Experimental Study on Mushroom Yield of Commercial Strains from *Pleurotus ostreatus* Cultivated on Rice Straw in Mexico

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Abstract

Four commercial strains of Pleurotus ostreatus *were cultivated at the pilot plant level on rice straw as substrate. In all strains, three harvest were obtained, except in one that only presented two, in a period of 41 to 59 days. The parameters evaluated were days in the formation of fruiting primordia, the pileus diameter (three groups G1: <5 cm; G2: of 5 to 9.9 cm; G3: >10 cm), biological efficiency (BE), yield (Y) and production rate (PR). Strains CP-281 and CP-753 showed the highest production with 261.1% and 240.6% of BE, 60% and 55.3% of Y, 5.2% and 5.8% of PR, respectively. Next, CP-245 strain showed 213.3% of BE, 49% of Y and 3.8% of PR. Lower production was presented on CP-50 strain (EB 170.9%, Y 39.3% and PR 4.2%). The fours trains can be cultivated in small or large scale in several regions of Mexico.*

Keywords: Mushroom cultivation, agricultural wastes, edible mushroom.

1. Introduction

Pleurotus spp., is one group of edible mushrooms cultivated commercially, which rank second worldwide (Royse *et al.,* 2017). In Latin America, commercial production is generated mainly in Brazil, Mexico, Colombia, Argentina and Guatemala (Royse and Sanchez, 2017). In Mexico, mushroom production (*Pleurotus* spp.) is 4.76%, of total production (Martínez-Carrera *et al.,* 2016). In the cultivation most strains of foreign origin which are adapted to grow on different substrates have mostly be used. Therefore, it is important to know strains that can be incorporated and adapted into the cultivation of edible mushroom in different regions of Mexico to obtain higher yields. In this study, we evaluated the production at the pilot plant level of four commercial strains of *Pleurotus ostreatus*, using rice straw (*Oryza sativa*) as a substrate.

2. Materials and methods

2.1. Strains and spawn

CP-245, CP-281, CP-753 and CP-50 strains of *P. ostreatus* were studied, which are deposited at the Genetic Resources Unit of Edible, Functional and Medicinal Mushrooms (CREGENHCFM), College of Postgraduates *Campus* Puebla, Mexico. They were maintained on potato dextrose agar (PDA, Difco) and incubated at 27ºC-28ºC. Spawn was prepared on wheat grains (*Triticum aestivum*), sterilized at 121ºC for 1 h in polypropylene bags (*ca.* 250 g/bag) and inoculated with 1 cm^2 of PDA with mycelium developed from each strain. Inoculated bags were incubated at 27ºC ± 2ºC for two weeks in darkness.

2.2. Substrate preparation and spawning

Rice straw was cut into 5 to 6 cm lengths and soaked in water for 18 h and pasteurized by immersion in hot water at 80ºC for 1 h. Once cold, it was placed into polypropylene bags (40 x 60 cm) with 1.5 kg fresh weight per bag and spawned (*ca*. 100 g inoculum). The moisture content of the substrate was 77%. Ten samples were prepared for each strain.

2.3. Incubation and crops

Inoculated bags were incubated at 25ºC-28°C in the dark. When the first primordia appeared they were transferred to the production room and placed on metal shelves, then the plastic was removed and the environmental conditions went from 76%-85% of relative humidity, 25ºC-27ºC, with day light conditions through windows.
Productivity was based on the number of days until primordia formation, biological efficiency (BE, fresh weight of mushrooms/dry weight substrate x 100), mature basidiocarps yield (Y) (fresh weight of mushrooms/fresh weight substrate x 100), production rate (PR, BE/total days of production). Basidiocarps were classified according to the diameter of pileus: group 1 (G1) <5 cm, group 2 (G2) from 5 to 9.9 cm and group 3 (G3) >10 cm (Gaitán-Hernández and Silva, 2016).

3. Experimental design and statistical analysis

A completely random design was used. Data were processed by an analysis of variance and the average values were analyzed using Tukey's multiple range test ($\alpha = 0.05$).

4. Results and discussion

Rice straw was a suitable substrate for fruiting of the four strains, which presented the first fruiting primordia between 15 and 45 days after spawning. The production cycle was between 41 and 59 days. In the size of the pileus, the percentages were for G1 between 18.9% and 50.9%, for G2 between 43% and 56.1%, and for G3 between 4.8% and 25% (**Table 1**).

