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EFFECT OF DIFFERENT WHEAT BRAN SUPPLEMENTS AND MOTHER CULTURES ON GROWTH AND YIELD OF OYSTER MUSHROOM

S. Chakma[1], M. M. Hossain[1], N. C. Sarkar[2], A. J. Kakon[2] and M. M. Hossain[3*]

Abstract

Present study was conducted in the laboratory and culture-house of Mushroom Development Institute, Savar, Dhaka during September 2015 to August 2016 with a view to determining the effect of wheat bran as a supplement with rice straw and saw dust substrate and two types of mother cultures on the growth and yield of oyster mushroom (*Pleurotus ostreatus*). The substrates were prepared by mixing rice straw and saw dust at 1:1 ratio, which were then supplemented with wheat bran at a rate of 5, 10, 20, and 30%. The substrates were sterilized in a Sterilization Cum Inoculation Chamber. Sterilized and supplemented substrates were inoculated with jute stick or rice grain based mother culture and shifted to spawn running room. The highest mycelium run rate of 0.48 cm/day was recorded in substrates supplemented with 30% wheat bran and inoculated with jute stick based mother culture, where a minimum of 20 days was required to complete mycelium running. On the other hand, the lowest mycelium run rate of 0.26 cm/day was observed in substrates supplemented with 5% wheat bran and inoculated with rice grain based mother culture, where a maximum of 34 days were required to complete the mycelium running. The highest biological yield (235.80 g/packet), economic yield (223.50 g/packet), biological efficiency (134.70 %) and benefit cost ratio (2.41) were recorded in substrate supplemented with 30% wheat bran and inoculated with jute stick based mother culture. Substrate supplanted with 30% wheat bran and inoculated with jute stick based mother culture is considered as the best strategy to achieve the highest biological yield, economic yield, biological efficiency and benefit cost-ratio.

Keywords: Substrate, rice grain based mother culture, jute stick based mother culture, mycelium running.

Introduction

Mushrooms are edible fungi with large reproductive structures. They are most popular nutritious and delicious vegetable with medicinal value. They are non-green fungal plants occurring seasonally in many parts of the world in various habitats ranging from sandy plains to tropic forests and green meadows to roadsides. There are more than 2000 edible species of which only a few have been brought under cultivation on commercial scale. Of these, 80 have been grown experimentally, 20 cultivated commercially and five are produced on industrial scale throughout the world (Pathak *et al.,* 1998). Among them, Oyster mushroom is usually cultivated in our country because of the favorable weather and the climatic conditions. Among the cultivable mushroom, the oyster mushroom (*Pleurotus ostreatus*) is usually

[1]Dept. of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur 1706, Bangladesh, [2]Mushroom Development Institute, Savar, Dhaka, [3]Dept. of Plant Pathology, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur 1706, Bangladesh. *Corresponding author: hossainmm@bsmrau.edu.bd

cultivated in Bangladesh because of suitable climatic factors of the country. Mushrooms are rich in protein, minerals, vitamins, and essential amino acids (Sadler, 2003). Mushrooms have medicinal properties like anti-cancerous, anti-cholesterol and are active against hyper cholesterolemic, hypertension, diabetes, and other infections (Alam *et al.,* 2007).

Bangladesh is an agrarian country with increasing number of population, but the available land for cultivation of vegetables is decreasing day by day. In such situation, mushroom production can play an important role because it grows fast and does not require any fertile land. Substrate is an important item for growing mushroom. It grows on agro-wastes like wheat or paddy straw, banana leaves, sugarcane baggasse and leaves, wheat bran, rice husk, sawdust, etc. (Sarker *et al.,* 2007). Substrates supplementation is commonly practiced to increase the productivity of mushroom (Moda *et al.,* 2005). Yoshida *et al*. (1993) reported the highest yield of mushroom in substrates (chopped straw or sawdust) mixed with wheat bran, rice bran, and bean curd at the rate of 45%. Sarker *et al.* (2008) achieved higher yield on waste paper and wheat straw using wheat bran and rice bran as supplements. The present experiment aimed at finding out the effect of different levels of wheat bran as supplement with basic substrate and the effect of two types of mother cultures on growth, biological and economic yield, biological efficiency and benefit-cost ratio.

