easily available in rural areas, the development of industry in rural areas will always be economically profitable in rural areas than in any other areas. The potential of mushroom (*Volvariella*) production on the basis of available straws has been estimated to be about 1.38 to 2.07 crore tonnes per annum which will fetch a price of about 13.8 to 20.7 crore Rupees (Table 2).

At present mushroom cultivation has already been started in several states of India including Himachal Pradesh, Punjab, Jammu & Kashmir, Tamil Nadu, Maharashtra, Kerala, Uttar

Table 2. Potential of *Volvariella* and fertilizer production from available straw from India per annum

	Quantity (Tonnes)	Value (Rs.) ^b mushroom & fertilizer
Total available straw (20%)	13.8 crores	
Mushroom (<i>Volvariella</i>) production per annum (Biological efficiency		
10%	1.38 crore	13.8 crore
15%	2.07 crore	20.7 crore
Fertilizer production ^a (tonnes)	41474	13.72 Lakhs

a Calculation based on one tonne of dry straw can produce 300 kg fertilizer after harvesting of mushroom (Kurtzman, 1976).

b The value of mushroom and fertilizer was calculated @ Rs. 10.00/kg and @ Rs. 33.10/tonne respectively.

— Data from All India Crop Estimate. 1984-85.

Pradesh, Orissa, West Bengal, Assam, Meghalaya and Delhi. All these states are producing a sizeable amount of mushroom every year though the production in 1978 was 32.64 tonnes only. The population of India has already reached to about 68.5 crores. If every person is habituated to take 10 g fresh mushroom (which is about 200 g in foreign mushroom growing countries), the annual requirement will be about 250025 crore tonnes. The present annual production is far behind their annual requirement.

For cultivation of *Volvariella*, the rural environment conditions are quite satisfactory and it does not require any sophistication (Samajpati, 1985). As such this species is quite suitable for cultivation in rural areas of India. Moreover the yield of mushroom will be always much more higher than any other agricultural crop (Table 3). As the mushroom cultivation does not require any cultivation land it will be of immense help for the marginal agricultural farmers to have additional income and also for landless labourers to have a potential source of income.

I may be permitted to request you to consider the following two proposals for the development of mushroom industry which is still in its infancy. Firstly to channel 50 per cent of the resources available to any mushroom workers for the mass publicity programme in order to popularise the

Table 3. Comparative yield of different crops and mushroom per annum

Crop and Mushrooms	Yield (Kg/sq.m
	Land area)
Paddy	0.114 ^a
Wheat	0.204 ^a
Jute	0.139 ^a
Pulse	0.056 ^a
Oilseeds	0.038 ^a
Cereals	0.121 ^a
Agaricus	620 ^b
<i>Volvariella</i>	586 ^c

^aYield data of 1976-77, Statistical Abstract, Bureau of Applied Economics & Statistics, Govt. of West Bengal

^bSchroeder *et al.* 1974. Mushroom News 22 : 15

^cChang 1982. In Tropical Mushrooms — Biological nature and cultivation methods eds S.T. Chang & T.H. Quimio pp 463-473

mushrooms among Indian people by organising as many as possible Demonstration-cum-Training Programmes including free supply of spawn etc. and other expertise services at Block level. Necessary help for these may be sought from the Extension Wing of Directorate of Agriculture, Government of India also in collaboration with Extension Wing, Directorate of Agriculture of the respective state. Secondly to utilise the rest 50 per cent of the resources to develop cultivation methods of *Volvariella* which will give a stable standard yield and to increase the biological efficiency of the species by developing high yielding strains and good quality spawn.

EDIBLE AND POISONOUS MUSHROOMS

To conclude, few of them are good to be eaten and most of them do suffocate and strangle the eater.

— John Gerard, *the Herball*, 1597

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Mushrooms have always been an article of curiosity for nature lovers. After rain when the sun shines, the umbrella shaped structure growing on ground etc. catches the eyes of everyone passing by. Carlyle has rightly said "Nature alone is antique and the oldest art a mushroom". The word mushroom is usually thought to be derived from the French "mousseron" (muceron), "mousse" or "moss", but it is not used in quite the same sense. It has been said that "mousseron" is a barbarous name which has caused endless confusion. Other versions are "muscheron" and "mouscheron" and from these it is easy to understand how the country name of mushroom originated. The earliest word in Sanskrit for mushroom appears to be "ksumpa" and in Hindi it has evolved into "khumbi".

The use of mushroom as food, goes back to ancient times. Their use in Indian literature dates back to nearly 3000 B.C. Even during Greek and Roman times mycophagy was known to exist. Earlier mushrooms have been regarded as an article of delicacy and

were eaten almost entirely for their culinary properties providing a flavour and garnish for other foods. However, with the passage of time the idea has changed. Now mushrooms are regarded as a source of protein to enrich human diets. For a country like India mushrooms have special significance as most of the people here are vegetarian and major population suffers from malnutrition especially because of deficiency of protein and vitamins.

