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

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*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) 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 lignocellulosic 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

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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 nutritious 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 bioactive properties and many compounds such as polysaccharides mainly ²-D glucan, heteroglycans, hexasaccharides, pachymanans, proteoglycans, terpenoids 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 compare 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, hypcholesterolaemic, 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

Preparation 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 transferred on autoclaved and cooled PDA medium in glass petriplates under Laminar air flow cabinet. These plates were then incubated at 20°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 prepared on PDA slants in glass test tubes and preserved in refrigerator.

Preparation of master spawn

Apparently 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°C. These flasks were shaken intermittently to facilitate 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.

Preparation of commercial spawn

Commercial spawn was prepared using 250-300 guage polypropylene bags 8 x 12 inch² 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 inoculated with a spoonful of master spawn and incubated with at 20°C temperature. The bags were shaken intermittently to facilitate through spread of mushroom mycelium. During incubation of the bags were regularly examined for mould infestation if any and contaminated bags were immediately 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 \textit{P. florida}, \textit{P. sajor-caju} and \textit{P. eous} were prepared. These commercial spawn bags were stored in refrigerator and used for spawning the substrates.

**Evaluation of agro-wastes**


**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 lbs 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 cm² (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 20-25°C 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 15-18°C 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 \textit{P. florida}, \textit{P. eous} and \textit{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 \textit{P. florida}, \textit{P. eous} and \textit{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 \textit{P. florida}, \textit{P. eous} and \textit{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 spanw run of \textit{P. florida}, \textit{P. eous} and \textit{P. sajor-caju} . It was observed that treatment \textit{T1} (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*

<table>
<thead>
<tr>
<th>Tr. No.</th>
<th>Treatments</th>
<th>SpawnRun Days required*</th>
<th>PinheadInitiation</th>
<th>MFB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><em>P. florida</em></td>
<td><em>P. eous</em></td>
<td><em>P. sajor-caju</em></td>
</tr>
<tr>
<td>T1</td>
<td>Paddy straw</td>
<td>14</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>T2</td>
<td>Wheat straw</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>T3</td>
<td>Soybean straw</td>
<td>18</td>
<td>19</td>
<td>18</td>
</tr>
<tr>
<td>T4</td>
<td>Sorghum straw</td>
<td>19</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>T5</td>
<td>Paddy + Wheat straw</td>
<td>16</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td>T6</td>
<td>Paddy + Soybean straw (1:1)</td>
<td>17</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>T7</td>
<td>Paddy + Sorghum straw (1:1)</td>
<td>21</td>
<td>21</td>
<td>23</td>
</tr>
<tr>
<td>T8</td>
<td>Wheat + Soybean straw (1:1)</td>
<td>17</td>
<td>24</td>
<td>21</td>
</tr>
<tr>
<td>T9</td>
<td>Wheat + Sorghum straw (1:1)</td>
<td>20</td>
<td>23</td>
<td>24</td>
</tr>
<tr>
<td>T10</td>
<td>Soybean + Sorghum straw (1:1)</td>
<td>19</td>
<td>20</td>
<td>26</td>
</tr>
</tbody>
</table>

