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Low-Cost Substrate for Sustainable Oyster Mushroom (*Pleurotus ostreatus*) Production at Salinity-Prone Coastal Region of Bangladesh

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Abstract: The yield of major crops is declining steadily due to increasing salinity intrusion in the coastal regions of Bangladesh. Mushroom production offers a viable alternative for improving the socio-economic conditions of coastal communities, as it is unaffected by field salinity and can be cultivated within household environments. The current research has been conducted in the Farm and Agricultural Chemistry Laboratory, Patuakhali Science and Technology University, Bangladesh to identify suitable pack size and low-cost substrate for oyster mushroom production. Here, rice straw, rain tree sawdust, cocoanut coir and rain tree biochar were used as substrates (0.5, 1.5 and 3.0 kg packets) for *Pleurotus ostreatus* mushroom production. Rice straw (3.0 kg) produced a higher amount of mushroom (765.10 gm) than other substrates. The highest average yield (400.5 gm) was observed in medium packet of rice straw, followed by saw dust (227.30 gm), and cocoanut coir (149.5 gm). Mushroom did not survive on the biochar substrate. Rice straw appears to be the most suitable substrate, yielding more mushrooms compared to other options. Here, small packet (0.5 kg) rice straw is more conducive, economic and profitable for *P. ostreatus* mushroom production rather than medium (1.5 kg) and large (3.0 kg) in respect to yield, labor and substrate cost (benefit-cost ratio for small packet, BCR 5.63). However, successful cultivation requires maintaining a temperature of 22–25 °C and a humidity level of 70–80%, which can be achieved by spraying water in the growing chamber four times daily. There was no significant variation in the nutritional composition of mushrooms grown on sawdust, rice straw, and coco coir substrates, except for differences in calcium, magnesium, phosphorus, and potassium. Nevertheless, the high protein content and low sodium-to-potassium ratio make mushrooms a healthy dietary option for everyone. The findings from this study can support farmers in improving their livelihoods and contribute to sustainable agricultural practices.

Keywords: rice straw; saw dust; oyster mushroom

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1. Introduction

About 60% of people are conducting the traditional ways of farming and livestock rearing for their livelihoods in coastal areas of Bangladesh but the production is steadily declining in the coastal regions of Bangladesh due to increasing salinity intrusion [1–3]. Mushroom cultivation is a promising option to address climate change, enhance the socio-economic conditions of coastal inhabitants, meet their nutritional needs, increase the income of marginal farmers, and its spent substrate can be used as good organic fertilizers [4–7]. The global demand of mushroom is also increasing day by day from 0.3 million tons to 3.4 million tons from 1965 to 2015 [8]. Industrial production of mushroom started very recently in Bangladesh but many growers failed to continue the production and already gave up their business due to the inconsistent environmental condition with high temperature (32–40 °C), low humidity (60–70%), lack of good spawn, quality substrate, and other factors [9,10]. Various substrates like saw dust from wood, rice straw, sugarcane bagasse, tea waste, water hyacinth etc. were used for mushroom production [11–16]. In coastal region of Bangladesh, there are many substrates which can be used as mushroom spawn production like saw dust from soft and hard wood, rice straw, fallen leaves, water hyacinth, banana leaves, coconut coir, mung bean straw, farm yard manure, compost, biochar etc. In addition, mushrooms cultivation does not require access to land and can be grown within a room using vertical racks. If these substrates are suitable for mushroom production, then mushroom production cost will be reduced and farmers will be more benefitted. So, the current research has been designed to develop low-cost substrates and analyze the environmental factors for sustainable mushroom cultivation in the salinity prone coastal region of Bangladesh.

