EFFECT OF DIFFERENT SUBSTRATES RATIO ON THE GROWTH AND YIELD OF OYSTER MUSHROOM

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CERTIFICATE

This is to certify that the thesis entitled, "EFFECT OF DIFFERENT SUBSTRATES RATIO ON THE GROWTH AND YIELD OF OYSTER MUSHROOM" submitted to the Department of Horticulture, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of Master of Science in Horticulture, embodies the result of a piece of bona fide research work carried out by HAFSA KHATUN LUCKY Registration No. 09-03581 under my supervision and my guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

Dated: June, 2015
Place: Dhaka, Bangladesh

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Dedicated to
My
Beloved Parents

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ABSTRACT

The experiment was carried out at the Tissue Culture Laboratory and Culture House of Mushroom Development Institute, Savar, Dhaka, during the period from January 2014 to June 2014. The experiment consisted of two varieties, viz. V_1 (*Pleurotus ostreatus*) and V_2 (*Pleurotus djamor*) and nine different Substrates ratio S_1 (25% straw + 10% paddy grain (mother culture) + 65% sawdust), S_2 (35% straw + 10% paddy grain (mother culture) + 55% Sawdust), S_3 (45% Straw + 10% paddy grain (mother culture) + 45% Sawdust), S_4 (55% Straw + 10% paddy grain (mother culture) + 35% Sawdust), S_5 (65% Straw + 10% paddy grain (mother culture) + 25% Sawdust), S_6 (75% Straw + 10% paddy grain (mother culture) + 15% Sawdust), S_7 (85% Straw + 10% paddy grain (mother culture) + 5% Sawdust), S_8 (90% Straw + 10% paddy grain (mother culture)), S_9 (90% Sawdust + 10% paddy grain (mother culture)). The experiment was laid out in Completely Randomized Design with three replications. The maximum yield (66.50 g), the highest number of fruiting body (16.53), number of effective fruiting body (12.11) were observed in V_1. Significant variation was found in all parameter due to the effect of substrates ratio. The highest number of fruiting body (15.25), number of effective fruting body (12.11) and highest yield (63.25) were recorded in S_3. The combination between different variety and different substrates ratio was found significant variation on the yield. The maximum yield (90.00 g) was produced by V_1S_3 and the minimum yield (21.00 g) was produced by V_2S_6.

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LIST OF ABBREVIATIONS

Abbreviation	=	Full word
%	=	Percent
@	=	At the rate
°C	=	Degree Centigrade
Anon.	=	Anonymous
BARI	=	Bangladesh Agricultural Research Institute
BAU	=	Bangladesh Agricultural University
BBS	=	Bangladesh Bureau of Statistics
CV	=	Coefficient of Variance
cv.	=	Cultivar (s)
DAI	=	Days After Inoculation
DMRT	=	Duncan's Multiple Range Test
e.g.	=	(For example) exampoli gratia
et al.	=	(And Others) et alibi
etc.	=	Etcetera
FAO	=	Food and Agriculture Organization
g	=	Gram
hr	=	Hour (s)
i.e.	=	That is
IRRI	=	International Rice Research Institute
ISTA	=	International Seed Testing Agency
kg	=	Kilogram
LSD	=	Least Significant Difference
no.	=	Number
SAU	=	Sher-e-Bangla Agricultural University
T	=	Treatment
t/ha	=	Ton per Hectare
UNDP	=	United Nation Development Program
$^{W}/_{V}$	=	Weight per Volume
$^{W}/_{W}$	=	Weight per Weight
wt.	=	Weight
BE	=	Biological efficiency
MRR	=	Mycelium Running Rate
NMDEC	=	National Mushroom Development and Extension Center
MCC	=	Mushroom Culture Centre
mg	=	Milligram
CHO	=	Carbohydrate
Conc.	=	Concentration

Chapter I

Introduction

CHAPTER I

INTRODUCTION

All of us are acquainted with green plants such as trees, flowers and grass, and when we think of plants it are those which we have in mind. But there are other plants which are not green and which do not produce flower or seeds and are often more or less inconspicuous. They are associated with spoiling and decay of food, wood etc. with the growth of their vegetative organ and may produce large fleshy masses. Mushrooms are the member of these groups of plants, the fungi.

Oyster mushrooms are large reproductive structures of edible fungi belong to the class of Basidiomycetes or Ascomycetes. Many varieties of mushroom are identified in the world. Among them which are fully edible and have no toxic effect are to be considered as edible mushroom. Out of these species of prime edible mushrooms about 80 have been grown experimentally, 20 cultivated commercially and 4-5 produced on industrial scale throughout the world (Chang and Miles, 1988). The vegetative part of mushroom consists of thread like long thin mycelium which under suitable condition forms fruiting body or sporocarps. This fruiting body is used as edible mushroom. The vegetative part of mushroom consists of thread like long thin mycelium which under suitable condition form fruiting body. This fruiting body is used as edible mushroom. Mushroom is a highly nutritious, delicious, medicinal and economically potential vegetable.

The oyster mushroom is grown under natural conditions on living trees as parasite or dead woody branches of trees as saprophyte and primary decomposer. The chemical composition of the fresh fruiting bodies of oyster mushroom, *Pleurotus ostreatus* indicates a large quantity of moisture (90.8 %), whereas fresh as well as dry oyster mushrooms are rich in proteins (30.4 %), fat (2.2 %), carbohydrates (57.6 %), fiber (8.7 %) and ash (9.8 %) with 45 K (cal) energy value on 100 g dry weight basis; while vitamins such as thiamin (4.8 mg), riboflavin (4.7 mg) and niacin (108.7 mg), minerals like calcium (98 mg),

phosphorus (476 mg), iron (8.5 mg) and sodium (61 mg) on 100 g dry weight basis, are also found present (Pandey and Ghosh, 1996). Rambelli and Menini (1985) reported that this mushroom is reputed to be antitumoural because of its chemical composition.

With increasing population and conventional agricultural methods we cannot cope with the food problem. Once, our staple food was rice and fish. At that time we could meet our need of protein from fish as well as energy from rice. In the last decades the fish production decreased and we had to meet our protein need from vegetable and pulse source. But now a day this is also much costly and now we should find an alternative source of protein as well as other food materials. Mushroom can useful in this aspect.

There are various types of mushrooms such as oyster mushroom, milky white mushroom, and button mushroom etc. which are cultivated in our country. Among them, oyster mushroom is widely cultivated in our country because the weather and climate of Bangladesh is suitable for its cultivation.

Mushroom substrates may be defined as a kind of ligno-cellulosic material which supports the growth, development and fruiting of mushroom (Chang and Miles, 1988). However, supplementation of the substrates with various materials is recommended prior to spawning for enhancement of the yield of mushrooms. To improve growth and yield of mushroom, various supplements can be added to the substrates **(**Hadwan *et al*. 1997). It is well known that, mycelium growth and mushroom production both are affected by cellulose, hemicelluloses and lignin proportions along with nitrogen content of the cultivating substrate **(**Mata and Savoie, 2005)

Substrate plays an important role in the yield and nutrient content of oyster mushroom. The substrates on which mushroom spawn (merely vegetative seed materials) is grown, affects the mushroom production (Klingman, 1950). Oyster

mushroom can grow on sawdust, rice and wheat straw, water hyacinth and other agro-waste. Sarker *et al*. (2007) observed a remarkable variation in nutritional content of oyster mushroom in different substrates.

The oyster mushrooms can be cultivated successfully under semi controlled conditions in a small space by using agricultural as well as industrial waste and other refuse as substrate. Badshah *et al*. (1992) have grown *Pleurotus ostreatus* on wheat straw, sugarcane bagasse, corn cobs or sawdust by mixing 120-130 g of spawn with 2 kg of substrate and placing the mixture in sterilized polyethylene bags which were kept in the dark at 25^0C for 2-3 weeks. Fruiting bodies were harvested at maturity with yields of 49.8 g/2 kg substrate (sawdust), 432.8 g/2 kg substrate (wheat straw), whereas control (grown in the field) yielded only 18.5 g/2 kg substrate.

Bernabe-Gonzalez and Arzeta- Gomez (1994) mixed *P. ostreatus* inoculum at 4 g/100 g substrate in 4 kg plastic bags using peanut hulls and maize leaves cut to 5- or 10-cm lengths.

Kausar and Iqbal (1994) used 5% spawn of *Pleurotus* (w/w basis) in 15 kg paddy straw, pinheads formed 28 days after spawning. The yield varied from 18.6 to 83.5% based on different nitrogen supplements amended with straw. Cangy and Peerally (1995) used spawning rates 0.75, 1.50, 3.00 and 6.00% of substrate fresh weight for 10 species of *Pleurotus*. Results showed that 1% spawning rate was found to be adequate when using the smaller bags (yields > 16% of spawned substrate weight) at mean temperature 18^0C (range 13-23^0C). Marimuthu (1995) reviewed the use of crop residues as growing media for oyster mushroom (*Pleurotus*) production. Paddy and wheat straw, cotton waste, maize cobs, waste paper and cotton stalks are all suitable for high production capacity, whole grains of sorghum, bajra (*Pennisetum glaucum*) or maize are recommended.

Patra and Pani (1995) cultivated five different species of *Pleurotus* in polythene [polyethylene] bags containing chopped paddy straw (2 kg) + spawn (200 g) + boiled wheat (200 g). The fungi took 13-16 days for complete mycelial run in the bags and 20-24 days for initiation of fruiting bodies, producing the heaviest (12.2 g), and the lightest (6.9 g) fruiting bodies.
Singh *et al.* (1995) recorded the maximum yield from baggase than from the paddy straw and wheat straw respectively.

In Bangladesh oyster mushroom is now widely cultivated in our country because the weather and climate of Bangladesh is suitable for its cultivation and the necessary materials required for oyster mushroom cultivation such as straw, sawdust, wheat bran, water hyacinth, agricultural and industrial waste products etc. are aslo avilable and cheap. The present studies were planned to find out the easiest, economical and practicable methodology of preparation and use of substrate, which may also be helpful to increase the growth and productivity of oyster mushroom. The findings will help and guide the mushroom growers, especially the people interested in the cultivation of oyster mushrooms. So the investigation is undertaken to fulfill the following aim and objectives:

- To find out better variety.
- To find out the appropriate ratio of substrates to increase the growth and yield of oyster mushroom.
- To find out appropriate combination of substrate and variety.

Chapter II

Review of literature

CHAPTER II

REVIEW OF LITERATURE

A number of literatures relating to the performance of different substrates on mushroom cultivation were available but performances on same substrate with other supplements were not available. The review of literature given below was based on the present information regarding the performance of oyster mushroom (*Pleurotus ostreatus*) and the effect of different substrates ratio on the growth and yield of oyster mushroom. The review includes reports of several investigators which appear pertinent in understanding the problem and which may lead to the explanation and interpretation of results of the present investigation.

Ashrafi *et al*. (2014) carried out an experiment to reuse of SMS of oyster mushroom for the production of oyster mushroom at Bangladesh Agricultural University (BAU), Mymensingh. Two mushroom species (*Pleurotus ostreatus* and *P. florida*) were grown on SMS supplemented with sawdust and wheat bran at different proportions. The results showed that SMS supplement with 60% sawdust + 20% wheat bran demonstrated the highest biological yield,economic yield and biological efficiency for both *P. ostreatus* and *P. florida.*Yield parameters were increased with increasing C/N ratio where as 36:1 C/N ratio exhibited the highest yield. The C/N ratio below or above 36:1 decreased yield of both species of oyster mushroom. The optimum C/N ratio for economic yield varied between the two oyster mushroom species and found to be 35.2 for *P. ostreatus* against C/N ratio of 40.1 for *P. florida.* Concerning biological yield and biological efficiency the optimum C/N ratio was found 35.7 for *P. ostreatus* and 40.6 for *P. florida*. The study emphatically indicated that reuse of spent mushroom substrate with supplementation can be a good solution to address the disposal problem where as supplemented SMS can be a good substrate for further mushroom production.

Bhattacharjya *et al*. (2014) reported the cultivation 0f *Pleurotus ostreatus* on different saw dust substrates such as *Ficus carica* (Fig tree, T_2), *Albizia saman* (Rain Tree, T_3), *Swietenia mahagoni* (Mahogany tree, T_4), *Leucaena leucocephala* (Ipilipil tree, T_5*), Eucalyptus globulus* (Eucalyptus tree, T_6) and mixture of all five tree sawdust (T_1) supplemented with 30% wheat bran and 1 % lime as basal substrates. The effects of various saw dust substrates on growth and yield of performance of Oyster mushroom were analyzed. The highest mycelium running rate (0.70 cm/day) and the lowest time from primordial initiation to harvest (3.33 days), were obtained in T_4. The highest time from stimulation to primordial initiation (8.00 days were found in T_1. The highest biological yield (373.4 g/packet), economic yield (371.8 g/packet), dry yield (37.16 g/packet), biological efficiency (213.2%), benefit cost ratio (5.62), the highest average number of primordia/packet (226.3), the highest average number of fruiting body/packet (122.3), the highest average weight of individual fruiting body (4.45 g) and the highest average number of effective fruiting body/packet (21.33) was obtained in T_3. Among all aspects, T_3 was found as a best substrate with biological yield 373.4 g/packet) and biological efficiency (213.2%) followed by T_1, T_4, T_6 T_5, T_2 for the production of mushroom.

