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Performance of Poultry Litter as a Supplement to Waste Paper on Growth, Yield and Quality of *Pleurotus ostreatus* (Jackuin ex Fr.) Kummer

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Abstract

Six different levels of poultry litter (50, 40, 30, 20, 10 and 0%) were tested as nutrient supplement to the waste paper for oyster mushroom production. The levels of poultry litter influenced the number of fruiting body, biological efficiency, biological yield and economic yield. The highest economic yield (50.18 g/packet) was recorded in 40% poultry litter that was statistically identical to those in 30 and 50% poultry litter. The lowest economic yield (16.57 g/packet) was observed in control treatment. The maximum benefit cost ratio (1.36) was recorded at 40%, which was followed by 30, 50, 20 and 10% of the supplement. Under control the ratio was only 0.52.

Key words: Poultry litter, waste paper, economic yield, biological efficiency and quality

INTRODUCTION

Oyster mushroom (*Pleurotus ostreatus*) is a nutritious vegetable that grows mostly on dead and rarely on living parts of plants, which are generally poor in nutrients and vitamins. Mushroom growers generally use sawdust and straw of cereals. Vijay and Upadhyay (1989) suggested using the sterilized chicken manure as supplement to the substrate of *P. sajor-caju* and *P. flabellatus* which is a burning problem for the poultry farmer as an environment pollutant in its growing areas of Bangladesh. But An and Awan (1996) obtained only 71.05% return on investment in *P. florida* production using mixture of rice straw + 15% rice bran + 15% chicken dung as a substrate and Cresswell *et al.* (1990) reported that boron (B) and copper (Cu) which are normally contributed to mushroom compost from poultry litter are unlikely to cause significant reduction in mushroom production. Therefore, it is necessary to verify the material as the supplement of substrate of *P. ostreatus*. The present work was undertaken to find out the effect of poultry litter as a supplement to substrate of oyster mushroom (*P. ostreatus)* and to standardize the level of poultry litter as a supplementary material to the waste paper.

MATERIALS AND METHODS

The experiment was carried out during October 2003 to February 2004. Waste paper was used as main substrate. Poultry litter was tested as nutrient supplement. Six different

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levels of poultry litter, *viz.* 50, 40, 30, 20, 10 and 0% were tested to determine the best levels of the material for mushroom production. Water was added to make the moisture of the mixture at 65% level. Calcium carbonate ($CaCO_3$) was added to the mixture at the rate of 0.57% (w/w). The materials were mixed thoroughly and the mixture was poured into heat resistant propylene bags at the rate of 500 g/bag. The neck of the bag was prepared by using heat resistant plastic neck. A hole of about 2/3 deep of the volume of the bag was made at the center with a sharp end stick for space to put inoculums. The neck was plugged with cotton and covered with brown paper and tied with a placing rubber band. The packets were sterilized in an autoclave for one hour at 120^0C under 1 kg/cm^2 pressure. After sterilization the packets were cooled for 24 hours and transferred into a clean bench. Each spawn packet was inoculated with the mother culture at the rate of two teaspoonfuls per packet. After inoculation, the packets were incubated in a incubation room at 25 ± 2^0C temperature. Growth of mycelium in the spawn packets was completed within 11 to 14 days.

Then the brown paper, rubber bands, cotton plug and plastic neck of the spawn packets were removed and the mouths of polypropylene bags were wrapped and tied with rubber bands. Two ends, opposite to each other of the upper position of the plastic bag were opened by removing the plastic sheet with a scalpel making 'D' shaped opening. The opened surface of the substrate was scraped slightly with a blade for removing the thin whitish mycelial layer. The spawn packets were soaked in water for 15 minutes and inverted for another 15 minutes to remove excess water. The packets were placed separately side-by-side on the rack of mushroom culture house. The relative humidity and temperature of culture house were maintained within optimum range by watering twice daily. Diffused daylight and proper ventilation in culture house were maintained for fruiting body development. The mushroom fruiting body was harvested by gentle twisting before the mushroom showed slightly split edges. After each harvest the scrapping, watering and other operation were done as first opening of the packet for subsequent harvests. All the data on various parameters except benefit cost ratio were statistically analyzed for ANOVA and means were compared using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Mycelial growth: Mycelium growth in spawn packet, having waste paper as the substrate amended with poultry litter at 0, 10, 20, 30, 40 and 50% (w/w), ranged from 1.02 to 0.94 cm/day is shown in Table 1. The parameters under different doses of the supplement were not significantly different. It required 11.00-13.25 days to complete the mycelium running in the spawn packet. Amendment of substrate with poultry litter caused significant decrease in number of days to complete mycelium running at all doses except 10%. The rate of reduction in days to complete mycelium running was positively correlated with the dose of application of the supplement. The minimum number of days was required at 50%, which was followed by 40 and 30%. The efficiency of the higher three doses was not significantly different. Days to complete mycelium running at 20% were statistically similar to those at 30% but significantly higher as compared to 40 and 50%.

Duration for primordia initiation and harvest: Amendment of substrate with poultry litter at 30-50% (w/w) gave significant reduction in duration from stimulation to primordia initiation, from primordia initiation to first harvest and days required for total harvest of oyster mushroom. But all doses increased duration of total harvest over control significantly. Duration (days) from stimulation to primordia initiation as well as first harvest at 50, 40, 30 and 20% was statistically similar and significantly higher as compare to 10% and 0% (control). Duration required from primordia initiation to first harvest at 0 and 10% poultry litter was 5.00 days. It was significantly higher as compared to 30, 40 and 50% of the supplement. The effect of the three higher doses on this parameter was statistically similar. Duration for total harvest at three higher doses was 68.00, 70.5 and 70.5 day. The effect of the three higher doses on this parameter was statistically similar and significantly higher as compared to other treatments including control. At 0%, harvest ceased after 37.75 days only. It was increased to 52.75 and 50.00 days due to application of the supplement at 10 and 20%, respectively (Table 2).

Table 1. Effect of poultry litter used as supplement to waste paper for spawn packet on mycelial growth of oyster mushroom

Doses of poultry litter level in waste paper (% w/w)	Mycelium run rate in spawn packet (cm/day)	Days required to complete mycelium running in spawn packet (day)
0	1.02 a	13.25 a
10	1.07 a	13.00 ab
20	1.01 a	12.50 bc
30	1.03 a	12.00 cd
40	0.93 a	11.75 d
50	0.94a	11.00 e
CV (%)	8.73	3.04

In a column, means followed by a common letter are not significantly different at 5% level by DMRT.

Table 2. Effect of amendment of substrate with poultry litter at different doses on duration for primordia initiation and harvest of oyster mushroom

Doses of poultry litter level in substrate (% w/w)	Duration from stimulation to primordia initiation (day)	Duration from primordia initiation to first harvest (day)	Duration from stimulation to first harvest (day)	Duration required for total harvest (day)
0	10.00 a	5.00 a	15.00 a	37.75 c
10	10.25 a	5.00 a	15.25 a	52.75 b
20	7.25 b	4.75 ab	12.00 b	50.00 b
30	7.00 b	4.25 bc	11.25 b	70.50 a
40	6.75 b	4.00 c	10.75 b	70.50 a
50	7.00 b	4.00 c	11.00 b	68.00 a
CV (%)	11.82	9.80	8.36	11.28

In a column, means followed by a common letter are not significantly different at 5% level by DMRT.

Yield attributes of oyster mushroom: Number of fruiting body of oyster mushroom was significantly increased due to amendment of substrate with poultry litter at 30, 40 and 50% (w/w) over control. Increase in the parameter over control was also achieved with 10 and 20% poultry litter but the increase was not significant as compared to control. The ranges of weight of fruiting body per packet, length and diameter of stalk, and thickness of pileus at different levels of the supplement were 2.53-3.80 g/packet, 1.72-2.14 cm/stalk, 0.63-0.73 cm/stalk and 0.63-0.73 cm/pileus, respectively. All levels of poultry litter, within the range of 10-50% of the substrate failed to increase or decrease in any of the four parameters (Table 3). Significantly increase in diameter of pileus was achieved with 30 and 40% poultry litter as compared to control. The highest increase was recorded at 40%. Size of the pileus at 0, 10 and 50% was statistically similar (Table 3).

Table 3. Effect of poultry litter used as a supplement to waste paper at different doses on the yield attributes of oyster mushroom

Doses of poultry litter (% w/w)	Number of fruiting body/pkt	Weight of fruiting body (g/pkt)	Length of stalk (cm/stalk)	Diameter of stalk (cm/ stalk)	Diameter of pileus (cm/ stalk)	Thickness of pileus (cm/pileus)
0	6.75 b	2.53 a	1.72 a	0.65 a	3.72 c	0.63 a
10	8.25 b	3.35 a	1.77 a	0.70 a	4.28 bc	0.70 a
20	8.75 b	3.55 a	1.76 a	0.65 a	4.45 abc	0.61 a
30	14.25 a	3.44 a	2.04 a	0.73 a	5.15 ab	0.68 a
40	13.25 a	3.80 a	2.14 a	0.71 a	5.26 a	0.69 a
50	12.52 a	3.53 a	2.02 a	0.63 a	4.17 c	0.53 a
CV (%)	19.93	21.51	15.71	16.76	13.29	14.61

In a column, means followed by a common letter are not significantly different at 5% level by DMRT.

Biological efficiency, biological yield and economic yield: Significant increase in biological efficiency, biological yield and economic yield of oyster mushroom was achieved through amendment of substrate with poultry litter at 10-50% (w/w). The minimum increase was obtained with 10% of the supplement, which was statistically similar to 20%. Each of the three parameters at 30, 40 and 50% poultry litter was statistically similar but significantly higher as compared to 0, 10 and 20% (Table 4). Maximum yield was harvested in the first flush, which was followed by 2nd and 3rd flush (Fig. 1). The functional relationship between levels of poultry litter and economic yield of mushroom is shown in Fig. 2. The economic yield of oyster mushroom increased gradually with the increased doses of poultry litter supplement to substrate up to 40% and decreased thereafter. The economic yield was also linearly and positively correlated with biological efficiency and number of fruiting body of oyster mushroom grown on waste paper amended with poultry litter (Fig. 3 and 4).

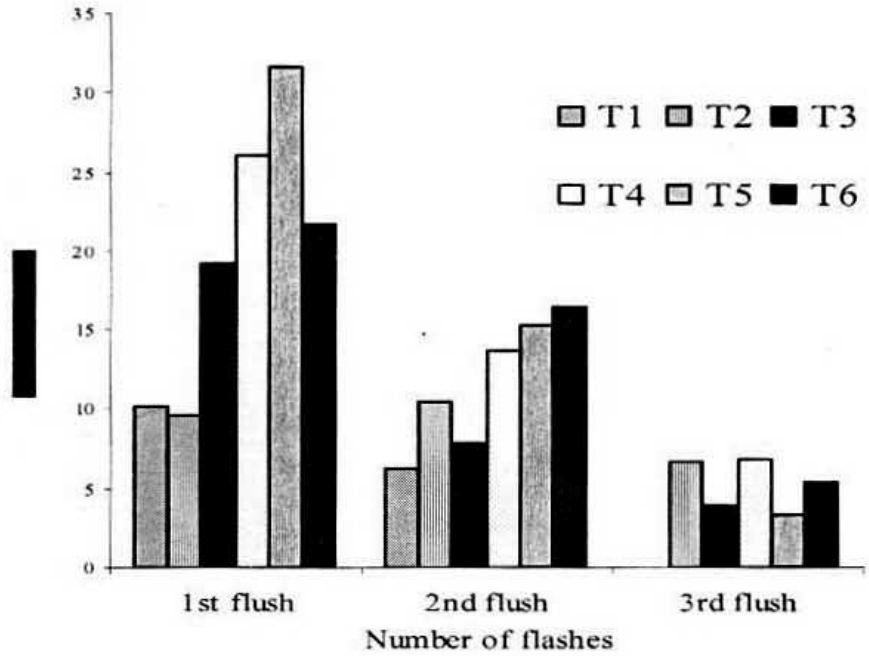

Fig. 1. Flushwise economic yield of oyster mushroom influenced by the poultry litter levels (T1 = 0% poultry litter,T2 = 10% poultry litter, T3 = 20% poultry litter, T4 = 30% poultry litter, T5 = 40% poultry litter, T6 = 50% poultry litter)

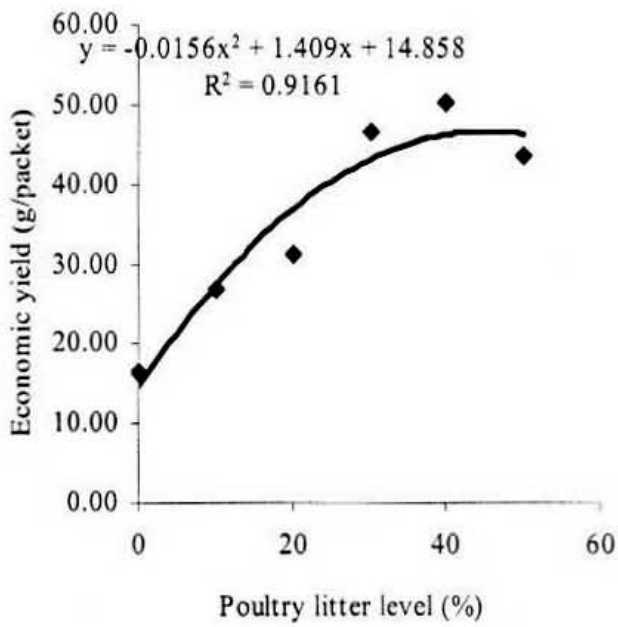

Fig. 2. Functional relationship between poultry litter level in substrate and economic yield of oyster mushroom

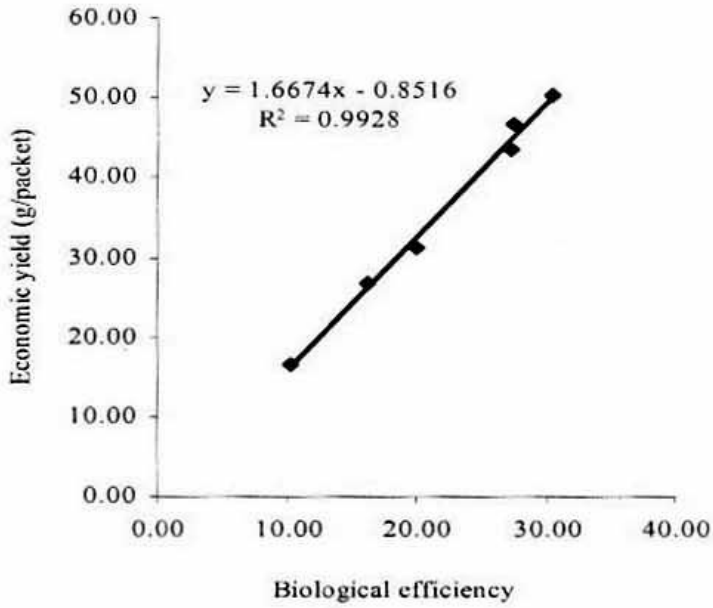

Fig. 3. Functional relationship between biological efficiency and economic yield of oyster mushroom influenced by the levels of poultry litter

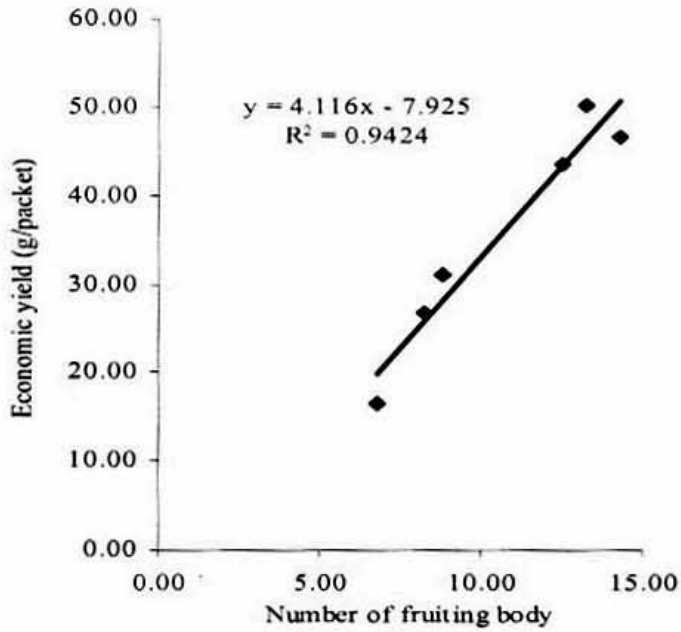

Fig. 4. Functional relationship between number of fruiting body and economic yield of Oyster mushroom influenced by the levels of poultry litter

Benefit cost ratio: The maximum benefit cost ratio (BCR) of 1.36 was recorded at 40% level of poultry litter, which was followed by 30, 50, 20 and 10% of the supplement. Under control benefit cost ratio was 0.52 only (Table 4).

Table 4. Effect of poultry litter tested at different level to amend substrate, on the biological efficiency, yields and benefit cost ratio of oyster mushroom

Doses of poultry litter level in substrate (% w/w)	Biological efficiency (%)	Biological yield (g/packet)	Economic yield (g/ packet)	Benefit cost ratio
0	10.25 c	17.96 c	16.57 c	0.52
10	16.25 b	28.42 b	26.82 b	0.81
20	20.04 b	35.07 b	31.05 b	0.90
30	27.58 a	48.27 a	46.67 a	1.31
40	30.52 a	53.42 a	50.18 a	1.36
50	27.27 a	47.72 a	43.56 a	1.14
CV (%)	15.48	15.49	14.31	-

In a column, means followed by a common letter are not significantly different at 5% level by DMRT.

