J.Mycopathol.Res. 62(3) : 647-652, 2024, ISSN : 0971-3719 (Print), 2583-6315 (Online) 10.57023/JMycR.62.3.2024.647

Effect of organic supplements with casing mixture on the Biological Efficacy of *Agaricus bisporus* under the agro-ecological condition of West Bengal

C. SHANMUGARAJ[1, 2], K. SARANRAJ[2], M. K. BISWAS[2]

[1]Division of Plant Pathology, ICAR- Indian Agricultural Research Institute (IARI), New Delhi 110012
[2]Department of Plant Pathology, Palli Siksha Bhavana, Visva-Bharati University, Sriniketan 731235, West Bengal

Received : 18.04.2024 Accepted : 25.06.2024 Published : 30.09.2024

Mushrooms frequently referred to as "vegetable meat" and "white vegetables," are celebrated for their high nutritional value and sustainable cultivation practices, particularly their use of agricultural by-products. This research explored the effectiveness of different additives - soybean meal, groundnut meal, and cottonseed meal incorporated into the casing mixture during the cultivation of white button mushrooms (*Agaricus bisporus*) in the lateritic regions of West Bengal. The addition of these supplements markedly impacted the duration of the case run period, time taken to reach the first harvest, yield and biological efficiency. Notably, casing material supplemented with Soybean meal exhibited the shortest case run and first harvest periods (9 and 8 days, respectively), followed closely by Groundnut meal (12 and 10 days) and Cottonseed meal (11 and 9 days). The maximum number of sporophores was obtained from the beds cased with Soybean meal-supplemented casing material (124/8 kg bag), followed by Cottonseed meal (115/8 kg bag) and Groundnut meal (93/8 kg bag). Yield and biological efficiency were significantly influenced by the supplements, with Soybean meal supplementation leading to the highest yield (1311.67 g/8 kg bag) and biological efficiency (16.40%), followed by Cottonseed meal (1213.33 g/8 kg bag, 15.17%) and Groundnut meal (1093.33 g/8 kg bag, 13.67%). Our findings underscore the potential of supplementing casing material with Soybean meal to enhance yield and biological efficiency in white button mushroom cultivation, offering valuable insights for optimizing cultivation practices in similar agro-climatic regions.

Keywords : Button mushroom, supplementary strategies, casing supplements, yield, biological efficiency

INTRODUCTION

The word "mushroom" originates from the French terms "mousse" or "mousseron," which mean champignon or fungus. In various cultures, mushrooms hold special significance. For example, in Romanian traditions, mushrooms are often served during celebrations and are considered "God's flesh" or "God's Food." Similarly, the Chinese regard mushrooms as the "Elixir of Life." The field of mycology, which comes from the Greek words "mykes" (meaning mushroom) and "logos" (meaning study or discourse), is dedicated to the study of fungi.

*Correspondence : spcshanmugaraj@gmail.com

Among the numerous fungal varieties, *Agaricus bisporus*, also known as the white button or European mushroom, is particularly noteworthy. White button mushrooms, belonging to Agaricaceae family, belong to the Agaricales order and Basidiomycetes class, are widely cultivated worldwide and make a significant contribution to India's mushroom production. The cultivation of *A. bisporus* typically involves composting agricultural residues such as paddy straw, wheat straw or maize stalks, along with the essential addition of a casing layer to initiate primordial formation. Various additives, like soybean meal, cottonseed meal, and sunflower meal have been utilized in order to improve the yield and quality characteristics of *A. bisporus*.

Numerous investigations have underscored the positive impacts of natural additives on crop yield

and the quality of sporophores (Adibian and Mami, 2015; Pardo-Gimenez *et al*. 2012, 2017; Yadav and Kumari, 2018). Notably, the addition of cotton seed meal has demonstrated promising results in increasing the production of button mushrooms. Similarly, soybean meal, known due to its rich protein levels and vital nutrients, has shown significant potential in enhancing growth and yield (Darwin and Britzma, 2005; Singh *et al*. 2007). Current studies have additionally explored the effectiveness of various supplements during the casing phase, revealing encouraging outcomes for improving yields (Sajyan *et al*. 2021; Singh *et al*. 2007; Maknali *et al*. 2021). Besides, GC-MS analyses of biochemical constituents in fruit body of *A. bisporus* have been illustrated by Barman *et.al*. (2021).