Materials and Methods

Location of experiment

The experiment was conducted at the Mushroom Development Institute, Savar, Dhaka Bangladesh during September 2015 to August, 2016.

Preparation of basic substrate and treatment

The basic substrate was prepared by mixing sun dried rice straw and saw dust. Rice straw was cut into small pieces (0.5-2.0 cm) and mixed with sawdust at 1:1 ratio. Four different levels of wheat bran viz. 5, 10, 20 and 30% (w/w) were added to rice straw and sawdust mixture as a supplement and then mixed. After preparation, the substrates were inoculated with jute stick mother cultures or colonized rice grain. Hence, there were altogether eight treatments. The experiment was laid out in a completely randomized design with three replications.

Preparation of jute stick based mother culture

Jute sticks were cut into approximately 5 cm long pieces, soaked in water for 24 hours and washed thrice with water. Ten to 12 pieces of jute sticks were bundled together and kept in a polypropylene bag with mouth being closed tightly. The polypropylene bags containing jute stick pieces were sterilized in an autoclave at 121°C and 1.0 kg/cm^2 for 3.5 hours. After sterilization, jute stick pieces were allowed to cool at room temperature and inoculated aseptically with PDA culture of the mushroom fungus. The mother culture was kept at room temperature for 6-8 days for colonization.

Preparation of rice grain based mother culture

Rice grains were boiled in water for 1 hour for sterilization and then kept for cooling. After cooling treated rice grains were inoculated with 12-15 blocks of PDA culture of oyster mushroom and mixed thoroughly. Three hundred gram of the mixture was poured in a single polypropylene bag and packed tightly using cotton plug. The bags were placed on the laboratory desk at room temperature for 6 to 8 days in order to allow the fungus to colonize the grains. Fully colonized rice grains were used as mother culture to inoculate the spawn packet.

Preparation of spawn packet

Water was added to the substrate mixture to adjust the moisture content at 60% and $CaCO_3$ was added at the rate of 0.2% (w/w) of the total mixture. A 500 g mixture of the dry substrate was poured in each polypropylene bag (17 cm × 25 cm). Each treatment was replicated three times and there were total 24 spawn packets. The spawn packets were sterilized by gas heat in a Sterilization Cum Incubation Chamber.

Inoculation of substrates by mother cultures

Each spawn packet was inoculated with jute stick or rice grain based mother culture at the rate of two tea spoonful per packet. After inoculation, the packets were incubated in the laboratory at 25°C for 18 to 61 days. After completion of mycelium running, the polypropylene bags were cut open on both side by D-shaped cut (2.35 cm× 10.25 cm) and were sprayed with water using a sprayer to maintain high relative humidity in the culture house. The spray of water was discontinued a day before the harvest of the fruiting bodies.

Collection and analysis of data

The harvesting time varied depending on the levels of supplement. Data were collected on mycelium run rate, time to complete mycelium run rate, number of fruiting bodies/ packet, number of effective fruiting body/ packet, weight, length and diameter of stalk, diameter and thickness of pileus, biological and economic yield, biological efficiency and cost benefit ratio. Biological yield/g packet was measured by weighing the whole cluster of fruiting body without removing the lower hard and dirty portion. Economic yield/g packet was recorded by weighing all the fruiting bodies in a packet after removing the lower hard and dirty portion. Biological efficiency was calculated by the following formula:

$$\text{Biological Efficiency} = \frac{\text{Total Biological weight} \times 100}{\text{Total weight of substrate}}$$

The benefit cost ratio for different low cost substrates were computed based on present market price of mushroom and cost of different inputs in the markets. The recorded data were statistically analyzed by using MSTAT-C program and means were separated following least significant difference (LSD) test at 5% level of probability (Gomez and Gomez, 1984).

