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Comparative study on growth parameters and yield potential of five species of oyster mushroom

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Abstract
Oyster mushroom is the second most largely growing mushrooms and has the good demand in the market and world trade too. An experiment was carried out with five *Pleurotus* species *viz. P. sajor-caju, P. florida, P. flabellatus, P. eryngii and P. ostreatus* for growth behavior, sporophores parameter and yield potential. Minimum spawn run periods was observed from *P. florida i.e.* 16 days. Pin head initiation was also early in *P. florida* and took 20.33 days. The harvesting of 1st, 2nd, 3rd and 4th flushes was completed early on *P. florida* (27.33, 35.67, 4.67 and 55.33 days respectively). In growth parameters maximum number of fruiting body was observed highest in *P. florida* (101.33). Maximum weight of fruiting body was found in *P. florida i.e.* 25g. Minimum weight was observed in *P. ostreatus* (4.53g). In *P. eryngii* average length and average width of stalk was found highest (6.43 cm) and (2.40 cm). Average diameter of cap and total length were found maximum in *P. florida* (7.67 cm) and (12.02 cm) respectively. The studies of yield potential of five *Pleurotus* species were evaluated and *P. florida* was in better performance. Highest average yield of 1st, 2nd and 3rd flush was obtained from *P. florida* (408.67g, 301.33g and 211.67g) but the yield of 4th flush was higher in *P. ostreatus* (64.67g) while the total yield was also maximum for *P. florida* (982.33g). Biological efficiency was highest in *P. florida* (98.23%) followed by *P. sajor-caju*. This experiment will help to mushroom growers for selection of best oyster species for obtaining better growth behaviour and yield potential.

Keywords: *Pleurotus* species, growth parameters, biological efficiency, yield potential, sporophores parameters

Introduction
A mushroom is characterized as "a macro fungus with a distinctive fruiting body which can be either epigeous or hypogeous. The macro fungi have fruiting bodies sufficiently extensive to be seen with the unaided eye and to be gotten by hand" (Chang and Miles, 1989) [1]. Mushrooms are neither plants nor creatures. They were reclassified into the separate Kingdom of fungi in the 1960, so every mushroom is fungi. Mushrooms are a heterogenous group of fungi with members from both Basidiomycotina and Ascomycotina.

There are about 1.69 million fungi known to man, out of them 10,000 are macro fungi, 2,000 palatable, around 80 has been cultivated, 20 on business scale and 5-6 on industrial scale (Sharma and Suman, 2006) [2]. Today the mushrooms under cultivation incorporate temperate species like button mushroom, sub-tropical species like oyster and shiitake mushrooms and tropical species like paddy straw, milky and oyster mushroom. There are about 38 species described under the genus *Pleurotus* from different parts of the world and more than 25 species have been reported from India. Presently about 25 species are commercially cultivated in different parts of the world which include. *P. ostreatus, P. pulmonarius, P. flabellatus, P. florida, P. sajor-caju, P. cirtinopileatus, P. sapidus, P. cystidiosus, P. eryngii, P. djamore, P. australis, P. purpureo-olivaceus* and *P. populinus* etc. In contrast to other cultivated mushrooms, species of *Pleurotus* exhibit much diversity in their adaptability to varying agro-climatic conditions.

On the surface of our planet, around 200 billion tons per year of organic matter are produced through the photosynthetic process. In addition, huge amounts of agricultural wastes and industrial by-products are produced worldwide from farm practices and industrial food products, respectively. On the other hand, the majority of this organic matter is not directly edible by humans and animals and in many cases, disposed into the environment without any treatment. This leads to serious environmental pollution, though they are rich in organic compounds that are worthy of being recovered and transformed into value-added products. Thus, these days mushroom cultivation technology is being a promising candidate to fight food insecurity along with the reduction of environmental pollution apart from their nutritional and medicinal value they have (Beetz and Kustudia, 2004) [3].

Rather than other mushroom species, oyster mushroom is the easiest, quickest and least expensive to grow, require less preparation time and production technology. Bioconversion of lignocellulosic deposits through development of *Pleurotus* species offer the chance to utilize inexhaustible assets in the production of consumable, protein-rich nourishment that will sustain food security for peoples in developing countries (Sanchez *et al.*, 2002) [4]. Development of edible mushrooms is a standout amongst the most financially suitable procedures for the bioconversion of lignocellulosic wastes (Bano *et al.*, 1993: Cohen *et al.*, 2002) [5, 6].

