JOURNAL OF PURE AND APPLIED MICROBIOLOGY, Dec. 2016. Vol. **10**(4), p. 2783-2792

Evaluation of Various Agro-Wastes for Production of *Pleurotus* spp. (*P. florida, P. sajor-caju* and *P. eous)*

Tarun Kumar Jatwa, K.T. Apet, S.S. Wagh, K.S. Sayyed, K.B. Rudrappa and S.P. Sornapriya

Department of Plant Pathology, V.N.M.K.V., Dist. Parbhani, India

http://dx.doi.org/10.22207/JPAM.10.4.37

(Received: 10 August 2016; accepted: 19 September 2016)

***P. florida, P. eous* and *P. sajor-caju* was cultivated on different agro-wastes viz. paddy straw, wheat straw, sorghum straw, soybean straw, paddy + wheat straw (1:1), paddy + sorghum straw (1:1), paddy + soybean (1:1), wheat + soybean straw (1:1), wheat + soybean straw (1:1) and soybean + sorghum straw (1:1) to determine the effect of these agro waste on yield, growth and biological efficiency. Paddy straw showed significantly highest yield of 1248.3, 1348.7 and 1275.7 g/1.5 kg of dry substrate of *P. florida, P. eous* and *P. sajor-caju* respectively and biological efficiency of 83.22 %, 89.90 % and 84.99 % with minimum days for spwan run completion, pinhead initiation, development of mature fruiting bodies of *P. florida* (14, 15 and 15 days), *P. eous* (18, 19 and 19 days) and *P. sajor-caju* (21, 24 and 23 days) respectively.**

Keywords: Waste, Agro-wastes, straw, biological efficiency.

Oyster mushroom (i.e. *Pleurotus spp*.) is commonly called as Dhingri in India because of its oyster like shape. *Pleurotus* is an efficient lignin degrading mushroom and can grow well on different types of lignocellulolosic materials. Different species of *Pleurotus* can grow well in variable temperature conditions; hence they are ideally suited for cultivation throughout the year in various regions of tropical country like India (Ahmed *et al.*, 2009). For many reasons the fungi of the *Pleurotus* genus have been intensively studied in many different parts of the world; they have high gastronomic value. They are able to colonize and degrade a large variety of lignocellulosic residues, they require shorter growth time when compared to other edible mushrooms, they demand few environmental controls, their fruiting bodies are not very often attacked by diseases and pests and they can be cultivated in a simple and cheap way (Patrabansh and Madan, 1997).

An attractive feature of oyster mushrooms is that they can utilize a large variety of agricultural waste products and transform the lignocelluloses biomass in to high quality food, flavor and nutritive value (Quimio, 1978; Bano and Rajarathanam, 1982; Jain and Vyas, 2003).

Oyster mushroom posses the appropriate enzymatic mechanism for the transformation of complex organic macromolecules into simple compounds have been exploited as the means for biodegradation of a wide range of plant litter due to their particular ability for selective delignification (Mayson & Verachtert, 1991; Martinez *et al.*, 1994). Most agricultural residues are rich in lignocelluloses compounds whose handling and disposal often problematic. Wheat straw, Soybean straw, Paddy straw and Sugarcane bagasses are the substrates of interest, Since they are produced in large

* To whom all correspondence should be addressed.
E-mail: tarunjatwa@gmail.com

quantities and rich in cellulose and lignin. The potential of bioconversion of lignocelluloses waste into value added products is emphasized in earlier studies (Philippoussis & Zervakis 2000; Poppe, 2000).

Mushrooms are consumed for their deliciousness and nutritive value. Mushrooms are excellent as a food as they provide a full protein diet containing twenty one amino acids besides vitamins and minerals. Being easily digestible (70-90%), mushroom protein is considered superior to vegetable proteins. Several mushrooms have been screened for their bio active properties and many compounds such as polysaccharides mainly ^{2}-D glucan, heteroglycans, hexose correlated compounds, pachymanans, proteioglycans, terpenoides such as ganoderic acid, ganoderol, ganodermic acid and compounds like germanium and ergosterol have been isolated and commercialized (Hobbs, 1996; Wani *et. al*., 2010).

The commercial cultivation of various *Pleurotus* species including *P. sajar-caju, P. eous, P. florida, P. flabellatus, P. ostreatus* etc. *Pleurotus florida* is white oyster mushroom it is white in colour from primordial / pin head formation to maturity. The pileus of this mushroom with thin margin, smooth and pileus thickness is lesser as compares to *P. ostreatus* and *P. sajor-caju*. The mushroom looks like a white disc, growing on a thick stipe with decurrent gills extending to the base of the stipe. This mushroom grew excellently at 18-22 °C temperature range but can grow up to 28°C.

Various *Pleurotus* species have been shown to possess a number of medicinal properties, such as antitumor, immunomodulatory, antigenotoxic, antioxidant, anti-inflammatory, hypochloesterolaemic, antihypertensive, antiviral and antimicrobial activity (Gregori *et al*, 2007).

