

Evaluation of *Pleurotus ostreatus* and *Pleurotus sajor-caju* nutritional characteristics when cultivated in different lignocellulosic wastes

M. Bonatti ^{a,b,*}, P. Karnopp ^a, H.M. Soares ^b, S.A. Furlan ^a

^a University of the Joinville Region, University Campus, Bloco A, sala A-123, P.O. Box 246, Bom Retiro, 89201-972 Joinville, SC, Brazil

^b Department of Chemical Engineering and Food Engineering, University of Santa Catarina, P.O. Box 476, 88040-900 Florianópolis, SC, Brazil

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Abstract

Fungi of *Pleurotus* genus present a high content of proteins and vitamins and low content of fat. Based on these facts, this work aimed to evaluate some nutritional characteristics of fruiting bodies of *Pleurotus ostreatus* and *Pleurotus sajor-caju* after the first harvest, using rice straw and banana straw as substrates. Both species presented a higher content of ash in the rice straw substrate (5.86% average) than in the banana straw (5.36%). *P. sajor-caju* CCB 019 showed higher moisture and fibre content when cultivated in rice straw (88.08% and 9.60%, respectively) than in banana straw (83.17% and 7.60%, respectively). The other parameters were not influenced by the cultivation substrate. The protein content (from 1.54% to 3.10%) of *Pleurotus* fresh fruiting bodies proved to be similar to, or even higher than, the values observed in various vegetables but lower than the protein contents of eggs, meat and cheese.

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1. Introduction

Pleurotus spp., commonly known as oyster fungus, is a common primary decomposer of wood and vegetal residues (Zadrzil & Kurtzman, 1981). It can be naturally found in tropical and subtropical rainforests, and can be artificially cultivated (Maziero, Bononi, & Capelari, 1992). Appreciated because of its delicious taste, this fungus has high quantities of proteins, carbohydrates, minerals (calcium, phosphorus, iron,) and vitamins (thiamin, riboflavin and niacin) as well as low fat (Sturion & Oetterer, 1995; Justo et al., 1998; Manzi, Gambelli, Marconi, Vivanti, & Pizzoferrato, 1999).

For many reasons the fungi of the *Pleurotus* genus have been intensively studied in many different parts in the world: they have high gastronomic value, they are able to colonize and degrade a large variety of ligno-

cellulosic 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, Rashad, & Abdu, 1995; Patrabansh & Madan, 1997).

Based on that, the objective of this work was to evaluate the nutritional value of *Pleurotus ostreatus* DSM 1833 and *Pleurotus sajor-caju* CCB 019, cultivated in rice straw and banana straw after the first productive flow.

2. Material and methods

2.1. Microorganisms and maintenance

Pleurotus ostreatus strain was obtained from the “Deutsche Sammlung von Mikroorganismen und Zellkulturen Gmdh” under the code of DSM 1833 and

* Corresponding author. Tel.: +39-041-234-8634; fax: +39-041-234-8690.

E-mail address: bonatti@unive.it (M. Bonatti).

P. sajor-caju was obtained from the “Basidiomycetes Cultivation Center of the University of São Paulo” under the code of CCB 019. The cultures were kept in Petri dishes containing TDA medium (1 litre of wheat extract, 20 g of dextrose and 15 g of agar) at 4 °C.

2.2. Inoculum production (spawn)

Wheat grains were used as substrate and support for growth. The grains were washed in flowing water and then cooked during 10 min (after boiling) in deionized water at the ratio of 1:2 (wheat grains:water, w:v). The extract obtained, was drained and the grains were supplemented with 0.35% CaCO₃ and 1.3% CaSO₄. The wheat grains, cooked and supplemented, were then packed (250 g wheat grains in polyethylene bags of 200 × 300 mm), closed and sterilized in an autoclave at 121 °C, for 1 h. After the sterilization, each bag was inoculated with 6 agar disks of 8 mm diameter containing mycelium and incubated at 30 °C, without any light during 15 days.