Sharma *et al.* (2013) observed the cultivation of *Pleurotus ostreatus* on different substrates such as rice straw, rice straw + wheat straw, rice straw + paper, sugarcane bagasse and sawdust of alder. All the substrates except rice straw were supplemented with 10% rice bran. The substrate without supplement was considered as control. The effects of various substrates on mycelial growth, colonization time, primordial appearance time, mushroom yield, biological efficiency (BE), size of the mushroom and chemical composition were analyzed. Among all aspects, rice straw (control) was found as a best substrate with yield (381.85g) and BE (95.46%) followed by rice plus wheat straw, rice straw plus paper waste for the production of mushroom. The nutritional composition was also better from mushroom fruit grown on rice straw.

Uddin *et al*. (2011) investigated the production of four species of oyster mushroom*: Pleurotus ostreatus, P. florida, P. sajor-caju and P. high king* cultivated in every season (January to December) in Bangladesh. The temperature (in ºC) and relative humidity (%) of culture house in each month, and parameters of mushroom production were recorded. In all of the selected species of this study, the minimum days required for primordial initiation, and the maximum number of fruiting bodies, biological yield and biological efficiency were found during December to February (14-27ºC, 70-80% RH). The production was found minimum during the cultivated time August to October. They suggested the cultivation of selected *Pleurotus spp*. in winter (temperature zone 14-27^{o}C with relative humidity 70-80%) for better production and biological efficiency.

Mandol *et al*. (2010) carried out in the mushroom cultivation laboratory, Horticulture Center, Khairtala, Jessore to evaluate the better performance of oyster mushroom *Pleurotus florida* in different substrate compositions as well as to find out the better substrate for mushroom cultivation. They reported the highest mycelium running rate in banana leaves and rice straw (1:1) but the lowest in control. Completion of mycelium running time was lowest in banana leaves and rice straw (1:3 and 3:1). Number of total primordia and effective primordia, found highest in control but the maximum pileus thickness was measured from rice straw. Highest biological yield and economic yield (164.4 g and 151.1 g) was obtained from rice straw which was much higher than control. From the graphical view, both positive and negative relationships were found between economic yield and different yield contributing attributes.

Islam *et al.* (2009) conducted an experiment at the laboratory of Food Microbiology, Institute of Food Science and Technology, BCSIR, Dhanmondi, Dhaka-1205 during July 2000 to May 2001 to find out the suitable sawdust as substrate for growing mushroom. Seven different type of substrates viz. Mango, Jackfruit, Coconut, Jam, Kadom, Mahogony, Shiris sawdust with

wheat bran and $CaCO_3$ were evaluated to find their growth and yield of Mushroom. The maximum biological yield per packet was obtained with Mango sawdust (150 g) followed by Mahogony (148 g), Shiris (146 g), Kadom (136 g), Jam (114 g), Jackfruit (97 g) and Coconut sawdust (83 g). The lowest yield was observed in Coconut sawdust (83 g). However, highest return was obtained with Mango sawdust (Tk 24.86) while the lowest with Jackfruit sawdust (Tk11.68). Cost benefit analysis revealed that the Mango sawdust and Shiris sawdust were promising substrates for the growing of oyster Mushroom (*Pleurotus flabellatus*).

Ashrafuzzaman *et al.* (2009) conducted an experiment on *Lentinus edodes* (Berk.), the shiitake mushroom, one of the most widely cultivated mushrooms in the word. They reported that sawdust is the most popular basal ingredient used in synthetic substrate formulations for producing shiitake spawn. However, the best sawdust for this uses needs to be determined. Shiitake mushroom was cultivated on sawdust from the woody plants Babla (*Acacia nilotica L.)*, Champa (*Michelia champaca* L.), Garzon (*Dipterocarpus alatus Roxb*.), Ipil-ipil [*Leucaena glauca* (*Linn*) Benth], Jackfruit (*Artocarpus heterophyllus Lam*), Mango (*Mangifera indica* L.), Raintree [*Albizia saman* (Jacq.) F Müll], Segun (*Tectona grandis* L), Shimul (*Bombax ceiba* L), Shisoo (*Dalbergia sissoo Roxb*) or mixtures of sawdust from all of the trees with equal ratio or rice straw to determine growth and fruiting characteristics. Cultivation on Jackfruit resulted in significantly faster mycelial growth compared to other substrates. With respect to fructification, culture on Jackfruit produced the first pinhead (primordium) earlier compared to other substrates. Numbers of primordial and effective fruiting bodies was highest on Jackfruit sawdust. Rice straw, surprisingly, did not produce any fruiting bodies as well as showing no yield attributes. Yield attributes including stalk length, stalk diameter and diameter and thickness of the pileus were significantly higher on Jackfruit. The lowest biological and economic yields were found when

culture was on Champa. Biological efficiency and biological yield, economic yield and dry yield at the first and final harvests were highest with culture on Jackfruit and its use is recommended in the production of shiitake mushroom in the tropics.

Kulsum *et al.* (2009) conducted an experiment to determine the effect of five different levels of cow dung (T_1=0%, T_2= 5%, T_3= 10%, T_4=15% and T_1=20%) as supplement with sawdust on the performance of oyster mushroom. All the treatments performed better over control. The mycelium running rate in spawn packet and the highest number of primordia/packet were found to be differed due to different levels of supplements used. The highest weight of individual fruiting body was observed in sawdust supplemented with cow dung @ 10% (3.69 g). The supplementation of sawdust with cow dung had remarkable effect on biological yield, economic yield, the dry yield, biological efficiency and cost benefit ratio. The highest biological yield (217.7 g), economic yield (213g), dry yield (21.27 g) biological efficiency (75.06%) and cost benefit ratio (8.41) was counted under sawdust supplemented with cow dung @ 10%. Among the chemical characteristics highest content of protein (31.30%), ash (8.41%), crude fiber (24.07%) was found under treatment T_3 (10%) and the lowest lipid (3.44%) and carbohydrate (32.85%) was counted also under treatment T_3 (10%). Among the minerals the highest amount of nitrogen (5.01%), potassium (1.39%), calcium (22.15%), magnesium (20.21%), sulfur (0.043%), iron (43.4%) and the lowest phosphorus (0.92) were counted under sawdust supplemented with cow dung @ 10% (T_3).

Ali (2009) conducted an experiment to investigate the performance of different levels of wheat bran as supplement with sugarcane bagasse on the production of oyster mushroom and analysis of their proximate composition. The highest mycelium running rate (0.96 cm) was observed due to sugarcane bagasse supplemented with wheat bran @ 40%. The lowest time (3.23 days) from

primordia initiation to harvest, the highest average weight (3.69 g) of individual fruiting body, the highest biological yield (254.7 g), economic yield (243.3 g), dry matter (23.40 g), biological efficiency (87.82%) and cost benefit ratio (8.29) were observed due to sugarcane bagasse supplemented with wheat bran @ 30%. The highest average number of primordia/packet (70.67), average number of fruiting body/packet (61.00) and the highest moisture content (90.45%) were observed due to sugarcane bagasse supplemented with wheat bran @ 40%. The highest content protein (30.31 %), ash (9.15 %), crude fiber (24.07 %), the lowest lipid (3.90 %) and carbohydrate (32.57 %) were observed due to sugarcane bagasse supplemented with wheat bran @ 30%. The highest percentage of nitrogen (4.85), potassium (1.39g/mg), calcium (22.08mg), magnesium (20.21mg), sulfur (0.042g/mg), iron (43.11mg) were observed due to sugarcane bagasse supplemented with wheat bran @ 30% but the highest percentage (0.92) of phosphorus was observed in control condition (sugarcane bagasse alone).

Sarker *et al.* (2007) found remarkable difference in nutrient content of oyster mushroom in respect of different substrates. Wide variation was recorded in the protein content of fruiting body. On dry weight basis, the highest protein content (11.63%) was observed in fruiting body grown on sugarcane bagasse. The 2^{nd} highest protein content (11.0%) was observed in that grown on wheat straw and water hyacinth. The lowest protein (7.81%) was observed in that grown on rice straw. Mushrooms are the good source of minerals also. Maximum of 18400 ppm calcium was found in mushroom which was grown on wheat straw. On other substrates its content varied from 1600 ppm to 18400 ppm. The content of iron in the mushroom grown on different substrates varied from 92.09 ppm to 118.40 ppm. The highest iron content was found in waste paper cultured oyster mushroom and lowest on water hyacinth.

Sarker *et al*. (2007) carried out an experiment to find out the performance of different cheap agricultural household byproducts, grasses and weeds as

substrate available in Bangladesh. Mycelium growth rate and time required to complete mycelium running in spawn packet varied significantly in different substrates. The minimum duration to complete mycelium running was 17.75 days in waste paper, which differed significantly from that in all other substrates. Significant variation was found in duration from stimulation to primordial initiation, primordial initiation to first harvest and stimulation to first harvest in different substrates. The minimum duration required from stimulation to first harvest was observed in sugarcane bagasse (6.75 days), which was statistically similar to that in waste paper, wheat straw and sawdust (7.00 days). The number of fruiting body was positively correlated with biological efficiency, biological yield and economic yield of oyster mushroom. The number of fruiting body grown on different substrates differed significantly and the highest number of fruiting body per packet (183.25) was recorded on waste paper, which was significantly higher as compared to all other substrates. The lowest number of fruiting body (19.25) was observed in water hyacinth. Significant variation in biological efficiency, biological yield and economic yield of oyster mushroom were observed in different substrates. The highest economic yield (225.43 g/packet) was estimated from the waste paper followed by wheat straw (215.72 g/packet).The economic yield on sugarcane bagasse was 191.98 g/packet, which was statistically similar to that grown on rice straw (183.28 g/packet), kash (182.93 g/packet) and ulu (175.15 g/packet).The economic yield on sawdust was 160.40 g/packet, which was statistically similar to that on ulu. The lowest economic yield was observed in water hyacinth (33.59 g/packet). No fruiting body and economic yield were obtained from para and napier grasses. Performances of the substrates were compared based on benefit cost ratio (BCR). The highest BCR (6.50) was estimated when wheat straw was used as substrate followed by sugarcane bagasse (5.90), waste paper (5.65), rice straw (5.58) and kash (5.25) The lowest BCR was obtained from water hyacinth (1.05) followed by ulu (4.74) and sawdust (4.90).

Amin *et al*. (2007) carried out an experiment to find out the primordia and fruiting body formation and yield of oyster mushroom (*Pleurotus ostreatus*) on paddy straw supplemented with wheat bran (WB), wheat flour (WF), maize powder (MP), rice bran (RB) and their three combinations (WB+MP, 1:1), (WB+MP+RB, 1:1:1) and wheat broken (WBr) at six different levels namely 0, 10, 20, 30, 40 and 50% were studied. The minimum time (4.5 days) for primordial initiation was observed in the MP at 20% level and the highest number of effective fruiting bodies (60.75) was obtained in WF at 50% level. The highest biological yield (247.3 g/packet) was recorded at 10% level of (WBr).

Bhatti *et al.* (2007) studied on the mushroom, *Pleurotus ostreatus* (Jacq. ex. Fr.) Kummer cultivated on wheat straw in polythene bags (containing 500 g wheat straw on dry weight basis per bag) using sorghum grain spawn at different rates. The spawning was done followed by boiling of substrate and sterilization of bags. The bags were kept in mushroom growing room at 25 to 35^{o}C with 80 to 100% relative humidity under regular white fluorescent light arranged by the tube lights in mushroom growing room (10' × 14' × 14'). The pinheads first appeared 32.33 days after spawning by using 70 g spawn rate per kg on substrate dry weight basis. The minimum period of 4.66 days after pinhead formation for maturation of fruiting bodies was recorded by using 60, 70, 80, 90 and 100 g spawn rate. The minimum period between flushes (6.33 days) was taken by using 20 g spawn rate. The maximum flushes (4.00) were harvested by using 70 g spawn rate. The maximum number of bunches per bag (7.66) were obtained by using 100 g spawn rate. The maximum number of fruiting bodies per bunch (7.30) was observed by using 70 g spawn rate. The maximum yield on fresh weight basis (45.4%) as well as on dry weight basis (4.63%) was also obtained by using 70 g of spawn rate per bag. The results were highly significant from each other. It is concluded that spawning at 70 g per kg on substrate dry weight basis found to be the best dose for obtaining early and high yielding crop of oyster mushroom, with minimum period for

maturation of fruiting bodies, maximum number of flushes and fruiting bodies per bag.

Zape et al. (2006) conducted a study to determine the spawn run, days taken to pin head initiation, yield and biological efficiency of three oyster mushroom species viz. *Pleurotus florida, P. eous* and *P. flabellatus* were grown on wheat straw substrate. Time required for spawn run and pinning was significantly less in *Pleurotus eous* followed by *P. florida*. However, the yield and biological efficiency did not differ significantly but was higher in *P. florida* than *P. flabellatus* and *P. eous*. In analyzing the physico-chemical composition of dehydrated fruit bodies of *Pleurotus* species revealed that among different species *P. eous* was rich in protein (33.89%), moderate in fat (3.10%), carbohydrate (32.60%) and ash (8%) followed by *P. florida*. However, *P. flabellatus* was rich in crude fibre, carbohydrate and ash but low in protein and fat content as compare to *P. eous* and *P. florida.*

Sainos *et al*. (2006) conducted a study to determine the mycelial growth, intracellular activity of proteases, laccases and beta-1,3-glucanases, and cytoplasmic protein were evaluated in the vegetative phase of *Pleurotus ostreatus* grown on wheat straw and in wheat-grain-based media in petridishes and in bottles. The productivity of the wheat straw and wheat-grain-based spawn in cylindrical polyethylene bags containing 5 kg of chopped straw was also determined. We observed high activity of proteases and high content of intracellular protein in cultures grown on wheat straw. This suggests that the proteases are not secreted into the medium and that the protein is an important cellular reserve. On the contrary, cultures grown on wheat straw secreted laccases into the medium, which could be induced by this substrate. *P. ostreatus* grown on media prepared with a combination of wheat straw and wheat grain showed a high radial growth rate in petridishes and a high level of mycelial growth in bottles.