The present investigation of mushroom cultivation planned with the following objective to evaluate bio-efficacy of various agro-wastes as sole and in combination i.e. paddy straw, wheat straw, sorghum straw, soybean straw, paddy + wheat straw (1:1), paddy + sorghum straw (1:1), paddy + soybean (1:1), wheat + soybean straw (1:1), wheat + soybean straw (1:1) and soybean + sorghum straw (1:1) for production of *P. florida, P. eous, and P. sajor- caju.*

MATERIALS AND METHODS

Prepartion of pure culture of *P. florida, P. sajor-caju* and *P. eous.*

Matured pileus/cap of *P. florida, P. sajor-caju* and *P. eous* was placed in the sterile glass petriplats (90 mm) lined with dark black coloured drawing sheet paper, facing gills underside covered with lid and kept as such for a over night. Next day morning abundant white coloured circular spore print on paper sheet was obtained. From this spore prints, spores were gently lifted with the wire loop and transfered on autoclaved and cooled PDA medium in glass petriplates under Laminar air flow cabinet. These plates were then incubated at 20^{0}C in an incubator. After a week of incubation, profused whitish, cottony growth was developed. From these plates, pure culture of *P. florida, P. sajor-caju* and *P. eous* were preapred on PDA slants in glass test tubes and preserved in refrigrator.

Prepartion of master spawn

Aperantly healthy, unbroken and clean wheat/bajra grains were paraboiled in clean water (1:1 w/v). After boiling, excess water was drained of by spreading the grains on wire mesh/sieve. Then these were spread on surface steralized (4% formalin) polythene sheet to which calcium sulphate @ 2% and calcium carbonate @ 5% were mixed on dry weight basis. These grains were filled in glass conical flasks (200 g/flask), plugged with non-absorbant cotton and then steralized in autoclave at 15 Lbs pressure for 20 min, for two consecutive days. After steralization, the flasks were transfered to Laminar-Air-Flow Cabinet, allowed to cool at room temperature and inoculate with 4-5 mycelial discs (5mm) of pure cultures of *P. florida, P. sajor-caju* and *P. eous* and incubated at 20^{0} C. These flasks were shaken intermittently to faciliate through spreading on the mushroom mycelium on the grains. After three weeks of incubation, the grains in flasks were fully covered with the mycelium of *P. florida, P. sajor-caju* and *P. eous*. Thus the master spawn was prepared.

Prepartion of commercial spawn

Commercial spawn was prepared using 250-300 guage polypropylene bags 8 x 12 inch^{2} wheat/bajra grains are paraboiled, amended with Calcium sulphate and Calcium carbonate as detailed under 3:3:2 filled in polypropylene bags (200 g/bag), closed the openings of bags using

PVC pipe (2.5cm dia.) piece and plugged the pipes with non absorbant cotton and autoclaved at 15 Lbs pressure for 20 minutes. The autoclaving was done for two consecutive days. Later these bags were shifted to Laminar-Air-Flow Cabinet, allowed cool at room temperature and inoculted with a sponful of master spawn and incubated with at 20° C temperature. The bags were shaken intermittently to facilate through spread of mushroom mycelium. During incubation of the bags were regularly examined for mould infestation if any and contaminated bags were immadiately discarded to avoid build up of contamination in the vicinity. Within 18-20 days of incubation, mushroom mycelium was fully covered on the grains surface and thus the commercial spawns of *P. florida*, *P. sajor-caju* and *P. eous* were preapred . These commercial spawn bags were stored in refrigrator and used for spawning the substrates.

Evaluation of agro-wastes

Standard polythene bag method of *Pleurotus* spp. mushroom cultivation (Zakia *et al*. 1979).

Substrate preparation

Physical sterilization of straws

The following substrates are used to cultivation i.e. paddy straw, wheat straw, sorghum straw, soybean straw, paddy + wheat straw (1:1), paddy + sorghum straw (1:1), paddy + soybean (1:1), wheat + soybean straw (1:1), wheat + soybean straw (1:1) and soybean + sorghum straw (1:1). The dry straws substrates were chopped to small pieces (3-5 cm long). The chopped substrate were weighed and then soaked in cold water for 12 hours. After soaking substrates were be taken out and excess of water drained off. After draining excess of water these straws were weighed. These straws were then sterilized in autoclave at 20 Ibs psi for 20 minutes. After autoclaving the straws were cooled down to ambient temperature and used for filling the polythene bags.

Cultivation steps

The polypropylene bags of the size 35 × 55 cm^2 (100 gauge thickness) will be sterilized by dipping in 2 % formalin prior to use and lower corners of the bags was tied with the string so that the bed assumes a round shape after filling the straw and were filled with sterilized substrates and multilayered spawning @ 2 percent of wet weight of the substrate. The bags was filled up to their 90 percent capacity and mouths will be closed tightly with threads with the help of sterilized needle, about 20-25 minute holes all round the filled bags was made.