In the beginning mushrooms were collected from the natural habitats but with time their cultivation techniques have been established, France being the pioneer in this field. There, cultivation of the button mushroom (*Agaricus bisporus*) started in the year 1707. Gradually the technique spread to countries like U.S.A., U.K., Canada, Japan, China, India and many other Asian countries. Now not only button mushroom but other types of mushrooms like paddy straw mushroom (*Volvariella volvacea*), Shiitake (*Lentinus edodes*) and Dhingri (*Pleurotus* sp.) can be cultivated on commercial basis. Even FAO has recommended

mushroom cultivation for third world countries.

Mushrooms are not only edible and nutritious but they are poisonous also. Many people reserve the word "mushroom" for edible mushroom and "toadstool" for poisonous mushroom, but scientifically it is not true. The fact is that many of the toadstools are edible. There are a number of popular misconceptions about the toxicity of fungi, that a poisonous mushroom will cause silver to tarnish and garlic to blacken, that if a cap has been eaten by a slug or animal it can safely be eaten by man, that only dried fungus is safe because toxins lose their strength as the carpophore dries, that no lignicolous (that is growing on wood) fungus is deadly and that symptom of poisoning will appear immediately upon ingestion. But, facts are otherwise. Although many fungi can cause a stomach upset within 30-60 minutes, the deadly poisonous *Amanita phalloides*, *A. verna*, *A. virosa* do not produce noticeable symptoms until 8-12 hours after ingestion. The toxicity of fungi is a genetic character of the species and the only way of establishing the edibility of a species is to have thorough knowledge of its morphological characters.

Lincoff and Mitchel (1977) have summarised the poisonous mushrooms as follows :-

— That some mushrooms are poisonous raw, but harmless when

cooked; e.g., the (Wood) Blewit, *Clitocybe nuda*.

- Some mushrooms are poisonous unless parboiled and then thoroughly cooked; e.g., *Gyromitra esculenta*.
- Some mushrooms are poisonous regardless of the manner of their preparation; e.g., *Amanita phalloides*.
- Some mushrooms are poisonous only under certain conditions, such as when consumed along with alcoholic beverages; e.g., *Coprinus atramentarius*.
- Some mushrooms are poisonous only when eaten in large quantity; e.g., *Verpa bohemica*.
- Some mushrooms are classified as poisonous, but since the characteristic symptom is hallucinogenic intoxication, and since these mushrooms are generally eaten to achieve this effect, they are not considered poisonous by the users except in cases of overdoses or unexpected adverse reaction : e.g., *Psilocybe semilanceata*.
- Some mushrooms, for reasons unknown, are poisonous to deadly in some geographical areas but edible in others; e.g., *Paxillus involutus*.
- Some mushrooms become poisonous (i.e., can cause stomach upset)

when they are old, decayed, or hit by frost, although they are edible when fresh and young; e.g., *Armillariella mellea*.

Cases of poisoning by fungi are mainly due to substance produced by it. They are usually contained in the fruit body. These substances technically known as toxins have been divided into four categories by Lincoff and Mitchel on the basis of their physical effects and the time of onset of symptoms — (time between eating the mushroom and feeling its effects.) :

— *Toxins causing cellular destruction, liver and kidney damage, and death; onset of symptoms after 6 hours, usually 10 hours of ingestion*

Group I Deadly cyclopeptide (amanitin) poisoning Genera involved : *Amanita* and *Galerina*.

Group II Deadly monomethyl hydrazine (gyromitrin) poisoning. Genus involved : *Gyromitra* (*Helvella*).

— *Toxins principally affecting the autonomic nervous system; onset of symptoms 20 minutes to 2 hours*

Group III Coprine (Antabuse-like) poisoning. Genus involved : *Coprinus*,
Group IV Muscarine (sweating) poisoning. Genera involved : *Clitocybe* and *Inocybe*.

Toxins principally affecting the central nervous system; onset of symptoms 20 minutes to 2 hours

Group V Ibotenic acid-muscimol (delirium) poisoning. Genus involved : *Amanita*.

Group VI Psilocybin-psilocin (hallucinogenic) poisoning. Genera involved : *Psilocybe* and *Panaeolus*.

— *Toxins principally causing gastrointestinal irritation; onset of symptoms 30 minutes to 3 hours*

Group VII Gastrointestinal irritants. Many genera involved.

