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Nutritional quality of chestnut (*Castanea sativa* Mill.) cultivars from Portugal

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Abstract

Chemical composition of eight sweet chestnut cultivars from the three protected designation of origin (PDO) areas in the Trás-os-Montes region were studied: Aveleira, Rebordã, Trigueira and Zeive from PDO 'Terra Fria', Demanda, Longal and Martaínha from PDO 'Soutos da Lapa' and Judia from PDO 'Padrela'. Chestnuts were characterised by high moisture content (~50%), high levels of starch (43 g 100 g^{-1} dry matter – d.m.) and low fat content (3 g 100 g^{-1} d.m.). Nuts contained significant amounts of fibre (3% d.m.), were rich in K (~750 mg 100 g^{-1} d.m.), P (~120 mg 100 g^{-1} d.m.) and Mg (~75 mg 100 g^{-1} d.m.). Moreover, chestnuts are a good source of total amino acids (6–9 g 100 g^{-1} d.m.). Amino acid profiles were dominated by L-aspartic acid, followed by L-glutamic acid, leucine, L-alanine and arginine. These results provide additional information about the nutritional value of each cultivar and confirm that chestnuts are an interesting healthy food.

Keywords: *Castanea sativa*; Proximate analysis; Fibre; Minerals; Amino acids; Chemical composition

1. Introduction

Populations with a typical Mediterranean diet, characterised by a low consumption in meat and a high consumption in fish, fruits and vegetables and having nuts as valuable compounds, present lower mortality rates from coronary heart disease and cancer (Sabaté, Radak, & Brown, 2000). An increasing amount of evidence shows that the consumption of fruits, particularly nuts, has become more important in human nutrition, due to the protection provided by the antioxidant compounds (Blomhoff, Carlsen, Andersen, & Jacobs, 2006). According to these authors, of the tree nuts, chestnuts, walnuts and pecans have the highest content of antioxidants. Therefore, in recent years, the consumers have been showing an increased interest in chestnut fruits because of their nutritional qualities and potential beneficial health effects. In fact, chestnuts are also rich in carbohydrates and are a good source of essential fatty acids and minerals (Desmaison & Adrian, 1986; Senter, Payne, Miller, & Anagnostakis, 1994; Ferreira-Cardoso, Rodrigues, Gomes, Sequeira, & Torres-Perreira, 1999; Künsch et al., 1999; Borges, Carvalho, Correia, & Silva, 2006). In addition, they present several vitamins and appreciable levels of fibre (Vaughan & Geissler, 1997).

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Chestnut (*Castanea sativa* Mill.) is one of the oldest edible fruits in Portugal and, in the past, was widely used as extensively as potato and most of the tubers (Ferreira-Cardoso et al., 1999). The mainly production area is located in the Trás-os-Montes region (Northeast of Portugal), with an important role in the economy and landscape patrimony, contributing with 84% of the total of Portuguese's production. In order to preserve the biological material and to improve its cultivation, in 1994 three protected designation of origin (PDO) called 'Castanha da Terra Fria', 'Castanha dos Soutos da Lapa' and 'Castanha da Padrela' were created. In each PDO, with different environmental conditions, there are many well-adapted native cultivars. Since information about the nutritional composition of the Portuguese chestnut cultivars from the three PDO areas is still limited, the aim of this work was to determine starch, reductor sugars, crude protein, crude fat, fibre, mineral content and amino acid concentration of eight important native cultivars. This study also provides a useful reference about the quality of each cultivar for fresh market and industrial processing and also for producers and breeders.

2. Materials and methods

2.1. Samples

From the protected designation of origin (PDO) in the Trás-os-Montes region were chosen eight of the most important chestnut native cultivars: Aveleira, Rebordã, Trigueira and Zeive from PDO 'Terra Fria', Demanda, Longal and Martaínha from PDO 'Soutos da Lapa' and Judia from PDO 'Padrela'. Each PDO area has specific environmental conditions (Table 1). In the 2005 chestnut ripening season three representative trees from each cultivar were selected. Three samples (1 kg of nuts per sample) of each selected tree were randomly collected and kept unshelled in a refrigerator (2 °C) until analyses were performed ($n = 9$). Each sample was analysed in triplicate.

Table 1
Geographic and soil characterisation of the three protected designation of origin (PDO)[a]

DOP	Altitude (m)	Latitude	Longitude	Soil[a]
'Terra Fria'	650–900	41°40′–41°55′N	6°50′–7°10′W	Distric cambisols from schists
'Soutos da Lapa'	700–800	40°59′–41°05′N	7°25′–7°50′W	Distric cambisols from granites
'Padrela'	800–900	41° 35′–41°35′N	7°24′–7°30′W	Humic umbrisols from granits

[a] According to the soil map region and the correspondence to the World reference base for soil resources (FAO, 1998).

2.2. Proximate analysis

Moisture content was determined using the AOAC method (AOAC, 1990) and ash content according to AOAC (2000). Starch content was determined by a polarimetric method (Garcia & Wolf, 1972). Reductor sugars were determined according to AOAC (2000). The total nitrogen content was detected using the Kjeldahl method and the percentages of nitrogen were transformed into protein content by multiplying by a conversion factor of 5.3 (AOAC, 2000). The total fat extraction was performed according to AOAC (2000) methodology, using a Soxhlet apparatus; petroleum ether was used for extraction during 16 h. Chestnuts were shelled before analysis.

2.3. Mineral analysis

Macro and micronutrients K, Ca, Mg, Cu, Fe, Mn, Na and Zn were determined by atomic absorption using a spectrophotometer model SP9 Unilamp (AOAC, 2000) and P was estimated using a UV spectrophotometer model Hitachi U-2000 (BOE, 1995).

2.4. Fibre analysis

Crude fibre (CF), acid detergent and neutral fibre (ADF and NDF, respectively) were evaluated after extraction with the neutral detergent solution hydrolysis according to the procedures described by Van Soest and Wine (1967) using a Dosi-fibre with six plates, code 4000623, J.P. Selecta, S.A.

2.5. Total free α-amino acids analysis

The extraction and purification of free α-amino acids were performed according to Stein and Moore (1978). Dry chestnut flour (0.3 g) was weighed into a volumetric flask with 50 ml of HCl 6 M, containing 1 g l^{-1} reagent grade phenol and 5000 nmol of norleucine as an internal standard. Following removal of the acid at 50 °C on a rotary evaporator, the hydrolysates were transferred to an Erlenmyer flask and the volume was completed with distilled filtered water (Spartan 13, 0.2 μm). Two ml of this solution was centrifuged for 2 min at 5000 rpm. The dried residue was dissolved in 5 ml sodium citrate buffer, pH 2.2 (Amersham Pharmacia Biotech AB). The resuspended solution was filtered and kept at −80 °C until quantification. After that, suitable aliquots were analysed by ionic-exchange chromatography (in an automatic amino acid analyser Biochrom 20, Amersham Pharmacia Biotech AB), using the standard protein hydrolysate program with sodium citrate buffer and ninhydrin detection (Amersham Pharmacia Biotech AB). Afterwards, they were detected at 440 and 570 nm, with a spectrophotometer incorporated in the analyser equipment. Identification and quantification of detected amino acids were done comparing the calibration curves, through a data acquisi-