DOI: https://doi.org/10.36036/MR.33.2.2024.156323
Mushroom Research 33 (2) : 175-180, 2024

Impact of growing white button mushroom (*Agaricus bisporus*) using zero energy polytunnel method of composting in North Eastern states of India

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ABSTRACT

Button mushroom (*Agaricus bisporus*) is the most cultivated mushroom in India. Button mushroom cultivation technique involves four components viz., composting, spawning, casing and crop management. Composting is solid state fermentation of substrate mixture for a certain period of time by the activities of various microorganisms. The present study reports testing and demonstration of zero energy polytunnel method of composting by Krishi Vigyan Kendra, Imphal, West Manipur in collaboration with ICAR-RCNEH, Manipur Centre during the period of 2019-2023. For the first three years, composting trials were conducted at ICAR Manipur centre and the fourth year, it was at farmer's field. Two batches of 1100 kg of compost were prepared in each winter season. It was observed that from one season of button mushroom cultivation adopting zero energy polytunnel with a modification based on local environmental condition, farmers could earn a gross return of Rs. 1,46,800/- and a net income of Rs.89,200/- with a benefit cost ratio of 2.55 This improved the socio-economic condition of the farmers and created an interest for entrepreneurship. This technology can easily be adopted by the small, marginal and landless farmers, unemployment youths and young Agri – entrepreneurs of North eastern states of India.

Keywords: Button mushroom, *Agaricus bisporus,* composting, zero energy polytunnel

White Button mushroom *Agaricus bisporus* is one of the most important commercially grown edible mushrooms in the world and most popular cultivated in India. The white button mushroom was a selection from the brown mushroom in 1926 in USA (Singh *et al.*, 2021). Button mushroom contributes around 73% of the total mushroom production of India (Sharma *et al.,* 2017). In terms of global production and consumption button mushroom accounts for 13% of global mushroom production in the year 2013 (Singh *et al.,* 2017). The cultivation technology involves four components viz., composting, spawning, casing and crop management. It requires a temperature of 14-18°C for vegetative growth and 14-18ÚC for fruiting and relative humidity more than 85-90 %. Production of button mushroom requires large capital investment and technically advanced equipment's. But it can be grown conveniently during the month of October – February. Button mushrooms are heterotrophs and obtain their nutrients by absorbing soluble inorganic and organic materials from a well composted substrate. Most of the nutrient required for mycelial growth and development are obtained from lignin, cellulose, hemicelluloses and protein (Waksman *et al.,* 1932).

Recieved on 10-09-2024; Accepted on 18-12-2024
https://epubs.icar.org.in/index.php/MR/article/view/156323

Due to advancement in technology, button mushroom can be grown round the year under controlled conditions but most of the Indian farmers are seasonal growers growing this mushroom during winter season. North eastern states is endowed with favourable agroclimate, abundance of crop waste and relatively low cost of labour but the cultivation of button mushroom is still in its infancy stage due to lack of infrastructure and high capital investment in composting and growing. In India, at present traditional long and short method of composting are used for preparation of compost (Vijay, 2011). The traditional composting method (Atkins, 1966) used in India (Mental *et al.,* 1972) for mushroom cultivation takes four to six weeks to complete the process in seven to eight turnings with an interval of three–four days to avoid anaerobic condition of substrate (Suman and Sharma, 2007). The two-phase short method of composting involves outdoor aerobic degradation for 10–12 days (Phase-I) followed by pasteurization (57-62°C for 6–8 h) and conditioning (46-50°C for 4-5 days) inside an insulated room by free circulation of air under definite set of conditions (Phase-II) (Beyer, 2005; Sinden 1950). The traditional long method of composting is prevalent in most of the seasonal mushroom growers of India.

Manipur is blessed congenial weather conditions for mushroom cultivation. Though there has been technologies for button mushroom compost preparation by short and long methods but the farmers could not adopt the technologies due to high investment and long time, respectively. For the first time, ICAR-RCNEH, Manipur centre in collaboration with ICAR- KVK, Imphal, West Manipur has trained farmers on Zero Energy poly tunnel composting process for the past 4 years. Zero energy tunnel technology is a composting process using passive aeration of compost pile making it suitable for the growth and fructification of button mushroom (Wakchaure and Singh, 2013). The objective of this study is to observe the button mushroom cultivation potential in Manipur and effect of Zero Energy Poly Tunnel method of composting on income of mushroom farmers.

