OPEN ACCESS Freely available online

Global Journal of
Biology, Agriculture & Health Sciences

Comparative study on effect of different substrates on yield performance of oyster mushroom

Deepesh Dubey [1*], Bina Dhakal [2], Kalpana Dhami [2], Poonam Sapkota [2], Mausami Rana [3], Nabin Sharma Poudel [4], Laxman Aryal [5]

1 Department of Entomology, Agriculture and Forestry University, Rampur, Chitwan, Nepal **2** Agriculture and Forestry University, Rampur, Chitwan, Nepal **3** Bidhan Chandra Krishi Vishwavidyalaya, Mohanpur, Nadia, West Bengal, India **4** Department of Plant Pathology, Agriculture and Forestry University, Rampur, Chitwan, Nepal **5** Nepal Agricultural Research Council, Nepal

Abstract

The research was carried out at Mushroom house, Institute of Agriculture and Animal Science (IAAS), Paklihawa, Bhairahawa during January to March 2015. The objective of the study was to determine the effect of different substrates on the performance of Oyster Mushroom (*Pleurotus sajor caju*). Various substrates as treatment, selected for the cultivation of oyster mushroom were rice straw (T1), wheat straw (T2), banana leaves (T3) and sugarcane bagasse (T4) each of 4.5 kg and replicated for 4 times. The experimental design used was single factor Completely Randomized Design (CRD). The highest yield (1515 gm) with highest stipe length (4.86 cm) and cap diameter (5.14 cm) was obtained from the rice straw followed by other substrates. The colonization duration (19 days) was lower for wheat straw and banana leaves while fruiting duration (20.5 days) was lower in case of wheat straw. The analysis showed that mushroom production was best suitable in terms of economic return from the rice straw than other agricultural residues with B-C ratio of 3.498.

Citation: Dubey D, Dhakal B, Dhami K, Sapkota P, Rana M, Poudel NS, Aryal L (2019) Comparative study on effect of different substrates on yield performance of oyster mushroom, GJBAHS 7: 7.

Received: December 05, 2018; **Accepted:** January 07, 2019; **Published**: January 14, 2019

Competing interests: The authors have declared that no competing interests exist.

Sources of funding: No funding.

*Email: deepeshdubey701@gmail.com

Keywords:

Economic return, Pleurotus, Substrates, Yield

Introduction

Oyster mushroom *(Pleurotus sajor caju*) is an edible mushroom that belongs to the family Pleurotaceae [1]. The term mushroom applies mostly to those fungi that have stem (stipe), cap (pileus), hymenium (lamellae) and spores on the underside of the cap [2]. Oyster mushroom can be grown at temperature ranging from 20 to 300 c and relative humidity 55%-70%. It can also be cultivated in summer months by providing the extra humidity required for its growth in hilly areas above 900 (masl), the best growing season is during March/April to September/October and in the lower regions from September/October to March/April. *P. sajor caju* are rich source of proteins, carbohydrates, minerals & vitamins. Mushroom contains digestible proteins (10%-40%), carbohydrates (3%-21%), dietary fiber (3%-35%), on dry weight basis which is higher than those of vegetables and fruits and is of superior quality [3]. High potassium to sodium ratio contain in Pleurotus species helps to cure patients suffering from hypertension & heart diseases. Mushroom as an excellent food source to alleviate malnutrition in developing countries due to their flavor, texture, nutritional value and high productivity per unit area [4].

Gunde and Cinerman, [5] reported that oyster mushroom at maturity has a cap spanning diameter of 5 to 25 cm. The fruiting body of oyster mushroom differs with respect to stipe length and girth, and pileus width when grown in different

farm substrates [6]. Agricultural wastes such as maize cob, maize straw, wheat straw, palm kernel cake, cotton seed hull, saw dust, spent grain; grass families are good materials for farm substrate production. Pleurotus are efficient lignin degraders, which can grow on different agricultural wastes which makes *P. sajor caju* cultivation an excellent alternative for production of mushrooms when compared to other mushrooms [7]. The mushroom yield was d related to chemical and biological composition of the substrate which is important for the growth of mushroom than other substrates [8]. Difference in mineral content of mushroom not only depended on mushroom species but also depended on substrates used [9]. Compost of wheat and paddy straw, banana leaves, sugarcane bagasses and leaves, sawdust etc. can be used as substrate for growing mushroom.

