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Effect of Different Chemical Nutrients (NPK) on Growth and Yield of Oyster Mushroom (*Pleurotus ostreatus*)

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Abstract: The study was conducted about the effect of different chemical nutrients (NPK) on the production and proximate composition of oyster mushroom (*Pleurotus ostreatus*). Mother culture of oyster mushroom was used as test crop for this experiment. The experiment consists of four different mixers of chemical nutrients *viz.* T_1 (only 10 kg straw); T_2 (2 g NPK in 10 kg straw); T_3 (4 g NPK in 10 kg straw) and T_4 (6 g NPK in 10 kg straw). Where NPK was kept as 2:1:1. The highest economic yield (267.38 g) was recorded in T_3 treatment, again the lowest economic yield (208.11 g) was observed in T_1. The highest moisture content was found in T_1 (88.57%) treatment, while the lowest moisture content was recorded in T_3 (84.12%). The highest biological yield (282.36 g) and economic yield (267.38 g) was attained from T_3. The highest benefit cost ratio (5.17) was found from T_3. Chemical nutrients (4 g NPK) with 10 kg rice straw performed significantly better on growth and yield of oyster mushroom.

Key words: NPK · Growth · Yield and mushroom (*Pleurotus ostreatus*)

INTRODUCTION

Mushroom nowadays considered as one of the most important functional food with many well-known therapeutic applications [1, 2, 3, 4, 5]. Over 200 species of mushrooms have long been used as functional foods around the world [6], but only about 35 species have been commercially cultivated [7, 8]. Several types of the mushrooms have been reported to have therapeutic properties such as antidiabetic, antimicrobial, antioxidant, anticancer, lipid lowering and immune-modulating effects [9]. *Pleurotus* species are very much effective in reducing harmful plasma lipids [10] and thus reduce the chance of atherosclerosis and other cardiovascular and artery-related disorders. These medicinal properties might be due to the presence of some important components in dietary mushroom.

Pleurotus spp. is one of most extensively studied white-rot fungi for its exceptional ligninolytic properties. This genus cleavages cellulose, hemicellulose and lignin from wood, whereas brown rot fungi only cleavage cellulose and hemicellulose. In basidiomycete fungi, extracellular laccases are constitutively produced in small amounts and the lignocellulolytic enzymes are affected by many typical fermentation factors, such as medium composition, pH, temperature, aeration rate, etc [11, 12, 13]. Phenolic compounds are produced by fungi in adaptation to abiotic and biotic stress conditions such as infection and low temperature [14].

Bangladesh is a thickly populated country and we have to increase intensive use of land for increasing crop production also considering natural resources. In this case mushroom cultivation can be a huge opportunity for increasing crop production per unit area with the vertical

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use of land. As a vegetable, mushroom can play an important role to meet the nutritional requirements of the population of our country. It is also a highly nutritious, delicious, medicinal and economically potential vegetable. The Greeks believed that mushrooms provided strength for warriors in battle. The Pharoaphs prized mushrooms as a delicacy and the Romans regarded mushrooms as the *"Food of the Gods, "* which was served only on festive occasions. The Chinese treasured mushrooms as a health food, the *"Elixir of life."* The Mexican Indians used mushrooms as hallucinogens in religious ceremonies and in witchcraft as well as for therapeutic purposes [15].

Pleurotus spp. are considered good source of superior quality protein, with well distributed essential amino acids [16]. Oyster mushroom has high nutritional value as an important source of protein, carbohydrates, vitamins, calcium and iron [17]. The nutritional advantages of mushrooms include a low content of calories and a high content of proteins, minerals and dietary fiber [18]. Oyster mushrooms are rich in Vitamin C, B complex and mineral salts required by the human body [19].