The hallucinogenic mushrooms although not poisonous in true sense but their consumption gives the effect of illusion, which could or could not be accompanied by uncontrolled laughter. However, effects differ with different people. Besides, there could be some side effects like severe dysphoria, vomiting and prostration, even temporary paralysis. The potency of these mushrooms varies with the manner of preparation and ingestion. They can be eaten fresh and raw, dried and raw, cooked or after an alcohol extract. They could be psychoactive when dried and smoked. The effects are more powerful when they are eaten on an empty stomach, and regardless of the manner of preparation or amount eaten, the effects could begin within 15-30 minutes and last about 4-6 hours.

The hallucinogenic mushrooms are usually small and inconspicuous and are not likely to attract anyone. Most

of the people who gather these mushrooms, deliberately look for those containing hallucinogens. The characteristics of these mushrooms is their habitat — growing on or near dung in pastures and blue staining of stem on handling. However, not all blue staining mushrooms are hallucinogenic. A number of *Boletus* spp. and *Mycenas* stain blue but none is known to be hallucinogenic.

The psychoactive compound of these mushrooms was isolated by Albert Hofmann and were named as psilocybin and psilocin after the name of the mushroom *Psilocybe mexicana* from which they have been isolated. The compound was found to be related to LSD, a synthetic drug. These compounds are indol alkaloids, specifically hydroxyltryptamine derivatives, related to bufotenin and serotonin. Later on psilocybin was isolated also from *Conocybe cyanopus*, *Panaeolus* sp. and several other mushrooms.

According to Schultes the narcosis induced by these mushrooms could be of potential use in experimental psychiatry — because the subject gets isolated from the world around him without getting unconscious. Albert Hoffman found importance of psychoactive drugs also in neuro and brain chemistry for investigating biochemical processes which form the basis of nervous and psychic functions.

Thus some of the mushrooms have now been accepted as an item of food for human consumption, the others are poisonous, hallucinogenic or non-edible and should better be avoided. Since there are no fool proof tests to distinguish them from one another the only alternative is to know them particularly morphologically and avoid those which one feels doubtful to distinguish correctly especially when collected from nature. However, the cultivated mushrooms provide no such problems.

TREATMENT OF MUSHROOM POISONING

Though many species cause toxicity but certain species of genus *Amanita*, particularly *A. phalloides* are responsible for almost all fatal poisonings. In case of symptoms of mushroom poisoning (acute diarrhoea) and pain doctor should immediately be summoned. The remains of the ingested fungus should be removed from the stomach by inducing vomiting. Purgatives may also be used to clean intestines. Dehydration should be treated with glucose-saline. Amelioration of acute symptoms should not be construed as completion of treatment as it is afterwards that irreparable damage to liver and kidney is caused — Liver function test like SGOT, SGPT, serum bilirubin and urea should be monitored. Administration of Thioctic acid (α -lipoic acid) 75-500 mg /day and strong doses of vitamin C have been reported for treatment of 'amanita poisonings'. As acute as well a chronic effects are likely to be fatal CALL A DOCTOR.

— R.D.R.

HALLUCINOGENIC MUSHROOMS

All is poison, nothing is without toxicity, and all is medicine. Just one dose makes a substance a poison or a medicine.

— Parucelsus

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Hallucinogenic or psychotropic fungi are those which affect the nervous system of the consumer individual in such a manner that he perceives non-existent sights and sounds or has hallucinations. Such mushrooms belong to a special category of poisonous mushrooms whose toxicity is confined to the induction of hallucinosis. All hallucinogenic fungi are not mushrooms, those containing alkaloids of the ergot group belong to Ascomycetes. Mushrooms having hallucinogenic effects are generally classified into four groups. To the first group belong members of Agaric families Strophariaceae, Bolbitiaceae, Coprinaceae and Cortinariaceae. Almost all the species in the genus *Psilocybe* (Strophariaceae) are known to be hallucinogenic; whereas, in other families only some of the species have psychotropic characteristics. Hallucinogenic principle in these species is Psilocybin, Psilocin or related alkaloids with Indole nucleus which on oxidation produce a blue pigment. Usually Psilocybin occurs in greater quantities than Psilocin but both exert similar effects. Psilocybin is

also produced artificially by culturing *Psilocybe* species in liquid media. Psilocybin is chemically related to Lysergic acid. Nearly all of the mushrooms used by the Mexican Indians and in Guatemala belong here. These have been used by people there for centuries, especially during religious ceremonies when a serious problem was intended to be solved through divine revelation, but they kept it so well guarded a secret that until a few decades ago only missionaries visiting these areas knew of their practice (Wasson and Wasson, 1957).

Psilocybin containing mushrooms are often eaten afresh; dried mushrooms are sometimes smoked or brewed into tea. It has been noticed that people who become addicts of *Psilocybe* species, age rapidly and may become senile before attaining middle age.

