Emerging Medical Science
Journal Homage: https://emspub.com
Volume 1 issue 1 (September 2022)

Comparative Growth and Nutritional Study of Oyster Small Mushroom *(Pleurotus ostreatus)*

Mohammad Azizur Rahman[1]*, Akter Jahan Kakon[2]

[1]Department of Biochemistry and Molecular Biology, Jahangirnagar University, Savar, Dhaka 1342, Bangladesh.
[2]Mushroom Development Institute, Ministry of Agriculture, Government of the Peoples Republic of Bangladesh.

Abstract
Mushrooms, the edible macro-fungi, have been allured as delicious and nutritious cuisine along with their immense medicinal importance. Naturally, mushrooms grow on wastes, garbage, trees, and trunks and on moist landscape. Naturally occurring and human leftovers of different food stuffs could be rich sources of mushroom cultivation that would reduce environmental nuisance as well as positively impact on fulfilling the nutritional demand of the ever increasing humanity. Present study explores comparative growth pattern of the oyster small (OS) mushroom, *Pleurotus ostreatus* on different amount of rice straw as substrate (100g, 200g, 500g, 1000 g/packet) followed by nutritional assessment of the mushrooms grown on each of the substrate's packet. Mushrooms grown on 200g packet contained the highest nutritional values as evaluated in the present study. Thus, current findings would aid highly in formulating cultivation of *Pleurotus ostreatus* on rice straw with a view to providing nutritional support to the humanity.

Key words: Fungi, Macro-fungi, Mushroom, Oyster Mushroom, Proximate Analyses.

Introduction

Mushrooms are non-green fungus plants that grow seasonally in a variety of settings ranging from plains to dense woods, lush meadows, and roadside paths all over the world [1]. It is made up of a wide number of different forms, sizes, appearances, and edible qualities [2]. Since the dawn of time, mushrooms have been recognized as a unique type of food [3]. Mushrooms were thought to provide strength to warriors in battle by the Greeks [4]. Mushrooms were considered a delicacy by the Pharaohs and the "Food of the Gods" by the Romans, who only offered them on special occasions [5]. Mushrooms were treasured in China as a health food, the "Elixir of Life" [5]. Mushrooms were utilized as hallucinogens in religious rites, witchcraft, and for healing purposes by the Mexican Indians [6]. Nutritional and medicinal values of mushrooms have been hailed throughout the world [7]. Thus, global demand for both edible and medicinal mushrooms has been skyrocketing. Interestingly, agricultural and industrial wastes can be used to cultivate and fulfill global mushroom demand [8]. More than half of the overall yield from the land is wasted as straws, leaves, stems, roots, and other garbage. These wastes could be converted into food as well as the planet could be cleared off the garbage.

Oyster mushrooms, also known as *P. ostreatus*, are one of the most widely farmed mushroom species on the planet [9]. It has also been popular in Bangladesh. Bangladesh is a rapidly developing nation with a large population. Our farmland is shrinking every day to accommodate a growing population. As a result, we must expand the intensive use of land in order to enhance crop output. However, due to natural risks and other obstacles, it is extremely tough in our country. In this situation, mushroom farming presents a significant chance to increase crop production per unit area through vertical land use, and as a result, mushroom cultivation is now becoming increasingly popular among farmers across the country. It grows without sunshine, is relatively fast-growing, and does not require fertile soil because it is cultivated on compost or non-compost agro-wastes such as wheat and paddy straw, sugarcane, banana leaves, rice husk, sawdust, bagasse and leaves, wheat barn and other agricultural wastes.

Bangladesh produces a large amount of rice straw per year that could be utilized for mushroom production. There has been no research on the oyster small (OS) mushroom to standardize mushroom cultivation procedures in this country. Therefore, the current research had been carried out to determine the nutritional

status of oyster small (OS) strain of *P. ostreatus* mushroom by using rice straw of different packet sizes; to evaluate the biological yield, economical yield and the biological efficiency of OS strain of *P. ostreatus* mushroom producing from different amount of rice straw. Also, comparative yield and physical attributes of *P. ostreatus*–OS grown on different amount of rice straw containing packets have been studied.

Materials And Methods

Location of experiment

The research was conducted at the Mushroom Development Institute, Savar, Dhaka from November 2021 to March 2022.

Experiments and Treatments

The experiment was set up using a single-factor Completely Randomized Design (CRD). To get the desired results, four separate treatments with four replications (n=4) of each strain were carried out. Total 60 spawn packets of different amount of rice straw were made for the experiment. Of them 15 spawn packets were made of 500g of rice straw, 15 were of 1000g of rice straw, 15 were of 1500 g of rice straw and another 15 were of 2000g of rice straw as substrate.

The following were the experiments:

Treatment 1 (T_1): *P. ostreatus*- Oyster Small (OS) + 500g Rice straw.
Treatment 2 (T_2): *P. ostreatus*- Oyster Small (OS) + 1000g Rice straw.
Treatment 3 (T_3): *P. ostreatus*- Oyster Small (OS) + 1500g Rice straw.
Treatment 4 (T_4): *P. ostreatus*- Oyster Small (OS) + 2000g Rice straw.

Collection of OS mother spawns

The required number of mother spawns of oyster small (OS) mushroom was collected from the mother spawn culture house of Mushroom Development Institute, Savar, Dhaka, Bangladesh. Their mycelium run was fully completed.

Mixing and Sterilization of Rice straw

At first, the rice straw and water were weighted precisely by a weight balance. The ratio of rice straw and water were 10:9. Then, they were mixed thoroughly with hand and feet for 10-15 minutes. The mixing was finished when there was no more water remaining after the rice straw had absorbed all of it. The moist rice straw was then placed in a net bag. The bag's opening was lightly bound and placed in the pasteurization chamber. The chamber's gate remained shut. At a temperature of 60°C, the pasteurization process continued for 1.5 hours. A thermometer was used to closely monitor the temperature. For the following 24 hours, the chamber's gate remained shut. The chamber was reopened the next day and the moist rice straw-filled bag had been removed from the chamber. The rice straw had been disinfected and was ready to be used in the spawn packets.

Preparation of spawn packets

The hands were adequately cleansed at first. To create the spawn packet for four distinct treatments, four different sizes of PP (polypropylene) bags were used. The dimensions are as follows:

i. Treatment 1: (9" ×12") for 500g RS packet
ii. Treatment 2: (12" ×16") for 1000g RS packet
iii. Treatment 3: (12" ×18") for 1500g RS packet
iv. Treatment 4: (14" ×20") for 2000g RS packet

The rice straw and mother spawn were then layered and mixed in a precise size PP bag for the specific treatment. For every 500g of rice straw, 100 g mother spawn was added. The filled polypropylene bags were made by placing a plastic neck at the opening part, plugging it with cotton, and securing it with a rubber band. Then, using a permanent marker, the treatment number, replication number, and packet number were written on the body of the spawn packet. The body of the 1500g and 2000g spawn packets was pierced with several little pores with a pin. After that, the spawn packets were transferred to the culture house.