The various species of *Pleurotus* normally grow within a temperature range from 15-25^{0}C and on various agricultural waste materials as substrate (Hasan *et al*., 2010) [7]. Although *Pleurotus* is leading mushroom in country most of the production relies on *P. sajor-caju* and is only confined in winter season. Still there is very negligible supply of oyster mushroom in summer season although the demand is increasing day by day. So, *P. florida*; a species of oyster mushroom growing easily in warmer condition may be the best substitute for the year round supply of Oyster mushroom supporting summer season. *P. florida* gives the highest yield at 30^{0}C and is preferred for summer season cultivation (Uddin *et al.*, 2010) [8]. *Pleurotus* spp. is one group of edible mushrooms cultivated commercially, which rank second worldwide (Royse *et al.*, 2017) [9]. The *P. florida* produces metabolites of medicinal and pharmacological interest, such as antimicrobials, immunostimulants, antioxidants and antitumourals (Elmastas *et al.*, 2007: Moradali *et al.*, 2007) [10, 11]. The substrate source, spawn quality, strain and compost affect the performance and growth of oyster mushroom (Jafarpour *et al.*, 2010) [12]. Various substrates such as wheat straw, rice straw and sawdust are used for oyster mushroom cultivation. The present study was undertaken to understand which oyster species was performing better in these conditions.

Material and methods

Mushroom culture

The Pure culture of Oyster mushroom viz., *P. sajor-caju*, *P. florida*, *P. ostreatus*, *P. flabellatus* and *P. eryngii* were obtained from Directorate of Mushroom Research Solan, (Himanchal Pradesh). These cultures were sub-cultured and maintained on PDA medium in BOD incubator at 25 ± 2ºC temperature for further investigation.

Mushroom spawn

Cleaned and healthy wheat grains were washed in clean water and boiled for 40 minutes or until they become soft. Excess water was drained off after boiling and the grains were cooled in plastic tray up to 60% moisture. These cooled grains were supplemented with 2% calcium carbonate and 2% calcium sulphate on dry weight basis of grains to avoid clumping of grains. These supplemented boiled wheat grains were filled (300g/ bottle) in clean 500ml saline bottle and polyethylene bags and plugged with non-absorbent cotton plugs. These wheat grain filled bottles/bags were sterilized in autoclave at 15 lb pressure (121˚C) for one hr. and then allowed to cool at room temperature for some time. These bottles were shaken at 4 days interval to allow proper spread of the mycelium between the grains. These bottles/bags were then completely colonized by mushroom mycelium in two weeks.

Preparation of substrate

For preparation of substrate, wheat straw was soaked in water for 18-20 hours and then excess water was drained off. The moist substrate was then sterilized by steaming under pressure inside an autoclave for 40 minutes at 15 lb pressure (121 ºC). After pasteurization substrate was taken out of the autoclave and allowed to cool down at room temperature.

Spawning

The mixing of spawn (mushroom seed) in the sterilized substrate is called spawning. For spawning, completely colonized fresh spawn were mixed thoroughly with the prepared substrate at a rate of 3-4% (w/w) on weight basis. The wheat straw substrate was mixed with spawn. Two kg spawned substrates were filled in polyethylene bags (40cm × 30cm) and mouth of each bag was bind with rubber band and 8-10 small holes (1 mm dia.) were made at 10 cm part from each other for aeration.

Cropping

The spawn bags were placed in dark growing chamber where temperature and relative humidity ranges between 20-25 ºC and 80-85% respectively. Spawned bags were kept vertically on a raised platform in cropping chamber for mycelia colonization of the substrate. After complete colonization of the mushroom bed, the polythene bags were cut off and removed and these blocks of compact substrate were arranged on the shelves. Humidity was maintained by sprinkling water on the floor and walls frequently. After completion of spawn running, pin heads were started appearing within one week and they became ready to harvest within another week.

Harvesting

Oyster mushrooms were harvested before spraying water. The right stage for picking can be judged by the shape and size of fruiting bodies. In young mushrooms, the edge of the cap is thick and the cap margin is enrolled, while the cap of mature mushrooms becomes flat and inward curling starts. It is advisable to harvest all the mushrooms at one time from a bag so that the next crop of mushrooms starts early. Fruiting bodies were harvested in about 4-5 days after their appearance. Picking was done by twisting the mushroom gently so that it was pulled out without leaving any stub, and also the surrounding fruiting bodies were not disturbed. Mushroom fruiting was continued after harvesting first, second and so on. After harvesting, lower parts of the stalks/stipes with adhering debris should be cut using a knife. Fresh mushroom was harvested four times at appropriate intervals.

