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Performance of Yield and Growth of Oyster (*Pleurotus sajor-caju*) Mushroom on Wheat Straw at Arid Ecosystem: A Study in Jodhpur District of Rajasthan

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ABSTRACT

The present study was undertaken in Popawas Panchayat comprising 4 villages viz., Rajwa, Popawas Sirodi and Ghantiyala of Jodhpur district of Rajasthan under Farmer FIRST Program. A random selection of 15 farmers were done from the four villages. The study was conducted to estimate the enhanced income while cultivating the oyster mushroom on wheat straw at arid ecosystem. Best yield of oyster was observed at 45 days after demonstration of first picking and approximate average yield of 6.90 kg / 10 bags. An amount of Rs 568 was the net return and the observed B: C ratio was 2.43.

Keywords Oyster mushroom, Arid eco-system, *Pleurotus sajor-caju* Yield, Growth.

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INTRODUCTION

Agriculture is considered to be the back bone of Indian economy and it contributes about 17% of total Gross Domestic Product of our country. More than 60% of the working population get their employment from this farming sector. The ever growing population in our country exerts enormous pressure for more food. Despite the food production increases at a faster rate in our country compare to the other growing economies the pattern of balanced food consumption among the citizen is still a dream. Agriculture sector, besides providing livelihood to farmers emphasizes and addresses the importance of balanced food consumption. Despite producing over 280 million tonnes of food grain, it is expected that about 15% of the population continued to live undernourished, as per 2014 estimates. The Food and Agricultural Organization (FAO), Food Security was defined by United Nations as a situation at all times for all people have sufficient access to nutritious and safe food to meet dietary needs for their health physically and economically.

Over the decades, it was observed that, increasing per capita income of individuals provides greater access to wide range of foods for human beings. Whereas, an inverse relationship had been observed in dependence on food grains and protein consumption for food. A healthy lifestyle can be attained for an individual by having a balanced diet, regular physical activities and giving enough consideration to choose the food products which could provide all the essential nutrients required for body. In this context, to satisfy

the above problems, mushrooms are considered to be one such proteinaceous food component that not only being a part of diversification but also find favor and grown among the landless and small farmers, that too on waste material. Since time immemorial mushrooms use in food and nutraceutical industries was very evident through our ancient literatures viz., Vedas, Bible and Epics. Traditionally mushrooms were valued for its delicious and medicinal values. Further adding protein rich mushrooms in our Indian diet not only bridge the protein gap, but also truly supplement the status of health of socio-economically backward classes.

The cultivation of mushroom has taken up in almost all the parts of the world. Globally, production of cultivated, edible mushrooms have gained momentum and found an increase of more than 30 fold since 1978 (from about 1 billion kg) to 2013 (34 billion kg). The increase in per capita consumption of mushrooms now exceeds 4.7 kg annually (Royse *et al*. 2017). In India, due to its rich diversity and varied agro-climates, cultivation of tropical, sub-tropical and temperate mushrooms were practiced throughout the year in our country (Shah *et al*. 2004). Oyster mushrooms are generally grown in temperate, sub-tropical and tropical parts of our country. Pleurotus mushroom (*Pleurotus sajor-caju*) (white-rot fungi), which is generally referred as "Oyster mushroom" or "Dhingri" in India and is one of the most sought edible fungi belonging to genus *Pleurotus* under Basidiomycetes class in the world of mushroom's market. Distinctly shell, fan or spatula shaped fruit bodies. The fruit bodies of this mushroom were found with different colors viz., white, cream, grey, yellow having excellent flavor and taste.