Table 1. Formation of primordia, total cultivation cycle (days) and the averages of mushroom production by size Group (percentage in parentheses) obtained by four *P. ostreatus* strains cultivated on rice straw.

	Appearance of primordia (days after spawning)				Groups by size of the pileus (g)		
Strains	1st	2nd	3rd	TCC[1]	G1[2]	G2	G3
CP-245	40-45	50-57	0	54-59	267.7 (36.3) b*	316 (43) bc	152.1 (20.7) ab
CP-281	20-23	30-31	42-48	47-53	458.7 (50.9) a	399.4 (44.3) ab	42.8 (4.8) b
CP-753	16-18	27-31	37-40	42-45	156.8 (18.9) c	465.9 (56.1) a	207.2 (25) a
CP-50	15-19	24-29	36-39	41-44	270.2 (45.9) b	269.5 (45.7) b	49.7 (8.4) b

[1]TCC = total crops cycle
[2]G1: < 5 cm; G2: of 5 to 9.9 cm; G3: > 10 cm.
*Different letters in the same column indicate statistical differences between mean values according to Tukey's multiple range test ($\alpha = 0.05$).

Three harvests in each strain was obtained, except one strain that only presented two, with total average values between 589.4 g and 900.9 g. The values obtained in each strain ranged from 170.9% to 261.1% of BE, 39.3% to 60% of Y and 3.8% to 5.8% of PR (**Table 2**).

Table 2. Distribution of total averages in mushroom production (g) (percentage in parentheses) and evaluation of the productivity achieved by four *P. ostreatus* strains.

	Harvests (g)				Productivity indices		
Strains	1st	2nd	3rd	Total (g)	BE%	Y%	PR%
CP-245	621.8 (84.5) a*	114.1 (15.5) c	0 c	735.9 b	213.3 ± 23 b	49 ± 5.3 b	3.8 ± 0.5 b
CP-281	573.3 (63.6) a	233.5 (25.9) a	94.2 (10.5) a	900.9 a	261.1 ± 21 a	60 ± 4.8 a	5.2 ± 0.4 a
CP-753	606.4 (73) a	165.8 (20) b	57.7 (7) b	829.9 ab	240.6 ± 35 ab	55.3 ± 8 ab	5.8 ± 0.9 a
CP-50	374.1 (63.5) b	139.4 (23.6) bc	76 (12.9) ab	589.4 c	170.9 ± 30 c	39.3 ± 7 c	4.2 ± 0.8 b

BE = biological efficiency
Y= yield
PR = production rate
*Different letters in the same column indicate statistical differences between mean values according to Tuke's multiple range test ($\alpha = 0.05$).

There are no comparative records on production in CP-245, CP-281 and CP-753 strains. CP-50 strain has been cultivated in Mexico on several agricultural residues such as wheat straw (*Triticum aestivum*), barley straw (*Hordeum vulgare*), bean straw (*Phaseolus vulgaris*), corn stubble (*Zea mays*), dehydrated coffee bagasse (*Coffea arabica*), and dehydrated alfalfa (*Medicago sativa*) as a supplement in several agricultural residues already mentioned, reaching BE between 62.71% and 179.4%, PR between 0.3% and 1.9%, with total production cycle between 62 to 95 days at 26ºC-28ºC (Romero-Arenas *et al.*, 2013; 2018).

The values obtained on the four strains are highly superior to those recorded with other *Pleurotus* strains on rice straw, such as *P. ostreatus* (BE 55.0%, 92.1% and 95.46 %) (Mamiro and Mamiro, 2011; Kimenju *et al.*, 2009; Sharma *et al.*, 2013); *P. pulmonarius* (BE 75.65%, PR 1.44%), *P. djamor* (BE 19.69% to 55.79%, PR 0.36% to 1.03%) (Vega and Franco,2013). In all data cited, BE, PR and Y values are lower, with production cycles longer than those obtained in this study.

5. Conclusions

The CP-281 strain was statistically superior, followed by CP-245 and CP-753 strains. These strains exceeded the production on CP-50 strain, which was statistically inferior. However, the four strains reached high BE, Y and PR and are potentially suitable for use in the commercial cultivation or in rural areas with self-consumption production in México.

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