MATERIALS AND METHODS

The trial and demonstration of Zero energy poly tunnel was carried out by ICAR-RCNEH, Manipur centre in collaboration with ICAR-KVK, Imphal, West Manipur during the period of 2019-2023. Composting trial was conducted at ICAR-RCNEH, Manipur centre for the first three year and the at farmer's field on fourth year. The materials used were locally available substrates. Instead of wheat straw and wheat bran, paddy straw and rice bran were used since wheat is not grown in Manipur and rice is predominant crop. The details of the ingredients used in the composting are listed below

Table 1. Raw material used for the preparation of compost using Zero enery polytunnel

Paddy straw: 600kg	Cocopeat: 100kg
Urea: 10kg	Formaldehyde: 1 liter
MOP: 6 Kg	Carbendazim: 600gm
SSP: 6 kg	HDPE pipe: 12 pipe
Rice bran: 60 kg	Plastic tarpaulin: 1 piece
Gypsum: 50 kg	Spawn: 12 kg
Mustard cake: 60kg	Shade net: 3 rolls

Method of composting

The chopped paddy straw was soaked in water for 6- 8 hour or overnight so that the moisture per cent reaches to 70%. On next day, Muriate of potash, Single super phosphate, Urea, and rice bran were mixed in the soaked Paddy straw. A pile was made with perforated HDPE pipes in specified manner and covered with tarpaulin with some modifications (Wakchaure and Singh, 2013). Pipes were placed in a sequence of six at the bottom, three and two at the

middle and one at the top. The pile was kept for 2 days. On the 3rd day, the pile was broken when the temperature reached to 60-75°C and allowed to cool down to release the ammonia. The pile was made again and kept for 2 days. On the 6th day, the pile was broken and mustard cake was mixed and pile was made by placing the HDPE pipe in zero energy poly tunnel method and kept it for two days again. On 9th day, the pile was broken, gypsum was mixed and fresh pile with perforated HDPE pipes was made. The pile was kept for two days again. On 12th Day, another turning was done. One more turning was given on 15th day. The pile was kept for 2 days before the pile was broken and treated with formaldehyde and carbendazim. In total 5 turnings were given to the composting pile and it took a total of 17 day for complete composting process.

Chemical pasteurization

The compost prepared by zero energy polytunnel method was chemically treated to avoid any possible contamination. The treatment involved addition of 250 ml formalin and 40g of carbendazim in 5 l of water and sprayed on to the compost. The compost was covered with polythene sheet and keep it for 2 days. The polythene sheet was removed and compost was shaken to remove the formalin fumes.

Cultivation trial

The compost was spawned @1% thoroughly and bags were kept in incubation room at 25°C. The *Agaricus bisporus* strain used was sylvan A15. Each polybag was filled with 10 kg compost to a height of 10 -12 inches. Incubation temperature was 24°C to 26°C and relative humidity was kept 80 – 90 % depend upon the strain and kept it for 13 – 15 days in incubation room. After 13- 15 days of incubation, the mushroom bags were cased with a mixture of coco-peat and soil (3:1). The casing of the spawned compost helps to stimulate and promote formation of fruiting bodies (Chang and Miles, 2004). After case run, temperature was bought down to 16-18°C for fruiting. After 15 days of casing pin head could be seen and the fruit bodies were harvested after a week.

RESULT AND DISCUSSION

Preparation of compost started from 2nd week of September and fruiting started from 1st week of November. The second batch of composting started from 1st week of November and fruiting started from 3rd week of January . It was possible to go for two batch of composting only if the season was followed strictly as the temperature was most suitable during this period. Beyond the month of March, the temperature becames higher and small pin head did not grow in to fruit bodies rather it dried off. One of the reasons was that the growing room used in this demonstration was low cost huts and temperature control was not there. Optimum temperature for the fruiting of *Agaricus bisporus* is 14±18°C (Borkar and Patil, 2020).

Studies reports that process of composting is governed by a succession of thermophilic microorganisms and their growth is highly influenced by moisture content and oxygen availability in the compost pile (Collins, 2009, Parati *et al.,* 2011). Wakchaure and Singh (2013) was the first to report this technology. They reported principles of natural passive aeration and, heat & mass transfer in this technology. The perforated HDPE pipes sucks the air from the outside atmosphere and due to convection, the air is circulated in the whole pile. As a result, temperature of compost pile increases due to microbial activity. The heated air inside the compost moves upward by convection and comes out from the pipe placed at the top. Thus, natural flow of the hot air was maintained during the entire composting process. Also heated air carrying the ammonia is released during composting, which helps to raise temperature of the surface layer of the pile for proper

Fig. 1. Steps involved in production of *Agaricus bisporus* using Zero energy polytunnel method of composting

pasteurization and conditioning of compost. The compost obtained was dark brown in colour, soft and with pleasant smell.

It took about a month and a half from composting to harvesting. According to the FAO (1970) "International Standards for Edible Fungi", *Agaricus bisporus* can be harvested in three stages namely buttons, caps and flats or opens. In Manipur condition, it was harvested in buttons and caps stages for local market. Two batches of compost were prepared in the winter season. The details are given in the table 2. Using 600kg of substrate, we could obtain 1100kg of compost. In the first batch, the yield recorded to be 198 kg while in the second batch, it was 154kg since the temperature around the fruiting bodies of 1st

Table 2. Cost of cultivation of white button mushroom using Zero Energy Polytunnel

