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PRODUCTION EFFICIENCY OF DIFFERENT STRAINS OF *PLEUROTUS OSTREATUS* USING VARIOUS CELLULOSIC AGRO-WASTES

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A B S T R A C T

Different local strains of Oyster mushroom were evaluated using different cellulosic agro-wastes including cotton waste, paddy straw and wheat straw for mycelial growth, spawn running and production efficiency of different strains of *Pleurotus ostreatsus*. Maximum production efficiency of *P. Sajur caju* was observed (195.9%) on wheat straw while minimum production efficiency was recorded (132.1%) on paddy straw followed by cotton waste where the production efficiency was 107.9%. *P. ostreatus* (white strain) showed maximum production efficiency (113.7%) on wheat straw and minimum (88.8%) on cotton waste. While the production efficiency of *P. ostreatus* (gray strain) was almost same on cotton waste and wheat straw but greater than paddy straw (128.3%). The Overall performance of *P. Ostreatus* (gray strain) remained best during its cultivation.

Keywords: *Pleurotus,* local strains, cellulosic agro-wastes, spawn running, mushroom yield.

INTRODUCTION

Mushroom industry is an aid to conventional crops to improve the economic status with low inputs. Total annual world mushroom business is of 50 billion dollars. Each year 95 million tons of oyster mushroom is being exported to Pakistan from Europe (Shah *et al.,* 2004). It is needed to flourish the mushroom industry in protein deficient countries like Pakistan. Among different mushroom species, *Pleurotus ostreatsus (Jacq.Fr)* is known for food of high quality, extraordinary flavor, elevated nutritional value and high content of protein, reduced fat content (4%), vitamins (B, C, niacin, biotin, riboflavin, cyanocobalamine and thiamine etc.) *Pleurotus ostreatsus* is rich in minerals (high in P, K, Ca, Fe, folic acid and low in Na), fibers and carbohydrate contents as compared to other foods. *Pleurotus ostreatsus* is also a rich source of essential and non-essential amino acids such as lysine which is low in cereals (Ali *et al*., 2007). Among 5000 species of *Pleurotus ostreatsus,* 1220 species have been reported as edible. *Pleurotus* species have ability to grow efficiently in a variable range of temperature conditions (15-30 ^{0}C), so they can ideally be cultivated throughout the year in different agro-ecological zones in tropical countries like Pakistan. Due to increased nutritive value and low production costs, *Pleurotus* species have gain importance throughout the world as an extra agri-business. These species have enlarged status followed by *Agaricus bisporus* especially *P. ostreatus* and *P. sajor caju.* In Pakistan only few of the edible mushroom species are common among growers and Oysters are being considered most popular due to high nutrition and delicious taste (Khan *etal,* 2008). Due to increased demand, better income sources and higher nutritional values people started cultivation (Kurt and Buyukalaca, 2010). Use of agricultural wastes in mushroom cultivation broadened the vision of farming community to think of its cultivation. With the passage of time mushroom cultivation has gained its status as a non-conventional agri-business along with conventional crop production (Jafari *et al.,* 2007).Pakistan is an agricultural country with its more than 70% population indulged directly or indirectly in agriculture. About 44% of country's workforce is directly employed in agriculture profession. Share of agricultural in country's GDP is about 21%. Farming

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community harvests the desirable parts of the crops annually and remaining is left unused subjected to either burnt or wasted (Iqbal *et al.,* 2005). Mushroom cultivation provides an alternative opportunity to utilize these wastes efficiently resulting in generation of extra income with little effort. It also helps to generate revenue for developing countries like Pakistan. Industrial scale utilization of these waste materials is now possible by growing mushrooms on them. These wastes are good source of nutrition for mushrooms which in turn imparts positive effects on economic status of grower as well as country (Choudhury *et al.,* 2009).

In Pakistan Oyster mushrooms are usually found humus rich places such as manure heaps and dump places. Large scale utilization and management of cotton waster, wheat straw and rice straw is still challenging all around the world. Among the few short comings of mushroom based business include fermentation problems, spawn preparation, determination of moisture contents lack of knowledge about its growth phases (Ahmad *et al.,* (2009).