Casing soil composition plays a crucial role in the initiation of primordia and the uniform development of fruiting bodies in mushroom cultivation. Our previous studies evaluated various casing mixtures, including combinations of Spent Mushroom Substrate (SMS), Garden Loam soil, Farm Yard Manure (FYM), Coco peat, Vermicompost, and Sand. Among these, the mixture of Garden Loam soil + FYM + Vermicompost (2:1:1) demonstrated superior performance, compared to thecommon casing mixture viz. FYM + Garden Loam soil (1:1) yielded the lowest (Shanmugaraj *et al*. 2021). However, the widespread availability of Vermicompost remains limited in various regions of the West Bengal. To address this limitation, this study aims to explore a supplementation strategy within the common casing mixture to enhance the yield and biological efficiency of white button mushrooms. By investigating alternative organic supplements, this research seeks to optimize casing formulations tailored to local resource availability, thereby improving mushroom cultivation practices and sustainability in diverse agricultural settings. This study seeks to explore how different organic additives affect the growth of *A. bisporus* in the agricultural and climatic conditions found in West Bengal. By evaluating how these additives impact production quantity, and yield, this investigation aims to offer valuable guidance for refining methods for cultivating button mushrooms in comparable settings.

MATERIALS AND METHODS

The entire experimental work was conducted at the Mushroom Research Laboratory, which is part of the Department of Plant Pathology at Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, in Sriniketan, Birbhum district, West Bengal. The study employed a Completely Randomized Design, with each treatment being repeated three times.

Compost Preparation

Creating compost is a crucial step in growing white button mushrooms, utilizing various methods such as long, short, and indoor techniques. This research focused on the production of white button mushrooms using locally available substrates, specifically paddy straw, through the long composting method adapted to the agro-climatic condition of West Bengal. In this study, compost preparation was carried out under the natural summer conditions typical of West Bengal, specifically during the months of May and June. During this period, the average temperature ranged from 30-35°C, and humidity levels were around 80-85%. Regular aeration was maintained by turning the compost piles, promoting efficient microbial activity and organic matter decomposition, ensuring the production of high-quality compost for mushroom cultivation.Compost acts as a fermented medium that supports the growth of mushroom mycelium and the eventual development of mushrooms. The composting process involves aerobic fermentation at temperatures between 50 to 60°C, with turnings performed on days 6, 10, 13, 16, 19, 22, and 25, resulting in the final compost by day 28. This method represents the end of aerobic decomposition, where cereal straws and other organic materials are broken down by microorganisms.

Spawning

After composting, the compost is placed into plastic bags, with a seeding rate typically varying from half a percent to two percent. Seeding is carried out either through mixed or layered methods, using spawns prepared in bottles or bags. For this research, the S-11 strain was used

at a two percent seeding rate with layered seeding technique.After filling compost into transparent polypropylene bags sized 16"X18" with a thickness of 150 gauges, each bag contains approximately 8 kilograms of compost. The experimental cultivation period extended from July to August 2020. During the spawn run phase, the bags were kept at cropping room exposed to natural conditions at temperatures ranging from 22 to 26 °C; with 90 % humidity controlled using moistened gunny bags and sand. Following the completion of the spawn run, typically within 15 days, the bags are prepared for casing.

Casing material

During the spawn colonization phase, casing materials are collected. Essential elements such as garden soil are procured from the Experimental Farm located within the Department of Agronomy at Visva-Bharati, Sriniketan. Farmyard manure is sourced from the Model Dairy and Poultry Farm associated with the Department of Animal Science at Visva-Bharati, Sriniketan.

Evaluation of supplementation

The introduction of various supplements into the casing soil aims to assess their impact on the yield and biological efficiency of button mushroom cultivation. To enhance both yield and biological efficiency, supplementation during casing is preferred over supplementation during spawning, as it mitigates contamination risks. This study aims to assess the efficacy of organic supplements like soybean meal, cottonseed meal, and groundnut meal when added to casing mixtures to boost yield. Each organic supplement (soybean meal, cottonseed meal, groundnut meal) was mixed separately with a standard casing mixture comprising farmyard manure and garden loam soil in a 1:1 ratio. The supplements were added at a 4% rate. Each treatment had three replications.The treatments were structured as follows:

T1: Farmyard manure + Garden loam soil (1:1) + Soybean meal
T2: Farmyard manure + Garden loam soil (1:1) + Groundnut meal
T3: Farmyard manure + Garden loam soil (1:1) + Cottonseed meal
T4: Farmyard manure + Garden loam soil (1:1) (control)

All supplements and casing mixtures were sterilized separately in an autoclave at 121.6°C and 15 psi for 2 hours, followed by cooling at room temperature. The casing, prepared with supplemented mixture, was applied to fully colonized beds. Data including case run period, number of fruiting bodies harvested, average fruiting body weight, average yield, and biological efficiency were recorded for each replication of every treatment.