The climatic conditions and seasonal diversity of Bangladesh is ideal for the cultivation of the oyster mushroom [20]. Mushroom production in rural communities can alleviate poverty and improve the diversification of agricultural production [21]. Oyster mushroom has been widely cultivated in many different parts of the world. It has abilities to grow at a wide range of temperatures utilizing various lignocelluloses [22]. Further, the oyster mushroom has many species which can be suitably cultivated in diverse agro-ecological situations [23]. Oyster mushroom (*P. ostreatus*) is a popular edible mushroom that is commercially cultivated worldwide [24]. Oyster mushrooms are the easiest and least expensive commercial mushrooms to grow because they are well known for conversion of crop residues to food protein [25]. Oyster mushroom is an edible mushroom having excellent fragrant and taste and its cultivation on crop residues is considered as potential source of income, an alternative food production, provision of employment and for recycling of agricultural wastes.

MATERIALS AND METHODS

The experiment was conducted at the Biochemistry laboratory and Mushroom Culture House (MCH) of the Department of Biochemistry, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh. Mother culture of oyster mushroom (Mushroom seed) was collected from National Mushroom Development and Extension Center, Savar, Dhaka, Bangladesh. The experiment was laid out in single factor Completely Randomized Design (CRD). The experiment included four treatments with five replications.

Fertilizer Treatments: The experiment consists of the following four different inorganic fertilizer treatments:

T_1: Control (0 g NPK in 10 kg straw)
T_2: 2 g NPK in 10 kg straw
T_3: 4 g NPK in 10 kg straw
T_4: 6 g NPK in 10 kg straw
Here, N:P:K=2:1:1

Cultivation of Spawn Packet: Two ends, opposite to each other of the upper position of plastic bag were cut in "D" shape with a blade and opened by removing the plastic sheet after which the opened surface of substrate was scraped slightly with a tea spoon for removing the thin whitish mycelial layer. Then the spawn packets were soaked in water for 5 minutes and inverted to remove excess water for another 15 minutes. The packets of each type were placed separately on the shelf of culture room and covered with newspaper. The moisture of the culture room was maintained 80-85% relative humidity by spraying water 3 times a day. The temperature of culture house was maintained 22 to 25°C. The first primordia appeared 2-4 days after D-shaped cutting depending upon the type of substrate. The harvesting time also varied depending upon the composition of chemical nutrients (NPK).

Harvesting of Mushrooms: Oyster mushrooms matured within 2-3 days after primordia initiation. The matured fruiting body was identified by curial margin of the cap, as described by Amin [26]. Mushrooms were harvested by twisting to uproot from the base.

Dimension of Bruiting Body (Stipe and Pileus): Length of the pileus of three randomly selected fruiting bodies was measured using a slide calipers. Diameter of stipe, diameter and thickness of pileus were also measured.

- Length of stipe (cm)
- Diameter of stipe (cm)
- Diameter of pileus (cm)
- Thickness of pileus (cm)

Dry Yield: About 50 g of randomly selected mushroom sample was taken in a paper envelop and was weighed correctly. The mushroom was oven dried at 72°C temperature for 24 hours and weighed again. The weight of blank envelop was subtracted from both the initial weight. The dry yield was calculated using the following formula [27]:

$$\text{Dry yield (g/400g packet)} = \text{Economic yield} \times \frac{\text{Oven dry weight of sample (g)}}{\text{Fresh weight of sample (g)}}$$

Statistical Analysis: The data obtained for different parameters were statistically analyzed to find out the significance of the difference among the treatments. All the data collected on different parameters were statistically analyzed by using computer software MSTAT-C. The mean values of all attributes were evaluated and analysis of variance was performed by the 'F' test. The significance of the difference among the treatment means was estimated by the least significant difference (LSD) test at 5% level of probability.

RESULTS AND DISCUSSION

Growth Characters

Time Required Completing Mycelium Running: Time required completing mycelium running of oyster mushroom varied significantly due to different chemical nutrients (Table 1). The highest time required to complete the mycelium running was recorded from T_1 (20.40 days) while, the lowest time required to complete mycelium running was found in T_3 (16.20 days).