Keeping in view the nutritional, medicinal and commercial value of Oyster mushroom it is needed to strengthen mushroom industry in Pakistan (Adebayo *et al.* 2009). The present study was conducted to evaluate the production efficiency of different local strains of Oyster mushroom using various cellulosic agro-wastes to fulfill the gap of malnutrition as mushrooms are very reliable and profitable option.

MATERIALS AND METHODS

1. Preparation of Substrate: Three substrates cotton waste, paddy straw and wheat straw were collected and wetted thoroughly followed by stacking on the floor. pH of these substrates was adjusted with lime. Three Oyster *spp.* were u---`1sed for effective cultivation with three blocks and five replications.

2. Method of Sterilization: Country style method of sterilization was used. Bags were steamed sterilized in drum (220L) for 1hr at 70 ^{0}C ± 5 ^{0}C.

3. Spawning of Bags: Spawning was done by inoculating the bags with 5 g of pure spawn. These bags were incubated for spawn running under complete darkness at room temperature. Data was recorded on 100% (full growth) of spawn completion in days of substrate bags.

4. Humidity: The humidity of the growing room was maintained between 80-90% and moisture requirements of the bags were accomplished by sprinkling water on them thrice a day using sprinkler. Humidifier was used to control the temperature of the growth room.

5. Ventilation: Exhaust fan, operated 3-4 times was used for air flush to retain oxygen requirements during mushroom fructification.

7. Recording of Data: The data was recorded on the following parameters.

I- Mycelial growth on substrates: Data on mycelial growth was recoded in days.

II- Days for completion of spawn running: Time was recorded in days for the completion of 25%, 50%, 75% and 100% growth of mycelium on each substrate in polypropylene bags.

III- Pinhead formation: Data on pinhead formation was recorded in days taken for appearance of primordial formation in substrates.

IV- Fruiting bodies formation: Time period of pinhead to maturation of fruiting bodies was recorded in days.

V - No. of flushes: The no. of flushes were recorded for each replication and each treatment.

VI - Average yield of all flushes: The yield in each flush was recorded for each block and each treatment.

VII- Yield and biological efficiency: In order to calculate biological and production efficiency of strains, the water contents of substrates at inoculation and at the end of incubation were measured. Biological and production efficiency was calculated by following formulas.

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$$\mathbf{B.E}\ (\%) = \frac{\text{Fresh weight of Mushroom harvested}}{\text{substrate dry content before inoculation}} \text{ X } 100$$

VI- Production efficiency:
Production efficiency of different strains was calculated by the following formula:

$$\mathbf{P.E}\ (\%) = \frac{\text{Fresh weight of mushroom harvested}}{\text{Substrate dry matter contents before croping}} \text{ X } 100$$

RESULTS AND DISCUSSION:

Mycelial growth on different substrates (in days): Data recorded on mycelial growth of different strains of *Pleurotus ostreatsus* on different substrates that maximum number of days for mycelial growth were taken by *P. sajur caju* (30.5days) on wheat straw and minimum no. of days (19.8days) showed in Table no(1). *P. ostreatus* (white strain) took more days (28.5) for the mycelial growth on wheat straw than on the paddy straw (23.6b) followed by mycelial growth on cotton waste (17.6). The same growth pattern of the mycelial growth of the *P. ostreatus* (gray strain) was observed. Mycelial growth of the *P. ostreatus* (gray strain) took minimum number of days (18.6) on cotton waste, greater number of days (21.7) on paddy straw and maximum number of days (23.9) on wheat straw. The overall performance of *P. ostreatus (*gray strain) was significantly the most effective on all three substrates in this regard. Mandeel *et al.* (2005) observed the max. growth rate (0.509.02 cm day^{-1}) on the same substrate. The mycelial growth rates in response to addition of sunflower seed hulls considered as energy supplying component (Iqbal *et al.,* 2005).

