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Composition of varieties of chestnuts from Galicia (Spain)

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Abstract

The nutrient composition of 15 widespread varieties of chestnuts from the region of Verín-Monterrei was studied in order to establish their suitability for industrial transformation. We found that practically all of them showed a moisture content greater than 50%. Starch was the major nutrient. Contents of sucrose were in the normal range for this kind of product. Glucose and fructose were detected, although in very low concentrations. Protein content ranged from 6.0 to 8.6%, fibre 2–3%, lipids 1.3–3% and ash 1.8–3%. Differences in the studied parameters, between pairs of chestnut varieties, were detected. Lipid content and ash content made it possible to differentiate between more pairs of varieties. Protein content was higher than in chestnuts of other origins, probably due to the schistose soils of the region.

Keywords: Chestnut; Nutritional composition; Starch; Sucrose; Glucose; Fructose; Fibre; Lipids; Ashes; Proteins

1. Introduction

The consumption of chestnuts, which have constituted the basic diet of the Galician rural population for a long time, suffered a decline during the sixteenth–seventeenth centuries as a consequence of the introduction of corn and potatoes. These products, originally from America, proved to be more productive and caused chestnuts to lose importance in the diet of several communities. Furthermore, at that time, they were considered low nutritional foods, associated with the poorest.

During the past three decades, the social view of chestnuts has undergone a curious transformation, losing the traditional image of food for the poorest and becoming an ingredient of dishes and culinary preparations characterised by a high degree of sophistication.

Parmentier, who published a study about the nutritional content of chestnuts in 1780 (Viéitez, Cortizo, Vieitez Madrinan, & Vieitez Madrinan 1996), defined them as "foods rich in carbohydrates and nitrogenous substances". Since then, several studies have dealt with the composition of chestnuts, but investigations about the nutritional characteristics of chestnuts produced in Galicia (Spain) have not been found in the literature.

The objectives of this work were to study the nutrient content of chestnut fruits from the 15 most wide spread varieties of *Castanea sativa* Mill growing in the Galician region Verín-Monterrei (Ourense) and to determine any differences in characteristics that could be important for their adaptation to industrial processes.

2. Materials and methods

2.1. Samples

One hundred chestnuts, from each of the 80 selected chestnut trees, were collected. Chestnut trees, which were spread all over the region of Verín-Monterrei (Ourense), belonged to the varieties *Bermella*, *Blanca*, *Boullona*, *Calva*, *Casarella*, *Corronchuda*, *Das Viñas*, *Famosa*, *Foleiro*, *Inxerta*, *Longal*, *Monfortiña*, *Soutiña*, *Touro* and *Vilamaesa*. The number of trees of each variety represents the percentage of the presence of the variety in the region. The amounts of chestnuts from each tree needed for the analytical determinations were randomly selected. They were hand-peeled and then analyzed.

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2.2. Analytical procedures

Moisture content was determined using the AOAC method Ref. 925.10 (AOAC, 1990). Starch content was assessed by the enzymatic method of Boehringer Mannheim, Ref. 207748, using a spectrophotometer UV/VIS. Sucrose, glucose and fructose contents were determined, after drying and hydroalcoholic extraction (80/20 v/v), by HPLC, following the Nomura, Ogasawara, Vemukoi, and Yoshida (1995) method with some modifications. Freeze-drying was chosen after verifying that vacuum-drying alters the sugar contents. Hydroalcoholic extraction was done in an ultrasonic bath. Time and temperature of extraction were optimized to half an hour and 60 °C. Sugars were determined in the combined extracts using high performance liquid chromatography (HPLC) with a universal evaporative light scattering detector. Mobile phase was a solution of acetonitrile and water (80/20), previously filtered and degasified. The column used was a Teknokroma, kromasil 100 NH_2 5 μm 25×0.46 cm, thermostattised at 30 °C in order to avoid fluctuations in detector responses. Working conditions were: flow rate of 1.5 ml/min, detector temperature 130 °C and pressure 40 mm Hg. The analyses were performed in triplicate batches. The fibre content was measured using the AOAC method Ref. 140.59 (AOAC, 1980). The total nitrogen content was detected using the Kjeldahl method Ref. 932.03 (AOAC, 1990). The percentages of nitrogen were transformed into protein content by multiplying by a conversion factor of 4.86, as reported by Lamelas (2000) for Galician chestnuts. Lipid content was assesed using the AOAC method, Ref. 140.59 (AOAC, 1980). The total mineral content was determined by incineration at 550 °C, following the AOAC method, Ref. 140.06 (AOAC, 1980). All analyses were performed in triplicate.

