

CULTIVATION OF BUTTON MUSHROOM AND ITS PROCESSING: AN TECHNO-ECONOMIC FEASIBILITY

B.K.Mehta, S.K.Jain, G.P.Sharma, A.Doshi¹, H.K.Jain²

Department of Processing & Food Engineering, CTAE, MPUAT, Udaipur.

¹Department of Plant Pathology, RCA, MPUAT, Udaipur.

²Department of Agricultural Statistics and Computer Applications, RCA, MPUAT, Udaipur

ABSTRACT:

Mushroom cultivation is of recent origin in India. It is mainly cultivated on the hills as it requires low temperature for its growth; however with the advent of modern cultivation technology it is now possible to cultivate this mushroom seasonally under uncontrolled conditions and throughout the year by employing environmentally controlled conditions. In the last ten years, large numbers of commercial units have been built by the entrepreneurs/farmers throughout the country for the production of button mushrooms. But, presence of more than 90 per cent moisture content, they are highly perishable and start deteriorating immediately after harvest. They develop brown colour on the surface of the cap due the enzymatic action of phenol oxidase, this results in shorter shelf life. In view of their high perishable nature, the fresh mushrooms have to be processed to extend their shelf life for off season use by adopting appropriate post-harvest technology to process surplus mushrooms into novel value-added products.

Keywords: *Agaricus bisporus*, Cultivation, Processing, , Shelf-life, Value-added.

Button mushroom (*Agaricus bisporus*) is the most popular variety, fetches high price, still dominating the Indian and International market. It contributes about 90 per cent of total country's production as against its global share of about 40 per cent. The method of cultivation of mushroom was recorded as early as 300 BC and their international cultivation was started as early as 600 AD in China. However, commercial production of white button mushroom was initiated in the hilly regions of the country (17-18°C) like Chail (Himachal Pradesh) Kashmir and Ooty (Tamil Nadu).

Mushroom cultivation slowly spread to North western plains of India (seasonal crop during winter). In Rajasthan, production of mushroom started in 1980. Mushrooms are the health food of the world. Analysis of fresh button mushroom show that they contain 90 to 93 per cent moisture,

28 to 42.5 per cent crude protein, 8.3 to 16.2 per cent crude fibre, 9.4 to 14.5 per cent ash, 59.4 per cent carbohydrates and 3.1 per cent fat. Among the minerals 71 mg calcium, 912 mg phosphorous, 106 mg sodium, 8.8 mg iron and 2850 mg potassium (per 100 g dry weight basis) are present. Among the vitamins 8.9 mg thiamine (B₁), 3.7 mg riboflavin(B₂), 26.5 mg ascorbic acid (C) and 42.5 mg niacin(B₃) are also available on 100 g dry weight basis [1].

Mushrooms are good as nutritious food for all ages and under all conditions of health. They are rich in good quality proteins with lysine and tryptophan that are normally deficient in cereals. The carbohydrates in the mushrooms are at a level of 4.5 to 5.0 per cent but are in the form of glycogen, chitin and hemicellulose instead of starch. The fat content is as low as 0.3 % but is rich in linoleic acid, an essential fatty acid.

Cholesterol is absent and in its place ergo-sterol is present which gets converted to vitamin D by the human body. Mushrooms are fairly good source of vitamin C and vitamin B complex, particularly thiamine, riboflavin, niacin, biotin and pantothenic acid. Folic acid and vitamin B₁₂ which are absent in most vegetables are present in the mushrooms which also supply a range of valuable minerals especially potassium and iron (Kurade *et al.* 1980; Rai and Sohi, 1990; [1]).

Mushrooms have traditionally been used for medicinal and tonic properties and cosmetic products. Compounds extracted from button mushroom have been reported to have anti-fungal and anti-bacterial properties [2]. The high proteins, sterols, macro-elements and low calorie content make mushroom ideal for prevention of cardiovascular diseases [3]. Thus they are an ideal food ever for patients, old people, pregnant ladies and children. Therapeutic properties of mushroom include enhancement of macro phase function and host resistance to many bacterial, viral, fungal and parasitic infections, activation of non-specific immune stimulation and reduction of blood cholesterol and glucose levels [4].

