Proceedings of 15th Agricultural Research Symposium (2016) 284-288

Effect of Casing Mixtures on Yield of Button Mushroom (*Agaricus bisporus*)

K.W.S. JAYANGA[1], R.I.G. UDAYANGA[2] and S.J.B.A. JAYASEKERA[1]

[1]*Department of Horticulture and Landscape Gardening, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP), 60170, Sri Lanka*

[2]*Dutch Malta (pvt) Ltd, Meepilimana, Ambewela, Nuwara Eliya, 22216, Sri Lanka*

ABSTRACT

This study was carried out with eight different casing mixtures in order to identify their effect on the growth and yield of white button mushroom (*Agaricus bisporus*). Maximum number of buttons harvested (249.6) and maximum yield (3721.5 g) were obtained from Netherland peat moss casing. Second highest yield (3497.2 g) was recorded by paddy soil and coir dust (1:1.5) casing mixture. There was no statistically significant difference between these two casing mixtures. Forty five rupees could be saved when preparing one compost bag by using paddy soil and coir dust (1:1.5) casing mixture with compared to the Netherland peat moss casing mixture. Therefore, when considering the cost effectiveness and the high yield, best casing mixture for button mushroom was paddy soil and coir dust (1:1.5). The result encourage to select paddy soil and coir dust casing mixture as the most suitable casing material for better growth behavior, optimum yield potential and better cost benefit of white button mushroom industry in Sri Lanka.

KEY WORDS: *Agaricus bisporus,* Casing, Peat moss, Ruffling, Spawn run,

INTRODUTION

Mushrooms are reproductive structures of edible fungi that belong to the class Basidiomycetes. These are named as the meat of the forest, because of the high content of proteins. Mushrooms occur under various ecological conditions from desert to forest. The vegetative parts of mushrooms consist of thread like thin mycelia which under suitable conditions form fruit bodies (sporocarps). They comprise a large heterogeneous group with different shapes, sizes, colors and edibility. All fungi, with the exception of the yeasts, grow as microscopic filaments called hyphen which extend and branch to form a mycelium. The mycelium is the vegetative phase of fungal growth and in many fungi, given an unrestricted supply of nutrients, is apparently capable of unlimited growth. The sexual phase of the fungi is represented by spore bearing structures (Bahl, 1994). Commercial production of button mushroom in Sri Lanka depends on two main substrates namely compost and casing medium. Two major components of the compost mixture are plant material and animal manure. Generally, plant materials include paddy straw, paddy husk, and rice bran. Poultry manure is used as an animal manure. Gypsum and urea are used as inorganic materials to control the pressure of hydrogen (pH) value in the compost mixture and for providing nitrogen respectively.

In Sri Lanka, button mushroom industry is one of the high demanding industries at present. But local production is not enough to meet the button mushroom demand of the local market.

The climatic condition prevailing in higher altitudes of Sri Lanka is suitable for the successful cultivation of button mushroom. However, earlier attempts to commercially cultivate button mushroom in Sri Lanka were not successful. This may be due to lack of knowledge in production technologies, non-availability of suitable *A. bisporus* strains and improper planting or utilization of natural climatic condition of Sri Lanka. The total demand for button mushroom in Sri Lanka is met by importation from other countries and the species fetches extraordinarily high price in the market (Babu *et al.*, 2004). At present peat moss is used as casing material in worldwide. Peat is a natural sedimentation formed by the partial decomposition of organic matter under anaerobiosis (Petroni *et al.*, 2000). It is collected from peat lands, highly fragile wetland ecosystems with ecological an archaeological value, which are included in the schedule of natural habitats with a potential degradation (Bustamante *et al.*, 2008). These ecosystems are important carbon natural reserves and influence the cycles of heavy metals. The increase in peat use has resulted in a rapid depletion of wetlands, causing the loss of non-renewable resources and becoming a source of the greenhouse effect due to the abundant liberation of CO_2 through the aerobic decomposition of carbon (Bustamante *et al.*, 2008).

