Comparative study of Various Substrates for Oyster Mushroom Cultivation and its Nutrient Analysis

Pushpa T P[1], Suman Pawar[2], Asha Gowda Karegowda[3]

[1]UG student, Department of Chemical Engineering, Siddaganga Institute of Technology, Tumakuru.
[2]Assistant professor, Department of Chemical Engineering, Siddaganga Institute of Technology, Tumakuru ,
[3]Associate Professor, Department of Master of Computer Applications, Siddaganga Institute of Technology, Tumakuru,

Abstract- *Edible mushrooms are the fleshy and edible fruit bodies of several species of macro fungi. Mushroom Edibility may be defined by criteria that include absence of poisonous effects on humans and desirable taste and aroma. It is a good source of amino-acids, proteins, vitamins and minerals. It has rich number of fibres and good energy boosters for adolescence. Mushroom cultivation is becoming one of the major income sources for Indian farmers. But most of farmers are not aware of mushroom cultivation process. Mushrooms can be cultivated using agro-based waste as substrate (growing medium). The yield of mushroom depends on substrate used and other mushroom cultivation room temperature, moisture, CO_2, and atmospheric humidity. This paper covers comparative study of impact of substrates on mushroom biological efficiency and its nutrients. Our main objective would be carrying out comparative analysis of impact of various types of substrates on both mushroom yield and its nutrient contents in particular for oyster mushroom. The figure millet and paddy were used as substrates in different proportion. Among the various combinations experimented, 100% Ragi substrate resulted in best yield and also resulted in better protein, carbohydrates and lipids when compared to other combination of substrates.*

Keywords: Oyster Mushroom, substrates, nutrient analysis, biological efficiency, Value added products

I. INTRODUCTION

Mushrooms are umbrella-shaped fruiting body (sporophore) of fungi and as the name suggest it requires moisture for its growth. In Rig-Veda, Ancient India, China mushrooms are ritual food, Greeks used to feed warriors. Due to absence of chlorophyll, it is unable to synthesize its own food and hence is dependent upon organic matter/substrate for food. In world there are about 69,000 varieties of mushroom but only 2000 of them are edible [1]. Mushrooms have high health benefits; it is good for people with diabetes, blood pressure since mushrooms are having low sodium content. Mushrooms have antimicrobial, anti-tumor, anti-viral properties, very little fat, sugar and without starch & cholesterol. Selenium: Mushrooms contain more selenium and all edible mushrooms are good sources of selenuim. Selenuim may also be an anti-cancer substance since it has been proven to reduce the risk of prostate cancer. There are more than 30,000 identified types of mushrooms worldwide; 99% of these are edible and roughly 1% is poisonous. Edible mushrooms are consumed by humans for their nutritional value and medical value. India, China, Taiwan, Japan, Korea and Thailand have the highest global export rates of mushrooms, since Asia's environment is suitable for mushroom cultivation. Mushroom cultivation incurs nominal cost, hence is a good source of income for farmers, in turn contributing to country's economy. The commonly grown mushroom in India are Button mushroom (Agaricusbisprous), Oyster mushroom (Pleurotusostreatus), Milky mushroom (Calocybeindica), Straw mushroom (Volvariellavolvaccea), Cremini Mushroom (Agaricusbisprous), Shiitake Mushroom (Lentinulaedodes) and Portobello Mushroom (Agaricus). Mushroom is commonly grown in the various states as shown in Figure 1. Mushroom industry in India is overwhelmingly focused on white button mushroom, milky mushroom and oyster mushroom [2].