Ramjan (2006) in his study found that high concentration of IAA is effective for mycelial growth and mustard straw performed best as a substrate for the production of fruiting bodies of oyster mushroom.

Namdev *et al.* (2006) conducted a study to determine the effect of different straw substrates on spawn growth and yield of oyster mushroom. The number of days required for spawn run was significantly less (14 days) in case of gram straw, parthenium straw, sugarcane straw and wheat straw, compared with 20 days for sunflower stalk, mustard straw and paddy straw. Yield was very poor on parthenium straw (95 g/500 g dry substrates) and it was highest on paddy straw (666 g/500 g), followed by wheat straw and mustard straw (427 and 400 g/500 g respectively).

Khlood & Ahmad (2005) conducted an experiment to study the ability of oyster mushroom (*Pleurotus ostreatus*) P015 strain to grow on live cake mixed with wheat straw. The treatments comprised : 90% straw + 5% wheat bran + 5% gypsum (control); 80% straw + 10% olive cake + 5% wheat bran + 5% gypsum (T_1); 70% straw + 20% olive cake 5% wheat bran + 5% gypsum (T_2); 60% straw + 30% olive cake + 5% wheat bran + 5% gypsum (T_3); 50% straw + 40% olive cake + 5% wheat bran +.5% gypsum (T_4); and 90% olive cake + wheat bran + 5% gypsum (T_5). After inoculation and incubation, transparent plastic bags were used for cultivation. The pinheads appeared after 3 days and the basidiomata approached maturity 3-7 days after pinhead appearance. Several growth parameters including primordial induction and fructification period, earliness, average weight of individual basidiomata, average yield for each treatment, diameter of the pileus and biological efficiency percentage (BE%) were examined and proximate analyses for protein, crude fat, crude fiber, ash, carbohydrates, mineral and moisture contents were performed. The addition of 30% olive cake to the basal growing medium gave the highest yield (400 g/500 g dry substrate), average weight (21.5 g/cap) and average cap diameter (7.05 cm/cap) and BE% (80%). Carbohydrate, protein and fiber contents were high in the *P. ostreatus* basidiomete. Ash contents were

moderate, while fat content was low. For mineral contents in the mushrooms the trend was the same in all treatments. The K and P contents were high compared to the other minerals in all treatments, sodium was moderate while both Mg and Ca were found at low concentrations (Mg was relatively higher than Ca). Fe and Zn were relatively high compared to Cu and Mn which had very low concentrations.

Habib (2005) tested different substrates such as sawdust, sugarcane bagasse, rice straw, wheat straw and waste paper for the production of oyster mushroom in polypropylene bag. Different substrates significantly affected the number of primordia, number of fruiting bodies and amount of fresh weight or yield. This experiment revealed that the highest number of primordia and fruiting bodies were found in waste paper 43.75 and 31.00 respectively. The highest amount of fresh weight was also found in waste paper 94.25 g.

Ancona-Mendex *et al.* (2005) conducted an experiment to grow oyster mushroom (*Pleurotus ostreatus* (Jacq.: Fr.) Kummer in either maize or pumpkin straw. Samples were taken for each one of the three harvests and analyzed for total nitrogen (N) content and amino acids profile. The substrate had no effect ($P>0.05$) on N content and amino acid profile of the fruits. However, N (g/100 g DM) increased ($P<0.05$) from 4.13 g in the first harvest to 5.74 g in the third harvest. In general, the amino acids tended to be higher on the first harvest samples, but no changes were found ($P>0.05$) in the amino acid profile due to substrate or harvest, except for valine decreasing ($P<0.05$) from 3.96 to 3.15 g/16 g N. Changes in the N content of the fruit could be explained by changes in the stipe and pileus proportions as they had different N content (3.15 and 5.48 + or 0.031 g N/ 100 g DM, respectively). The amino acid profile of the mushroom was adequate according to the FAO/WHO adult human amino acid requirements.

Shah *et al.* (2004) carried out an experiment to investigate the performance of oyster mushroom on the following substrates: 50 % sawdust + 50 % wheat

straw, 75 % sawdust + 25 % leaves, 50 % wheat straw + 50 % leaves, 100 % sawdust, 100 % wheat straw and 100 % leaves. The temperature was kept at 25ºC for spawn running and 17-20ºC for fruiting body formation. The time for the completion of mycelial growth, appearance of pinheads and maturation of fruiting bodies on different substrates were recorded. The number of fruiting bodies and the biological efficiency of substrates were observed. The results show that spawn running took 2-3 weeks after inoculation, while small pinhead-like structures formed 6-7 days after spawn running. The fruiting bodies appeared 3-6 weeks after pinhead formation and took 27-34 days later after spawn inoculation. Sawdust at 100 % produced the highest yield (646.9 g), biological efficiency (64.69%) and the number of fruiting bodies (22.11). Therefore, sawdust is recommended as the best substrate for oyster mushroom cultivation.

Moni *et al*. (2004) cultivated the oyster mushroom (*Pleurotus sajor-caju*) on paddy straw, banana leaves, sugarcane baggase, water hyacinth and beetle nut husk. The fruiting bodies were sun-dried and analyzed for various nutritional parameters. Considerable variation in the composition of fruit bodies grown on different substrates was observed. Moisture content varied from 88.15 to 91.64%. On dry matter basis, the percentage of nitrogen and crude protein varied from 4.22 to 5.59 and 18.46 to 27.78%, respectively and carbohydrate from 40.54 to 47.68%. The variation in content of crude fat and crude fiber ranged from 1.49 to 1.90 and 11.72 to 14.49% respectively.

Maniruzzaman (2004) in his study used wheat, maize, rice and sawdust for the production of spawn in oyster mushroom and found that substrate rice was the best for spawn production of oyster mushroom.

Banik and Nandi (2004) carried out an experiment on oyster mushroom for its ease of cultivation, high yield potential as well as its high nutritional value. Laboratory experimentation followed by farm trial with a typical oyster mushroom *Pleurotus sajor- caju* revealed that the yield potential of these

mushrooms can be increased significantly when grown on a lignocellulose crop residue - rice straw supplemented with biogas residual slurry manure in 1:1 ratio as substrate. Residual slurry manures obtained from biogas plants utilising cattle dung or poultry litter, jute caddis or municipal solid waste as substrates for biogas production were all effective in increasing the yield of *Pleurotus sajor-caju* significantly although to different extents. Disinfection of straw and manure by means of 0.1% KMnO< sub>4</ sub> plus 2% formalin solution in hot water caused 42.6% increase in yield of *Pleurotus sajor-caju* over control, i.e., when disinfection done with hot water. In addition to increased yield, the above treatments caused significant increase in protein content, reduction in carbohydrate and increase in essential mineral nutrients in mushroom sporophores. Thus, it is concluded from the study that supplementation of rice straw with biogas residual slurry manure has strong impact in improving the yield potential, protein and mineral nutrient contents of *Pleurotus sajor caju* mushroom in Indian subcontinent or similar climatic conditions.

Amin (2004) in his experiment reported that the highest number of primordia of oyster mushroom was found in sterilized paddy straw at first flush; whereas the lowest was obtained with saw dust.

Obodai *et al.* (2003) evaluated eight lignocellulosic by-products as substrate, for cultivation of the oyster mushroom. *Pleurotus ostreatus* (Jacq. ex. fr.) Kummer. The yields of mushroom on different substrates were 183.1, 151.8, 111.5, 87.5, 49.5, 23.3, 13.0 and 0.0 g for composted Sawdust of *Triplochiton scleroxylon*, Rice straw, Banana leaves, Maize stover, Corn husk, Rice husk, Fresh Sawdust and Elephant grass respectively. The biological efficiency (BE) followed the same pattern and ranged from 61.0%, for composted Sawdust to 50.0% for elephant grass. The Yield of mushroom was positively correlated to cellulose (r^2= 0.6). Lignin (r^2 = 0.7) and fiber (r^2 = 0.7) contents of the substrates. Based on the yield and BE of the substrates tested, Rice straw appeared to be the best alternate substrate for growing oyster mushroom.

Baysal *et al.* (2003) conducted an experiment to spawn running, pin head and fruit body formation and mushroom yield of oyster mushroom (*Pleurotus ostreatus*) on waste paper supplemented with peat, chicken manure and rice husk (90+10; 80 + 20 W:W). The fastest spawn running (mycelia development) (15.8 days), pin head formation (21.4 days) and fruit body formation (25.6 days) and the highest yield (350.2 g) were realized with the substrate composed of 20% rice husk in weight. In general, increasing the ratio of rice husk within the substrate accelerated spawn running, pin head and fruit body formation and resulted increased mushroom yields, while more peat and chicken manure had a negative effect on growing.

Manzi *et al.* (2001) analyzed fresh and processed mushrooms (*Agaricus bisporus*, *Pleurotus ostreatus* and Boletus group). Results showed that botanical variety, processing and cooking are all effective determinants of mushroom proximate composition. Dried mushrooms (Boletus group) after cooking show the highest nutritional value, essentially due to insufficient dehydration. Dietary fiber, chitin and beta glucans, all functional constituents of mushrooms are present in variable amounts. Chitin level ranges from 0.3 to 3.9 g/100 g, while beta glucans which are negligible in *Agaricus*, range from 139 to 666 mg/100 g in *Pleurotus ostreatus* and Boletus group. On an average, a serving (100 g) of mushroom will supply 9 to 40% of the recommended of dietary fiber.

Dhoke *et al.* (2001) studied the effect of different agro-wastes on cropping period and yield of *Pleurotus sajor-caju* the experiments carried out in Prabhani and Maharashtra in India, during 1998-99. Various plant materials, i.e. soybean, paddy, cotton, wheat and jowar (*Sorghum bicolor*) were used. Cropping period on different substrates was recorded for first, second and third picking. The cropping period for third picking varied from 42.25 to 43.50 days in different substrates. The days required for first picking indicated that soybean straw took 22.00 days to produce first crop of harvestable mushroom while a minimum of 21.25 days were required for paddy and wheat straw. For

second picking, jowar and cotton waste took the maximum days of 32.75 days while soybean took the minimum of 31.50 days. The final and third picking was completed in 43.50 days in case of soybean straw which was statistically higher compared to paddy and wheat straw (42.25) and cotton and jowar straw (42.75). The highest yield of 993.00 g/kg was obtained from cotton, followed by soybean straw (935.25 g/kg) and paddy straw (816.0 g/kg). The lowest yield of 445.50 g/kg was recorded in jowar straw.

Upamanya and Rathaiah (2000) conducted an experiment to test the effect of fortification of rice straw with rice bran on the yield and quality of oyster mushroom (*Plelrrotus ostrentus*) in Jorhat, Assam, India. Treatments comprised: (i) addition of rice bran at 5% w/w (weight of rice bran/weight of dry substrate) at the time of spawning and (ii) control (without rice bran). Rice straw fortified with rice bran exhibited a higher yield compared to the control. Rice bran application had no effect on the crude protein content of mushroom but increased the yield by 44% over the control.

Ayyappan *et al.* (2000) used sugarcane trash and coir waste alone and in combination with paddy straw (3:1, 1:1 and 1:3 w/w) for sporophore production of two species of *Pleurotus*. The highest yields of *P. florida* (1395 g) and *P. citrinopileatus* (1365 g) were recorded in a mixture of sugarcane.

Rathaiah and Shill (1999) in their experiment found that parboiled paddy was as good as wheat for spawn production of oyster mushroom. The spawn prepared from parboiled paddy was also compared with conventionally prepared paddy spawn. The suitability of parboiled paddy for spawn of paddy straw mushroom (*Volvariella volvacea*) was also confirmed.

Patil and Jadhav (1999) reported that *Pleurotus sajor-caju* was cultivated on cotton, wheat, paddy, sorghum and soyabean straws in Marathwada, India. Cotton stalks + leaves was the best substrate for production (yield of 1039 g/kg dry straw), followed by soyabean straw (1019 g/kg). Paddy and wheat straw yielded 650 and 701g/kg. The lowest yield (475 g/kg) was obtained on

sorghum straw. Pileus size and stipe length of *P. sajor-caju* were greatest on sorghum straw.

Zhang-Ruihong *et al.* (1998.) cultivated oyster mushroom (*P. sajor-caju*) on rice and wheat straw without nutrient supplementation. The effects of straw size reduction methods and particle sizes spawn inoculation level and types of substrate (rice straw vs. wheat straw) on mushroom yield, biological efficiency and substrate degradation were determined. The protein content of mushrooms produced was 27.2% on an average. The dry matter loss of the substrate after mushroom growth varied from 30.1 to 44.3%. Yields were higher from substrates which had been ground-up to 2.5 cm lengths; further size reductions lowered yields. Mushroom cultivation is a highly efficient method for disposing of agricultural residues as well as producing nutritious human food.