There are two button mushroom farms in Sri Lanka located in Kurunegala and Nuwara Eliya. Best location for button mushroom cultivation is Nuwara Eliya, because the low

temperature (17.5 °C) reduces the cost of production up to some extent. However, one of the costliest inputs in button mushroom production is casing material imported from Netherlands for establishment of mushrooms. Locally available media or casing materials are not effective. Therefore, the specific objective of this study was to identify locally available, cost effective and high yielding casing for button mushroom cultivation. The general objectives of this research are to enhance the button mushroom production to meet the local demand and encourage the button mushroom farmers to exploit the export market.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted in Dutch Malta (Pvt) Ltd., Nuwara-Eliya located in upcountry wet zone (WU3) in Sri Lanka (06°53'53'N, 80°48'08'E). Elevation is 1864 m. Mean annual temperature is 17.5 °C Annual rainfall is greater than 2,000 mm.

Materials

Polythene (150 Gauge), balance, tape, pH meter and planting material such as spawn were used during the study.

Method of Mushroom Compost Preparation

Mushroom compost is the substrate on which button mushroom grows. The bio chemical activities of a number of microorganisms make the substrate for the growth of mushroom (*Agaricus bisporus*). The process of compost making is known as composting. Quality of the mushroom compost depends on three factors, such as nature and quality of basic materials, organic and inorganic supplements and management of the compost during composting *etc.* (Bahl, 1994). Button mushroom compost preparation is a little bit complicated because button mushroom is very sensitive to compost condition. To prepare button mushroom compost, paddy straw, paddy husk, rice brand, poultry manure, urea and gypsum were used.

The compost mixture should be able to provide all the necessary nutrients for the growth of mushroom because they have no chlorophyll for photosynthesis. The main objective of compost preparation is *Agaricus bisporus* unable to convert .There are two compost preparation methods such as long method and short method. Long composting method is done without pasteurization process. Short composting method consists of two main steps such as phase one and phases two.

Mixing and wetting the ingredients were done during the first phase of compost preparation. Pasteurization and removing the ammonia is the two main functions practiced during the second phase of compost preparation.

Paddy straw wetting and making pile was the first step of compost preparation. Then, paddy husk, poultry manure, urea and rice bran were added on to the wetted paddy straw pile and mixed well. Immediately after mixing, it was brought into the compost bunker and again made the pile. During this process, required amount of water was added. Mushroom compost pile was mixed and wetted after two days. During this time period, compost mixture had very harsh ammonia odor, and temperature inside the compost mixture was 60 °C to 80 °C. After two days, again the compost was turned and wetting was done. After the seventh day, compost was transferred from the compost bunker to the pasteurization chamber. During the first two days inside the pasteurization chamber, it was necessary to maintain the temperature in between 60 °C to 62 °C and two days after, the temperature was reduced up to 49 °C to 52 °C and it was maintained during the next five days. Temperature can be maintained automatically and manually. Main objective of pasteurization was to destroy pests, fungus, insects, nematodes and other harmful pathogens. Then, compost was ready for spawning after seventh day. At that time, compost had some white color powdery like things. These powdery like structures are known as *Actinomycetes* spp. They are very important for the growth of button mushroom. Due to the presence of *Actinomycetes,* the compost mixture is decomposed up to the right amount to get the nutrients for the growth of button mushroom. After the spawning, hygienic conditions were needed to reduce the extent of infection. Therefore, spawning place was cleaned by using formalin. Hands, boots and other instruments were cleaned by using chlorine water. Then, the polythene bags were filled with compost mixture. Weight of one bag was 25 kg. These bags were kept inside a growing tunnel. The temperature was controlled between 22 °C to 25 °C. Vegetative growth needs that temperatures and reproductive stage needs 14 °C to 18 °C.

Casing

Casing means covering the compost with a thin layer of soil or soil-like material, after the spawn has spread in the compost (spawn run) (Bahl, 1994). Netherland peat moss is used as casing in Sri Lanka. Casing is not nutritionally rich when compared with compost. It can create a stress, necessary for the induction of fruit bodies. Casing also provides water for the

growth and development of fruit bodies and maintains humidity and temperature in cropping room by evaporative cooling. It provides a medium of low osmotic value compared to compost and hence provides a proper mix for developing pin heads and support to developing fruit bodies. When selecting the suitable casing material instead of peat moss, it should fulfill above characteristics.