Most organic matters containing cellulose, hemicelluloses and lignin can be used as mushroom substrate i. e. rice and wheat straw, banana leaves, cottonseed hulls, corncob, sugarcane baggase, sawdust, waste paper, leaves, and so on. The amount of nutrition requirement differs according to mushroom species and types of substrate used. The Pleurotus mushroom requires low amount of nitrogen but more carbon source. This study was designed to identify the alternative substrates from various agricultural and forest residue. So the main objective of study to determine the effect of different agro based residues on the yield performance of oyster mushroom.

Materials and Methods

Site of study

The research was conducted at Mushroom house, Institute of Agricultural and Animal Science, Tribhuvan University, Paklihawa during January to March 2015 for determination of effect of different substrates on the performance of *Pleurotus sajor caju.*

Treatments

The substrates selected for the cultivation of oyster mushroom were wheat straw, rice straw, banana leaves and sugarcane bagasse and allocated treatments as T1 (rice straw), T2 (wheat straw), T3 (Sugarcane bagasse) and T4 (banana leaves) each weighing 4.5 kg. The experimental design was a single factor experiment which was laid in a Completely Randomized Design (CRD). Four treatments were replicated 4 times thus making total 16 bags.

Substrate collection

Different substrates required for experiment were collected from different sources. Rice straw and Banana leaves were collected from Livestock farm and Horticulture farm, IAAS, Paklihawa. Similarly, wheat straw was collected from local farmers and sugarcane bagasse from local market of Bhairahawa.

Substrates preparation and bags filling: All those collected substrates were chopped into small pieces (2-4 cm long) and soaked in clean tap water overnight. Next day, soaked straw was then cleaned with clean water for 3-4 times until clear water was obtained and then squeezed the excess water from the substrates or was allowed to run off until set to required moisture and prepared for sterilization. Steam sterilization was done with the help of a drum.

There was 4”-6” water in the drum inside of which a perforated round plate of tin was placed, supported by stand. Then, the drum was filled with moist substrates layer by layer and each layer was separated with the help of jute sac. The top opening of the drum was tied with plastic sheet on the rim and the fire was set up. It was steamed for 3 hours to kill all insects and wild fungus. After steam sterilization it was cooled by spreading on a clean sterilized plastic mat and when the temperature lowered to about 250c, it was used for filling. For inoculation of the spawn transparent plastic bags of dimension 16”X24” were taken and its one side was tied with a rope. Tying was done in such a way that it gets its circular shape after filling it with substrate. The bags were filled with substrates making 3 layers, each layer weighing 1.4 kg making total weight of 4.5 kg.

Inoculation / Spawning: Spawning was carried out aseptically with grain spawn. Spawn was spread in every layer of straw and pressed slightly to make bag compact. The last layer was broadcasted with spawn and covered with thin layer of substrate. After inoculating the bag with spawn, mouth of the bag was secured tightly with thread. Small holes were made for aeration on the lateral sides and top of the bag.

Incubation: The packed bags or blocks were incubated in a well-ventilated dark room until the mycelium fully penetrated to the bottom of the substrate. The bags were supported by bricks to raise their height and to prevent direct contact of those bags with water and insect pests.

Growing: After about 19-24 days, the spawn run was observed and the whole bags were covered with white mycelium. Then the outer covering plastic was cut gently and those blocks were arranged on wooden racks about 20 cm apart with gap of 50 cm between two shelves. Regular watering was done thrice a day at morning, noon and evening.

Primordial growth of mushroom was seen within about one week after cutting of plastics. During this stage room was exposed to the diffused light. The rack was all covered with wet jute sack to maintain the humidity condition of the mushroom house as it was hot weather.