2.3. Statistical methods

For the statistical analysis Winsdows SPSS 10.0 was used. Comparisons were carried out at 95% confidence by application of ANOVA or Kruskall–Wallis Test and Student's two-tailed *t*-test or Mann–Whitney–*U*-Wilcoxon Rank Sum W Test.

3. Results and discussion

Results of investigation of the nutritional composition of the different chestnut varieties studied are shown in Table 1.

Moisture content ranged between 48.37 and 59.35%. According to Breisch (1995), who stated that the humidity content of chestnuts should not be lower than 49% or higher than 60% for an adequate conservation, most of the varieties of chestnuts had suitable water contents for stability.

Starch percentages varied between 56.74 and 81.7%. These results are in accordance with those obtained by Bassi and Marangoni (1984) for Italian chestnut varieties, Torres-Pereira Gaspar, Sequeira, and Torres de Castro (1992) for Portuguese varieties and Bergougnoux (1978) and Desmaison and Adrian (1986), who studied French varieties. The values obtained for sucrose were

Table 1
Means and standard deviations of the nutritional variables

Variety	Moisture (%)	Starch (%d.m.)	Sucrose (%d.m.)	Glucose (%d.m.)	Fructose (%d.m.)	Fibre (%d.m.)	Proteins (%d.m.)	Lipids (%d.m.)	Minerals (%d.m.)
Bermella	49.08±5.85	70.2±4.83	11.5±2.17	0.08±0.12	0.09±0.14	3.04±0.33	8.16±1.37	1.66±0.47	2.71±0.21
Blanca	58.47±1.21	81.7±5.54	8.63±2.94	0.23±0.39	0.13±0.23	2.69±0.34	8.11±2.00	1.31±0.28	2.26±0.56
Boullona	54.85±3.18	74.4±7.53	13.4±8.77	0.16±0.23	0.22±0.19	2.67±0.02	7.65±0.93	2.10±0.94	2.31±0.06
Calva	54.58±2.83	80.9±5.05	6.55±1.00	0.20±0.02	0.11±0.09	1.99±066	6.23±0.69	2.01±0.74	2.18±0.35
Casarella	54.85±10.96	57.1±9.43	19.0±0.25	0.16±0.23	0.22±0.31	2.90±0.10	7.65±0.18	2.49±1.00	2.88±0.30
Corronchuda	52.92±9.59	74.9±7.32	13.4±3.85	0.25±0.06	0.31±0.15	2.31±0.48	8.20±1.94	2.98±0.78	2.41±0.25
Das Viñas	49.94±4.36	69.9±6.97	16.7±5.76	0.13±0.13	0.14±0.16	2.43±0.39	6.19±0.30	1.47±0.32	2.17±0.18
Famosa	51.25±8.87	75.7±6.27	9.28±3.32	0.27±0.18	0.25±0.14	2.61±0.41	7.51±1.34	1.79±0.54	2.45±0.74
Foleiro	54.15±2.48	78.8±5.31	9.91±2.95	0.26±0.05	0.26±0.13	2.64±0.51	7.76±1.33	1.26±0.65	1.79±0.06
Inxerta	58.90±3.41	76.2±12.25	13.1±6.52	0.18±0.09	0.30±0.08	2.26±0.86	7.87±1.37	2.51±1.16	2.67±0.59
Longal	54.13±1.88	80.2±8.07	8.96±2.34	0.17±0.13	0.19±0.11	2.60±0.31	6.80±0.71	2.14±0.27	2.23±0.28
Monfortiña	48.37±4.22	56.7±7.14	19.5±2.47	0.30±0.05	0.27±0.12	3.10±0.13	8.57±1.57	2.96±0.20	3.10±0.34
Soutiña	59.35±0.07	75.5±4.63	11.2±0.46	0.00±0.00	0.08±0.01	2.44±0.42	8.58±0.17	1.31±0.36	2.30±0.01
Touro	52.23±4.25	75.1±7.52	11.3±5.41	0.25±0.22	0.18±0.19	2.47±0.30	6.02±2.09	2.47±0.51	2.22±0.18
Vilamaesa	48.64±2.66	73.0±3.06	15.9±2.93	0.04±0.12	0.04±0.11	2.86±0.55	6.85±0.82	2.05±0.47	2.32±0.35