Casing of the bed

Upon the completion of the spawn run, which is indicated by the consistent white growth of *A. bisporus* mycelium, the disinfected casing materials, enhanced with various organic additives, are spread evenly across the bed surface to a depth of 4 cm.The cased beds were moved to a cropping room where the temperature was kept between 16-18°C and the relative humidity was maintained at 80-90%. An air conditioner was used to control the temperature, while wet sands and gunny bags were employed to sustain the humidity levels during the case run. Primordial initiation typically occurred within 10-15 days, varying based on the supplements used.

Yield and Biological Efficiency

The international standard for harvesting button mushrooms stipulates that the membrane should remain intact, with a stem length no greater than 2 cm (approximately 3/4 inch) and a cap diameter between 2.5 and 6 cm (around 1-2.5 inches). Ideally, mushrooms are harvested when the cap is twice the size of the stem. The formula used to calculate biological efficiency is as follows :

$$\text{Biological Efficiency (\%)} = \frac{\text{Fresh Mushroom Weight in grams}}{\text{Compost Weight in grams}} \times 100$$

RESULTS AND DISCUSSION

To evaluate the effectiveness of different supplements on the yield and biological efficiency of button mushroom cultivation in the lateritic belt

of West Bengal, various supplements such as Soybean meal, Groundnut meal, and Cottonseed meal were added during casing, along with the standard casing mixture composed of FYM and Garden loam soil in a 1:1 ratio. The objective was to observe their impact on parameters including the case run period, days to the first harvest, number of fruiting bodies harvested, yield, and biological efficiency. The data pertaining to all these parameters are presented in Table 1.

Time for case run and first harvest

The casing material enriched with Soybean meal demonstrated a shorter case run period and time to the first harvest, recorded at 9 and 8 days respectively. Following closely, the casing material supplemented with Groundnut meal exhibited a case run period and first harvest time of 12 and 10 days respectively, while the casing material enriched with Cottonseed meal showed similar results, with a case run period of 11 days and first harvest time of 9 days. Notably, there was no significant variance in the case run period and first harvest time between the casing materials supplemented with Groundnut meal and Cottonseed meal. In comparison, the control group, consisting of casing material alone, displayed the longest case run period and first harvest time, recorded at 16 and 13 days respectively (Fig. 1).

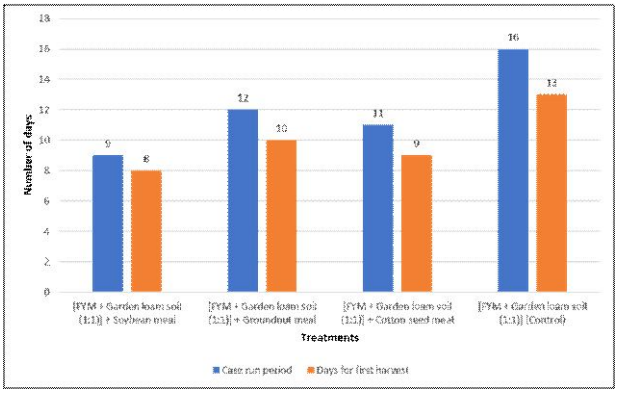

Fig. 1 : Efficacy of various supplements on growth and harvest of *Agaricus bisporus*

Sporophore production

The highest number of sporophores, at 124 per 8 kg bag, was observed in the bed cased with casing material enriched with soybean meal. Following this, the casing material supplemented with cottonseed meal yielded 115 sporophores per 8 kg bag, while the casing material supplemented with groundnut meal produced 93sporophores per 8 kg bag. In contrast, the average number of fruiting bodies was lowest in the beds where casing material alone was used, at 73 per 8 kg bag (Fig.2).