Harvesting: Harvesting was done when the cap attained the maximum diameter. Picking was done by twisting gently so that it is pulled out without leaving any stalk and also the nearby fruiting bodies are not disturbed. The base of the stipe deep within the straw was removed by cutting with sharp knife. The right stage for picking was judged by observing the shape and size of the fruit body. Mushroom was weighed after each harvest. In average, three harvesting was done. Weight of final substrate was also taken.

Data collection and analysis: Data were recorded periodically during the growing season from colonization to final substrates weight on different parameters like number of days to full colonization, number of days to first fruiting, harvesting duration (day), total mushroom yield (gm), mushroom pileus diameter (cm), mushroom stipe length (cm), final substrate weight (Kg) and benefit cost ratio. Collected Data were analysed using MSTAT-C statistical package (version 2.0).

Analysis of Variance (ANOVA) was used to test among treatments and means were separated using Least Significant Difference (LSD) at the 5% level of significance.

Result and Discussion

The yield and yield attributing characters of mushroom obtained from different substrates were compared. The substrates used in this study showed variation in spawn run, duration of first fruiting, days to harvest, total yield and final substrate weight.

Effect of substrates on 1st colonization duration, 1st fruiting duration, 1st harvest duration and 2nd harvest duration

Highly significant results were observed among treatments in terms of days taken for colonization duration of *Pleurotus sajor-caju.*

Among the tested substrate, wheat straw and banana leaves required lesser time for spawn run (19 days each) followed by sugarcane bagasse (20.25 days) and longer duration was required for rice straw (24.5 days). Similarly, first fruiting and first harvest was also found to be faster in wheat straw (20.5 & 27 days) and banana (21 & 27 days) leaves followed by rice straw (27.25 & 32 days) and sugarcane bagasse (33.5 & 39.5 days) respectively.

In case of second harvest duration also, there was no significant difference among wheat straw and banana leaves (44.25 & 40.75 days) but sugarcane bagasse was found significantly different (53.5 days).

Mondal, et al. [10] reported that the duration of colonization, fruiting and harvesting of oyster mushroom was lower in banana leaves in comparison to rice straw.

Effect of substrates on stipe length and cap diameter

The stipe length and cap diameter of Pleurotus mushroom was measured in an average upto two harvests and observed the significant difference among the substrate (Table 1). The highest stipe length was obtained in rice straw 4.8575 cm followed by banana leaves, wheat straw and lastly sugarcane bagasse were 4.3425 cm, 3.675 cm and 3.275 cm respectively.

Likewise cap diameter was also found highest from rice straw i.e. 5.135 cm followed by wheat straw, banana leaves and lastly sugarcane bagasse which were 4.105 cm, 3.48 cm and 3.255 cm respectively under similar environment and cultural practices among other substrates. Mondal, et al. [10] reported that the stipe length, pielus diameter and total yield

of mushroom was higher in rice straw than in banana leaves.

These results are also similar to the findings of our research.

Table 1: Mean values of total yield, stipe length, cap diameter and final substrate weight of *Pleurotus sajor caju* on different substrates from Jan-Mar, 2015, IAAS, Paklihawa.

Treatment	Stipe length (cm)	Cap diameter (cm)	Total yield (gm)	Final Substrate weight (gm)
Rice straw			1515A	
Wheat straw			480.0B	
Sugarcane bagasse			98.75C	
Banana Leaves			567.5B	
SEm (±)			65.45	117.4
LSD (0.05)			201.7	361.7
CV%	1.52	15.39	19.67	12.24
Probability	0.0000	0.0000	0.000	0.000

Effect of different substrates on total yield and final substrate weight of oyster mushroom. The final weight of substrate composed from agricultural wastes was lowest in case of rice substrate i.e. 750 g followed by wheat straw, banana leaves and sugarcane bagasse were 1155 g, 1790 g and 3975 g respectively.