2. Methodology

2.1. Tissue Culture, Mother Spawn and Commercial Spawn Production

Tissue culture of oyster mushroom (*Pleurotus ostreatus*) was successfully done in the Agricultural Chemistry Laboratory of Patuakhali Science and Technology University (PSTU) for quality spawn production using potato dextrose agar (PDA) media during 2023–2025. The oyster mushroom strain *Pleurotus ostreatus* (PO2) was obtained from the National Mushroom Development & Extension Centre, Department of Agricultural Extension, Savar, Dhaka, Bangladesh during October 2023. The mother spawn was prepared from the tissue culture using wheat (*Triticum aestivum* L., variety: BARI Gom-33, commonly cultivated species collected from Bangladesh Wheat and Maize Research Institute, BWMRI, BARI, Bangladesh during October, 2023) as the substrate [17]. Clean and healthy wheat grains, free from mold or contaminants, were selected. The wheat grains were thoroughly rinsed with water to remove dirt and impurities. The wheat grains were soaked in water for 12–24 h to allow them to absorb moisture, making them suitable for fungal growth. After soaking, the water was drained and boiled the grains for 15–20 min until they were soft but not mushy. It is ensured the grains did not burst; they retained their shape while being fully hydrated. Spread the cooked grains on a clean surface or tray and allowed them to cool and dry slightly. Mixed in a small amount of calcium carbonate (about 1.5% by weight) to maintained a neutral pH, which was ideal for mushroom growth. The prepared grains were transferred into sterilizable containers, ensuring the lids were tightly secured and equipped with air filters or holes for gas exchange. The jars were sterilized at 121 °C (15 psi) for 1 h (hr) in an autoclave. This step was crucial for eliminating unwanted microorganisms. The sterilized jars were cooled at room temperature in a sterile environment to prevent contamination. A small piece of mushroom tissue or mycelium (three actively growing PDA mycelial agar pieces of 5 mm × 5 mm size) were transferred to the prepared substrate (300 g wheat grains) under laminar air flow chamber to minimize the contamination. 500 g commercial spawn were prepared using wheat grains after proper cleaning, soaking and boiling until adequately hydrated, and adding 2% gypsum. The processed wheat grains were then filled into a poly bag and sterilized. After cooling, 15 g mother spawn were added aseptically under laminar air flow cabinet. Incubation was done until completely colonized by mycelium.

2.2. Collection and Preparation of Substrate for Oyster Mushroom

The substrate of oyster mushroom was prepared by using rice (*Oryza sativa*. L) straw, rain tree (*Samanea saman* (Jack.) Merr.) sawdust (GPS coordinates: 22.4616559, 90.3843489), coconut (*Cocos nucifera* L.) coir and biochar (made from rain tree wood, GPS coordinates: 22.4616559, 90.3843489, Date: November 2023). Rice straw was cut into 2.5 cm long pieces as this size produced higher mushroom then cleaned and soaked in water for 2 to 4 hrs [18]. $CaCO_3$ and rice bran are mixed at 0.2 and 1%, respectively followed by filling in a polypropylene bag. The moisture was adjusted at 65% by spraying water. The details of treatments were given in supplementary Table S1. The mixture was filled into heat tolerant polypropylene bags (0.5, 1.5 and 3 kg/packet). Similar bag was prepared using the other substrate. Then all spawn bags were autoclaved (at 121 °C and 15 PSI) for 1 hr. Cooling

of spawn substrate and inoculation was done with commercial spawn under laminar airflow chamber at the rate of 5% per packet in a layer alternating with substrate. Packets were then incubated for mycelium running and mushroom cultivation in the incubation room at 22–24 °C. Then the bags were placed on rack in the previously prepared mushroom grown house (made by bamboo and straw for good aeration) in the Farm area of Patuakhali Science and Technology University (PSTU), Patuakhali at 200–500 Lux light intensity [19]. Ten replicates for packet size were maintained for each substrate and details of treatments were given in Supplementary Table S1. All instruments, glassware and culture media were sterilized by autoclaving with 15 PSI at 121 °C for 1 hr. The culture room of the laboratory was cleaned by gently washing with detergent followed by 70 % ethyl alcohol regularly.

2.3. Yield Data Collection and Nutritional Analysis

After three days of incubation, the packet was cut side by side using a sterile stainless-steel blade to produce small opening to facilitate the fruiting of mushroom. Water sprayed four times a day (7:30 AM, 11:30 AM, 3:30 PM, and 5:30 PM) with the help of a spray machine. Yield data of mushroom (fresh weight) was recorded after each flush/harvest namely- 1st, 2nd, 3rd, 4th, 5th and 6th flush. Finally, yield was analysis from all harvested data from each packet. Unfortunately, no fruiting was not found in biochar spawn, hence no data regarding biochar is presented here. Relative humidity and temperature data was recorded four times a day. The collected mushroom was chemically analyzed for protein, carbohydrate, sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), phosphorus (P), iron (Fe), ash, moisture content etc. using standard methods [3,20,21]. Three replications were maintained for nutritional analysis.