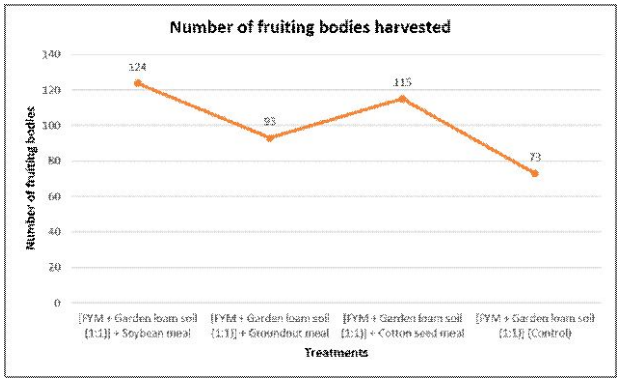

Fig. 2 : Efficacy of various supplements on sporophore production of *Agaricus bisporus*

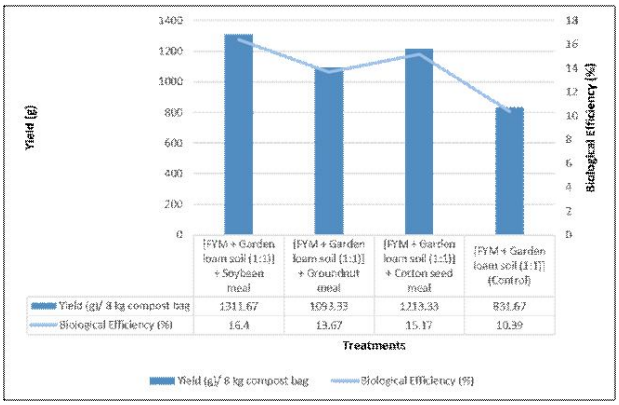

Fig. 3 : Efficacy of various supplements on yield and biological efficiency of *Agaricus bisporus*

Performance of Yield and Biological efficiency

Yield and biological efficiency served as the primary measures for assessing the impact of various supplements used during casing in *A. bisporus* cultivation. The highest yield and biological efficiency were achieved in beds where the casing material was supplemented with Soybean meal, yielding 1311.67 g/8 kg bag and 16.40% respectively. This was followed by beds supplemented with cottonseed meal, which yielded 1213.33 g/8 kg bag and 15.17% biological efficiency. The casing material supplemented with groundnut meal also showed a significant increase in yield and biological efficiency, with values of 1093.33 g/8 kg bag and 13.67%

Table 1 : Assessing the effectiveness of different supplements on yield and biological efficiency of *Agaricus bisporus*

Treatments	CRP	DFFH	No. of FH	Yield (g)	B.E (%)
[FYM + Garden loam soil (1:1)] + Soybean meal	9	8	124	1311.67	16.40
[FYM + Garden loam soil (1:1)] + Groundnut meal	12	10	93	1093.33	13.67
[FYM + Garden loam soil (1:1)] + Cotton seed meal	11	9	115	1213.33	15.17
FYM + Garden loam soil (1:1) (Control)	16	13	73	831.67	10.39
SE(m)(±)	0.41	0.41	2.06	5.27	0.07
CD @ 1%	1.33	1.33	6.72	17.19	0.21
CV (%)	5.85	7.13	3.52	0.82	0.82

CRP – Case Run Period, DFFH – Days For First Harvest, No. FH – Number of Fruiting bodies Harvested, B.E – Biological Efficiency

respectively. In contrast, the lowest yield and biological efficiency were observed in beds where casing material alone was used, yielding 831.67 g/8 kg bag and 10.39% respectively. Notably, all treatments exhibited significant differences from each other (Fig.3).

Based on the findings of this study, supplementing casing materials with soybean meal emerges as the most effective strategy for enhancing the cultivation of white button mushrooms (*A. bisporus*). Our results indicate significant improvements across several key metrics: soybean meal supplementation resulted in the shortest case run and first harvest periods, highest sporophore production, yield, and biological efficiency compared to both cottonseed meal and groundnut meal supplements. Our findings align closely with the results reported by Mami *et al.* (2013) and Raina *et al.* (2013), highlighting the significant benefits of soybean meal supplementation in mushroom cultivation. Mami *et al*. (2013) found a substantial increase in yield from 17 kg/m² in the control to 23 kg/m² with soybean meal, emphasizing its effectiveness in enhancing productivity. Similarly, Raina *et al*. (2013) observed reduced case run and first harvest periods alongside higher yields when soybean meal was added to casing materials. Specifically, the reduction in case run to 12 days and first harvest to 15 days, along with a yield of 2134 g per 10 kg compost, compared favorably to control values. These outcomes underscore soybean meal's potential to optimize mushroom cultivation practices, suggesting it as a promising avenue for further research and application in agricultural settings.