Cultivation of spawn packet

After 15-20 days, when the mycelium runs were completed, the spawn packets were ready to cut. Two ends of the upper position of the plastic bag, opposite one other, were cut in a "D" form with a blade and opened

by removing the plastic sheet, following which the opening surface of the substrate was scraped slightly with a tea spoon to remove the thin whitish mycelium layer. From that day the relative humidity in the culture room was kept at 80-85% by spraying water three times a day. The culture house was kept consistently lit at 300-500 lux and ventilated. The culture house's temperature was kept between 22 and 25 °c. Depending on the packet size, the first pinhead appeared 3-7 days after scribing. Harvesting time was also affected by the amount of substrate used.

Collection of produced mushrooms:
After pinhead formation, oyster mushrooms matured in 4-6 days. The curial border of the cap, as reported by Amin, was used to identify the ripened fruiting body (2002). Mushrooms were gathered by twisting the base of the mushroom to uproot it. Then the lower hard and dirty area of the fruiting body was removed with a scissors & put the mushrooms in marked packets.

Data Collection
Inoculation Date The inoculation date is the day when the spawn packets were made and the mother spawn was mixed with the rice straw. The dates have been recorded.
Mycelium running completion Date The time it took from inoculation to completion of mycelium running was calculated.
Open Date: The day when the packet was cut in D shape was recorded.
First Pinhead Date (PiD): When the first pinhead of the mushroom was visible, the day was recorded.
Average number of Fruiting body/packet (Fb): The total number of fruiting bodies grown from a packet were counted ad recorded.
Average number Effective of Fruiting body/packet (EFb): The number of fruiting bodies that were fully matured was counted. Fruiting bodies that were dry or pinheaded were eliminated, but tiny fruiting bodies were counted.
Average Length of Stalk (LS): One large, one medium and one small fruiting body from each packet were selected for measurement. The lengths of the three stalks are recorded.
Average Width of Stalk (WS): One large, one medium and one small fruiting body from each packet were selected for measurement. The width of the three stalks is recorded.
Average Diameter of Pileus (DP): One large, one medium and one small fruiting body from each packet were selected for measurement. The diameters ofthe three pileus are recorded.
Average Thickness of Pileus (TP): One large, one medium and one small fruiting body from each packet were selected for measurement. The thickness ofthe three pileus is recorded.
Average weight of individual fruiting body/packet: By dividing the total weight of fruiting bodies per packet by the total number of fruiting bodies per packet, the average weight of individual fruiting bodies was calculated.
Biological yield: Weighing the entire cluster of fruiting body without cutting the lower hard and unclean piece yielded a biological yield per 500 g packet.
Economic yield: Weighing all of the fruiting bodies in a packet after removing the lower hard and dirty area yielded an economic yield per 500g package.
Biological efficiency: The following formula (Ahmed, 1998) was used to calculate biological efficiency

$$\text{Biological efficiency} = \frac{\text{Total biological weight (g)}}{\text{Total weight substrate used (g)}} \times 100$$

Drying of mushrooms: The mushrooms' fruiting bodies were gathered and taken to the lab. Here, the data on many parameters were gathered. The fruiting bodies were torn into little pieces and placed on papers. Then they're dried for 3-4 hours at 50 ° C in the oven. For improved drying, the stipe and pileus are separated throughout the drying process. After that, the weight of oven dry sample was taken.
Collection of Produced Mushrooms from Different Flush Number: When the in-rolled borders of the mushroom caps began to flatten, three flushes of mushroom were collected from each of the culture bags for individual treatments. The overall harvesting time (from the first to the last harvest) and the time from inoculation to the first harvest were observed and recorded. The harvested fruiting bodies were weighed and the mushroom size was assessed after each flush.

Proximate analyses

Proximate analyses had been performed following established methods in biochemistry.

Determination of total protein: Total protein content was measured according to the Biuret method

Determination of total lipid: Total lipid was determined by slight modified method of Folch *et al.* (1957) [10].

Determination of crude fiber: Crude fiber was determined by gravimetric method [11].

Determination of total ash: Ash was determined by following the standard Association of Official Agricultural Chemists **(**AOAC) method [[12].

Determination of total carbohydrate: The content of the available carbohydrate was determined by the following equation [13]:

Carbohydrate (g/100g sample) = [100 – (Moisture + Fat + Protein + Ash + Crude fiber)].

Results and Discussion

Time period from inoculation to fully run of mycelium (Days)

The time period from the inoculation to fully run of mycelium of *P.ostreatus*-OS mushroom was ranged from 16.93 to 21.92 days depending on the amount of rice straw used as substrate. The highest time period was observed in Treatment 4: 2000g of rice straw packet (27 days) and the lowest was in Treatment 1: 500g of rice straw packet (16.93 days). The other treatments also varied significantly which are showed in Table 1.

Time period from packet opening to pinhead initiation (Days)

The time period from the packet opening to pinhead initiation was varied from 12.09 to 25.83 days depending on the different amount of rice straw. The shortest time taken for the pinhead initiation was observed in Treatment 4: 2000g of rice straw packet (12.09 days). The maximum days were counted for Treatment 2: 1000g of rice straw packet (25.83 days). The other treatments also varied significantly. They are also showed in Table 1.

Time from pinhead initiation to harvest (Days)

The maximum time was observed in Treatment 4: 2000g of rice straw packet (5.36 days) and the lowest time was in Treatment 1: 500g of rice straw packet (5 days). The other treatments also showed similarly results.

Table 1.Effect of different amount of Rice Straw on mycelium growth, time from packet opening to pinhead initiation (Days) and time from pinhead initiation to harvest (days) of *P. ostreatus*-Oyster Small (OS) mushroom.

Treatments	Time period from inoculation to fully run of mycelium (Days)	Time period from packet opening to pinhead initiation (Days)	Time from pinhead initiation to harvest (Days)
T_1	16.93	14.44	5
T_2	21.92	25.83	5.18
T_3	19	14.91	5.30
T_4	27	12.09	5.36

T_1=500g Rice straw spawn packet, T_2=1000g Rice straw spawn packet, T_3=1500g Rice straw spawn packet, T_4= 2000g Rice straw spawn packet.