In arid Rajasthan, oyster mushroom is cultivated during winter season. The economic use of oyster lies in its consumption. Mushroom possess affluent Vit. C and B complex, 1.6 to 2.5 % protein and requisite mineral salts for human body. Compare to any other vegetables, it contains ten times higher niacin and folic acid (Randive and Sonali 2012). Presence of higher amount of tryptophan, lysine and other amino acids in oyster makes the mushroom ideal for patients who are suffering from obesity, hypertension and diabetes (Carel *et al*. 2013). Carbon sources such as hemicellulose, cellulose and lignin are considered to be the main nutrients for *Pleurotus sajor-caju* mushroom and it also requires the nutritional sources such as carbon, nitrogen and inorganic compounds for their growth. Optimum growth of mushrooms can be attained between 20 to 30^{o}C. It can also be cultivated during summer months provided the temperature and humidity is being maintained. In order to ensure the alternative crop which is highly rich in protein for the ever growing population, cultivation of mushroom is the best and viable option which one can bank upon. Keeping the above things in view and to meet these needs and challenges in food and nutritional security an attempt was made to assess the growth performance and yield of *Pleurotus sajor-caju* cultivated in arid ecosystem on wheat straw at farmers field condition demonstrated under the ICARs ongoing Farmer FIRST Program.

MATERIALS AND METHODS

The research was carried at farmers field of Popawas Panchayat of Jodhpur district comprising four villages viz., Rajwa, Popawas, Sirodi and Gantiyala in Rajasthan during October to December 2019. The fresh spawn of oyster mushroom (*Pleurotus sajor-caju*) was collected from Plant Pathology Department, MPUAT, Udaipur, Rajasthan. A total of 15 partner farmers were selected randomly from the above four villages and 10 polybags were provided to each farmer under Farmers FIRST Program. So a total of 150 polybags were included in the study. The wheat straw, which is going to use as a substrate was chopped into 5 – 10 cms for easy handling and operation during filling process. Selected substrates, which was treated with bavistin and formaldehyde were soaked and stalked in water and kept overnight for 24 hr to get moistened uniformly. On the next day the soaked substrates were opened on the cemented floor of an area of 2 X 2 m^2 to remove excessive moisture from substrates to attain the level between 65-75%. The individual polythene bags weighing one kilogram was filled with air dried substrate and the filled bags were inoculated oyster mushroom (*Pleurotus sajor-caju*) spawn.

Spawn running: According to the dry weight of substrates 5% per bag was kept as the spawn running rate.

Under controlled temperature 25°C with complete darkness the bags were inoculated for spawn running. Spawn running and fructification are the two important phases of mushroom cultivation. The temperature was controlled and kept between 17-20°C for fruiting body formation and 25°C for spawn running. Water was sprayed twice a day on the bags to bring down the humidity. Oxygen is considered to be utmost essential for mushroom during fructification. The extra gases produced during fructification inside mushroom growing room were taken out by using the exhaust fans. To eliminate gases in substrate bags paper pins were used to make pinhole and during cropping they were three times watered in a day. To facilitate cross ventilation 6–8 holes were punched on the sides of the plastic bags. Finally, a total of 150 polythene bags @ 10 bags per farmer were filled with chosen substrates and were inoculated with the spawn brought from MPUAT, Udaipur.

Biological efficiency

It was calculated by dividing yield of fresh mushroom (in Kg) by air dried substrate (in Kg) the result was multiplied by 100 (Peng *et al*. 2000).
Biological efficiency = Fresh mushroom yield (kg) / Total weight of used substrate (gm) X 100

Identification of chemical toxicity test

Fresh fruit body was pressed to leave a drop of juice on a piece of newspaper. Hydrochloric acid was dropped on the dried spot of newspaper to identify the presence of toxic substance. Visibility of blue spot indicated its presence.

Data collection and statistical analysis

Randomized Block Design (RBD) was the design laid out in above four villages taking into account of 15 farmers @ 10 polybags / farmer for this experiment. Data was recorded in days for the fruiting bodies maturation, pin head appearance and mycelium growth on substrates or different farmers. The data were also recorded for the number of fruiting bodies per poly bag and total yield for all the polybags. Obtained data was analyzed statistically and the differences between the means of individual village were assessed by ANOVA.