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*

<table>
<thead>
<tr>
<th>Tr. No.</th>
<th>Treatments</th>
<th>Av. Number of pinhead</th>
<th>Av. Number of matured fruiting bodies</th>
<th>Av. Size* of pileus Dia. (cm²)</th>
<th>Av. Size* of stipe Dia. (cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><em>P. florida</em></td>
<td><em>P. eous</em></td>
<td><em>P. sajor-caju</em></td>
<td><em>P. florida</em></td>
</tr>
<tr>
<td>T1</td>
<td>Paddy straw</td>
<td>140.33</td>
<td>142.67</td>
<td>147.33</td>
<td>116.33</td>
</tr>
<tr>
<td>T2</td>
<td>Wheat straw</td>
<td>138.67</td>
<td>134.67</td>
<td>140.33</td>
<td>108.67</td>
</tr>
<tr>
<td>T3</td>
<td>Soybean straw</td>
<td>135.33</td>
<td>136.67</td>
<td>137.00</td>
<td>105.00</td>
</tr>
<tr>
<td>T4</td>
<td>Sorghum straw</td>
<td>132.00</td>
<td>127.67</td>
<td>130.67</td>
<td>104.67</td>
</tr>
<tr>
<td>T5</td>
<td>Paddy + Wheat straw</td>
<td>139.67</td>
<td>141.33</td>
<td>140.33</td>
<td>115.33</td>
</tr>
<tr>
<td>T6</td>
<td>Paddy + Soybean straw (1:1)</td>
<td>127.33</td>
<td>125.67</td>
<td>139.00</td>
<td>102.00</td>
</tr>
<tr>
<td>T7</td>
<td>Paddy + Sorghum straw (1:1)</td>
<td>123.33</td>
<td>139.00</td>
<td>130.67</td>
<td>96.33</td>
</tr>
<tr>
<td>T8</td>
<td>Wheat + Soybean straw (1:1)</td>
<td>117.33</td>
<td>131.00</td>
<td>123.67</td>
<td>96.67</td>
</tr>
<tr>
<td>T9</td>
<td>Wheat + Sorghum straw (1:1)</td>
<td>121.33</td>
<td>121.33</td>
<td>125.67</td>
<td>95.33</td>
</tr>
<tr>
<td>T10</td>
<td>Soybean + Sorghum straw (1:1)</td>
<td>120.67</td>
<td>122.67</td>
<td>121.67</td>
<td>98.66</td>
</tr>
</tbody>
</table>
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*

<table>
<thead>
<tr>
<th>Tr. No.</th>
<th>Treatments</th>
<th>Yield (g/bed)*</th>
<th>Dry weight (g)*</th>
<th>Moisture* (%)</th>
<th>B.E. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><em>P. florida</em></td>
<td><em>P. eous</em></td>
<td><em>P. sajor-caju</em></td>
<td><em>P. florida</em></td>
</tr>
<tr>
<td>T1</td>
<td>Paddy straw</td>
<td>1248.3</td>
<td>1348.7</td>
<td>1275.0</td>
<td>118.80</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(71.49)**</td>
</tr>
<tr>
<td>T2</td>
<td>Wheat straw</td>
<td>1167.7</td>
<td>1307.0</td>
<td>1114.3</td>
<td>123.83</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(70.21)</td>
</tr>
<tr>
<td>T3</td>
<td>Soybean straw</td>
<td>991.00</td>
<td>1061.0</td>
<td>1053.3</td>
<td>110.11*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(70.30)</td>
</tr>
<tr>
<td>T4</td>
<td>Sorghum straw</td>
<td>881.33</td>
<td>1009.7</td>
<td>1036.3</td>
<td>102.92</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(69.98)</td>
</tr>
<tr>
<td>T5</td>
<td>Paddy + Wheat straw</td>
<td>1235.0</td>
<td>1275.0</td>
<td>1229.0</td>
<td>125.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(71.55)</td>
</tr>
<tr>
<td>T6</td>
<td>Paddy + Soybean straw (1:1)</td>
<td>836.33</td>
<td>1094.0</td>
<td>1001.3</td>
<td>89.92</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(70.30)</td>
</tr>
<tr>
<td>T7</td>
<td>Paddy + Sorghum straw (1:1)</td>
<td>877.00</td>
<td>871.00</td>
<td>880.33</td>
<td>91.44</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(71.23)</td>
</tr>
<tr>
<td>T8</td>
<td>Wheat + Soybean straw (1:1)</td>
<td>795.00</td>
<td>856.00</td>
<td>806.67</td>
<td>89.33</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(71.58)</td>
</tr>
<tr>
<td>T9</td>
<td>Wheat + Sorghum straw (1:1)</td>
<td>820.67</td>
<td>889.67</td>
<td>804.67</td>
<td>91.06</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(70.49)</td>
</tr>
<tr>
<td>T10</td>
<td>Soybean + Sorghum straw (1:1)</td>
<td>893.00</td>
<td>867.00</td>
<td>759.00</td>
<td>94.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(71.03)</td>
</tr>
</tbody>
</table>

