Nutritional and Inorganic contaminants profiles of Shitake mushrooms (Lentinula edodes) growing under different conditions

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Abstract – The aim of this study was to evaluate and compare the nutritional composition of shiitake mushrooms (Lentinula edodes) obtained by different cultivation processes from different areas (fruiting induced by sprinkler from Amarante or dipping method from Sintra). Macronutrient, vitamin B1 and B2, minerals and contaminant trace metals were quantified in three samples.
Variability among the different samples regarding macronutrients, minerals content was found. Regarding contaminants content, only one sample showed an atypical high value for arsenic. The results obtained indicate that the shiitake mushroom is an important dietary source of several nutrients, and the sample fructified by dipping seems to be nutritionally richer and chemically safer.
Keywords: mushrooms, shiitake, *Lentinula edodes*, nutritional composition.

INTRODUCTION

The growing adoption of the shiitake mushroom by Western consumers, due to its nutritional, medicinal and organoleptic properties, resulted in a major expansion of the natural habitat of this species, being currently the second most popular edible mushroom in the world.[8] The cultivation of shiitake mushroom in nature is very similar to manipulated cultivation method most used today – log cultivation.[8] The production process begins with the selection and preparation of logs and spawn; followed by inoculation of logs; incubation; fruiting; and harvesting.[5]
It is known that this species is rich in vitamin B, essential amino acids, proteins and minerals, with a water content between 88-92%.[2][5][8] However, different factors affect the nutritional composition of shiitake mushroom and probably its contaminant profile: cultivation process, strain used, method and fruiting conditions, species of wood used for the underlying base structure, weather and the region of production.[10]

MATERIALS AND METHODS

❑ Sample characterization and preparation

	Samples		
Characterization	A1	A2	A3
Strain		Shiitake donko	
Amount (kg)		0,5	
Local of production	Amarante	Amarante	Sintra
Induction of Fruiting	Sprinkler	Sprinkler	Dipping
Spawn origin	Portuguese	Belgian	Portuguese

Each sample of fresh mushrooms was divided into two subsamples of 0.25 kg. One was freeze-dried and the other was immediately used to macronutrient and vitamin analysis. The freeze-dried portion was used for the determination of contaminants profile, minerals and trace elements. In these assays the samples were previously digested in microwave in closed vessels.

❑ Methods applied

Assay		Method
Macronutrients	Moisture	Gravimetric
	Ash	Incineration process (525 °C)
	Fat matter	Acid hydrolysis with extraction
	Total protein	Kjeldahl
	Total sugar	Munson and Walker
	Fiber content	Enzymatic-gravimetric
	Carbohydrates	Calculation
Micronutrients	Vitamins B1 and B2	HPLC
	Copper, manganese, iron, zinc, magnesium, calcium, sodium, phosphorus, potassium	ICP-OES
	Selenium	ICP-MS
Contaminants profile	Arsenic, cadmium, lead and chromium	ICP-MS

RESULTS AND DISCUSSION

❑ Quality assurance and traceability

A rigorous quality assurance program followed the ISO 17025 requirement was implemented for analysis. Certified Reference Material GBW 10014 Cabbage and NIST 1548a Typical Diet was used to test the accuracy and precision of the method of analysis Recoveries between 80% and 120% were obtained. All samples were analyzed in triplicate and the repeatability were always below 10%.

Table 1. Moisture, ash and macronutrient content of analyzed shiitake mushrooms (g/100 g fresh weight)

	Samples		
	A1	**A2**	**A3**
Moisture	90,6	87,5	79,0
Ash	0,7	0,8	1,1
Fat	0,4	0,4	0,4
Protein	1,6	1,8	2,0
Fiber	4,6	4,1	6,7
Carbohydrates	1,0	4,4	6,7
Sugar	1,1	1,0	4,1

Published studies report shiitake mushroom as a source of protein with high ash content, low fat and high content of fiber. [1][3][4][7] The results obtained in this study are consistent with what is described.
Regarding the sugar, this results are generally lower than the sugar content reported by previous studies.[9]
in relation to moisture, Bisen et al. (2010) reported a moisture content between 88-92 g/100 g in the fruitbodies of *L. edodes,* slightly lower than that obtained.[2]

Table 2. Vitamin B1 (thiamine) and vitamin B2 (riboflavin) content of analyzed shiitake mushrooms (mg/100 g fresh weight).

	Samples		
	A1	**A2**	**A3**
Vitamin B1	< 0,05	< 0,05	< 0,05
Vitamin B2	0,18	0,17	0,19

Several studies have identified the shiitake mushroom as being rich in vitamin B1 and B2.[2][5] Our study showed a significant content of vitamin B2 in shiitake mushrooms (Table 2).

Table 3. Mineral content of analyzed shiitake mushrooms (mg/100 g fresh weight).

	Samples		
	A1	**A2**	**A3**
Cu	0,09	0,13	0,14
Mn	0,30	0,35	1,61
Fe	0,34	0,36	0,40
Zn	0,51	0,50	0,68
Mg	14,57	15,03	18,86
Ca	1,90	1,92	7,42
Na	1,62	2,89	6,40
P	76,41	78,38	84,45
K	314,41	358,95	510,19
Se	0,001	n.d.	0,002

Minerals and trace elements were found in all samples (table 3). The literature describes that the potassium and phosphorus are the two dominant major elements of the mineral content of this mushroom, that was consistent with the results obtained.[4] [8] Sample A3 showed higher mineral content than samples A1 and A2. The amount of minerals is highly correlated with the ash content of the samples.

Table 4. Trace elements content of analyzed shiitake mushrooms (mg/kg fresh weight)

	Samples		
	A1	**A2**	**A3**
As	0,060	0,200	0,005
Cd	0,04	0,06	0,04
Pb	n.d.	n.d.	n.d.
Cr	0,02	0,03	0,04

The profile of contaminants and trace elements showed low values for all elements in the different samples, with the exception of arsenic in A2 which (Table 4). Still, all arsenic results are in the normal range found in shiitake mushrooms produced in non-polluted areas (0.5-5 mg/kg).[6]

CONCLUSIONS

The study involves a critique and comparative analysis about the nutritional composition and contaminants of three samples of shiitake mushrooms cultivated by different processes in different areas. In conclusion, the results obtained in this study indicate that the shiitake mushroom is an important dietary source of several nutrients, and the sample fructified by dipping (sample A3) seems to be nutritionally richer and chemically safer.

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