2.4. Mushroom Sample Processing for Chemical Analyses

Oyster mushroom (*Pleurotus ostreatus*) was collected from each substrate separately. Mushroom samples were thoroughly rinsed with tap water followed by double distilled water to remove surface dirt, and spread out on blotting paper to remove excess water. Then the samples were air dried followed by oven dry (Heraeus, Germany) at 70 °C for 48 hrs and grinding to make powder using a grinding machine (A11, Basic analytical mill, IKA, Germany) [3].

2.5. Wet Oxidation and Chemical Analyses of Mushroom Samples

Exactly 0.2 to 0.4 gm (METTLER TOLEDO, Max. 210 g, Min. 0.01 g, d = 0.1 mg) of oven dried and powdered sample was extracted using 8–10 mL di-acid mixture (HNO_3:$HClO_4$ = 2:1, MERK, Germany) in a digestion chamber (DK 20 Digestion Unit, VELP Scientifica Srl, Italy) followed by addition of 2 mL H_2O_2 (30%, *v*/*v*) for elemental (Na, K, Ca, Mg, P, and Fe) determination after filtration with Whatman No. 42 filter paper and necessary dilution [3,22]. Then the extracts were used for K and Na determination by flame photometry method using flame emission spectrophotometer (Spectrolab, UK) using selective filter. Phosphorus was determined by UV-VIS spectrophotometry method (UV 1900i, Shimadzu, Japan) at 660 nm, after necessary color developments [23,24]. Nutrients elements like Ca, Mg, and Fe were determined by using atomic absorption spectrophotometer (AAS Spectra 55B, Varian, Australia) [25]. Carbohydrate and moisture were determined by anthrone method and evaporation method, respectively, whereas ash by using a muffle furnace [26]. Protein was determined from mushroom samples followed by Kjeldahl method using Kjeldahl digestion and auto distillation apparatus as described by Latimer [27].

2.6. Statistical Analysis

Data were statistically analyzed and results were expressed as the means ± standard deviation (SD) of ten replicates. The significance level was calculated using appropriate statistical software packages (JMP 14 and Microsoft Office 2010 Professional). We performed a *t*-test to compare the treatment groups, specifically the nutritional compositions of mushrooms grown on various substrate (sawdust, rice straw, and coco coir). Two-way ANOVA were also performed to identify mushroom yield efficiency (g kg^{-1} substrate) based on substrate and packet size.

3. Results and Discussion

3.1. Results

3.1.1. Yield of Mushroom at Rice Straw, Saw Dust and Coconut Coir in Small Pack (0.5 kg)

The yield of *Pleurotus ostreatus* mushroom on rice straw, saw dust, and coconut or coco coir small pack (0.5 kg) were represented in Figure 1 and Supplementary Table S2. The highest average yield was observed in case of rice straw packet (287.10 gm) and the lowest was found in coconut coir small packet (116 gm). The maximum (340 gm) amount of mushroom was harvested from individual packet of rice straw small packet (Supplementary Table S2). Cocoanut coir small pack represented the lowest yield followed by saw dust and rice straw (Supplementary Table S2). In case of 1st flush, the highest average yield was also observed in rice straw pack (87 gm), followed by saw dust packet (52 gm), and coco air pack (39.50 gm). The same scheme was found in case of 2nd, 3rd, 4th and 5th flush that rice straw pack provided the highest yield followed by saw dust and coco coir (Supplementary Table S2). In case of 6th time, the production rice straw and coco air pack gave the same yield. It is found that, the production of mushroom from rice straw small pack is better than that of saw dust and coco coir substrate. It is mentioned that, the mycelia colonization was rapidly completed in rice straw (25–28 days) followed by saw dust (26–29 days) and coco coir (29–32 days of incubation). The first flush was done after 3–5 days of full colonization and harvesting was continued until 7–8 weeks (up to 6th flush) on average for all packets.