A spawned substrate bag was kept in mushroom house where the temperature and humidity were maintained around 20-25ÚC and 80-90 %, respectively with sufficient light and ventilation for 20 days. After completion of spawn run the bags were removed by cutting longitudinally with sharp blade and these beds was kept on bamboo racks/platform at 15-18ÚC temperature and 80-90 % relative humidity for cropping. Pinhead initiation was evident within 3-4 days after removal of poly bags. The beds were maintained up to the harvest of the third flush, which was completed in 35-40 days after sowing. A small layer of substrate was scrapped off from all the side of the beds after each harvest.

RESULTS AND DISCUSSION

Evaluation of various agro-wastes for production of *P. florida, P. eous and P. sajor caju*.The experiment on productivity were carried out to study the effect of different substrates i.e. paddy straw, wheat straw, sorghum straw, soybean straw, paddy + wheat straw (1:1), paddy + sorghum straw (1:1), paddy + soybean (1:1), wheat + soybean straw (1:1), wheat + soybean straw (1:1) and soybean + sorghum straw (1:1) on number of day required for completion of spawn run, number of days required for pinhead intiation, number of days required for development of matured fruiting bodied, number of pinhead, number of matured fruiting bodies, diameter of stipe, pileus diameter, yield, moisture content, dry weight and biological efficiency of *P. florida, P. eous* and *P. sajor-caju.*

Days required for completion spawn run, pinhead initiation and matured fruiting bodies

The data on average number of days required for completion of spawn run, pinhead initiation and matured fruiting bodies of *P. florida, P. eous* and *P. sajor-caju* in the table 1, 2 nad 3. The analyzed of variance indicated that the treatments significantly affected the number of days required for completion of spwan run of *P. florida, P. eous* and *P. sajor-caju* . It was observed that treatment T_1 (100 % Paddy straw) required minimum days (14, 15 and15 days) to complete spawn run followed

Table 1. Effect of various substrates on vegetative and reproductive growth of *P. florida*, *P. eous* and *P. sajor-caju*

Tr. No.	Treatments	Days required* SpawnRun			PinheadInitiation			MFB		
		P. florida	*P. sajor-caju*	*P. eous*	*P. florida*	*P. sajor-caju*	*P. eous*	*P. florida*	*P. sajor-caju*	*P. eous*
T_1	Paddy straw	14	15	15	18	18	19	21	23	24
T_2	Wheat straw	16	16	16	20	19	20	23	24	25
T_3	Soybean straw	18	19	18	22	22	22	24	27	27
T_4	Sorghum straw	19	20	22	20	23	26	23	28	31
T_5	Paddy + Wheat straw	16	18	17	21	21	21	28	26	26
T_6	Paddy + Soybean straw (1:1)	17	19	19	24	22	23	27	28	28
T_7	Paddy + Sorghum straw (1:1)	21	21	23	25	24	27	28	29	32
T_8	Wheat + Soybean straw (1:1)	17	24	21	22	27	24	26	32	30
T_9	Wheat +Sorghum straw (1:1)	20	23	24	24	27	29	27	31	34
T_{10}	Soybean + Sorghum straw (1:1)	19	20	26	23	24	30	26	30	35

Table 2. Effect of various substrates on number of pinhead, matured fruiting bodies, size of pileus diameter and stipe diameter of *P. florida*, *P. eous* and *P. sajor-caju*

Tr. No.	Treatments	Av. Number of pinhead			Av. Number of matured fruiting bodies			Av. Size* of pileus Dia. (cm^2)			Av. Size* of stipe Dia. (cm^2)		
		P.florida	*P.eous*	*P.sajor -caju*	*P.florida*	*P.eous*	*P.sajor -caju*	*P.florida*	*P.eous*	*P.sajor -caju*	*P.florida*	*P.eous*	*P.sajor -caju*
T_1	Paddy straw	140.33	142.67	147.33	116.33	121.33	118.67	9.66	12.00	12.00	3.66	4.00	4.33
T_2	Wheat straw	138.67	134.67	140.33	108.67	120.00	117.67	9.00	10.00	10.00	3.00	3.66	4.00
T_3	Soybean straw	135.33	136.67	137.00	105.00	112.33	117.67	9.33	8.33	9.33	2.66	3.33	3.66
T_4	Sorghum straw	132.00	127.67	132.00	104.67	108.67	105.67	6.00	8.00	7.33	2.00	2.33	3.33
T_5	Paddy + Wheat straw	139.67	141.33	140.33	115.33	118.00	117.33	6.66	11.33	11.33	3.33	3.66	4.00
T_6	Paddy + Soybean straw (1:1)	127.33	125.67	139.00	102.00	103.00	103.00	4.66	6.00	6.66	2.33	2.66	2.33
T_7	Paddy + Sorghum straw (1:1)	123.33	139.00	130.67	96.33	99.00	99.00	3.66	6.00	7.00	1.33	2.33	1.33
T_8	Wheat + Soybean straw (1:1)	117.33	131.00	123.67	96.67	95.33	95.67	4.33	4.33	7.33	2.66	1.66	1.66
T_9	Wheat +Sorghum straw (1:1)	121.33	121.33	125.67	95.33	96.66	92.66	3.66	2.33	4.00	1.00	2.00	1.66
T_{10}	Soybean + Sorghum straw (1:1)	120.67	122.67	121.67	98.66	92.66	92.33	4.00	6.33	5.00	1.66	1.66	2.00