Time from Stimulation to Primordia Initiation: Different chemical nutrients showed statistically significant variation in terms of time from stimulation to primordia initiation of oyster mushroom (Table 1). The highest time from stimulation to primordia initiation was observed in T_1 (3.50 days) treatment which was statistically similar with T_2 (3.20 days) whereas, the lowest time from stimulation to primordia initiation was obtained in T_3 (2.70 days) treatment. Sarker [27] observed that duration of primordia initiation to oyster mushroom was significantly lower as compared to control.

Time from Primordia Initiation to Harvest: Statistically significant variation was recorded in terms of time from primordia initiation to harvest of oyster mushroom due to chemical nutrients (Table 1). The highest time from primordia initiation to harvest was attained in T_1 (4.60 days) treatment. On the other hand, the lowest time from primordia initiation to harvest was found in T_4 (3.50 days) which was statistically identical with T_3 (3.60 days) treatment. Formalin treatment behaved poorly as the species took maximum time to complete their mycelial growth. Mahjabin *et al*. [28] reported minimum days (13.25) required for completion of mycelial growth was observed in chemical nutrients whereas the highest days (31.75) required for mycelial growth was observed in 5 g NKP in 10 kg straw.

Average Number of Primordia Per Packet: Average number of primordia per packet of oyster mushroom varied significantly due to chemical nutrients (Table 1). The highest average number of primordial per packet was recorded in T_3 (74.40) treatment while, the lowest average number of primordial per packet was observed in T_1 (63.40) treatment. Pathan *et al*. [29] that 5 g NKP in 10 kg straw was the best in relation to studied characters. Amin [30] in his experiment found that the highest number of primordia of oyster mushroom was found in nutrients paddy straw but lowest was found in control treatment.

Average Number of Fruiting Body per Packet: Chemical nutrients showed statistically significant differences in terms of fruiting body per packet of oyster mushroom (Table 1). The highest average number of fruiting body per packet was observed in T_3 (65.40) which was statistically similar with T_4 (62.40) and T_2 (62.00) treatment whereas, the lowest average number of fruiting body per packet was found in T_1 (56.30) treatment. Sarker et al. [31] reported that the number of effective fruiting bodies was the highest (21.00) in autoclaved N, P and K (2:1:1) and it was the lowest (7.50) in autoclaved N, P and K (1:1:1).

Average Weight of Individual Fruiting Body: Significant variation was observed in terms of average weight of individual fruiting body of oyster mushroom due to chemical nutrients (Fig. 1). The highest average weight of individual fruiting body was attained in T_3 (3.61 g) treatment which was statistically similar with T_4 (3.45 g) treatment. On the other hand, the lowest average weight of individual fruiting body was found in T_1 (2.83 g) and closely followed by T_3 (3.18 g) treatment. Pathan *et al*. [29] that 6 g NPK was the best in relation to studied characters.

Table 1: Effect of different chemical nutrients (NPK) on growth characters of oyster mushroom

Treatments	Time required to complete mycelium running (days)	Time from stimulation to primordia initiation (days)	Time from primordia initiation to harvest (days)	Average number of primordiapacket^{-1}	Average number of fruiting body packet^{-1}
T_1	20.40 a	3.50 a	4.60 a	63.40 c	56.30b
T_2	18.40 b	3.20 ab	4.10 b	69.40 b	62.00 a
T_3	16.20 c	2.70 bc	3.60 c	74.40 a	65.40 a
T_4	17.80 b	3.00 b	3.50 c	70.10 b	62.40 a
$LSD_{(0.05)}$	1.101	0.485	0.455	4.283	5.132
CV(%)	3.32	4.24	3.00	4.36	5.47

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.
T_1: Control (0 g NPK in 10 kg straw), T_2: 2 g NPK in 10 kg straw, T_3: 4 g NPK in 10 kg straw and T_4: 6 g NPK in 10 kg straw

