

RESPONSE OF OYSTER MUSHROOM ON DIFFERENT AGRICULTURAL WASTES OF SOUTHERN PUNJAB

Samiya Mahmood Khan^{1,*}, Aamir Nawaz¹, Muhammad Asif Ali², Tanveer Ahmad²,
Nasir Ahmad Khan³ and Atiq-Ur-Rehman¹

¹University College of Agriculture, Bahauddin Zakariya University, Multan

²Institute of Horticultural Sciences, University of Agriculture Faisalabad

³Department of Plant Pathology, University of Agriculture Faisalabad

*Corresponding author's email: drsamivakhan@hotmail.com

Five strains of oyster mushroom namely *Pleurotus ostreatus* (strain PK 505), *Pleurotus ostreatus* (strain PK 409), *P. florida* (strain PK 514), *P. sajor-caju* (strain PK 411), *Pleurotus sajor-caju* (strain PK 408) and *Pleurotus ostreatus* (strain PK412) were compared for their yield potential on different substrates (paddy straw, wheat straw, mung bean straw, cotton waste, corncobs, corn stovers and sugarcane bagasse). Results on time required for completion of spawn running, formation of pin-heads and maturation of fruiting bodies on different substrates indicated that in all the cases, they appeared earlier on cotton waste. Similarly, maximum yield was obtained when these strains were grown on cotton waste while it was on the lower side mungbean straw.

Keywords: Oyster mushroom, substrates, spawn running, strains

INTRODUCTION

Mushrooms are also called as white vegetable or boneless vegetarian meat contains ample amount of protein, minerals, vitamins and fibers. Mushroom contain 20-35 % protein (dry weigh), which is higher than of vegetables and fruits (Chang and Mshigeni, 2001). It is considered health food for patients of hypertension and diabetes. Mushrooms are known to convert lignocellulosic residues from agricultural forests into protein rich food (Khan *et al.*, 2011, Michal *et al.*, 2011). Such processing of agro-wastes not only reduced environmental pollution but spent compost of mushroom is also a good source of fertilizer, animal feed and soil conditioner (Panjabrao *et al.*, 2007).

In Pakistan, agricultural byproducts such as wheat, millet, cotton and rice straw, corn stalks, sugar cane bagasse, sawdust and wood shavings, wild acacia, and banana and pulse wastes, etc. are plentiful, inexpensive and available most of the year. Large quantities of these materials are burned and used as fuel. Pakistan's production of wheat, rice and maize in 2005 reached a total of 31.7 million metric tons consisting of 21.6 million tons of wheat, 7.9 million tons of rice, and 3.2 million tons of maize (FAO, 2009-2010). Cereal straw is estimated to total 50.7 million tons composed of the following amounts: 36.7 million tons of wheat, 7.3 million tons of rice straw and 6.7 million tons of maize straw. These values for straw production were derived by using the grain conversion factors of Chang (1999) as follows: 1.0 for rice, 2.4 for maize and 1.7 for wheat. In addition, there are thousands of tons of cotton waste and sawdust alongwith other agricultural byproducts available

throughout the year that could be used for mushroom protein production.

Assuming that only 10% of the cereal straws produced annually would be used for mushroom protein production while about 5 million tons of straw could be used to produce mushroom protein. From these byproducts, 2.5 million tons of fresh mushrooms could be produced annually (assuming 50 % biological efficiency). In addition, about 1.25 million tons of good crop fertilizer, soil conditioner or feedstuffs could be produced from the spent mushroom substrates. Keeping in view the use of various agricultural byproducts, present studies were carried out to assess the yield potential of different oyster mushroom (*Pleurotus* species) strains on different substrates available in Southern Punjab.