Observation and measurement

The following parameters were observed and measured during this investigation-

Growth behaviour (in days)

1. Spawn run period
2. Initiation of pinhead
3. First harvesting
4. Second harvesting
5. Third harvesting
6. Fourth harvesting

Sporophores parameters

1) Total no. of fruiting bodies
2) Maximum weight of fruit bodies (g)
3) Minimum weight of fruit bodies (g)
4) Average length of stalk (cm)
5) Average width of stalk (cm)

6) Average diameter of mushroom cap (cm)
7) Total length of mushroom (cm)

Yield potential
1. Yield of first flush (g)
2. Yield of second flush (g)
3. Yield of third flush (g)
4. Yield of fourth flush (g)
5. Total yield (g)
6. Biological efficiency (%)

The biological efficiency (BE) was calculated by given formula (Chang *et al.,* 1981) [13]

$$\text{Biological efficiency (BE)} = \frac{\text{fresh weight of mushrooms}}{\text{dry weight of the substrate}} \text{x } 100$$

Results
The field experiment was conducted during 2016-17 for observation of growth behavior and yield potential of five *Pleurotus* species *viz*: *P. sajor-caju, P. florida, P. flabellatus, P. eryngii* and *P. ostreatus*.

A) Growth behavior of *Pleurotus* species
The growth behavior of fruiting bodies like spawn run period, pin head initiation, days for first harvesting, second harvesting, third harvesting and fourth harvesting were recorded and results were shown in Table 1.

Spawn run period
Number of days for the completion of spawn running was found significantly different on different species of oyster mushroom. Results revealed that the growth period of five *Pleurotus* species (*P. sajor-caju, P. florida, P. flabellatus, P. eryngii* and *P. ostreatus*) was ranged between 16.0 to 20.33 days. Results showed that spawn run of *P. florida* was found very fast, where it took 16.00 days. The mushroom bags of other oyster mushroom *P. sajor-caju*, *P. ostreatus*, *P. flabellatus* and *P. eryngii* were completely colonized in 17.33 days, 18.67 days, 19.67 days and 20.33 day respectively. Slowest growth of spawn run was found in *P. eryngii i.e.* 20.33 days.

Initiation of pin head
Time required for initiation of pin head in all oyster species was ranged between 20.33-25.33 days. Data presented in the table showed that the mushroom pin head was first initiated in *P. florida* in 20.33 days while in *P. sajor-caju*, pin head was initiated in 22.33 days, followed by *P. ostreatus* 23.67 days, *P. flabellatus* 23.00 days, *P. eryngii* 25.33 days. *P. eryngii* had taken maximum time *i.e.* 25.33 days for initiation of pin head (Table 1).

Harvesting of flushes and total crop period
In oyster mushroom four flushes were harvested during a crop period. The result in respect to harvesting of first flush was ranged between 25.67 to 29.00 days. *P. florida* took minimum time 25.67 days for first flush as compared to other oyster species *P. sajor-caju* (27.33 days), *P. ostreatus* (28.33 days), *P. flabellatus* (28.67 days), *P. eryngii* (29.00 days). After harvesting of first flush, the second flush took 35.67 to 39.67 days' time for harvesting. *P. florida* was early harvested in 35.67 days on wheat straw, while *P. flabellatus* was late harvested in 39.67 days. The data pertaining to the harvesting of third flush showed that *P. florida* took minimum time 44.67 days and maximum time was taken by *P. eryngii* (48.00 days). In fourth flush maximum time (59.33 days) was taken by *P. eryngii*. Minimum cropping period was recorded in *P. florida* where it took 55.33 days followed by *P. sajor-caju* (57.00 days).

