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CULTIVATION OF SHIITAKE USING SAWDUST FROM WIDELY AVAILABLE LOCAL WOODS IN ARGENTINA

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ABSTRACT

The cultivation of shiitake (\textit{Lentinula edodes}) in Argentina began in recent years; however, tree species commonly used as substrates in Southeast Asia or North America are not present. We assayed eight types of easily available local woods: “coihue” (\textit{Nothofagus dombeyi}), “lenga” (\textit{N. pumilio}), “ñire” (\textit{N. antarctica}), “robler pelín” (\textit{N. obliqua}), eucalypt (\textit{Eucalyptus camaldulensis}), pine (\textit{Pinus elliottii}), “Paraná pine” (\textit{Araucaria angustifolia}), and willow (\textit{Salix babylonica}). Two strains of shiitake were studied, using experimental blocks (1 kg) which contained the following substrate formulation: 80\% sawdust, 10\% wheat bran, 10\% millet seed, 2\% chalk, adjusted to 74\% moisture. Blocks were incubated at 25 C for a month, and then subjected to a cold shock at 5 C for 7-10 days in order to promote fruiting. After induction, the blocks were placed in a room at 18±3 C, about 9 h/day of lighting, and watered daily. Fruit bodies were obtained from most wood types studied, with the exception of “Paraná pine” and pine. The strain BAFC-2250 had higher biological efficiencies (BE), which were recorded in “robler pelín” (60.4\%), “lenga” (52.3\%), and eucalypt (26.5\%). The highest mushroom yield was also shown by the strain BAFC-2250.

Key words: \textit{Lentinula edodes}, shiitake, mushroom cultivation, sawdust, \textit{Nothofagus}, Argentina.
INTRODUCTION

Shiitake is an edible mushroom cultivated worldwide, mainly in SE Asia and the U.S.A. In the rest of America, it is also produced in Canada, Mexico, and Brazil.

In Argentina, the production of shiitake began in the early 1990s as small rural enterprises, and since 1999 the fresh product is available in most supermarkets. Current production is mainly based on wood log cultivation. However, many hardwood trees commonly used as a substrate for shiitake cultivation elsewhere are not available in Argentina. In this study, we tested local and exotic trees, which are widely available, as possible commercial formulations for shiitake production.

MATERIALS AND METHODS

Strains and spawn

The strains BAFC-1318 (commercial strain from Canada) and BAFC-2250 (commercial strain, origin unknown) of Lentinula edodes (Berk.)Pegler, deposited at the culture collection from the Dept. of Biological Sciences, School of Exact and Natural Sciences, University of Buenos Aires (BAFC), were used in all experiments. The spawn was prepared according to Royse and Bahler in 750 ml glass bottles by the addition of the following ingredients: rye grain, 80 g; sawdust, 6 g; CaCO₃, 2 g; and tap water, 105 ml. Bottles were autoclaved for 1 h at 121 C, cooled, then inoculated and the mycelium was allowed to grow for 3 weeks.

Substrate preparation and mycelial colonization

Sawdust from native Fagaceae trees, “coihue” [Nothofagus dombeyi (Mirb.)Oerst.], “lenga” [N. pumilio (Oep. et Endl.)Krasser], “fire” [N. antarctica (Forst.)Oerst.], and “roblo pellin” [N. obliqua (Mirb.)Oerst.]; eucalyptus (Eucalyptus camaldulensis Dehn); pine (Pinus elliottii Engelm); “Paraná pine” [Araucaria angustifolia (Bert.)Kunze]; and willow (Salix babylonica L. XS. alba L. ev “A-131-25”) were independently used to prepare eight different substrates, according to the formulation proposed by Royse: 80% sawdust, 10% wheat bran, 10% millet seed, and 2% chalk. Final moisture was adjusted to 74% (w/w) in each substrate. Polypropylene bags (30x45 cm) were filled with 1 kg of each prepared substrate, and stoppered with cotton plugs. All bags were autoclaved twice at 125 C for 120 min, having an interval of 24 h between sterilizations. Inoculation was carried out at a spawning rate of 7% (fresh weight). Four replicate bags were prepared for each substrate and strain tested. Inoculated bags were incubated at 25 C, in the dark, until the substrate was fully colonized (30-90 days). After colonization, the bags were transferred once to a cold chamber at 5-7 C for 7-10 days, in order to induce fruiting.

Fruiting

Blocks subjected to a cold shock were placed in a growing room for fruit-body development. We used one room system for all stages of fruiting. Conditions were: temperature, 18 ±3°C; relative humidity, 70-90 %; watering by means of automatic aspersor system, 5 min each 3 h; and the lighting was controlled automatically (9 h, fluorescent lamps). Mature fruit bodies were harvested when the veil had broken, gills were fully exposed, and the margin of the pileus was still slightly convex. Their pileus diameter was measured, and the number of basidiomata was recorded per block, as well as their fresh weight. Blocks were kept for about four months. Biological efficiency (BE) was calculated as BE = (TFW/ DWS) x 100, where TFW is the total fresh weight of harvested mushrooms, and DWS is the dry weight of the substrate.
Experimental design
An unbalanced factorial design of 6 x 2 treatments with replicates was followed. The factors considered were: type of wood and strain studied. A computer was used to perform an unbalanced analysis of variance of two factors, and to carry out tests of simple effects.