Preparation of Casing Mixture

The selected casing materials were prepared by using coir dust, saw dust, compost, garden soil, half burnt paddy husk, paddy soil, used peat, decomposed cow dung and peat moss. Compost was bought from local market. Used peat was two years old and previously used for mushroom production.

Treatments

Eight different casings were prepared and used as treatments. Casing prepared having imported peat moss was used as control.

T_1- Peat moss: saw dust (2:1)
T_2- Coir dust: compost: saw dust: garden soil (1:1:1:1)
T_3- Compost: saw dust: garden soil (1:1:1)
T_4- Half burnt paddy husk: coir dust: compost: paddy soil (1:1:1:1)
T_5- Coir dust: paddy soil (1.5:1)
T_6- Saw dust: used peat: half burnt paddy husk (1:1:1)
T_7- Coir dust: decomposed cow dung: compost (1:1:1)
T_8- Netherland peat moss (control)

Prepared casing mixtures were sterilized by dipping them 20 minutes in boiling water.

Casing Application

After the spawn run process, the crop becomes ready to enter in to the reproductive phase to produce the fruit bodies (mushrooms). However, it will not produce fruit bodies unless the compost surface is covered. The process of applying casing layer on the surface of compost bed is called "casing" of mushroom beds. It induces the transition from vegetative phase to reproductive phase and that transition determines the commercial viability of the crop (Pardo *et al.*, 2004). The casing matrix supports the growth of bacteria considered important when fruiting is to be initiated. Casing changes the diffusion rate for metabolic gases, gases that influence primodium formation and mushroom growth (Beyer and Paul, 1996). The main properties of good casing layer are that should be capable of holding a reasonable quantity of water for a long time and should be sufficiently porous even wet, to allow carbon dioxide to escape and oxygen to enter the compost. Also, it should be neither too acidic nor too alkaline. The pH should be between 7 and 7.5 and free from pest and diseases. The casing layer should have a fairly open texture and should not pan when water is applied (Verma, 1999).

Ruffling

Ruffling is a process of loosening the casing layer by hand 10-12 days after casing application. It is important to take early harvest and it helps easy harvest; because without ruffling, mushrooms may grow little bit deeper in to the casing mixture making it difficult to harvest. Hence, ruffling was done as recommended.

Harvesting

Mushrooms mostly appear in flushes at an optimum temperature of 15 °C. It generally takes seven to 8 days to come to the button stage from the first appearance of the formation of a pin head. Button mushrooms were harvested by twisting the mushrooms gently clock-wise, and then anti clock-wise and afterwards it was pulled up very softly. Along with the mushrooms, soil particles of the casing mixture also came up clinging with the mycelia threads of the mushroom. The lower portion of the stipe was cut with a sharp knife and kept in the trash box. The cleaned mushrooms were collected in another box. When all the mushrooms of the desired size have been harvested, the next stage was to fill up the holes with a mixture of sterilized casing mixture (Bahl, 1994).

Data Analysis

Yield parameters obtained through the research were: yield per bag, girth, number of buttons per pack, number of buttons contained in a 200 g pack, weight per button and cost to produce 1 kg of mushroom in each treatment. Yield of mushroom, number of buttons and cost of each treatment were recorded for analysis purposes.

Yield parameter data of the different casing mixtures were analyzed using Latin Square Design (LSD) by using SAS system.

RESULTS AND DISCUSSION

The highest yield was recorded from the control treatment (3372.5 g) while the lowest was from T_6. The yields were significantly different (Table 1); however, T_1, T_5 and T_7 were not significantly different from the control (T_8). Among them, T_5 yielded 3497.2 g and T_1 gave a yield of 3095.10 g. The T_1 was a mixture of

Table 1. Yield performance among different treatment

Treatment	Weight(g)	Girth(cm)	No. of buttons*	Wt/button (g)	No. of button per 200 g
T_1	3095.1^{ab}	11.9	202.00^{a}	15.32	13
T_2	2423.1^{bcd}	12.13	127.60^{b}	18.98	11
T_3	2008.8^{d}	12.08	83.80^{b}	24.1	8
T_4	2605.4^{bcd}	12.09	132.40^{b}	19.67	10
T_5	3497.2^{a}	12.22	206.00^{a}	16.98	12
T_6	2157.9^{cd}	11.99	89.60^{b}	24.07	8
T_7	2868.3^{abc}	11.94	105.40^{b}	27.31	7
T_8	3721.5^{a}	11.82	249.60^{a}	14.94	13