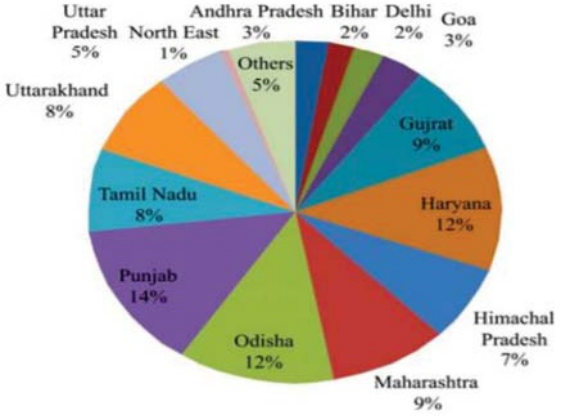

Fig. 1 Mushroom growing in various states

The Pleurotus (Oyster mushroom) species produce several medicinal and pharmacologically interested metabolites, such as antimicrobials, immunostimulants, antioxidants and anti-tumourals. This mushroom is also known as "wood decaying fungus".

Mushroom contains 20-35% protein which is higher than those of vegetables and fruits and is of superior quality. Mushroom cultivation technology is the suitable method for the conversion of agricultural waste. This is the most efficient and economically valuable technology for conversion of high lignocelluloses into high quality protein food. In India, Mushroom growing is highly rewarding because of variable climate where different kinds of mushrooms can be grown in various environmental situation [2-5].

In the cultivation room should be strictly maintained like relative humidity, moisture, air circulation, Temperature is to be maintained according to type of mushroom. In general, relative humidity is 75-95%, Carbon dioxide 600-700 ppm, apt Temperature 25^0C.

Commonly used substrate is: banana leaves, citrus peels, coffee sawdust, corn (cobs and stalks), cotton straw, grasses, gum and pine sawdust, straws of paddy, ragi, maize, jowar, bajra, sugarcane baggase, sorghum or any millet, coffee grounds**,** wood shavings, legume straw and pods, paper waste, water hyacinth, wheat straw and wood logs etc have been successfully used for cultivating oyster mushroom. [6].

This paper is briefed as follows. Section 2 briefs about related work on mushroom cultivation. Section 3 covers the oyster mushroom cultivation process. Experimental work carried using two types of substrates: paddy and finger millet (ragi) straw and its different combination of Rice and paddy to evaluate the effect of different substrates on mushroom yield using biological efficiency and nutrient analysis is briefed in Section 5 followed by conclusion in Section 6.

II. Literature Review

Among the available mushroom grown, oyster mushroom can be easily grown from locally available agricultural waste /products as substrate.

R. Vijayakumar et al.,[1] suggested that growing oyster mushroom in paddy straw, sugarcane trash, banana leaf sheath, and leaf litter and its combination , among that paddy straw and Leaf litter + paddy has shown highest yield 526g and 478.6g, biological efficiency 52.6% & 47.86% respectively and has shown maximum number of proteins and carbohydrates while in Somashekhar et al.[3],Oyster mushroom on different substrates like Ragi straw, coconut husk, Areca nut husk, Fodder Sorghum Straw, Guinea grass straw which is abundantly available in local area when compared to Paddy straw. Ragi straw has shown maximum yield (1.41 kg) and biological efficiency (70.4%) followed by paddy straw (61.6%) and Guinea grass straw (60.0%) significantly compared to other substrates.

Baysal [7] suggested that oyster mushroom cultivation in waste paper supplemented with peat, chicken manure and husk rice (90 + 10; 80 + 20 w/w) in its combination they found that addition of rice husk to waste paper significantly increased spawn running, pin head formation, fruit body formation and mushroom yield, waste paper added to chicken manure and peat has shown in loss due to high C/N ratio.

As mushroom's life span is less of 2-3 days it can converted into value added products like Mushroom Jamoon, preserved as Murabba, Rasam Powder, Pickle, biscuit, Soup powder, Nuggets, Ketch-up, Candy, etc also in turn increasing the income. Mushroom could use as weekly twice food supplements as curry's [8].