In the last 10-15 years, large numbers of commercial units have been built by the entrepreneurs/farmers throughout the country for export. There are chiefly two types of mushroom growers in India. These are (i) Environment controlled mushroom growers (high cost technology) and (ii) Seasonal mushroom growers (Low cost technology). Both the technologies are relevant in Indian conditions. Large environment controlled units grow mushroom mainly for export purpose only while seasonal growers take a few crops of mushrooms in winter months/all year round in hills. There are scores of spawn producing laborites supplying mushroom seed/spawn to mushroom grower in India. Mushroom cultivation has now become a household name in almost all regions in India.

The world's largest button mushroom growing unit is located in India (Punjab). The present production of all types of mushroom in India is about 1,00,000 tonnes in 2008 [5] and the bulk of it is the white button mushroom. World's total production of mushroom is about 22 million tonnes with China contributing the lions share.

Mushroom cultivation requires cereal straws for substrate preparation and there is abundant cereal straw available in India for recycling to edible biomass of highly nutritional and medicinal value. India produces nearly 140 million tones of cereals and equal amount of straw is generated by the farmers, which can partly be utilized by the farmers for mushroom cultivation. Land requirement is a minimum and any spare room of the house can be converted into a mushroom growing room, or a hut built on a piece of land can also be used for the purpose. The raw materials required for crop raising or generated by the farmers on their own fields (paddy/wheat/or any other cereal straw).

The family labour is used for different operations and the only input required from outside is the seed/spawn of mushrooms. This makes the farmer self confident in raising the crop with great remuneration. A farmer grows one crop or two in the season and his income subsisted to a greater extent. The raw materials requirement for raising a crop of mushroom is recyclable cereal straw/organic waste/organic byproducts. The main byproducts used for substrate preparation for mushroom farming are:

- a. Wheat / paddy straw.
- b. Sugarcane baggage
- c. Saw dust
- d. Cotton seed meal/soybean meal
- e. Scores of the locally available agro byproducts and other agro waste materials like banana pseudo stem/ corn cobs/ groundnut hull etc.

A. Expenditure (production costs per crop of 20 tonnes compost)	
1. Fixed cost (facilities used more than one time)	Rs
(i) Land rent per crop season (land required-0.5 acres)	2000
(ii) Seasonal growing hut (raw bricks/thatched roof/bamboo) 60×20×10-12 feet (h), 1200 feet @ Rs 25/square foot=Rs 30000 life span of 3 crop seasons, 1 crop season cost	10,000
(iii) Spraying equipments, hoses, tubs, buckets, forks, spades, etc. (life span 5 seasons =Rs 5000), cost for 1 season	1,000
2. Variable costs (materials used one time only)	
(i) Cereal straw – 12 tonnes @ Rs 1000/tonne	12,000
(ii) Supplement wheat bran 300 kg/tonne – 3600 kg @ Rs 6/kg	21,600
(iii) Urea 20 kg / tone – 240 kg @ Rs 5/kg	1,200
(iv) Cotton seed cake – 60 kg/tonne, 720 kg @ Rs 10/kg	7,200
(v) Gypsum – 35 kg/tonne, 420 kg @ Rs 2/kg	840
(vi) Spawn- 5 kg/tonne, of compost 100 kg @ Rs 50/kg	5,000
(vii) Casing material (decomposed FYM), 2 kg/bag of 10 kg compost-4 tonnes @ Rs 250/tonne + Farmalin treatment cost	2,000
(viii) Labour-composting 30 LD, spawning 10 LD casing 10 LD, cropping 60LD, Miscellaneous 10 LD=120 LD @ Rs100/LD	12,000
(ix) Water costs	1,000
(x) Power costs	500
(xi) Pesticides, disinfectants, chemicals	1,000
(xii) Poly-bags for packing	500
(xiii) Poly-bags for cropping	2,000
(xiv) Miscellaneous expenses	2,000
Total (1+2)	81,840