Wani and Sawant (1998) reported that among the various edible fungi, oyster mushroom (*Pleurotus spp.*) has a broad adaptability due to having a wide range of suitable substrates, a simple cultivation technique and minimal cultural requirements. Various substrates on which oyster mushroom can be cultivated are mentioned.

Pani and Mohanty (1998) used water hyacinth alone and in combination with paddy straw (3:1, 1:1 and 1:3 ratios) for cultivation of *Pleurotus sajor-caju* and *P. Florida*. Paddy straw alone sustained highest mushroom yield (83.3-84.6% BE). Water hyacinth in combination with paddy straw produced higher yields than when used alone.

Gupta (1989) found that the fruiting bodies appeared 12-15 days after the bags were removed, and the first crop was harvested 2-3 days later on wheat straw and *Pleurotus sajor-caju* can be successfully cultivated in both hot and spring seasons.

Chowdhury *et al.* (1998) examined the effects of adding rice husks, soybean meal, pea meal, wheat bran, poultry manure or neem cake (each at 2 or 5%) to

rice straw for growing oyster mushrooms (*P. sajor-caju*). Adding 5% soybean or pea meal gave the highest yield of 630 g/kg dry straw.

Patrabansh and Madan (1997) used three different kinds of biomass, namely *Pofulus deltoides*, *Isuhatoriiun adenophorum* and sericulture waste individually for the cultivation of *Pleurotus sajor-caju*, alone and mixed with paddy straw. *P. sajor-caju*, when used alone, exhibited a very good colonizing ability on these substrates except in sericulture waste.

Krishnamoorthy (1997) cultivated oyster mushrooms *Pleurotus citrinopileatus* and *P. sajor-caju*) on paddy straw with 1 of 15 different organic supplements at 2% of the wet weight of substrate. Neem cake increased the yield of *P. citrinopileatus* and *P. sajor-caju* by 48.7 and 75.0%, respectively compared with the control. Red gram husk, green gram husk and black gram husk also significantly increased yields compared with the control. Importantly, mushrooms harvested from amended paddy straw did not differ in flavor and taste compared with control.

Kalita *et al.* (1997) studied the growth of *Pleurotus sajor-caju* in polyethylene bag on different combinations of substrates viz. only rice straw, rice straw plus rice husk mixture (1:1 v/v), water hyacinth, chopped banana leaves, areca nut husk and sugarcane bagasse. They found that only rice straw, rice straw plus rice husk mixture and areca nut husk substrates completed spawn running comparatively within short time (12-14 days) but other substrates took longer time.

Biswas *et al.* (1997) reported that methods including spawning percentage, combinations of paddy straw, wheat straw and supplements, to improve the biological efficiency (BE) of *P. florida* were investigated in Madhya Pradesh, India. Increasing spawning rates reduced the time required for spawn runs. The highest BEs (66.8-101.25%) was observed after the use of the highest spawning percentages. A 1:1 mixture of paddy straw wheat and straw promoted a high BE (106.5%); supplementation of this substrate with 5% rice flour also promoted BE (125.75%).

Ragunathan *et al.* (1996) investigated that the fruiting bodies of oyster mushroom were rich in nutrients such as carbohydrate, protein, amino nitrogen and minerals and low fat content. The moisture content of the fruit bodies ranged from 84.70 to 91.90 % and the carbohydrate content ranged from 40.6 to 46.3 %, the crude protein content ranged from 31.9 to 42.5 %, 26.92 to 38.8%, and 30.0 to 42.5% in *Pleurotus sajor-caju*, *Pleurotus platypus* and *Pleurotus citrinopileatus* respectively.

Mathew *et al.* (1996) investigated that *Pleurotus sajor-caju*, *Pleurotus* citrinopileatus, *Pleurotus florida*, *Pleurotus platypus* and *Pleurotus ostreatus* were evaluated for their yield performance on various substrates, both for spawn production and cultivation, in the plains and in the high ranges of Kerala in studies conducted in the summer and rainy seasons. Sorghum, wheat and paddy grains were equally good for spawn production. *Pleurotus sajor-caju*, *Pleurotus citrinopileatus* and *Pleurotus florida* were the most suitable species for cultivation in both the plains and the high ranges. These 3 species were successfully cultivated on paddy straw, *Eliocharis plantogena* [*Eleocharis plantaginea*] and rubber wood [Hevea] sawdust, although for commercial cultivation of *Pleurotus sajor-caju*, rubber wood sawdust was not rated as an ideal medium.

Jadhav *et al.* (1996) reported that oyster mushroom (*Pleurotus sajor-caju*) was cultivated on wheat straw, paddy straw, stalks and leaves of maize or cotton, jowar, soyabean straw, groundnut creepers plus wheat straw (1:1), soyabean straw plus groundnut creepers (1:1), or groundnut creepers alone. Cotton stalks and leaves gave the best results with respect to sporophore number, weight of sporophore (5.12 g) and total yield (914 g/kg of dry straw). Yields obtained on other substrates were: 796 g on paddy straw; 557 g on soyabean straw; and 508 g on soyabean + wheat straw. The lowest yield was recorded on groundnut creeper (258 g).

Singh *et al.* (1995) reported that the *Pleurotus florida* was cultivated on wheat straw, paddy straw and sugarcane trash (dried leaves) used either separately or in 1:1 ratio, yield and biological efficiency were the highest in paddy straw. The effects of different forest wastes on the radial growth of *Lentinus edodes* Berk were studied. Three types of sawdust from Shishum (*Dalbergia sisso*) 'Kikar' (*Acacia arabica*) and Poplar (*Populus alba*) amended with wheat bran and lime were used for spawn preparation.

Patra and Pani (1995) mentioned that five species of *Pleurotus* were cultivated in polythene [polyethylene] bags containing chopped paddy straw (2 kg) + spawn (200 g) + boiled wheat (200 g). Highest yield was observed in *P. Florida*, followed by *P. sajor-caju*, *P. citrinopileatus*, *P. sapidus* and *P. flabellatus*. The fungi took 13-I6 days for complete mycelial run in the bags and 20-24 days for initiation of fruiting bodies. *P. sajor-caju* produced the heaviest fruiting bodies (12.2 g) and *P. citrinopileatus* the lightest (6.9 g).

Murugesan *et al.* (1995) cultivated mushroom P. *sajor-caju* (Fr.) Sing, on water hyacinth (*Elchhorni crassipe*). They compared water hyacinth with other conventional substrates paddy straw. Total yields for 20 bags of the two substrates were 15.0 and 10.5 kg respectively, although the time taken to reach the pin-head stage was longer on the water hyacinth substrate (17 days in water hyacinth and 10 days in paddy straw). The high yield on water hyacinth was attributed to the C: N ratio (24.3 compared with 53.5) and low lignin content (9% compared with 17%) of this substrate. Use of water hyacinth would provide a cheap substrate and a means of eradicating a troublesome aquatic weed.

Isik *et al.* (1995) conducted an experiment to find out the best preparation formulas of horse manure and synthetic compost. Horse manure, wheat straw, gypsum as basic materials and wheat bran, cotton seed meal, sunflower meal, malt sprout, chicken food, molasses, ammonium sulphate, urea as activators were used. The nitrogen content of the starting mixture was brought up 2 in all applications. According to the results, the highest yields with horse manure

compost were obtained from the combinations of 1000 kg of horse manure, 50 kg of wheat bran, 3.1 kg of ammonium sulphate, 1.5 kg of urea, 35 kg of gypsum and 1000 kg of horse manure, 40 kg of chicken food or malt sprout, 7.5 kg of urea, 35 kg of gypsum. The highest yields with synthetic compost were obtained from the combinations of 1000 kg of wheat straw, 282 kg of wheat bran, 13 kg of urea, 23.5 kg of ammonium nitrate, 40 kg of molasses, 60 kg of gypsum and 1000 kg of wheat straw, 65 kg of cotton seed meal or 100 kg of chicken food, 25 kg of urea, 40 kg of molasses and 0 kg of gypsum.

Abraham and Pradeep (1995) reported that *C. odorata*, a common weed of the tropics, was examined as a potential substrate for cultivation of *Pleurotus flabellatus*. Performance was evaluated using *C. odorata*, dried or fresh and sterilized or not sterilized, as a sole substrate and in combination with paddy straw (1:1). The results indicate that *C. odorata* residues can be used for the commercial cultivation of *Pleurotus*.

Sarawish (1994) found no significant difference in either the growth of mycelium or the yield of straw mushroom on kaptok residue, chopped-dried water hyacinth, chopped-dried banana stem or chopped-dried water hyacinth, chopped-dried banana stem chopped-dried rice straw as a main substrate.

Marimuthu *et al.* (1994) investigate *Pleurotus sajor-caju, P. citrinopileatus* and *P. platypus* on paddy straw were tested for their response to substrate amendment with neem cake, rice bran, wheat bran and tapioca thippi (Factory waste). 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 and reduced the number of days required for completion of spawn run by 2-6, 5 and 6 days, respectively compared with control.

Dhanda *et al.* (1994) conducted an experiment on the use of fermented, semi-fermented and unfermented paddy straw as substrate for *Pleurotus spp*. (oyster mushroom). PAU-4 strain showed early primordia initiation, giving 60%

biological efficiency whereas PAU-3 exhibited these effects much earlier with 70% biological efficiency.

Badshah *et al.* (1994) mentioned that *Pleurotus ostreatus* and *P. florida* were grown on wheat straw, sugarcane bagasse, corn cobs or sawdust, by mixing 120-130 g of spawn with 2 kg of substrate and placing the mixture in sterilized polyethylene bags which were kept in the dark at 25°C for 2-3 weeks. Once the bags became full of mycelial growth, they were removed, leaving the substrate uncovered. Watering was carried out 2-3 times a day. Fruiting bodies were harvested at maturity. *P. ostreatus* and *P. florida* yields ranged from 49.8 and 277.7 g/2 kg substrate respectively on sawdust, to 432.8 and 420.5 g/ 2 kg substrate respectively, on wheat straw. Controls (grown in the field) yielded only 18.5 and 28.5 g/2 kg substrate for *P. ostreatus* and *P, florida*, respectively. In both species, wheat straw and sugarcane bagasse substrates resulted in the highest mushroom ascorbic acid contents and protein, fat and fiber contents were also affected by substrate. *Pleurotus florida* had higher fat but lower protein contents than *P. ostreatus*.

Ijaz and Khan (1992) reported that mushroom has been recently introduced in Pakistan. Different species/strains i.e. *Pleurotus sajor-caju*., *P. ostreatus* strain XI, *P. ostreatus* strain 467 and *P. ostreatus* were cultivated on cotton waste. *P. ostreatus* strain XI gave higher (260 g) basidiocarps out of 750 g of substrates per flush. It had 104 percent biological efficiency and 49% sustenance potential. In the same manner cotton waste scored maximum yield, biological efficiency and sustenance potential by defeating paddy straw + 25 percent synthetic compost, paddy straw and wheat straw in descending order.

Royse *et al.* (1991) found that yields of *Pleurotus sajor-caju* strain 537 from the substrate supplemented with the commercial nutrient were 1.7-fold higher than yields from non-supplemented substrate. As the supplement level increased from 6 to 12 %, the mushroom yields increased. The yields ranged from 3.56 kg/m^2 for non-supplemented substrates to 7.36 kg/m^2 for substrate supplemented (12% DW) with formaldehyde soybean meal.

Khan *et al.* (1991) used sawdust to prepare compost for spawn running amended with lime and different combinations of wheat chaff, wheat bran, paddy straw and cotton waste. Sawdust from *D. sisso* was the most suitable for spawn preparation and all types of sawdust amended with cotton waste were found to give optimum conditions for spawn running.

Chapter III

Materials and Methods

CHAPTER III

MATERIALS AND METHODS

The experiment was carried out to find out the effect of different substrates ratio on the growth and yield of oyster mushroom. This chapter deals with a brief description on location and design of experiment, experiments and treatments, preparation of substrates, preparation of packets, cultivation of spawn packet, collection of produced mushrooms, data recording and their analysis under the following headings and sub-headings.

3.1 Location

The experiment was carried out at the Tissue Culture Laboratory and Culture House of Mushroom Development Institute, Savar, Dhaka, during the period from January 2014 to June 2014. Experimental site was given in appendix I.

3.2 Experimental materials

Two oyster Mushroom varieties such as-V_1 (*Pleurotus ostreatus*) and V_2 (*Pleurotus djamor)* were tested on different substrates sawdust and rice straw with supplement. Spawn packet of 500 g size was prepared by through spawning method and was maintain the definite substrates ratio.

3.3 Treatments

The experiment was consisted with the following two treatment factors:

Factor-A: Mushroom variety

V_1 = *Pleurotus ostreatus*

V_2 = *Pleurotus djamor*

Factor-B: Substrates ratio

S_1 = 25% Straw + 10% paddy grain (mother culture) + 65% Sawdust

S_2 = 35% Straw + 10% paddy grain (mother culture) + 55% Sawdust

S_3 = 45% Straw +10% paddy grain (mother culture) + 45% Sawdust

S_4 = 55% Straw + 10% paddy grain (mother culture r) + 35% Sawdust

S_5 = 65% Straw + 10% paddy grain (mother culture) + 25% Sawdust

S_6 = 75% Straw + 10% paddy grain (mother culture) + 15% Sawdust

S_7 = 85% Straw + 10% paddy grain (mother culture) + 5% Sawdust

S_8 = 90% Straw + 10% paddy grain (mother culture)

S_9 = 90% Sawdust + 10% paddy grain (mother culture)

3.4 Experimental design

The experiment was laid out in Completely Randomized Design (CRD) with three replications. The experiments with eighteen treatments with three replications were conducted to achieve the desired objectives.