Almost no work is reported for studying impact of paddy and ragi and its different combination on both nutrient analysis and biological efficiency of mushroom. In this context, we have carried out work to study the impact of paddy and rice and its different combination on both nutrient analysis and biological efficiency of mushroom. In addition, ragi is commonly grown in Karnataka in addition to paddy, hence are easily available local farmers with no investment on substrates. Farmers are not aware of mushroom value added products, this paper covers various value added products of mushroom, which can be additional source of income.

III. Oyster Mushroom Cultivation Processes

Figure 2 depicts the Oyster Mushroom cultivation processes. Usually, most of the farmers both in India and abroad use polythene bags for cultivating oyster mushroom. The mushroom cultivation room must be hygienic to avoid any microbial and/or fungal attack in mushroom. The substrate is chopped and sterilized followed by partial drying so as retain enough moisture to prepare mushroom bed. The drying test is done by squeezing test. The spawns and substrate material is filled in the polythene bags in layered fashion. Spawning is recommended to be done at lower rates because over spawning can cause rise in temperature and CO_2 concentration within substrate which can be harmful for mycelium. Slightly cooled straw is filled in the plastic bags and spawning is done. By sanitizing hand

with dettol or being sure the hands are free from pathogens then straw was filled in the bags. During spawning great care should be taken to avoid pathogenic contamination. Spawn is spread in every layer of 4-5 cm height and pressed the straw slightly to make bag compact. After filling the bag with spawn and straw, mouth of bag should be tied with thread. Pin holes are made with the help of needle for aeration. These bags are kept for incubation in dark room for 15-17 days depending on the substrate combination, the bags appear white due to growth of mycelium. The bags are kept for additional 3-5 days to ensure mycelium growth. After first 20 days from the day of cultivation, the spawns start growing into mushroom. This is usually seen as white patches inside the polythene cover, in those while patch location, the framers need to manually cut the polythene covers gently with utmost care to provide place for spawns to sprout out. Primordial growth of mushroom is seen one week after cutting of plastics. During this stage diffused light was provided in the room. The right time to judge fruiting body is when it has reached a shape and size. Mushroom fruit body doubles for every single from the day its pin head appears so hence fruit body is achieved soon within 4-6 days. Picking was done by twisting the mushroom gently so that it is pulled out without leaving any stub and also nearby fruiting bodies are not disturbed. During the entire process of mushroom cultivation, the moisture, temperature of mushroom bed and CO_2 in cultivation room must be monitored so as to get better yield. This process involves daily monitoring and dedicated man power.

Fig. 2 Oyster mushroom cultivation process

IV. Materials And Methods

An experiment was conducted using paddy and ragi straw as substrates in different proportions so as to estimates its impact on both nutrient analysis and yield. Oyster Spawn, Polypropylene cover of size 12×16 inches, Paddy and ragi straw, Chemicals: Formalin and cliva plus are used for mushroom cultivation. Oyster spawn was purchased from Krishi vigyan Kendra, Hirehalli, Tumkur, Karnataka. Both paddy and ragi Straw was collected from local farmers. Proportion of substrates (paddy and ragi) used for the experimental work is briefed in Table 1. Total of 10 bags of mushroom was cultivated using one kg spawn and 600g (wet) substrate per bag.

Table 1: Proportion of substrates (Ragi and Paddy) used for the experimental work

S. No	Percentage Proportion for the experiment
1	100% Paddy straw (PS)
2	100% Ragi Straw (RS)
3	75% PS + 25% RS
4	75% RS + 25% PS
5	50 % PS + 50% RS

