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ADD-VALUE OF *LACTARIUS DELICIOSUS* AND *MACROLEPIOTA PROCERA* WILD MUSHROOMS DUE TO THEIR NUTRITIONAL AND NUTRACEUTICAL POTENTIAL

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Abstract

This study describes the nutritional and nutraceutical potential of two species of wild edible mushrooms (*Lactarius deliciosus* and *Macrolepiota procera*) commonly consumed in the region of Trás-os-Montes, Northeast Portugal.

The nutritional parameters analyzed were moisture, ash, fat, proteins, carbohydrates and energetic contribution. Free sugars and fatty acids were also determined by high performance liquid chromatography coupled with a refractive index detector (HPLC/RI) and gas chromatography coupled with a flame ionization detector (GC/FID), respectively. Macronutrient profile revealed that the studied species are rich sources of carbohydrates, proteins and energy, revealing low fat content. Mannitol and trehalose were the most abundant sugars in both species. The main fatty acid found in *M. procera* was linoleic acid, while stearic acid was the most abundant in *L. deliciosus.*

The nutraceutical potential was also evaluated through antioxidant properties measured by DPPH (1,1-diphenyl-2-picrylhydrazyl) radical scavenging activity, reducing power, inhibition of β-carotene bleaching and inhibition of LPO using thiobarbituric acid reactive substances (TBARS). The mentioned assays showed and high antioxidant activity for both samples species. Phenolic acids and related compounds were analysed by HPLC coupled to diode array detection (HPLC/DAD) and *p*-Hydroxybenzoic acid was found in *L. deliciosus* and cinnamic acid in *M. procera.*

Keywords: Wild mushrooms, nutritional value, nutraceutical potential, antioxidants.

INTRODUCTION

Natural products with antioxidant activity may be useful to aid human body protecting against endogenous production of free radicals and may be used as nutraceuticals. From this perspective, the antioxidants in our diet, and particularly in mushrooms, are of great importance as possible protective agents against oxidative damage (Ferreira et al., 2009). In fact, wild mushrooms are becoming more and more important in our diet for their nutritional (Kalač, 2009) and nutraceutical potential (Ferreira et al., 2009; 2010). The nutritional and chemical characterization of wild species is very important, in order to promote the consumption of wild edible mushrooms and to conserve their habitats. Furthermore, as they are a source of important antioxidants, those species can be used in the diet as nutraceuticals and/or functional foods maintaining and promoting health, longevity and life quality.

*Lactarius deliciosus (*L. ex Fr.) S. F. Gray and *Macrolepiota procera* (Scop. ex Fr.) Singer are among the most consumed wild species in Northeast of Portugal, one of the European regions with higher mushrooms biodiversity. Thus, the present study reports an evaluation of the nutritional and nutraceutical potential of those two species of wild edible mushrooms.

MATERIALS AND METHODS

Nutritional value

Macronutrients were evaluated by determining the moisture, protein, fat, carbohydrate according to AOAC procedures. Total carbohydrates were calculated by difference. The total energy was calculated according to the following equation: energy (kcal) = 4 × (g protein + g carbohydrate) + 9 × (g lipid). Free sugars were determined by HPLC-RI after extraction with ethanol:water (80:20, v/v) at 80 ºC. An Eurospher 100-5 NH_2 column (4.6 mm × 250 mm, 5 mm, Knauer) wa sused and the mobile phase was acetonitrile/deionized water, 70:30 (v/v). Fatty acids were determined by GC-FID after a trans-esterification procedure with methanol:sulfuric acid:toluente 2:1:1 (v:v:v). A Macherey-Nagel column (30 m × 0.32 mm i.d. × 0.25 μm d_f) was used and the carrier gas was hydrogen (Barros et al., 2007).

Nutraceutical value

Antioxidant activity of the mushrooms methanolic extracts was evaluated by DPPH radical-scavenging activity, reducing power, inhibition of β-carotene bleaching in the presence of linoleic acid radicals and inhibition of LPO using thiobarbituric acid reactive substances (TBARS). The extract concentrations providing 50% of antioxidant activity or 0.5 of

absorbance (EC_{50}) were calculated from the graphs of antioxidant activity percentages (DPPH and β-carotene bleaching assays) or absorbance at 690 nm (reducing power assay) against extract concentrations (Barros et al., 2007).