Table 1: Comparison of different species of *Pleurotus* for growth behavior

***Pleurotus* species**	**Mushroom growth period recorded in days after spawning**					
	Spawn run period	**Pinhead initiation**	**1st harvesting**	**2nd harvesting**	**3rd harvesting**	**4th harvesting**
P. florida	16.00±1.00^{d}	20.33±0.58^{c}	25.67±0.58^{c}	37.33±0.58^{bc}	44.67±1.15^{c}	55.33±1.15^{c}
P. sajor-caju	17.33±0.58^{c}	22.33±0.58^{b}	27.33±0.58^{b}	35.67±1.53^{c}	45.33±0.58^{bc}	57.00±1.00^{bc}
P. ostreatus	18.67±0.58^{b}	23.67±1.15^{b}	28.33±0.58^{ab}	38.67±1.15^{ab}	46.67±0.58^{ab}	58.00±1.73^{ab}
P. flabellatus	19.67±0.58^{ab}	23.00±1.00^{b}	28.67±1.15^{ab}	39.67±0.58^{a}	47.00±1.00^{a}	58.33±0.58^{ab}
P. eryngii	20.33±0.58^{a}	25.33±0.58^{a}	29.00±1.00^{a}	38.67±1.15^{ab}	48.00±1.00^{a}	59.33±0.58^{a}

Values are expressed as means ± standard deviation of three replications

Values with different small letters in the same column are significantly different at the level of 0.05.

B) Comparative study on growth parameters of five *Pleurotus* species
Total number of fruiting body
Number of fruiting body was found significant among different oyster mushroom. Maximum number of fruiting bodies were obtained in *P. florida* (101.33) followed by *P. sajor-caju* (95.67), *P. ostreatus* (90.67), *P. flabellatus* (85.67) respectively. While minimum number of fruiting body was observed in *P. eryngii* (82.67). Yield of mushroom was mainly dependent on number of fruit bodies and yields were further declined where decline in the number of fruit bodies (Table: 2).

Maximum and minimum weight of fruiting body
The result indicated that the highest weight of fruiting body was produced by *P. florida* (25.00g) followed by *P. sajor-caju* (21.10g), *P. eryngii* (18.83g), *P. ostreatus* (18.73g) and *P. flabellatus* (16.77g) respectively. Minimum weight of fruiting body was observed in *P. ostreatus* (4.53g) followed by *P. eryngii* (4.57g) and *P. flabellatus* (5.10g). Weight of fruiting body was depending on size of sporophores of mushrooms.

Average length of stalk
Average length of stalk was observed maximum in *P. eryngii* (6.43 cm) followed by *P. florida* (6.30 cm), *P. ostreatus* (5.94 cm), *P. sajor-caju* (5.71 cm). Minimum length of stalk was found in *P. flabellatus* (5.05 cm).

Table 2: Comparison of different species of *Pleurotus* for growth parameter

Pleurotus species	Total number of fruiting body	Maximum weight of fruiting body (g)	Minimum weight of fruiting body (g)	Average Length of stalk (cm)	Average Width of stalk (cm)	Average Diameter of mushroom cap (cm)	Total length of mushroom (cm)
P. florida	101.33±3.51^{a}	25.33±1.53^{a}	6.43±0.47^{a}	6.30±0.20^{a}	2.34±0.16^{ab}	7.67±0.50^{a}	12.02±0.21^{a}
P. sajor-caju	95.67±2.08^{b}	21.10±1.65^{b}	6.93±0.81^{a}	5.71±0.10^{b}	1.99±0.12^{c}	7.30±0.46^{a}	10.08±0.63^{a}
P. ostreatus	90.67±2.08^{c}	18.73±1.34^{c}	4.53±0.25^{b}	5.94±0.16^{ab}	2.06±0.19^{bc}	5.97±0.68^{b}	9.98±1.09^{b}
P. flabellatus	85.67±3.06^{d}	16.77±0.67^{c}	5.10±0.56^{b}	5.05±0.23^{c}	1.86±0.12^{c}	5.77±0.61^{b}	9.35±1.18^{b}
P. eryngii	82.67±0.53^{d}	18.83±0.76^{bc}	4.57±0.35^{b}	6.43±0.55^{a}	2.40±0.17^{a}	5.23±0.45^{b}	10.01±0.32^{b}

Values are expressed as means ± standard deviation of three replications

Values with different small letters in the same column are significantly different at the level of 0.05.

Average width of stalk

The average width of the stalk was highest in *P. eryngii* (2.40 cm), followed by *P. florida* (2.24 cm). Minimum width of stalk was found in *P. flabellatus* (1.86 cm). In remaining oyster mushroom width of stalk was observed as *P. sajor-caju* (2.01 cm), *P. ostreatus* (1.94 cm).