Results of the experiment show that poultry litter is an effective supplement to substrate for mushroom cultivation. The material is comparatively available in Bangladesh. Amount of substrate with poultry litter at an appropriate rate 30-40% gave appreciable increase in mycelial growth and yield of oyster mushroom. It causes increase in number of flushes but decrease in duration for primordia initiation, effective fruiting body formation and first harvest. Use of the supplement extended the period of total harvest due to increase in number of flushes.

Poultry litter contributes high amount of nitrogen and other nutrient element. Vijay and Upadhyay (1989) suggested using the sterilized chicken manure as supplement to the substrate. Application of poultry litter to mushroom culture substrates probably enriches the substrate with various nutrient elements necessary for the growth of the mushroom. It may be one of the reasons of obtaining increase in growth and yield of mushroom in substrate having waste paper amended with poultry litter.

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Comparative Study of the Nutritional Composition of Oyster Mushrooms Cultivated in Bangladesh

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Abstract

The nutritional composition of six species of oyster mushrooms such as *Pleurotus sajor-caju, P. ostreatus, P. florida, P. cystidiosus, P. highking 51* and *P. geestaranus* was determined. The protein content was found highest in *P. sajor-caju* (24.5g/100g of dry weight) followed by *P. ostreatus, P. highking 51, P. florida, P. geestaranus* and *P. cystidiosus*. The highest lipid content was found in *P. cystidiosus* (5.5g/100g dry sample) followed by *P. highking 51, P. sajor-caju, P. florida, P. geestaranus* and *P. ostreatus*. The carbohydrate content was found highest in *P. geestaranus* (45.9g/100g dry sample) followed by *P. cystidiosus, P. florida, P. ostreatus, P. sajor-caju* and *P. highking 51*. The fiber content was found highest in *P. highking 51* (30.3 g/100g dry sample) followed by *P. ostreatus, P. florida, P. geestaranus, P. sajor-caju* and *P. cystidiosus*. The total ash content was found highest in *P. florida* (8.3 g/100g dry sample) followed by *P. sajor-caju, P. ostreatus, P. cystidiosus, P. highking 51* and *P. geestaranus*. Following these data the highest metabolizable energy was found in *P. cystidiosus* (262.8 kcal/100g dry sample) followed by *P. sajor-caju* (254.1 kcal/100g), *P. geestaranus* (252.7 kcal/100g), *P. florida* (250.1 kcal/100g), *P. highking 51*(249.7 kcal/100g) and *P. ostreatus* (242.6 kcal/100g). The moisture content of fresh oyster mushrooms was found 85-88%.

Key words: Oyster mushrooms, protein, lipid, fiber, carbohydrate, ash and metabolizable energy.

INTRODUCTION

Mushrooms are being recognized as important food items from ancient times. Their usage is being increased day by day for their significant role in human health, nutrition and disease. Although the history of mushroom cultivation is very recent in Bangladesh, its consumption is increasing rapidly in this country. Mushrooms of *Pleurotus* sp. are commonly called 'oyster mushrooms'. They are the second most popular mushrooms after button mushroom all over the world (Adejoye *et al.*, 2006) and the most popular in Bangladesh. Oyster mushrooms grow over a wide range of temperature of 15-30^0 C and hence are ideally suitable for cultivation under both temperate and tropical climatic conditions. In Bangladesh, oyster mushrooms are cultivated and harvested all over the year (Amin *et al.*, 2007). These mushrooms are the most prospective mushrooms of Bangladesh.

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Several species of oyster mushrooms are of highly medicinal importance. *Pleurotus sajor-caju* inhibits hypertensive effects through its active ingredients, which affect the renin-angiotensin system (Chang, 1996). *Pleurotus ostreatus* ameliorates atherogenic lipid in hypercholesterolaemic rats (Hossain *et al.*, 2003). *P. ostreatus* also possesses antitumor activity (Yoshioka *et al.*, 1985) and it has hypoglycaemic effects in experimentally induced diabetics (Chorvathoba, *et al.*, 1993) and human subjects (Khatun *et al.*, 2007). *Pleurotus florida* has antioxidant and antitumor activities in experimental animals (Manpreet *et al.*, 2004; Nayana & Janardhanan, 2000). Methanol extracts of *P. florida* inhibits inflammation and platelet aggregation (Nayana *et al.*, 2004). Water extracts of the fruiting bodies of *P. sapidus* have antibiotic activity especially on *Staphylococus aureus* (Gunde-Chimerman, 1999). *Pleurotus cystidiosus* is strong antioxidant (Li *et al.*, 2007). These medicinal values of *Pleurotus* mushrooms are due to the nutritional or chemical composition of these mushrooms. However nutritional composition is affected by many factors including differences among strains, the composition of growth substrate, the method of cultivation, stage of harvesting, specific portion of the fruiting bodies used for analysis, time interval between harvest and measurement methods (Benjamin, 1995). Although many scientific research works have been conducted to determine the nutritional composition of different mushrooms in different culture conditions, it should require further research works to investigate the nutritional composition of mushrooms cultivated in Bangladesh especially different species of oyster mushrooms (*Pleurotus* sp.). With this aim, this research work has been designed.

MATERIALS AND METHODS

This study was carried out in the 'Quality Control and Quality Assurance' laboratory of National Mushroom Development and Extension Centre, Savar, Dhaka from February to April 2008.

Moisture determination: Moisture of fresh mushrooms was determined by using automatic moisture analyzer (Weighed moisture box. *A&D company ltd. N 92; P1011656; Japan*).

Determination of total protein: Five gram of grinded mushroom was taken with 50ml of 1N NaOH and boiled for 30 minutes. The solution was cooled in room temperature and centrifuged at 1000 × g by a table centrifuge machine (*DIGISYSTEM: DSC-200T; Taiwan*). The supernatant was collected and total protein content was measured according to the Biuret method (Burtis & Ashwood, 2006).

Determination of total lipid: Total lipid was determined by slight modified method of Folch *et al.* (1957). Five gram of grinded mushroom was suspended in 50ml of chloroform: methanol (2:1 v/v) mixture then mixed thoroughly and let stand for 3 days. The solution was filtrated and centrifuged at 1000 × g by a table centrifuge machine. The upper layer of methanol was removed by Pasteur pipette and chloroform was evaporated by heating. The remaining was the crude lipid.

Determination of crude fiber: Moisture and fat free sample was treated with 0.255N H_2SO_4 and 0.313N NaOH and then washed with ethanol and ether. It was then transferred to a crucible, dried overnight at 80-100^{0}C and weighed (W_1) in an electric balance (*KEY1: JY-2003; China*). The crucible was heated in a muffle furnace (*Nebertherm: Mod-L9/11/c6; Germany*) at 600^{0}C for 6 hours, cooled and weighed again (W_2). The difference in the weights (W_1-W_2) represents the weight of crude fiber (Raghuramalu *et al.*, 2003).

$$\text{Crude fiber (g/100g)} = \frac{[100-(\text{moisture} + \text{fat})] \times (W_1-W_2)}{\text{Weight of sample}}$$

Determination of total ash: One gram of the sample was weighed accurately into a crucible. The crucible was placed on a clay pipe triangle and heated first over a low flame till all the material was completely charred, followed by heating in a muffle furnace for about 6 hours at 600^{0}C. It was then cooled in a dessicator and weighed. Then total ash was calculated as following equation (Raghuramalu *et al.*, 2003):

$$\text{Ash content (g/100g)} = \frac{\text{Weight of ash} \times 100}{\text{Weight of sample taken}}$$

Determination of total carbohydrate: The content of the available carbohydrate was determined by the following equation (Raghuramalu *et al.*, 2003):

Carbohydrate (g/100g sample) =

[100 – (Moisture + Fat + Protein + Ash + Crude Fiber)]

Determination of metabolizable energy content: Fat, protein or carbohydrates can supply energy. Metabolizable energy is calculated as the following formula:

$$\text{ME (Kcal /100g)} = [(3.5 \text{ X CP}) + (8.5 \text{ X CF}) + (3.5 \text{ X NFE})]$$

Where, ME = Metabolic Energy; CP = % Crude Protein; CF = % Crude Fat; NFE = % Nitrogen Free Extract (carbohydrate)

RESULTS AND DISCUSSION

The moisture contents of oyster mushroom were found 85-88% (Table 1) with no significant difference at P≤0.05 level. The highest moisture content was found in *P. florida* followed by *P. sajor-caju, P. ostreatus, P. cystidiosus, P. geesteranus* and *P. highking* 51.

The nutritional composition of different oyster mushrooms is shown in Table 2. The protein content was found highest in *P. sajor-caju* (24.5g/100g of dry weight) followed by *P. ostreatus* (23.5g/100g), *P. highking 51* (21.9g/100g), *P. florida* (20.6g/100g), *P. geestaranus* (19.0g/100g) and *P. cystidiosus* (17.7g/100g). The variation in protein content between *P. sajor-caju* and *P. cystidiosus* is significant at P≤0.05.

Table 1. Moisture content of different oyster mushrooms

Mushroom species	Moisture (%)
Pleurotus sajor-caju	87.2 ± 0.5
Pleurotus ostreatus	86.5 ± 0.8
Pleurotus florida	87.4 ± 1.1
Pleurotus cystidiosus	86.5 ± 0.8
Pleurotus highking 51	85.6 ± 0.9
Pleurotus geestaranus	85.9 ± 1.0

Results show mean ± SEM of 5 trials.

Table 2. Nutritional composition of oyster mushrooms (g/100g of dried sample)

Mushroom species	Protein	Lipid	Carbohydrate	Fiber	Ash
P. sajor-caju	24.5±2.9[a]	4.0±0.6[a,b]	37.2±4.2	26.2±2.0	8.0±0.3[a]
P. ostreatus	23.5±2.8[a,b]	2.6±0.2[b]	39.4±5.9	27.0±2.2	7.4±0.9[a]
P. florida	20.6±2.6[a,b]	3.9±0.2[a,b]	40.3±4.5	26.8±1.9	8.3±0.2[a]
P. cystidiosus	17.7±0.6[b]	5.5±2.0[a]	44.0±1.6	25.5±1.7	7.4±0.5[a]
P. highking 51	21.9±0.6[a,b]	5.2±0.1[a,b]	36.9±2.2	30.3±1.3	5.7±0.6[b]
P. geestaranus	19.0±1.2[a,b]	3.0±0.3[a,b]	45.9±1.7	26.3±0.5	5.7±0.2[b]

The results are the mean ± SEM of 5 trials. Values in the same column that do not share a common superscript are significantly different at P≤0.05 (Duncan's multiple range test).

The highest lipid content was found in *P. cystidiosus* (5.5g/100g dry sample) followed by *P. highking* 51 (5.2g/100g), *P. sajor-caju* (4.0g/100g), *P. florida* (3.9g/100g), *P. geestaranus* (3.0g/100g) and *P. ostreatus* (2.6g/100g). The variation in lipid content between *P. cystidiosus* and *P. ostreatus* is significant at P≤0.05.

The carbohydrate content was found highest in *P. geestaranus* (45.9g/100g dry sample) followed by *P. cystidiosus* (44.0g/100g), *P. florida* (40.3g/100g), *P. ostreatus* (39.4g/100g), *P. sajor-caju* (37.2g/100g) and *P. highking 51* (36.9g/100g). The variation in carbohydrate content between different species of mushrooms is not statistically significant at P≤0.05.

The fiber content was found highest in *P. highking 51* (30.3 g/100g dry sample) followed by *P. ostreatus* (27.0g/100g), *P. florida* (26.8g/100g), *P. geestaranus* (26.3g/100g), *P. sajor-caju* (26.2g/100g) and *P. cystidiosus* (25.5g/100g). The variation in fiber content between different species of mushrooms is not statistically significant at P≤0.05.

The total ash content was found highest in *P. florida* (8.3 g/100g dry sample) followed by *P. sajor-caju* (8.0g/100g), *P. ostreatus* (7.4g/100g), *P. cystidiosus* (7.4g/100g), *P. highking 51* (5.7g/100g) and *P. geestaranus* (5.7g/100g). The total ash content of first four types differs with the last two significantly at P≤0.05.

Using these data the highest metabolizable energy was found in *P. cystidiosus* (262.8 kcal/100g dry sample) followed by *P. sajor-caju* (254.1 kcal/100g), *P. geestaranus* (252.7 kcal/100g), *P. florida* (250.1 kcal/100g), *P. highking 51*(249.7 kcal/100g) and *P. ostreatus* (242.6 kcal/100g) [fig 1]. The difference in metabolizable energy content is not statistically significant at $P \leq 0.05$.

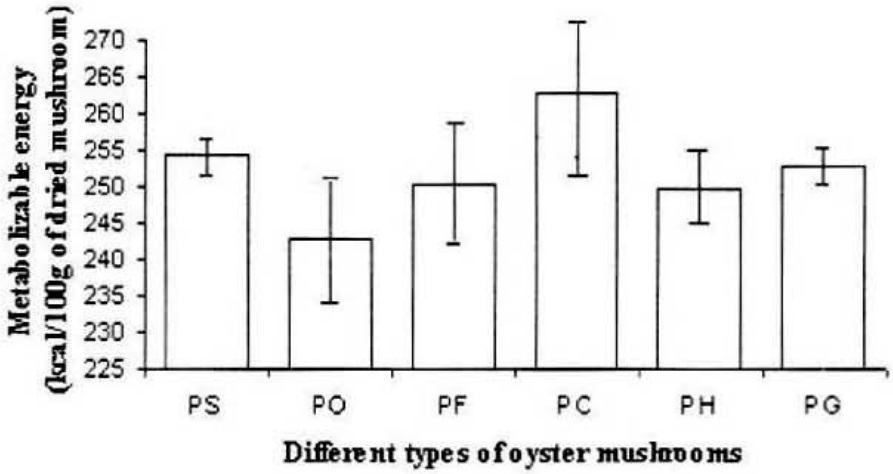

Fig. 1. Metabolizable energy content of different oyster mushrooms (kcal/100g of dried sample). The results are the mean ± SEM of 5 trials

The protein and lipid content of *P. sajor-caju, P. ostreatus, P. florida* found in this study is near about similar to the findings of Rai and Sohi (1988) and Alam *et al.* (2007). But carbohydrate, fiber and ash content are different from the report of Rai and Sohi (1988), however relevant to Alam *et al.* (2007). Protein content in *P. sajor-caju* is also similar to the findings of Banik and Nandi (2004) and protein, carbohydrate, fat and metabolizable energy value of *P. florida* is relevant to the findings of Shashirekha *et al.* (2005).

The present study suggests that oyster mushrooms differ from each other in nutritional composition although they are of same genus, however each species are nutritious with high protein and fiber value with low fat. Hence fruiting bodies of oyster mushrooms can be taken regularly as a protein supplement or as an alternative to fish and meat. Vegetarians could also eat mushrooms because it might serve as alternative protein supplements in their diet. The low lipid and high fiber contents of the oyster mushrooms make it health beneficial food items especially against heart diseases and diabetes.

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Influence of Different Amount of Rice Straw Per Packet and Rate of Inocula on the Growth and Yield of Oyster Mushroom (*Pleurotus ostreatus*)

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Abstract

This experiment was conducted to find out the appropriate amount of rice straw per packet and rate of inocula for better growth and higher yield of oyster mushroom (*Pleurotus ostreatus*). Different amount of rice straw such 0.125kg, 0.25kg, 0.375kg, 0.500kg, 0.625kg, 0.75kg, 0.875kg, 1kg, 1.125kg, 1.25kg per packets (dry basis) were used as treatment. The highest yield (828.3g/packet) was obtained in 1.125kg/packet, which was statistically similar to 1.250kg/packet. The amount of straw had significant positive effect on yield but incase of biological efficiency it was different. The highest biological efficiency (104.3%) was obtained in 0.50kg/packet. Different rate of inocula (sawdust spawn) 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0, 22.5, and 25.0% of substrate (wet basis) were used in this study. The maximum growth was observed at 20.0% followed by 17.5% of inocula. The highest biological yield (564.0 g/packet) and economic yield (553.3 g/packet) were observed at 20.0%, which was statistically similar to 17.50%, 22.5% and 25%. The results revealed that cultivation of oyster mushroom using 20% inocula on rice straw 0.50 kg/ packet was profitable.

Key words: Inocula, paddy straw, *Pleurotus ostreatus,* cost of cultivation.

INTRODUCTION

Oyster mushroom has recently occupied the second position among globally cultivated edible mushrooms because of its easy and low cost production technology, and it successfully cultivated on wide range of substrates such as sawdust, sugarcane bagasse, straw, waste paper, water hyacinth etc (Sarker *et al.,* 2007; Amin *et al.,* 2007) with high yield potential or biological efficiency. Among the substrates, rice straw performed as best substrate (Sarker *et al.,* 2007) and it is comparatively low cost in Bangladesh. The important factor for high yield potential in cultivation of oyster mushroom on rice straw such as amount of substrates, amount of inoculums and opening methods (Zhang, *et al.,* 2002). Amount of substrate is the important factor for determination of Biological Efficiency of mushroom. If the Biological Efficiency is high that will be maximum profitable for the cultivators. In case of button mushroom it was observed that maximum number of effective fruiting bodies as well as yield was obtained with the increase of substrate (Jebunnahar *et al.,* 2007). So it was needed to determination of suitable amount of substrate for oyster mushroom that helps to obtain better yield. At the same time it was important to investigate the suitable rate of inocula. If the grater amount of inoculums were used, the colonization of mycelium in the substrate become faster, as a result the

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growth of competitor is hindered and the yield would be regular (Pathak, 1998; Sing and Singh, 2005). It was also reported that high amount of inocula were created unusual heat as a result compost temperature became uncontrolled and killed spawn. Shanmugam (1986) was reported that the rate of spawn varies from 3-15% by dry weight of the substrate but the optimum is 10 percent, it also been reported that increasing of inoculum level could increase the yield (Sivaprakasam and Kandaswamy, 1982; Sivaprakasam and Ramaraj, 1991). Stamets (2000) has been reported that 20% inoculum was ideal for better growth and yield. Therefore, the objectives of these studies were to determine the appropriate amount of rice straw and rate of inocula for the better growth and higher yield of oyster mushroom (*Pleurotus ostreatus*).