Results and Discussion

Mycelium run rate

Significantly the highest mycelium run rate (0.48 cm/day) was recorded at 30% wheat bran supplement and inoculated with jute stick based mother culture (Table 1). The second highest mycelium run rate was observed at 20% wheat bran supplement and inoculated with jute stick based mother culture, which was statistically similar to that of 30% wheat bran inoculated with rice grain based mother culture. The minimum mycelium run rate was recorded at five wheat bran supplements inoculated with rice grain mother culture. The results showed that jute stick based mother culture showed higher mycelium running than rice grain based mother culture, and mycelium run rate increases with higher level of wheat bran supplement. Jute sticks contain high nitrogen and lignin and also good source of cellulose (Rombaldo *et al*., 2014). The ligno-cellulosic materials may increase mycelium

Table 1. Effect of two types of mother cultures and different levels of wheat bran supplements on the mycelium growth of oyster mushroom

Mother culture	Level of wheat bran supplement (% w/w)	Mycelium run rate (cm/day)	Days required to complete mycelium running
Jute stick	30	0.48 a	20 e
	20	0.391 b	23 d
	10	0.362 c	25 c
	5	0.344 d	26 c
Rice grain	30	0.38 b	28 b
	20	0.305 f	29 b
	10	0.270 g	33 a
	5	0.258 h	34 a

Values within the same column with a common letter (s) do not differ significantly (*P=0.05*)

run rate and help produce good quality spawn packets. Use of jute stick based mother culture in a spawn packet appeared to induce mycelial growth equally from both lower and upper portion of spawn packets thereby mycelial growth completed within a short period of time. In rice grain based mother culture, mycelia started to grow from top to bottom which required longest time to complete the mycelial growth. Hasan *et al*. (2015) observed that the highest mycelium running (0.96 cm/day) was observed on sugarcane bagasse supplemented with 50% and the lowest (0.72 cm) on 0% level of wheat bran supplement. Sarker *et al.* (2008) reported that the biological and economic yield as well as the mycelium run rate of oyster mushroom increased gradually with the increased rate of wheat bran supplement up to 40% and started to decrease thereafter. Ali (2009) also reported that the highest mycelium running rate (0.96 cm/day) was observed on sugarcane bagasse supplemented with wheat bran at the rate of 40%.

Days to complete mycelium running

Minimum 20 days were required to complete mycelium running at 30% wheat bran, which was followed by 23 days at 20% supplement, while maximum 34 days were required to complete mycelium running at 5% wheat bran, and 33 days was required at 10% wheat bran (Table 1). The findings of the present study are more or less similar to the reports to many other investigators. Sarker *et al*. (2007) found that any amount of molasses and wheat bran added to saw dust increased the mycelium growth and decreased days to complete mycelium running. Ali (2009) reported that the lowest time (3.23 days) was required from completion of primordia initiation to harvest. The findings of the present study on mycelium run rate and days to complete mycelium running were corroborated with the findings of previous workers (Sarker *et al.,* 2008; Ali, 2009; Hasan *et al.,* 2015). They found that the mycelium running of oyster mushroom was greatly influenced by wheat bran supplement.

Yield attributes of oyster mushroom

Number of fruiting bodies: Maximum number of total fruiting bodies were recorded at 30% wheat bran inoculated with jute stick mother culture (JSMC) followed by that of spawn packed inoculated with rice grain mother culture (RGMC). The minimum number of total fruiting bodies were recorded from the substrate with 5% supplement and inoculated with RGMC, which was statistically similar to that with 5% supplement inoculated with JSMC. Significantly the highest number of effective fruiting bodies were found in substrate having 30% wheat bran followed by that with 20% wheat bran inoculated with JSMC, 30 and 20% wheat bran inoculated with RGMC. The number of effective fruiting bodies at 5% inoculated with JSMC and RGMC were statistically similar but significantly lower compared to other treatments. Wheat bran (30%) inoculated with JSMC was superior to RGMC because ligno-cellulosic materials not only increased total number of fruiting bodies, but also increased total number of effective fruiting bodies (Table 2).

Length and diameter of stalk: The length of stalk under different treatments ranged from 2.50 to 2.59 cm, where maximum length of stalk was observed in 30% wheat bran supplemented substrate inoculated with JSMC followed by that in 20% wheat bran supplement. All the wheat bran supplemented (5-30%) substrates inoculated with RGMC were statistically similar to each other. The diameter of stalk in these substrates ranged from 5.44 to 5.84 cm. Inoculation of wheat bran supplemented substrates by JSMC did not cause significant difference in length of stalk except those supplemented with 20% and 30% wheat bran (Table 2).