This signifies that mushroom grown in the substrates composed from rice agricultural waste absorbed the available nutrient more efficiently than those composed from other agricultural wastes. Thus, it indicates that higher percentage of biological efficiency obtained in the substrate composed of rice agricultural waste. The statistical analysis shows the significant difference in the total yield of mushroom obtained from the different substrates. The maximum yield of 1515 g was recorded in paddy straw substrate followed by banana leaves 517.5 g, wheat straw 480 g and sugarcane bagasse 98.75 g. Biological efficiency variation of different substrates might be due to low lignolytic and cellulonitic activity of the substrates.

Zang, [11] cultivated *Pleurotus sajor caju* on rice straw and wheat straw and observed 10% higher yield in case of paddy straw under the same cultivation condition.

Correlation studied

Relationship between first colonization duration and first harvest duration: A positive linear relationship was observed between first colonization duration and first harvest (Figures 1-4).

This suggests that first harvest duration depends on first colonization duration and more than 8% (R2=0.0864) of variation in the first harvest duration may be explained by variation of first colonization duration (Table 2).

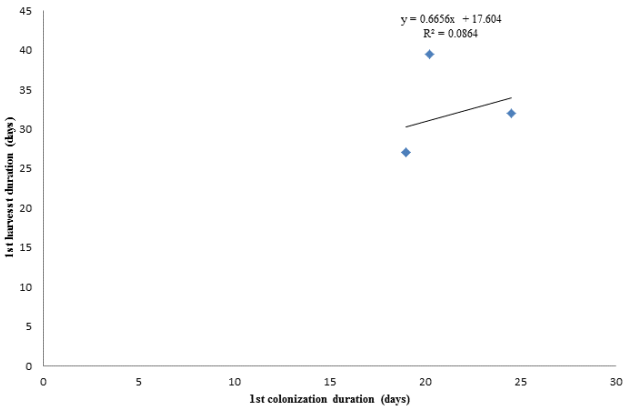

Figure 1: Linear relationship between 1st colonization duration and 1st harvest duration of oyster mushroom during January-March, 2015 at IAAS, Paklihawa.

Treatments	1st colonization duration	1st fruiting duration	1st harvest duration	2nd harvest duration
Rice straw				
Wheat straw				
Sugarcane bagasse				
Banana leaves				
SEm(±)	0.4019		0.9014	

LSD(0.05)	1.238	3.105	2.777	8.430
CV (%)	3.88	7.88	5.75	11.91
Probability	0.000	0.000	0.00	0.0373

Table 2: Mean values of 1st colonization duration, 1st fruiting duration, 1st harvest duration and 2nd harvest duration of *Pleurotus sajor caju* on different substrate from January-March, 2015, IAAS, Paklihawa.

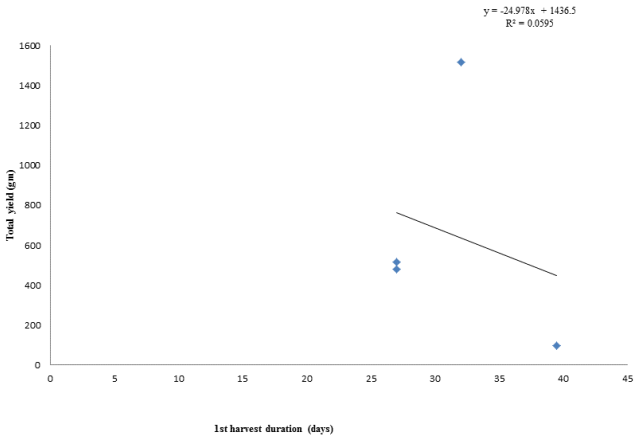

Figure 2: Linear relationship between 1st colonization duration and total yield of oyster mushroom during January-March, 2015 at IAAS, Paklihawa.

Relationship between first harvest duration and total yield: A negative linear relationship was observed between first harvest duration and total yield (Figure 3).