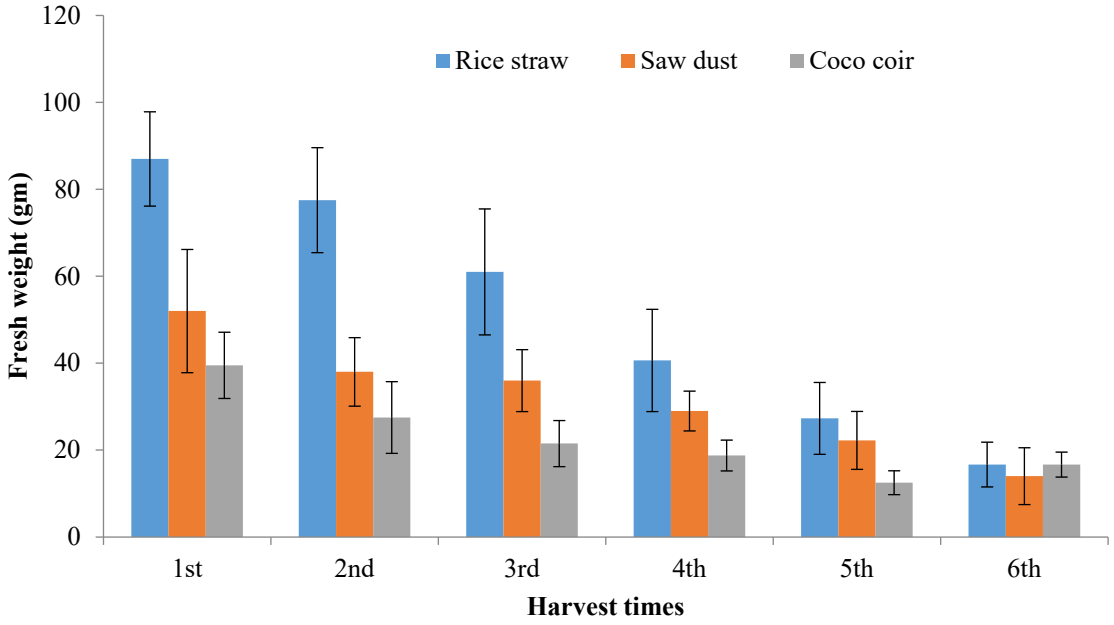


Figure 1. Production and harvesting times of *P. ostreatus* mushroom using small packet (0.5 kg) substrates [Error bar indicates mean ± sd (n = 10)].

3.1.2. Yield of Mushroom at Rice Straw, Saw Dust and Coconut Coir in Medium Pack (1.5 kg)

The observation on yield of mushroom at saw dust, rice straw and coconut coir pack (1.5 kg) at different harvesting time are presented in Figure 2 and Supplementary Table S3. The highest average yield was observed in case of rice straw packet (400.5 gm) among which 310 gm was minimum and 505 gm was maximum, which was followed by saw dust (227.30 gm), and coconut coir pack (149.5 gm) (Supplementary Table S3). Here's 2nd harvesting time displayed more performance than 1st timer and average yield comparison is 98 gm > 89 gm for medium packet rice straw (Supplementary Table S3), then gradual decrease of yield occurred. Other substrates like saw dust and coco coir pack performed like in Figure 2. Here rice straw also showed better performance as substrate for growing this oyster mushroom species.

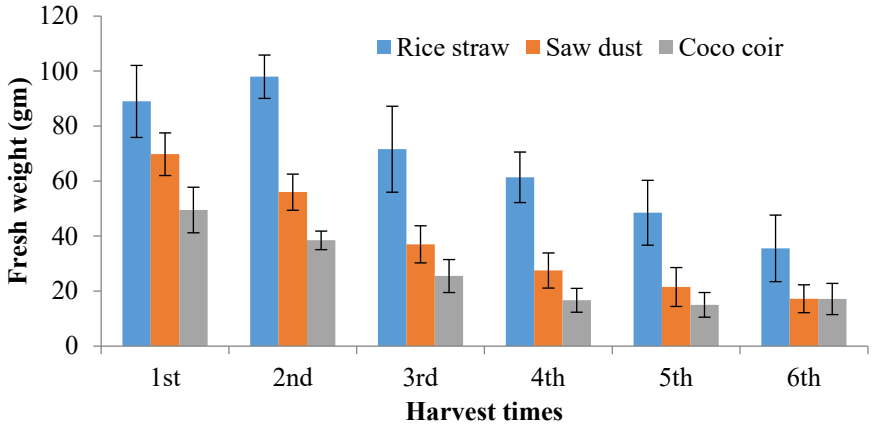


Figure 2. Production and harvesting times of *P. ostreatus* mushroom using medium packet (1.5 kg) substrates [Error bar indicates mean ± sd (n = 10)].