The second category comprises of members of Amanitaceae. They contain hallucinogens different from Psilocybin. Their use goes back to pre-scientific times. It is eaten in Orgies by

some Siberian tribes, in the Kamachattca peninsula. Wasson (1969) concluded from the study of ancient Indian literature that the 'Soma' of ancient India is nothing but *A. muscaria*. More than a thousand hymns have been devoted to 'Soma' in the Rig Veda. Chemical constituents of *A. muscaria* have been studied for over a century but the exact nature of all the compounds concerned have still not been fully determined. Two alkaloids isolated are Muscarine and Bufotone, but these occur in such small quantities that they can scarcely produce any psychotropic effect. Hallucinogenic principle seems to be due to Muscimol, a cyclic acid acting together with two cyclic amino acids, Muscazone and Ibotenic acid. *A. muscaria* is ingested fresh or dried. Much of the hallucinogenic substances are known to excrete out unchanged in the urine, and urine is often used by natives of North-Eastern Asia, which is reported to produce the same hallucinogenic effect as the mushroom itself. (Rumack and Salzman, 1978).

A. muscaria is one of the most widely used psychotropic mushrooms in the United States. It is a very distinctive species which grows all over United States. It is mycorrhizic with conifers and hardwoods. We have collected it growing with *Picea smithiana*, *Abies pindrow* and *Quercus diltata*. It is widely used as a recreational drug in some parts of U.S.A. (Ott, 1976). Although Wasson

(1969) presents convincing circumstantial evidence in favour of 'Soma' being a product of *A. muscaria*, further pointing out that this mushroom must have been accessible to the priests either from Himalayan localities or by introduction from farther North-East, presently no where in the N.W. Himalayan part, not even in the tribal areas, this or any other mushroom is being used for obtaining supernatural elation. May be the use, if at all it was there, has been gradually lost with the passage of time. Instead, people use preparations of *Cannabis* and *Datura* for recreational purposes and for making divine revelations.

To the third group of hallucinogenic mushrooms belong the species of Russulaceae, Boletaceae and Strobilomycetaceae. Ritualistic uses of some of these mushrooms have been reported from Waghi river region in New Guinea (Ross, 1936; Heim, 1965). The hallucinogenic principle in these mushrooms has not been identified chemically as yet. These mushrooms are eaten boiled or grilled with vegetables and are reported to cause a state of hysteria like 'Follies' (Rumack & Salzman, 1978).

In the fourth category are the members of gastromycetes especially puffballs and some mushroom species of *Paneolus* and *Pholiota* but nothing is known about their chemical nature, though they have been mentioned in the literature as supposedly hallucinogenic.

NATURAL OCCURRENCE OF SOME INTERESTING AGARICOLOUS FUNGI IN HIMACHAL PRADESH

The specialization of science is an inevitable accomplishment of progress....

— J.R. Oppenheimer, 1954

H.S. Sohi and R.C. Upadhyay

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During the course of surveys in the forest areas of Himachal Pradesh in the months of July-October, 1985 and February 1986, a number of interesting and rare agaricolous moulds were collected on various fleshy fungi in nature and identified. On artificial inoculation most of them were pathogenic on *Agaricus bisporus* and *Pleurotus* spp. these include :—

(i) *Nyctalis asterophora* (Fries) Fr. : The fungus was noticed to parasitize old fruit bodies of *Russula* sp. in nature. It formed whitish cottony growth consisting of branched septate mycelium with brownish thick walled stellate chlamydospores, 16-20µ and creamish coloured small distinct agaricoid fruit bodies with poorly developed gills and stipe.

(ii) *Mycogone perniciosus* Magn. : It was also collected on the fruit bodies of *Russula* and *Lactarius* sp. showing pinkish mycelial growth of branched hyphae with verticillate to subverticillate hyaline conidiophores bearing one to three celled terminal conidia. Thick