Phases of completion of spawn running: (Number of days): Maximum number for spawn running were taken by the strain *P. sajur caju* (36.4) on wheat straw while number of days for spawn running were less (20.6) on cotton waste followed by paddy straw (16.5). Same pattern was recorded by *P. ostreatus* (White strain) where the spawn running on white straw was completed on 31.2 days higher than cotton waste (20.2 days). Minimum days (16.7) for spawn running were observed on paddy straw. *P. ostreatus* (gray strain) showed maximum spawn running in (33.8) days on wheat straw and minimum in (17.2) days on cotton waste. The overall performance of *P. ostreatus* (white strain) was found significantly the best on all three substrates in this regard. The results were found in lined with Iqbal *et al.* (2005) and Mandeel *et al.* (2005) who deduced that banana leaves, cotton waste, wheat straw and paddy straw were good for cultivation of oyster mushroom with nutrition and economic point of view.

Phases of Pinheads formation: The days taken for appearance of primordia are an important estimation of the end yield and biological efficiency. The maximum no. of days for pinheads formation were taken by *P. Ostreatus* and *P. Sajur caju* (32.7) on wheat straw while minimum no. of days for pinheads formation were recorded (15.5) in Cotton waste showed in Table(3). *P. ostreatus* (white strain) showed maximum pinheads formation in (32.7) days on wheat straw and minimum in (15.5) days on cotton waste. While, *P. ostreatus* (gray strain) showed maximum pinheads formation in (31.5) days on wheat straw and minimum in(17.7) days on cotton waste. The overall performance of *P. Sajur caju* white strain was the best on all three substrates. The results achieved in this section are found satisfactory as cotton was proved to be the best substrate and results exhibited in this section were found in line with Ahmad *et al.* (2009).

Maturity of fruiting bodies formation: The no. of days required for maturity of fruiting bodies is

important estimate of the end yield and biological efficiency. Data recorded showed that maximum number of days for maturity of fruiting bodies formation were taken by *P. Sajur caju* (53) on wheat straw while minimum no. of days for maturity of fruiting bodies formation were recorded (32.9) by *P. ostreatus* on the same substrate. Number of days taken by *P. sajur caju* on paddy straw (51.9) was more than on cotton waste (50.9). *P. ostreatus* (white strain) took more number of days (35.3) on paddy straw and less number of days (32.9) on wheat straw and minimum number of days was taken on the cotton waste. *P. ostreatus* (gray strain) showed maximum maturity of fruiting bodies formation in (50.8) days on wheat straw and minimum in (46.1) days on paddy straw. The overall performance of *P. Ostreatus* (gray strain) was the best on all three substrates. These results were found satisfactory as *P. ostreatus* took minimum no. of days maturity of fruiting bodies. These results were found in line with Ahmad *et al.* (2009).

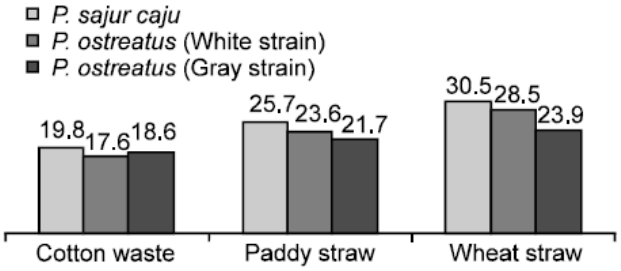

Fig. 1: Mycelial growth on different substrates (in days). *Means sharing similar letter in a column are statistically non-significant (p>0.05)

Fig. 2: Spawn running on different substrates (in days). *Means sharing similar letter in a column are statistically non-significant (p>0.05)

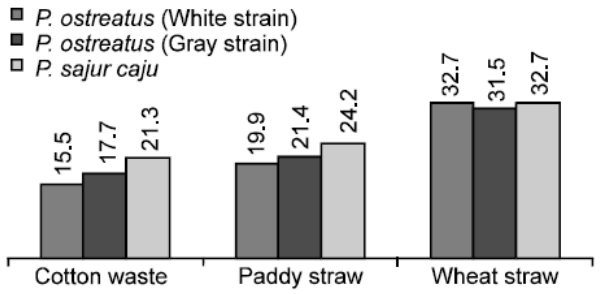

Fig. 3: Pinheads formation on different substrates. *Means sharing similar letter in a column are statistically non-significant (p>0.05)