Number of total Fruiting body (Fb)

The highest number of fruiting body was noted in Treatment 4: 2000g of rice straw packet (40.42) & the lowest were in Treatment 1: 500g of rice straw packet. (Table2)

Number of total Effective Fruiting body (EFb)

The maximum number of fruiting body was noted in Treatment 4: 2000g of rice straw packet (28.42) & the lowest were in Treatment 1: 500g of rice straw packet (10.15). (Table, 2).

Length of Stalk (LS)

One large, one medium and one small fruiting body from each spawn packet were selected for measurement. The average length of the three stalks was calculated. The smallest stalk was found in Treatment 1: 500g of

rice straw packet (2.41cm). The largest was in Treatment 4: 2000g of rice straw packet (4.01cm). The results from other treatments are also mentioned in Table 2.

Diameter of Stalk (DS)

The largest Diameter of Stalk was found in Treatment 4: 2000g of rice straw packet (1.59cm) and the smallest one was found in Treatment 1: 500g of rice straw packet (1.25 cm). The results from other treatments are also mentioned in Table 2.

Diameter of Pileus (DP)

One large, one medium and one small fruiting body from each spawn packet were selected for measurement. The average diameter of the three pileus was calculated. The largest Diameter of Stalk was found in Treatment 4: 2000g of rice straw packet (9.04 cm) and the smallest one was found in Treatment 1: 500g of rice straw packet (6.31 cm). The results from other treatments are also given in Table 2.

Thickness of Pileus (TP)

One large, one medium and one small fruiting body from each spawn packet were selected for measurement. The average diameter of the three pileus was calculated. The thickest Diameter of Pileus was observed in Treatment 4: 2000g of rice straw packet (.93 cm) and the thinnest one was found in Treatment 2: 1000g of rice straw packet (.78 cm). The results from other treatments are also given in Table 2:

Table 2. Effect of different amount of Rice Straw on the yield contributing characters of *P. ostreatus*-Oyster Small (OS) mushroom.

Treatments	No. of Fb	No. of EFb	LS (cm)	DS (cm)	DP (cm)	TP (cm)
T_1	14.15	10.15	2.41	1.25	6.31	0.81
T_2	27.58	19.5	3.26	1.39	8.12	0.78
T_3	24.7	20.2	2.70	1.32	7.14	0.86
T_4	40.42	28.42	4.01	1.59	9.04	0.93

T_1=500g Rice straw spawn packet, T_2=1000g Rice straw spawn packet, T_3=1500g Rice straw spawn packet, T_4= 2000g Rice straw spawn packet.

Fb=Fruiting body, EFb=Effective Fruiting body, LS= Length of Stalk, DS=Diameter of Stalk, DP=Diameter of Pileus, TP=Thickness of Pileus

Biological Yield (g)

The biological yield varies depending on the amount of rice straw used. The Treatment 4: 2000g of rice straw spawn packet (662.4g) had the largest biological yield, Treatment 1: 500g of rice straw spawn packet (433.42g) had the lowest biological yield (193.7g). In terms of biological yield, the other treatments differed significantly. (Table, 3).

Economic Yield (g):

The Treatment 4: 2000g of rice straw spawn packet produced the maximum economic yield (656.4), while PCYS-1 + RSD produced the lowest economic yield (188.3g). The other treatments differed significantly (Table 3).

Biological efficiency (%)

The highest biological efficiency of 33.12 % was calculated in Treatment 4: 2000g of rice straw and the lowest biological efficiency of 28.44% were calculated from Treatment 2: 1000g of rice straw. Other treatments are shown here. (Table, 3).

Table 3. Effect of different amount of Rice Straw on Biological Yield (g), Economic Yield (g), Biological efficiency (%) of *P. ostreatus*-Oyster Small (OS) mushroom.

Treatments	Biological Yield (g)	Economic Yield (g)	Biological efficiency (%)
T_1	163.46	159.46	32.68
T_2	284.38	279.08	28.44
T_3	434.12	428.42	28.94
T_4	662.4	656.4	33.12

T_1=500g Rice straw spawn packet, T_2=1000g Rice straw spawn packet, T_3=1500g Rice straw spawn packet, T_4= 2000g Rice straw spawn packet.

Effect of different amount rice straw on yield and Biological Efficiency

One of the primary goals of mushroom growers is to increase productivity *P. ostreatus*-Oyster Small (OS) mushroom can be cultivated on various amounts of rice straw. They demonstrated a considerable variation in mushroom output (Table 4). There were just three flushes in the mushroom *P.ostreatus*-Oyster Small (OS) mushroom. The first flush produced the maximum amount of OS mushrooms, followed by the second and third flushes. In the instance of the mushroom OS mushroom, Treatment 4: 2000g of rice straw spawn packet yielded the highest total yield (662.4 g/bag), while Treatment 1: 500g of rice straw spawn packet yielded the lowest (163.46 g/bag).

Table 4. Effect of different amount rice straw on yield per flash number and Biological Efficiency of oyster mushroom *P. ostreatus*-Oyster Small (OS):

Treatments	1st flush (g/bag)	2nd flush (g/bag)	3rd flush (g/bag)	Total yield (g/bag)	BE (%)
T_1	76.06	51.09	36.31	163.46	32.68
T_2	120.08	91.62	72.68	284.38	28.44
T_3	186.71	134.0	113.41	434.12	28.94
T_4	310.5	191.2	160.7	662.4	33.12

T_1=500g Rice straw spawn packet, T_2=1000g Rice straw spawn packet, T_3=1500g Rice straw spawn packet, T_4= 2000g Rice straw spawn packet, BE: Biological Efficiency.

Nutrient composition of *P.ostreatus*-OS mushrooms grown on 500g Rice straw

As per analysis we saw that, *P. ostreatus*-OS mushroom powder sample formulae grew on 500g Rice straw were high in carbohydrate and low in lipid content, making them good foods for low-calorie diets (Figurre 1). The maximum content found in the fruiting bodies powder sample was carbohydrate (53.97$\pm$1.85) & the lowest was lipid (5.08$\pm$0.67g) (Figure 1).