MATERIALS AND METHODS

This research work was conducted in the National Mushroom Development and Extension Centre (NAMDEC), Savar, Dhaka, during the month of October, 2007 to February, 2008. Rice straw was used as basic substrate. Different amount of substrate such as 0.125kg, 0.25kg, 0.375kg, 0.500kg, 0.625kg, 0.75kg, 0.875kg, 1.00kg, 1.125kg, 1.25kg (dry basis) per packet and rate of inocula 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0, 22.5, and 25.0% of substrate were used as treatment.

Preparation of spawn packets: Dried rice straw was chopped into 2-4cm length. On the other hand a drum with water heated by a gas burner when water temperature reaches at boiling point, the chopped straw placed on water. After half an hour the burner was stopped and this straw was kept to cool for 8-10 hrs. After cooling the straw was spread on the cemented floor for removal of excess water. After 3-4 hrs, the excessive moisture was removed from substrate. Then the polypropylene bags of different sizes were filled with substrate according to treatment. During bagging the packets was inoculated at the rate of 20% inocula of substrate. After completion of bagging, all packets were plugged by inserting water-absorbing cotton with the help of plastic ring, rubber band and placed in a dark room maintaining about 25^0c temperature for mycelium growth. Five hundred grams of straw per packets was used in second experiment. The packets were inoculated by above rate of inocula following by layer spawning method.

Experimental condition: After completion of mycelium running, spawn packets were opened by square shaped (1″× 1″) cut on the different places and placed in a culture house. The temperature and relative humidity of culture house was maintained by spraying water.

Data collection and analysis: These studies were laid out following completely randomized design with 4 replications. Data on days to complete mycelium running, days to first primordia initiation, number of effective fruiting bodies, days required for total harvest, biological yield, economic yield and biological efficiency were recorded. Data were analyzed following MSTAT-C computer program. Means were computed following Duncan's Multiple Test (Gomez and Gomez, 1984) using the same computer program.

RESULTS AND DISCUSSION

Days required completing mycelium running: Days to complete mycelium running ranged from 8.00 to 28.25 days. Minimum 8.00 days was recorded in 0.125kg/packet, which was statistically similar to 0.250kg and that was significantly lower as compare to all other treatments. Maximum (28.25 days) was recorded in 1.250 kg/packet, which was statistically similar to 1.125kg/packet (Table 1).

Incase of amount of inocula it was ranged from 11.25 to 23.25 days. Minimum (11.25 days) was recorded in packets when inoculated with 20.0% and maximum (23.25 days) was recorded in 2.5 % (Table 2). The result was similar to the report of Patra and Pani (1995). It was observed that time required to complete mycelium running was 13-16 days on rice straw.

Table1. Effects of amount of paddy straw on the yield attribute and yield of oyster mushroom (*Pleurotus ostreatus*)

Amount of substrate kg. (dry weight)	Days to complete mycelium running	Days to primordial initiation	Days to total harvest	Number of effective fruiting bodies	Biological yield (g/packet)	Economic yield (g/packet)
0.125	8.00 g	3.25 f	23.50 f	14.50 g	92.75 g	89.25g
0.250	9.00 g	4.25 f	34.25 e	35.25 f	164.5 f	159.0f
0.375	11.25 f	5.75 e	39.00 e	41.75 e	286.3 e	276.0e
0.500	15.25 e	5.75 e	53.75 d	60.00 f	521.3 d	509.3d
0.625	19.00 d	7.75 d	64.75 bc	75.25 d	557.3 d	539.3d
0.750	22.25 c	9.00 cd	76.50 a	89.75 c	684.8 c	664.5c
0.875	23.50 bc	10.00 c	72.25 ab	96.75 c	729.8 bc	712.0bc
1.000	24.75 b	11.50 b	71.25 abc	107.0 b	769.3 b	750.3b
1.125	27.50 a	12.75 ab	68.00 abc	128.3 a	869.5 a	828.3a
1.250	28.25 a	13.50 a	63.00 c	94.50 c	851.0 a	821.8a

In a column, means followed by a common letter are not significantly different at 5% level by DMRT.

Days required for primordial initiation : Days required for primordial initiation ranged from 3.25 to 13.50. Minimum days (3.25) were recorded in 0.125 kg/packet, which was significantly lower as compare to all treatments. Maximum days (13.50) were recorded in 1.250 kg (Table 1). Incase of amount of inocula, days were ranged from 6.25 to 9.25 days. The minimum days (6.25) were observed at 17.5% and highest days (9.25) at 2.5% (Table 2). Patra and Pani (1995) have been reported that days required for primordia initiation were 4 to 8 days.

Numbers of effective fruiting bodies: The lowest result (14.50) was recorded in 0.125kg and highest result (128.30) in 1.125kg of rice straw per packets. The number of effective fruiting bodies was increased with the increase of rice straw per packet up to 1.125kg substrate but with the further increasing of substrate the result was decreased. (Table1). Similar trends was reported by Jebunnahar *et al.* (2007) incase of button mushroom. In case of amount of inocula the numbers of effective fruiting bodies were ranged from

13.75 to 65.0. The highest number (65.0) was found at 20.0% and the lowest (13.75) at 2.5% level of inocula (Table2).

Table 2. Effect of rate of inocula on the growth and yield of Oyster mushroom (*Pleurotus ostreatus*) on paddy straw substrate

Rate of inocula (%)	Days to complete mycelium running	Days to primordia initiation	Number of effective fruiting bodies	Days to total harvest	Biological yield (g/ packet)	Economic yield (g/ packet)
2.5	23.25 a	9.25 a	13.75 g	36.50 e	281.5 c	276.8 c
5.0	17.25 b	8.00 bc	30.00 f	48.00 d	444.8 b	436.5 b
7.5	16.75 b	7.75 bc	43.50 e	58.25 bc	453.3 b	443.0 b
10.0	15.25 c	8.75 ab	47.00 de	65.75 a	465.3 b	454.3 b
12.5	14.00 cd	8.25 a-c	54.75 bc	57.75 bc	440.5 b	429.5 b
15.0	13.25 d	7.25 cd	53.50b-c	57.00 c	439.8 b	431.0 b
17.5	11.50 ef	6.25 d	57.50 b	48.50 d	550.8 a	539.0 a
20.0	11.25 f	7.50 c	65.00 a	62.25 ab	564.0 a	553.3 a
22.5	12.75 de	8.25 a-c	50.00c-e	56.25 c	554.3 a	543.3 a
25.0	13.25 d	7.50 c	56.00 bc	62.25 ab	542.3 a	531.0 a
CV (%)	5.90	9.63	9.50	5.69	3.60	3.34

In a column, means followed by a common letter are not significantly different at 5% level by DMRT.

Days required for total harvest: After opening the bag the days required for total harvest was ranged from 23.50 to 76.50 days. Minimum days (23.50) were observed in 0.125kg and maximum days (76.50) were observed in 0.750 kg, which was statistically similar to 0.875 kg, 1 kg and 1.125kg (Table 1). Incase of rate of inocula, it was ranged from 36.50 to 65.75 days. The lowest days (36.50) were observed at 2.5% inocula and the highest days (65.75) were observed at 10.0% inocula, which was statistically similar to 20.0% and 25.0% (Table2). The result is relevant with Stamets (2000) who observed 56 days required for total harvest

Biological yield and Economic yield: Biological yield and economic yield were found in the range of 92.75 to 869.50 g/packet and 89.25g to 828 g/packet respectively. Lowest biological yield (92.75g) and economic yield (89.25g/packets) were harvested in 0.125kg/packet and maximum yield (869.50 g) and (828g) respectively were observed in 1.125 kg/packet, which was statistically similar to 1.25kg/packet. So the result shown increasing trends with the increased of substrates. These results agree with the findings of Amin *et al.* (2007).

The biological yield and economic yield were ranged from 281.50g to 564.00g/packet and 276.8 g/packet to 553.3 g/packet. The highest biological yield (564.0g) and economic yield (553.3 g/packet) was recorded at 20.0% inocula that were statistically similar to 17.5%, 22.5% and 22.5% inocula. The lowest biological yield (281.5g) and economic yield (276.8 g/packet) was recorded at 2.5% rate of inocula. Stamets (2000) has reported that 20% rate of inocula was best.

Biological Efficiency: The highest biological efficiency (104.26%) was observed in 0.500 kg substrate and lowest biological efficiency (65.80%) was found in 0.250 kg substrate (Fig. 1).

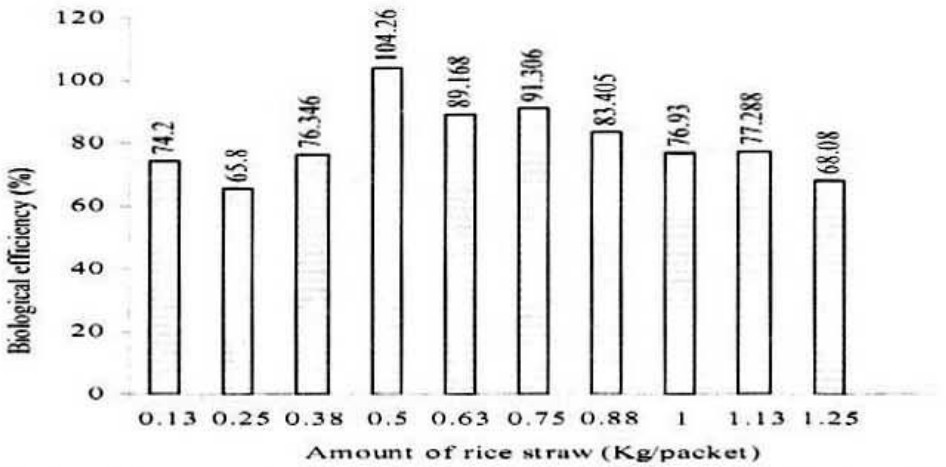

Fig. 1. Biological efficiency (%) of oyster mushroom on spawn packtes containing different amount of rice straw

Benefit cost ratio: It is clear from above result that increasing the amount of straw have significant positive effect on yield. But benefit is also associated with expenditure of substrate and inocula. Oyster mushroom is sold at the local markets at the price of Tk 100 per kg while cost of one kg rice straw is Tk.5. The highest yield (828 gm) was obtained by using 1.125 kg straw (dry basis). The expenditure behind this yield being 13 Tk. where as the price of mushroom is Tk 82.83. On the other hand the highest biological efficiency was observed when 0.500 kg straw (dry basis) was used in a packet. So the expenditure behind this yield being Tk 8 and prices of mushroom is Tk 50.93. From the experiment it can be recommended that 1 kg wet basis substrate (0.500 kg dry basis) and 20% inocula (sawdust spawn) are profitable for farmers.

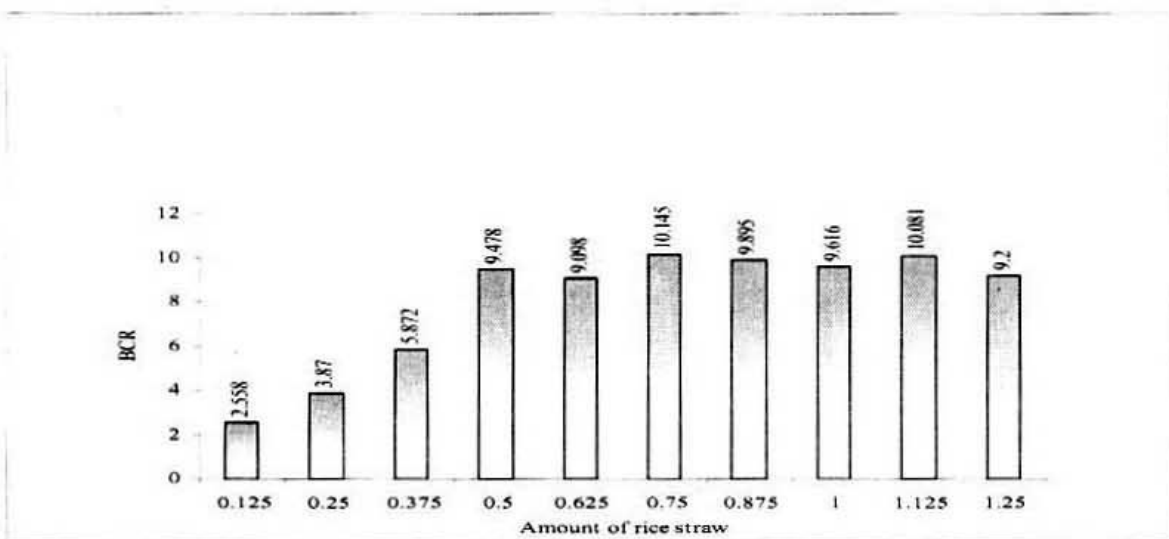

Fig. 2. Benefit Cost Ratio of Oyster mushroom on spawn packet containing different amount of rice straw with 20% inocula

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Effect of *Ganoderma lucidum* (Fr.) Karst on Acute Metabolism

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Abstract

Acute metabolic study of the hot water extract of *Ganoderma lucidum* (GLRM) was performed on normal metabolic process of Swiss-Webster mice. In the 24 hour acute metabolic study, six parameters of normal metabolic process, i.e. water intake, urination, food intake, defecation, water content of stool and weight of dry stool were taken into account. Water intake, though not significantly but was noticeably, increased in the 3rd hour after the administration of GLRM at a dose of 20 ml/kg body weight; significant decreasing effect on the urination was observed at the 2nd hour after the administration of GLRM, may be due to a slight decreased intake of water at the 2nd hour. The hot water extract of *Ganoderma lucidum* showed mild decreasing effect on all the parameters of the acute metabolic processes (under investigation), with an interesting exception (i.e. increase) in defecation, water in defecation and weight of dry stool during the period of 4th to 6th hours after the administration.

Key words: *Ganoderma lucidum*, acute metabolic study.

INTRODUCTION

Medicinal mushrooms have a long history of use in folk medicine. *Ganoderma lucidum* (*G. lucidum*), a basidiomycetes mushroom, is one of the most popular chemopreventive mushrooms in oriental countries. Many bioactive components have been identified from its fruit bodies, mycelia, spores and culture media. Two of the major categories of the bioactive ingredients are polysaccharides and triterpenes. It has been found that polysaccharides from *G. lucidum* exert their *in vitro* and *in vivo* anticancer effect via an immuno modulatory mechanism (Furusawa *et al.*, 1992; Lieu *et al.*, 1992 and Wang *et al.*, 1997). Reishi mushroom (*G. lucidum*) has been used in traditional medicine for at least 2,000 years for deficiency of vital energy. It is used to increase longevity and has been highly prized as an elixir of life. In traditional medicine, Reishi is called Ling Zhi which means "spirit plant." Reishi contains several major constituents, including sterols, coumarin, mannitol, polysaccharides, and triterpenoids called ganoderic acids (Jones, 1990; Willard, 1990). Scientific studies on the beneficial actions of Reishi extract demonstrate potential health benefits including oxygen free radical scavenging, hypolipidemic, antiatherosclerotic, cardiovascular-regulating, hepatoprotective,

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hypoglycaemic and stress-reducing (Jones, 1998). Reishi's overall effects could be described as regulatory and beneficial to the restoration of homeostasis. Reishi improves energy, sleep and conserves and promotes good health. So the present study was designed to study the effect of *G. lucidum* on acute metabolism of Swiss-Webster mice.

MATERIALS AND METHODS

Experimental animal: Female mice (Swiss-Webster strain, 20-25g body weight) bred in the animal house of the Department of Pharmacy, Jahangirnagar University were used for the acute metabolic study. The mice were housed in plastic cages (having dimensions of 30×20×13cm and bedding was soft wood chips) under controlled conditions of 12 hours dark-light cycles. They all received a basal diet of food preparation formulated by the Bangladesh Council of Scientific and Industrial Research (BCSIR) and tap water *ad libitum*. The mice were divided into two groups- Control and *G. lucidum* treated group (GLRM).

Collection of *G. lucidum*: The Reishi mushrooms were collected from the National Mushroom Development and Extension Centre, Savar, Dhaka, Bangladesh. The mushrooms were powdered using a grinder and preserved in air tight polythene packet. This powder was used in the experiment.

Preparation of the water extract of *G. lucidum:* Ten gram powder of *G. lucidum* was mixed in 200 ml distilled water. The mixture was heated to reduce the volume. The condensed mixture was filtered off through a cotton cloth to get approximately 40 ml filtrated solution. Again 200 ml water was added to the residue and the total procedure was repeated to get 80 ml (40ml+40ml) filtrate, which was then heated and ultimately condensed to 40 ml. This liquid extract was administered orally at the dose of 20ml/kg body weight by using gastric gavage needles.

Acute Metabolic Study: Utilizing a 'Nalgene Metabolic Case' the effect of the extract (GLRM) on acute metabolism was performed (Khan *et al.*, 1998). After a period of one day (i.e. 24 hours) of adjustment, they were administrated with graded dosage of the extract. The rate of food and water intake as well as defecation and urination were measured for as period of 3 days (72 hours) maintaining a 3 days of rest before each days (24 hours) of test. The mice of one cage were treated as control (administering distillated water) and the mice of the remaining 2 cages were treated with the same extract maintaining the same dose as duplicate. Within the next 24 hours, food and water intake as well as urination and defecation were measured with an interval of one hour for the first 4 hours, interval of two hours for the next 4 hours; next measurement was after another 4 hours and the final measurement after another 12 hours (i.e. a total of 24 hours). The test was repeated in the next two days with alternating control group (according to the Latin Square Design). Then the percent deviation of the drug treated group was compared with the control group.

