Comparative Study of the Growth and Yield of Pleurotus florida (Oyster Mushroom) on Some Tropical Trees

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ABSTRACT

Chopped stems of four tropical trees namely mango (Mangifera indica), neem (Azadirachta indica), acacia (Acacia species) and coconut (Cocos nucifera) with their mixed bed, as the fifth, were evaluated as substrates for the cultivation of Pleurotus florida, an edible mushroom. Observations were made for the growth and yield parameters of the mushroom namely; number of fruits (NF), fruit weight (FW), width of pileus, length of stipe, biological efficiency (BE) and production efficiency (PE), mycelia extension, days to full colonization, days to initiation and extension per day. The results obtained from this study indicated that the fruit weight (FW) of P. florida (80 g) was highest when cultivated on chopped mango stem. The same trend was observed in BE (46%) and PE (17%). Chopped coconut stem produced the least FW (48 g) and length of stipe (4 cm). Its BE (27%) and PE (11%) were also the least. However, the highest width of pileus (12 cm) was produced by coconut while chopped acacia stem (6 cm) produced the least. The highest mycelia extension (11 cm) was obtained from coconut while the least was from mango. The results obtained indicated that the stem of mango is a suitable substrate for the cultivation of P. florida (Oyster mushroom).

Keywords: biological efficiency, production efficiency
Abbreviations: ANOVA; analysis of variance; BE, biological efficiency; DMRT; Duncan's multiple range test; FW, fruit weight; NF, number of fruits; PE, production efficiency; PVC, poly vinyl chloride

INTRODUCTION

Edible mushrooms are nutritionally endowed fungi (mostly Basidiomycetes) that grow naturally on the trunks, leaves and roots of trees as well as decaying wood materials (Iwalokun et al. 2001). Mushrooms are actually fruits of the fungus (Okhuoya and Okogbo 1990). The fruit body lasts for a few years but the mycelium living on the organic materials in the soil may survive for years (Oyetayo and Oyetayo 2008). Mushrooms have high contents of qualitatively good protein, crude fibre and minerals but are poor sources of lipids (Fasidi and Kadiri 1990). They have high nutrient value of almost twice that of any other vegetable or fruits (Sivriyata et al. 2002). They are non-traditional horticultural crops having high quality of proteins, high fibre value, vitamins and minerals (Narayanasamy et al. 2009). Mushrooms are rich sources of mineral elements and vitamins, with mineral elements already detected being potassium, phosphorus, calcium, sodium, magnesium, zinc, iron, manganese, nickel, copper, chromium, cobalt and vitamins (B, C, K) and niacin (Ogundana and Fagade 1982; Zakary et al. 1983). They are rich in protein, minerals, and vitamins, and they contain an abundance of essential amino acids (Sadler 2003). In medicine, they are used to immodulate both humoral and cellular immune factors in the body (Wasser 2002). Pharmaceutical applications of mushrooms had been in their use as antitumor, antibacterial, antifungal and antiviral agents (Wasser 2002). Most mushrooms make their appearance during the rainy season (Aletor 1995). Attempt had been made on the husbandry of the more nutritious species of mushrooms on agro waste. Lentinus subnudus and Tubaregium had been successfully cultivated on various cellulosolytic agricultural wastes (Fasidi and Ekuere 1993; Fasidi and Kadiri 1993). The rapid growth and the ability to utilize various lignocellulosic substances make Pleurotus species cultivation possible in different parts of the world. Pleurotus species have been grown on different kinds of sawdust, straw and many other agricultural and industrial wastes (Hadder et al. 1993). Some of these otherwise valueless lignocellulosic wastes: cotton wastes, sawdust, cereal stover, corncob, wheat, paddy straw and sugarcane bagasse, have been used either mixed or singly as substrates for the cultivation of various species of edible mushrooms by various researchers (Fasidi and Kadiri 1993; Manzil et al. 1999; Ragunathan and Swaminathan 2003). Pleurotus spp. can also colonize and produce mushrooms on pretreated conifer (Pinus spp.) wood chips but they do not always readily colonize non-pretreated conifer wood, due to the presence of inhibitory components (Croan 2004). Some strains can, however, be adapted for cultivation on conifer sawdust-based substrates (Ruan et al. 2006). Pleurotus spp. can also be cultivated on wood waste or unused wood residues associated with harvesting or thinning operations, which can enhance economic returns needed to support ecosystem management (Croan 2002). A lot of studies were reported on the suitability of various substrates for mushroom production namely straws of rice (Oryza sativa), wheat (Triticum vulgare), ragi (Elucine coracana), baza (Pennisetum typhoidaes), sorghum (Sorghum vulgare), maize (Zea mays), wood of poplar (Populus robusta), oak (Quercus luecothricopora), horse chest nut (Aesculus indica), Acacia sp., chopped banana pseudostem, cotton stalk, pea shells and poplar saw dust (Saidu et al. 2011). Cultivation of saprophytic edible mushrooms may be the only currently economical biotechnology for lignocellulose organic waste recycling that combines the production of protein rich food with the reduction of environmental pollution (Obodai et al. 2003). Most of the commercial producers of mushroom in Malaysia presently are using sawdust and rice husk (Saidu et al. 2011). Substrates may also be obtained from various plant remnants without enrichments by expensive additives. Similarly, utilization of agricultural waste as growing media
for the production of mushroom play a key role in reducing the waste and at the same time useful as a fertilizer (Sher et al. 2011). Pleurotus species have extensive enzyme systems capable of utilizing complex organic compounds that occur as agricultural wastes and industrial by-products (Baysal et al. 2003). For this reason, it is not necessary to process substrates for cultivation of Pleurotus species (Yalınkılıç et al. 1994). These mushrooms are also found to be one of the most efficient lignocelluloses solid state decomposing types of white rot fungi (Baysal et al. 2003).