MATERIALS AND METHODS

Selection of strains and substrates: Present Studies were conducted at University College Agriculture, Bahauddin Zakariya University, Multan. Five strains of oyster mushroom viz., *Pleurotus ostreatus* (strain PK 409), *P. florida* (strain PK 514), *P. sajor-caju* (strain PK 411), *Pleurotus sajor-caju* (strain PK 408) and *Pleurotus ostreatus* (strain PK412) were taken from the Mushroom Laboratory Department of Plant Pathology, University of Agriculture, Faisalabad. The cultures were maintained on 2% potato dextrose agar slants. Spawn was prepared on sorghum grains. Paddy straw, wheat straw, mungbean straw, cotton waste, sugarcane bagasse, corncobs and corn stovers were collected from the local farms while cotton waste was collected from ginning

factories located near Multan. The mushroom growing rooms consisted of iron cum plastic racks with 3 stages in each row. The assembly was meant to maximize the utility of available space for mushroom cultivation. The temperature of growing room was kept constant at $25 \pm 2^\circ\text{C}$ with the help of electric heater for spawn running and for production of fruiting bodies. Temperature was kept below 25°C with spraying of water on beds and floor of the room.

Linear mycelial growth of different strains: Linear mycelial growth of five strains of *Pleurotus* species viz., *Pleurotus ostreatus* (strain PK 409), *P. florida* (strain PK 514), *P. sajor-caju* (strain PK 411), *Pleurotus sajor-caju* (strain PK 408) and *Pleurotus ostreatus* (strain PK412) were studied on potato dextrose agar medium. The sterilized medium was dispensed aseptically into sterile 9 cm Petri-dishes. Agar plates were inoculated centrally with standard inoculated discs and incubated at $25 \pm 2^\circ\text{C}$. Measurement of radial extension of colonies along two diameters at right angles was recorded at the intervals of 3, 5 and 7 days (Khan *et al.* 2005).

Spawn running of different strains of *Pleurotus* spp.: The spawn running data of different strains of oyster mushroom i.e. *Pleurotus ostreatus* (strain PK 409), *P. florida* (strain PK 514), *P. sajor-caju* (strain PK 411), *Pleurotus sajor-caju* (strain PK 408) and *Pleurotus ostreatus* (strain PK 412) were compared and observations were recorded after the completion of 25, 50, 75 and 100 % spawn running.

Time taken by various phases of oyster mushroom cultivation on various substrates: The data regarding the spawn running as well as pinhead to fruiting bodies development were recorded in days (3, 5 and 7 days) at different stages.

Yield of oyster mushroom: The total yield was obtained in 4 flushes on different substrates used for evaluation of yield like wheat straw, paddy straw, corncobs, corn stovers, Mungbean straw, cotton waste and sugarcane bagasse. These substrates were filled in polythene bags at the rate of 1kg / bag and mouth were tied with rubber bands. These bags were autoclaved at 121°C and 15 psi pressure for 1hour (Ali *et al.*, 2007). Spawn was inoculated in these bags and placed them under complete darkness for spawn running. Total weight of all the fruiting bodies harvested from four pickings was measured as total yield of mushrooms. In all the treatments 10 bags of each substrate were used (Khan *et al.*, 2006). There were seven treatments (T₁-Cotton waste, T₂-Paddy straw, T₃-Mungbean straw, T₄-Wheat straw, T₅-Corn cobs, T₆-Corn stovers and T₇-Sugarcane bagasse). The experiment was laid in CRD with three replications in each treatment, for the analysis of data. LSD test at 5 % probability was applied to compare the differences among the treatments (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

1. Linear growth of different strains of *Pleurotus* species:

The growth of different strains of *Pleurotus* species on potato dextrose agar medium in 9 cm Petri-dishes at the interval of three, five and seven days (Fig.1) indicated that *P. florida* (strain PK 514) grew faster than all other strains with the colony diameter of 4.20 cm followed by *Pleurotus ostreatus* (strain PK412) with 3.53cm. A radial growth of 3.13cm was recorded in *Pleurotus ostreatus* (strain PK 409). However, an average growth of 1.96cm was recorded in case of *Pleurotus sajor-caju* (strain PK408) and *P. florida* (strain PK 514).