RESULTS AND DISCUSSION

Oyster mushroom cultivation technology is a very simple indoor activity, which requires low investment and less infrastructure. Practically in a year about 2-3 crops @ 45-60 days can be grown within a period of 6-7 months under arid conditions. It can also be cultivated in summer months provided the temperature and humidity is controlled. Harvesting of mushroom was done on each bag basis and the weight was done periodically. In this experiment, seeding for the first bag was done the end of first fortnight of October month and the subsequent seeding was done at the end of December and January. Inoculation was done on the same day for all the substrates at farmers field. 20-22 days after inoculation running of spawn took place. The complete colonization was observed in substrate on 21 days (Fig. 1). The results were in agreement with Tan (1981) and Pathania *et al*. (2017) reported that it took two to three weeks for spawn running. Whereas, Kumari and Achal (2008) reported that substrate colonization was completed within 20 days of inoculation.

During oyster cultivation the pinheads formation is considered to be the second stage of mycelial growth and the first pinhead appeared between 24-27 days, i.e., after 4-5 days of spawn running in various demonstrations. These results agree with Ahmad

Fig. 1. Complete spawn run of *P. sajor-caju*.

Fig. 2. Pinheads formation of *P. sajor-caju*.

(1986) who stated that *Pleurotus ostreatus* completed spawn running in 17-20 days and it took 23-27 days for formation of pinheads on different substrates. Shah *et al*. (2004) reported that it took 27-34 days of inoculation for primordial formation of *P. ostreatus* which is partially in agreement with the study results.

During this third stage, mycelium has fully colonized the substrate and the fungus is ready for fruiting. Appearance of fruiting bodies occurred after 9-10 days after pinheads formation (Figs. 2, 3). In this final stage frequent spraying of water is required in the cropping room depending upon the atmospheric humidity. Further the contaminated bags with moulds were discarded while bags with good mycelium growth were left for some more days to complete

Fig. 3. Fruiting body formation of *P. sajor-caju*.

the mycelial growth. These findings are supported with Pathania *et al*. (2017) who reported that fruiting bodies were formed 10 days after pinheads formation. Whereas Quimio (1978) reported that fruiting bodies were formed 3-4 weeks after the spawn inoculation.

During the initial months we could reap maximum yield of oyster and the harvesting was done in three flushes, whereas at the end the mushrooms yield shown a decreasing trend. The yield improvement in initial periods may be attributed due to the optimum temperature and relative humidity prevailing which helped in development of mycelium by various locations. The maximum total yield (7.50 kg/10 bags) were obtained from popa was village followed by ghantiyala (7.20 kg/10 bags). Whereas, minimum yield of mushroom was found in rajwa and sirodi villages, 6.70 kg/ 10 bags and 6.20 kg/ 10 bags, respectively. Overall, an average yield of 6.90 kg was obtained from10 poly bags composing about 10 kg wheat straw for a single farmer. The finding was partially supported by Kumari and Achal (2008) cultivated *P. ostreatus* on different substrates and reported the highest yield on wheat straw. The comparison of yield obtained from mushrooms at different villages are given below.

It could be inferred from the Table 1 that the treatments across locations were found significantly different. The mushroom yield from villages namely popa was and gantiyala were found statistically at par with each other. Whereas, Sirodi's yield was significantly differed from these two villages. Further it was observed that village Rajwa and Sirodi's mushroom yield were not significantly different from each other. The difference in yield could be attributed to the technology practiced by farmers in various manner viz., watering, maintaining temperature and humidity as well as the darkness maintained insider

Table 1. Comparison of yield of mushroom at different villages. CD at 5% 0.068, CV 10.8.

Particulars	Mean
Popawas	0.75
Rajwa	0.67
Sirodi	0.62
Ghantiyala	0.72
Average	0.69

Table 2. Comparison of *Pleurotus sajor-caju*'s biological efficiency on wheat straw. *DAI=Day after inoculation.