Additionally, the results corroborate with the findings highlighting the effectiveness of cottonseed meal supplementation as the second-best option (Sajyan *et al.* 2021). Although casing material supplemented with groundnut meal and cottonseed meal exhibit significant differences in terms of the number of fruiting bodies harvested, yield, and biological efficiency, they demonstrate statistical parity in terms of case run and first harvest periods.

CONCLUSION

In summary, button mushroom cultivation holds significant potential for meeting nutritional demands and agricultural sustainability. The results emphasize the essential contribution of supplementing casing materials in enhancing both yield and biological efficiency, with soybean meal standing out as the most beneficial supplement. This study underscores the importance of strategic supplementation during casing to enhance the productivity and quality of white button mushroom cultivation.

ACKNOWLEDGEMENTS

The authors are thankful to the Palli Siksha Bhavana, Visva-Bharati for providing support, encouragement and facilities during the course of this investigation.

DECLARATION

Conflict of Interest. Author declares no conflict of interest.

REFERENCES

Adibian, M., Mami, Y. 2015. Mushroom supplement added to casing to improve postharvest quality of white button mushroom. *Eur. J. Hortic. Sci.* **80**: 240-248. https://doi.org/10.17660/eJHS.2015/80.5.6

Barman, S., Chakraborty, U., Chakraborty, B.N. 2021. GC-MS analyses of biochemical constituents in fruit body of *Agaricus bisporus. J. Mycopathol. Res.* **59**: 47-61.

Darwin, J., Britzma, F. 2005. Evaluation of soybean meal protein content. *J. Appl. Microbiol.* **1**: 21-25.

Maknali, F., Kashi, A., Mohammadi, R.S., Khalighi, A. 2021. Enrichment of casing soil with Fe and soy-flour under *Pseudomonas* inoculation on yield and quality of button mushroom. *Revista de Agricultura Neotropical*. **8**:e5111. https://doi.org/10.32404/rean.v8i2.5111

Mami, Y., Peyvast, G., Ghasemnezhad, M., Ziaie, F. 2013. Supplementation at casing to improve yield and quality of white button mushroom. *Agric. Sci.* **4**: 27-33. https://doi.org/10.4236/as.2013.41005

Pardo-Gimenez, A., Pardo-Gonzalez, J.E., Cunha-Zied, D. 2017. Supplementation of high nitrogen *Agaricus* compost: yield and mushroom quality. *J. Agr. Sci. Tech*. **19**:1589-1601. http://jast.modares.ac.ir/article-23-1846-en.html

Pardo-Gimenez, A., Zied, D.C., Alvarez-Orti, M., Rubio, M., Pardo, J.E. 2012. Effect of supplementing compost with grapeseed meal on *Agaricus bisporus* production. *J. Sci Food Agric*. **92**: 1665-71. https://doi.org/10.1002/jsfa.5529

Raina, P.K., Gupta, A., Singh, M.G., Zutshi, S.K., Sharma, S. 2013. Effect of organic supplements at spawning and casing on growth and yield of *Agaricus bisporus*. *Mushroom Res*. **22**: 37-41. https://epubs.icar.org.in/index.php/MR/article/view/48980

Sajyan, T.K., Abou Fayssal, S., Bejjani, R., El Sebaaly, Z., Sassine, Y.N. 2021. Casing and cropping. In: Mushrooms *Agaricus bisporus*. (Ed. Y.N. Sassine), CABI: Oxfordshire., UK, 240-78.

Shanmugaraj, C., Saranraj, K., Biswas, M.K. 2021. Response of various casing materials on the biological efficiency of white button mushroom (*Agaricus bisporus*) under the agro-climatic condition of West Bengal. *J. Mycopathol. Res.* **59**: 455-459.

Singh, M., Singh, A.K., Gautam, R.K. 2007. Effect of casing and supplementation on yield of milky mushroom (*Calocybe indica*). *Indian Phytopathol*. **60**: 191-193. https://epubs.icar.org.in/index.php/IPPJ/article/view/13004

Yadav, S., Kumari, K. 2018. Effect of casing and supplemented meal on yield of *Calocybe indica*. *Int. J. Res. Eng. Sci. Manag*. **1**: 712-713.