

### European mushroom (*Agaricus bisporus*)

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Ag.  
Technologies.  
Mushroom  
Cultivation

#### Introduction

*Agaricus bisporus* (Lange) Sing is popularly known as the button mushroom. This mushroom is extensively cultivated throughout the world and contributes about 40% of the total world production of mushroom. At present, India is roughly producing about 20,000 tonnes of this mushroom. The reasons for such a low production can be attributed to lack of awareness among masses, shortage of quality spawn, use of traditional methods of cultivation and inadequacy of post harvest disposal facilities. In India, the potential for the cultivation of this mushroom is tremendous due to vast availability of agricultural wastes. According to a rough estimate, about 300 million tonnes of straw is produced in India annually and if only 0.5% of it is utilized for white button mushroom production, then about 3,00,000 tonnes of mushroom can be produced which would be the highest production of mushroom any country in the world.

#### Area and distribution

Out of 20,000 tonnes produced in India, Haryana contributes around 1200 tonnes, Punjab 1000 tonnes, U.P 800 tonnes and H.P. 2500 tonnes. Rest of the production comes through J& K, Tamil Nadu, Karnataka, Kerala and other States.

#### Method of cultivation

Most of the production of white button mushroom in our country is seasonal. The cultivation is done using conventional methods. Usually, unpasteurized compost is used, hence yields are very low. However, in recent years, yield of mushroom has increased as a result of introduction of improved agronomic practices. Cultivation of the common white button mushroom requires technical skill. Apart from other factors, the system requires humidity, two different temperatures that is

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Temperature for spawn or vegetative growth: 22-28°C

For fruit body formation: 15-18°C Humidity: 85-95% and enough ventilation during

Substrates that are sterilized are easily contaminated unless spawned under very aseptic conditions. Therefore steaming at 100°C (pasteurization) is more acceptable steamer.

### Compost preparation

Agricultural by products like cereal straw (wheat, barley, paddy, oat and rice), maize stalks, hay, sugarcane bagasse or any other cellulose wastes can be employed. Wheat straw should be freshly harvested, shining yellow in colour and should not have been exposed to rains. The straw should be in about 5-8cm long pieces, otherwise heap prepared by long straw would be less compact which may lead to improper fermentation. Conversely; too short straw makes heap too compact to allow enough oxygen to enter the centre of the heap and lead to anaerobic fermentation. Wheat straw or any of the above materials provide cellulose, hemicellulose and lignin, which are utilized by the mushroom mycelium as the carbon source. These materials also provide physical structure to the substrate needed to ensure proper aeration during composting for the build up of microflora, which is essential for the fermentation. Rice and barley straw are very soft, degrade very quickly during composting and also absorb more water as compared to wheat straw. While using these substrates, care should, therefore, be taken on the quantity of water to be used, schedule of turnings and adjustment to the rate and type of supplements. Since the byproducts used in composting do not have adequate nitrogen and other components required for the fermentation process, compounding mixture is supplemented with the nitrogen and carbohydrates, to start this process.

### Spawning

Spawning is mixing of spawn infor optimum and timely yields. Optimum dose for spawn ranges between 0.5 and 0.75% of fresh weight of compost. Lower rates result in slow spread of mycelium and chances for diseases and competitors may increase. Higher rates may increase cost of spawning and very high rate of spawn sometimes results in unusual heating of compost.

### Crop management after spawning

The optimum temperature for growth of *A. bisporus* is 23 ± 2°C. Relative humidity in growing room should range from 85-90% during spawn-run.

### Harvesting

Usually 3 to 4 days after opening the bags, mushroom primordia begin to form. Mature mushrooms become ready for harvesting in another 2 to 3 days. An average biological efficiency (fresh weight of mushrooms harvested divided by air-dry substrate weight x 100) can range between 80 to 150% and sometimes even more. To harvest the mushrooms, they are grasped by the stalk and gently twisted and pulled. A knife should not be

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used. The mushrooms remain fresh for up to 3 to 6 days in a refrigerator/cool place.

# NEWS

Wednesday, December 9, 1998

## Mushroom park cleared for Punjab

EXPRESS NEWS SERVICE

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CHANDIGARH, Dec 8: The Punjab government has approved the Punjab Agri and Export Corporation and Agro Dutch Foods Limited tie-up to set up a mushroom industrial park in the state near Lalru to promote the cultivation of mushroom.

The decision was taken at a high-level meeting chaired by Chief Minister Parkash Singh Badal.

Presently, out of Rs 75 crore export of mushrooms from the country, Punjab's share is Rs 45 crore.

It was decided to start Punjab mushroom school on the Dutch pattern to train students for mushroom cultivation for export purposes. This school would impart six months training to 50 students in each batch. The trainee would get a stipend of Rs 1,000, besides free boarding and lodging. The school is proposed to train 2,000 mushroom farmers initially under this scheme to produce 12,000 metric tonnes of mushroom per annum.