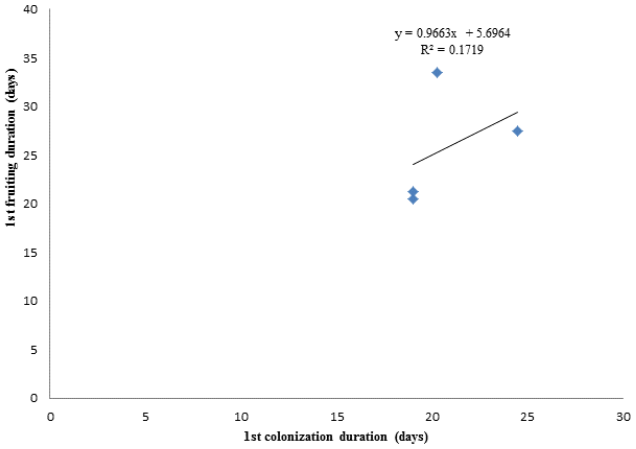

Figure 3: Linear relationship between 1st colonization duration and total yield of oyster mushroom during January-March, 2015 at IAAS, Paklihawa.

This means that increase in first harvest duration resulted into decrease in total yield. In our research, longest duration was taken by sugarcane bagasse for first harvest in which yield was lowest among all. More than 5% (R2=0.0565) decrease in total yield was determined by increase in first harvest duration. Garg, [12] also reported the similar results, in his study of evaluation of combination usage of five substrates viz., Cottonseed hulls, Wheat straw (WS), Sugarcane bagasse (SB), Sunflower stalks (SFS) and Rice straw in performance of oyster mushroom.

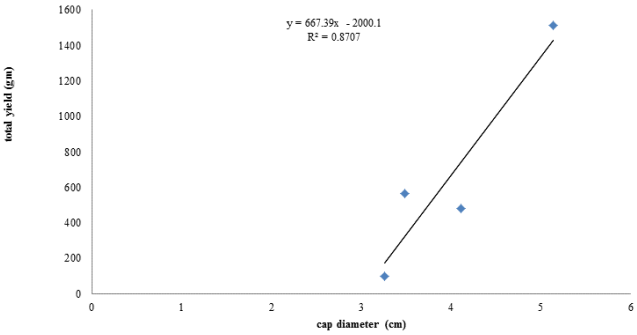

Figure 4: Linear relationship between 1st colonization duration and total yield of oyster mushroom during January-March, 2015 at IAAS, Paklihawa.

Relationship between first colonization and first fruiting: The graph below represents the linear relationship between first colonization duration and first fruiting duration which is found to be positive. In general, if colonization duration is short, then ultimately first fruiting will be faster. In our results, more than 17% (R2=0.1719) variation in first fruiting duration was due to variation in first colonization duration.

Relationship between cap diameter and total yield: A positive linear relationship was observed between cap diameter and total yield. It means, larger the size of cap, more was the yield. It is very obvious relationship. The value of R2 (0.8707) in graph presented above signifies that, more than 87% variation in total yield was governed by variation in cap diameter.

Economic analysis

Cost of cultivation: It includes cost of different materials and that of substrates. In our research, cost of required materials is same for each treatment, except cost of substrate which are given in Tables 3-5. B-C Ratio: It is defined as the ratio of benefit from selling of output expressed in monetary terms, relative to the total cost during production. Project will be accepted and vice-versa,

if the B: C ratio is greater than 1. As the value of B: C increases, the level of feasibility of the project in economical aspect. In our study, B: C ratio of different treatments was obtained as follows:

1. T1-Rice straw= 1515/433=3.498
2. T2-wheat straw=480/433=1.108
3. T3-sugarcane bagasse=98.75/453=0.217
4. T4-banana leaves= 567.5/403=1.408

This result shows that higher economic benefit can be obtained from use of rice straw as substrate for cultivation of *P. sajor caju* with highest B: C ratio (3.498) followed by banana leaves and wheat straw. But B: C was found less than 1 in case of sugarcane bagasse (0.217) indicating rejection. The rice substrate is easily available in low cost and the return from the cost was higher according the results obtained from the study. So the farmers can used the rice straw for higher economic return with low investment.

The low yield in sugarcane bagasse might be due to presence of high moisture content or, high sugar content resulting into fermentation producing alcoholic substances, which suppresses the colonization of fungus.

Table 3: Cost of materials.