Average diameter of the mushroom cap

A significant result was recorded in different *Pleurotus* species for average diameter of mushroom cap. Result indicated from the table: 2 showed that the maximum diameter of mushroom cap was recorded from *P. florida* (7.67 cm) followed by *P. sajor-caju* (7.30 cm), *P. ostreatus* (5.97 cm), *P. flabellatus* (5.77 cm). Minimum diameter of cap was recorded in *P. eryngii* (5.23 cm).

Total length of mushroom

Significant result was observed among different species of oyster mushroom for total length of mushroom. Total length of fruiting body was measured that included both length of stalk and length of mushroom cap. The result showed that the maximum length of fruiting body was recorded in *P. florida* (12.02 cm), followed by other species like *P. sajor-caju* (10.08 cm), *P. ostreatus* (9.98 cm), *P. eryngii* (9.35 cm). Minimum length of mushroom was recorded in *P. flabellatus* (9.37 cm).

C) Yield potential of mushroom

There was a significant result obtained for the yield pattern of different species of oyster mushrooms. Total four flushes were harvested during the trial and observation of the yield was recorded in each flush. Mushroom yield was calculated by using fresh weight. A continuous reduction in yield was recorded during harvest of next flush. The maximum yield of oyster mushroom in first flush was obtained from *P. florida* (408.67g) while minimum yield was recorded in *P. eryngii* (342.33g). Similarly in the second flush, highest yield was obtained in *P. florida* (301.33g) whereas lowest yield was recorded in *P. flabellatus* (252g). Table: 3 showed that in the third flush maximum yield was recorded in *P. florida* (211.67g) followed by *P. sajor-caju* (194.67g), *P. flabellatus* (177.33g) and *P. ostreatus* (165.33g). In the fourth flush maximum yield was obtained from *P. ostreatus* (64.67g) and minimum yield was recorded in *P. flabellatus* (47.33g). *P. florida* was better in performance, yielded 982.33 g/kg of dry wheat straw substrate. *P. sajor-caju* was found second in production with 920.33g followed by *P. ostreatus* (877.67g) and *P. flabellatus* (844.67g). Least yield 828.33g was acquired from *P. eryngii*.

Biological efficiency was recorded for different species of oyster mushroom. The highest biological efficiency was recorded from *P. florida* (98.23%) pursued by *P. sajor-caju* (92.03%), *P. ostreatus* (87.77%) and *P. flabellatus* (84.47%). Minimum biological efficiency was recorded in *P. eryngii* (82.33%).

Table 3: Comparison of different species of *Pleurotus* for yield potential

Pleurotus species	1st flush (g)	2nd flush (g)	3rd flush (g)	4th flush (g)	Total yield (g)	Biological efficiency (%)
P. florida	408.67±4.16^{a}	301.33±3.51^{a}	211.67±3.06^{a}	60.67±3.06^{a}	982.33±10.02^{a}	98.23
P. sajor-caju	381.67±4.04^{b}	282.00±1.73^{b}	194.67±3.51^{b}	62.00±3.00^{a}	920.33±8.74^{b}	92.03
P. ostreatus	374.67±3.06^{c}	273.00±5.29^{c}	165.33±3.51^{d}	64.67±3.51^{a}	877.67±5.03^{c}	87.77
P. flabellatus	368.00±1.00^{d}	252.00±3.61^{c}	177.33±3.21^{c}	47.33±3.21^{b}	844.67±5.03^{d}	84.47
P. eryngii	342.33±3.06^{e}	266.67±2.52^{d}	163.00±8.00^{d}	51.33±2.52^{b}	823.33±9.50^{e}	82.33

Values are expressed as means ± standard deviation of three replications

Values with different small letters in the same column are significantly different at the level of 0.05.

Discussion

Presented study showed that the spawn run was very fast in *P. florida* as compared to other species and in *P. eryngii* had taken maximum time for spawn run. Similarly in *P. florida* pin head formation and harvesting period was earlier as compared to other species. Biological efficiency and total number of fruiting body was also highest in *P. florida*. Similarly sporophores parameters and yield was also highest in *P. florida.*

Our finding was confirmed by Holkar and Chandra (2016) [14], who compared five *Pleurotus* species in perspective of actual time required for every development stage viz., spawn run period, number of days required for beginning of pin heads of sporophores, average weight of fruiting bodies in the entire harvesting and overall yield. *Pleurotus florida* require less time for spawn run and initiation of pin head than other oyster mushrooms have also been reported by Zape *et al.,* (2006) [15]. Results found by Vyas *et al.,* (2003) [16] have also similar in view that wheat straw gives the spawn run period of 17 days and first harvest time of 27 days. Jiskani *et al.,* (2003) [17] have found that pin head formation time and fruiting body maturation time of *Pleurotus florida* was earlier.