Table 3. Effect of various substrates on yield, dry weight, moisture content and biological efficiency (BE) of *P.florida, P. eous* and *P. sajor-caju*

Tr. No.	Treatments	Yield (g/bed)*			Dry weight (g)*			Moisture* (%)			B.E. (%)		
		P.florida	*P.eous*	*P.sajor -caju*	*P.florida*	*P.eous*	*P.sajor -caju*	*P.florida*	*P.eous*	*P.sajor -caju*	*P.florida*	*P.eous*	*P.sajor -caju*
T_1	Paddy straw	1248.3	1348.7	1275.0	118.80	120.85	122.66	89.82 (71.49)**	90.95 (72.49)	90.35 (71.90)	83.22 (65.81)	89.90 (71.46)	84.99 (67.20)
T_2	Wheat straw	1167.7	1307.0	1114.3	123.83	139.22	112.81	88.54 (70.21)	89.21 (70.82)	89.84 (71.41)	77.84 (61.91)	87.13 (68.97)	74.28 (59.52)
T_3	Soybean straw	991.00	1061.0	1053.3	110.11‘	108.88	120.3	88.65 (70.30)	89.72 (71.29)	89.33 (70.93)	64.04 (53.15)	70.73 (57.24)	70.22 (56.92)
T_4	Sorghum straw	881.33	1009.7	1036.3	102.92	97.18	114.14	88.29 (69.98)	90.69 (72.23)	88.94 (70.57)	58.75 (50.03)	67.31 (55.12)	69.08 (56.21)
T_5	Paddy + Wheat straw	1235.0	1275.0	1229.0	125.22	125.6	118.5	89.99 (71.55)	90.11 (71.67)	90.33 (71.88)	82.33 (65.14)	84.99 (67.20)	81.93 (64.84)
T_6	Paddy + Soybean straw (1:1)	836.33	1094.0	1001.3	89.92	118.55	108.29	88.64 (70.30)	89.11 (70.73)	89.18 (70.79)	55.75 (48.30)	72.93 (58.64)	66.75 (54.78)
T_7	Paddy + Sorghum straw (1:1)	877.00	871.00	880.33	91.44	90.77	91.84	89.65 (71.23)	89.53 (71.12)	89.56 (71.14)	58.46 (49.87)	58.06 (49.63)	58.68 (49.99)
T_8	Wheat + Soybean straw (1:1)	795.00	856.00	806.67	89.33	93.11	80.55	90.02 (71.58)	89.10 (70.72)	90.19 (71.74)	52.99 (46.71)	57.06 (49.05)	53.77 (47.16)
T_9	Wheat +Sorghum straw (1:1)	820.67	889.67	804.67	91.06	86.96	82.33	88.85 (70.49)	90.22 (71.77)	89.76 (71.33)	54.70 (47.69)	59.30 (50.35)	53.64 (47.08)
T_{10}	Soybean + Sorghum straw (1:1)	893.00	867.00	759.00	94.22	80.33	84.33	89.44 (71.03)	90.74 (72.28)	88.85 (70.49)	59.53 (50.49)	57.79 (49.48)	50.59 (45.33)

*:- Mean of three replications, BE :- Biological efficiency (%),
Bed :- 1.5 kg dry substrate ** :- Figures in parenthesis are angular transformed value

Fig. 1. Growth of *P.florida, P. eous* and *P. sajor-caju* on the substrates used for cultivation

Fig. 2. Spwan run and pinhead initiation on substrates of *P.florida, P. eous* and *P. sajor-caju*

by T_2 (100% wheat straw; 16 days in the following three pleurotus spp. respectivly and maximum days were required to complete spawn run for *P. florida* (21 days) in T_7 (paddy + sorghum straw 1:1), *P. eous* (26 days) in T_{10} (soybean + sorghum straw 1:1) and *P. sajor-caju* (24 days) in tratment T_8 ((paddy + sorghum straw 1:1) respectivly.

The number of days required for pinhead initiation of *P. florida, P. eous and P. sajor caju* on different substrates were recorded. Paddy straw took minimum number of days in tratment T_1 (18,19 nad 18 days) to produce pinhead in mushroomrespectively. While highest number of days were taken in T_7 (50 % paddy straw + 50 % sorghum straw; 25 days) for *P. florida* , T_{10} (50 % soybean straw + 50 % sorghum straw; 30 days) for *P. eous* and T_8 (50 % wheat straw + 50 % soybean straw; 28 days) for *P. sajor caju* respectivly.