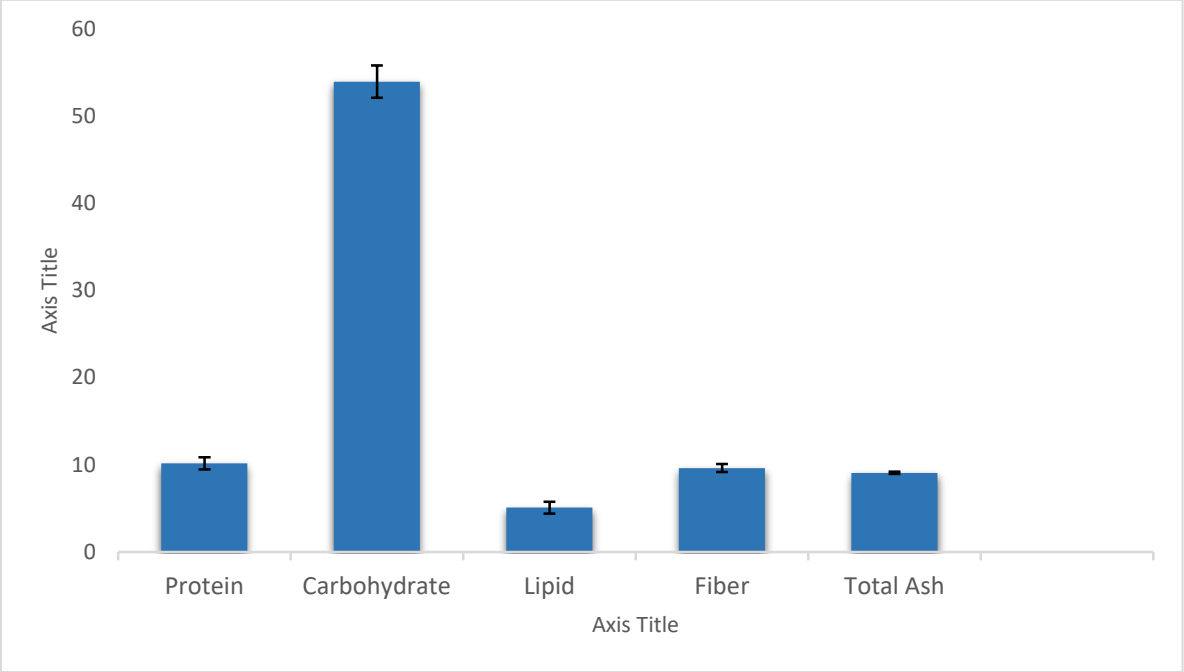

Fig 1. Nutrient composition of *P. ostreatus*-OS mushroom cultivated on 500g Rice straw (g/100g dry sample) (where n=4). Results are expressed as mean *R* SEM (Standard error of mean) of tetraplicate determination.

Nutrient composition of *P. ostreatus*-OS mushrooms grown on 1000g Rice straw

According to our findings, *P. ostreatus*-OS mushroom powder sample formulations grew on 1000g of Rice straw has high carbohydrate content and a low fat level, making it an ideal low-calorie snack (Figure 2). Carbohydrate (55.71±1.32g) had the highest quantity in the fruiting bodies powder sample, while lipid (3.27g) had the lowest. (Figure 2)

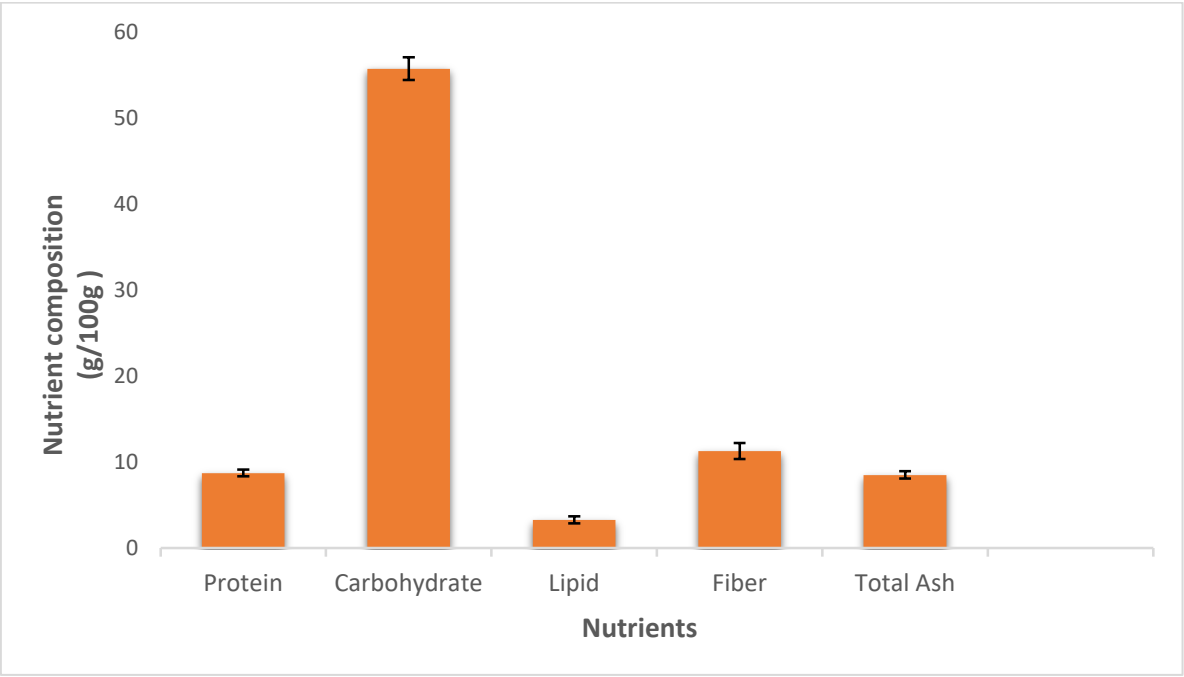

Fig 2.Nutrient composition of *P. ostreatus*-OS mushroom cultivated on 1000g Rice straw (g/100g dry sample) (where n=4). Results are expressed as mean ± SEM (Standard error of mean) of tetraplicate determination.

Nutrient composition of *P. ostreatus*-OS mushrooms grown on 1500g Rice straw

P. ostreatus-OS mushroom powder sample formulations grown on 1000g of Rice straw have a high carbohydrate content and low fat content, making it a suitable low-calorie food, according to our findings (Figure 3). In the fruiting bodies powder sample, carbohydrate (55.84±1.25g) had the highest concentration, while lipid (5.89±0.67g) had the lowest (Figure 3).