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. The nutritional requirements and the limits of the physical environment for mycelia growth and fruiting have been investigated for many Pleurotus sp. Recent studies have indicated that cotton waste is also a good substrate for the cultivation of Pleurotus sp. (Narayanasamy et al. 2009). Paddy straw mushroom (Pleurotus florida) is an edible mushroom of the tropic and sub-tropic region (Narayanasamy et al. 2009). 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 (Jwanny et al. 1995; Patrabansh and Madan 1997). Mushroom cultivation ensures their availability throughout the world irrespective of season since cultivated mushrooms can be grown under different climatic conditions on cheap, readily available agro wastes. The cultivation process guarantees edibility and serve as the most economically viable process for the bioconversion of low value wastes produced primarily from the activities of agricultural, forest and food processing industries to produce higher value fungal protein for human consumption (Wasser 2002). This study was, therefore, aimed at investigating the effects of different substrates on the growth and yield of P. florida (oyster mushroom).

**MATERIALS AND METHODS**

**Collection of materials**

Within the premises of the National Horticultural Research Institute (NIHORT), Ibadan, the trees involved: mango (Mangifera indica), neem (Azadirachta indica) and acacia (Acacia species) trees were obtained for this study but the coconut tree (Cocos nucifera) was obtained at Apete Area of Ibadan metropolis. These trees were between 25-27 years old before harvesting. The spawn of P. florida was obtained from the mushroom unit, NIHORT, Ibadan. The inoculums used were generated from the mushroom sporophore obtained at Songhai in Porto Novo in Benin Republic and maintained on Potato Dextrose Agar (PDA) for regular sub-culturing.

**Composting of materials**

The stems (the bark with the inner tissues excluding the leaves) of the trees (substrates) were harvested at their vegetative stage during the dry season and stored for a period of about three months. With a hand cutter, each of the tree stems (substrates) was chopped into pieces of length 3-5 cm. The substrate used were acacia, coconut, mango, neem and the mixed bed which was prepared by mixing equal portions of the four trees together. They were separately soaked overnight and excess water was removed by pressing the following morning until the moisture content was about 65%. Polyethylene bags were filled with each of the substrate with each bag weighing 500 g and packed tightly. Heat resistant PVC tube was used to make the neck of the bag. The opening was then covered with a cotton plug. These bags were sterilized in an autoclave at 121°C for 30 min and allowed to cool to room temperature.

**Spawn inoculation and incubation**

After cooling, about 50 g of inoculum (10% by weight of the substrate in each bag) was introduced into the bags through the neck. The experiment was a completely randomized design with three replicates per treatment. They were incubated for 30 days after spawning. The bags were brought out for weighing and then transferred into the fruiting house. It was conducted during the raining season.

**Data collection and analysis**

Harvesting of the mushrooms was done manually and weighed. The data collected for five (5) fruits per flush included: number of fruits, NF, fruit weight, FW (g), width of pileus (cm), length of stipe (cm), PE (%), BE (%), mycelia extension (cm), days to full colonization, primordia initiation and the average extension per day (cm). The data obtained were subjected to analysis of variance ANOVA. Significant means were separated using Duncan’s multiple range test, (DMRT) at P ≤ 0.05.

**RESULTS**

The results of the growth and yield of the mushroom (P. florida) as affected by the different substrates are summarized in Tables 1 and 2. The results of the ANOVA revealed that the substrates had significant effects on NF, FW, width of pileus, length of stipe, BE, PE, mycelia extension and days to full colonization except days to initiation and average extension per day.