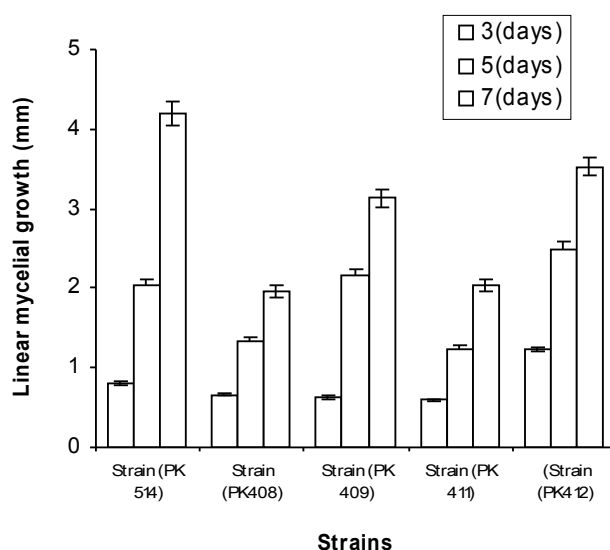


Figure 1. Linear mycelial growth of five strains of oyster mushroom on potato dextrose agar medium

Both liquid and semi-solid media are widely used in studies in studies on mycelial growth. Measurements of linear growth rates provide a basis for determining the suitable conditions for growth. Recording linear extension on agar media is often considered the simplest practical of measuring of fungal growth. This is mostly studies in Petri-dishes and the increase in colony diameter is recorded at suitable intervals (Ali, 1997). Such linear growth measurements are useful in screening procedures for comparing mushroom strains.

2. Spawn running of different strains of *Pleurotus* spp: The data pertaining to the completion of spawn running in various *Pleurotus* stains revealed significant differences among different *Pleurotus* species strains and substrates (Fig. 2) where *P. ostreatus* (strain PK412) took 6 days for the one fourth and 18 days for full spawn running *P. florida* (strain PK515) took 3 days for one forth and 15 days for full spawn running. On the *P. ostreatus* (strain PK 409) took 5-

6 days forth 14.3 days for full spawn running. While, *P. sajor-caju* (strain PK 411) took 5.50 days for one fourth, 11.33 days for half, 12.6 days for three fourth and 20.83 days for full spawn running.

It is concluded from the data that *Pleurotus ostreatus* (strain PK 409) is best of all six strains. Statistically *P. ostreatus* (strain PK 505) and *P. ostreatus* (strain PK412) behaved alike while their difference with other strains was significant. The mean difference of time taken by three strains to complete spawn running is significant. Leong (1980) reported that a fast growing strain of *Pleurotus florida* took 19-21 days for full spawn running on cotton waste when temperature held between $20 \pm 30^\circ\text{C}$.

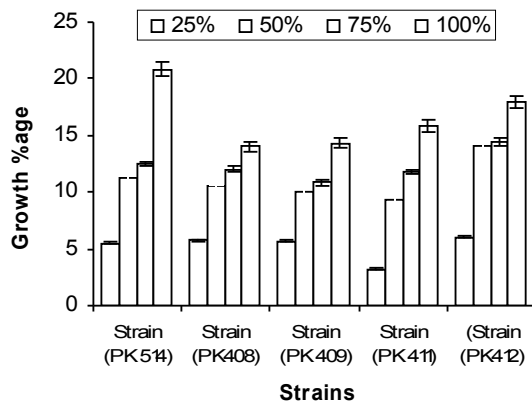


Figure 2. Spawn running of different strains of *Pleurotus* spp.

3. Time taken by various phases of oyster mushroom cultivation on various substrates:

Data regarding time taken for spawn running, pin head formation and fruiting bodies formation on different substrates is presented in Fig. 3. It was observed that average time taken for spawn running on cotton waste, wheat straw, paddy straw, corn cobs, corn stovers, sugarcane bagasse and straw was 16.50, 14.50, 18.75, 20.50, 12, 16 and 14 days, respectively.

After spawn inoculation average time taken by pin head formation and fruiting bodies formation on 100% cotton waste, 100% wheat straw, 100% paddy straw, 100% corn cobs, 100% Corn stovers, 100% sugarcane bagasse and 100% mungbean straw were 23.50, 21.50, 22.0, 27.50, 16.00, 21.00 and 17.00 days respectively. Similarly, average time taken by fruiting bodies formation in different substrates ranged between 18.00-27.50 days (Fig. 3). Tan (1981) got fruiting bodies after 23-26 days and Ramzan (1982) obtained pin head formation of five strains of *P. ostreatus* between 20-24 days on wheat and rice straw. Patra and Pani (1995) recorded 20-24 days on paddy straw. Similarly, Khanna and Garcha (1981) found a crop in 104 days on paddy straw.