Statistical analysis: The results are expressed as mean ± SEM (Standard error of mean). Means were compared by independent sample t-test. The statistical program "SPSS 12.0

for Windows" was used to test the level of significance. Probability (p) value of 0.05 or less ($p<0.05$) was considered as significant. Here * indicates $p<0.05$.

RESULTS AND DISCUSSION

Water Intake: Water intake though not significantly but yet was noticeably increased at the 3rd hour after the administration of GLRM, and there was no other significant or noticeable change in the water intake in the total period of the observation (Table 1). The cumulative study reveals that it has overall slight decreasing effect on the water intake (Table 2).

Table 1. Water intake (Hourwise)

Type	1st	2nd	3rd	4th	5-6th	7-8th	9-12th	13-24th
Control	0.286±	0.646±	0.322±	0.717±	2.662±	1.644±	2.003±	2.785±
	0.133	0.396	0.066	0.422	0.593	0.380	0.883	0.373
GLRM 2x	0.351±	0.301±	0.542±	0.761±	2.270±	1.905±	1.808±	2.618±
	0.117	0.089	0.061	0.233	0.367	0.328	0.506	0.288
	-0.354	0.850	-2.325	-0.101	0.599	-0.504	0.209	0.355
t/p	/0.735	/0.478	/0.059	/0.923	/0.571	/0.632	/0.841	/0.735

Table 2. Water Intake (Cumulative study)

Type	00-02	00-03	00-04	00-06	00-08	00-12	00-24
Control	0.932±	1.25±	1.97±	4.63±	6.28±	8.28±	11.06±
	0.529	0.522	0.94	1.46	1.81	2.69	2.87
GLRM 2x	0.652±	1.19±	1.95±	4.22±	6.13±	7.94±	10.55±
	0.104	0.151	0.23	0.54	0.60	1.00	1.00
	0.520/	0.112/	0.017/	0.316/	0.095/	0.144/	0.205/
t/p	0.652	0.920	0.988	0.762	0.927	0.890	0.844

Urination: Significant decreasing effect on urination was observed at the 2nd hour after administration of GLRM, which may be due to a slight decrease in the intake of water. Slight decrease in urination was observed in between 2-8 hours interval and slight increase in between 9-24 hours interval (Table 3). The cumulative study reveals that GLRM causes overall insignificant decrease in the urination in 0-8 hours interval (Table 4).

Table 3. Urination (Hourwise)

Type	1st	2nd	3rd	4th	5-6th	7-8th	9-12th	13-24th
Control	0.135±	0.312±	0.397±	0.266±	0.671±	0.404±	0.445±	1.667±
	0.135	0.049	0.130	0.078	0.364	0.158	0.050	0.679
GLRM 2x	0.188±	0.135±	0.136±	0.213±	0.674±	0.377±	0.837±	1.853±
	0.081	0.041*	0.062	0.088	0.209	0.129	0.242	0.491
	-0.365	2.689	2.074	0.405	-0.007	0.132	-1.581	-0.227
t/p	/0.727	/0.036	/0.083	/0.699	0.995	/0.899	/0.183	/0.828

*$p<0.05$

Table 4. Urine (Cumulative study)

Type	00-02	00-03	00-04	00-06	00-08	00-12	00-24
Control	0.447±	0.844±	1.11±	1.78±	2.18±	2.63±	4.30±
	0.122	0.197	0.274	0.15	0.26	0.29	0.96
GLRM 2x	0.324±	0.460±	0.673±	1.35±	1.72±	2.56±	4.41±
	0.069	0.090	0.079	0.24	0.0.95	0.32	0.80
	0.965/	2.043/	1.932/	1.303/	1.675/	0.147/	-0.090/
t/p	0.372	0.087	0.102	0.240	0.145	0.888	0.931

Food Intake: Food intake was noted to be slightly decreased in between the time interval of 3rd to 24th hours after the administration of GLRM. But, it was increased slightly in the first 2 hours and 7th to 8th hours (Table 5). The cumulative food intake calculation reveals that GLRM causes an overall decrease in the food intake (Table 6).

Table 5. Food Intake (Hourwise)

Type	1st	2nd	3rd	4th	5-6th	7-8th	9-12th	13-24th
Control	0.832±	0.615±	0.884±	1.187±	3.443±	2.227±	2.578±	4.055±
	0.149	0.336	0.302	0.759	0.990	0.641	0.827	0.385
GLRM 2x	0.853±	0.734±	0.703±	1.113±	2.895±	2.432±	2.388±	3.828±
	0.176	0.367	0.187	0.329	0.648	0.420	0.533	0.249
	-0.081	-0.217	0.543	0.104	0.486	-0.280	0.203	0.520
t/p	/0.938	/0.835	/0.606	/0.921	/0.644	/0.789	/0.846	/0.622

Table 6. Food Intake (Cumulative study)

Type	00-02	00-03	00-04	00-06	00-08	00-12	00-24
Control	1.45±	2.33±	3.52±	6.96±	9.19±	11.77±	15.82±
	0.46	0.745	1.48	2.41	3.02	3.78	4.12
GLRM 2x	1.59±	2.29±	3.40±	6.30±	8.73±	11.12±	14.95±
	0.32	0.207	0.48	0.98	1.27	1.76	1.83
	-0.258/	0.053/	-0.091/	0.302/	0.165/	0.178/	0.226/
t/p	0.805	0.962	0.930	0.773	0.875	0.864	0.829

Defecation: A slight decrease in defecation was observed all throughout the total period of the observation, with an interesting exception (i.e. increase) during the period of 4th to 6th hours after administration of GLRM (Table 7 and 8).

Table 7. Weight of stool (Hourwise)

Type	1st	2nd	3rd	4th	5-6th	7-8th	9-12th	13-24th
Control	0.112±	0.009±	0.026±	0.046±	0.428±	0.892±	1.682±	2.859±
	0.056	0.009	0.026	0.025	0.092	0.338	0.273	0.412
GLRM 2x	0.077±	0.000±	0.000±	0.124±	0.541±	0.381±	1.767±	2.360±
	0.060	0.000	0.000	0.067	0.212	0.141	0.261	0.241
	0.385	1.000	1.000	-0.849	-0.389	0.903	-0.211	1.134
t/p	/0.713	/0.423	/0.423	/0.429	/0.711	/0.401	/0.840	/0.300

Table 8. Weight of stool (Cumulative study)

Type	00-02	00-03	00-04	00-06	00-08	00-12	00-24
Control	0.121±	0.147±	0.194±	0.622±	1.51±	3.20±	6.06±
	0.062	0.083	0.101	0.167	0.47	0.68	0.96
GLRM 2x	0.077±	0.077±	0.201±	0.742±	1.35±	3.12±	5.48±
	0.06	0.061	0.124	0.323	0.44	0.67	0.89
	0.476/	0.697/	-0.042/	-0.269/	0.235/	0.074/	0.416/
t/p	0.651	0.512	0.968	0.797	0.822	0.944	0.692

Water Content in the Stool: Water content in the stool was decreased slightly in the total period of the observation, with an interesting exception (i.e. increase) during the periods of 4th to 6th hours after the administration of GLRM (Table 9 and 10).

Table 9. Water content in the stool (Hourwise)

Type	1st	2nd	3rd	4th	5-6th	7-8th	9-12th	13-24th
Control	0.063±	0.004±	0.009±	0.025±	0.200±	0.381±	0.806±	1.284±
	0.033	0.004	0.009	0.016	0.035	0.166	0.166	0.383
GLRM 2x	0.057±	0.000±	0.000±	0.070±	0.240±	0.257±	0.799±	1.119±
	0.044	0.000	0.000	0.047	0.099	0.066	0.136	0.128
	0.103	1.000	1.000	-0.699	-0.299	0.827	0.030	0.506
t/p	/0.922	/0.423	/0.423	/0.511	/0.775	/0.440	/0.977	/0.631

Table 10. Water content in the stool (Cumulative study)

Type	00-02	00-03	00-04	00-06	00-08	00-12	00-24
Control	0.067±	0.077±	0.102±	0.302±	0.68±	1.49±	2.77±
	0.036	0.044	0.052	0.061	0.22	0.34	0.62
GLRM 2x	0.057±	0.057±	0.127±	0.307±	0.62±	1.42±	2.54±
	0.044	0.044	0.091	0.181	0.24	0.36	0.48
	0.160/	0.296/	-0.195/	-0.265/	0.165/	0.121/	0.296/
t/p	0.878	0.778	0.852	0.800	0.875	0.908	0.777

Eight of the Dry Stool: A slight decrease in the content of the solid mass in the stool was observed in the total period of the observation, with the exception (i.e. increase) during the periods of 4th to 6th hours and 9th to 12th hours after administration of GLRM (Table 11 and 12).

Table 11. Weight of dry stool (Hourwise)

Type	1st	2nd	3rd	4th	5-6th	7-8th	9-12th	13-24th
Control	0.049±	0.005±	0.017±	0.021±	0.228±	0.511±	0.876±	1.574±
	0.024	0.005	0.016	0.010	0.068	0.173	0.114	0.097
GLRM 2x	0.020±	0.000±	0.000±	0.054±	0.300±	0.355±	0.968±	1.241±
	0.016	0.000	0.000	0.024	0.113	0.076	0.126	0.127
	0.968	1.000	1.000	-1.282	-0.456	0.971	-0.488	1.810
t/p	/0.391	/0.423	/0.423	/0.253	/0.664	/0.369	/0.643	/0.120

Table 12. Weight of dry stool (Cumulative study)

Type	00-02	00-03	00-04	00-06	00-08	00-12	00-24
Control	0.054±	0.071±	0.092±	0.319±	0.83±	1.71±	3.28±
	0.027	0.039	0.048	0.108	0.25	0.35	0.45
GLRM 2x	0.020±	0.020±	0.074±	0.375±	0.73±	1.70±	2.94±
	0.016	0.016	0.035	0.144	0.20	0.31	0.42
	1.155/	0.408/	0.293/	-0.267/	0.309/	0.021/	0.530/
t/p	0.292	0.209	0.779	0.799	0.768	0.984	0.615

The highlighting findings are, water intake though not significantly but yet was noticeably increased in the 3rd hour after the administration of GLRM and significant decreasing effect on the urination was observed at the 2nd hour after the administration of GLRM, may be due to a slight decreased intake of water at the 2nd hour. Overall, it can be concluded that the hot water extract of *Ganoderma lucidum* showed mild decreasing effect on all the parameters of the acute metabolic processes with an interesting exception (i.e. increase) in defecation, water in defecation and weight of dry stool during the period of 4th to 6th hours after the administration. Therefore, further studies are required to explore the mechanism of action of the constipating effect at the 2nd and 3rd hours and the active ingradient(s) responsible for these activities.

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Relationship Between Nutrient Content in Substrates and Economic Yield of Oyster Mushroom (*Pleurotus ostreatus* (Jacquin ex Fr.) Kummer)

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Abstract

A quadratic relationship was observed between carbon content in substrate and economic yield and 73.47% of the economic yield was attributed due to the carbon content in substrate. The economic yield increases with the increase of carbon content in substrate up to 49.08% level but further increase in carbon content decreases the economic yield. A significant negative linear relationship was found between nitrogen content in substrate and the economic yield and the highest economic yield was observed in 0.43% nitrogen level and it was decreased with the increase of nitrogen content in substrates. A positive relationship between C: N ratio and economic yield of oyster mushroom was observed and the economic yield increased with the increase in C: N ratio. A significant negative relationship was found between phosphorus, magnesium and sulfur content in substrate and economic yield. The relationship between potassium content in substrate and economic yield was found highly significant and the quadratic response curve was fitted to the observed economic yield against different potassium level in substrate. No significant relationship was observed between calcium, sodium, boron and zinc content in substrate and the economic yield of oyster mushroom.

Key words: Oyster mushroom, economic yield, nutrient content in substrate and relationship.

INTRODUCTION

Oyster mushroom (*Pleurotus ostreatus*), a delicious and nutritious vegetable having medicinal properties, can be grown on various agricultural waste materials. It grows well on mixture of sawdust and rice bran, rice straw and rice bran, sawdust and other combination of tropical wastes, corn cobs, cotton waste, sugarcane bagasse and leaves, corn leaves, grasses, rice hulls and water hyacinth leaves (Pathak *et al.*, 2007). The mushroom grows well in wide range of temperature (15-30^{0}C) which prevails most of the time in our country. But the yield of the mushroom not yet satisfactorily, might be due to lack of some nutrient in substrates used in the country. Nutrient content in substrate is an important factor in the yield and yield attributes of oyster mushroom. An and Awn (1996) reported that carbon level at 17.86 and nitrogen level at 1.54 percent gave the highest yield with the use of Rice straw as the main substrate and 15 percent Rice bran and sugar

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as additive. Jonathan and Fasidi (2001) found that the best carbon/nitrogen ratio was 2:3 (66.67%) and the least utilized ratio was 5:1, might be due the differences in sources of the nutrient. Therefore it is very important to know the contribution of different nutrient element on the growth and yield of the mushroom, which would be possible to supplement to the substrate. Therefore the present study was under taken to determine the relationship between the nutrient content in substrate and the economic yield of oyster mushroom.

MATERIALS AND METHODS

The experiment was conducted during January to April 2003. Ten different substrates namely, sawdust, rice straw, water hyacinth, wheat straw, sugarcane bagasse, 'ulu', 'kansh', waste paper, para grass and napier grass were used in the experiment. Blanket applications of wheat bran at 1/3rd of total dry matter and CaCO3 at 0.57% of total dry matter were mixed thoroughly with each of the substrate materials. The packets were prepared using 500g of substrate per packet and autoclaved, inoculated, incubated and cultured according to Sarker *et al.* (2007). Chemical analysis of the substrate was performed and contents of C, N, P, K, Ca, Mg, S. Na, B, Zn and C:N ratio were determined.

Estimation of nutrient content of substrates: Nitrogen content of mushroom was estimated by "Colorimetric method" described by Linder (1944) digesting the substrate samples in 'Kjeldahl' digestion flask with salicylic sulfuric acid and digestion catalyst. After digestion the absorbance of the solution was measured at 625 nm wavelengths with a Double Beam Spectrophotometer (Model 200-20, HITACHI). Content of different mineral elements in different substrates, such as phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfer (S), Sodium (Na), Boron (B) and Zinc (Zn) were estimated by "Perchloric acid digestion method" as proposed by Yamakawa (1992).

Table 1. Nutrient content in different substrates

Substrate	%C	%N	C:N ratio	%P	%K	% Ca	% Mg	% S	% Na	B (ppm)	Zn (ppm)
S_1	51.53	0.47	110.44	0.19	0.47	0.37	0.16	0.020	0.12	68.63	11.34
S_2	46.27	0.60	76.87	0.20	1.10	0.31	0.22	0.024	0.12	85.67	13.40
S_3	44.85	0.72	62.02	0.23	1.18	1.27	0.35	0.025	0.31	65.96	21.64
S_4	48.67	0.52	93.13	0.19	0.91	0.29	0.17	0.021	0.16	64.29	15.46
S_5	46.42	0.49	93.85	0.19	0.50	0.15	0.14	0.020	0.06	55.27	15.46
S_6	48.87	0.55	89.53	0.20	0.83	0.29	0.20	0.022	0.11	62.62	15.46
S_7	50.51	0.59	85.91	0.20	0.91	0.30	0.21	0.022	0.10	50.60	19.58
S_8	49.08	0.43	113.10	0.18	0.42	0.83	0.16	0.021	0.08	68.30	15.46
S_9	45.60	0.87	52.26	0.36	1.21	0.29	0.30	0.024	0.09	50.60	13.40
S_{10}	43.56	0.84	52.15	0.23	1.21	0.26	0.27	0.024	0.09	53.60	15.46

S_1 = Sawdust
S_2 = Rice straw
S_3 = Water hyacinth
S_4 = Wheat straw
S_5 = Sugarcane bagasse
S_6 = Ulu
S_7 = Kansh
S_8 = Waste paper
S_9 = Para grass
S_{10}= Napier grass

RESULTS AND DISCUSSION

Relationship between the nutrient content in substrates and economic yield: There was a quadratic relationship between carbon content in substrate and economic yield (Fig. 1) as $y = -7.2988x^2 + 719.09x - 17509$ ($R^2 = 0.7347^{**}$). The R^2 value of the relationship was strong and significant at 1% level. The value indicated that 73.47% of the economic yield was attributed due to the carbon content in substrate. From the response curve it is observed that the carbon content in substrate had an increasing effect on economic yield to 49.08% level (Fig. 1 and Table 1). At this level of carbon content in substrate the economic yield was highest (225.43 g/packet). Further increase in the carbon content in substrate had decreasing effect on economic yield. But a significant negative linear relationship was found between nitrogen content in substrate and the economic yield (Fig. 2). The equations $y = -546.29x + 469.23$ gave a good fit to the data and the value of co-efficient of determination ($R^2 = 0.8747^{**}$) was significant at 1% level. The graph also indicated that the highest economic yield (225.43 g/packet) was observed in 0.43% nitrogen level and it decreased with the increase of nitrogen content in substrates. But An and Awn (1996) reported that carbon level at 17.86 and nitrogen level at 1.54 percent gave the highest yield with the use of Rice straw as the main substrate and 15 percent Rice bran and sugar as additive. The cause behind it might be source of C and N and other physical conditions.

A positive relationship between C: N ratio and economic yield of Oyster mushroom was found highly significant ($R^2 = 0.7706^{**}$) at 1% level of significance (Fig. 3). The equation $y = 3.5783x - 159.89$ gave a good fit to the data. It indicated that the economic yield increased with the increase in C: N ratio and it was with the increase of C: N ratio up to 113.10. But Jonathan and Fasidi (2001) found that the best carbon/nitrogen ratio was 2:3 (66.67%) and the least utilized ratio was 5:1, might be due the differences in sources of the nutrient.

A significant negative relationship ($R^2 = 0.5834^{*}$) at 5% level of significance was found between phosphorus content in substrate and economic yield when the data were regressed (Fig. 4). It appears from the graph that the economic yield was decreased with the increase of phosphorus content in substrate.