The present piece of work concluded that the oyster mushroom *Pleurotus florida* showed best performance among all the five species for growth behaviour, sporophores parameters and yield potential and it might be recommended for mushroom growers in Varanasi region of Uttar Pradesh.

References

1. Chang ST, Miles PG. Edible mushroom and their cultivation. Florida, CRC Press. 1989, 345.
2. Sharma UP, Suman BC. Disease and pest of mushrooms. Agrobios. Jodhpur, 2006.
3. Beteez A, Kustudia M. Mushroom Cultivation and Marketing Horticulture Production. Guide. Abstract: ATTRA Publication. 2004, 1-25.
4. Sanchez JE, Huerta G, Montiel E. Mushroom biology and mushroom products. In Proceedings of the Fourth International Conference. Universidad Autónoma del Estado de Morelos. México, 2002.
5. Bano Z, Shashirekha MN, Rajarathnam S. Improvement of the bioconversion and biotransformation efficiencies of the oyster mushroom (*Pleurotus sajor-caju*) by supplementation of its rice straw substrate with oil seed cakes. Enzyme and Microbial Technology. 1993; 15(11):985-989.
6. Cohen R, Persky L, Hadar Y. Biotechnological applications and potential of wood-degrading mushrooms of the genus *Pleurotus*. Applied microbiology and biotechnology. 2002; 58(5):582-594.
7. Hasan MN, Rahman MS, Nigar S, Bhuiyan MZ, Ara N. Performance of oyster mushroom (*Pleurotus ostreatus*) on different pretreated substrates. Int. J Sustain. Crop Prod. 2010; 5(4):16-24.
8. Uddin MN, Yesmin S, Khan MA, Tania M, Moonmoon M, Ahmed S. Production of oyster mushrooms in different seasonal conditions of Bangladesh. Journal of Scientific Research. 2011; 3(1):161-161.
9. Royse DJ, Baars J, Tan Q. Current overview of mushroom production in the world. Edible and medicinal mushrooms: technology and applications. 2017; 5:5-13.
10. Elmastas M, Isildak O, Turkekul I, Temur N. Determination of antioxidant activity and anti-oxidant compounds in wild edible mushrooms. J Food Compos Anal. 2007; 20:337-345.
11. Moradali MF, Mostafavi H, Ghods S, Hedjaroude GA. Immunomodulating and anticancer agents in the realm of *Macromycetes fungi* (macrofungi). International immunopharmacology. 2007; 7(6):701-24.
12. Jafarpour M, Jalali A, Dehdashtizadeh B, Eghbalsaied S. Evaluation of agricultural wastes and food supplements usage on growth characteristics of *Pleurotus ostreatus*. African Journal of Agricultural Research. 2010; 5(23):3291-3296.
13. Chang ST, Lau OW, Cho KY. The cultivation and nutritional value of *Pleurotus sajor-caju.* European Journal of Applied Microbiology and Biotechnology. 1981; 12:58-62.
14. Holkar KS, Chandra Ram. Comparative evaluation of five *Pleurotus* species for their growth behaviour and yield performance using wheat straw as substrates. Journal of Environmental biology. 2016; 37(1):7-12.
15. Zape AS, Thakur MP, Bainade PS, Nichal SS. Analysis of major chemical constituents and yield of three different species of *Pleurotus* on wheat straw. Journal of Plant Disease Sciences. 2006; 1(2):171-172.
16. Vyas NL, Singh M, Joshi SP. Evaluation of locally available plant materials for production of oyster mushroom (*Pleurotus florida*) in arid region of India. Journal of Eco-Physiology. 2003; 6(1, 2):41-43.
17. Jiskani MM, Pathan MA, Wagan KH. Evaluation of different cereal straw for early and high yielding crop of oyster mushroom, *Pleurotus florida*. Mycopathology. 2003; 1(2):125-128.