3.1.3. Yield of Mushroom at Rice Straw; Saw Dust and Coconut Coir in Large Pack (3.0 kg)

The economical yield of *Pleurotus ostreatus* strain on saw dust; rice straw and coco coir pack (3.0 kg) are displayed in Figure 3 and Supplementary Table S4. The highest average yield was observed in case of rice straw packet (765.10 gm) followed by saw dust packet (336.5 gm) and coco coir pack (258 gm). From 1st time harvest, the highest yield was found in rice straw pack (193.50 gm) followed by saw dust (73.50 gm) and coco coir (64 gm). In case of 2nd time production, rice straw also provided the highest yield which was greater than 1st time production (202.50 > 193.5 gm) (Supplementary Table S4). Same result was found in all other time production. But the yield was gradually decreased for mushroom growing in saw dust and coco coir with increasing the flush time, like the highest yield was found in 1st time production and the lowest yield found in 6th time production. For medium and large rice straw pack, the highest amount was found in 2nd flush and then gradually decreased with time (Supplementary Tables S3 and S4).

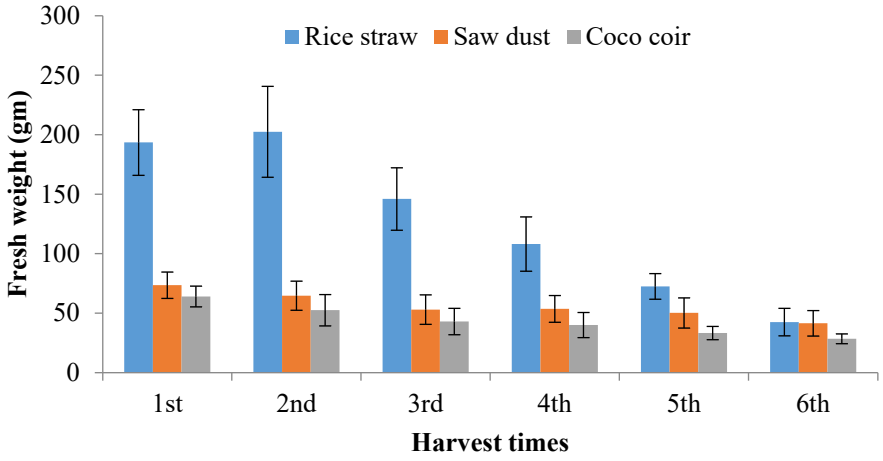


Figure 3. Production and harvesting times of *P. ostreatus* mushroom using large packet (3.0 kg) substrates [Error bar indicates mean ± sd (n = 10)].

3.1.4. Average Yield Efficiency

Figure 4 displayed average yield of mushroom in relation to packet size. Large packet was found higher production than medium and small packet. Rice straw packet displayed always maximal yield than others. In case of 0.5 kg pack, the highest average yield was observed at rice straw packet (287.10 gm) followed by saw dust packet (182 gm) and coco coir packet (116 gm). From 1.5 kg packet better yield was observed than that of 0.5 kg pack, (rice straw> saw dust > coco coir = 400.5 > 227.30 > 149.5 gm). Yield variation was also observed from 3.0 kg packet, rice straw > saw dust > coco coir = 765 > 336.5 > 258 gm). The yield was almost twice for rice straw substrate than saw dust and coco coir. Two-way ANOVA showed that substrate type, packet size, and their interaction significantly affected mushroom yield efficiency (g kg^{-1} substrate) ($p < 0.001$) (Supplementary Tables S5 and S6). Substrate type had a strong effect (F = 257.77), with rice straw producing the highest overall efficiency

(365.41 g kg^{-1}), followed by sawdust (209.23 g kg^{-1}) and coconut coir (139.22 g kg^{-1}). Packet size also significantly affected efficiency (F = 335.85), with the 0.5-kg packet showing the highest overall efficiency (390.07 g kg^{-1}). The significant interaction (F = 16.57) indicates that efficiency varied according to both substrate and packet size. Rice straw at 0.5 kg showed the highest efficiency (574.20 g kg^{-1}).