The relationship between potassium content in substrate and economic yield was found highly significant ($R^2 = 0.8029^{**}$) at 1% level of significance. The quadratic response curve was fitted to the observed economic yield against different potassium level in substrate (Fig. 5). From the response curve it is observed that the potassium content in substrate had an increasing effect on economic yield up to a level of 0.91%. At this potassium level the economic yield was highest. The further increase in the level of potassium had decreasing effect on economic yield. The relationship could be mathematically expressed as $y = -750.3x2 + 1024.6x - 120.2$.

No significant relationship was observed between calcium content in substrate and the economic yield (Fig. 6). A negative linear relationship was observed between magnesium content in substrate and economic yield (Fig. 7). Here the equation $y = -1159.1x +$

390.21 gave a good fit to the data and the value of co-efficient of determination (R^2 = 0.7457**) showed that the fitted regression line had a significant regression co-efficient at 1% level of significance.

No significant relationship was observed between sulfur, sodium, boron and zinc content in substrates and economic yield of oyster mushroom (Fig. 9, 10 and 11).

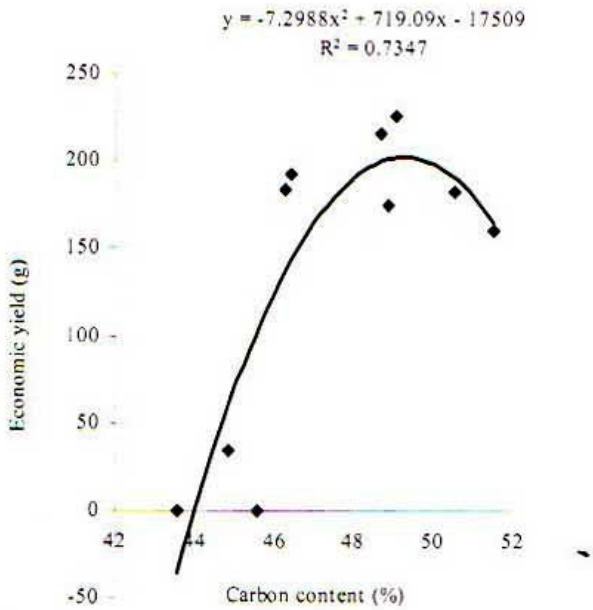

Fig. 1. Functional relationship between carbon content in substrate and economic yield of oyster mushroom

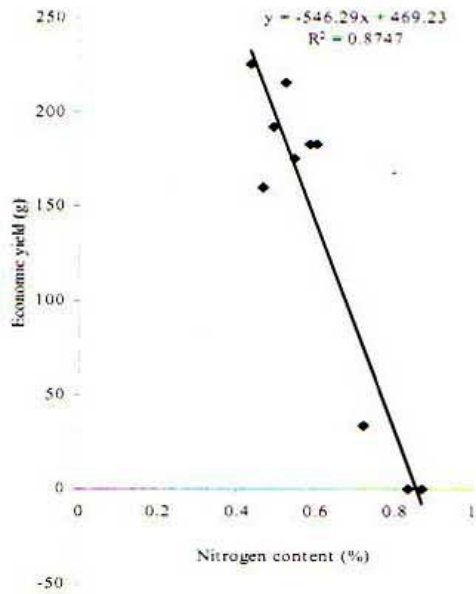

Fig. 2. Functional relationship between nitrogen content in substrate and economic yield of oyster mushroom

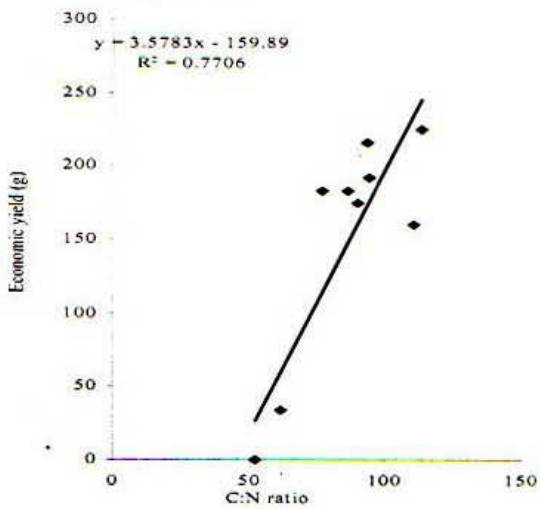

Fig. 3. Functional relationship between C:N ratio in substrate and economic yield of oyster mushroom

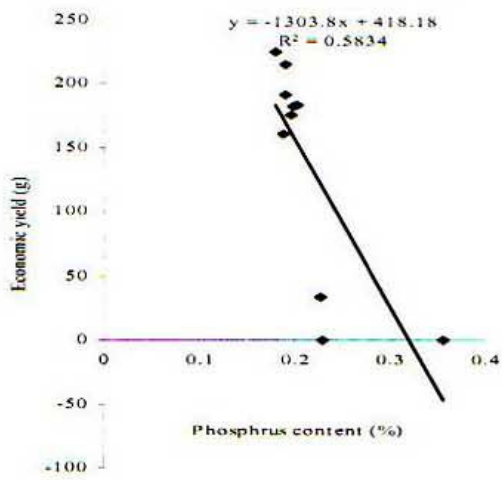

Fig. 4. Functional relationship between Phosphorus content in substrate and economic yield of oyster mushroom

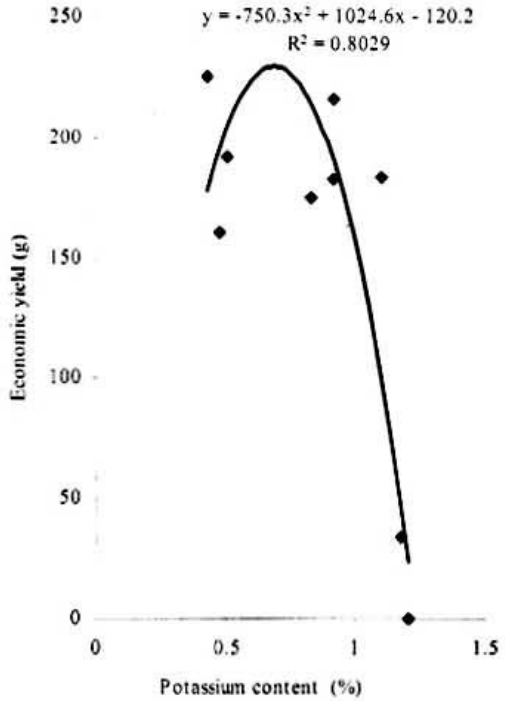

Fig. 5. Functional relationship between potassium content in substrate and economic yield of oyster mushroom

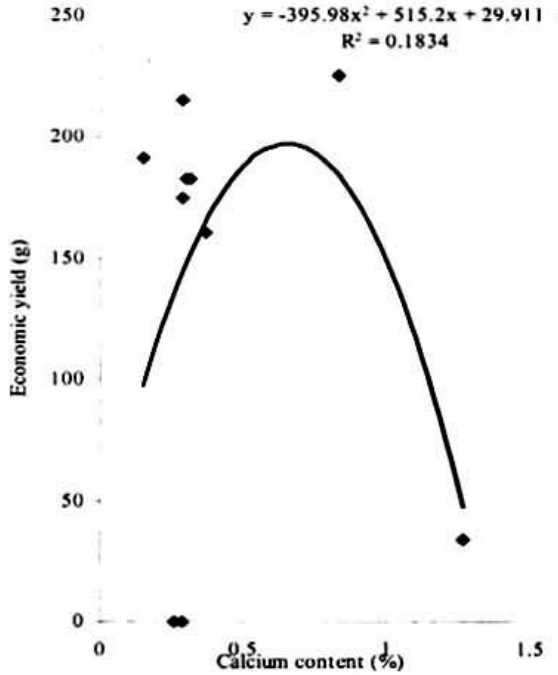

Fig. 6. Functional relationship between calcium content in substrate and economic yield of oyster mushroom

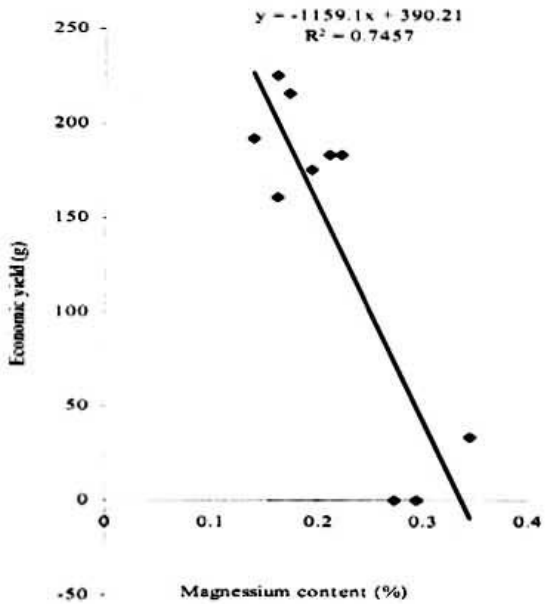

Fig. 7. Functional relationship between magnesium content in substrate and economic yield of oyster mushroom

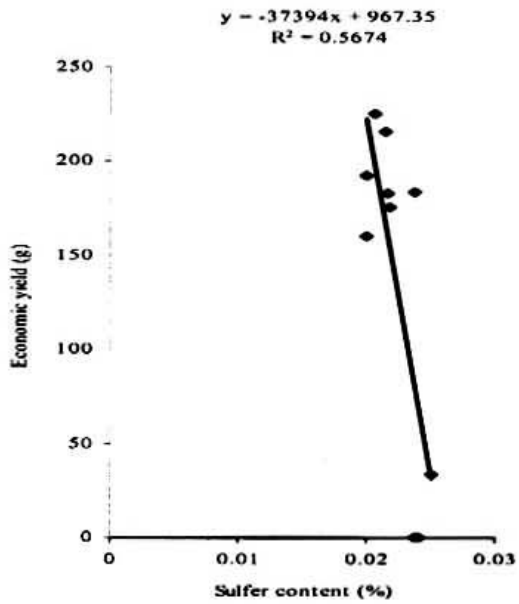

Fig. 8. Functional relationship between sulfer content in substrate and economic yield of oyster mushroom

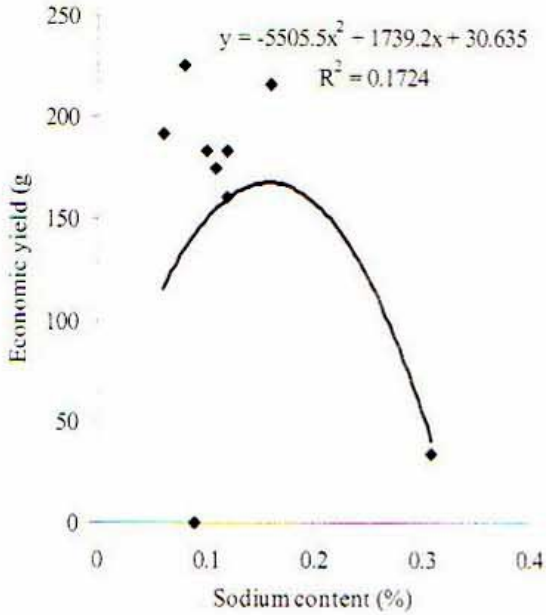

Fig. 9. Functional relationship between sodium content in substrate and and economic yield of oyster mushroom

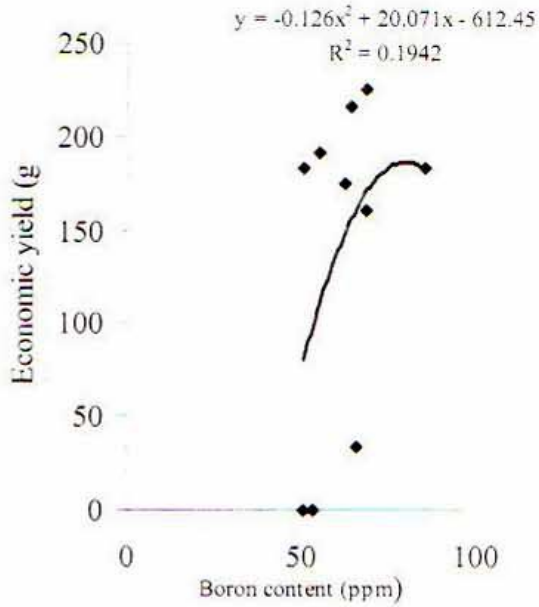

Fig. 10. Functional relationship between Boron content in substrate and economic yield of oyster mushroom

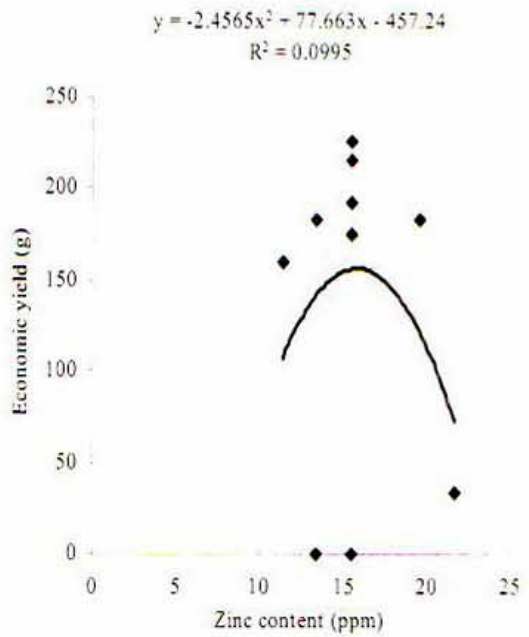

Fig. 11. Functional relationship between Zinc content in substrate and economic yield of oyster mushroom

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Bangladesh J. Mushroom. 2(1): 35-42, 2008 (June)

Mycelial Propagation of *Agrocybe cylindracea* Strains Collected from Different Ecological Environments

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Abstract

Ten strains of *A. cylindracea* were collected from different ecological origins of Korea, China and Taiwan. Identification of species was performed by PCR (polymerase chain reaction) and the propagation of mycelia of these strains was studied. Highest mycelial growth was found at the temperature range of 25-30°C and pH 6. Ten different culture media were used to find out the optimal mycelial growth. Mycelial growth and density of this mushroom were noted most suitable on potato dextrose agar followed by yeast malt extract, glucose peptone, Czapek Dox and Hamada media. Among 10 different carbon sources, sucrose was the best followed by dextrin, mannose and sorbitol for mycelial propagation of *A. cylindracea*. As nitrogen source, arginine was the best followed by glycine and potassium nitrate for vegetative growth on culture media.

Key words: *Agrocybe cylindracea*, factors, vegetative growth, PCR, propagation

INTRODUCTION

Agrocybe cylindracea is one of the most popular edible mushrooms in the world belonging to Bolbitiaceae, Agaricales. In addition to its nutritional value, it has long been used for folk remedies. The fruiting body of *A. cylindracea* is popularly used to combat human diseases. It has anti-tumor, blood sugar decreasing (Kiho *et al.*, 1989 & 1994), immuno-stimulating (Yoshida *et al.*, 1996; Wang *et al.*, 2002) and lipid peroxidation inhibitory activities (Kim *et al.*, 1997 & 1999). In it, antifungal protein named agrocybin has been identified that shows the inhibitory activity of HIV-1 reverse transcriptase (Ngai *et al.*, 2003 & 2005).

The propagation of mycelia is a foremost step to cultivate fruiting bodies of mushroom. Mycelial growth and development depends on a number of factors such as pH, temperature and different nutrients. The purpose of this study was to find out the best cultivation media, pH and temperature range as well as carbon and nitrogen source for mycelial growth of *Agrocybe cylindracea*.

MATERIALS AND METHODS

Collection and identification: The fruiting bodies of 10 strains of *Agrocybe cylindracea* were collected from the different ecological regions of Korea (IUM0562, IUM0736, IUM1663, IUM1664 and IUM1665), China (IUM1403, IUM1437 and IUM1497) and

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Taiwan (IUM1389 and IUM1590). After identification and isolation the strains were cultured on potato dextrose agar (PDA) medium and incubated for 10 days at 25 °C for further study. The confirmation of species identification was done by polymerase chain reaction (PCR) using universal primers ITS1 (5′-TCCGTAGGTGAACCTGCG-3′) and ITS4 (5′-TCCTCCGCTTATTGATATGC-3′). The mycelial pure cultures were deposited in Culture Collection of Wild Mushroom (CCWM) and acquired accession number of Incheon University Mushroom (IUM). The strains used in different experiments were performed with 5 replications.

Temperature: To screen a suitable temperature for the mycelial growth of 10 strains, cultures were incubated for 10 days at 5 different temperatures. A 5 mm diameter agar plug removed from 10 days old cultures grown on PDA was placed in the centre of each plate filled with PDA. The medium was adjusted to pH 6 and incubated for 10 days at 15°C, 20°C, 25°C, 30°C and 35°C separately. Radial growth of mycelia on each Petri dish was measured at 3 directions such as A to B, C to D and E to F (Fig. 1). Average value of mycelial growth of each Petri dish was calculated out of those 3 measurements. Similarly, mycelial growth was measured of remaining 4 Petri dishes (since 5 replications were used for each strain).