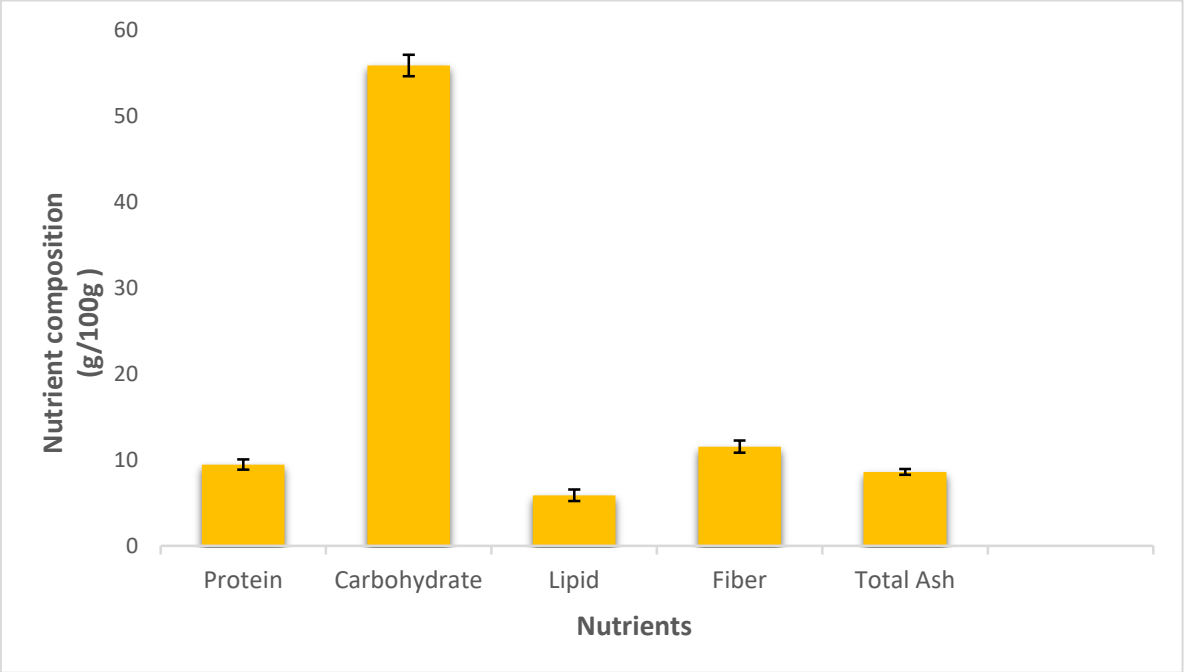

Fig 3.Nutrient composition of *P. ostreatus*-OS mushroom cultivated on 1500g Rice straw (g/100g dry sample) (where n=4). Results are expressed as mean ± SEM (Standard error of mean) of tetraplicate determination.

Nutrient composition of *P. ostreatus*-OS mushrooms grown on 2000g Rice straw

As per analysis we saw that, *P. ostreatus*-OS mushroom powder sample formulae grew on 2000g Rice straw were high in carbohydrate and low in fat content, making them good foods for low-calorie diets (Figure 4). The maximum content found in the fruiting bodies powder sample was carbohydrate (52.08±1.02g) & the lowest was lipid (5.33±0.31g) (Figure 4).

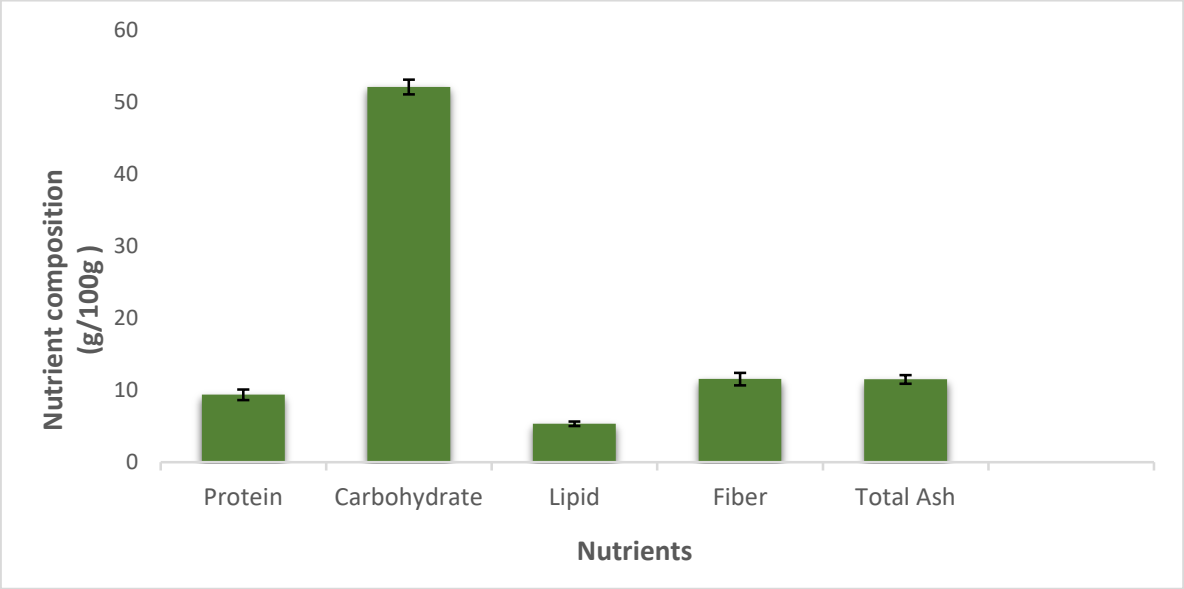

Fig 4. Nutrient composition of *P. ostreatus*-OS mushroom cultivated on 2000g Rice straw (g/100g dry sample) (where n=4). Results are expressed as mean ± SEM (Standard error of mean) of tetraplicate determination.

Comparative study on Nutritional Composition of *P. ostreatus*-OS mushrooms

Protein Content

Figure 5 shows the protein content of *P. ostreatus*-OS mushrooms that were cultivated on various amounts of Rice straw. Protein is present in all of the treatments in significant amounts. Protein content in mushrooms grown on various amounts of Rice straw as substrate ranged from 8.73±0.38 to 11.48±0.62% (w/w). Treatment-4: OS+2000g RS had the highest protein content (11.48±0.62%), while treatment-3: OS+1500g RS had the lowest protein level (8.73±0.38%). In terms of protein content, the other treatments differed significantly from the control (Figure 5).

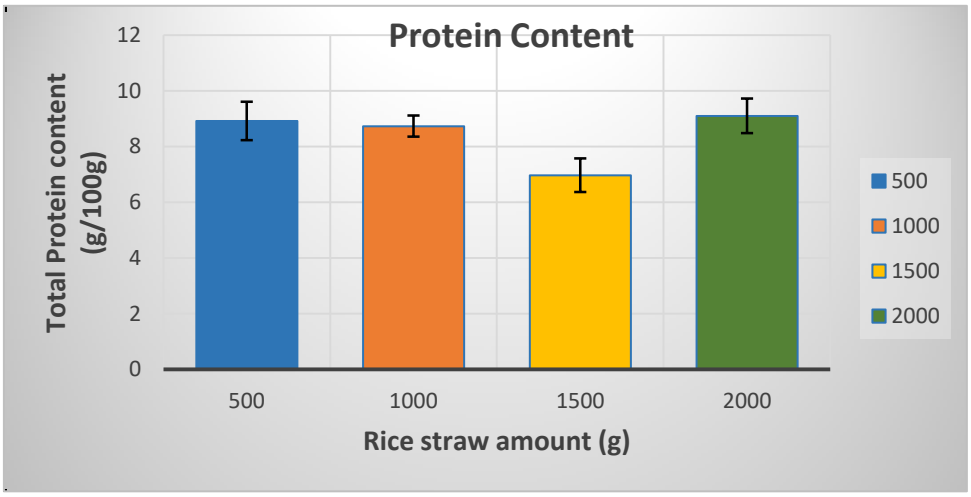

Fig5. Effect of different amount of Rice straw as substrate on Protein content of *P. ostreatus*-OS mushroom. (g/100g of dried sample) (where n=4). Results are expressed as mean ± SEM (Standard error of mean) of tetraplicate determination.