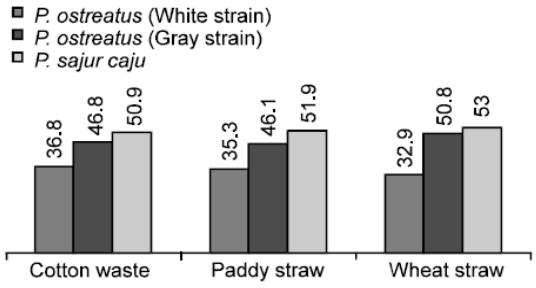

Fig. 4: Maturity of fruiting bodies. *Means sharing similar letter in a column are statistically non-significant (p>0.05)

Maturity of fruiting bodies formation: The no. of days required for maturity of fruiting bodies is important estimate of the end yield and biological efficiency. Data recorded showed that maximum number of days for maturity of fruiting bodies formation were taken by *P. Sajur caju* (53) on wheat straw while minimum no. of days for maturity of fruiting bodies formation were recorded (32.9) by *P. ostreatus* on the same substrate. Number of days taken by *P. sajur caju* on paddy straw (51.9) was more than on cotton waste (50.9). *P. ostreatus* (white strain) took more number of days (35.3) on paddy straw and less number of days (32.9) on wheat straw and minimum number of days was taken on the cotton waste. *P. ostreatus* (gray strain) showed maximum maturity of fruiting bodies formation in (50.8) days on wheat straw and minimum in (46.1) days on paddy straw. The overall performance of *P. Ostreatus* (gray strain) was the best on all three substrates. These results were found satisfactory as *P. ostreatus* took minimum no. of days maturity of fruiting bodies. These results were found in line with Ahmad *et al.* (2009).

Number of flushes: Number of flushes in Oyster mushroom gives a better estimation of overall yield, biological efficiency and production efficiency. On an average, the total number of flushes in each Oyster mushroom strain cultivated on each substrate was (4gm). The best results found in this regard were in *P. sajur caju* cultivated on wheat straw and cotton straw. Maximum no. of days for no. of flushes were taken by *P. sajur caju* (3.77) on wheat straw while minimum no. of days for no. of flushes were recorded (3.33) in wheat

straw. *P. ostreatus* (white strain) produced more number of flushes (3.06) on wheat straw than on cotton waste (2.86) while maximum number of flushes (3.26) on paddy straw. *P. ostreatus* (gray strain) produced maximum number of flushes (3.46) on cotton waste and minimum number of flushes (3.20) on wheat straw. The overall performance of *P. sajur caju* was significantly the best on all three agro-wastes. The best results found in this regard were in *P. sajur caju* cultivated on wheat straw and cotton straw and are in lined with Amin *et al.* (2007); Nwokoye *et al.* (2008) and Sarker *et al.* (2007).

Average yield of all flushes: The average yield of all flushes gives a best estimate of economic output. Maximum average yield of all flushes were taken by *P. Sajur caju* (35.2gm) on wheat straw while minimum no. of days for average yield of all flushes were recorded (16gm) in wheat straw. *P. ostreatus* (white strain) showed maximum average yield of all flushes in (20.4 gm) on wheat straw While, *P. ostreatus* (gray strain) showed maximum average yield of all flushes in (24.26 gm) on Cotton waste and wheat straw as well. *P. ostreatus* (white and gray stains) give minimum yield on paddy straw. The overall performance of *P. Ostreatus* (gray strain) was the best on all three substrates in this. The best result found in reference to average yield was found in *P. sajur caju* cultivated on wheat straw. The results were found in lined with Ali *et al.* (2007); Dundar *et al.* (2009) and Fanadzo *et al.* (2010).

Biological Efficiency: Biological efficiency of mushrooms gives a best response estimate of economic importance output. Data recorded shows that maximum biological efficiency was noted with P. sajur caju (195.9%) on wheat straw while minimum biological efficiency was recorded (97.7%) on cotton waste. P ostreatus (white strain) showed maximum biological efficiency (113.7) on wheat straw. Biological efficiency on P. ostreatus on paddy straw (128.3) was more than on cotton waste (121.3). P. ostreatus (gray strain) showed maximum biological efficiency (134.4%) on wheat straw and minimum (121.3%) on cotton waste. The overall performance of P. ostreatus (gray strain) was best on all three substrates in this regard. Same results on biological efficiency of different strains of Oyster mushrooms were recorded by Omoanghe et al., (2009); Sangitrao (2000) and Taniguchi et al., (2005).