Diameter and thickness of pileus: Diameter of the pileus ranged from 5.40 to 5.86 cm. The highest diameter of pileus was found in substrate having 30% wheat bran, which was statistically similar to that of the other three levels of the supplement inoculated with

Table 2. Effect of two types of mother cultures and different levels of wheat bran supplement to rice straw and saw dust substrates mixed with $CaCO_3$ at 0.2% on yield attributes of oyster mushroom

Mother culture	Level of wheat bran supplement (% w/w)	No. of fruiting-bodies/pkt	No. of effective fruiting-bodies/pkt	Length of stalk (cm)	Diameter of stalk (cm)	Diameter of pileus (cm)	Thickness of pileus (cm)
Jute stick	30	87.50 a	75.50 a	2.59 a	5.59abc	5.62abcd	0.99 ab
	20	76.50c	68.50 b	2.57 ab	5.44bc	5.58bcd	0.90 c
	10	63.50 d	56.50 c	2.56 b	5.45bc	5.54cd	0.80 d
	5	57.50 e	45.50 d	2.50c	5.78a	5.40d	0.79 d
Rice grain	30	84.50 b	66.50 b	2.52 c	5.84a	5.86a	0.96 ab
	20	77.50 c	65.50 b	2.52 c	5.80a	5.78abc	0.91 bc
	10	64.50 d	53.50 c	2.51 c	5.80a	5.83ab	0.89 c
	5	56.50 e	48.50 d	2.51 c	5.74ab	5.67abcd	0.80 d

Values within the same column with a common letter(s) do not differ significantly (*P=0.05*)

RGMC and 30% supplement but inoculated with JSMC. Thickness of the pileus ranged from 0.79 to 0.99 cm. The maximum pileus thickness was found in substrate supplemented with 30% wheat bran, which was not significantly different from treatments having 20% supplement and inoculated with JSMC of 30, 20, and 10% supplement inoculated with RGMC (Table 2).

Yield and benefit cost ratio of oyster mushroom

Biological yield, biological efficiency and economic yield of oyster mushroom were observed to be 161.75-235.80 g/packet and 92.43 -134.70% and 155.85 -223.50 g/packet, respectively. The biological yield at 30% supplement inoculated with JSMC was significantly higher compared to that of other levels of supplement followed by that with 30% supplement inoculated with RGMC. The biological yield of mushroom at 5 and 20% was statistically different and significantly lower compared to that at 30% supplement irrespective of two mother cultures. Identical trends in influence of different levels of supplement were recorded in case of biological efficiency and economic yield. The highest benefit cost ratio of 2.41 was obtained with 30% supplement and inoculated with JSMC, which was followed by that with 30% supplement inoculated with RGMC and 20% supplement inoculated with JSMC. The lowest benefit-cost ratio of 1.97 was achieved with 5% wheat bran supplement and inoculation with RGMC (Table 3).

Conclusion

In the present investigation, the effect of different levels of wheat bran supplement in basic substrate and inoculation with two different types of mother cultures on the growth and yield of oyster mushroom (*Pleurotus ostreatus*) was studied, and the highest mycelium and minimum days to complete mycelium running were observed at 30% wheat bran supplement and inoculation with jute stick based mother culture. Similarly, highest biological yield, economic

Table 3. Effect of two types of mother cultures and different levels of wheat bran supplement added to rice straw and saw dust substrates mixed with $CaCO_3$ at 0.2% on yield and benefit cost ratio of oyster mushroom

Mother culture	Level of wheat bran supplement (% w/w)	Biological yield (g/pkt)	Economic yield (g/pkt)	Biological efficiency (%)	Benefit Cost Ratio
Jute stick	30	235.8 a	223.50 a	134.70 a	2.41
	20	199.25 c	186.25 c	113.90 b	2.13
	10	175.75 e	166.75 d	100.40 c	2.02
	5	167.80 g	156.72 e	95.89 c	1.98
Rice grain	30	224.70 b	215.50 b	128.40 a	2.32
	20	194.60 d	184.55 c	111.20 b	2.11
	10	173.80 f	164.78 d	99.31 c	2.00
	5	161.75 h	155.85 e	92.43 c	1.97

Values within the same column with a common letter(s) do not differ significantly (*P=0.05*) yield, biological efficiency and benefit cost ratio were recorded at the highest wheat bran supplement inoculated with jute stick based mother culture. Based on the findings of the present experiment, substrate supplemented with maximum dose of wheat bran inoculated with jute stick based mother culture is considered as the best treatment to achieve the highest biological yield, economic yield, biological efficiency and benefit cost-ratio.

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