Mushroom grown on chopped stems of neem and acacia produced the highest number of fruits (13) followed by mango (12) though, these were not significantly different from one another (Table 1). Coconut produced seven (7) numbers of fruits while the mixture of all the substrates produced the least (3). Mango stem produced significantly higher FW (80 g) than others. This was followed by acacia which produced 72 g. However, coconut produced the least FW (48 g). Similar trend was observed in the BE and PE (Table 1) in the order mango > acacia > mixed > neem > coconut.

While coconut and mixed bed produced the largest width of pileus (12 cm), acacia produced the least (6 cm). The width of pileus decreased in the order of coconut > mixed bed > neem > mango > acacia (Table 1). Contrary to the NF and FW, mixed bed produced the longest (6 cm) length of stipe. This was significantly different from acacia that produced 4 cm. Chopped stem of neem produced 4 cm length of stipe which was not significantly different from coconut that produced 4 cm. However, mango produced the shortest length of stipe (4 cm). Like the width of pileus, coconut stem produced the longest mycelia extension (14 cm) while mango produced the shortest (11 cm). This was similar to the trend obtained in the length of stipe (Table 1). However, the longest average mycelia extension per day occurred in mango while the shortest was in acacia (Table 2).

**DISCUSSION**

The varied substrate media yielded different amounts of mushrooms as observed in the total NF, FW, width of pileus and length of stipe. This result is in accordance with the view of the other researchers. The trials conducted by growing oyster mushroom (P sajor-caju) on rice and wheat straw with nutrient supplementation recorded higher yields on both the substrates (Larborde et al. 1993). Sangwan and Samni 1995 cultivated P sajor-caju (Fr.) Singer on different agro-industrial wastes, alone and in combination, as amendments for the growing medium of P sajor-caju. The addition of sugarcane bagasse to wheat or paddy straw was the most effective and increased the BE from 99% to 118% and 119%, respectively. Ragunathan and Swaminathan (2003) discovered that when Pleurotus spp. were cultivated on various agro-wastes, P sajor-caju and P citrinopileatus
Table 1  Mushroom yield on 5 different substrates.

<table>
<thead>
<tr>
<th>Substrate</th>
<th>NF (g)</th>
<th>FW (g)</th>
<th>Width of pileus (cm)</th>
<th>Length of stipe (cm)</th>
<th>PE (%)</th>
<th>BE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mango</td>
<td>12.00a</td>
<td>80.00a</td>
<td>6.76cd</td>
<td>3.93c</td>
<td>17.18a</td>
<td>45.71a</td>
</tr>
<tr>
<td>Neem</td>
<td>12.33a</td>
<td>60.67d</td>
<td>9.00bc</td>
<td>4.43bc</td>
<td>13.89c</td>
<td>34.67d</td>
</tr>
<tr>
<td>Mixed Bed</td>
<td>2.33c</td>
<td>67.33e</td>
<td>9.73ab</td>
<td>6.23a</td>
<td>15.36b</td>
<td>38.48e</td>
</tr>
<tr>
<td>Acacia</td>
<td>12.33a</td>
<td>72.33b</td>
<td>6.43d</td>
<td>4.73b</td>
<td>16.95a</td>
<td>41.14b</td>
</tr>
<tr>
<td>Coconut</td>
<td>6.67b</td>
<td>48.00e</td>
<td>12.13a</td>
<td>4.40bc</td>
<td>10.96d</td>
<td>27.41e</td>
</tr>
<tr>
<td>LSD0.05</td>
<td>3.29</td>
<td>4.43</td>
<td>2.55</td>
<td>0.70</td>
<td>1.09</td>
<td>2.58</td>
</tr>
</tbody>
</table>

Means with the same letters along column are not significantly different from one another (DMRT at P ≤ 0.05).

Table 2  Mushroom growth on 5 different substrates.

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Days to full colonization</th>
<th>Days to initiation</th>
<th>Average mycelia extension/day (cm)</th>
<th>Mycelia extension (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mango</td>
<td>31.00b</td>
<td>28.33b</td>
<td>0.43a</td>
<td>11.30c</td>
</tr>
<tr>
<td>Neem</td>
<td>33.33a</td>
<td>30.00ab</td>
<td>0.36b</td>
<td>13.20b</td>
</tr>
<tr>
<td>Mixed Bed</td>
<td>31.33b</td>
<td>28.67b</td>
<td>0.37b</td>
<td>11.97d</td>
</tr>
<tr>
<td>Acacia</td>
<td>33.33a</td>
<td>30.67a</td>
<td>0.35b</td>
<td>12.50c</td>
</tr>
<tr>
<td>Coconut</td>
<td>33.33a</td>
<td>29.67b</td>
<td>0.38b</td>
<td>13.97a</td>
</tr>
<tr>
<td>LSD0.05</td>
<td>1.49</td>
<td>1.88</td>
<td>0.04</td>
<td>0.47</td>
</tr>
</tbody>
</table>

Means with the same letters along column are not significantly different from one another (DMRT at P ≤ 0.05).

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