RESULTS AND DISCUSSION

The mean pileus diameter (MPD) of basidiomata, total fresh weight (TFW), and BE obtained for each type of wood and strain are shown in Table 1. MPD varied from 58.9-93.6 mm for “coihue” (strain BAFC-2250) and “lenga” (strain BAFC-2250), respectively. MPD was larger in the strain BAFC-2250 for all types of wood (TW), with the exception of “coihue”. The highest mushroom yield and BE were recorded with the strain BAFC-2250, using two woods of the family Fagaceae (Fig. 1), “roble pellín” (Nothofagus obliqua: 629 g; 60.4%) and “lenga” (N. pumilio: 544 g; 52.3%), followed by eucalypt (Eucalyptus camaldulensis: 276 g; 26.5%). With the exception of “coihue” and willow, higher BEs were recorded for all TW with the strain BAFC-2250. Significant differences were found for all cases in the analysis of variance from TFW of fruit bodies harvested, indicating influence of TW, strain, or their combination. Likewise, there were significant differences considering the simple effect between strains used and TW; this was the case for the effect strain-“lenga” and strain-“roble pellín.” For the simple effect between different TW and each strain separately, significant differences were also found for the interaction TW-strain BAFC-2250. It seems appropriate accordingly the use of several shiitake strains when testing different types of woods.

In the TW belonging to the family Fagaceae (Table 1), the highest BE was recorded in “roble pellín” (60.4%) and “lenga” (52.3%). “Roble pellín” is a high density wood (720 kg/m³), similar to those species of Fagaceae from the Northern hemisphere which have been reported as substrates to obtain the best yields in shiitake production. Similar results have previously been obtained by other authors using supplemented sawdust as a substrate. Royse and Bahler reported BEs ranging from 7.9-132.3% using Quercus rubra (northern red oak). Donoghe and Denison, after testing Q. garryana (Oregon white oak), obtained BEs varying from 61-62%. Rinker studied a mixture of white and red oaks, and reported a BE of 55.9%. In Mexico, Morales and Martínez-Carrera tested Quercus spp. and Bursera simaruba, obtaining BEs ranging from 45.9-53.7%.

BEs obtained with willow (22.3%) and eucalypt (26.5%) were lower than other formulations studied (Table 1), as these TW are considered moderately suitable for shiitake production.

Sawdust from pine and “Paraná pine” had BEs of 0 and 2.0%, respectively, and therefore are not good substrates for shiitake cultivation.

In general, the resinous wood from most pines is not recommended for the commercial production of this edible mushroom, unless supplementation is provided, old sawdust is used (> 1 year), or the sawdust is treated with sodium car-

Fig. 1. Cultivation of shiitake on blocks of Nothofagus sawdust.
bonate to partially degrade resins and phenolic compounds.

In Argentina, the most available sawdusts at domestic level are in decreasing order: pine, eucalypt, and willow, thus it is recommended to test several mixtures of sawdust, particle sizes, supplements, and strains, in order to obtain higher BEs in large-scale cultivation. Nevertheless, in the southwest of the country, the forests are almost exclusively of *Nothofagus*, so the possibility of growing shiitake is a very interesting economic alternative for the region.

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**Table 1.** Number of fruit bodies harvested (NF), mean pileus diameter (MPD), total fresh weight (TFW), and biological efficiency (BE) of two strains (BAFC-1318 & -2250) of *Lentinula edodes* cultivated on a substrate formulation containing several types of wood.

<table>
<thead>
<tr>
<th>Type of wood</th>
<th>Spawn strain</th>
<th>NF</th>
<th>MPD (mm)</th>
<th>TFW (g)</th>
<th>BE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A³ A⁴</td>
</tr>
<tr>
<td>“Colhue”</td>
<td>1318</td>
<td>4</td>
<td>69.0</td>
<td>80</td>
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<tr>
<td>(Notofagus dombeyi)</td>
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<td>39</td>
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<td></td>
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<td></td>
<td></td>
<td>A A</td>
</tr>
<tr>
<td>“Lenga”</td>
<td>1318</td>
<td>8</td>
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<td>263</td>
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<tr>
<td>(N. pumilio)</td>
<td>2250</td>
<td>13</td>
<td>93.6</td>
<td>544</td>
<td>52.3</td>
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<td></td>
<td></td>
<td></td>
<td>B B</td>
</tr>
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<td>A A</td>
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<td>“Roble pellín”</td>
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<td>5</td>
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<td>233</td>
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³ Differences between the two strains assayed. Means at the same column for a given wood followed by the same letter are not significantly different at P= 0.005 level for the test of simple effects.

⁴ Differences among types of wood. Means at the same column for a given strain followed by the same letter are not significantly different at P= 0.005 level for the test of simple effects.

LITERATURE CITED