The number of days required for matured fruiting bodies of *P. florida* on different substrates were recorded. Minimum number of days required for development of mature fruiting bodies was 21, 24 and 23 days was recorded in the treatment T_1 in which paddy straw was used respectively. The maximum number (28 days) of days to reach maturity stage were observed in T_5 (50 % paddy straw + 50 % sorghum straw; 28 days) for *P. florida*, T_{10} (50 % soybean straw + 50 % sorghum straw; 35 days) for *P. eous* and T_8 (50 % wheat straw + 50 % soybean straw; 32 days) *P. sajor caju* respectivly.

Similar variation in days required for spawn run, pinhead initiation and matured fruiting bodies has been recorded by earlier workers (Iqbal *et. al,* 2011; Jafarpour *et. al,* 2011; Musieba *et. al,* 2012; and Pala *et. al,* 2012).

Average number of pinhead/ bed and matured fruiting bodies/bed

The average number of pinhead and matured fruiting bodies of *P. florida, P. eous* and *P. sajor-caju* on different substrates were recorded and showed in table 4. The maximum average number of pinhead 140.33 mm, 142.67 mm and 147.33 mm were recorded in the treatment T_1 in which Paddy straw was used as a substrate for *P. florida, P. eous* and *P. sajor-caju* respectivly and The minimum number of pinhead were recorded in T_8 (wheat straw + soybean straw; 117.33 mm), T_9 (wheat straw + sorghum straw; 121.33 mm and T_{10} (soybean straw + sorghum straw; 121.67 mm) for *P. florida, P. eous* and *P. sajor-caju* respectivly.

The greater number of pinhead is due to moisture content present in the growing substrates. Similar variation in number of pinhead has been reported by several workers in the past (Mondal *et. al,* 2010; Patil *et. al,* 2012).

The average number number of matured fruiting bodies/bed of *P. florida, P. eous* and *P. sajor-caju* were recorded the maximum matured fruiting bodies (116.33 mm, 121.33 mm and 118.67 mm) were obtained in treatment in which paddy straw was used as a substrates respectivly. The minimum average matured fruiting bodies were recorded in the treatment in which T_9 wheat straw + sorghum straw (95.33 mm), T_{10} soybean straw + sorghum straw (92.66 mm) and T_{10} soybean straw + sorghum straw (92.33 mm) was used as a substrate respectivly.

The maximum number of fruiting bodies was recorded on Paddy straw amongest the different substrates in *P.florida, P.eous and P.sajor-caju*. The least number of matured fruiting bodies was recorded with wheat + sorghum straw in *P.florida* and soybean + sorghum straw in *P. eous* and *P. sajor-caju.* Similar variation in number of matured fruiting bodies has been recorded by several workers (Jadhav *et. al,* 1996; Patil *et. al,* 1996; Dhoke, 1998; Mandhare, 2000, Mondal *et. al,* 2010 and Survase, 2012).

Average pileus diameter and stipe diameter

The data pertaining to pileus diameter of *P. florida, P. eous and P. sajor-caju* on different substrates was presented in Table 3.

The average pileus diameter of *P. florida, P. eous and P. sajor-caju* on different substrates was recorded The highest average pileus diameter (9.33 cm^2, 12 cm^2 and 12 cm^2) was obtained in the treatment in which paddy straw used for three spp respectively. The lowest average diameter of pileus was recorded in the treatment T_7 paddy straw + sorghum straw (3.66 cm^2), T9 wheat straw + sorghum straw (2.33 cm^2) and T8 wheat straw + soybean straw (4 cm^2) for *P. florida, P. eous and P. sajor-caju* on different substrates respectively.

The average diameter of stipe of *P. florida, P. eous and P. sajor-caju* on different substrates was recorded that the data clearly indicated that significantly highest average stipe diameter (3.66 cm^2, 4 cm^2 and 4.33 cm^2) in treatment in which paddy straw used as a substrate respectivly and the lowest average stipe diameter was recorded in treatment T9 wheat + sorghum straw, T8 wheat + soybean straw (1.66 cm^2) and T7 paddy + sorghum straw (1.33 cm^2) used as substrate respectively for the following three spp *P.florida, P.eous and P.sajor-caju.*

The pileus diameter and stipe diameter of *P.florida, P.eous and P.sajor-caju* has been influenced by different substrates and here to the similar observation were recorded. The pileus diameter and stipe diameter of *P.florida, P. eous and P. sajor-caju* maximum on Paddy straw amongst the different substrates and least on wheat + sorghum straw and soybean + sorghum straw. Such a variation in size of pileus and stipe of *P.florida, P.eous and P.sajor-caju* due to different substrates was recorded by different workers in the past (Patil, 1996; Dhoke, 1998; Mandhare, 2000; Mane *et. al,* 2007; Mondal *et. al,* 2010 and Patil *et. al,* 2012).