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## **Introduction - historical**

Mushroom cultivation in India was initiated for the first time at Solan in mid sixties when Dr. E. F. K. Mental from Germany started the work as the FAO consultant at Solan. He started the work on a small scale at the Dept. of Agriculture, H. P. Govt., Solan and successfully grew button mushrooms for the first time in India. Also associated with the project at Solan were the late Dr. P.K. Seth from the Dept. of Agriculture and Dr. S. Kumar. Simultaneously button mushroom cultivation was begun as a pilot project at Srinagar (Kmr) by Mr Stewart (a Britisher settled at Srinagar) along with a team of workers from the Dept. of Agriculture at Lalmandi, Srinagar. At both places the activity grew in size and mushroom growers started growing mushrooms in their houses as a cottage industry. Solan developed more rapidly as the effort at the Dept. of Agriculture (later Himachal Pradesh Agricultural University) was pursued vigorously and the first commercial unit of white button mushrooms in the seventies was put up at Kasauli (near Solan) by Mr. Saigal with the help from the C.O.A., Solan. Then came, his Highness, the Maharaja of Patiala who started growing mushrooms in the seventies at Dochi and Chail, near Solan on a much larger scale. He monopolised the button mushroom market in India for sometime and mushrooms from his farm would travel, in fresh condition, as far away as Bombay. Meanwhile mushroom growing took the shape of a cottage industry in Kashmir in the seventies where people started growing button mushrooms on a large scale in villages on composts prepared by the long method. The mushrooms produced in Kashmir were purchased by local canners and marketed in other parts of the country. The growers were producing button mushrooms against greater odds with little know-how available, especially for producing quality mushrooms. The mushroom activity spread to other hilly regions of India like the hills of UP and Tamil Nadu. Growers in the North Western plains started button mushroom growing (as a winter crop) to take advantage of the winter season in this region. Farmers in the NW plains in and around Delhi started growing a winter crop of button mushrooms successfully and marketing the produce in nearby Delhi. In the mid-seventies Dr. W. A. Hayes was appointed as FAO expert on mushrooms in India and worked at Solan for some time to establish and standardize the facility for the short method of composting at the College of Agriculture, Solan. This resulted in the establishment of an air conditioned cropping house at Solan with a facility for peak heating of mushroom compost. With the contribution of the College of Agriculture at Solan, many students pursued a mushroom programme for obtaining their MS and Ph.D. degrees under the guidance of Prof. R. L. Munjar, Prof. and Head of Dept. of Plant Pathology and Head of Mushroom Research Laboratory, Solan. This was shortly followed by the establishment of a mother composting unit at Solan in the early eighties under UNDP assistance where James Tunney from the UK worked for several years commissioning the mother composting facility at Solan. The seeded compost at the mother unit was provided to growers in and around the Solan hills to initiate mushroom cultivation. The mushrooms thus produced were purchased by canners and sold in the market. But the consumption of mushrooms was confined to the richer sections of society. The National Research Centre for Mushrooms was set up by the Indian Council

of Agricultural Research at Solan in 1983 (June) and I was given the responsibility of starting the Centre at the old/vacated campus of the College of Agriculture, HP Agriculture University, Solan. The Centre took several years to develop the facility at Solan and today we have 15 scientists working at the Centre in 4 different disciplines such as Mushroom Production and Improvement, Mushroom Protection, Mushroom Nutrition and Crop Utilization and Extension. Today this Centre has attained national and international recognition for the contribution made in mushroom R & D in India and the World. We have most modern laboratories with the latest equipment and instruments for conducting research on various aspects of mushrooms. The biotechnology laboratory for DNA fingerprinting and use of DNA markers in breeding is working full-time on a mushroom breeding programme. The climate-controlled cropping rooms (13) are ready to be commissioned for use in experimentation within a month. The mushroom industry in the eighties increased in size by way of expansion of mushroom growing activities all over the country. Button mushrooms were grown in cooler regions and oyster/straw mushrooms in hotter regions. Meanwhile Pleurotus sajor-caju cultivation became more and more popular all over the country with its minimal requirement of infrastructures. Simple hot water treatment or chemical treatment (Bavistin/formalin) of the substrate was found good enough to protect the substrate from competitor moulds during cropping. In late eighties and early nineties some modern air conditioned mushroom farms were built near cities like Pune, Bombay, Delhi, Chandigarh, Hyderabad and Madras. With the introduction of spawn of improved/hybrid strains in the nineties by some leading spawn companies from the US and Europe, the industry got a further boost. By the early nineties production of all types of cultivated mushrooms was 5-7 thousand tonnes, and a minor part of it was exported. Besides that, mushrooms harvested from nature like Morels/Kabul Dhingri were exported in greater quantities to Europe and America in the dried form. The mushroom industry saw its biggest expansion in the mid-nineties with production going up to 40,000 tonnes and exports increasing dramatically. About 70-80% of this production was exported to the US and Europe. The exports became more organised in the nineties but the mushroom industry saw a downturn in the late nineties with China causing a fall in international prices by dumping mushrooms produced cheaply in their country, in the more competitive markets. The prices dropped in the international market from US\$ 28-30 to 18-20 and subsequently to 12-14 per case. This could not compensate even for the production costs and the industry in India suffered a set back, and people stopped investing in this area. Today the prices are better around US\$ 18-20 per case, with little antidumping duty enforced on Indian exports by the US Govt. The Industry was expected to reach a production figure of 100000 tonnes by the turn of the century, but could reach the half way mark only by 2001. Today, there are limited enquiries on mushroom industry investment when raw materials, labour and technology are available readily at a comparatively lower costs. We have mushroom growing activity spread over the length and breadth of the country, with local spawn laboratories proliferating in areas of greater demand. The per capita consumption is 15-20g only and by increasing the per capita consumption to 100g, we should be able to market 100000 tonnes of mushrooms within the country. There are positive signs emanating from the consumer in India, and today cultivated mushrooms are available in all common vegetable shops, grocery stores and departmental stores in small and big towns in India. Mushrooms are more relevant to predominantly vegetarian India.