Carbohydrate Content

The carbohydrate content grown on various amounts of Rice straw of *P. ostreatus*-OS mushroom is shown in Figure 6. The lowest percentage of carbohydrate was counted under Treatment-4: OS+500g RS (52.08±1.02%) and the highest carbohydrate percentage was counted under Treatment-3: OS+500g RS (55.84±1.25%).

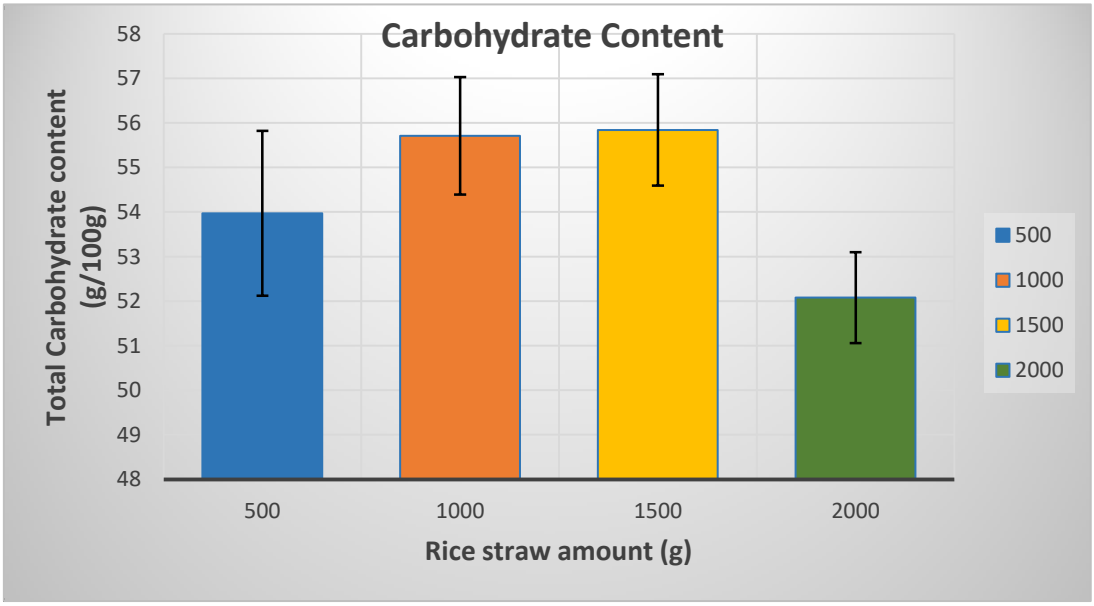

Fig6. Effect of different amount of Rice straw as substrate on carbohydrate content of *P. ostreatus*-OS mushroom. (g/100g of dried sample) (where n=4). Results are expressed as mean ± SEM (Standard error of mean) of tetraplicate determination.

Lipid Content

The Treatment-2: OS+1000g RS had the lowest lipid percentage (3.27±0.41%), while The Treatment-3: OS+1500g RS had the greatest lipid percentage (5.89±0.67%) (Figure, 7). The lipid content of *P. ostreatus*-OS mushroom is lower when grown on 1000g than when cultivated on 500g, according to the findings of this study.

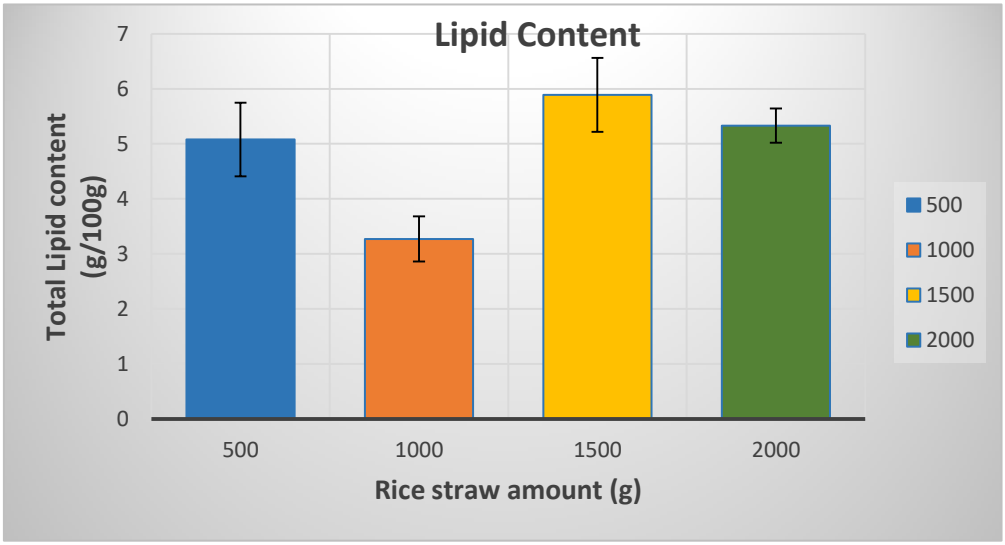

Fig7. Effect of different amount of Rice straw as substrate on Lipid content of *P. ostreatus*-OS mushroom. (g/100g of dried sample) (where n=4). Results are expressed as mean ± SEM (Standard error of mean) of tetraplicate determination.

Fiber Content

Figure 8 shows the fiber content of *P. ostreatus*-OS mushrooms that were cultivated on various amounts of Rice straw. Fiber content in mushrooms grown on various amounts of Rice straw as substrate ranged from 8.13 to 16.54 % (w/w). Treatment-3: OS+1500g RS had the highest fiber content (11.54±0.71%), while treatment-1: OS+500g RS had the lowest (9.63±0.46%). In terms of fiber content, the other treatments differed significantly from the control (Figure, 8).