Fresh yield of mushroom

The average yield of *P.florida, P.eous and P.sajor-caju* on different substrates was recorded as follow. The mean data revealed that the maximum yield (1248.33 g/1.5 kg dry substrate) for *P.florida* ,(1348.33 g/1.5 kg dry substrate) for *P.eous* and (1275 g/1.5 kg dry substrate) for *P.sajor-caju* was recorded in treatment T_1 in which paddy straw used as a substrate respectivly, which was found to be higher than all other treatment and the minimum total yield (795 g/1.5 kg dry substrate) was weighed in treatment T8 wheat straw + soybean straw used as substrate for *P.florida,* (856 g/1.5 kg dry substrate) in T8 wheat straw + soybean straw for *P.eous* and (759 g/1.5 kg dry substrate) was weighed in treatment T10 in which soybean straw + sorghum straw used as substrate for *P.sajor-caju* respectivly.

The yield of *P. florida, P. eous and P. sajor-caju* has been influenced by different substrates. The yield of *P. florida* was maximum with paddy straw and followed by Paddy + wheat straw and Wheat straw and least on Wheat + soybean straw. The yield of *P. eous* was maximum with paddy straw and followed by Wheat straw and Paddy + wheat straw and least on Wheat + soybean straw.The yield of *P. sajor-caju* was maximum with paddy straw and followed by Wheat straw and Paddy + wheat straw and least on Wheat + sorghum straw. Similar diffrential yield of *P. florida, P. eous and P. sajor-caju* with different substrates has been reported by (Kirbag and

Akyuz., 2008; Pandey *et. al,* 2008; Ingale and Ramteke., 2010; Jafarpour *et. al,* 2011; Raja and Ganesh, 2013 and Sharma *et. al,* 2013).

Dry weight of mushroom

The average dry weight of *P. florida,* on different substrates was recorded as follow. The maximum average dry weight (125.22 g) was noticed in treatment T5 in which paddy straw + wheat straw used as a substrate Minimum dry weight (89.33 g) was recorded in treatment T8 in which wheat straw + soybean straw used as a substrate. The average dry weight of *P. eous* on different substrates was recorded in between 80.33 to 139.22 g. The maximum average dry weight (139.22 g) was noticed in treatment T2 in which wheat straw used as a substrate and Minimum dry weight (80.33 g) was recorded in treatment T10 in which soybean straw + sorghum straw used as a substrate and average dry weight *P. sajor-caju* on different substrates the maximum average dry weight (122.66 g) was noticed in treatment T1 in paddy straw used as a substrate and Minimum dry weight (80.55 g) was recorded in treatment in which wheat straw + soybean straw used as a substrate.

The average dry weight of *P.florida, P.eous and P.sajor-caju* differed with substrates used for cultivation. The highest dyr weight of *P. florida* was recorded with Paddy + Wheat straw and followed by Wheat straw amongst different substrates. The average dry weight of *P. florida* was recorded in present investigatin ranged between 125.22 – 91.06 g. The highest dyr weight of *P. eous* was recorded with Wheat straw amongst different substrates. The average dry weight of *P. eous* was recorded in present investigatin ranged between 139.22 – 80.33 g. The highest dyr weight of *P. sajor-caju* was recorded with Wheat straw amongst different substrates. The average dry weight of *P. sajor-caju* was recorded in present investigatin ranged between 120.3 – 80.55 g. similar variation in respect of dry weight of *P.florida, P.eous and P.sajor-caju* were reported by different workers in the past (Ingale and Ramteme, 2010 and Patil *et. al, 2012*).

Moisture content of mushroom

The moisture content of dehydrated air dried mushroom of *P. florida, P. eous and P. sajor-caju* had been estimated and are presented in Table 16.

The result indicated that the moisture content of *P. florida* ranged between 88.65 to 90.02 per cent on different substrates. The highest moisture content (90.02 %) was recorded in the treatment in which wheat straw + soybean straw used as a substrate and the least moisture content (88.29 %) was recorded in treatment in which sorghum straw used as a substrate and moisture content of *P. eous* ranged between 89.10 to 90.95 per cent on different substrates. The highest moisture content (90.95 %) was recorded in the treatment in which paddy straw used as a substrate and the least moisture content (89.10 %) was recorded in treatment in which wheat straw + soybean straw used as a substrate

The moisture content of *P. sajor-caju* ranged between 88.53 to 90.35 per cent on different substrates. The highest moisture content (90.35 %) was recorded in the treatment in which paddy straw used as a substrate and the least moisture content (88.53 %) was recorded in treatment in which soybean straw + sorghum straw used as a substrate.

In present investigation, highest moisture content of *P.florida* was evident with Wheat + Soybean straw amongst the substrates. In *P. eous* highest moisture content was evident with paddy straw and in *P. sajor-caju* highest moisture content was evident with paddy straw followed by wheat + soybean straw. Similar variation in moisture content of *Pleurotus* species has been reported in the past (Dundae *et. al,* 2009; Sayed *et. al,* 2009; Hassan *et. al,* 2010 and Patil *et. al,* 2010).

Biological efficiency of *P. florida, P. eous* and *P. sajor-caju*

The effect of substrates on yield contributing charecters such as biological efficiency was varied (Table 5).

It was necessary to calculate percentage of biological efficiency because certain substrates were denser than other. The conversion percentage from dry substrate weight to fresh mushroom weight (biological efficiency) was determined. The different substrates showed different responde on biological efficiency of mushroom (Table 16).