Materials requires	Quantity	Cost (Rs) 1st batch (A)	Cost (Rs) 2nd batch (B)
Paddy straw	600kg	3600	3600
Urea	10kg	400	400
MOP	6 Kg	300	300
SSP	6 kg	300	300
Rice bran	60 kg	900	900
Gypsum	50 kg	1300	1300
Mustard cake	60 kg	2400	2400
Coco-Peat	100 kg	6000	6000
HDPE pipe	12 pipe	18000	-
Plastic tarpaulin	1 piece	4000	-
Shade Net	3 roll	4000	-
Spawn	12kg	3600	3600
Labour (cutting straw, wetting, turning , pasteurizing etc,)	12 mandays	3600	3600
Miscellaneous (Formaldehyde, Carbendazim, plastic bags)	-	1000	1000
Total Cost		49400	8200
Total cost (A+B)		**57600**	

Table 3. Economics of button mushroom cultivation using Zero Energy Polytunnel

Compost	Yield (kg)	Gross return (Rs/ha)	Gross cost (Rs/ha)	Net return (Rs/ha)	B:C Ratio
(1st batch)	198	82200	49400	32800	1.6
(2nd batch)	154	64600	8200	56400	7.87
Total	**352**	**146800**	**57600**	**89200**	**2.55**

batch was most optimum, whereas in second batch, the temperature goes beyond optimum temperature where the second and third picking decreased drastically. Since some of the materials requirement was one-time investment so, the cost of cultivation in second batch was lesser than the first batch. Even though, the yield was less in second batch the farmers could gain a huge margin of return. The economics from both the batches are shown in the table 3. It has been found that from one season of cultivation of *Agaricus bisporus* adopting ZEPT with little modification, the farmers could earn a gross return of Rs. 1,468,00/- and a net income of Rs. 89,200/- with a benefit-cost ratio of 2.55, which really benefits the farmers adopting this technology for growing button mushroom as it is of low cost comparing to long method and short method of composting.

CONCLUSION

This modified zero energy polytunnel method of button mushroom composting used a total of 10 perforated pipes in the pile to ensure proper air circulation in the compost. It significantly enhanced

the aeration and helped in maintenance of uniform temperature and reducing the excess moisture of the compost. Ultimately, it enhanced the function of the micro-organisms involved in the composting process and thereby the temperature inside the pile could be maintained. This method proved to be good for growing button mushroom in Manipur conditions with low investment. This technology can easily be adopted by the small, marginal and landless farmers, unemployment youths and young Agri – entrepreneurs of North eastern states of India.

REFERENCES

1. Atkins, F.C. 1966. *Mushroom Growing Today*, Faber and Faber, London, U.K.

2. Beyer, D.M. 2005. Best management practices of mushroom substrate preparation. *Mushroom News* **53(11):** 30- 34.

3. Borkar, S.G. and Nisha Patil 2020. *Mushroom A Nutritive food and its cultivation*. Daya publishing house.

4. Chang, S. and P.G. Miles. 2004. *Mushrooms: Cultivation, Nutritional Value, Medicinal Effects and Environmental Impact*. 436p. CRC Press, Boca Raton, FL.

5. Collins, E.R. 2009. *Composting dead poultry*. Publication No. 424-437, Virginia Cooperative Extension, Blackburg.

6. FAO. 1970. *Recommended international general standard for edible fungi and fungus products / Codex Alimentarius Commission*. 25p. Food and Agriculture Organization of the United Nations. World Health Organization. Rome.

7. Mental, E.F.K., R.K. Agarwal and P.K. Seth. 1972. *A guide to mushroom cultivation.* Farm Bull.2, Farm Information Unit, Directorate of Extension, Ministry of Agriculture, New Delhi.

8. Parati, F., R. Altieri, A. Esposito, A. Lobianco, M. Pepi M and L. Montesi. 2011. Validation of thermal composting process using olive mill solid waste for industrial scale cultivation of *Agaricus bisporus. Intl Bio-deterioration & Biodegradation* **65(1):** 160-163.

9. Sharma,V.P., S.K. Annepu, Y. Gautam, M. Singh and S. Kamal. 2017. Status of mushroom production in India. *Mushroom Research* **26(2):** 111-120.

10. Sinden, J.W. and E. Hauser. 1950. The short method of mushroom composting. *Mushroom Science* **1:** 52-59.

11. Singh, M. 2021. Global Status of Mushroom. In National Web Conference on Mushroom 2021- Mushroom Biology: Opportunities and Challenges- 15-17 April, 2021.

12. Singh, M., S. Kamal and V.P. Sharma. 2017. Status and trends in world mushroom production-I. *Mushroom Research* **26(1):** 1-20.

13. Suman, B.C. and V.P. Sharma. 2007. *Mushroom Cultivation in India.* 179 p. Daya Publishing House, New Delhi, India.

14. Vijay, B. 2011. Economics of button mushroom cultivation under environment controlled conditions. In mushrooms cultivation, marketing and consumption, Singh, M. *et al.* (eds). pp. 113-124. DMR Solan, India.

15. Wakchaure, G.C. and M. Singh. 2013. Zero energy polytunnel: A rapid composting method for *Agaricus bisporus* cultivation. *Mushroom Research* **22:** 9-18.

16. Waksman, S.A and M. Allan. 1932. Comparative rate of decomposition of composted manure and spent soil. *Soil Sci* **34:** 189-195.