Production of Shiitake (*Lentinula edodes*) Mushrooms in Lignocellulosic Residues

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Abstract
Lignocellulosic residues were tested as artificial log to mushroom production of *Lentinula edodes*. Three isolates of *L. edodes* were grown in substrates based on corn bog, and sawdust or bark of eucalypt, enriched with rice bran 20%. The biological efficiency (BE) were higher when corn borg and sawdust was used and the isolate UFV 73 was that presented well shaped mushrooms and higher productivity. The isolates UFV 16 and UFV 52 presented many deformed mushrooms. These results show the importance to select well-adapted isolates for mushrooms production on synthetic logs.

1. Introduction

Mushroom cultivation is a very important biotechnological process in the modern society, not only because it produces food of high nutritional value, but also because this fungus can be grown on agro-industrial residues, representing one of the more efficient ways by which these residues can be recycled (Madan *et al*., 1987). Application of agro-industrial residues in bioprocesses besides provides alternative substrates, also helps in solving pollution problems, which their disposal may otherwise cause (Pandey *et al*., 2000).

Lentinula edodes mushrooms have been cultivated on lignocellulosic substrates, which can comprise sawn wood logs, or artificial logs, made from comminuted residues such as wood sawdust and agricultural wastes (cereal straws, sugarcane bagasse). Those logs are spawned, the fungus colonizes them, and after a period, its mycelium produces a fruiting body (Suguimoto *et al*., 2001).

The objective of this work was to explore the potential of some agro-industrial residues for shiitake mushrooms cultivation in artificial logs.

2. Material and methods

2.1 Microorganism and solid-state cultivation

Three strains (UFV-16, UFV-52 and UFV-73) of Shiitake (*Lentinula edodes*), was obtained from the collection of Department of Microbiology/BIOAGRO of Federal University of Vicosa. Mycelium of these isolates was transferred from the stock culture to Petri dish containing PDA (potato dextrose agar) and incubated a 25'C for 7 days.

2.2 Substrates preparation

Three agro-industrial residues were tested: fragmented corn bog, eucalypt bark (obtained direct from the cellulose industry) and eucalypt sawdust. The substrate was prepared by mixing rice bran to the residues (1:4 v/v). Water was added to give final moisture content of 60 %. Approximately, 0.6 Kg of the substrate was packed in high-density polyethylene bags and autoclaved at 120'C for 2 hours. The autoclavation was repeated after 48 h to guarantee complete elimination of resistant spores. After cooling, each bag was inoculated with 20 g of PDA containing mycelium.

The experiment was performed in 3 x 3 factorial, consisting of combinations of three *L. edodes* isolates and three types of substrates, in 5 replicates.

2.3 Spawn run, log browning and soaking
After 60 days of spawn running, 15 slits (5 mm each) were made on the top of each bag with a sharp scalpel to provide gas exchange. At the end of 10 days, at 23 ±1 'C and relative humidity 90-95 %, the plastic bags was opened in the upper portion, and maintained at same conditions, during 7 days, for permitting a hard and thick brow coat formed on the surface of the block. After this period the plastic bag was completely removed, and the artificial logs were soaked into the water at 10 ±2'C for 12 h. Then, the blocks were placed in a fruiting room with a controlled temperature of a 23'C and relative humidity between 85-90% and 12 hours of light were provided.

2.4 Evaluation of productivity
Mushrooms were harvested from the substrate when the veil had broken and the gills were fully exposed. The mushrooms were then counted and weighed. Productivity was evaluated using the following parameters:
-Biological efficiency (BE), was calculate as (mushroom fresh weight (Kg) / block dry weight (Kg)) x100;
-Mean number of mushroom (MNM), corresponding to number of mushrooms per block;
-Yield (weight of fresh mushrooms (Kg) / weight substrate (Kg)).

3. Results and discussion

All isolates were able to form mushrooms in all substrates (Tab. 1), but higher productivity was obtained in corn bogs (Tab. 1).
Highest BE and yield was obtained by strain UFV-73 when grown on corn bog based substrate (Tab. 1), while the smallest growth was recorded to strain UFV-16 (Tab. 1).

Although sawdust has been the more common substrate for artificial logs, some substrates, as sugarcane bagasse, has showing a good alternatives, presenting high productivity and BE (Ruegger *et al*., 2001). Good shaped and biggest mushrooms were also formed by the isolate UFV-73 (Fig. 1). Mushrooms formed by the isolates UFV-16 (Fig. 2) and UFV-52 (Fig. 3) were small and deformed. Theses results show the importance of to select isolates adapted to be used in artificial log.

The effective cost in mushroom production depends on the reliability, availability and cost of substrate ingredients (Royse *et al*., 2004). According our results, shiitake cultivation in artificial logs using corn bogs based substrates appear that is economically viable alternative. Development of alternative substrates with higher yield capacity and cheap for shiitake mushroom production should ultimately lower the cost to consumers.

Table 1. Biological efficiency (BE), Yield (Y), mean number of mushroom per block (MNM), Dry weight of mushroom (Kg) and average size of mushroom pileus (cm) of three *Lentinula edodes* isolates when grown in different substrates compositions.

Substrate	Isolate	BE [a] (%)	Yield [b] (kg)	MNM	Dry wt. (kg)	Size (cm)
Eucalypt sawdust	UFV-16	13.67	0.18	4.6	9.15	3.17
Corn bog	UFV-16	13.64	0.27	9.0	27.88	2.90
Eucalypt bark	UFV-16	2.73	0.03	0.6	6.69	3.73
Eucalypt sawdust	UFV-52	11.95	0.15	2.6	10.48	3.35
Corn bog	UFV-52	2.19	0.04	0.6	4.83	3.12
Eucalypt bark	UFV-52	3.47	0.05	0.6	4.75	3.36
Eucalypt sawdust	UFV-73	21.47	0.28	8.5	21.18	3.46

Corn bog	UFV-73	37.56	0.60	5.2	60.15	4.20
Eucalypt bark	UFV-73	6.92	0.11	1.0	9.68	4.15

[a] %BE = (kg fresh mushrooms/kg dry substrate) x 100 (includes supplement wt.).
[b] Yield = (kg fresh mushrooms harvested at maturity / 0.6 kg moist substrate weight.

Fig.1. Mushrooms of *Lentinula edodes* (UFV-73) on substrate based on eucalypt sawdust, corn bog and eucalypt bark (from left), after 60 days of spawn running.

Fig.2. Mushrooms of *Lentinula edodes* (UFV-16) on substrate based on eucalypt sawdust, corn bog and eucalypt bark (from left), after 60 days of spawn running.

Fig.3. Mushrooms of *Lentinula edodes* (UFV-52) on substrate based on eucalypt sawdust, corn bog and eucalypt bark (from left), after 60 days of spawn running.

4. Conclusion

The corn bog is a good alternative for be using in artificial logs and the well adapted strain was UFV-73. Strains adapted to eucalypt sawdust and bark have been selected for an efficient shiitake production.

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6. References

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