2.3. Culture medium and environmental conditions for fruiting bodies formation

Rice straw and banana straw were used as cultivation substrates. The rice straw consisted of residues used in irrigated rice cultivation (stems and leaves) which were left apart by the harvester and furnished by Vila Nova Industry located in Joinville-SC, Brazil. The banana straw consisted of banana plant leaves supplied by producers of the Pirabeiraba region in Joinville-SC, Brazil. The straws were ground into particles of 2–5 cm, dried in an oven at 60 °C for 1 h and packed in raffia bags. The bags containing the straw were kept under immersion in deionized water for 12 h according to the methodology proposed by Madan, Vasudevan, and Sharma (1987). In sequence, 150 g (dry weight) substrate was packed in a transparent polyethylene autoclavable bag of 40 × 30 cm and 50 µ thickness. Later, each plastic bag, containing substrate, was supplemented with 5% of rice bran (on dry weight basis) and closed while maintaining a vent filled with foam in order to allow moderate air exchange and to avoid external contamination. The plastic bags containing the substrate were then homogenized, sterilized in an autoclave at 121 °C, during 1 h 30 min, cooled to environment temperature under UV radiation for 30 min, inoculated in a continuous laminar flow chamber using 10% inoculum (on dry weight basis) and homogenized. After that, they were kept in a cultivation chamber at 25 ± 2 °C, 60% relative air humidity, in the presence of light for 20 days. Later, the induction of the fruit bodies formation was achieved by the plastic bag perforation (to increase air exchange), light exposure for a period of 12 h per day and increase of relative air humidity to 90%.

2.4. Harvest

The harvest point was determined in a visual way, as described by Sturion and Oetterer (1995). The fruiting bodies were harvested with a scalpel and put into trays. Each experimental unit was identified and weighed on semi-analytic weigher scale to determine the wet weight.

2.5. Analysis

The fruiting bodies of *P. ostreatus* DSM 1833 and *P. sajor-caju* CCB 019 were dried in an oven at 60 °C to constant weight, ground in a blender and kept under refrigeration at 4 °C. The analyses were carried out in triplicate and consisted of: moisture, total fat, total carbohydrates, ash, total nitrogen, total protein and total fibre. The analyses for moisture, total fat, total carbohydrates and ash were carried out through AOAC (1975) methods. The total nitrogen content was determined by the Kjeldahl (AOAC, 1975) method. The total protein was determined from the total nitrogen content, using the correction factor 4.38 (Breene, 1990).

2.6. Statistic analysis

The variables statistically analyzed were moisture, total fat, total carbohydrates and ash. The determinations were done in triplicate and these averages were used to verify significant differences, using the Duncan's test (Vieira, 1999) at the significance level of 5%.

3. Results and discussion

The composition of *P. ostreatus* DSM 1833 and *P. sajor-caju* CCB 019 fruiting bodies determined in these experiments can be found in Table 1.

Table 1 shows that the moisture of the *P. ostreatus* DSM 1833 fruiting bodies (86.85% average) was not influenced by the kind of cultivation substrate. However, *P. sajor-caju* CCB 019 fruiting bodies presented a higher moisture when cultivated in rice straw. The moisture values found in the work, are in accordance with the literature: Manzi et al. (1999) obtained moisture of 90.7% in *P. ostreatus* cultivated in wheat straw supplemented with sugar beet. From the total fat presented in Table 1, it can be verified there is a higher total fat in *P. ostreatus* DSM 1833 fruiting bodies than in *P. sajor-caju* CCB 019 fruiting bodies when cultivated in rice straw. The total fats found in fruiting bodies are similar to those reported by Ortega, Martinez, Betancourt, Gonzalez, and Otero (1993) for *P. ostreatus* cultivated in sugar cane (5.3%).

Total carbohydrate contents, showed no significant differences between fruiting bodies, species or cultivation substrates used. The carbohydrate contents obtained in

Table 1
Composition of *P. ostreatus* DSM 1833 and *P. sajor-caju* CCB 019 fruiting bodies, cultivated in rice straw and banana straw

Parameters	<i>P. ostreatus</i> DSM 1833		<i>P. sajor-caju</i> CCB 019	
	Banana straw	Rice straw	Banana straw	Rice straw
Moisture	88.06 ^{ac}	85.64 ^{ac}	83.17 ^{ac}	88.08 ^{bc}
Total fat	5.97 ^{ac}	6.32 ^{ac}	5.26 ^{ac}	4.99 ^{ad}
Total carbohydrates	47.0 ^{ac}	47.6 ^{ac}	43.00 ^{ac}	42.8 ^{ac}
Ash	5.58 ^{ac}	6.13 ^{bc}	5.14 ^{ad}	5.59 ^{bc}
Total fibre	9.41 ^{ac}	9.86 ^{ac}	7.60 ^{ad}	9.60 ^{bc}
Total nitrogen	3.85	3.00	4.20	2.96
Total protein	16.9	13.1	18.4	13.0

Except for moisture (g/100 g of wet mass), the other values are in terms of dry mass (g/100 g of dry mass).