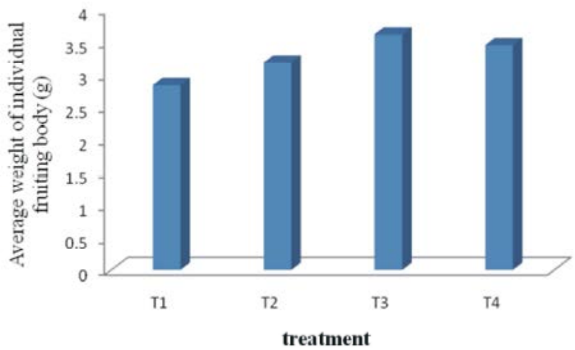

Fig. 1: Effect of chemical nutrients (NPK) on average weight of individual fruiting body of oyster mushroom

Table 2: Effect of chemical nutrients (NPK) on the dimension of fruiting body of oyster mushroom.

Treatments	Length of stipe (cm)	Diameter of stipe (cm)	Diameter of pileus (cm)	Thickness of pileus (cm)
T_1	1.82 c	0.96 d	6.03 d	0.67 d
T_2	2.22 b	1.03 c	6.51 c	0.71 c
T_3	2.68 a	1.16 a	6.87 a	0.83 a
T_4	2.56 a	1.09 b	6.72b	0.77 b
$LSD_{(0.05)}$	0.378	0.047	0.138	0.025
CV(%)	5.36	4.36	3.26	5.47

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.
T_1: Control (0 g NPK in 10 kg straw), T_2: 2 g NPK in 10 kg straw, T_3: 4 g NPK in 10 kg straw and T_4: 6 g NPK in 10 kg straw.

Length of Stipe: Length of stipe of oyster mushroom varied significantly due to chemical nutrients (Table 2). The highest length of stipe was observed in T_3 (2.68 cm) treatment which was statistically similar with T_4 (2.56 cm) treatment whereas, the lowest length of stipe was found in T_1 (1.82 cm). Sarker *et al*. [31] reported that length of stalk ranged from 1.80 to 2.57 cm which was similar to the findings of this experiment.

Diameter of Stipe: Statistically significant variation was recorded in terms of diameter of stipe of oyster mushroom due to chemical nutrients (Table 2). The highest diameter of stipe was found in T_3 (1.16 cm) treatment and closely followed by T_4(1.09 cm), while the lowest diameter of stipe was attained in T_1 (0.96 cm) treatment and closely followed by T_2 (1.03 cm) treatment. Habib [32] found that stipe of oyster mushroom on different substrates varied from 0.74 cm to 1.05 cm.

Diameter of Pileus: Chemical nutrients showed statistically significant variation in terms of diameter of pileus of oyster mushroom (Table 2). The highest diameter of pileus was recorded in T_3 (6.87 cm) treatment and closely followed by T_4 (6.72 cm) and T_2 (6.51 cm) treatment, whereas the lowest diameter of pileus was observed in T_1 (6.03 cm) treatment. Pathan *et al*. [29] reported that NKP was the best in relation to studied characters. Sarker *et al*. [31] reported the diameter pileus ranged from 5.66 to 7.44 cm. The highest diameter of pileus (7.44 cm) was found in NKP (2:1:1).