Materials required	Rate	Quantity	Amount (Rs.)
Spawn	Rs. 75/packet	2 packets	150/-
Plastic bags	Rs. 2/bag	4	8/-
Covering plastic	Rs. 30/meter	1 meter	30/-
Rectified spirit		100 ml	100/-
Rope	Rs. 15/ball	1 ball	15/-
Firewood	Rs. 10/kg	10 kg	100/-
Total			403/-

Table 4: Total Cost.

Treatments	Cost of materials	Cost of substrates (10kg)	Total cost
Rice straw	403	Rs. 30	433
Wheat straw	403	Rs. 30	433
Sugarcane bagasse	403	Rs. 50	453
Banana leaves	403	-	403

Table 5: Benefit from selling of mushroom.

Treatments	Total yield (kg)	Rate (Rs./kg)	Benefit (Rs.)
Rice straw	6.06	250	1515/-
Wheat straw	1.92	250	480/-
Sugarcane bagasse	0.395	250	98.75/-
Banana leaves	2.27	250	567.5/-

Conclusion

This study was conducted by growing *Pleurotus sajor-caju* on four different substrates i.e. paddy straw, wheat straw, sugarcane bagasse and banana leaves. Among all the treatments, rice straw was found most favorable for mushroom cultivation in terms of yield (1515 g) than other substrates banana leaves, wheat straw and sugarcane bagasse.

The analysis showed that mushroom was best suitable in terms of economic return in case of rice straw than other agricultural residues with B-C ratio of 3.498. Hence we conclude that the both yield and the economic return were more in rice straw, farmers involved in commercial cultivation of *Pleurotus sajor caju* are suggested to use rice straw as substrate.

References

1. Randive DS. Cultivation and study of growth of oyster mushroom on different agricultural waste substrate and its nutrient analysis. Adv Appl Sci Res 2012;3:1938-1949.
2. Masarirambi MT, Mamba MB, Earnshaw DM. Effect of various substrates on growth and yield of oyster mushrooms. Asian J Agric Sci. 2011;3:375-380.
3. Mallavadhani UV, Sudhakar AVS, Satyanarayana KVS, Mahapatra A, Li W, et al. Chemical and analytical screening of some edible mushrooms. Food Chem 2006;95:58-64.
4. Eswaran A and Ramabadran R. Studies on some physiological, cultural and post harvest aspects of oyster mushroom, Pleurotus ostreatus. Tropi Agric Res 2000;12:360-374.
5. Gunde CN, Cinerman. Pleurotus fruiting bodies contain the inhibitor of 3-hydroxy-3-methylglutaryl-coenzyme a reductase-lovastatin J Exp Mycol 1995;19:1-6.

6. Shah ZA, Ashraf M, Ishtiaq M. Comparative study on cultivation and yield performance of oyster mushroom (Pleurotus ostreatus) on different substrates (wheat straw, leaves, saw dust). Pak J Nutr 2004;3:158-160.
7. Kausar T. Cultivation of mushrooms using crop residues as substrate. Ph. D. Thesis. Department of Botany. University of Punjab. Lahore, Pakistan. 1998.
8. Tsegaye Z, Tefera G. Cultivation of oyster mushroom (Pleurotusostreatus Kumm, 1871) using agro- industrial residues. J Appl Microb Res. 2017;1:15-20.
9. Hoa HT, Wnag CL, Wang CH. The effects of different substrates on the growth, yield, and nutritional composition of two oyster mushrooms (Pleurotus ostreatus and Pleurotus cystidiosus). Mycobiology 2015;43:423-434.
10. Mondal SR, Rehana MJ, Noman MS, Adhikary SK. Comparative study on growth and yield performance of oyster mushroom (Pleurotus florida) on different substrates. J Bangladesh Agril Univ 2010;8:213-220.
11. Zang RH. Mushroom cultivation with rice and wheat straw. Ameican society of agriculture engieneers (ASE),USA.1998.
12. Gogoi G, Adhikary AK. Suitability of certain newer plant waste for production of oyster mushroom. Mushroom Res 2002;25-27.