3.5 Preparation of pure culture:

Pure cultures of two strains were prepared on Potato Dextrose Agar (PDA) medium. Afresh and juvenile stage sporophore of above mentioned mushrooms were collected and surface sterilized with 70% alcohol by rubbing cotton soacked in alcohol. Tissues were collected from inner region of the joint of stalk and pileus. The tissues cut into small pieces and placed on the solidified test tube containing PDA. After inoculation, the tube was covered with cork. All operations were done under sterile condition in a clean bench. The inoculated tubes were kept in a growth chamber maintaining temperature at 20-25^{0}C and incubated 8-15 days until the tubes full of whitish mycelia. Then the pure culture was used for inoculation of mother culture.

3.6 Preparation of mother culture:

To prepare mother culture of test mushroom ((*Pleurotus ostreatus* and *Pleurotus djamor*) good quality paddy grains were used as media of mother culture. At first 2 kg of grains collected which was free from diseases and not broken, old, and insect damaged. The grains were thoroughly washed in sufficient water three to four times to remove unfilled grain, soil debris, straw particles and other undesirable things. Then washed grains were soaked in sufficient water for 2-3 hours and boiled in a container (saucepan) for 30- 45

minutes until cracking. Excess water from the boiled grains was removed by heating and continuous shaking. When the water removed burner was stopped. Then the boiled grains were kept 1-2 hours for cooling. The cooled grains were thoroughly mixed with sawdust containing master mother culture at 10% rate. This mixing was done the same container after wearing gloves and the mixed grains were poured into polypropylene bags (18cm × 25cm) at 250-300 g/bag and their mouths were plugged by inserting absorbing cotton without neck. The bags were kept in rack at room temperature. After 10 to 15 days the mother culture became white due to complete the mycelium running and then it was ready for spawning of spawn packets.

3.7 Preparation of substrates:

Two different substrates namely, sawdust (SD) and rice straw (RS) were used as media. Both the substrates were prepared by pasteurization method. In case of SD, twenty kg sawdust was mixed with 17 litter of water and 8-10 kg mixture was poured into cribriform nylon bag. In case of RS, the straw was chopped to 4-5 cm length and then poured 4-5 kg into cribriform nylon bag. The bags were submerged in water for sometimes and then drained out the excess water. After that both the bags containing SD and RS were kept in a pasteurization chamber at 60-65^{0}C for one hour. The bags were kept in same place for 18-20 hours to get cool slowly. After 20 hours the prepared sawdust and straw were spread over polythene sheet in open place to reduce moisture 63%. These substrates were ready for spawn packet preparation.

3.8. Preparation of spawn packets

According to treatment combination prepared substrates and 10% mother culture were mixed thoroughly and filled into 18cm × 25cm polypropylene bags at 500 g/bag. The mouths of the filled polypropylene bags were plugged by inserting absorbing cotton with the help of plastic neck and rubber band by spawning method.

3.8.1 Mycelium running in spawn packets/ Incubation

The packets were kept at room temperature until the packets become white with the mushroom mycelium. After completion of the mycelium running the rubber band, cotton plug and plastic neck of the mouth of spawn packet were removed and the mouth was wrapped tightly with rubber band. Then these spawn packets were transferred to the culture house.

3.8.2 Opening the packet

Two ends, opposite to each other of the upper position i.e. on shoulder of plastic bag were cut in "D" shaped with a blade and opened by removing the plastic sheet after which the opened surface of substrate was scraped slightly with a blade for removing the thin whitish mycelial layer.

3.8.3 Cultivation of spawn packet

The packets of each type were placed separately on the rack of culture room. The moisture of the culture room was maintained 80-85% relative humidity by spraying water 3-5 times a day. The light around 150-200 lux and ventilation of culture house was maintained uniformly. The temperature of culture house was maintained 22°C to 25°C. The first primordia appeared 2-4 days after scribing depending upon the type of substrate. The harvesting time also varied depending upon the type of substrate.

3.8.4 Cultural operation, collection of produced and harvesting of mushroom

After completing the first harvest again the packets were scrapped at the place where the ‘D’ shaped cut had been done and then placed in the culture house and water was sprayed regularly. The primordia appeared 9-10 days after first harvest and 7-8 days after second harvest. Water spraying was continued until the mushrooms were ready to be harvested.

3.9 Data collection

Data were collected on the following parameters:

3.9.1 Days required pinhead initiation to 1st harvest:

Days required from pinhead initiation to 1st harvest were recorded.

3.9.2. Number of fruiting body/packet:

Number of total fruiting body was recorded.

3.9.3. Number of effective fruiting body/packet:

Number of well-developed effective fruiting body was recorded. Dry and pinheaded fruiting bodies were discarded but tiny fruiting bodies were included in counting.

3.9.4. Dimension of pileus and stalk:

Thickness of the pileus of four randomly selected fruiting bodies were recorded using a slide caliper. Length and diameter of pileus, length and diameter of stalk were recorded.

3.9.5. Yield:

Yield in g/500g packet was recorded by weighing all the fruiting bodies in a packet after removing the lower hard and dirty portion.

3.10 Statistical analysis:

The collected data were analyzed statistically following completely randomized design by MSTAT-C computer package programme. The treatment means were compared by Least Significance Differences (LSD), Duncan's Multiple Range Test (DMRT) and regression lines were performed as and when necessary (Gomez and Gomez, 1984).

Chapter IV

Results and Discussion

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to effect of different substrates ratio on the growth and yield of oyster mushroom. Data of the different parameters analyzed statistically and the results have been presented in the Tables and Figures. The results of the present study have been presented and discussed in this chapter under the following headings.

4.1 Days required from pinhead initiation to 1st harvest

Variety of mushroom showed influence on days required from pinhead initiation to 1st harvest. The lowest time (3.22 days) from pinhead initiation to 1st harvest was in the treatment V_1 (*Pleurotus ostreatus*) and the highest time (4.39 days) from pinhead initiation to 1st harvest was observed in the treatment V_2 (*Pleurotus djamor*) (Fig. 1).

Significant variation was found in days required from pinhead initiation to 1st harvest due to the effect of substrates ratio**.** The lowest time (3.50 days) from pinhead initiation to 1st harvest was in the treatment S_4 , S_5, S_6 and S_7 and the highest time (4.50 days) from pinhead initiation of 1st harvest was observed in the treatment S_9 (fig 2). The result of the present study keeps in with the findings of several workers (Khan *et al.*, 2001; Dhoke *et al.*, 2001; Royse, 2002 and Kulsum *et al.,* 2009). Khan *et al.* (2001) who reported that after spawn running pinhead formation took 7-8 days and fruiting body formed after 3-5 days, sporocarps may be harvested after 10-12 days. Dhoke *et al.* (2001) found significant effect of different agro-wastes on yield of oyster mushroom. The days required for first picking varied from 11.25-12.00 and the final picking complete from 42.25 to 43.50 days depending on different substrates. Royse (2002) found as the spawn rate increased the number of days to production decreased. Kulsum *et al.* (2009) observed that the lowest time from primordia initiation to harvest was 3.2 days due to sawdust supplemented with cow dung @ 10%.

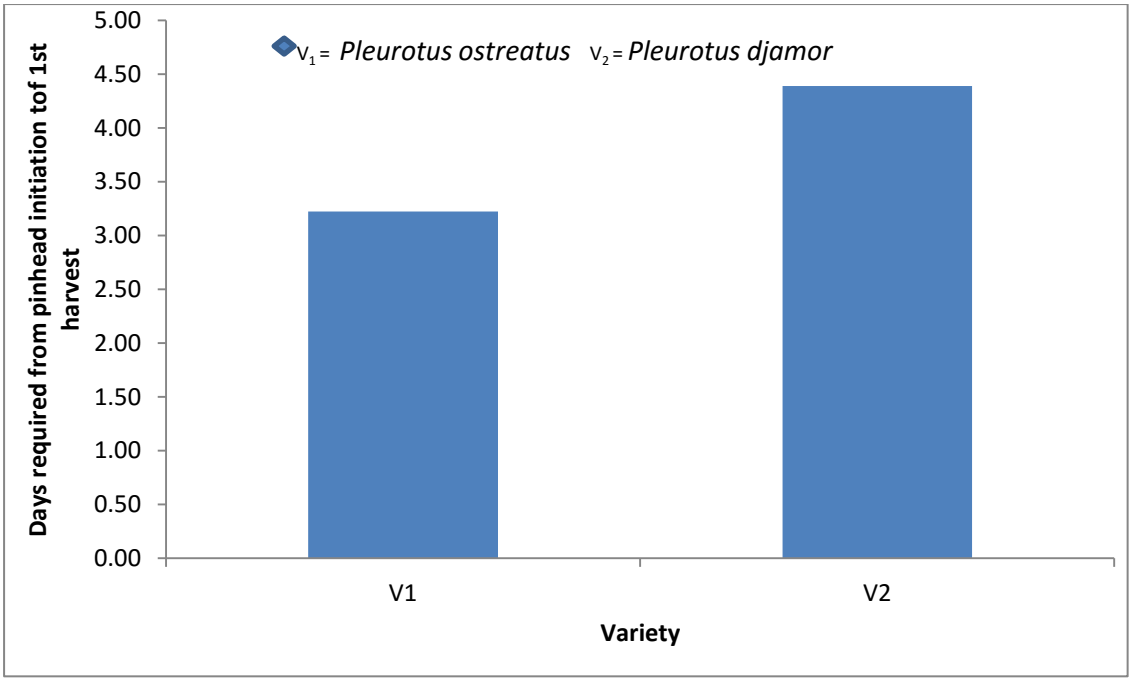

Fig. 1 Effect of variety on Days required from pinhead initiation to 1st harvest of oyster Mushroom

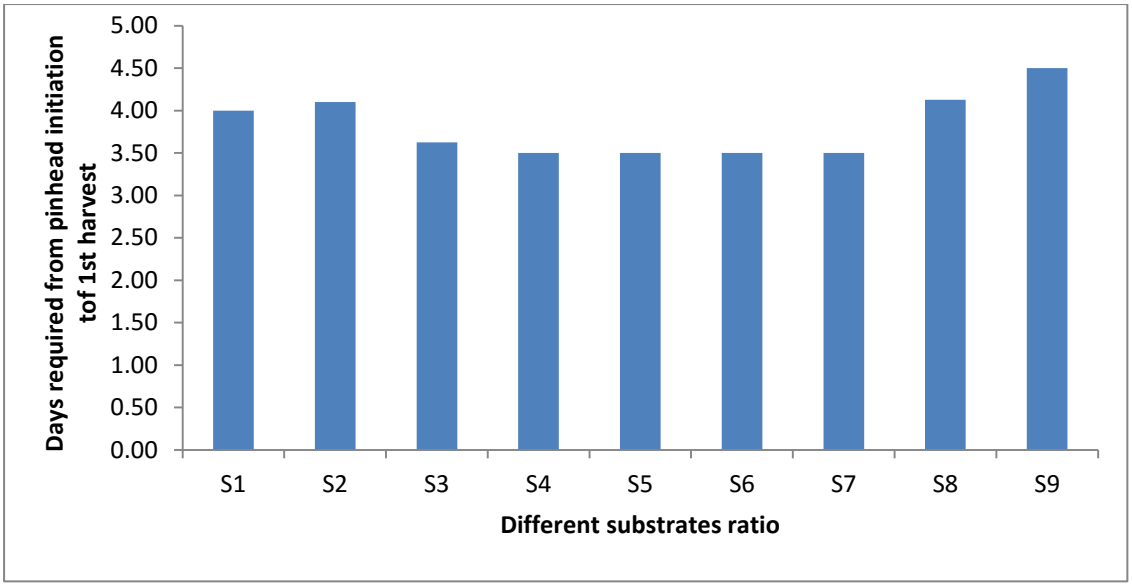

Fig. 2 Effect of substrates ratio on Days required pinhead initiation to 1st harvest of Oyster Mushroom

S_1= 25% Straw + 10% paddy grain (mother culture) + 65% Sawdust
S_2= 35% Straw + 10% paddy grain (mother culture) + 55%Sawdust
S_3= 45% Straw + 10% paddy grain (mother culture) + 45% Sawdust
S_4= 55% Straw + 10% paddy grain (mother culture) + 35%Sawdust
S_5= 65% Straw + 10% paddy grain (mother culture) + 25%Sawdust
S_6= 75% Straw + 10% paddy grain (mother culture) + 15%Sawdust
S_7= 85% Straw + 10% paddy grain (mother culture) + 5%Sawdust
S_8= 90% Straw + 10% paddy grain (mother culture)
S_9= 90% Sawdust + 10% paddy grain (mother)

Interaction effect of varieties and substrates ratio was found significant on days required from pinhead initiation to 1st harvest. The lowest time (3.50 days) from pinhead initiation to 1st harvest was in the treatment V_1S_1 , V_1S_2, V_1S_3, V_1S_4, V_1S_5, V_1S_6 and V_1S_7 and the highest time (5.0 days) from pinhead initiation to 1st harvest was observed in the treatment V_2S_1, V_2S_2 and V_2S_9 (Table 1).