Village	Spawn running (DAI)*	Pinheads formation (DAI)	Fruiting bodies formation (DAI)	Average No. of fruiting bodies	Biological efficiency (%)
Popawas	20-22	24-27	33-37	13	75
Rajwa	21-23	23-26	34-37	12	67
Sirodi	20-22	24-27	32-36	10	62
Gantiyala	19-21	25-28	33-38	13	42
Average	20-22	24-27	33-37	12	69

the mushroom cultivation room.

Biological efficiency

The biological efficiency was worked out against the dry weight of wheat straw. It is clear from Table 2 that about 69% biological efficiency were worked out from 10 kg of wheat straw.

Economic analysis

Cost of cultivation: It includes cost of different materials and substrate which are amounted to Rs 398.08 and that were given in Table 3. The total expenditure was about Rs 398.08 for 10 bags with 10 kg straw @ 1 kg straw / polybag. Economic analysis further reveals that the cost of production per kg of mushroom was Rs 39.81. Gross return was Rs 966.00. The net return was worked about and it came about Rs 567.92.

B-C Ratio:

Gross return	Net return	B:C ratio
Rs 9,66.00	Rs 567.92	2.43

In order to determine that the mushroom production was profitable or not, Benefit Cost ratio (B/C ratio) was worked out. The B/C ratio was defined as an indicator showing the relationship between the relative costs and benefits of a proposed project, expressed in monetary or qualitative terms. It is expected that for any production business the B: C ratio must be always greater than 1. As the value of B: C increases, the level of feasibility of mushroom production is more economical to the producer. B: C ratio of 2.43 was obtained for this study indicates that this mushroom production is expected to deliver a positive results for the farmer producers at field condition.

Table 3. Cost of materials used.

Sl. No.	Materials required	Rate	Quantity	Amount (Rs)
1.	Spawn	Rs 100/kg	1 kg	100/-
2.	Plastic bags	Rs 2/bag	10 bags	20/-
3.	Wheat straw	Rs 6/kg	10 kg	60/-
4.	Formalin	-	120 ml	7.20/-
5.	Bavistin	-	1.36 gm	10.88/-
6.	Labor charge	Rs 50/hr	4 hr	200/-
	Total			398.08/-

CONCLUSION

Cultivation of mushroom is one of the most viable economic process to convert the agro industrial wastes into protein rich food items through microbial technology. It was also proven that the cultivation of edible mushrooms from lignocellulosic wastes is an innovative method for improving the nutritional quality of the waste materials as well as to generate entrepreneurship among the rural youths. This study of oyster mushroom cultivation was conducted at farmers field of four villages at Popa was panchayat with the average production hovering around 6.9kg. Among all the villages, popa was village was found to have the highest yield (7.5 kg) in mushroom cultivation followed by Gantiyala, Rajwa and Sirodi. The analysis showed that mushroom technology was best suitable for cultivation among the landless, marginal and small farmers in terms of low investment coupled with more economic returns in rural areas in arid ecosystem. In the present study the yield of mushroom per bag of 1 kg wheat straw was recorded between 600 – 700 g with a gross return of Rs 966 and the B: C ratio was found to be 2.43. Hence it may be concluded that the oyster cultivation was found to be much more suitable and profitable for the arid farmers and could

be taken up as a commercial enterprise at village level.

Cultivation of mushroom not only reduce the by product wastages but also it recycles in a better and efficient way. It was also found over various studies that *P.ostreatus* which was grown on various substrates provide nutritious, low fat and enriched fiber with protein. It also offers economic incentives for agribusiness and enterprises as well as for evaluation of these residues as valuable resources which could be channeled upon to produce nutritious mushroom products (Ahlawat *et al*. 2005). Therefore, cultivation of mushroom is not only profitable agribusiness but also a better way of recycling wastes by providing a clean and green environment (Sharma *et al*. 2013). Further as per the government objectives to double the farmers income the mushroom technology can be upscaled in arid regions in general and Jodhpur in particular.

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