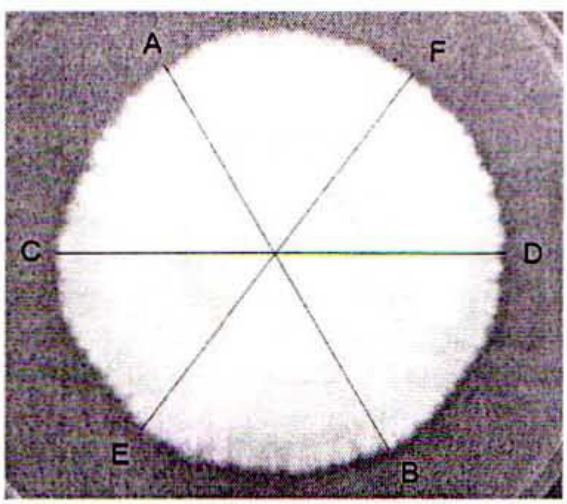

Fig. 1. Method of measuring mycelial growth on Petri plate

The following formula was used to calculate the mycelial growth.
Average mycelial growth on

1^{st} Petri dish $(AB_1+CD_1+EF_1)/3 = R_1$
2^{nd} Petri dish $(AB_2+CD_2+EF_2)/3 = R_2$
Similarly, 3^{rd}, 4^{th} and 5^{th} Petri dish is R_3, R_4 and R_5, respectively.

And average mycelial growth of each strain is $(R_1+ R_2 + R_3 + R_4 + R_5)/5 = F$
Therefore, average mycelial growth of *A. cylindracea* is $(F_1+ F_2+.....+F_n) / n$
[Where n = 10 (Number of strain)]

Carbon and nitrogen sources: To screen carbon and nitrogen sources favorable for the mycelial growth of selected mushroom strains, the tests were performed on the basal medium (Sung *et al.*, 1993) supplemented with each of 10 carbon and 10 nitrogen sources separately. The basal medium was composed of $MgSO_4$ 0.05 g, KH_2PO_4 0.46 g, K_2HPO_4 1.0 g, thiamine-HCl 120 µg, agar 20 g and 1000 *ml* of distilled water. To screen carbon source favorable for the mycelial development, each carbon source with 5 g of peptone was added to the basal medium separately at the concentration of 0.1 M per 1000 ml and mixed thoroughly (Shim *et al.*, 1997). The basal medium which was used for screening a favorable nitrogen sources was made of same additive as those described by Sung *et al.*, (1993). Each nitrogen source with 20 g of glucose was added to the basal medium at the concentration of 0.02 M (Shim *et al.*, 1997). In both cases, the basal medium was adjusted to pH 6 before autoclave for 15 minutes at 121°C and poured into a plate. To measure the colony diameter on the media, all plates were incubated for 10 days at 25 °C. Radial mycelial growth and density were measured following same method.

RESULTS AND DISCUSSION

Effect of temperature: A temperature range of 15-30 °C was considered to find out the most suitable one. The highest mycelial growth (82 mm) was observed at 25 °C and the lowest (15 mm) at 15 °C (Fig. 2). This finding is correlated with that of Lee *et al.* (1999) and Shim *et al.* (2003).

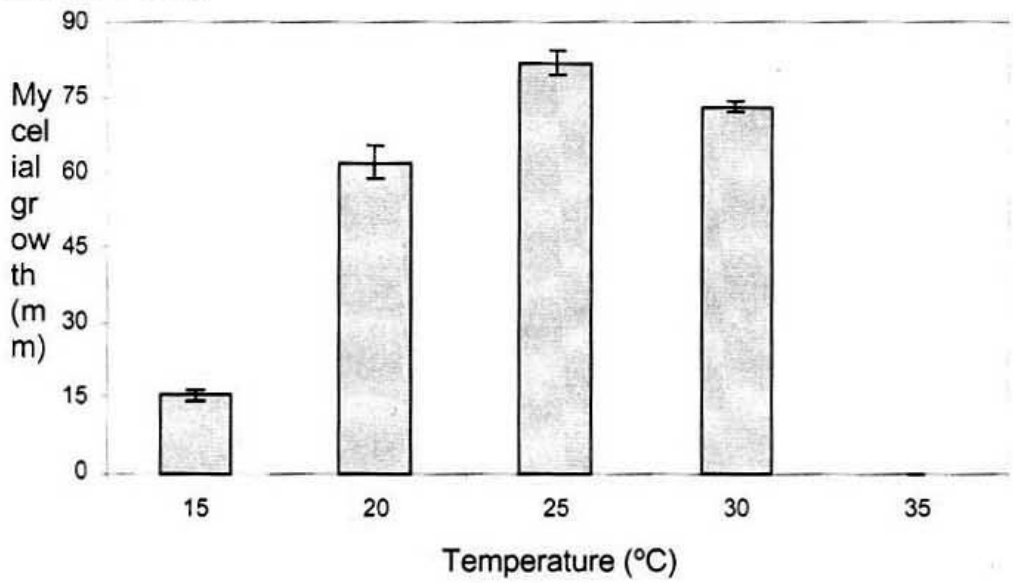

Fig. 2. Effect of temperature on the mycelial growth of *A. cylindracea* on PDA after 10 days of incubation. Vertical bars show standard errors (n=10×5=50)

Effect of pH: To determine suitable pH for the mycelial growth of *A. cylindracea,* a pH range of 5~9 was observed. The highest radial growth of mycelium was found at pH 6 (Fig. 3). There was no significant variation between the range of pH 5~8 on mycelial growth. At pH 9, mycelial growth of *A. cylindracea* was also countable (77 mm).

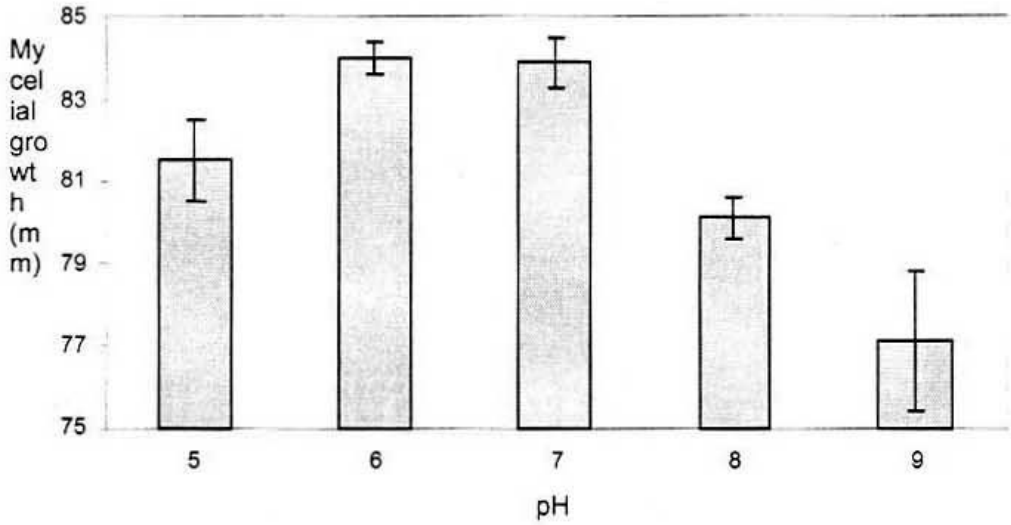

Fig. 3. Effect of pH on the mycelial growth of *A. cylindracea* on PDA after 10 days of incubation at 25 °C. Vertical bars show standard errors (n=10×5=50)

Effect of culture media: Ten different culture media were used to determine the optimal mycelial growth. According to the mycelial growth and density, PDA was found to be the best followed by Yeast Malt, glucose peptone and Hamada but mycelial density was always compact. In Czapek Dox, mycelial growth was well but mycelial density was thin. Hoppkins and Hennerberg were the most unfavorable for radial growth of this fungus (Fig. 4). This result is correlated with that of Shim *et al.* (2005) where PDA, YM and Hamada were found to be the most suitable and Czapek Dox and glucose peptone were unfavorable to mycelial growth.

Effect of carbon sources: Among the ten different carbon sources used to find out the optimal culture condition, sucrose was found to be the best for mycelial propagation of *A. cylindracea* followed by dextrin, mannose and sorbitol. On the other hand, lactose and galactose were the most unfavorable carbon sources. In every carbon source, mycelial density was compact (Fig. 5). This result is completely similar to that of Shim *et al.* (1997, 2005).

Effect of nitrogen sources: Among the ten different nitrogen sources studied in the present experimentation, arginine was found to be the best followed by glycine and potassium nitrate. The most unsuitable sources were alanine, calcium nitrate, histidine and methionine for mycelial growth on the culture media. Compact mycelial density was found on the culture media supplemented with glycine as nitrogen source and the rest were thin (Fig. 6).

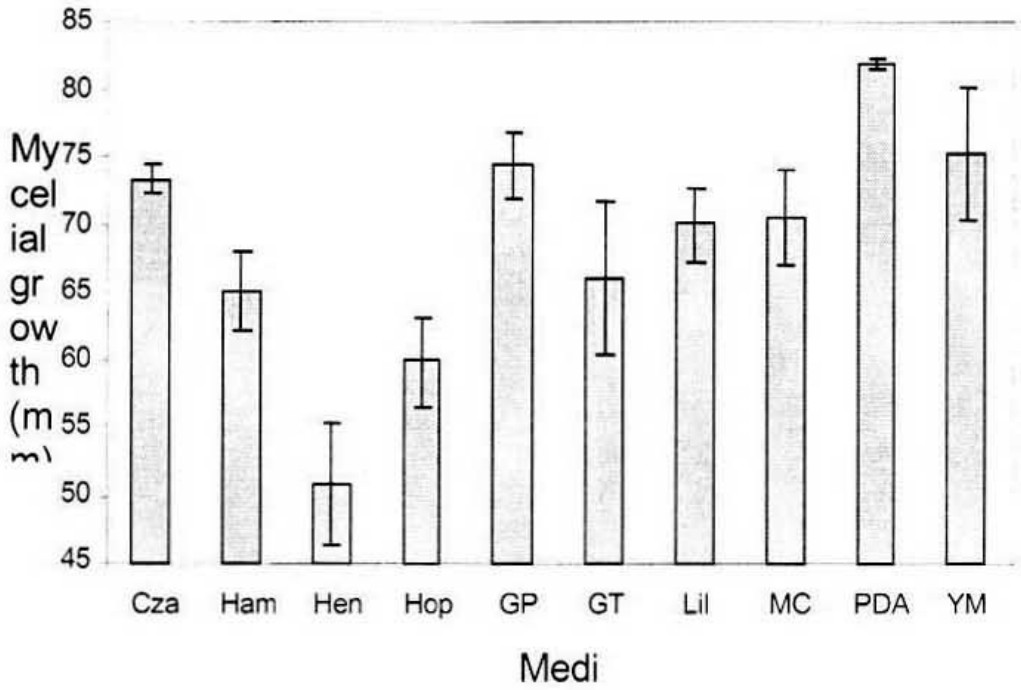

Fig. 4. Effect of different media on the mycelial growth of *A. cylindracea* after 10 days of incubation at 25 °C. Vertical bars show standard errors (n=10×5=50). Cza: Czapek Dox, Ham: Hamada, Hen: Hennerberg, Hop: Hoppkins, GP: Glucose peptone, GT: Glucose tryptone, Lil: Lilly, MC: Mushroom complete, PDA: Potato dextrose agar and YM: Yeast-malt agar.

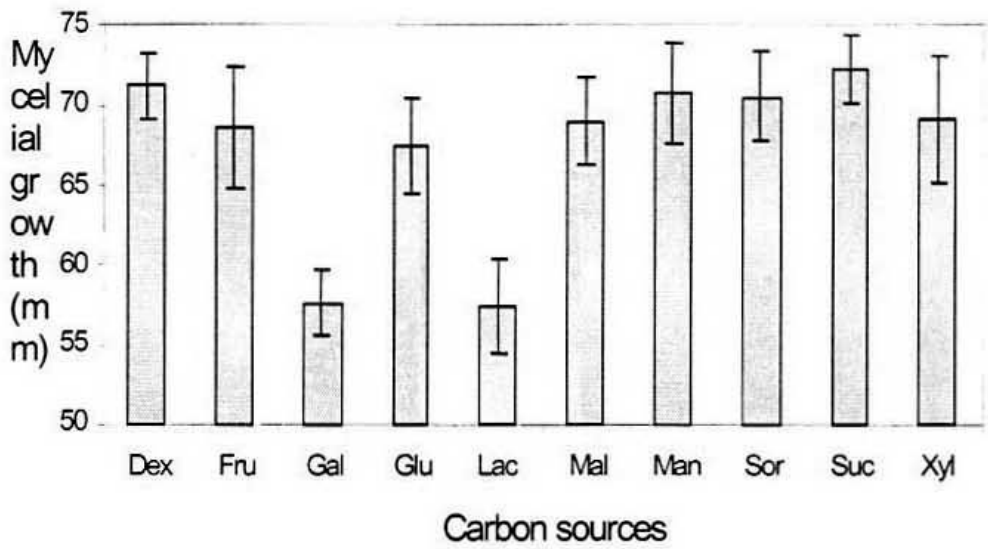

Fig. 5. Effect of carbon sources on the mycelial growth of *A. cylindracea* on basal medium after 10 days of incubation at 25 °C. Vertical bars show standard errors (n=10×5=50). Dex: Dextrin, Fru: Fructose, Gal: Galactose, Glu: Glucose, Lac: Lactose, Mal: Maltose, Man: Mannose, Sor: Sorbitol, Suc: Sucrose and Xyl: Xylose. Each carbon source was added to the basal medium at the concentration of 0.1 M.

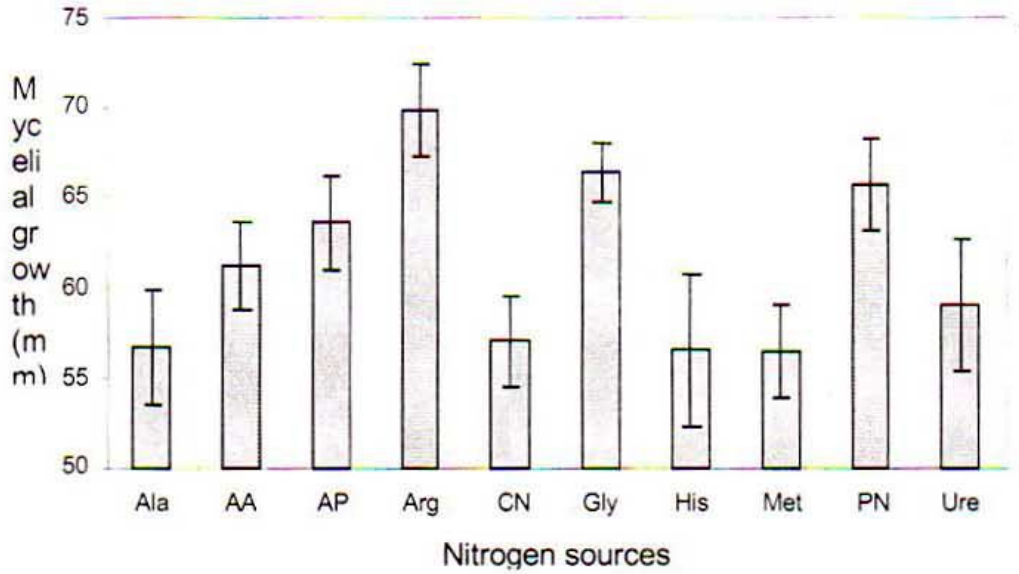

Fig. 6. Effect of nitrogen sources on the mycelial growth of *A. cylindracea* on basal medium after 10 days of incubation at 25°C. Vertical bars show standard errors (n=10×5=50). Ala: Alanine, AA: Ammonium acetate, AP: Ammonium phosphate, Arg: Arginine, CN: Calcium nitrate, Gly: Glycine, His: Histidine, Met: Methionine, PN: Potassium nitrate and Ure: Urea. Each nitrogen source was added to the basal medium at the concentration of 0.02 M.

The present study states that conditions required for best mycelial growth of the *Agrocybe cylindracea* include PDA medium, temperature range 25-30°C , pH 6, sucrose as carbon source and arginine as the nitrogen source.

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Effect of Opening Patterns of Rice Straw Spawn Bag on the Yield of Oyster Mushroom (*Pleurotus ostreatus*)

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Abstract

Different opening patterns of spawn packets were used to find out the appropriate opening pattern for the cultivation of oyster mushroom. The minimum time (5.0 days) for primordia initiation was observed in both side opening at the shoulder of the bag (1cm×1cm) and the maximum time (9.75 days) was recorded in both side opening at the shoulder and middle abdomen of the bag (1cm×1cm).The highest number of effective fruiting bodies (71.75) was observed in both side opening at the shoulder, upper and middle abdomen of the bag (3cm×2cm) and the highest duration (67.75 days) for total harvest was recorded in both side opening at the shoulder of the bag (5cm×2cm). The highest biological yield (690.3g/packet) was recorded in both side opening at the shoulder and middle abdomen of the bag (3cm×2cm) that was statistically similar to both side opening at the shoulder and middle abdomen of the bag (1cm×1cm). The lowest biological yield (372.0g/packet) was recorded in full opened spawn packet.

Key words: Opening pattern, rice straw, spawn bag, *Pleurotus ostreatus*.

INTRODUCTION

Cultivation of edible mushroom is a process to convert agriculture residues such as straw, sawdust, cottonseed hull etc into valuable human food. In Bangladesh rice straw is more suitable substrate for the cultivation of oyster mushroom as it is available and cheap (Amin *et al.*, 2007). In cultivation of oyster mushroom, several steps are involved such as substrate preparation, inoculation, opening and harvesting (Zhang *et al.*, 2002). Among these steps opening of spawn packet is most important for fructification. In mushroom cultivation special attention is needed in transitional stages, when primordia are beginning to form (Amin *et al.*, 2007). The most crucial factor during primordial initiation is high relative humidity (90-95%), oxygen supply, exposure to diffused light (Stamets, 2000), which may be influenced by the opening pattern of the packet. In this respect opening pattern may play an important role in maintaining these factors.