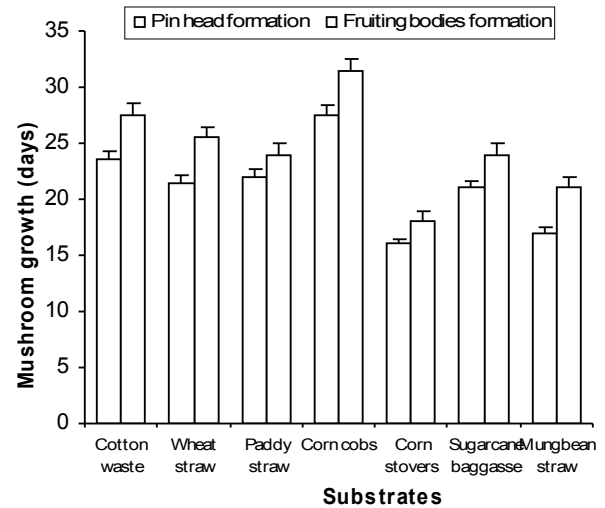


Figure 3. Time taken for pin head and fruiting bodies formation on *Pleurotus* cultivation on various substrates

4. Yield performance of oyster mushroom on various substrates:

Data regarding average yield of oyster mushroom strains was obtained in four flushes on different substrates is shown in Fig. 4. Highest yield (190, 150, 120 and 80) of oyster mushroom was recorded on cotton waste followed by paddy straw (160, 140, 120 and 80 g), wheat straw (170, 150, 120 and 40 g) while it was minimum (130, 110, 90 and 70 g) in case of corn stovers.

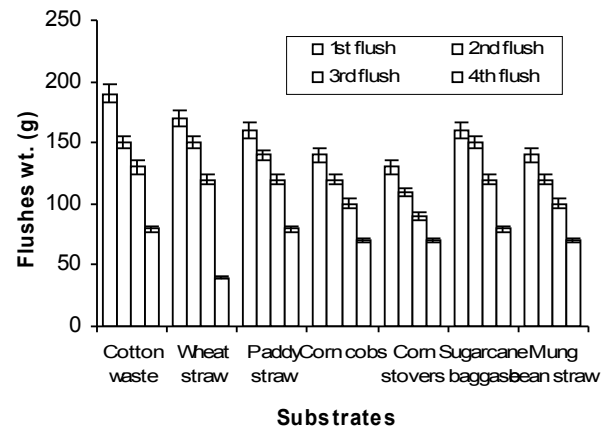


Figure 4. Yield performance of oyster mushroom on different substrates

These results revealed that using cotton waste is a better option to get higher yields. These results supports the findings of Jiskani *et al.* (1999), mushrooms can easily and successfully be cultivated on wheat, paddy, cotton waste, sugarcane bagasse etc. Our findings are in line with Manan

(2000) that highest yield (198.67 g) of oyster mushroom (*P. ostreatus*) was recorded on cotton waste gave the whereas wheat straw gave the mean yield 29.253 g. However paper waste gave no yield and paper waste + wheat straw gave the minimum yield of 58.95 g.

Keeping in view the importance of mushroom in Pakistan, cultivation of oyster mushroom on agricultural wastes and industrial waste products was conducted to study its performance for yield and yield parameters. Similarly, Zadrazil (1973) obtained the yield (weight as a percentage of the wet substrate) of 20.6% for first and 4.2% for the second flush. Zhang *et al.* 2002 got more mushroom yield on wheat straw as compared to rice. Das *et al.* (1987) used successfully a range of substrates including agricultural wastes such as wheat straw, maize straw and rice straw for the cultivation of two *Pleurotus* spp. The best average yield of 1650 gm of *Pleurotus flabellatus* and 1970 gm from *Pleurotus sajor-caju* was obtained from 3kg wheat straw using spawn multiplied on wheat straw.

From these results, it can be concluded that various substrates used like cotton waste, paddy straw and wheat straw, helped in bioconversion of these wastes by oyster mushroom. Maximum yield was obtained from cotton waste while it was on the lower side in case of corn stovers, whereas *Pleurotus ostreatus* (strain Pk 409) yielded more weight as compared to the other species. As far as species are concerned, *Pleurotus florida* yielded more weight as compared to the other species.