In *P. florida, P. eous* and *P. sajor-caju* maximum biological efficiency 83.22 %, 89.90 % and 84.99 % of mushroom was noticed in treatment in which paddy straw used as substrate respectively and minimum biological efficiency (52.99 %) of mushroom was recorded in treatment

T8 wheat straw + soybean straw used as substrate in *P. florida,* (57.06 %) in treatment T8 wheat straw + soybean straw used as substrate in *P. eous* and (50.59 %) of mushroom was recorded in treatment T10 soybean straw + sorghum straw used as substrate in *P. sajor-caju* respectivly.

Similar diffrential biological efficiency of *P. florida, P. eous and P. sajor-caju* with different substrates has been reported by (Kirbag and Akyuz., 2008; Pandey *et. al,* 2008; Ingale and Ramteke., 2010; Jafarpour *et. al,* 2011; Raja and Ganesh, 2013 and Sharma *et. al,* 2013).

CONCLUSION

The result of present investigation revealed that in *P. florida, P. eous* and *P. sajor-caju* the number of days required for spawn run, pinhead initiation and matured fruiting bodies was minimum on paddy straw. The number of pinhead and matured bodies was maximum on Paddy straw. Stipe and pileus are important edible parts of mushroom. Highest pileus diameter and stipe diameter was recorded on paddy straw. The average yield and biological efficiency of matured fruiting bodies was maximum on Paddy straw amongst the different substrates. Maximum dry weight was recorded on Paddy + Wheat straw in *P. florida* and *P. sajor-caju* and wheat straw in *P. eous*. The highest moisture content was recorded on wheat + soybean straw in *P. florida* and paddy straw in *P. eous* and *P. sajor-caju*. Paddy straw for cultivation of *P. florida, P. eous* and *P. sajor-caju* superior

REFRENCES

1. Ahmad, S.A., Kadam, J.A., Mane, V.P., Patil, S.S. and Baig, M.M.V. Biological efficiency and nutritional contents of Pleurotus florida cultivated on different agro-wastes. *Nature and Sceince.*, 2009; **7**: 44-48.
2. Bano, Z. and Rajarathanam, S. Studies on the cultivation of Pleurotus sajor-caju, *The Mushroom Journal,* 1982; **115**: 243-245.
3. Dundar, A., Acay, H. and Yildiz, A. Effect of using different lignocellulosic wastes for cultivation of *Pleurotus ostreatus* on mushroom yield, chemical composition and nutritional value. *African J. Biotec,* 2009; **8**(4): 662-666.
4. Gregori, A., Svagelj, M and Pohleven, J. Cultivation techniques and medicinal properties of *Pleurotus* spp. *Food Technol. Biotechnol,* 2007; **45** (3): 236-247.
5. Hassan, F. R. H., Medany, G. M. and Hussein, S. D. A. Cultivation of king oyster mushroom (*Pleurotus eryngii)* in Egypt. *Australian J. Basic Appl. Scie,* 2010; **4**(1): 99-105.
6. Hobbs, C. Medicinal Mushrooms: An Exploration of Tradition, Healing and Culture. Botanica Press, Santa Cruz, CA 1996.
7. Inagle, A. and Ramteke, A. Studies on cultivation and biological efficiency of mushroom grown on different agro-residues. *Innov. Romanian Food Biotechno,* 2010; **6**: 25-28.
8. Iqbal, Sh. M., Rauf, Ch. A. and Sheikh, M. I. Yield performance of oyster mushroom on different substrates. *Int. J. Agri. Biol,* 2005; **7** (6): 900-903.
9. Jafarpour, M., Jalalizand, A. and Eghbalsaied, S. High fiber media as the most efficient substrate for *Pleurotus florida* culture. *Arch. Biol. Scie., Belgrade,* 2011; **63** (3): 889-895.
10. Jain, A. K. and Vyas, D. Cultivation of three Pleurotus sp. on different substrates *J. Basic Appl. Mycol.*, 2003; **2**: 88-89.
11. Kirbag, S. and Akyuz, M. Effect of various agro-residuces on growing period, yield and biological efficiency of *Pleurotus eryngii. J. Food Agric. Envt.*, 2008; **6** (3 & 4): 402-405.
12. Mandhare, V. K. Productivity of *Pleurotus* spp. on different straw and it's effect on nutritional indices of spent straw. PhD. (Agri.) thesis submitted to Marathwada Agri. Univ., 2000; Parbhani (India).
13. Mane, V. P., Patil, S. S., Syed, A. A. and Baig, M. M. V. Bioconversion of low quality lignocellulosic agricultural wastes into edible protein by *Pleurotus sajor-caju* (Fr.) Singer. *J. Zehejiang Univ.of Sci. B.,* 2007; **8**(10):745-751.
14. Martinez, A.T., Camarero, S., Guillen, F., Gutierrez, A., Munoz, C. Varela, E., Martinez, M.J., Barrasa, J. M. ,Ruel, K. and Pelayo**,** M. Progress in biopulping of non- woody materials: Chemical, Enzymatic and ultrastructural aspect of wheat straw delignification with lignolytic fungi from the genus Pleurotus. *FEMS Microbiology Reviews,* 1994; **13:** 265-274**.**
15. Mayson, E. and Verachert, H. Growth of higher fungi on wheat straw and their impact on the digestibility of the substrate. *Applied Microbiology and Biotechnology,* 1991; **36**, 421-424
16. Mondal, S. R., Rehana, J., Noman, M. S. and Adhikary, S. K. Comparative study on growth and yield performance of oyster mushroom (*Pleurotus florida)* on different substrates. *J. Bangladesh Agri. Univ,* 2010; **8**(2): 213-220.
17. Musieba, F., Okoth, S., Mibey, R. K., Wanjiku,