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### **Mushroom Spawn**

Mushroom spawn was initially available from only one centre in India, that was College of Agriculture, Solan and that was the situation until the end of the sixties. Then spawn laboratories were established at Srinagar by Dept. of Agriculture and Regional Research Laboratory with the production of reasonable quantities of pure culture spawn. Some spawn was also produced by Teg's Mushrooms at Chail. The College of Agriculture, Solan became the chief source of supply of spawn in the country. In the eighties some laboratories in agricultural universities started providing pure culture mushroom spawn to the mushroom growers and spawn was also available from the Indian Institute of Horticultural Research, ICAR, Bangalore. With the setting up of the National Research Centre for Mushrooms at Solan, spawn was made available from the Centre to small and marginal farmers and by the late eighties many commercial spawn laboratories were set up in and around Delhi. About this time Sylvan, USA, started operations in India marketing spawn produced at their European centres. But unfortunately, they did not find the market big enough to set up their own production unit. We do not have large spawn companies operating in India with a R&D back-up facility, the spawn companies that are operating just multiply the spawn and sell it. The availability of strains is limited to S-11, 310, 791, 76 (all non-hybrid strains of *A.bisporus*) and U-3 (Hybrid). These strains were officially procured in earlier times by different spawn producing centres in the Government sector. A dozen species of *Pleurotus* are also available in India for cultivation in different agro-climatic zones of India. Also NRCM released 3 new strains of *A.bisporus* (NCS-100, NCS-101 and NCH-102) in 1997 and 2 strains of *A.bitorquis* (NCB-6 and NCB-13) in 2000. The cultures of all these strains are available from the culture bank maintained at the centre at NRCM, Solan. Today our centre is the chief source of mushroom cultures in the country. We maintain cultures in our culture bank in a refrigerator (frequent sub-culturing), in liquid paraffin and liquid nitrogen (cryopreservation). Spawn is prepared and supplied in 500g and 1kg polypropylene packs and one kg of mushroom spawn costs about Rs.50.00 (approx. one US\$). Some big spawn companies are supplying spawn to commercial growers in India at almost 3 times the price of that available locally. The quality of the spawn produced by Indian companies is comparable to the best in the world except that it is in small packs of 1kg and the choice of strains is limited. The big companies from US and Europe can make it big in India if they cater to the markets from surrounding areas like China, Indonesia, Thailand and other countries. The biggest advantage India offers is the lower cost of production of spawn with low cost of inputs. Presently Indian market demand is about 8000-10000 tones of spawn. Spawn in India is mostly produced on wheat grain and bajra grain (lesser millet). The spawning rate in button mushroom is 0.5-0.7% and in *Pleurotus* is about 2% of the wet weight of substrate.