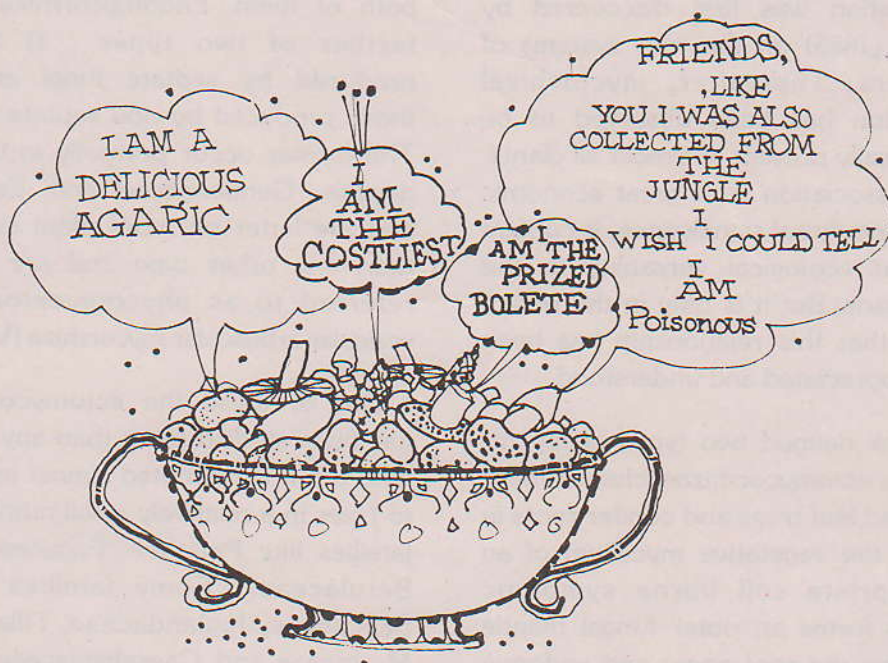
walled, amber brown mostly two celled and sometimes one celled chlamydospores were formed on short stalks either terminally or laterally. It was pathogenic on *A.bisporus* on artificial inoculation.

(iii) *Sepedonium chrysospermum* (Bull.) Link. : The mould was observed as white fluffy growth on sporophores of *Boletus* sp. which later on turned into orange to golden yellow in colour. Verticillately branched, hyaline conidiophores with bottle shaped conidia were noticed. Chlamydospores were mainly globose, orange colored and terminal. Lateral chlamydospores were lighter and smaller in size.

(iv) *Hypomyces chrysospermum* Tul. : It was observed as orange colored mouldy growth on rotten drying sporophores of *Boletus* sp. Numerous globose to sub globose pear shaped, stalked, dark brown, thick walled perithecia were observed, which contained numerous 8-spored, cylindrical asci. Ascospores were hyaline, bicelled, fusiform and 13.5 - 19.0 x 5 µ.

(v) *Cladobotryum variospermum* (Link) Hughes : This mycoparasite was collected from fruit bodies of *Phomitopsis insulare* Murr. and *Polyporus versicolor* L. ex. Fr. as whitish mouldy growth on the lower surface of the fructification. It showed hyaline, profusely branched, septate hyphae with erect, long septate hyaline conidiophores, branching

irregularly and repeatedly terminating in irregular groups of phialides. Phialospores were terminal, hyaline, non septate to 1- septate subglobose to broadly ellipsoidal thick walled. On inoculation it produced irregular small, brownish, sunken spots with profuse conidial formation on *A.bisporus* and whitish mouldy growth on oyster mushroom.



MYCORRHIZA AND MUSHROOMS

There is a good possibility that in the twilight of this world the forms of life predominating will be the fungi and those plants and animals smart enough to have gone into partnership with them.

— C.M. Christensen, *The Molds and Man*, 1965

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The term mycorrhiza literally means fungus-root association. It is a symbiotic partnership between fungi and the root systems of plants. This association was first discovered by Frank (1885) on the root systems of conifers. Thereafter, mycorrhizal condition has been observed to be universally present in almost all plants. This association is of great economic and agricultural significance. It confers a great ecological versatility to the possessor. But it is only in the recent years that this relationship has been fully appreciated and understood.

Frank defined two types of mycorrhizae : ectomycorrhizae, characteristic of broad leaf trees and conifer roots in which the vegetative mycelium of an appropriate soil borne symbiotic fungus forms an outer fungal mantle covering the root apex; and endomycorrhizae characteristic of other plants, in which the outer mycelial sheath is relatively poorly developed but the hyphae penetrate both inter- and intracellularly. Now a third type,

ectendomycorrhiza is also recognised which is in some ways intermediate between ecto- and endomycorrhizae and possesses some of the features of both of them. Endomycorrhizae are further of two types : i) those produced by septate fungi and ii) those produced by non septate fungi. The former occur primarily in Orchidaceae, Gentianaceae and Ericales and the latter on more plant species than any other type and are often referred to as phycomycetous or vesicular arbuscular mycorrhiza (VAM).