S. and Moraa, K. Suitability of locally available substrates for cultivation of the Kenyan indigenous Golden oyster mushroom (*Pleurotus citrinopileatus* Siner). *Aric. J,* 2012; **7**(4): 240-244.

18. Pala, S. A., Wani, A. H. and Mir, R. A. Yield performance of *Pleurotus sajor- caju* on different agro-wastes. *Ann. Bio. Res,* 2012; **3**(4): 1938-1941.
19. Pandey, R. K., Pandey, I. B. and Jha, S. Performance of oyster mushroom (*Pleurotus sajor-caju)* on different agricultural wastes. *Agricultra-Stiintasi-Practica,* 2008; **3**(4): 26-33.
20. Patil, B. D., Jadhav, S. W. and Kakade, D. S. The studies in cultivation of *Pleurotus sajor-caju* on different substrates. *J. Maharashtra Agric. Univ,* 1996; **14** (2): 156-158.
21. Patil, K. K., Kulkarni, R. V. and Gupta, D. N. Enhancing yield and biological efficiency (BE) in oyster mushroom by supplementation. *Academic J. Plant Sci*, 2010; **4**(2): 41-44.
22. Patil, R. R., Mate, G. D. and Swami, K. V. Studies on production of oyster mushroom on different substrates. In Souvenir and Abstract, National Symposium (IPS) on "Microbial consortium approaches for plant health management". 2012; P.D.K.V. Akola. pp.102.
23. Patil, S. S. Cultivation of *Pleurotus sajor-caju* on different agro- wastes. *Sci. Res. Repo*, 2012; **2**(3): 225-228.
24. Patrabansh, S., and Madan, M. Studies on cultivation, biological efficiency and chemical analysis of Pleurotus sajor-caju (Fr.) Singer on different biowastes. *Acta Biotechnologica*, 1997; **17**: 107-122.
25. Philippoussiis, A. and Zervakis, G**.** Management of agro-industrial wastes through the cultivation of edible mushrooms. Proceedings of the fourth waste Forum, Milano 2000.
26. Poppe, J. Use of agricultural waste materials in the cultivation of mushrooms. In Proceedings of the 15 th International Congress on the Science and Cultivation of edible fungi, ed. Van Griensive L.J.L.D., **3**-23. Rotterdam ; Balkema 2000.
27. Quimio, T. H. Introducing Pleurotus flabellatus for your dinner table *Mushroom Journal*, 1978; **69**:282-283.
28. Raja, E. and Ganesh, P. Studies on oyster mushroom (*Pleurotus florida)* on using different substrates. *Indian streams Res. J*., 2013; **3**(3): 1-3.
29. Sayed, A. A., Kadam, J. A., Mane, V. P., Patil, S. S. and Baig, M. M. V. Biological efficiency and nutritional content of *Pleurotus florida* (Mont.) singer cultivated on different agro-wastes. *Nature and Science*, 2009; **7**(1): 44-48.
30. Sharma, S., Yadav, R. K. P. and Pokhrel, C. P. Growth and yield of oyster mushroom (*Pleurotus ostreatus)* on different substrates. *J. New Biol. Reports,* 2013; **2**(1): 03-08.
31. Survase, D. M. Bioconversion of agro-waste into edible protein rich mushroom by *Pleurotus sajor-caju* (Fr.) singer. *Int. Peet-Reviewed J,* 2012; **1** (1): 60-62.
32. Wani, B. A., Bodha, R. H. and Wani, A. H. Nutritional and medicinal importance of mushrooms. *Journal of Medicinal Plants Res*, 2010; **4**(24). 2598-2604.
33. Zakia, B., Rajrathnam, S. and Nagaraja, N. Some aspect on the cultivation of *Pleurotus flabellatus* in India. *Indian Mush. Sci.,* 1979; **10**(2):597-608.
34. Zakia, bano., Srinivasan, K.S. and Srivastava, H.C. Amino acid composition of the protein from a mushroom (*Pleurotus* spp.). *App. Microbio,* 1962; **11**: 184-187
35. Zhang, R. H. and Li, X. J. Mushroom cultivation with rice and wheat straw. ASAE Ann. Int. Meeting, Orlando, USA held during 12-16 July 1998.