Phenolic acids were analyzed by HPLC-DAD after extraction with acetone:water (80:20, v:v) at -20ºC. Separation was achieved on a Spherisorb (Phenomenex, Torrance, CA) reverse phase C_{18} column (3 μm, 150 nm × 4.6 mm i.d.). The solvents used were: 2.5% acetic acid in water, acetic acid 2.5%:acetronitrile (90:10) and 100% HPLC-grade acetonitrile. Detection was carried out in a DAD, using 280 nm as the preferred wavelength (Barros et al., 2009).

RESULTS AND DISCUSSION

The results obtained in the analysis of nutritional potential are shown in Table 1.

Table 1. Nutritional composition of two species of wild edible mushrooms (Mean ± SD; n=3).

	Lactarius deliciosus	*Macrolepiota procera*
Nutritional value		
Moisture (g/100 g of fresh weight)	90.05±1.84	90.01±1.73
Ash (g/100 g of dry weight)	14.28±0.22	9.86±0.72
Fat (g/100 g of dry weight)	6.47±0.70	1.45±0.13
Protein (g/100 g of dry weight)	17.87±1.62	7.62±0.08
Carbohydrates (g/100 g of dry weight)	60.30±2.73	80.38±0.19
Energy (Kcal/100 g of dry weight)	370.90±3.97	365.01±0.59
Free sugars (g/100 g of dry weight)		
Mannitol	15.41±1.90	4.73±0.26
Trehalose	0.88±0.17	2.92±0.13
Fatty acids (relative percentage of each FA)		
Stearic acid	44.38±1.34	2.38±0.08
Linoleic acid	23.19±1.23	64.55±0.34
Total SFA	54.38±1.72	24.63±0.55
Total MUFA	21.85±0.40	10.17±0.31
Total PUFA	23.65±1.36	64.72±0.35

Both species revealed high moisture, carbohydrates, proteins content and energy, in contrast to low fat levels, which make them suitable to incorporate low caloric diets. Mannitol and trehalose, analysed by HPLC-RI, were the main sugars in the studied mushrooms, being the highest total sugars content observed in *L. deliciosus.* The main fatty acid found in *M. procera* was linoleic acid (C18:2n6c), an essential fatty acid to mammals precursor of arachidonic acid and of prostaglandins biosynthesis, which play important physiologic activities. Stearic acid (C18:0) was the most abundant fatty acid in *L. deliciosus,* which according to our research is a characteristic fatty acid of *Lactarius* species.

The results obtained in the analysis of nutraceutical potential are shown in Table 2.

Table 2. Nutraceutical composition of two species of wild edible mushrooms (Mean ± SD; n=3).

	Lactarius deliciosus	*Macrolepiota procera*
Antioxidants (mg/kg of dry weight)		
p-Hydroxybenzoic acid	22.66±0.36	n.d
Cinnamic acid	n.d	21.53±1.65
Antioxidant activity (EC_{50} values; mg/mL)		
DPPH radical scavenging activity	16.31±0.24	5.38±0.50
Reducing power	4.98±0.02	4.18±0.02
β-Carotene bleaching inhibition	3.76±0.24	5.19±0.16
TBARS assay	26.40±0.03	>50

Phenolic acids and related compounds, analysed by HPLC-DAD, were also found in the studied mushrooms, particularly *p*-hydroxybenzoic acid in *L. deliciosus* and cinnamic acid in *M. procera*. These compounds are well-known antioxidants and might be related to the antioxidant activity showed by both species, measured by scavenging properties, reducing power, β-Carotene bleaching inhibition and lipid peroxidation inhibition.

CONCLUSION

Being a source of important nutrients and antioxidants, the studied wild species can be used in diet as nutraceuticals and/or functional foods maintaining and promoting health, longevity and life quality.

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