Out of these the ectomycorrhiza has been studied more than any other kind but it is restricted almost entirely to trees in a relatively small number of families like Pinaceae, Fagaceae and Betulaceae. Some families like Salicaceae, Juglandaceae, Tillaceae, Myrtaceae and Caesalpiniaceae have both ecto- and endo-mycorrhizal species with both types occurring occasionally on the same plant. There are many fungi known or thought to be involved in the formation of

ectomycorrhiza. The fungi producing ectomycorrhiza are primarily higher fungi belonging to agaricales and gasteromycetes. About 3% of the total number of plant species are estimated to have ectomycorrhiza. The fungi that enter into mycorrhizal associations belong to a number of common genera like *Boletus*, *Amanita*, *Tricholoma*, *Cortinarius*, *Suillus*, *Lactarius* and *Rhizopogon*. The connections between the fruitbodies of species in these genera and the trees with which they are mycorrhizal can be easily traced. Because mycorrhizal species account for the bulk of the higher forms of fungi, it is, therefore, not easy to present an adequate list of the fungal species and their respective symbiotic plants. The situation is further complicated by the fact that a single fungus species may be associated with various plant species or there may be a specific two way relationship between the fungus and plant. Such mycorrhizal fungi may have a wide host range but some have an extremely restricted range; e.g. *Boletus elegans* and *B. gravillei* are confined to species of Larch, whereas, *Septularia sumneriana*, a cup fungus, is found only beneath Cedars. Furthermore there are species like *Phallus impudicus* which live saprophytically but can also enter into mycorrhizal associations whereas fungi like *Scleroderma aurantiacum* which are normally mycorrhizal with a wide variety of herbs, also can survive as saprophytes.

In this North-Western Himalayan part during the decade 1976-1986, about 80 species in Agaricales have been found to be mycorrhizal with trees like, *Betula* sp., *Quercus* sp., *Pinus wallichiana*, *Cedrus deodara*, *Abies pindrow* and *Picea smithiana*. Even *Morchella deliciosa* has been recorded growing in mycorrhizal association with grass, fern and strawberry roots. The forests where tree felling had been rampant and soil eroded, *Helvella crispa* and *Suillus sibiricus* were never present, whereas they were recorded again when those areas were regenerated with *P. wallichiana* and *C. deodara*. This clearly proves the belief that the symbiotic relationship leads to the ecological success of both the fungus and the tree and allows both organisms to exploit habitats in which neither alone would grow successfully (Cooke, 1977).

Mycorrhizal roots are more efficient than non-mycorrhizal roots in taking up mineral nutrients from the soils. The fungal sheath of hyphae increases the absorptive surface of the mycorrhizal roots, compensating for the absence of root hairs. This sheath absorbs the nutrient from soil and passes these to the plant roots through the hyphae lying in between the cortical cells. Such roots show 2-5 times increased uptake of mineral nutrients from soil than non-mycorrhizal roots. Therefore, the mycorrhizal seedlings show better

growth, development and survival, especially in nutrient poor soils. In addition, mycorrhizae also make plants resistant to feeder root pathogens. There are many instances around the world where the failure of plantations is attributed to the absence of mycorrhiza.

There are edible fungi that grow in symbiosis with forest plants but which have eluded artificial cultivation so far. *Boletus edulis*, *B. granulatis*, *Tricholoma matsutake* and species of the genus *Tuber* are some of such fungi. They have been now cultivated under field conditions. This practice provides two-fold benefits : artificial mycorrhizal inoculation of known symbionts in

abandoned, deforested and denuded sites makes reforestation programmes successful and production of fruiting bodies by fungal symbiont offer the possibility of an increased income to the grower.

Smith (1971) stressed the need for systematically working out the mycorrhiza forming fungi and pointed out that value of such studies to a mycorrhiza worker would be "that he can expect closely related species to have rather similar biochemical processes providing the same or closely related compounds, and such a classification (will) furnish him with a guide to what species to test for a particular synthesis".

BIOLUMINESCENCE — THE PATH SHOWING FUNGI

Some fungi belonging to basidiomycetes have the property to emit light. Mycelium or fruit body or both may luminesce depending upon the species. Glow from decaying wood, rotting tree roots and fruit bodies was known to ancestral man and may have been used as marker for pathways in forests. The light emitted by these fungi is not monochromatic and emission of light is a biological degradative process requiring oxygen. Why this phenomenon evolved in basidiomycetes; what is its advantage to the species, are the questions of interest. The common examples of fungi having the property of bioluminescence are *Armillaria mellea* and *Pleurotus japonicus*.

— M.S.B.

MORCHELLA — A FASCINATING MUSHROOM

'Your are at the edge of promises and prophesies'.

—O. Cromwell, 1653

S.C. Kaushal

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'The Morels' of commerce, as the species of *Morchella* are known, are undoubtedly the most prized and one of the highly delectable table delicacies amongst edible mushrooms, with fairly good protein value. Primarily a vernal genus, *Morchella* is the safest to eat, gentle and unheard of causing even the slightest uneasiness to its patron. Although easy to recognize (infact difficult to confuse with anything else) with their pitted, honey-comb like spongy head with different hues of pale brown to smoky brown colouration, the species of *Morchella* are famous for hide and seek temperament in the field. These have often baffled the professional and amateur mycologists who spend sleepless night and undertake long journeys to hills to be able to collect these fungi from their natural habitats. During my fungal forays spread over eighteen years, I have myself sometimes collected the species of *Morchella* from a spot, with a single gathering being as heavy as 2 kg and also been frustrated from the same spot when revisited even on three consecutive years. That is what is a fascinating and challenging hide

and seek of morels. The reasons are, of course, many-fold and from simple to complex.