*:* Mean of three replications, BE :- Biological efficiency (%),
Bed :- 1.5 kg dry substrate **:- Figures in parenthesis are angular transformed value.
by T₂ (100% wheat straw; 16 days in the following three pleurotus spp. respectively and maximum days were required to complete spawn run for P. florida (21 days) in T₇ (paddy + sorghum straw 1:1), P. eous (26 days) in T₉ (soybean + sorghum straw 1:1) and P. sajor-caju (24 days) in treatment T₈ ((paddy + sorghum straw 1:1) respectively.

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 treatment T₁ (18.19 and 18 days) to produce pinhead in mushroom respectively. While highest number of days were taken in T₆ (50% paddy straw + 50% sorghum straw; 25 days) for P. florida, T₁₀ (50% soybean straw + 50% sorghum straw; 30 days) for P. eous and T₈ (50% wheat straw + 50% soybean straw; 28 days) for P. sajor-caju respectively.

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 T₁ in which paddy straw was used respectively. The maximum number (28 days) of days to reach maturity stage were observed in T₅ (50% paddy straw + 50% sorghum straw; 28 days) for P. florida, T₁₀ (50% soybean straw + 50% sorghum straw; 35 days) for P. eous and T₈ (50% wheat straw + 50% soybean straw; 32 days) P. sajor-caju respectively.

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 T₁ in which Paddy straw was used as a substrate for P. florida, P. eous and P. sajor-caju respectively and The minimum number of pinhead were recorded in T₇ (wheat straw + soybean straw; 117.33 mm), T₉ (wheat straw + sorghum straw; 121.33 mm and T₁₀ (soybean straw + sorghum straw; 121.67 mm) for P. florid, P. eous and P. sajor-caju respectively.
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 respectively. The minimum average matured fruiting bodies were recorded in the treatment in which T1 wheat straw + sorghum straw (95.33 mm), T10 soybean straw + sorghum straw (92.66 mm) and T9 soybean straw + sorghum straw (92.33 mm) was used as a substrate respectively.

The maximum number of fruiting bodies was recorded on Paddy straw amongst 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 cm², 12 cm² and 12 cm²) 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 T1 paddy straw + sorghum straw (3.66 cm²), T9 wheat straw + sorghum straw (2.33 cm²) and T8 wheat straw + soybean straw (4 cm²) 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 cm², 4 cm² and 4.33 cm²) in treatment in which paddy straw used as a substrate respectively and the lowest average stipe diameter was recorded in treatment T9 wheat + sorghum straw, T8 wheat + soybean straw (1.66 cm²) and T7 paddy + sorghum straw (1.33 cm²) 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 T1 in which paddy straw used as a substrate respectively, 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 respectively.

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 differential yield of P. florida, P. eous and P. sajor-caju with different substrates has been reported by (Kirbag and

**Dry weight of mushroom**

The average dry weight of *P. florida*, on different substrates was recorded as follows. 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. The average dry weight of *P. sajor-caju* on different substrates the maximum average dry weight (122.66 g) was noticed in treatment T8 in which soybean straw + sorghum 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 dry 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 investigation ranged between 125.22 – 91.06 g. The highest dry weight of *P. eous* was recorded with Wheat straw amongst different substrates. The average dry weight of *P. eous* was recorded in present investigation ranged between 139.22 – 80.33 g. The highest dry 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 investigation 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 Ramteke, 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 character 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 response 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* respectively.

Similar differential 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. florid*, *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

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