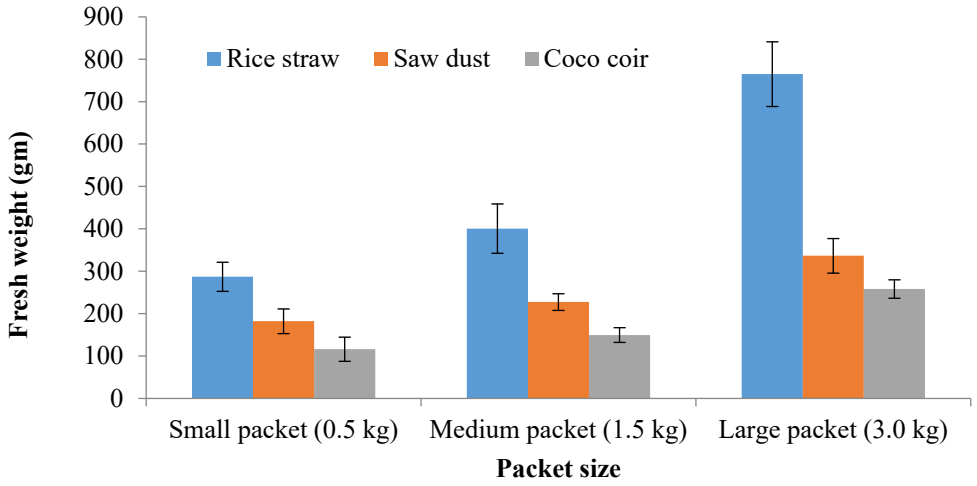


Figure 4. Average yield of *P. ostreatus* mushroom (gm) in relation to packet size [Error bar indicates mean ± sd (n = 10)].

3.1.5. Cost-Benefit Analysis

The cost-benefit analysis demonstrated substantial differences among substrate types and packet sizes. Rice straw showed the highest overall economic performance, particularly at the 0.5-kg packet size, which produced the highest benefit-cost ratio (BCR, 5.63), indicating the greatest return relative to production investment (Supplementary Table S7). It also achieved the highest substrate-use efficiency (574.20 g kg^{-1} substrate). However, the 3.0-kg rice-straw treatment produced the highest absolute mushroom yield (765.10 g $packet^{-1}$), and highest net return (BDT 114.78 $packet^{-1}$). Although its BCR (2.50) was lower than that of the 0.5-kg treatment, the larger packet generated substantially greater production and absolute profit per cultivation unit. Sawdust was also economically promising at 0.5 kg, with a BCR of 3.08 and net return of BDT 30.75 $packet^{-1}$. However, its economic performance declined markedly with increasing packet size, reaching a BCR below 1.0 at 3.0 kg. Coconut coir showed comparatively poor economic performance, with only the 0.5-kg treatment generating a positive return. Overall, rice straw was the most suitable substrate under the studied conditions, while 0.5 kg was optimal for economic efficiency and 3.0 kg was optimal for maximum yield and absolute net return.

3.1.6. Nutritional Quality of Oyster Mushroom Grown in Saw Dust, Rice Straw and Coco Coir Substrate

The nutritional quality of this oyster mushroom grown in saw dust, rice straw and coco coir substrate were presented in Table 1. There were no significant variations of nutritional composition of mushroom grown in this substrate except magnesium, phosphorus and potassium content in mushroom grown in rice straw and calcium content in mushroom grown in coco coir substrate. *Pleurotus ostreatus* mushroom has high nutritive values containing high amount of protein (26.87–27.10%, dry basis) which is almost equal to beef meat [28]. Total carbohydrate content was found in range from 35.53 to 36.97%. It is a rich source of P, K and Fe (Table 1). It also contains higher amount of ash, Ca and Mg, P and K but low in sodium. The Na/K ratio (0.14–0.15) and Ca/Mg ratio (0.65–0.78) which is <1.0 indicated its human health benefits. From the nutritive assessment, it is concluded that mushroom is good for health in all aspects.

3.1.7. Effect of Environmental Factors on Yield of Oyster Mushroom

Environmental factors especially temperature and humidity have distinct effects on yield of oyster mushroom in coastal region of Bangladesh. Here daily four-time spray were given per day to control the temperature at 22–25 °C and relative humidity (RH) at 80–90% of the growth chamber. Data presented in Table 2 indicated that January and February are the most suitable time for mushroom production in coastal Patuakhali region of Bangladesh as this period provides lower temperatures (13–28 °C) and higher relative humidity (43–86%). In case of seasonal variation, the average yield of this variety (winter) was higher in all cases. The all six harvests were

done during the January—February months (Supplementary Tables S2–S4) giving four times spray per day. Later on, the yield was gradually decreased. So seasonal impact in respect to temperature and humidity has distinct effects on mushroom production.

Table 1. Nutritional composition of *Pleurotus ostreatus* mushroom grown in saw dust, rice straw and coco coir [data indicates mean ± sd, n = 3, * indicates significantly difference at 5% level].