Although principally the morels are inhabitants of temperate hills and/or plains, an interesting exception is a new variety of *M.esculenta* first reported by Sharma *et al* (1977) from Kathua in Jammu and Kashmir, under tropical conditions. I made a good collection of this variety in 1984 and 1985 in the months of November and December. Infact I was astonished to see it growing in abundance along the irrigational water channels meant for wheat fields.

Interesting observations and some erroneous beliefs and myths on appearance of morels have dominated the scene for quite sometime. The appearance of morels on burnt soil led to the view that these grow abundantly on burnt up areas. In many countries people started burning the woodlands so that they could obtain a rich crop of morels. This practice of burning woodlands became a major cause of forest destruction in Germany. To

prevent the people from this habit, ultimately it was banned by law.

People in our hills believe that morels appear near the melting snow and along the trenches in which the snow water runs. They also link the appearance of 'Morels' with the lightening and believe that after lightening and thundering soil bursts open to let the morels appear. A sizeable number of natives from villages around Chamba and Bagghi in Himachal Pradesh and from Kishtwar in Jammu and Kashmir told me that if I wanted to collect maximum morels from collection sites, I must go covered with a blanket; and this I faithfully did on several occasions without much luck for a better collection. One more myth which is prevailing in Palampur area with 'Gaddi people' is that if one carries some morels along with him, one will be able to collect more morels.

The morels have defied commercial cultivation in true sense till today, although there are reports of harvesting rich crops of this mushroom under simulated natural conditions. A few fascinating earlier accounts will not, perhaps, be out of place.

Simer (1874) describes the composition of the soil on which he successfully raised the crop of morels. According to him the composition of the soil should be made as follows:

- One quarter of two-year-old tan (well rotted).
- One quarter of heath mould or leaf mould.
- One quarter of ordinary vegetable mould.
- One quarter of fresh loam.

Addition of fifth proportion of mould from some spot where morel is known to thrive.

He directed that the whole be carefully mixed together for refilling the pots with this fresh compost. Beginning from October, after three weeks, sometimes a month, growth of the mycelium was found in these pots. Then it started disappearing and after a few weeks, he found hundreds of morels of the size of pinheads. The most suitable temperature was 47F at beginning of the culture and 50F towards its close.

In 1889, the Baron d' Yvoire succeeded in growing these fungi. Starting from a plantation of artichokes, in May or June, he incorporated into the soil surface, pieces of morels. In autumn, apple pulp was spread around the artichoke stalks. One to two weeks later, the bed of apple pulp was covered with a layer of dry leaves protected with branches. This was removed the following spring. The substrate, fully run with the mycelium of morels was maintained in a rather moist condition and fruiting occurred year after year from then on.

Molliard (1905) by using sterilized earth with the addition of various organic substances and also sterilized carrots (actual medium he did not describe) was able to grow morels. He used spawn of *M. esculenta* and inoculated this in a pot filled with earth to which he added some compost from apples. The carpophores obtained after a while (e.g. after 20 days) were either rather small or few and isolated. Spawn inoculated on beds in the open experimental gardens, under modified conditions gave better results. He also observed that morels often grow on residue of apples and on paper waste — an observation corroborated by other French Mycologists including Singer.

Constantin (1936) by repeating Molliard's experiment obtained yield of 350 g/sq.meter of bed surface. Matruchot (1909, 1910) obtained fruit bodies on paper pulp wastes and rotten wood mixed with sand. He concluded that the fruiting mycelium of morels utilizes cellulose substrates. Babee' (1936) repeated the cultivation of *Morchella costata* on ordinary household garbage mixed with garden earth and decomposing in lots near the woods during one year. It has been reported that in France (Heim 1936) a rich crop was harvested as a result of crumpling dried morel ascocarps on ground previously, 'fertilized' with apple mash obtained from the cedar factories. I understand

natural seeding of *Morchella* in also being attempted by NCMRT, Chambaghat, Solan under stewardship of Dr. H.S.Sohi who is now heading the Centre.