Table1:**Economics of button mushroom (*Agaricus bisporus*) cultivation in India under seasonal growing conditions (Low-cost technology system)**

Besides above, poultry manure is also used as nitrogen rich supplement for compost making for button mushroom cultivation. These raw materials are locally available in all the rural areas of the country at very reasonable rates. The

farm yard manure (FYM), spent mushroom substrate and coir industry waste are three main ingredients used as casing materials after proper decomposition in button mushroom farming in India.

Bamboo and synthetic cloth are used for making temporary structures (mushroom growing huts), which are also available at very cheap rates all over the country. For seasonal growing no power is required for crop raising excepting the light. Good quality water which is good for human consumption is good enough for mushroom cultivation as well. Say, Rs 82,000

B. Returns
Returns at 12-15% of compost weight in 8 weeks of cropping at an average price Rs 50.00 kg
At 12%, 20 tonnes × 120 kg per ton compost, 2,400 kg
Rs. 1,20,000
At 15%, 20 tonnes × 150 kg per ton compost, 3,000 kg
Rs. 1,50,000
Profit at 12 % yield, Rs 1,20,000-Rs 82,000
Rs 38,000
Profit at 15% yield, Rs 1,50,000-Rs 82,000
Rs. 68,000

Table 2: Economics of a Plant having 200 tonnes per annum (TPA) production of button mushrooms (High-cost production technology system)

A. FIXED EXPENDITURE (ASSETS) APPROX. COST

1. Land procurement and its development

(labelling, plantation, fencing, etc) Rs5,00,000.00

2. Civil works

a)Compost unit: Rs7,00,000.00

b)Production and processing facility

Rs33,00000.00

c)Spawn laboratory Rs3,500,00.00

d)Office block Rs2,50,000.00

3. Plant and machinery

a)Compost and casing unit Rs7,00,000.00

(compost turner, filling line, boilers, electrical system, tube well etc)

b)Production unit Rs30,00,000.00

(Chilling plant, low pressure boilers, vapour proof lighting, racks etc)

c)Canning spawn laboratory and other requirement Rs10,00,000.00

(spawn lab. and quality control equipment, canning line etc)

B. COST OF PRODUCTION
Approx. cost

1. Recurring expenditure

a) Wages and salary: Rs6,00,000.00

b) Expenses on raw materials, energy and fuel
Rs14,00,000.00

2. Interest and depreciation

a) On land (15 per cent interest)
Rs75,000.00

b) On building (15 % interest and 5 % depreciation) Rs9,20,000.00

c) On machinery (10 % interest and 15 % depreciation) Rs11,75,000.00

Total production at 100 per cent capacity utilization:

At 18 % conversion: 180 tonnes

At 20 % conversion: 200 tonnes

Cost of production per Kg: Rs23.30 (18 % conversion)

Cost of production per Kg: Rs21.00 (20 % conversion)

Profit analysis: At 18 % conversion,

total production: 180 tonnes

Cost of production Rs 41,94,000.00

Sale realization @ Rs 40/kg Rs 72, 00,000.00

Net profit Rs 30,06,000.00

Similarly, at 20% conversion,

Net profit Rs 38,00,000.00

Just after harvest, the mushrooms cannot be stored for more than 24 hours at ambient temperature (Lal Kaushal and Sharma, 1995). Due to presence of more than 90 per cent moisture content, mushrooms are highly perishable and start deteriorating immediately after harvest. They develop brown colour on the surface of the cap due the enzymatic action of phenol oxidase, this results in shorter shelf life. Loss of texture, development of off flavour and discolouration results in poor marketable quality and restricts trade of fresh mushrooms.