4.2 Number of fruiting body\packet

Variety of mushroom showed influence on number of fruiting body. The highest number of fruiting body (16.53) was observed in V_1 (*Pleurotus ostreatus*) and the lowest average number of fruiting body (5.56) was in the treatment V_2 (*Pleurotus djamor*) (Fig. 3).

There was significant variation in number of fruiting body due to substrates ratio. The highest number of fruiting body (15.25) was observed in the treatment S_3 (45% Straw + 10% paddy grain (mother culture) + 45% Sawdust), which was statistically similar with S_2 and S_1 and the lowest number of fruiting body (7.26) was in the treatment S_6 (75% Straw + 10% paddy grain (mother culture) + 15% Sawdust) (Fig 4). The other treatments significantly varied in terms of number of fruiting body. The result of the present findings keep in with the findings of Yoshida *et al.,* 1993; Amin, 2004; Sarker, 2004 and Kulsum *et al.,* 2009. Yoshida *et al.* (1993) reported that the number of fruiting bodies was lower but increased when the substrates was mixed with different supplements. Amin (2004) reported that the number of primordia grown on different substrates differed significantly. Sarker (2004) found that the number of primordia increased with the levels of supplement and continued up to a certain range and decline thereafter. Kulsum *et al.* (2009) observed that the highest average number of fruiting body/packet was 60.42 due to sawdust supplemented with cow dung @ 10%.

Table 1. Combined effect of variety and substrates ratio on days required pinhead initiation to 1st harvest, number of fruiting body and number of effective fruiting body of oyster Mushroom

Treatment	Days required from pinhead initiation o 1st harvest		Number of fruiting body		Number of effective fruiting body	
V_1S_1	3.00	d	18.50	c	15.00	a
V_1S_2	3.00	d	24.00	b	15.00	a
V_1S_3	3.00	d	26.00	a	16.00	a
V_1S_4	3.00	d	15.00	de	13.00	b
V_1S_5	3.00	d	13.75	ef	12.00	bc
V_1S_6	3.00	d	10.00	g	7.50	fg
V_1S_7	3.00	d	13.25	ef	9.50	de
V_1S_8	4.00	c	12.25	f	11.00	cd
V_1S_9	4.00	c	16.00	d	10.00	d
V_2S_1	5.00	a	4.00	l	4.00	i
V_2S_2	5.00	a	6.50	ijk	6.50	gh
V_2S_3	4.25	b	8.75	gh	8.25	ef
V_2S_4	4.00	c	4.25	l	4.25	i
V_2S_5	4.00	c	8.00	ghi	8.00	efg
V_2S_6	4.00	c	4.50	kl	4.50	i
V_2S_7	4.00	c	7.00	hij	7.00	fg
V_2S_8	4.25	b	5.25	jkl	5.25	hi
V_2S_9	5.00	a	1.75	m	1.75	j
LSD (0.05)	0.24		1.95		1.48	
CV (%)	4.38		12.46		11.87	

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

V_1 = *Pleurotus ostreatus*, V_2 = *Pleurotus djamor*

S_1= 25% Straw + 10% paddy grain (mother culture) + 65% Sawdust

S_2= 35% Straw + 10% paddy grain (mother culture) + 55%Sawdust

S_3= 45% Straw + 10% paddy grain (mother culture) + 45% Sawdust

S_4= 55% Straw + 10% paddy grain (mother culture) + 35%Sawdust

S_5= 65% Straw + 10% paddy grain (mother culture) + 25%Sawdust

S_6= 75% Straw + 10% paddy grain (mother culture) + 15%Sawdust

S_7= 85% Straw + 10% paddy grain (mother culture) + 5%Sawdust

S_8= 90% Straw + 10% paddy grain (mother culture)

S_9= 90% Sawdust + 10% paddy grain (mother)

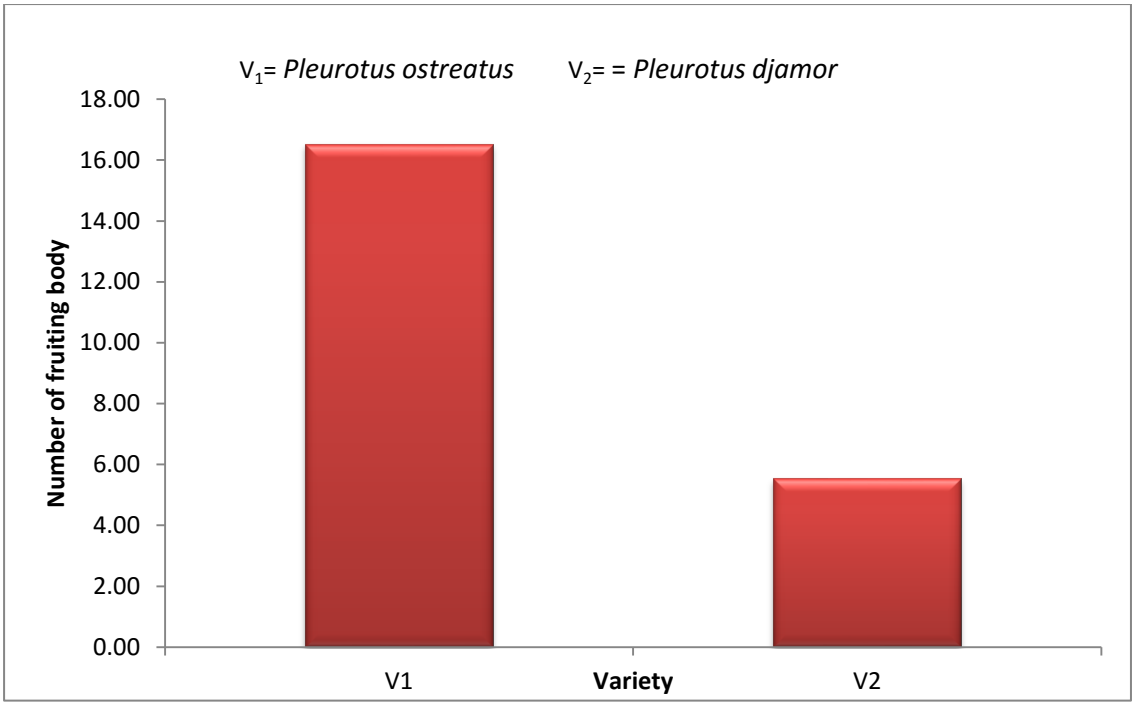

Fig. 3 Effect of variety on number of fruiting bodyof oyster Mushroom

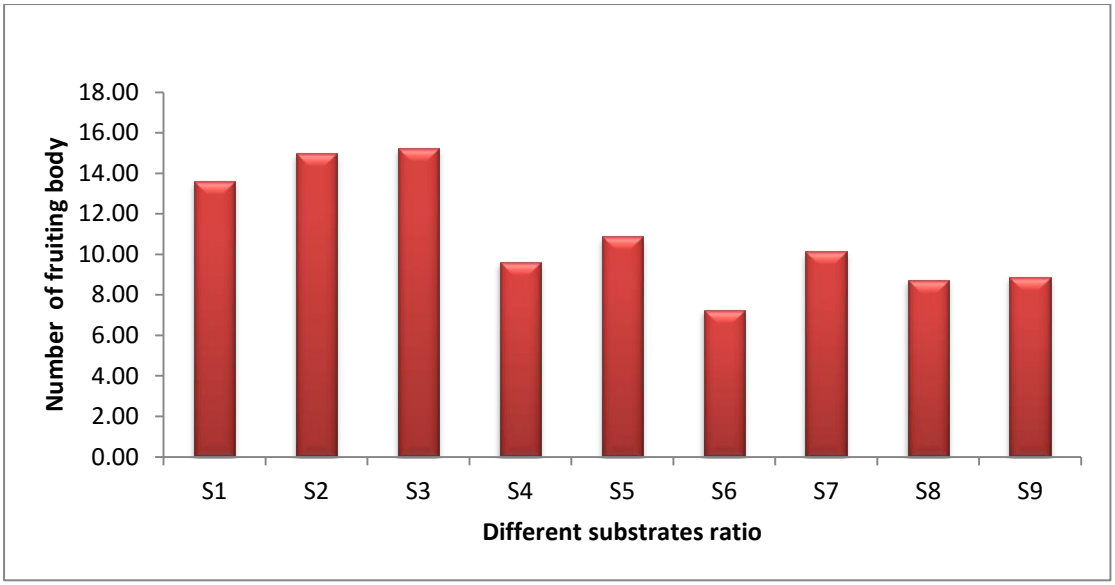

Fig. 4 Effect of Different substrates ratio on number of fruiting body of Oyster Mushroom

S_1= 25% Straw + 10% paddy grain (mother culture) + 65% Sawdust
S_2= 35% Straw + 10% paddy grain (mother culture) + 55%Sawdust
S_3= 45% Straw + 10% paddy grain (mother culture) + 45% Sawdust
S_4= 55% Straw + 10% paddy grain (mother culture) + 35%Sawdust
S_5= 65% Straw + 10% paddy grain (mother culture) + 25%Sawdust
S_6= 75% Straw + 10% paddy grain (mother culture) + 15%Sawdust
S_7= 85% Straw + 10% paddy grain (mother culture) + 5%Sawdust
S_8= 90% Straw + 10% paddy grain (mother culture)
S_9= 90% Sawdust + 10% paddy grain (mother)

Combined effect of varieties and substrates ratio were showed significant variation on number of fruiting body (Table 1). The highest number of fruiting body (26.00) was observed in the treatment V_1S_3(*Pleurotus ostreatus* with 45% Straw + 10% paddy grain (mother culture) + 45% Sawdust) and the lowest number of fruiting body (4.00) was in the treatment V_2S_1 (*Pleurotus djamor* with 25% Straw + 10% paddy grain (mother culture) + 65%Sawdust).

4.3 Number of effective fruiting body\packet

Number of effective fruiting body affected due to the varieties. The highest number of effective fruiting body (12.11) was obtained from V_1 treatment. The lowest number of effective fruiting body (5.50) was obtained from V_2 treatment (Fig. 5).

Significant variation was observed highest number of effective fruiting body due to substrates ratio. The maximum number of effective fruiting body (11.63) was observed in the treatment S_3, and the lowest number of effective fruiting body (5.88) was in the treatment S_9 (90%Sawdust+10% paddy grain (mother)). The other treatments significantly varied in terms of number of effective fruiting body (Fig 6). The result of the present findings keeps in with the findings of Yoshida *et al.,* 1993; Amin, 2004; Sarker, 2004 and Kulsum *et al.,* 2009. Yoshida *et al.* (1993) reported that the number of fruiting bodies was lower but increased when the substrates was mixed with different supplements. Amin (2004) reported that the number of primordia grown on different substrates differed significantly. Sarker (2004) found that the number of primordia increased with the levels of supplement and continued up to a certain range and decline thereafter. Kulsum *et al.* (2009) observed that the highest average number of fruiting body/packet was 60.42 due to sawdust supplemented with cow dung @ 10%.

Combined effect of varieties and substrates ratio was showed significant variation on number of effective fruiting body (Table 1). The highest number of effective fruiting body (16.00) was observed in the treatment V_1S_3 (*Pleurotus ostreatus* with 45% Straw + 10% paddy grain (mother culture) + 45% Sawdust) and the lowest number of fruiting body (1.75) was in the treatment V_2S_9 (*Pleurotus djamor* with 90% Sawdust + 10% paddy grain (mother).

4.4 Length of stalk

A significant variation in the length of stalk was found among the varieties. The longest stalk length (4.04 cm) was obtained from V_1 treatment and the shortest stalk length (2.15 cm) was obtained from V_2 treatment (Table 2). Length of stalk had significant variation due to the substrates ratio. The maximum (3.94 cm) length of stalk was recorded from S_3, while S_6 gave the minimum (2.04 cm) length of stalk (Table 3).

The interaction between different variety and substrates ratio was found significant on the stalk length. The maximum length of stalk (5.00 cm) was produced by V_1S_3 and the lowest length of stalk (1.03 cm) was produced by V_2S_6 which is presented in Table 4.