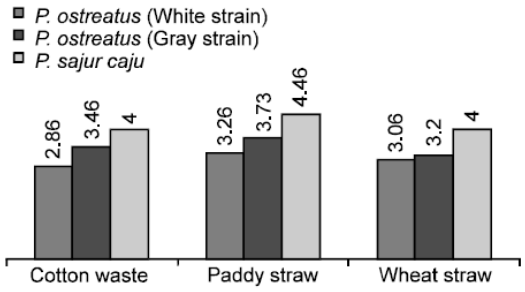

Fig. 5: No. of flushes of different substrates.
*Means sharing similar letter in a column are statistically non-significant (p>0.05)

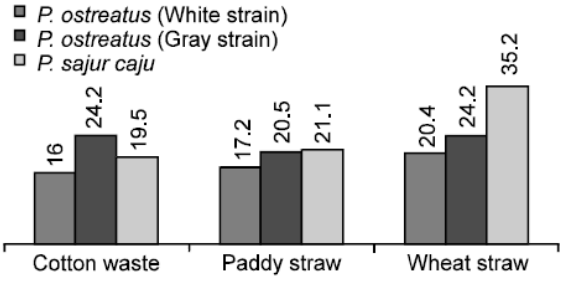

Fig. 6: Average yield of all flushes (gm).
*Means sharing similar letter in a column are statistically non-significant (p>0.05)

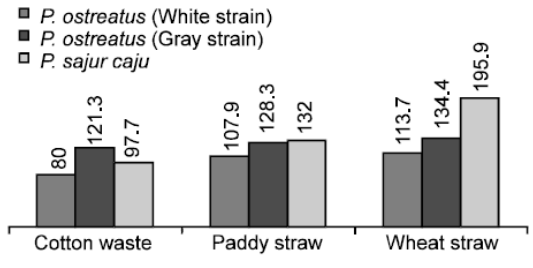

Fig. 7: Biological efficiency on different substrates.
*Means sharing similar letter in a column are statistically non-significant (p>0.05)

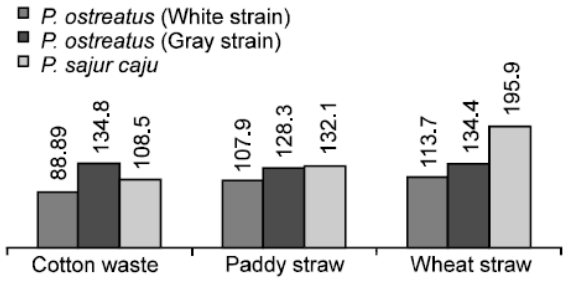

Fig. 8: Production efficiency on different substrates.
*Means sharing similar letter in a column are statistically non-significant (p>0.05)

Production Efficiency: Maximum production efficiency was noted of *P. Sajur caju* (195.9%) on wheat straw while minimum production efficiency was recorded (108.5 %) on cotton waste. *P. ostreatus* (white strain) showed maximum production efficiency (113.7%) on wheat straw. Production efficiency of *P.*

ostreatus (white strain) was more on the paddy straw (107.9%) thank cotton waste where the production efficiency recorded was minimum (88.89%). *P. ostreatus* (grays strain) showed maximum production efficiency (134.8 and 134.4%) on Cotton waste and wheat straw with a slight difference. The overall performance of *P. Ostreatus* (gray strain) was proved the best on all three substrates in this regard. The results were found in line with Kattan and Salama (1996); Pandey *et al.* (2008) and Saghir *et al.* (1998).

CONCLUSION:

Among different local strains tested for biological and production efficiency *P. sajur caju* remained greater than *P. ostreatus* (White strain) and *P. ostreatus* (gray strain.). Production efficiency of *P. ostreatus* (gray strain) was more than *P. ostreatus* (white strain). Among different cellulosic agro wastes wheat straw was best in improving biological efficiency and nutrient contents of the Oyster mushrooms.

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