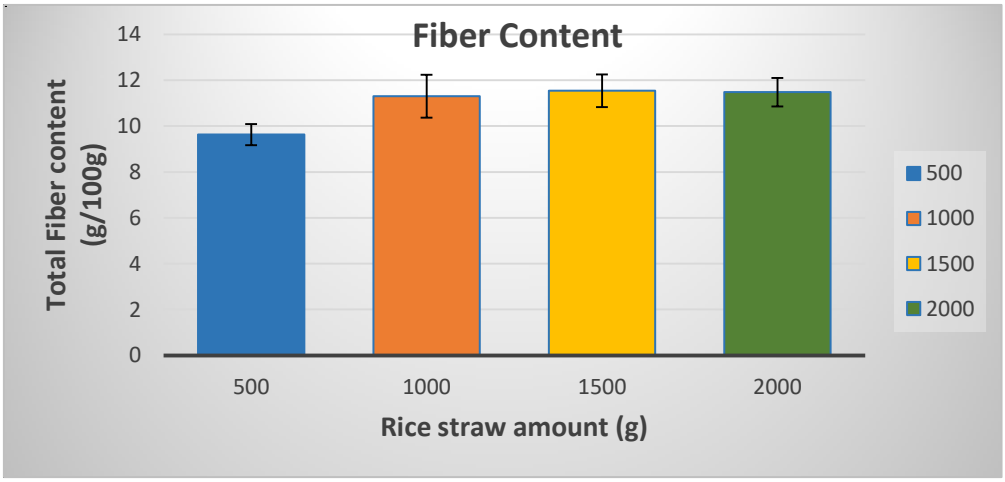

Fig8. Effect of different amount of Rice straw as substrate on carbohydrate content of *P. ostreatus*-OS mushroom. (g/100g of dried sample) (where n=4). Results are expressed as mean ± SEM (Standard error of mean) of tetraplicate determination (n=4).

Ash Content

The Treatment-3: OS+1500g RS had the lowest ash percentage (8.5±0.43%), while The Treatment-4: OS+2000g RS had the greatest (11.48±0.62%) (Figure, 9). The ash content of *P. ostreatus*-OS mushroom is lower when grown on 1500g & higher when cultivated on 2000g, according to the findings of this study.

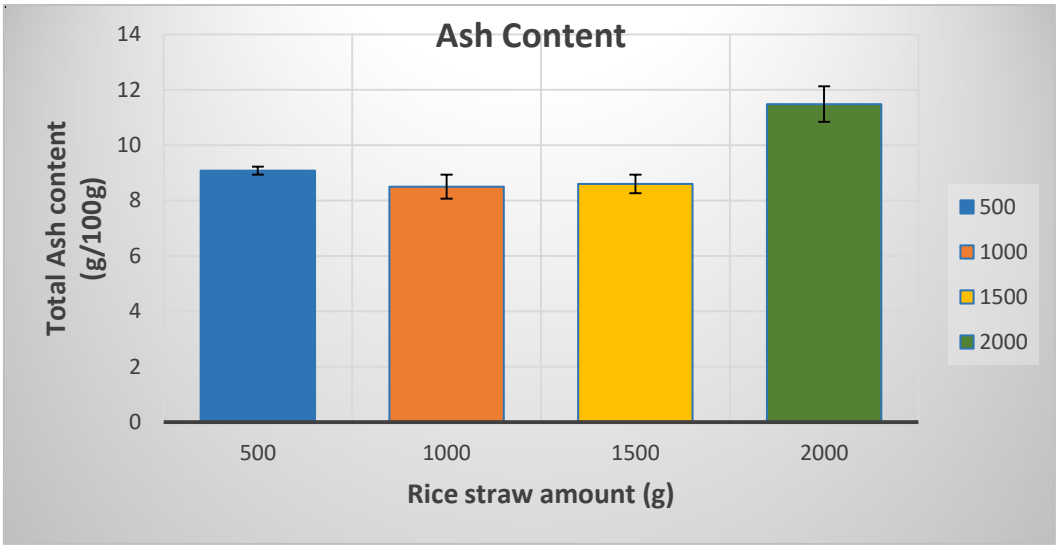

Fig 9. Effect of different amount of Rice straw as substrate on ash content of *P. ostreatus*-OS mushroom. (g/100g of dried sample) (where n=4). Results are expressed as mean ± SEM (Standard error of mean) of tetraplicate determination.

Conclusion

Pleurotus ostreatus-OS mushroom are rich in nutrients. Fiber, vitamins, minerals, and other essential components are abounding in OS mushrooms. The result of the present study showed that, mushroom grown on 2000g rice straw was more nutritious than others with lower carbohydrates, and higher protein content. The highest biological efficiency was also counted in mushroom cultivated on 2000g rice straw. However, mushrooms grown on each treatment are highly nutritious with high protein and fibre value with low fat and carbohydrates which make it health beneficial food especially against cardiac diseases and diabetes.

Acknowledgement

Authors gratefully thank Jahangirnagar University authority for providing the funding to conduct this research.

References

1. Emilio Martínez-Ibarra1, María Belén Gómez-Martín and Xosé Anton Armesto-López, 2019.Climatic and socioeconomic aspects of mushrooms. The case of Spain. Sustainability, 11(4):1030.
2. Kakon ,A.J. and M.B.K.Choudhury,2015.Nutritional and medicinal perspective of *Hericium* mushroom. Bangladesh Journal of Mushroom,9(1):67-75.
3. Ng'etich,O.K., O.I. Nyamangyoku, J.J. Rono1 A.N. Niyokuri and J.C. Izamuhaye,2013. Relative performance of oyster rmushroom (*Pleurotus florida*) onagro-industrial and agricultural substrate. International Journal of Agronomy and Plant Production, 4(1):109-116.
4. Md. Nuruddin Miah, Asma Begum, Nasrat Jahan Shelly, Debu Kumar Bhattacharjya, Ratan Kumar Paul and Md. Homayun Kabir,2017. Effect of different sawdust substrates on the growth, yield and proximate composition of white oyster mushroom (*Pleurotus ostreatus*). Bioresearch Communications, 3(2):397-410.
5. Syed Abrar Ahmed, J.A.Kadam1, V.P. Mane, S.S. Patil and M.M.V. Baig Biological ,2009.efficiency and nutritional contents of *Pleurotus florida* (Mont.) Singer cultivated on different agro-wastes. Nature and Science,7(1):44-48.
6. World Bank, 2004.World Development Reports, Oxford University Press, Inc., NewYork.