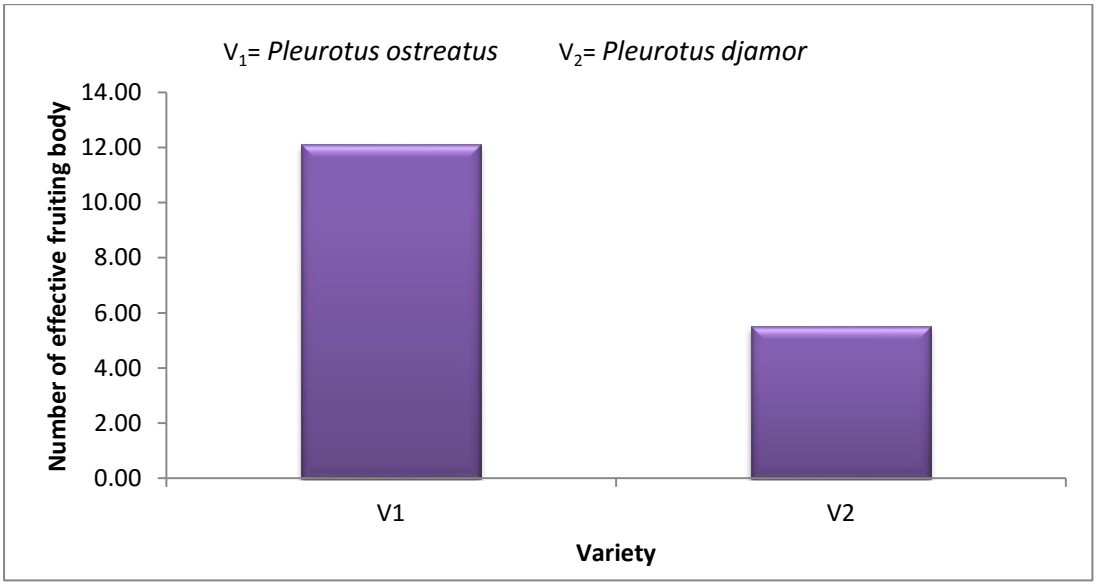

Fig 5. Effect of variety on number of effective fruiting body of oyster Mushroom

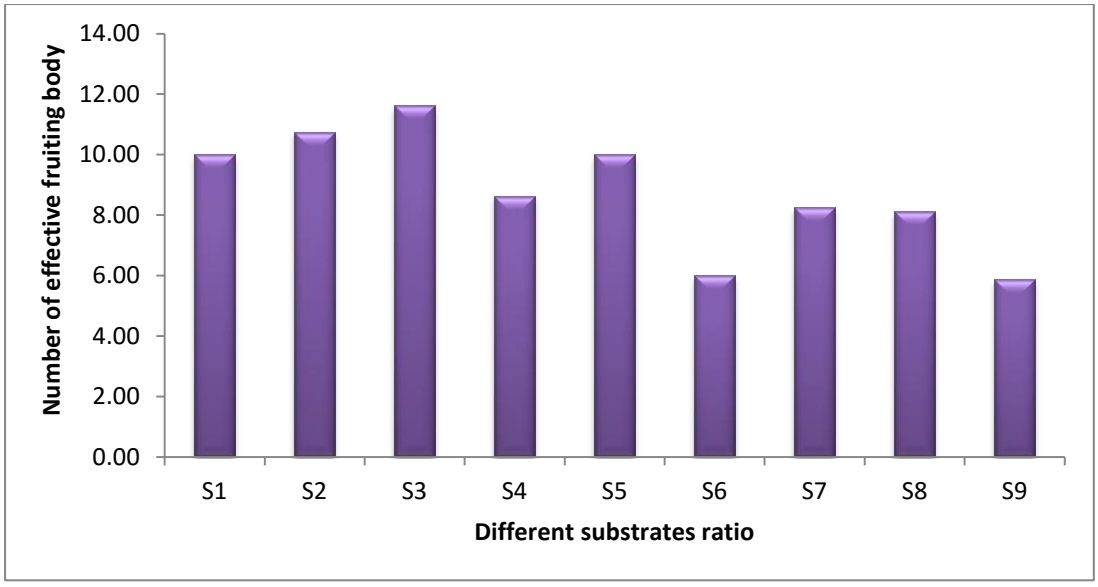

Fig. 6 Effect of Different substrates ratio on number of effective fruiting body of oyster Mushroom

S_1= 25% Straw + 10% paddy grain (mother culture) + 65% Sawdust
S_2= 35% Straw + 10% paddy grain (mother culture) + 55% Sawdust
S_3= 45% Straw + 10% paddy grain (mother culture) + 45% Sawdust
S_4= 55% Straw + 10% paddy grain (mother culture) + 35% Sawdust
S_5= 65% Straw + 10% paddy grain (mother culture) + 25% Sawdust
S_6= 75% Straw + 10% paddy grain (mother culture) + 15% Sawdust
S_7= 85% Straw + 10% paddy grain (mother culture) + 5% Sawdust
S_8= 90% Straw + 10% paddy grain (mother culture)
S_9= 90% Sawdust + 10% paddy grain (mother)

Table. 2 Effect of variety on Length of stalk and Diameter of stalk of Oyster Mushroom

Treatment	Length of stalk(cm)	Diameter of stalk(cm)
V_1	4.04	1.14
V_2	2.15	0.72
CV (%)	14.26	16.87

V_1 = *Pleurotus ostreatus*
V_2 = *Pleurotus djamor*

Table 3. Effect of Different substrates ratio on Length of stalk and Diameter of stalk of Oyster Mushroom

Treatment	Length of stalk(cm)		Diameter of stalk(cm)	
S_1	2.96	b	0.88	abc
S_2	3.23	ab	0.86	abc
S_3	3.94	a	1.06	a
S_4	3.28	ab	1.05	a
S_5	3.06	b	1.03	ab
S_6	2.04	c	0.82	bc
S_7	2.89	b	0.78	c
S_8	2.98	b	0.89	abc
S_9	3.49	ab	1.00	ab
LSD (0.05)	0.72		0.20	
CV (%)	14.26		16.87	

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

S_1= 25% Straw + 10% paddy grain (mother culture) + 65% Sawdust
S_2= 35% Straw + 10% paddy grain (mother culture) + 55% Sawdust
S_3= 45% Straw + 10% paddy grain (mother culture) + 45% Sawdust
S_4= 55% Straw + 10% paddy grain (mother culture) + 35% Sawdust
S_5= 65% Straw + 10% paddy grain (mother culture) + 25% Sawdust
S_6= 75% Straw + 10% paddy grain (mother culture) + 15% Sawdust
S_7= 85% Straw + 10% paddy grain (mother culture) + 5% Sawdust
S_8= 90% Straw + 10% paddy grain (mother culture)
S_9= 90% Sawdust + 10% paddy grain (mother)

Table 4. Combined effect of varieties and different substrates ratio on length of stalk and diameter of stalk of Oyster Mushroom

Treatment	Length of stalk		Diameter of stalk	
V_1S_1	4.15	bc	1.00	cde
V_1S_2	4.46	ab	1.02	cd
V_1S_3	5.00	a	1.60	a
V_1S_4	4.51	ab	1.23	bc
V_1S_5	4.35	ab	1.36	b
V_1S_6	3.06	de	0.84	defg
V_1S_7	3.06	de	0.96	def
V_1S_8	3.59	cd	1.00	cde
V_1S_9	4.19	bc	1.23	bc
V_2S_1	2.88	e	0.75	efgh
V_2S_2	2.00	f	0.70	fgh
V_2S_3	1.78	f	0.78	defg
V_2S_4	2.05	f	0.86	def
V_2S_5	1.76	f	0.71	fgh
V_2S_6	1.03	g	0.80	defg
V_2S_7	2.73	e	0.60	gh
V_2S_8	2.37	ef	0.78	defg
V_2S_9	2.79	e	0.52	h
LSD (0.05)	0.63		0.22	
CV (%)	14.26		16.87	

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

V_1 = *Pleurotus ostreatus*, V_2 = *Pleurotus djamor*

S_1= 25% Straw + 10% paddy grain (mother culture) + 65% Sawdust

S_2= 35% Straw + 10% paddy grain (mother culture) + 55% Sawdust

S_3= 45% Straw + 10% paddy grain (mother culture) + 45% Sawdust

S_4= 55% Straw + 10% paddy grain (mother culture) + 35% Sawdust

S_5= 65% Straw + 10% paddy grain (mother culture) + 25% Sawdust

S_6= 75% Straw + 10% paddy grain (mother culture) + 15% Sawdust

S_7= 85% Straw + 10% paddy grain (mother culture) + 5% Sawdust

S_8= 90% Straw + 10% paddy grain (mother culture)

S_9= 90% Sawdust + 10% paddy grain (mother)

4.5 Diameter of stalk

A significant variation in the diameter of stalk was found among the varieties. The largest stalk diameter (1.14 cm) was obtained from V_1 treatment, and the shortest stalk diameter (0.72 cm) was obtained from V_2 treatment (Table 2).

Stalk diameter differed significantly due to the substrates ratio. The highest (1.06 cm) diameter of stalk was recorded from S_3, which was statistically similar with S_4 treatment. While S_7 (85% Straw + 10% paddy grain (mother culture) + 5%Sawdust) gave the minimum (0.78) diameter of stalk (Table 3).

The interaction between different variety and different substrates ratio was found significant variation on the stalk diameter. The maximum diameter of stalk (1.60 cm) was produced by V_1S_3 and the diameter of stalk (0.52 cm) was produced by V_2S_9 (Table 4).

4.6 Length of pileus

A significant variation in the length of pileus was found among the varieties. The longest pileus length (7.72 cm) was obtained from V_1 treatment and the shortest pileus length (6.05 cm) was obtained from V_2 treatment (Table 5).

Length of pileus had significant variation due to the substrates ratio. The maximum (7.32 cm) length of pileus was recorded from S_3, which was statistically similar with S_1 while S_6 gave the minimum (6.34 cm) length of pileus (Table 6).

The interaction between different variety and substrates ratio was found significant on the pileus length. The maximum length of pileus (8.64 cm) was produced by V_1S_3 and the lowest length of pileus (5.38 cm) was produced by V_2S_6 which was statistically similar with V_2S_5 (Table 7).

Table. 5 Effect of variety on yield and yield contributing character of Oyster Mushroom

Treatment	Length of pileus (cm)	Diameter of pileus (cm)	Thickness of pileus (cm)	Yield (g/plant)
V_1	7.72	9.02	0.87	66.50
V_2	6.05	5.31	5.54	33.17
CV (%)	16.58	7.22	12.55	5.65

V_1 = *Pleurotus ostreatus*, V_2 = *Pleurotus ostreatus*

Table 6. Effect of Different substrates ratio on yield and yield contributing of oyster Mushroom.

Treatment	Length of pileus (cm)		Diameter of pileus (cm)		Thickness of pileus (cm)		Yield (g/plant)	
S_1	7.29	a	4.98	ab	4.89	d	54.50	b
S_2	6.84	abc	5.27	a	4.84	d	62.88	a
S_3	7.32	a	5.66	a	10.41	a	63.25	a
S_4	7.01	ab	4.54	b	4.93	cd	44.50	c
S_5	6.58	bc	5.03	ab	5.77	c	58.50	ab
S_6	6.34	c	0.87	c	4.65	d	35.00	d
S_7	6.67	bc	0.78	c	9.34	b	45.50	c
S_8	7.00	ab	0.79	c	9.94	ab	42.88	c
S_9	6.96	ab	0.95	c	9.70	ab	41.50	c
$LSD_{(0.05)}$	0.53		0.66		0.84		4.59	
CV (%)	16.58		7.22		12.55		5.65	

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

S_1= 25% Straw + 10% paddy grain (mother culture) + 65% Sawdust
S_2= 35% Straw + 10% paddy grain (mother culture) + 55% Sawdust
S_3= 45% Straw + 10% paddy grain (mother culture) + 45% Sawdust
S_4= 55% Straw + 10% paddy grain (mother culture) + 35% Sawdust
S_5= 65% Straw + 10% paddy grain (mother culture) + 25% Sawdust
S_6= 75% Straw + 10% paddy grain (mother culture) + 15% Sawdust
S_7= 85% Straw + 10% paddy grain (mother culture) + 5% Sawdust
S_8= 90% Straw + 10% paddy grain (mother culture)
S_9= 90% Sawdust + 10% paddy grain (mother)

Table 7 Combined effect of varieties and different substrates ratio on yield and yield contributing of Oyster Mushroom

Treatment	Length of pileus (cm)		Diameter of pileus (cm)		Thickness of pileus (cm)		Yield (g/plant)	
V_1S_1	8.00	ab	0.80	de	8.54	d	87.50	a
V_1S_2	7.88	abc	0.81	de	8.83	d	87.50	a
V_1S_3	7.93	ab	0.76	de	12.00	a	90.00	a
V_1S_4	8.64	a	0.84	de	8.99	d	68.00	b
V_1S_5	7.19	abcde	0.81	de	10.66	bc	70.00	b
V_1S_6	7.04	abcde	0.84	de	8.78	d	42.00	ef
V_1S_7	7.13	abcde	0.71	e	8.78	d	49.00	d
V_1S_8	8.00	ab	0.88	de	8.88	d	43.00	e
V_1S_9	7.70	abcd	1.43	d	8.81	d	61.50	c
V_2S_1	6.58	bcde	9.75	b	0.75	e	21.50	i
V_2S_2	5.79	de	9.21	b	0.84	e	38.25	fg
V_2S_3	5.98	cde	10.50	a	0.88	e	36.50	g
V_2S_4	6.13	bcde	8.25	c	0.88	e	28.00	h
V_2S_5	5.48	e	9.25	b	0.88	e	47.00	d
V_2S_6	5.38	e	0.90	de	10.63	bc	21.00	i
V_2S_7	6.21	bcde	0.85	de	9.90	c	42.00	ef
V_2S_8	6.00	cde	0.71	e	11.00	b	42.75	e
V_2S_9	6.94	abcde	0.48	e	8.90	d	21.50	i
LSD (0.05)	1.62		0.57		0.73		3.99	
CV (%)	16.58		7.22		12.55		5.65	

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

V_1 = *Pleurotus ostreatus*, V_2 = *Pleurotus djamor*

S_1= 25%Straw + 10%paddy grain (mother culture) + 65%Sawdust

S_2= 35%Straw + 10%paddy grain (mother culture) + 55%Sawdust

S_3= 45%Straw + 10%paddy grain (mother culture) + 45%Sawdust

S_4= 55%Straw + 10%paddy grain (mother culture r) + 35%Sawdust

S_5= 65%Straw + 10% paddy grain (mother culture) + 25%Sawdust

S_6= 75%Straw + 10% paddy grain (mother culture) + 15%Sawdust

S_7= 85% Straw + 10% paddy grain (mother culture) + 5% Sawdust

S_8= 90% Straw + 10% paddy grain (mother culture)

S_9= 90% Sawdust + 10% paddy grain (mother)

4.7 Diameter of pileus

A variation in the diameter of pileus was found among the varieties. The largest pileus diameter (9.02 cm) was obtained from V_1 treatment, and the shortest pileus diameter (5.31 cm) was obtained from V_2 treatment (Table 5).