Sl. No.	Name of Components	Mushroom Grown in Saw Dust	Mushroom Grown in Rice Straw	Mushroom Grown in Coco Coir
1.	% Moisture	86.90 ± 0.62	87.67 ± 1.72	87.43 ± 1.43
2.	% Dry matter	11.57 ± 1.16	11.33 ± 1.10	11.35 ± 1.07
3.	% Ash	8.83 ± 0.75	8.80 ± 0.75	8.53 ± 0.59
		Oven dry basis composition		
4.	% Protein	27.10 ± 0.75	26.87 ± 0.67	27.03 ± 0.50
5.	% Carbohydrate	35.53 ± 1.45	36.97 ± 1.29	35.90 ± 0.96
6.	Calcium (mg/100 g)	8.63 ± 0.40	10.03 ± 1.06	* 11.07 ± 1.05
7.	Magnesium (mg/100 g)	13.00 ± 1.14	* 15.50 ± 0.72	14.33 ± 0.67
8.	Iron (mg/100 g)	26.60 ± 0.62	26.93 ± 0.45	27.37 ± 1.27
9.	Phosphorous (mg/100 g)	934.37 ± 24.18	* 975.23 ± 13.82	920.43 ± 20.85
10.	Sodium (mg/100 g)	4.20 ± 0.30	4.10 ± 0.17	4.03 ± 0.21
11.	Potassium (mg/100 g)	27.63 ± 0.85	* 28.53 ± 0.55	26.73 ± 0.38
12.	Na/K ratio	0.15 ± 0.01	0.14 ± 0.01	0.15 ± 0.01
13.	Ca/Mg ratio	0.67 ± 0.08	0.65 ± 0.08	0.78 ± 0.11

Table 2. Relative humidity and temperature condition during *Pleurotus ostreatus* mushroom cultivation at different day time before water spray [data represent mean ± sd].

Month	7.30 AM		11:30 AM		3:30 PM		5:30 PM	
	Temp °C	%RH	Temp °C	%RH	Temp °C	%RH	Temp °C	%RH
January	13.2 ± 2.0	85 ± 4	14 ± 1.9	60 ± 6	25 ± 1	43 ± 4	24 ± 3	45 ± 3
February	17.9 ± 4.0	86 ± 6	26 ± 2.2	55 ± 6	28 ± 3	45 ± 8	25 ± 2	54 ± 6
March	23.1 ± 2.2	86 ± 6	31 ± 3.1	60 ± 10	31 ± 3	42 ± 11	30 ± 1	55 ± 9
April	25.6 ± 2.1	86 ± 2	32 ± 1.5	62 ± 7	33 ± 2	56 ± 9	32 ± 1	56 ± 4
May	29.7 ± 2.3	87 ± 5	32 ± 1.5	70 ± 5	32 ± 2	67 ± 9	33 ± 2	73 ± 5

3.2. Discussion

The highest yield was found in rice straw substrate for all pack size which is consistent with the findings of De et al. [29], Sharma et al. [19], and Zhang and Fadel [18]. Sharma et al. [19] found the best yield using rice straw (381.85 gm) as substrate compared to substrate from sugarcane bagasse and saw dust, whereas Zhang and Fadel [18] revealed that rice straw produced 10% more yield compared to wheat straw. But vermicompost in combination with rice straw (1:2) was found higher yield for *Pleurotus ostreatus* in comparison with rice straw alone or vermiwash [30]. Rice straw showed better results as it is a reservoir of cellulose, hemicellulose and lignin which is utilized by this species during the growth and development [31]. This is might be due to the rice straw in combination with rice bran easily break down or decompose to supply nutrients to the *P. ostreatus* for rapid fruiting [19]. Shah et al. [32] reported that colonization formation of *P. ostreatus* appears within 27–34 days of inoculation which is consistent with the results of this study (25–28 days). They also found that the size of fruiting bodies was higher in case of rice straw due to higher degradation of various constituents of the substrate rice straw and consumption of high nutrients by *P. ostreatus*. *P. ostreatus* is not sustained on biochar substrate might be due to the presence of high organic carbon (76.11%) and low amount of available nutrients [33].