REFERENCES

- Ali. M.A., M.I. Mehmood, R. Nawaz, M.A. Hanif and R. Wasim. 2007. Influence of substrate pasteurization methods on the yield of oyster mushroom (*Pleurotus species*). Pak. J. Agri. Sci. 44: 300-303.
- Chang, S.T. 1999. World production of cultivated and medicinal mushrooms in 1997 with emphasis on *Lentinus edodes*. Intl. J. Medicinal Mushrooms. 1: 291-300.
- Chang, S.T. and Mshigeni, K.E. 2001. Mushroom and their human health: their growing significance as potent dietary supplements. The University of Namibia, Windhoek, Namibia.
- FAO. 2009-2010. FAO data base on agricultural production (FAO-STAT/prodSTAT/crops). Rome, Italy.
- Jiskani, M.M., M.A. Pathan and K.H. Wagan. 1999. Yield performance of oyster mushroom *Pleurotus florida* (strain PK, 401) on different substrates. Pak. J. Agric., Agric. Engg. Vet. Sci. 15: 26-9.
- Khan, S.M., A.G. Kausar and M.A. Alvi. 1981. Yield performance of different strains of oyster mushroom on paddy straw in Pakistan. Mush. Sci. 11: 657-678.
- Khan, S.M. and M.A. Ali. 1981. Cultivation of oyster mushroom (*Pleurotus* spp.) on cotton boll locules. Mush. Sci. 11: 691-5.
- Khan, S.M., A. Nawaz, W. Malik, N. Javed, T. Yasmin, M. Rehman, A. Qayyum, Q. Iqbal, T. Ahmad and A.A. Khan. 2011. Morphological and molecular characterization of Oyster mushroom (*Pleurotus spp.*) Afric. J. Biotech. 10: 2638-2643.
- Khan, S.M., N. Javed and S.M. Khan. 2005. Chemical control of mould of oyster mushroom. Pak. J. Phytopath. 17: 185-186.
- Khan, S.M., N. Javed, Z.H. Khan and S.M. Khan. 2006. Yield performance of oyster mushroom. Pak. J. Phytopath. 18: 89-93.
- Khanna, P. and H.C. Garcha. 1981. Studies on nutritional value of mushroom *Pleurotus florida*. Mush. Sci. 11: 561-572.
- Leong, P.C. 1980. Utilization of cotton waste substrate with temperature treatments for the cultivation of oyster mushroom (*Pleurotus*) in Singapore. Singapore J. Primary Indus. 8: 21-27.
- Manan, A.R. 2000. Cultivation of oyster mushroom on paper waste. M. Sc. Thesis. Deptt. Plant. Path. Univ. Agri. Faisalabad.
- Michael, H.W., G. Bultosa and L.M. Pant. 2011. Nutritional contents of three edible oyster mushrooms grown on two substrates at Haramaya, Ethiopia, and sensory properties of boiled mushroom and mushroom sauce. Intl. J. Food Sci. Technol. 46: 732-738.
- Panjabrao, M.V., P.S. Sopanrao, S.A. Ahmed and B.M.M. Vaseem. 2007. Bioconversion of low quality lignocellulosic agricultural waste into edible protein by *Pleurotus sajor-caju* (Fr.) Singer. J. Zhejiang Uni. Sci. 8: 745-751.
- Ramzan, M., 1982. Studies on the cultivation of oyster mushroom (*Pleurotus spp.*) in Faisalabad. M.Sc. Thesis, Deptt. Plant Pathology, Faculty of Agric., Uni. Agric. Faisalabad, Pakistan.
- Singh, R.P. 1981. Cultivation of *Pleurotus sajor-caju*. Fr. Mush. Sci. 11: 667-673.
- Steel, R.G.D and J.H. Torrie. 1984. Procedure of Statistics. p.172-177. McGraw Hill Book Int. Co. Singapore.
- Tan, K.K. 1981. Cotton waste is good substrate for the cultivation of *P. ostreatus* the oyster mushroom. Mush. Sci. 11:705-710.
- Zadrazil, F. 1973. Cultivation, yield and keeping quality of *P. florida* Fovo. Sci. Champignon 13:17-19.