Different opening systems are practiced in different countries depending on their climatic condition. In case of polythene or gunny bags after completion of mycelium running, the packets are cut open and in case of trays, removal of covering system is followed (Chadha and Sharma, 1998). In Bangladesh sawdust spawn packet is opened at shoulder by maintaining 5.0 ×2.5 cm areas (Amin *et. al.*, 2007). But the opening pattern and required opening area for rice straw spawn packet is quite unknown. In Bangladesh, most of the

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farmers are cultivating mushroom on rice straw in polypropylene bags without maintaining standard opening pattern and area. The aim of the experiment was to determine the appropriate opening pattern and size for oyster mushroom cultivation on rice straw.

MATERIALS AND METHODS

This experiment was conducted in the National Mushroom Development and Extension Centre (NAMDEC), Savar, Dhaka during November, 2007 to February, 2008. Paddy straw was used as substrate. Eighteen opening patterns of the spawn bags viz T_1: Pinhole (50), T_2: Both side opening at the shoulder (1cm×1cm), T_3: Both side opening at the shoulder and middle abdomen of the bag (1cm×1cm), T_4: Both side opening at the shoulder, upper and middle abdomen of the bag (1cm×1cm), T_5: Both side opening at the shoulder of the bag (2cm×2cm), T_6: Both side opening at the shoulder and middle abdomen of the bag (2cm×2cm), T_7: Both side opening at the shoulder, upper and middle abdomen of the bag (2cm×2cm), T_8: Both side opening at the shoulder of the bag (3cm×2cm), T_9: Both side opening at the shoulder and middle abdomen of the bag (3cm×2cm), T_{10}: Both side opening at the shoulder, upper and middle abdomen of the bag (3cm×2cm), T_{11}: Both side opening at the shoulder of the bag (4cm×2cm), T_{12}: Both side opening at the shoulder and middle abdomen of the bag (4cm×2cm), T_{13}: Both sides opening at the shoulder, upper and middle abdomen of the bag (4cm×2cm), T_{14}: Both side opening at the shoulder of the bag (5cm×2cm), T_{15}: Both side opening at the shoulder and middle abdomen of the bag (5cm×2cm), T_{16}: Both side opening at the shoulder, upper and middle abdomen of the bag (5cm×2cm), T_{17}: Cut the bag from upper surface of the packet, T_{18} : Full open of the bag were used as treatment.

Preparation of spawn packets: Dried paddy straw was chopped into 2-4cm length and placed in hot water at 100^0C for half an hour and kept it for 8 hours in the water after stopping the gas burner to cool the straw. After cooling, the straw was spread on the cemented floor for removal of excess water. After 3-4 hrs, the excessive moisture was removed from the substrate which was checked by palm test. Then the polypropylene bags of 45 ×30 cm sizes were filled with substrate of 1.0kg. After completion of bagging, all packets were plugged by inserting water-absorbing cotton with the help of plastic ring, rubber band and then placed in a well-ventilated room for mycelium growth.

Experimental condition: After completion of mycelium running the packets were opened according to the treatment and were transfered into culture house. The temperature (25-30°C) and relative humidity (70-80%) of culture house was maintained by spraying water.

Experimental design: The experiment was laid out following by completely randomized design with 4 replications. Data on days to complete mycelium running, days to first primordia initiation, number of first primordia, number of effective fruiting bodies, days required for total harvest and biological and economic yield were recorded. Data were analyzed following MSTAT-C computer program. Means were computed following

Duncan's Multiple Range Test (Gomez and Gomez, 1984) using the same computer program.

RESULTS AND DISCUSSION

The result obtained from the experiment was presented in Table 1.

Days required to primordia initiation: The lowest time (5.0 days) was observed in T_2 [both side opening at the shoulder of the bag (1cm×1cm)] which was significantly lower as compare to all the treatment. Maximum time (9.75 days) was required to primordia initiation in case of T_3 where both sides were opened at the shoulder and middle abdomen of the bag (1cm×1cm) that was significantly higher as compare to all the treatments. No significant variation was observed among the rest sixteen treatments in terms of days required to primordia initiation. The result was agreed with the Patra and Pani (1995) who reported that oyster mushroom took 4-8 days for initiation of fruiting bodies.

Number of primordia iniation: The number of primordia in first flush in different opening method differed significantly (Table 1). The highest number of primordia (32.25) was found in T_7 treatment which was statistically similar to T_3. The lowest number of primordia (9.50) was observed in T_{14} treatment which was statistically similar to T_6 treatment.

Table 1. Effect of opening method on the growth and yield of oyster mushroom (*Pleurotus ostreatus*) on rice straw

Treatment	Days required to primordia initiation (Days)	Number of primordia iniation	Number of Effective fruiting bodies	Days required for total harvest (Days)	Biological yield (g/ packet)	Economic yield (g/ Packet)
T_1	8.00 b	13.00 f	46.00 fg	59.75 e-g	489.00 e-h	479.80e-h
T_2	5.00 c	16.00 e	55.25 c-e	66.50 a-c	477.30 e-h	465.50e-h
T_3	9.75 a	31.00 a	56.00 cd	67.00 ab	651.00 ab	637.50 ab
T_4	7.00 b	23.50 c	51.50 de	61.00 d-f	444.00 gh	434.30 gh
T_5	7.75 b	26.25 b	58.75 c	58.75 fg	543.30 c-f	531.30 c-f
T_6	8.25 b	10.75 g	56.50 cd	56.50 gh	615.30 bc	604.00 bc
T_7	7.00 b	32.25 a	57.50 c	51.00 i	496.80 e-g	486.00e-g
T_8	8.00 b	20.50 d	46.50 fg	52.50 hi	472.50 f-h	463.80e-h
T_9	7.50 b	22.50 cd	60.00 bc	64.25 a-d	690.30 a	676.30 a
T_{10}	7.75 b	16.50 e	71.75 a	63.00 b-f	581.30 b-d	568.00b-d
T_{11}	7.50 b	15.50 e	43.75 g	65.25 a-d	468.00 f-h	457.00 f-h
T_{12}	7.25 b	22.25 cd	57.00 c	54.50 hi	552.00 c-e	539.80 c-e
T_{13}	8.25 b	17.00 e	44.00 g	61.25 d-f	516.30 d-g	506.00d-g
T_{14}	7.50 b	9.50 g	64.00 b	67.75 a	470.80 f-h	460.80e-h
T_{15}	6.75 b	22.00 cd	56.25 cd	62.25 c-f	486.80 e-h	474.30e-h
T_{16}	8.25 b	16.50 e	55.00 c-e	64.00 a-e	605.50 bc	591.30 bc
T_{17}	8.25 b	16.50 e	50.75 ef	65.75 a-c	416.80 hi	405.50 hi
T_{18}	8.00 b	15.75 e	42.75 g	55.75 gh	372.00i	360.80 i
CV (%)	12.37	8.10	5.90	4.50	9.28	9.45

In a column, means followed by a common letter are not significantly different at 5% level by DMRT.

Number of effective fruiting bodies: The number of effective fruiting body in different treatments ranged from 42.75 to 71.75 (Table 1). The highest number of effective fruiting body (71.75) was found in T_{10} where both sides were opened at the shoulder, upper and middle abdomen of the bag (3cm×2cm) and the lowest (42.75) in T_{18} (full open).

Days required for total harvesting: Days required for total harvest after opening the bag ranged from 51.0 to 67.75 days under different treatments (Table 1). The lowest time (51.0 days) was required to complete total harvest of mushroom in T_7. Significantly the highest duration (67.75 days) for total harvest was recorded in T_{14} which was followed by T_3, T_2, T_{17} and T_{11}.

Biological and economic yield: Significant variation was observed on biological and economic yield of oyster mushroom (*Pleurotus ostreatus*) grown on rice straw on different patterns of opening method. The biological and economic yield of *Pleurotus ostreatus* ranged 372.0-690.3g/packet and 360.8-676.3g/packet respectively. The highest biological yield (690.3g) was recorded in T_9 that was statistically similar to T_3. The lowest biological yield (372.0g) was recorded in T_{18}. Similar trend was observed in case of economical yield.

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Performance of Different Substrate on the Growth and Yield of *Volvariella volvacea* (Bull. ex. Fr.) Sing

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Abstract

Different locally available agro-wastes such as rice straw (RS), sugarcane bagasse (SB), cotton waste (CW) and their combinations like rice straw & cotton waste (RS+CW), rice straw & sugarcane bagasse (RS+SB) and cotton waste & sugarcane bagasse (CW+SB) were used to identify the best substrate for *Volvariella volvacea*. The highest biological efficiency (20.34%) was observed on rice straw, while 8.62%, 8.44%, 5.07%, 2.77% and 1.37% were obtained for RS+CW, CW, RS+SB, CW+SB and SB respectively. The highest economic yield (691.0 g/bed) and the minimum days required to primordia initiation as well as first harvest were found in rice straw.

Key words: *Volvariella volvaceae*, agro-wastes, growth and yield.

INTRODUCTION

The genus *Volvariella* is cosmopolitan in distribution. *Volvariella volvacea* is a popular mushroom of this genus. It is commonly known as straw mushroom, paddy straw mushroom or the Chinese mushroom. It is referred to as a "Warm mushroom" because it can grow at relatively high temperatures (28^0 to 34^0C) (Qumio *et.al.*, 1990). In Bangladesh it is most suitable for summer season and especially in the northern part of the country where summer is extremely hot.

The *Volvariella volvacea* has been intensively studied in the world because it is of high gastronomic value, able to colonize and degrade a large variety of lignocellulosic residues, required shorter growth time when compared to other mushrooms and can be cultivated in a cheap and simple way. But biological efficiency is lower than other commonly cultivated mushrooms.

It was a commercial as well as constituted much on the agricultural economics of Thailand, Cambodia, Vietnam, Taiwan and China (Stamets, 2000) and it is also highly nutritious mushroom. Rai and Sohi (1988) reported the proximate composition (% of fresh weight) of this mushroom; 90.1% moisture, 2.1% protein, 1% fat, 4.7% carbohydrate, 1% fiber and 1.0% ash.

It can be cultivated on various lignocellulosic materials, which have been investigated, in several scientific works; such as sugarcane bagasse (Hu *et al.*, 1973), cotton wastes and

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rice straw (Chang and Miles, 1987) dried banana leaves (Wade, 1970), water hyacinth (Cheng and Mok, 1971). Most of them are available and unused as agro wastes e.g. about fourty five million tons of wheat and rice straw is produced every year in Bangladesh (BBS & DAE, 2007).

The large differences observed in the yield of straw mushroom on different lignocellulosics are due to the varying proportions of different components like cellulose, hemicellulose, lignin, heterogeneity of lignocellulosics used and the degree of crystallinity that cause large differences in the ability of *Volvariella* to degrade them (Chadha and Sharma, 1995). The biological efficiency of this mushroom is very poor, may be due to lack of suitable substrate selected for the cultivation of this mushroom or lack of information for the production of this mushroom under Bangladesh conditions. Based on that, the objective of this work was to evaluate the suitability of locally available different agro-waste for the production of *Volvariella volvacea*.

MATERIALS AND METHODS

The experiment was conducted in the National Mushroom Development and Extension Centre, Sobhanbag, Savar, Dhaka during the months of March - May 2008.

Substrates preparation: The agro-wastes such as rice straw *(Oryza sativa)*, sugarcane bagasse (*Saccharum officinarum*), cotton waste (*Gossypium spp*) and their combination (1:1): rice straw & cotton waste (RS+CW), rice straw & sugarcane bagasse (RS+SB) and cotton waste & sugarcane bagasse (CW+SB) were used as substrates. The substrates were mixed with 5% $CaCO_3$ and water and then pasteurized for 2 to 5 days.

Bed preparation: Polythene sheet was placed in incubation room and then both end open box (frame type) was placed on the sheet. The size of the box was 100cm (L) X 30cm (W) X 30cm (H). It was filled with 3-layer pasteurized substrates (each layer with 10 cm thick). Then mother culture was inoculated to each layer. The mother culture was taken out of the packet followed by placing on a tray and subsequent pressure to form into small pieces. The pieces were immersed within the holes made on the layers at regular intervals of 12 to 15 cm and finally the top layer was covered with a 4cm deep of substrates. The whole bed was covered with a polythene sheet so that temperature and humidity did not get lost. After 6 days, the sheet was removed to allow sufficient amount of light, aeration, temperature and humidity so that fructification could be ensured. Temperature and relative humidity during the experiment were 27-35^{0}C and 85-95% respectively. Mushroom was harvested at egg stage (pileus is pushed out of the veil)

Data collection: Data on days required to primordia initiation, days to first harvest, days required for total harvest, number of effective fruiting bodies, economic yield and biological efficiency were taken. Biological efficiency was determined by the formulae:

$$BE\ (\%) = Biological\ yield\ (g) \times 100 / Total\ substrate\ used\ (g)$$

Data were analyzed by using MSTAT-C program.

RESULTS AND DISCUSSION

Days required to primordia initiation: Days required to primordia initiation were observed between 8.75 to 16.25 days. The lowest time (8.75 days) was observed in rice straw, which was statistically lower as compared to all other treatments followed by cotton waste (10.50 days). The highest time (16.25 days) was observed in CW + SB substrate (Table 1). The results are relevant to the findings of Salmones *et al.* (1988) who found that the primordia appeared in 11 to 16 days.

Table 1. Effect of different substrates on fruiting body formation and Yield of straw mushroom

Treatment	Days required for primordia initiation (days)	Days required for first harvest (days)	Days required for total harvest (days)	Number of effective fruiting bodies/ bed	Economical yield (g/bed)
Rice straw	8.75c	9.750e	42.50a	62.25b	691.8a
Sugarcane bagasse	11.75b	13.50cd	33.50c	14.50e	137.0d
Cotton waste	10.50bc	11.75de	35.75bc	69.00a	602.5b
Rice straw + Cotton waste	14.25a	15.75bc	32.00c	75.00a	615.5b
Rice straw + Sugarcane bagasse	15.75a	18.00ab	40.25ab	45.25c	362.3c
Cotton waste + Sugarcane bagasse	16.25a	19.25a	32.00c	37.25d	345.8c
CV%	11.97	10.66	10.66	10.47	2.80

In a column, means followed by a common letter are not significantly different at 5% level by DMRT.

Days to first harvest: The days to first harvest varied from 9.75 to 19.25 days. The maximum time (19.25 days) was required in CW + SB. The minimum time (9.75 days) was required in rice straw (Table 1). The result is relevant with Chang and Miles (1987) who found that the days to first harvest 8 to 17 days.

Days required for total harvesting: Days required for total harvest ranged from 32.00 to 42.50 days. The highest duration (42.50 days) was recorded in rice straw. The lowest duration (32.00 days) was recorded in RS + CW and CW + SB (Table 1). The result is relevant with Chang and Miles (1987) who found that days required for total harvest 38 to 50 days.

Number of effective fruiting bodies/bed: The highest number of effective fruiting bodies (75.0) was obtained in RS + CW which was statistically similar to Cotton waste but the quality of this mushroom was not as good as that on rice straw. The lowest number of fruiting bodies (14.50) was observed in Sugarcane bagasse (Table 1).

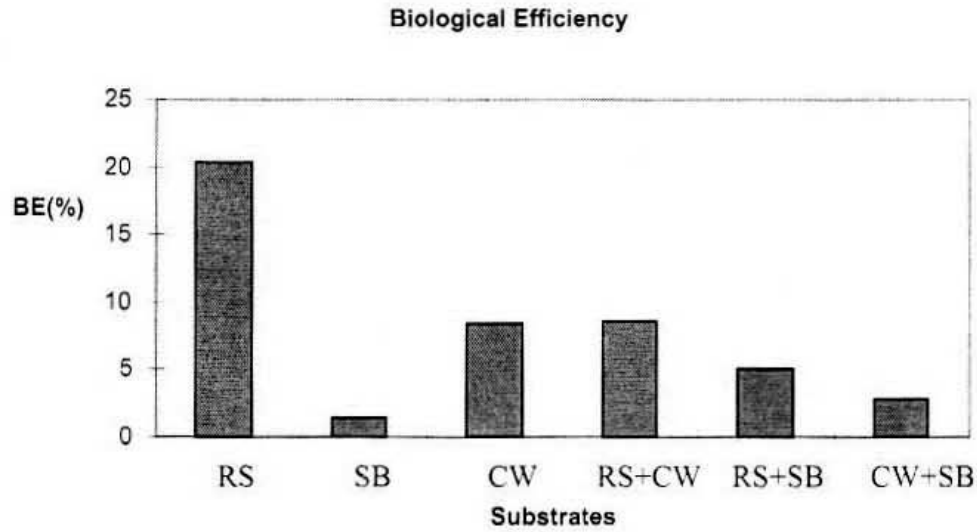

Fig. 1. Biological efficiency of *Volvarila volvacea* on different substrates
(RS=Rice straw, SB= Sugarcane bagasse, CW= Cotton waste)

Biological efficiency and economic yield: The highest biological efficiency (20.34%) was recorded in rice straw that was significantly higher as compared to all other treatments. The lowest biological efficiency (1.37%) was recorded on Sugarcane bagasse (Fig.1). Almost similar trend was observed in case of economic yield. The highest economic yield (691.8g/bed) was recorded in rice straw and lowest economic yield (137.0g/bed) was recorded in Sugarcane bagasse (Table 1). The addition of organic nitrogen to the cotton waste compost increases the N level of the compost and improves texture and quality of mushroom. Incase of paddy straw, it was determinated that with the addition of organic nitrogen there was no improvement in yield (Garch *et al.*, 1989), which are in agreement with the present results.