Physiological studies show that a pH(6.93) relatively higher than the optimum for most of the fungi is best for the growth of *M. esculenta*, that starch, maltose, fructose, furanose, glucose and sucrose are good sources of carbon and both ammonium and nitrates can be utilized in addition to urea, some aminoacids and surprisingly enough NaNO_2 as N source (Brock,1951). On agar cultures, inulin gave poorer results. This was contrary to the earlier findings in which *Morchella esculenta* was found parasitizing roots of *Helianthus tuberosus* which is notoriously high in inulin and that attempts at planting artichokes together with morels were particularly successful. However, the reason is not known. Ammonium citrate, thiourea, hydroxylamine-HCl and hydrazine $\cdot 2\text{HCl}$ were all observed to be toxic.

India is the major exporter of 'Black Himalayan Morels' along with Pakistan and Italy. An estimated 50-60 tons of dry morels are exported every year. The lucrative business is in few hands who export the fungus to Europe where it sells at an average price of around U.S.\$150 per Kg. However there are several problems and a concerted effort is needed to improve

the standard of product and the manner of export.

Botanists working with crops like wheat, have often asked, why so little has been done in the field of mushrooms in India, even when the work is going on since nearly three decades. The reason is, unfortunately that the Govt. of India has not

invested even the bare minimum funds in research and development of various types of mushrooms in general and nothing at all in morels. Still some of us are enjoying an obsession with mushrooms and have given far better results in proportion to financial investment. However, none can produce the results of wheat with investment of mushrooms.

MUSHROOM STAMPS — CONTRIBUTION OF MYCOLOGY TO PHILATELY

Mushrooms because of their colour, shape and appearance at odd places have attracted the attention of human being. The larger fungi including both edible and poisonous fungi growing on diverse substrates under different habitats have appeared as stamps in number of countries like Algeria, Andona, Australia, Botswana, Brazil, China, Central African Republic, East Germany, Guinea, Fiji, Hungary, Kampuchea, Kuwait, Lesotho, Libya, Mexico, Norfolk Island, St. Helena, Solomon Islands, Zambia, and many others

— M.S.B.



COMMITTEES

The following committees were constituted for the inaugural function, seminar on mushrooms and workshop of All India Co-ordinated Mushroom Improvement Project held at National Centre for Mushroom Research & Training, Solan from 23rd to 25th September, 1986.

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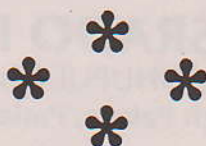
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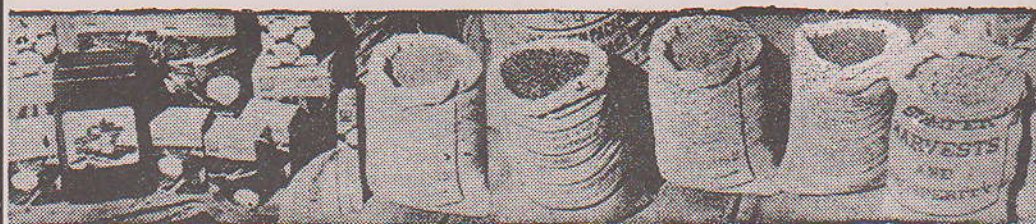
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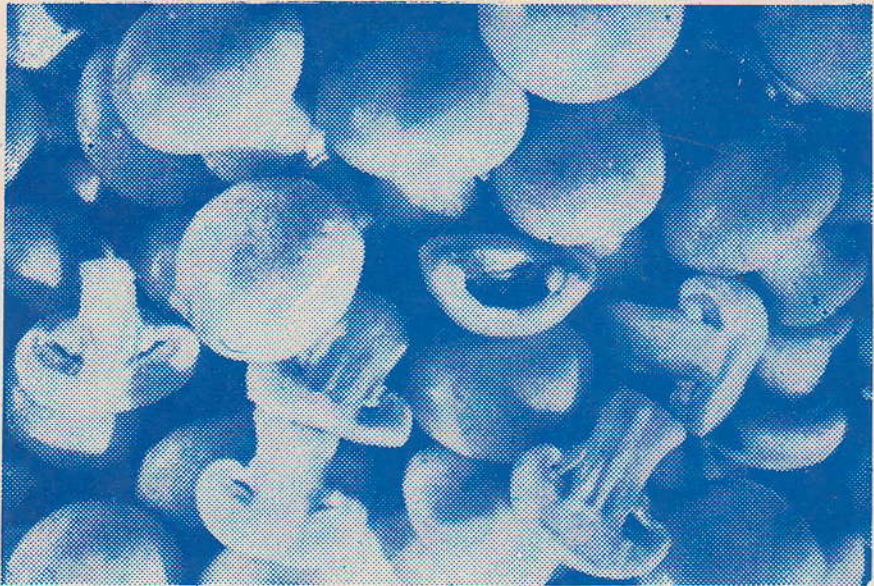
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