### **Compost technology**

White button mushroom is still the most commonly cultivated mushroom grown and accepted by the consumer in India. Today we have the most modern compost producing technology in use in the country. There are principally two sets of mushroom growers in India, first those who grow mushrooms seasonally and they produce the compost by a long method in a single phase outdoors in 20-25 days without phase-II, mainly depending upon the selectivity of the substrate for obtaining a single crop of mushrooms. Second is the commercial grower who takes 4-5 crops in a year in environmentally controlled modern cropping houses. These units have facilities for phase-I and phase-II of composting with use of modern machines for turning, filling and emptying. Some of the units have built indoor phase-I bunkers and are using these facilities with good productivity. Composting by this method is accomplished in 18-20 days (6-7 days in pre-wet, 6-7 days in phase-I, 6-7 days in phase-II). On most of the mushroom farms wheat/paddy straw are used as chief base materials and poultry manure along with N-fertilizer and organic N-sources are used as supplements for composting to bring base materials to desired C:N ratio at the start. Most of the commercial units have excelled in the art of composting with measurement of compost parameters at every stage. A nitrogen percentage of around 2.3% is acceptable after completion of Phase-II as a good measure with moisture content of about 67-68% at spawning, with bulk density of 100-110kg per m<sup>2</sup>. As short sized/finely chopped wheat straw is used for composting in India as against 10"-12" long wheat straw used in Europe. This results in our composts becoming denser as a greater quantity fits into a smaller space. The wheat straw is principally available finely chopped, basically prepared as animal feed, as the mushroom industry in India is not so big as yet to attract the attention of the wheat straw handler. Sugarcane bagasse is also used as a base material in some areas for composting in combination with paddy straw, but the composting takes longer by 5-7 days. Farm Yard Manure and Mushroom Spent Compost are commonly used for casing after steam/formalin treatment, as peat is not available in our country. Coir pith after composting is also used in combination with FYM with good results. Casing material is a major bottleneck in button mushroom cultivation in India. Importing Irish peat is expensive for the grower.

### **Growers**

There are two main types of mushroom growers in India, seasonal growers and round the year growers. Both grow white button mushroom for the domestic market and export. The seasonal button mushroom growers are confined to temperate areas such as Himachal Pradesh, Jammu and Kashmir, hilly regions of Uttar Pradesh, hilly regions of Tamil Nadu and North Eastern hilly regions where growers take 2-3 crops of button mushrooms in a year. Also included in the seasonal growers are the growers from North Western plains of India who grow one winter crop of button mushrooms and sell it fresh. The all-season growers are scattered all over the country. The large/export oriented units (EOU) are located in Punjab (near Chandigarh), Dehradun (Near Massoorie hills), Gurgaon (near Delhi), Hyderabad (South India), Madras (South India), Ooty hills (South India), Pune (near Bombay), Paonta Sahib/Nalagarh (HP) and at Goa (Western India). These large units have the growing capacity in the range of 200 to 5000 tonnes per annum. M/s Agro Dutch located in Punjab (near Chandigarh) is the largest EOU with installed capacity of about 5000 tonnes. Some of these units were built with the assistance from foreign machinery sellers/consultants; but entire air handling/cooling machines are now manufactured and commissioned in India.



### **Waste recycling**

Spent compost has been found to possess good qualities for soil application in place of chemical fertilizers at NRCM, Solan. It was found possible to fertilize the soil with spent compost for the cultivation of soybean/maize with very good results. It can also be used as manure for flower and vegetable cultivation under tropical/temperate climate. One way of recycling Agaricus spent compost is as its use for casing, after suitable decomposition and water leaching. Many mushroom farms are using decomposed spent compost in combination with FYM or other materials with good results.

### **Marketing and exports**

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Marketing of fresh mushrooms is always done in the nearby city, especially Delhi, Bombay, Madras, Chandigarh and others. Most of the produce from big commercial farms is canned in brine and exported to destinations outside India, especially USA. The quality of the mushrooms exported is excellent as most of the big commercial farms are growing hybrid strains of *A.bisporus* made available to them by multinational spawn companies like Sylvan, Amycel and others. The mushrooms are blanched and preserved in brine in large containers for shipment to distant destinations in containers, and are repacked at the final destination to suit local markets. A quantity is freeze-dried by the producer and exported at a good price. The mushrooms for freeze drying require to be picked as smaller buttons, hence reduced yields.

The retail price of fresh mushrooms in Indian ranges from Rs.50/- to Rs.100/- per kg, depending upon the season. In summer months the prices are higher than in winter months due to the high cost of electricity for cooling. Prices are lower in winter due to arrival of mushrooms into the market from seasonal growers. Prices of mushrooms in the marriage season go as high as Rs.150.00 per kg for a short period due to greater demand.

India being a tropical country, fresh marketing is at a premium, except for a brief winter period. The commonly used packaging is the polythene bag. Most of the mushrooms sold in fresh markets are treated with potassium metabisulphite due to market demand as mushrooms become extra white after the treatment and the casing adhering is also removed. The export market for India is chiefly the USA, with some quantities going to UAE, Russia, The Netherlands, Germany, UK, Switzerland, Denmark, Israel, Sweden and other countries. There is no quota available from EU for India, and Indian exporters have to sell processed mushrooms in the EU with additional taxes levied as per the laws of the EU, which makes it difficult for the Indian exporters to compete in the EU market.

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