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Effect of Media on Mycelial Growth of Edible Mushrooms

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Abstract

Five media such as Potato Dextrose Agar, Yeast Extract Agar, Malt Extract Agar, Wheat Extract Agar and Cane Juice Agar were used in this study to find out the suitable media for the mycelial growth of six edible mushroom species such as *Pleurotus ostreatus*, *Pleurotus highking-51*, *Pleurotus geesteranus*, *Pleurotus eryngii*, *Lentinus edodes* and *Hypsizygus tessulatus*. Maximum mycelial growth of *P. ostreatus* (0.475 cm/day), *P. highking 51* (0.47 cm/day), *P. eryngii* (0.51 cm/day), *Hypsizygus tessulatus* (0.60 cm/day) was recorded on Malt Extract Agar and incase of *P. geesteranus* (0.83 cm/day) and *Lentinus edodes* (0.55 cm/day) maximum growth was observed on Wheat Extract Agar and Potato Dextrose Agar respectively. Minimum days required for completion of mycelium in petriplates were observed in *P. ostreatus* (7.75days), *P. highking* 51 (8.25 days), *P. eryngii* (10.5days), *Hypsizygus tessulatus* (9.25 days) on Malt Extract Agar and *P. geesteranus* (7days), *Lentinus edodes* (11days) on Wheat Extract Agar and Potato Dextrose Agar respectively.

Key words: Media, mushroom, mycelial growth.

INTRODUCTION

The vegetative part of mushroom is called mycelium. So it is an important part for mushroom production as well as production for several secondary metabolites that's use of therapeutic purpose. The mycelium growth depends on several factors such as growing media, pH, temperature, nutrient element and some environmental factors (Calam, 1971 and Prit, 1975). Media is the most important factor because it supply necessary nutrient for the growth of mushroom mycelium. Different agar medium such as potato dextrose agar, yeast extract agar, malt extract agar, lamberts agar and compost extract agar are mostly used for the growth of mycelium (Pathak *et al.*, 1998). Mycelium growth is the best tool to identify necessary nutrients for the production of fruiting bodies because mycelium growth requires short time compare to fruiting bodies development (Kalmis and Kalyoncu, 2006).

Mycelial biomass powder can be used to formulate various types of health tablets and capsules (Chen and Xiu, 2001). When mushroom mycelium was grown in different wastes it may not be chemically pure but in culture media, it may be pure. Culture media permits acceleration of mycelial growth, ensures quality and year round production (Chang, 2001). So, the aim of this study was to determine the suitable media for the production of quality mycelium within short time.

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MATERIALS AND METHODS

This experiment was conducted in the tissue culture laboratory of National Mushroom Development and Extension Centre (NAMDEC) during January to April 2008. Different mushroom species such as *Pleurotus ostreatus, Pleurotus highking-51, Pleurotus geesteranus , Pleurotus eryngii, Lentinus edodes* and *Hypsizygus tessulatus* and different synthetic media such as Potato Dextrose Agar (PDA), Yeast Extract Agar (YEA), Malt Extract Agar (MEA), Wheat Extract Agar (WEA) and Cane juice Agar (CJA) were used in this study. The inocula were collected from the germplasm centre of NAMDEC.

Preparation of synthetic media: The basal component of each media mixed with 20g of dextrose and 18g of agar at pH 6.5. The mixture was boiled on gas burner until the agar dissolved. The media was poured into petri dishes at 20 ml/plates and sterilized in an autoclave for 20 minutes at 120°C under 1 kg/cm^2 pressure. After sterilization and solidification, the plates were inoculated with the inocula of above mushroom species. Then plates were transferred in incubation room for mycelium running at 20-25° C temperature.

Statistical Analysis: The experiment was laid out in Completely Randomized Designs (CRD) with 4 replications. Data on mycelium growth rate, days to complete mycelium running and thickness of mycelium were collected and analyzed following standard methods (Gomez and Gomez, 1984) using MSTAT-c computer Programme. Means were computed following DMRT using the same computer program.

RESULTS AND DISCUSSION

Mycelial growth rate (cm/day): The result of mycelial growth rate in different culture media is shown in Table 1. Highest mycelial growth rate of *Pleurotus ostreatus* (0.475 cm/day) was observed in MEA, which was statistically similar to WEA, and lowest mycelial growth rate (0.38 cm/day) was observed in YEA media. Incase of *Pleurotus highking-51,* highest mycelial growth rate (0.47 cm/day) was observed in MEA and lowest mycelial growth rate (0.27 cm/day) was recorded in CJA media. Highest mycelial growth rate of *Pleurotus geesteranus* (0.83 cm/day) was obtained in WEA, which was statistically similar to MEA and lowest mycelial growth rate (0.47 cm/day) in CJA media. In *Pleurotus eryngii,* highest mycelial growth rate (0.51 cm/day) was recorded in MEA and lowest result (0.21 cm/day) was found in YEA media. Alavi *et al.* (2005) reported that malt extract was more effective on mycelial and reproductive growth of mushroom. Highest growth rate (0.55 cm/day) of *Lentinus edodes* was obtained in PDA and lowest mycelial growth rate (0.09 cm/day) in CJA media and incase of *Hypsizygus tessulatus* highest mycelial growth rate (0.60 cm/day) was observed in MEA and lowest mycelial growth rate (0.16 cm/day) in CJA media. Huang (1993), Jeffers & Martin (1996) and Kadiri (1990) reported that both malt extract agar and potato dextrose agar have been widely supported to better growth of mushroom mycelia.

Table 1. Mycelial growth (cm/day) of different mushroom species on different media

Variety	Media				
	Potato Dextrose Agar	Yeast Extract Agar	Malt Extract Agar	Cane juice Agar	Wheat Extract Agar
Pleurotus ostreatus	0.43efgh	0.38i	0.475de	0.41ghi	0.47def
Pleurotus highking-51	0.30jkl	0.34j	0.47de	0.27 l	0.40hi
Pleurotus geesteranus	0.56bc	0.50d	0.80a	0.47def	0.83a
Pleurotus eryngii	0.31jkl	0.21m	0.51d	0.42fghi	0.31jkl
Lentinus edodes	0.55c	0.46defg	0.29jkl	0.09o	0.46defg
Hypsizygus tessulatus	0.28kl	0.56bc	0.60b	0.16n	0.33jk
CV (%)			7.41		

Means followed by a common letter are not significantly different at 5% level by DMRT.

Days required to completion of mycelium running: The days required to the completion of mycelium running in different media is shown in Table 2. The lowest time (7.75 days) required for the completion of mycelium running of *Pleurotus ostreatus* was observed in MEA which was statistically similar to PDA and WEA and the highest time (11.0 days) was observed in YEA media. Incase of *Pleurotus highking-51*, lowest time (8.25 days) was observed in MEA and highest (21.75 days) was observed in CJA media. The minimum time (7.0 days) for completion of mycelium running of *Pleurotus geesteranus* was required in WEA and maximum (11.75 days) was observed in CJA media. In *Pleurotus eryngii,* lowest (10.5 days) was observed for completion of mycelium running in MEA and highest (17.25 days) in CJA media. Minimum result (11.0 days) for the completion of mycelium running of *Lentinus edodes* was observed in PDA and highest (17.25 days) was observed in CJA media and in *Hypsizygus tessulatus*, lowest (9.25 days) was required in MEA and highest (25.0 days) in CJA media.

Table 2. Time (days) required for completion of mycelium of different mushroom species on different media

Name of species	Media				
	Potato Dextrose Agar	Yeast Extract Agar	Malt Extract Agar	Cane juice Agar	Wheat Extract Agar
Pleurotus ostreatus	8.0m	11.0ij	7.75m	10.0k	8.0m
Pleurotus highking-51	9.0 l	9.0 l	8.25m	21.75b	10.0k
Pleurotus geesteranus	9.25 l	11.5hi	8.0m	11.75h	7.0n
Pleurotus eryngii	13.0g	14.75ef	10.5jk	17.25c	15.5d
lentinus edodes	11.0ij	14.5f	13.25g	17.25c	15.25de
Hypsizygus tessulatus	11.25hi	10.0k	9.25l	25.0a	10.25k
CV (%)			3.39		

Means followed by a common letter are not significantly different at 5% level by DMRT.

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Impact of Mushroom Cultivation on Education of Different Community Farmers of Savar, Dhaka Area

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Abstract

Mushroom is a nutritious and delicious non-green crop popularizing in Bangladesh. Considering the importance of this crop a study was conducted to examine the effect of mushroom cultivation on different types of non-formal education of slum dweller, snake charmer and marginal community farmers. The reading and writing ability of the slum dweller, snake charmer and marginal farmers were increased from 50.00, 16.67 and 86.67% to 60.00, 23.33 and 90.00% respectively. Only 20% children of snake charmer would go to school before mushroom cultivation, which was increased to 56.67% within 6 month of mushroom cultivation. The ability of women's decision about education of sons and daughter was only 20.00, 13.33 and 16.67% in slum dweller, snake charmer and marginal farmers, which were increased to 43.33, 56.67 and 43.33% respectively. Education concerning nutrition was near about nil in slum dwellers (13.33%) and snake charmer (10%). After training and cultivation of mushroom the education level of all the groups raised to 70-90%. Education concerning health and sanitation of all the groups was raised up to 66-87% though the level of snake charmer was very poor (16.67%). The education concerning crop production technology was totally absent in snake charmer and it was 56.67 and 36.67% in slum dweller and marginal farmer respectively which was increased to 60, 80 and 93.33% respectively. The decision-making ability of women was very poor in all the community, which were increased to 63.33, 76.67 and 40.00% in slum dweller, snake charmer and marginal farmer respectively. Education concerning marketing was very poor in marginal farmers (26.67%) and slum dweller (33.33%) which was increased to 53.33% and 66.67% respectively. Also the education concerning savings was changed in all community farmers positively.

Key words: Education, mushroom, slum dweller, snake charmer and marginal farmer.

INTRODUCTION

Mushrooms are good source of protein, vitamins and minerals (Chadha and Sharma, 1995) and can be grown independent of sunlight and without fertile land. Mushroom cultivation is a women-friendly operation and offer vast employment potential (Pathak, *et al.* 2007). Education is the process of desirable change in human behavior in knowledge, attitudes, and skills, either in all or one or more than them (Redds, 1976). Mushroom cultivation can play an important role in desired changes in the behaviors of the growers, as it is a multi dimensional work. Mushroom growers have to communicate with mushroom experts, equipment traders and spawn producer for mushroom production. The growers also have to communicate with consumers. The consumers of mushroom are the

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people of different section of society. They may be political leader, administrator, teacher, lawyer, physician and patient. They also have to communicate with the food traders and wholesale marketer. During this communication and activities, there may be a change in behavior, views and attitude, which may influence a positive change in education. In Savar, Dhaka area there lives a number of people communities. Some are well to do; some are small and marginal farmer. There is a group of people who are poor and slum dweller. A section of people live in Savar who are snake charmer. Mushroom may be cultivated by all type of people, as it does not require any fertile land and high investment. Therefore, the aim of the present investigation was to study the impact of mushroom cultivation on education of different community farmers like slum dweller, snake charmer and marginal farmer of Savar, Dhaka Area.

MATERIALS AND METHODS

Three farmer groups each of 30 women were selected from three areas and community. The groups were (1) Slum dweller of Auk para, (2) Snake charmer of Amar pur and (3) Marginal farmer of Joypara-Jamshing. The signature ability of the farmer was determined by asking the question whether they are able to sign or not. The reading and writing ability was estimated by giving a book to the farmer to read it and seeing their hand writing. The children education level was estimated by observing whether they send their children to school or not. The ability of women's decision about education of son and daughter was estimated by questioning whether they were empowered or not to send her children to school. The education concerning nutrition of the farmers were estimated by questioning that whether they were aware about the balance food, cooking procedure and amount of food needed for different age, sex and group. The education concerning health and sanitation was estimated by knowing their knowledge on personal hygiene, safe use of water and toilet and Extended Programme for immunization. The education concerning crop production technology was determined by interviewing the farmers whether they were trained or not by a Government or Non-Government institute on vegetable or other crop production or they were cultivating any crop in scientific way. The decision making ability was estimated by asking the question the female farmers that whether they were dependent or not dependent to her husband or father to start or initiate any new work or business. The education concerning marketing and savings were also determined by asking question about their marketing and saving policy and conditions.

RESULTS AND DISCUSSION

Signature and reading and writing ability: Table 1 shows that in case of slum dweller the signature ability and reading and writing ability of the farmers were increased after mushroom cultivation. Before mushroom cultivation only 16.67% farmers were able to put only their signature and 50% were able to read and write. But now, 40% farmers are able to put signature and 60% are capable to read and write. In case of snake charmer, signature ability was increased from 40% to 76.67% and reading and writing ability was increased from 16.67% to 23.33%. About 86.67% marginal farmers were able to read and

write before mushroom cultivation, which was increased to 90% after mushroom cultivation for 6 months. The Table 1 shows that the signature ability of marginal farmer was decreased. The cause behind it was the percentage of reading and writing ability increased.

Table 1. Impact of mushroom cultivation on signature, reading and writing ability of different community farmers of Savar area

Name of Farmer community	Total number of farmer interviewed	Only signature ability				Reading and writing ability			
		Before mushroom cultivation		After mushroom cultivation		Before mushroom cultivation		After mushroom cultivation	
		Number	%	Number	%	Number	%	Number	%
Slum dwellers	30	5	16.67	12	40.00	15	50.00	18	60.00
Snake charmer	30	12	40.00	23	76.67	5	16.67	7	23.33
Marginal farmer	30	4	13.33	3	10.00	26	86.67	27	90.00

Children education and ability of women's decision about education of sons and daughters: Table 2 reveals that the percentage of children education and ability of women's decision about education of sons and daughters were increased both in slum dwellers, snake charmer and marginal farmer. In case of snake charmer, only 20% farmer would send their children to school before mushroom cultivation, which was increased in 56.67% within 6 month of mushroom cultivation. The ability of women's decision about education of sons and daughter was only 20.00, 13.33 and 16.67% in slum dweller, snake charmer and marginal farmers, which were increased to 43.33, 56.67 and 43.33% respectively after 6 month of mushroom cultivation.

Table 2. Impact of mushroom cultivation on children education and the ability of women's decision about education of sons and daughter of different community farmers of Savar area

Name of Farmer community	Total number of farmer interviewed	Children education				Ability of women's decision about education of son and daughter			
		Before mushroom cultivation		After mushroom cultivation		Before mushroom cultivation		After mushroom cultivation	
		Number	%	Number	%	Number	%	Number	%
Slum dwellers	30	12	40.00	13	43.33	6	20.00	13	43.33
Snake charmer	30	6	20.00	17	56.67	4	13.33	17	56.67
Marginal farmer	30	13	43.33	13	43.33	5	16.67	13	43.33

Education concerning nutrition, health and sanitation: Education concerning nutrition was almost nil in slum dwellers (13.33%) and snake charmer (10%). After training and

cultivation of mushroom the education level of all the groups was raised to 83.33, 73.33 and 90% respectively (Table 3). The Table also shows that the education concerning health and sanitation of snake charmer was very poor. After cultivation of mushroom the health and sanitation education level of all the groups was raised up to 73.33, 66.67 and 86.67% respectively.

Table 3. Effect of mushroom cultivation on Education concerning nutrition, health and sanitation of different community farmers of Savar area

Name of Farmer community	Total number of farmer interviewed	Education concerning nutrition				Education concerning health and sanitation education			
		Before mushroom cultivation		After mushroom cultivation		Before mushroom cultivation		After mushroom cultivation	
		Number	%	Number	%	Number	%	Number	%
Slum dwellers	30	4	13.33	25	83.33	12	40.00	22	73.33
Snake charmer	30	3	10.00	22	73.33	5	16.67	20	66.67
Marginal farmer	30	12	40.00	27	90.00	14	46.67	26	86.67

Education concerning crop production technology: Education concerning crop production was totally absent in snake charmer. The education level in slum dweller and marginal farmer were 56.67 and 36.67% respectively. Due to proper training on production technology of mushroom as well as green crops specially vegetable and short duration fruits, the education level of crop production in slum dweller, snake charmer and marginal farmer was raised up to 80, 60 and 93.33% respectively (Table 4).

Table 4. Effect of mushroom cultivation on Education concerning crop production technology and decision making ability of women of different community farmers of Savar area

Name of Farmer community	Total number of farmer interviewed	Crop production education				Decision making ability of women			
		Before mushroom cultivation		After mushroom cultivation		Before mushroom cultivation		After mushroom cultivation	
		Number	%	Number	%	Number	%	Number	%
Slum dwellers	30	17	56.67	25	80.00	5	16.67	19	63.33
Snake charmer	30	0	0.00	18	60.00	15	50.00	23	76.67
Marginal farmer	30	11	36.67	28	93.33	4	13.33	12	40.00

Decision-making ability of women: The decision-making ability of women was very poor in slum dweller (16.67%) and marginal farmer (13.33%). The level was increased in all the groups, which were 63.33, 76.67 and 40.00% in slum dweller, snake charmer and marginal farmer respectively.

Education concerning marketing and savings Education concerning marketing was very poor in marginal farmers (26.67%) and slum dweller (33.33%) which was increased to 53.33% and 66.67% respectively but in case of snake charmer it did not change as their marketing ability was better previously. The education concerning savings was changed in all community farmers positively. The percentages of education concerning savings were changed from 23.33 to 80.00% in slum dweller, 13.33 to 76.67% in snake charmer and 26.67 to 83.33% in marginal farmer.

Table 5. Effect of mushroom cultivation on education concerning marketing and savings of different community farmers of Savar area

Name of Farmer community	Total number of farmer interviewed	Education concerning marketing				Education concerning savings			
		Before mushroom cultivation		After mushroom cultivation		Before mushroom cultivation		After mushroom cultivation	
		Number	%	Number	%	Number	%	Number	%
Slum dwellers	30	10	33.33	20	66.67	7	23.33	24	80.00
Snake charmer	30	25	83.33	25	83.33	4	13.33	23	76.67
Marginal farmer	30	8	26.67	16	53.33	8	26.67	25	83.33

The probable causes of improvement of all the education level of different farmers community might be due to intensive training on mushroom including social activities and proper monitoring by the Mushroom Development Project. The training activities and exchange of ideas and view with elite class person during different activities and marketing of mushroom in this period also helped to improve the education level of the three mushroom farmer communities.

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