V. Results And Discussion

Analysis of impact of different combination of ragi and paddy substrate on biological efficiency of oyster mushroom: Biological efficiency (BE) of mushroom is calculated using Eq. (1) and the obtained results are shown in Table 2. Mushroom was cultivated for three flushes F1, F2 and F3. The mushroom cultivated in flush F1 and F2 was not infected with any kind of diseases, but flush F3, almost all the substrates was infected by green mould hence resulted in very poor yield. Table 2 clearly proves that for F1 and F2 flush, substrate with 100% Ragi straw resulted in better yield and biological efficiency when compared to other substrate combination. Compared to second flush, the BE for first flush is high, may be due to the availability of maximum nutrients in substratum. But since the flushF3 was infected by green mould it resulted in reduced yield & BE. The results in Table 2 prove that the substrate definitely has impact on both yield and BE, but in addition one should maintain the hygienic condition, since if not take care, it results in poor yield and BE irrespective of type of substrate used. The impact of different combinations of proportions of Ragi and Paddy straw on BE for three flushes is depicted in Figure 3. BE for F3 illustrates the impact of presence of green mould in reduction of BE as well as impact of substrate nutrients on BE.

Time course for completion of spawn running, days for initiation of pin heads and fruiting body formation and completion of fruit body formation for oyster mushroom is briefed in Table 3. It was observed that for F3 which was infected by green mould, the completion of spawn running, days for initiation of pin heads and fruiting body formation for oyster mushroom was delayed by almost 1 week.

$$\text{Biological efficiency} = \frac{\text{Weight of fresh mushroom harvested}}{\text{Weight of wet substrate in each bag}} \times 100 \quad \text{----------(1)}$$

The biological efficiency was determined against the dry weight of each substrate. The biological efficiency of different substrates ranges between 49.50 % to 108.03 %.

Table 2: Weight, Average yield and biological efficiency of oyster mushroom for different combination of substrates for 3 flushes.

Substrate	Weight of substrate(g)	Weights in batches (g) (yield)			Total yield (g)	Biological efficiency (of 3 flushes)
		Disinfected Mushroom batches		Green mould infected mushroom batch		
		F1-yield	F2-yield	F3-yield		
100 % Paddy Straw [PS]	600	290	210	118.2	618.2	103.03
100% Ragi straw[RS]	600	309.6	230	110	649.6	108.26
75%PS+25%RS	600	137	105	55	297	49.50
50%PS+50%RS	600	262.4	230	55	547.4	91.23
25%PS+75%RS	600	225.2	202	75.7	502.9	83.82

Protein was highest with 11.09 for 100 % Paddy Straw [PS substrate and lowest for 100 % Ragi straw [RS] substate]. Carbohydrates was highest with 56.89 for 100% R substrate and lowest with 14.08 for 75 % PS + 25 % RS Substate. Amino acid was highest with 3.46 for 100 % RS substrate and lowest wih 1.27 for 100 % PS Substate. Lipids was highest with 3 for 100 % RS substrate and lowest with 1.19 for 75 % PS + 25 % RS Substate. The nutrient analysis of oyster mushroom for each substrate was done and is shown in Table 4. According to R. Vijayakumar et al, [1] the steps for nutrient analysis was done and the results are recorded and tabulated.

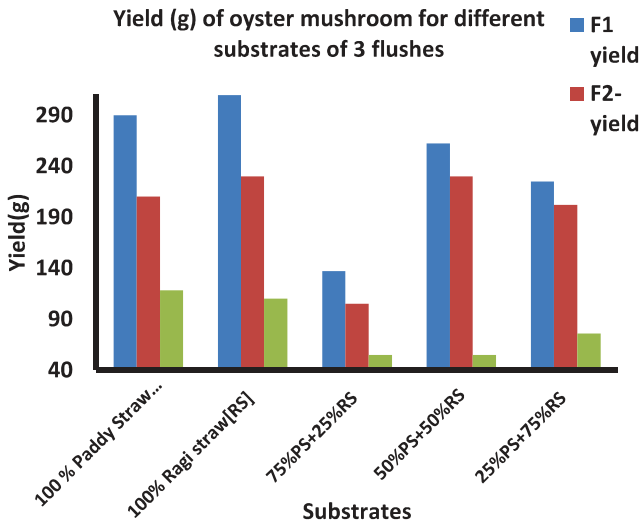

Fig. 3 Comparative Yield (g) of oyster mushroom for different proportion substrate in three flushes.