7. Chandha ,K.L. and S.R. Sharma Advances,1995.in horticulture mushroom, Malhotra Publication House, New Delhi.
8. Chang, S., 1997. "World production of cultivated edible and medicinal mushrooms in 1997 with emphasis on< i> Lentinus edodes</i>(Berk.) Sing, in China," International Journal of Medicinal Mushrooms, vol. 1, 291-300.
9. Obodai ,M., J. Cleland-Okine, and K. Vowotor, 2003."Comparative study on the growth and yield of pleurotus ostreatus mushroom on Different ligno cellulosic by-products," Journal of Industrial Microbiology and Biotechnology, vol. 30, 146-149.
10. Sánchez ,C., 2010. "Cultivation of *Pleurotus ostreatus* and other edible mushrooms," Applied Microbiology and Biotechnology, vol. 85, 1321-1337.
11. Garcha ,H. K. P. S. G., 1993.Nutritional importance of mushrooms. In: Mushroom biology and mushroom products Chinese University, B. J. C. S. E. Chang S, Ed., Hong Kong: Chinese University Press.
12. Asmamaw ,T., T. Abebe and K. Gebre, 2015. "Optimization of oyster (*Pleurotus ostreatus*) mushroom cultivation using locally available substrates and materials in Debre Berhan, Ethiopia," Journal of Applied Biology & Biotechnology, vol. 3, 15-20.
13. Justo ,M. G. G. M. E. D. C. M. G. C. E., 1998. "Chemical composition of three mushrooms strains (*Pleurotus ostreatus*) (Composição química de três cepas mexicanas de setas (Pleurotus Ostreatus)," Archive Latin Nutrition, vol. 48, 359-363.
14. Manzi ,P., L. Gambelli, S. Marconi, V. Vivanti and L. Pizzoferrato, 1999. "Nutrients in edible mushrooms: An inter-species comparative study," Food Chemistry, vol. 65, 477-482.
15. Bonatti ,M., P. Karnopp, H. M. Soares and S. A. Furlan, 2004."Evaluation of *Pleurotus ostreatus* and *Pleurotus sajor-caju* nutritional characteristics when cultivated in different lignocellulosic wastes," Food Chemistry, vol. 88, 425-428.
16. Shashirekha ,M. N., S. Rajarathnam and Z. Bano, 2005."Effects of supplementing rice straw growth substrate with cotton seed on the analytical characteristics of the mushroom *Pleurotus florida* (Block &Tsao)," Food Chemistry, vol. 92, 255-259.
17. Pedra ,W.and R. Marino, 2006."Axenic cultivation of *Pleurotus* spp. in coconut exocarp sawdust supplemented with rice bran ou wheat bran (Cultivo axênico de Pleurotus spp. em serragem da casca de coco (Cocos nucifera Linn.) suplementada com farelo de arroz e/ou," Archives of the Biological Institute, vol. 73, 219-225.
18. Pedra ,W., M. Carnelossi, G. Silva, P. Yaguiu, M. L. Lira, G. B. Gonçalves and R. Marino, 2009. "Chemical and sensorial analysis of *Pleurotus ostreatus* cultivated in coconut exocarp supplemented with wheat bran and/or rice bran (Análise química e sensorial de Pleurotus ostreatus cultivado em casca de coco suplementada com farel," Archives of the Biological Institute, vol. 76, 91-98.
19. Menolli ,J., T. Asai, M. Capelari and L. Paccola-Meirelles, 2010. "Morphological and molecular identification of four brazilian commercial isolates of *Pleurotus* spp. and cultivation on corncob," Brazilian Archives of Biology and Technology, vol. 53, 397-408, View at Google Scholar | View at Publisher Current Research in Agricultural Sciences, 2018, 5(1): 15-22 21.
20. Omarini ,A., V. Nepote, N. Grosso, J. Zygadlo and E. Albertó, 2010. "Sensory analysis and fruiting bodies characterisation of the edible Mushrooms *Pleurotus ostreatus* and *Polyporus tenuiculus* obtained on leaf waste from the essential oil production industry," International Journal of Food Science & Technology, vol. 45, 466-474.
21. Eira ,A., Edible fungi (Fungos comestíveis),2004.In: Fungi: An introduction to biology, biochemistry and biotechnology (Fungos: uma introdução à biologia, bioquímica e biotecnologia), (Azevedo JL (Ed.) ed.). Caxias do Sul: Educs.: Espósito E.
22. Ali, M.R., M.S. Hoque, K.U. Ahmed and M.H. Rahman,2010.Effect of Wheat Bran Supplements with Sugarcane Bagasse on the Yield and Proximate Composition of Oyster Mushroom (*Pleurotus ostreatus*). Bangladesh J. Mushroom. 4(2): 21-26.
23. Amin, S.M.R. ,2002. Performance of different Oyster mushroom (*Pleurotus* spp) varieties. M.S. Thesis. Bangabundhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur. 72.
24. Amin, S.M.R., N. C. Sarker, A. Khair and N.Alam,2007. Detection of Novel Supplements on Paddy Straw Substrates on Oyster Mushroom Cultivation. Bangladesh J. Mushroom. 1(2): 18-22.

25. Ancona-Mendex, M.L., C. Sandoval, R. Belmar-Casso and C.M. Capetilo-Leal,2005.Effect of substrate and harvest on the amino acid profile of oyster mushroom (*Pleurotus ostreatus*). J. Food Comp. Analysis. 18(5): 447-450.
26. Alam, N., A. Khan, M.S. Hossain, S.M.R. Amin and L.A. Khan,2007. Nutritional Analysis of dietary Mushroom *Pleurotus florida* Eger and *Pleurotus sajorcaj* (Fr.) Singer. Bangladesh J. Mushroom. 1(2): 1-7.
27. Alam, S.M. and R.Saboohi,2001.Importance of mushroom. http://www. Mushroom world. com.
28. Ali, M.A., S. Hussain, R. Nawaz, A.Ahsan and M. Siddiq,2004. Effect of pasteurization techniques on mycelial growth of Oyster Mushroom, *Pleurotus* spp. J. Agric Res.. 42(2): 201-205.
29. Akyuz ,M. and S. Kirbag ,2010.Nutritive value of wild edible and cultured mushrooms. Turk J Biol 34: 97–102.
30. Alam, N., R. Amin, A. Khan, I. Ara, M. Shim, M.W. Lee *et al.* ,2009. Comparative effects of oyster mushroom on lipid profile, liver and kidney function in hypercholesterolemic rats. Mycobiology 37: 37-42.
31. Alam ,N., R. Amin, A. Khan, I. Ara, M. Shim, M.W. Lee, *et al.* ,2008. Nutritional analysis of cultivated mushroom in Bangladesh *Pleurotus ostreatus*, *Pleurotus sajor-caju*, *Pleurotus floridai* and *Calocybe indica*. Mycobiology 36:228-232.
32. Bauerova,K., E. Paulouicova, D. Mihalava, K.Svik and S. Ponist ,2009. Study of new ways of supplementary and combinatory therapy of rheumatoid arthritis with immuno-modulators Glucomannan and Immunoglukan in adjuvant arthritis. Toxicol Ind Health 25:329-335.