**per 10 bag, T_1- Peat moss: sow dust (2:1), T_2- Coir dust: compost: saw dust: garden soil (1:1:1:1) T_3- Compost: saw dust: garden soil (1:1:1), T_4- Half burnt paddy husk: coir dust: compost: paddy soil (1:1:1:1), T_5- Coir dust: paddy soil (1.5:1), T_6- Saw dust: used peat: half burnt paddy husk (1:1:1), T_7- Coir dust: decomposed cow dung: compost (1:1:1), T_8-Netherland peat moss (control)*

imported peat moss and saw dust while T_5 was a combination of coir dust and paddy soil.

The girths in treatments were not significantly different. The values ranged from 11.82 cm to 12.22 cm. The control (T_8) recorded the lowest value while T_5 recorded the highest value (Table1).

The number of buttons yielded per 10 bags, ranged widely. The range was 83.8 (T_3) and 249.6 (T_8). The difference between T_1, T_5 and T8 were not significant, while others were significantly different from T_1, T_5 and T_8 and recorded lesser number of buttons per 10 bags (Table1).

Weight per button too had a wide range. The casing (T_8) recorded the lowest value (14.94 g) while T_7 recorded the highest value (27.31 g). The three treatments (T_3, T_6 and T_7) that had lesser number of buttons, were the heaviest giving values over 24 g per button, while buttons from all other treatments recorded values less than 20 g (Table 1).

The weight per button also had an effect on the number of buttons that can be included in a 200 g pack. Two hundred gram packs are the most common and popular among the consumers. They prefer to buy 200 g packs. Heavier the mushroom, lesser the number in a pack. Hence, T_3, T_6 and T_7 gave lesser number per pack, i.e. seven to eight, while T_1, T_5 and T_8 gave 12 to 13 per pack and T_2 and T_4 had 10 to 11 buttons per pack. Based on consumer's preference T_1, T_5 and T_8 are more suitable.

Since the casing is presently imported and expensive cost incurred per bag was Rs.125. However, the other mixtures recorded less values ranging from Rs. 55 to Rs. 90 and also gave savings ranging from Rs. 35 to Rs. 70 for T_1 to T_7 over control (Table 2).

Although some treatments recorded a higher saving as high as 70, their yield performance and other attributes were not acceptable. Further, profit margin from each treatment was also variable and T_5 gave the highest profit margin (Rs.770.80) beating the control (Rs.693.87). The T_7 too had a profit margin little lesser than T_8 (Rs.645.75), but the buttons were bigger in size and could hold only seven buttons per 200 g pack (Table 3).

Considering the yield, button weight, number of buttons per pack and profit margin, it can be concluded that the local casing mixture with coir dust and paddy soil (1.5: 1) is a better option than imported peat moss casing mixture to be used by the button mushroom producers in Sri Lanka.

Table 2. Cost per bag for treatment

Treatment	Cost per treatment (Rs.)	Saving over cost (Rs.125)
T_1	90	35
T_2	65	60
T_3	60	65
T_4	75	50
T_5	80	45
T_6	55	70
T_7	70	55
T_8	125	0

Rs.- Sri Lankan Rupees, T_1- Peat moss: sow dust (2:1), T_2- Coir dust: compost: saw dust: garden soil (1:1:1:1), T_3- Compost: saw dust: garden soil (1:1:1), T_4- Half burnt paddy husk: coir dust: compost: paddy soil (1:1:1:1), T_5- Coir dust: paddy soil (1.5:1), T_6- Saw dust: used peat: half burnt paddy husk (1:1:1), T_7- Coir dust: decomposed cow dung: compost (1:1:1), T_8-Netherland peat moss (control)

CONCLUSIONS

Imported peat moss casing from the Netherlands, is an expensive input in the button mushroom production in Sri Lanka. Price increases do take place regularly and importation of this material has caused several problems to the mushroom producers time to time. Due to this constraint, the expansion of the industry has not taken place significantly over the past several years resulting a limited production coming in to the local market.