In view of their high perishable nature, the fresh mushrooms have to be processed to extend their shelf life for off season use. This can be achieved by adopting appropriate post-harvest technology to process surplus mushrooms into novel value-added products. The value-added products are the need of the hour for the mushroom growers not only to reduce the losses but also to enhance the income by value-addition and boost the consumption of this important horticultural crop. The possible value-added products can be developed either by converting freshly harvested mushrooms into ketch-up, murabba, candy, chips

and pickles or by dehydrating freshly harvesting mushrooms into dehydrated form and then making soup powder, biscuit, nuggets and RTE.

Mushroom Ketch-up: Freshly harvested button mushrooms are washed in 0.05 per cent KMS Solution, sliced and cooked in 50 per cent of water for 20 minutes. Mushroom paste is prepared using a mixer grinder with 0.2 per cent Arrarote, 1.5 per cent acetic acid and other ingredients and cooked to bring its TSS to 35⁰ Brix. Then the ketch-up is filled in the sterilized jars. Followings are the ingredients that are used for preparation of ketch-up are:

(i) Salt	10 per cent
(ii) Sugar	25 per cent
(iii) Acetic acid	1.5 per cent
(iv) Sodium benzoate	0.065 per cent
(v) Onion	10 per cent
(vi) Garlic	0.5 per cent
(vii) Ginger	3 per cent
(viii) Red chilly powder	1.0 per cent
(ix) Ajinomoto	0.2 per cent
(x) Arrarote	0.2 per cent
(xi) Cumin	1.0 per cent
(xii) Black pepper	0.1 per cent

Mushroom Murabba: A murabba is made by cooking it whole or in the form of pieces in heavy sugar syrup, till it becomes tender and transparent. In preparation of 1kg mushroom murabba 1.250kg of sugar is required and cooking is continued till a concentration of at least 68 per cent of soluble solid is reached. Freshly button mushrooms are graded, washed, pricked and blanched in 0.05 per cent Potassium metabisulphite (KMS) for 10 minutes. It is treated with 40 per cent of its weight of sugar daily for 3 days. Then, mushrooms are taken out from the syrup and 0.1 per cent citric acid and remaining 40 per cent of sugar are mixed in the syrup. After making its concentration to 65⁰ Brix, mushrooms are added in the syrup and the good

quality murabba is prepared (Arumuganathan et al., 2005).

Mushroom Candy: A fruit or vegetable impregnated with sugar, subsequently drained and dried is called a candied fruit or vegetable. The total sugar content of the impregnated fruit or vegetable is kept at about 75 per cent to prevent fermentation.

Fresh mushrooms after harvesting are subjected to washing and halved into two pieces. Halved pieces are blanched for 5 minutes in 0.05 per cent of KMS solution. After draining for half an hour they are treated with sugar. Sugar treatment is given at the rate of 1.5 kg sugar per kg of blanched mushroom. Initially sugar has to be divided into three equal parts. On the 1st day, blanched mushrooms are covered with one part of sugar and kept it for 24 hours. Next day, the same mushrooms are covered with 2nd part of sugar and again kept for overnight and on the third day mushrooms are removed from the sugar syrup. This sugar syrup is boiled with 3rd part of sugar and 0.1 per cent of citric acid to bring its concentration up to 70⁰ Brix. Blanched mushrooms are mixed with this syrup and again the contents are boiled for 5 minutes to bring its concentration up to 72⁰ Brix. After cooling, the mushrooms are removed from the syrup and drained for half an hour. The drained mushrooms are placed on the sorting tables to separate only defected and unwanted pieces are subjected to drying in a cabinet drier at about 60⁰ C for about 10 hours. As soon as they become crispy, all mushrooms are taken out and packed in polypropylene bags. The candy can be stored up to 8 months with excellent acceptability and good taste. Joshi et al. (1991) developed a sweet chutney from button mushroom and the storage of the product was more than a year.