Thickness of Pileus: Significant difference was recorded in terms of thickness of pileus of oyster mushroom due to applied chemical nutrients (Table 2). The highest thickness of pileus was observed in T_3 (0.83 cm) treatment which was closely followed with T_4 (0.77 cm) treatment. On the other hand, the lowest thickness of pileus was

Table 3: Effect of chemical nutrients (NPK) on the yield parameter and benefit cost ratio of oyster mushroom

Treatments	Biological yield (g)	Economic yield (g)	Dry yield (g)	Benefit cost ratio
T_1	226.49 c	208.11 c	23.00 d	4.03d
T_2	265.38b	239.62 b	30.36 c	4.69c
T_3	282.36 a	267.38 a	41.90 a	5.17 a
T_4	274.90ab	255.75ab	37.29 b	4.85 b
$LSD_{(0.05)}$	15.18	18.035	1.027	0.240
CV(%)	4.32	5.46	4.69	3.34

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.
T_1: Control (0 g NPK in 10 kg straw), T_2: 2 g NPK in 10 kg straw, T_3: 4 g NPK in 10 kg straw and T_4: 6 g NPK in 10 kg straw

found in T_1 (0.67 cm) treatment which was closely followed by T_2 (0.71 cm) treatment. Sarker *et al*. [31] reported the thickness of pileus ranged from 0.47 to 0.55 cm respectively and the highest was found in NKP (2:1:1).

Yield Parameters

Biological Yield: Chemical nutrients showed statistically significant variation in terms of biological yield of oyster mushroom (Table 3). The highest biological yield was found in T_3 (282.36 g) treatment which was statistically identical with T_4 (274.90 g) treatment whereas, the lowest biological yield was recorded in T_1 (226.49 g) treatment which was closely followed by T_2 (265.38 g) treatment. Marimuthu *et al*. [33] reported earlier that neem cake at 5% level increased the yield of *P. citrinopileatus, P. sajor-caju* and *P. pathypus* by 26-49, 24-79 and 16%, respectively compared with control.

Economic Yield: Statistically significant variation was recorded in terms of economic yield of oyster mushroom due to chemical nutrients (Table 3). The highest economic yield was recorded in T_3 (267.38 g) treatment which was statistically identical with T_4 (255.75 g) and T_2 (239.62 g) treatment, again the lowest economic yield was observed in T_1 (208.11 g) treatment. Sarker *et al*. [31] recorded the highest economic yield in autoclaved NPK at 2:1:1 ratio respectively.

Dry Yield: Dry yield of oyster mushroom varied significantly due to chemical nutrients (Table 3). The highest dry yield was observed in T_3 (41.90 g) treatment and closely followed by T_4 (37.29 g) treatment whereas, the lowest dry yield was found in T_1 (23.00 g) treatment which was closely followed by T_2 (30.36 g) treatment. Pathan *et al*. [29] that NKP soaking was the best in relation to studied characters. Kulsum *et al*. [34] found that the highest dry yield was 21.27 g due to 6 g NKP socking.

Benefit Cost Ratio: Benefit cost ratio of oyster mushroom showed statistically significant variation due to applied chemical nutrients under the present trial (Table 3). Data revealed that the highest benefit cost ratio was observed in T_3 (5.17) treatment and closely followed by T_4 (4.85) treatment, whereas the lowest benefit cost ratio in T_1 (4.03) treatment which was closely followed by T_2 (4.69) treatment. Sarker *et al*. [35] mentioned the performances of substrates were significantly differed based on benefit cost ratio and the highest of 6.50 with NKP socking wheat straw.

CONCLUSIONS

The lowest time from stimulation to primordial initiation (2.70 days) and lowest time required to complete mycelium running (16.20 days) was recorded in T_3. The maximum average number of primordial per packet (74.40) and fruiting body per packet (65.40) was recorded from T_3. The highest biological yield (282.36 g) and economic yield (267.38 g) was attained from T_3. The highest benefit cost ratio (5.17) was found from T_3. So chemical nutrients (4 g NPK) with 10 kg rice straw performed significantly better on growth and yield of oyster mushroom (*Pleurotus ostreatus*).

Recommendations: In this experiment, mixture of different applied chemical nutrients (NKP) performed better in respect of different growth and yield attributes of oyster mushroom. Therefore, 4 g NPK in 10 kg straw can be recommended for farmer level oyster mushroom cultivation.

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