Results of this study indicate that, imported casing can be replaced with the coir dust and paddy soil casing, without causing any reduction to yield or profit. In fact, the profit margin has increased by nearly Rs.75 per kg.

Table 3. Total profits for each treatment

Treatments	Casing (Rs.)	Compost (Rs.)	Yield (g)	T C/bag (Rs.)	Revenue/bag (Rs.)	Profit/bag (Rs.)	Profit/1kg (Rs.)
T_1	90.00	175.00	309.50	265.00	464.25	199.25	643.78
T_2	65.00	175.00	242.30	240.00	363.45	123.45	509.49
T_3	60.00	175.00	200.80	235.00	301.20	66.20	329.68
T_4	75.00	175.00	260.50	250.00	390.75	140.75	540.31
T_5	80.00	175.00	349.70	255.00	524.55	269.55	770.80
T_6	55.00	175.00	215.70	230.00	323.55	93.55	433.70
T_7	70.00	175.00	286.80	245.00	430.20	185.20	645.75
T_8	125.00	175.00	372.15	300.00	558.23	258.23	693.87

One bag = 0.11m², Selling price=Rs. 1500.00, TC-Total cost, T_1- Peat moss: sow dust (2:1), T_2- Coir dust: compost: saw dust: garden soil (1:1:1:1), T_3- Compost: saw dust: garden soil (1:1:1), T_4- Half burnt paddy husk: coir dust: compost: paddy soil (1:1:1:1), T_5- Coir dust: paddy soil (1.5:1), T_6- Saw dust: used peat: half burnt paddy husk (1:1:1), T_7- Coir dust: decomposed cow dung: compost (1:1:1), T_8- Netherland peat moss (control)

Therefore, the mixture can be recommended as a casing for button mushroom production in future which would result in a significant impact on growth and expansion of the button mushroom industry in the country. However, paddy soil may differ from place to place and therefore; it has to be thoroughly studied to identify the best paddy soil for the preparation of the casing.

ACKNOWLEDGEMENTS

Sincere thanks are extended to Mr.K.H.M.I. Karunarathne, Instructor Information and Communication Technology (ICT) Center for his assistance in statistical analysis of data. Sincere thanks are also due to all staff members of Dutch Malta (Pvt) Ltd, Nuwara Eliya.

REFERENCES

Babu, A.G.S., Udugama, M.G.B., Hemachandra, S.R. and Sharma, H.C. (2004). Potential of cultivating *Agaricus bisporus* strains in upcountry wet and intermediate zones of Sri Lanka. In: Proceedings of the Annual Symposium of the Department of Agriculture. Sri Lanka, **6**, 29-37.

Bahl, N. (1998). Hand book of mushrooms. Oxford & IBH Publishing Co (Pvt) Ltd., 15-40.

Bayer, D.M. and Wuest, P.J. (1996). Manufacture and Recycled Material used as Casing in (*Agaricus bisporus*). Mushroom Production Mushroom Biology and Mushroom products. Royse (ed) Penn State University, 241-250.

Bustamante, M.A., Paredes, C., Moral, R., Agullo, E., Perez-Murcia, M. D. and Abad, M. (2008). Composts from distillery wastes as peat substitutes for transplant Production. *Resource Conservation and Recycle.* **52**, 792–799.

Pardo, A., Juan, A.J. De, Pardo, J. and Pardo, J.E. (2004). Assessment of different casing materials for use as peat alternatives in mushroom cultivation. Evaluation of quantitative and qualitative production parameters, **2**, 267–272.

Petroni, S.L.G., Pires, M.A.F. and Munita, C.S. (2000). Adsorption of zinc and cadmium on peat columns. *Quimica Nova*, **23**, 477–481.

Verma, R.N. (1999). National and International Scenario of Mushroom Production and Trade. Conference on the Mushroom Industry in India-A Decade of Achievements and Future Prospective, Dec. 3, Solan (H.P.), India, 5-8.

Verma, R.N. (2004). Indian Mushroom Industry: Contribution and Potential of Himachal Pradesh. In: Advances in Horticulture, ed. Sharma, Deep and Deep Publications, Pvt. Ltd., New Delhi, India,139-142.