^{a,b} Indicate the existence or not of significant difference among the values obtained from banana straw and rice straw for the parameters moisture, total fat, total carbohydrates, ash and total fibre, according to the Duncan's test, at the 5% confidence level.

^{c,d} Indicate the existence or not of significant difference among the values obtained from the species *P. ostreatus* DSM 1833 and *sajor-caju* CCB 019 for the parameters moisture, total fat, total carbohydrates, ash and total fibre, according to the Duncan's test, at the 5% confidence level.

Table 2
Protein content of *P. ostreatus* DSM 1833 and *P. sajor-caju* CCB 019, obtained in this work and other food

Food	Proteins (g/100 g fresh mass)	Reference
Fresh <i>P. ostreatus</i> DSM 1833	2.01	This work: Banana straw
	1.89	This work: Rice straw
Fresh <i>P. sajor-caju</i> CCB 019	3.10	This work: Banana straw
	1.54	This work: Rice straw
Fresh fungi	1.70	Franco (1999)
Canned corn	3.00	
Canned heart of palm	1.60	
Raw white potato	1.80	
Raw entire chicken egg	12.30	
Cottage cheese	18.00	
Raw bluefish	19.60	
Raw beef	16.20	

this work are in accordance with the ones reported by Patrabanish and Madan (1997), who found between 42.8% and 47.7% for *P. sajor-caju* cultivated in different agro-industrial residues. The ash contents in the *P. ostreatus* DSM 1833 and *P. sajor-caju* CCB 019 fruiting bodies were higher when rice straw was used as cultivation substrate. When banana straw was used a higher ash content in *P. ostreatus* DSM 1833 fruiting bodies was noticed. Manzi et al. (1999) found 8.3% of ash in *P. ostreatus* cultivated in wheat straw supplemented with sugar beet. Total fibre content values obtained in this work (7.6–9.86%) are lower than those reported in the literature: 34.8% for *P. ostreatus* cultivated in wheat straw (Justo et al., 1999); 12.70–18.01% in *P. sajor-caju* cultivated in various agro-industrial residues (Patrabanish & Madan, 1997). However, this can be explained by the different cultivation substrate used by other authors. According to Sturion and Oetterer (1995), the fungal nutritional value can be greatly affected by the cultivation substrate. The total nitrogen content found for *P. ostreatus* DSM 1833 (3.00–3.85%) and for *P. sajor-caju* CCB 019 (2.96–4.20%) are close to those described by the majority of the authors for these species, grown in different substrates: 3.94–4.56% in *P. ostreatus*

cultivated in wheat straw (Justo et al., 1999); 4.4% in *P. sajor-caju* cultivated in banana straw and banana straw mixed with sugar cane bagasse (Ranzani & Sturion, 1998). Higher nitrogen contents are also described by Manzi et al. (1999), who found 6.5% in *P. ostreatus* cultivated in wheat straw supplemented with sugar beet. Sturion and Oetterer (1995) obtained 4.7% in *P. sajor-caju* cultivated in different substrates.

The protein contents of *P. ostreatus* DSM 1833 and *P. sajor-caju* CCB 019, obtained in this work are presented in Table 2, in terms of g/100 g of dry mass, in comparison to other food.

P. ostreatus DSM 1833 and *P. sajor-caju* CCB 019 fruiting bodies cultivated in banana straw and in rice straw, had protein contents similar to those found in canned corn and palm heart and in raw white potato. However, they were content lower than those found in chicken egg, cottage cheese, raw bluefish and raw beef.

4. Conclusions

The total carbohydrate contents did not show significant differences, at the 5% level, for the different fungal

species cultivated (*P. ostreatus* DSM 1833 and *P. sajor-caju* CCB 019) for either of the cultivation substrates used (rice straw or banana straw). Nevertheless, the total fat content was higher in *P. ostreatus* DSM 1833 than in *P. sajor-caju* CCB 019, when rice straw was the cultivation substrate used. Both *P. ostreatus* DSM 1833 and *P. sajor-caju* CCB 019 had higher ash contents when cultivated in rice straw than in banana straw. *P. ostreatus* DSM 1833 had a higher total fibre content when cultivated in banana straw while *P. sajor-caju* CCB 019 had a higher total fibre content when cultivated in rice straw.

The *Pleurotus* fruiting bodies had a protein contents similar to or higher than those found in many vegetables, but lower than the protein contents of eggs, beef and cheese.

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