The cultivated mushroom contained high amount of protein (26.87–27.10%) and carbohydrates (35.53–36.97%) which is lower than the findings of Patil et al. [34] but higher than the findings (crude protein 17.06%) of Effiong et al. [35] and consistent with the results of Sharma et al. [19] who found that fruiting bodies of *P. ostreatus* are quite rich in protein (22.89–25.97%) and carbohydrate (30.24–42.26%). Tiupova et al. [36] found that oyster mushroom contained about 43–60% of carbohydrate and only 1.2% fat, whereas, Boadu et al. [37] found that average carbohydrate content was 56.28%. There is no significant variation of nutritional composition of this mushroom grown in different substrate except Ca, Mg, P and K. Magnesium, P and K are significantly ($p < 0.05$) higher in mushroom grown in rice straw than others (Table 1). The amount of P and Fe in *P. ostreatus* are ranges from 920–975 and 26.60–27.37 mg/100 gm, respectively (Table 1) which is higher than most of the fruits and vegetables commonly available in Bangladesh [38]. Zhang and Fadel [18] found 970 mg/100 gm in another oyster mushroom, *P. sajor-caju*. The Na/K and Ca/Mg ratio were less than 1.0 in this species makes it safe consumption of hypertension and cardiovascular patients [39,40]. Successful cultivation of oyster mushroom requires to maintain a temperature of 22–25 °C and a relative humidity level of 70–80%, which is naturally available (before noon time) at Jan-Feb of the year in the coastal region of Bangladesh. So, if anybody wants to

cultivate the mushroom other than Januray-February, then 4 times water spray in a day will achieve these favorable conditions. Some other researchers also revealed that *Pleurotus* species can grow in ranges of 25 to 30° C temperature and 80 to 90% humidity [41–43].

4. Conclusions

The most suitable substrate for mushroom production is rice straw which is easily available and cheaper among the substrates. The maximum average yield (765.10 gm/packet) was obtained from large packet rice straw (3.0 kg), but BCR analysis demonstrated that 0.5-kg rice straw packet produced the highest BCR (5.63). In all cases, the order of mushroom yield is rice straw > saw dust > coco coir. Mushroom did not survive in biochar and hence data were not shown here. The temperature and relative humidity for mushroom cultivation is about 22–25 °C and 80–90%, respectively which is achieved by four times water spray in mushroom growing chamber. So, December to February is the most suitable time for this oyster mushroom production in the coastal region of Bangladesh. Small packet is more economic and profitable for this mushroom variety than medium and large pack under above environment in relation to cost of substrate collection and processing. Nutritional values of mushroom grown in all substrate were rich in protein, phosphorus, potassium and iron, but low in sodium, and there was no significant variation of nutritional composition except Ca, Mg, P and K of mushroom grown in saw dust, rice straw and coco coir substrate.

5. Limitation of the Study

Substrate samples were not analyzed for C:N ratio, nutritional, minerals and proximate compositions. No data was recorded on number of fruiting bodies and other growth parameters fruiting bodies along with other growth parameters like size, diameters, shape, biological efficiency, bioconversion of mushroom etc. except fresh yield of mushroom.

Supplementary Materials

The additional data and information can be downloaded at: https://media.sciltp.com/articles/others/2611161431180557/PMSC-26050197-SM.pdf. Supplementary Table S1: Details of treatment. Supplementary Table S2: Yield (gm) of *Pleurotus ostreatus* mushroom using small packet (0.5 kg) substrates of RS (rice straw), SD (saw dust) and CC (coconut coir). Supplementary Table S3: Yield (gm) of *Pleurotus ostreatus* mushroom using medium packet (1.5 kg) substrates of RS (rice straw), SD (saw dust) and CC (coconut coir). Supplementary Table S4: Yield (gm) of *Pleurotus ostreatus* mushroom using large packet (3.0 kg) substrates of RS (rice straw), SD (saw dust) and CC (coconut coir). Supplementary Table S5: Two-way ANOVA of mushroom yield efficiency (g kg^{-1} substrate) based on substrate and packet size. Supplementary Table S6: Mean yield efficiency of mushroom (g kg^{-1}). Supplementary Table S7: Benefit-cost-ratio analysis.

Author Contributions

All authors contributed to the study conception and design. Material preparation, data collection, and analyses were performed by S.M.R.M., M.S.I., J.C.B., M.A.T.R., M.I.B., M.E.R., M.N.U. and M.S. The first draft of the manuscript was written by S.M.R.M. and J.C.B. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

This study involved experiments on cultivated plant species and did not involve human participants or animals. All experimental procedures involving plant materials were conducted in accordance with relevant institutional and national guidelines. The plant materials used in this study were obtained from authorized sources and handled responsibly. No endangered, threatened or protected plant species were collected or used in this research. All authors have read, understood, and have complied as applicable with the statement on “Ethical responsibilities of Authors” as found in the Instructions for Authors.

Informed Consent Statement

Not applicable.

Data Availability Statement

All data are available in the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

Use of AI and AI-Assisted Technologies

No AI tools were utilized for this paper.

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