Pileus diameter differed significantly due to the substrates ratio. The highest (10.41 cm) diameter of pileus was recorded from S_3, While S_6 gave the minimum (4.65) diameter of pileus (Table 6).

The interaction between different variety and different substrates ratio was found significant variation on the pileus diameter (Appendix V). The maximum diameter of pileus (12.00 cm) was produced by V_1S_3 and the diameter of pileus (00.84 cm) was produced by V_2S_1 (Table 7).

4.8 Thickness of pileus

A variation in the Thickness of pileus was found among the varieties. The maximum thickness of pileus (5.54 cm) was obtained from V_2 treatment, and the minimum thickness of pileus (0.87 cm) was obtained from V_1 treatment (Table 5).

Thickness of pileus differed significantly due to the substrates ratio. The highest (5.66 cm) Thickness of pileus was recorded from S_3, While S_7 gave the minimum (0.78 cm) Thickness of pileus (Table 6).

The interaction between different variety and different substrates ratio was found significant variation on the thickness of pileus. The maximum Thickness of pileus (10.50 cm) was produced by V_2S_3 and the Thickness of pileus (0.48 cm) was produced by V_2S_9 (Table 7).

4. 9 Yield (g/plant)

A variation in the yield was found among the varieties. The maximum yield of mushroom (66.50 g/plant) was obtained from V_1 treatment, and the minimum yield (33.17g) was obtained from V_2 treatment (Table 5).

Significant variation was observed yield due to substrates ratio. The highest yield (63.25 g) was recorded under treatment S_3 and the lowest yield was recorded under S_1 (35.00 g). The other treatments varied significantly as in terms of yield (Table 6). Chowdhury *et al.* (1998) examined the effects of adding different supplements to substrates for growing oyster mushrooms (*Pleurotus sajor-caju*) and found adding 5% supplements gave the highest yield of oyster mushroom. Baysal *et al.* (2003) found the highest yield of oyster mushroom (*Pleurotus ostreatus*) with the substrate composed of 20% rice husk in weigh.

The interaction between different variety and different substrates ratio was found significant variation on the yield. The maximum yield (90.00g) was produced by V_1S_3 and the minimum yield (21.00g) was produced by V_2S_6 (Table 7).

Chapter V

Summary and Conclusion

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was carried out at the Tissue Culture Laboratory and Culture House of Mushroom Development Institute, Savar, Dhaka, during the period from January 2014 to June 2014 to find out the effect of different substrates ratio on the growth and yield of oyster mushroom. The experiment consisted of two varieties, viz. V_1 = *Pleurotus ostreatus* and V_2 = *Pleurotus djamor* and nine different Substrates ratio S_1 = 25% Straw + 10% paddy grain (mother culture) + 65% Sawdust, S_2 = 35% Straw + 10% paddy grain (mother culture) + 55% Sawdust, S_3 = 45% Straw + 10% paddy grain (mother culture) + 45% Sawdust, S_4 = 55% Straw + 10% paddy grain (mother culture) + 35% Sawdust, S_5= 65% Straw + 10% paddy grain (mother culture) + 25% Sawdust, S_6= 75% Straw + 10% paddy grain (mother culture) +15% Sawdust, S_7= 85% Straw + 10% paddy grain (mother culture) + 5% Sawdust, S_8= 90% Straw + 10% paddy grain (mother culture), S_9 = 90% Sawdust + 10% paddy grain (mother). The experiment was laid out in Completely Randomized Design (CRD) with three replications. The recorded data on various parameters were statistically analyzed. Using MSTAT statistical package programmed. Difference between treatment means were determined by Duncan`s new Multiple Range Test (DMRT).The summary of the results has been presented in this chapter.

Variety of mushroom showed influence on days required from pinhead initiation to 1st harvest. The lowest time (3.22 days) from pinhead initiation to 1st harvest was in the treatment V_1 (*Pleurotus ostreatus*). The highest number of fruiting body (16.53) was observed in V_1 (*Pleurotus djamor*). The highest number of effective fruiting body (12.11) was obtained from V_1 treatment. The longest stalk length (4.04 cm) was obtained from V_1. The largest stalk diameter (1.14 cm) was obtained from V_1 treatment. The longest pileus length (7.72 cm) was obtained from V_1 treatment. The largest pileus diameter (9.02 cm) was obtained from V_1 treatment. The maximum thickness of pileus (5.54 cm) was obtained from V_2 treatment. The maximum yield of mushroom (66.50 g) was

obtained from V_1 (*Pleurotus ostreatus*) treatment, and the minimum yield (33.17 g) was obtained from V_2 (*Pleurotus djamor*) treatment.

Significant variation was found in all parameter due to the effect of substrates ratio. The lowest time (3.50 days) from pinhead initiation to 1st harvest was in the treatment S_4 , S_5, S_6 and S_7 and the highest time (4.50 days) from pinhead initiation to1st harvest was observed in the treatment S_9. The highest number of fruiting body (15.25) and number of effective fruiting body (12.11) was observed in the treatment S_3 (45% Straw + 10% paddy grain (mother culture) + 45% Sawdust). The maximum length of stalk (3.94 cm), diameter of stalk (1.06 cm) was recorded from S_3 (45% Straw + 10% paddy grain (mother culture) + 45% Sawdust). The highest (7.32 cm) length of pileus, (10.41 cm) diameter of pileus, (5.66 cm) Thickness of pileus was recorded from S_3. Significant variation was observed yield due to substrates ratio. The highest yield (63.25 g) was recorded under treatment S_3 (45% Straw + 10% paddy grain (mother culture) + 45% Sawdust) and the lowest yield was recorded under S_1 (35.00 g).

Interaction effect of varieties and substrates ratio was found significant on all parameter. The lowest time (3.50 days) from pinhead initiation to 1st harvest was in the treatment V_1S_1, V_1S_2, $V1S_3$, V_1S_4, V_1S_5, V_1S_6 and V_1S_7. The highest number of fruiting body (26.00) was observed in the treatment V_1S_3 (*Pleurotus ostreatus* with 45% Straw + 10% paddy grain (mother culture) + 45% Sawdust). The highest number of effective fruiting body (16.00) was observed in the treatment V_1S_3 (*Pleurotus ostreatus*) with 45% Straw + 10% paddy grain (mother culture) + 45% Sawdust). The maximum length of stalk (5.00 cm) and maximum diameter of stalk (1.60 cm) was produced by V_1S_3. The maximum length of pileus (8.64 cm) was produced by V_1S_3. The maximum diameter of pileus (12.00 cm) was produced by V_1S_3. The maximum Thickness of pileus (10.50 cm) was produced by V_2S_3. The interaction between different variety and different substrates ratio was found significant variation on the yield. The maximum yield (90.00 g) was produced by V_1S_3 (*Pleurotus ostreatus* with 45% Straw + 10% paddy grain (mother culture) + 45% Sawdust) and the minimum

yield (21.00 g) was produced by V_2S_6 (*Pleurotus djamor* with 75% Straw + 10% paddy grain (mother culture) + 15% Sawdust).

Considering the stated findings, it may be concluded that yield and yield contributing parameters are positively correlated with variety and substrates ratio. However, *Pleurotus ostreatus* in combination with substrates ratio of 45% Straw + 10% paddy grain (mother culture) + 45% Sawdust would be beneficial for the farmers.

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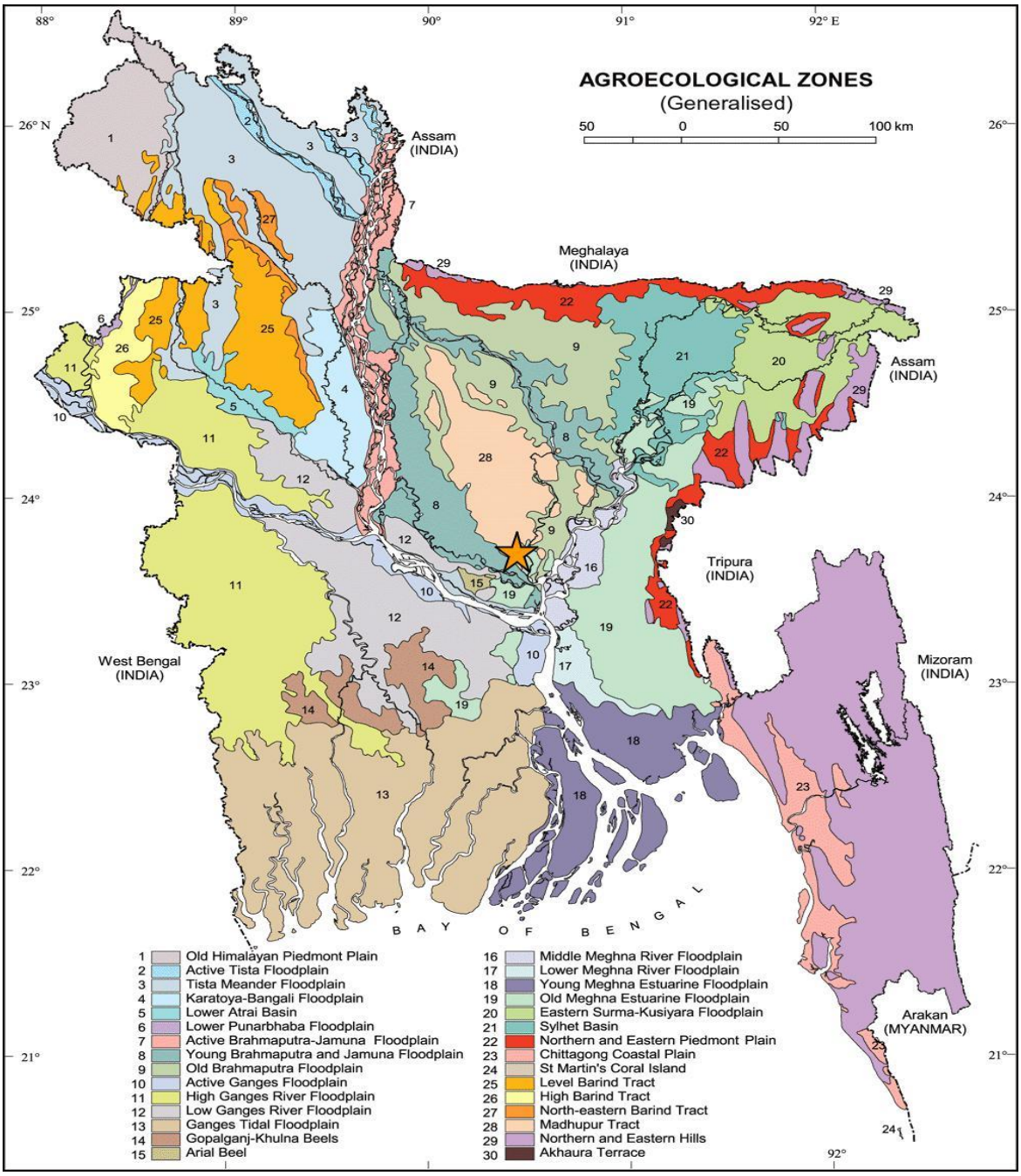
Appendices

APPENDICES

Appendix I: Map showing the experimental sites under study.



★ **The experimental site under study**

Appendix II. Temperature and Relative humidity of culture house and outside during oyster mushroom cultivation through the year

	Temp(^{0}C) of culture house	RH(%) of culture house	Outside temp(^{0}C)	Outside RH(%)
Jan	14-25	72-80	16-28	50-58
Feb	14-25	70-80	20-32	47-51
March	22-30	70-78	23-34	42-48
April	22-33	72-78	24-33	50-60
May	22-33	73-79	26-32	68-76
June	24-30	75-88	26-32	77-81
July	23-30	90-95	26-31	75-81
Aug	25-30	85-90	26-31	76-80
Sep	25-30	80-90	26-31	75-81
Oct	24-30	80-90	24-31	70-74
Nov	20-28	65-70	20-29	65-67
Dec	16-27	70-80	14-26	60-66

RH: Relative humidity

Appendix III. Analysis of variance of the data on days required pinhead initiation to1st harvest, number of fruiting body and number of effective fruiting body of oyster mushroom as influenced by variety and substrates ratio

Source of Variance	Degrees of Freedom	Mean square		
		Days required pin initiation of 1st harvest	Number of fruiting body	Number of effective fruiting body
Factor A	1	24.5	2167	786.72
Factor B	8	1.066*	67.25*	31.847*
AB	8	0.594*	67.951*	19.347*
Error	54	0.028	1.894	1.093

* = Significant at 5% level of probability