Mushroom chips: The freshly harvested button mushrooms are washed, sliced and blanched in 2% brine solution. The mushrooms are dipped

overnight in a solution of 0.1 per cent of citric acid + 1.5 per cent of NaCl + 0.3 per cent of chilly powder. After draining off the solution, the mushrooms are subjected to drying in cabinet dryer at 60°C for 8 hours. Then it is fried using the refined oil and good quality chips are prepared. Garam masala and other spices can be spread over the chips to enhance the taste. After spice mixing, the chips are packed in polypropylene packets and sealed after proper labelling.

Mushroom soup powder: Soups are commonly used as food appetizers. Mushroom powder is produced from dried mushroom slices with the help of mixer. Then mushroom soup powder is prepared by mixing this mushroom powder with the following ingredients:

- (i) Mushroom powder 16 %
- (ii) Milk powder 50%
- (iii) Corn flour 05%
- (iv) Refined oil 04%
- (v) Salt 10%
- (vi) Suar 10%
- (vii) Cumin powder 02%
- (viii) Black pepper 02%
- (ix) Ajinomoto 02%

The above soup powder when mixed with equal quantity of water gives a good quality mushroom soup.

Mushroom biscuit: Mushroom biscuit is prepared from mushroom powder by mixing it with following listed ingredients:

- (i) Maida 100g
- (ii) Fat 45g
- (iii) Sugar 30g
- (iv) Milk powder 1.5g
- (v) Glucose 1.5g
- (vi) Baking powder 0.6g
- (vii) Salt 0.6g
- (viii) Ammonium bicarbonate 0.3g

- (ix) Vanilla essence 0.02g
- (x) water 12 to 22%

Above mentioned items are mixed in a mixer for 3 to 5 minutes. Then dough is kept at 30°C in an oven for 90 minutes. The dough is then spread to a thickness of 2 to 4 mm over a cleaned platform and cut into desired shape (circular or triangular shapes) of 5 cm diameter and baked for 10 to 20 minutes at 210°C in a laboratory backing oven.

Mushroom nuggets: Nuggets are generally used for the preparation of vegetables curry along with suitable vegetable or alone in North India and is prepared from dhal powder such as black gram powder, soybean powder, urad dhal powder etc. It adds taste as well as nutrients to the meal. For preparation of mushroom nuggets, mushroom powder is mixed with the urad dhal powder and a paste is prepared by adding water. The ingredients is added to the prepared paste and round balls of 2 to 4 cm diameter are made out of the paste. The prepared balls will be spread over a tray and are sun dried. Thus the mushroom nuggets are prepared. Following are the ingredients that are used for preparation of mushroom nuggets:

- (i) Urad dhal powder 80%
- (ii) Mushroom powder 10%
- (iii) Salt 02%
- (iv) Red chilli powder 01%
- (v) Sodium bicarbonate 0.01%
- (vi) water 07%

Ready-to-eat mushroom curry (RTE): It is generally prepared from freshly harvested mushrooms. But it can also be prepared from dried button mushroom slices after its re-hydration by adding the following ingredients:

- (i) Onion 510g
- (ii) Green chilli 250g
- (iii) Garlic 250g
- (iv) Ginger 200g
- (v) Salt 160g
- (vi) Red chilli powder 150g

- (vii) Curry powder 100g
- (viii) Oil 400ml
- (ix) Water 1000ml

References:

1. Shrivastava, M. (1998). Studies on mushroom dehydration (*Pleurotus florida*). *PhD. Thesis submitted to IIT, KGP, W.B., India*
2. Chang, S. T. and J. A. Buswell. 1996. Mushroom nutraceuticals. *World J. Microbiology Biotech*,12:473-476.
3. Poongodi, G. K. and D, Sakthisekaran. 1995. Nutrient content of the mushrooms. *Madras Agricultural Journal*, **82**(9):555-556.
4. Cheung, P. C. K. 1998. Functional properties of edible mushrooms. *Journal of Nutrition*,128:1512-1516.
5. Sharma, R. K. and Dhar, B. L. 2010. Mushroom cultivation: A highly remunerative crop for Indian farmers. *Indian Farming (New Direction)*, January,2010.