Table 3: Time course for completion of spawn running, days for initiation of pin heads and fruiting body formation for oyster mushroom of three flushes

Substrate (straw)	Completion of spawn running (In days) for first flush	Days for initiation of pin head formation for first flush	Fruiting bodies formation (Days) first flush	Completion of fruiting body formation in days of last i.e. 3rd flush
100% Paddy straw [PS]	19.26	22.5	27.3	45
100% Ragi straw [RS]	17.15	21.3	26.4	55
75%PS+25%RS	21.35	22.4	28.5	51
50%PS+50%RS	19.07	26.04	33.3	58
25%PS+75%RS	22.34	23.05	29.3	50

Table 4: Compariative study of the nutrient analysis of oyster mushhoom for each substrate

Substrate	Protein (mg/g)	Carbohydrates (mg/g)	Amino (mg/g m)	Lipids (mg/g m)
100 %	11.09	15.866	1.27	1.58
100 %	7.67	56.89	3.46	3.0
50 % PS +	9.86	49.68	3.1	2.99
75 % PS +	10.119	14.08	1.32	1.19
25 % PS +	10.22	60.11	2.38	2.9

VI. Conclusion

A comparative study of impact of two types of substrates namely Ragi and Paddy straw and their combination was done for oyster mushroom cultivation. Best mushroom yield was obtained using Ragi as substrate with biological efficiency of 108.26 and lowest for (75 % paddy PS + 25 % RS) combination substrate. It was observed that the one of batch which got infected by green mould resulted in poor yield, hence we can conclude that it's not only substrate that has impact on yield but one needs to maintain hygienic conditions during mushroom cultivation process. In addition, a comparative study of impact of two types of substrates on mushroom nutrients was carried out. Mushroom grown with ragi substrate has protein of 7.67 mg/g, carbohydrates of 56.89 mg/g, amino acid 3.46 mg/g and lipids of 3.0 mg/g. Ragi straw which is abundantly available in Tumakuru district of Karnataka, hence could be a potential agricultural substrate in this location for mushroom cultivation at low

cost. Since the mushroom cultivation process is easy and requires nominal investment, it can be taken as addition source of income for rural women.

REFERENCES

[1] R. Vijayakumar, S.S. Sudha, A. Panneerselvam. A comparative study on cultivation and nutritional status of Oyster Mushroom Pleurotusostreatus on different substrates, 1(4): 209-212 (2008)

[2] Valverde, M, E., Talía Hernández-Pérez, Octavio Paredes-López. Edible Mushrooms: Improving Human Health and Promoting Quality Volume, Article ID 376387, 14 pages (2015).

[3] Somashekhar, Radha Banakar, N Loganandhan. Oyster Mushroom Production in different Agricultural substrates ISSN: 2319-7706 Volume 9 (2020).

[4] Sharma Usha. Challenges and Opportunities of Indian Agriculture. Shodhaytan Vol 7, Issue 14 (2020).

[5] D'souza S. F. Radiation Technology in Agriculture for Development of Improved Crop Varieties. Anusandhan Vol 4, Issue 8 (2015).

[6] Marek Siwulski Piotr Rzymski, Anna Budka, Pavel Kalač, Sylwia Budzyńska, Luiza Dawidowicz· Edmund Hajduk Lidia Kozak, Joanna Budzulak, Krzyszt of Biegalski, Przemysław Niedzielski. The effect of different substrates on the growth of six cultivated mushroom species and composition of macro and trace elements in their fruiting bodies/Published online (2018).

[7] Baysal E, Peker H, Yalinkilic M K. Temiz A, Cultivation of oyster mushroom on waste paper with some added supplementary materials, Bioresource Technology Mugla University, Keotekli, Mugla, 89 95–97(2003).

[8] Sharma VP, Sudheer K Annepu, Yogesh Gautam, Manjit Singh and Shwet Kamal, Status of mushroom production in India Mushroom Research Invited Status Paper 26 (2) 111-120 (2017).