d.m.: dry matter.

Table 2
Coefficients of variation [(standard deviations/mean)*100] of the parameters corresponding to the nutritional composition of the fruits

Variety	Moisture	Starch	Sucrose	Glucose	Fructose	Fibre	Proteins	Lipids	Minerals
Bermella	11.9	6.9	19.0	150	156	10.9	16.8	28.3	7.75
Blanca	2.07	6.78	34.1	170	176.9	12.6	24.7	21.4	24.8
Boullona	5.80	10.1	65.69	144	86.4	0.75	12.2	44.8	2.60
Calva	5.18	6.24	15.27	10	81.8	33.2	11.1	36.8	16.1
Casarella	20.0	16.5	1.32	144	141	3.45	2.35	40.2	10.4
Corronchuda	18.1	9.77	28.8	24	48.4	20.8	23.7	26.2	10.4
Das Viñas	8.73	9.97	34.6	100	114	16.1	4.84	21.8	8.29
Famosa	17.3	8.29	35.8	66.7	56	15.7	17.8	30.2	30.2
Foleiro	4.58	6.74	29.8	19.2	50	19.3	17.1	51.6	3.35
Inxerta	5.79	16.1	49.9	50	26.7	38.1	17.4	46.2	22.1
Longal	3.47	10.1	26.1	76.5	57.9	11.9	10.4	12.6	12.6
Monfortiña	8.72	12.6	12.7	16.7	44.4	4.19	18.3	6.76	11.0
Soutiña	0.12	6.13	4.10	0	12.5	17.2	1.98	27.5	0.44
Touro	8.14	10.8	47.8	88	106	12.1	34.7	20.7	8.11
Vilamaesa	5.47	4.19	18.4	300	275	19.2	12.0	22.9	15.1

around 6.5–19.5% although most varieties were in the range 8–15%, in accordance with the values obtained by Lamelas (2000) and Bergougnoux, Verlhac, Breisch, and Chapa (1978). The variety *Calva* showed the lowest content in this disaccharide, which explains the slightly bitter taste detected in the taste tests carried out with this variety (Miguez, 1996), *Calva* being the least sweet chestnut of the 15 varieties studied. As expected, glucose and fructose contents were very low. The residual values of these sugars were the result of sucrose hydrolysis, since the ratio glucose/fructose was near 1. The percentages of fibre ranged, approximately, between 2 and 3%, in accordance with the results obtained by Lamelas (2000), but were somewhat lower than those obtained by Desmaison and Adrian (1986) for French chestnuts. The highest content of fibrous components was in *Bermella*, whilst *Calva* showed the lowest content.

Protein content was high, ranging from 6.02 to 8.58%, with the highest values for *Bermella*, *Blanca*, *Monfortiña* and *Soutiña* and the lowest for *Calva*, *Das Viñas* and *Touro*. Since the transformation factors of total nitrogen content into protein content were not always reported, protein contents of our varieties could not be compared to protein contents of other chestnuts. Total nitrogen contents of the 15 varieties were similar to those reported by Desmaison and Adrian (1986), slightly lower than that of Lamela (2000) and higher than those of Torres-Pereira, Gaspar et al. (1992).

Gomes, Abreu, and Castro (1997) detected a relationship between the protein content of chestnuts and the type of soil in which they had grown. Chestnuts from places in which schists predominated showed a much higher protein content (mean 8.6%) than those from granite-based soils (mean 3.3%). Our results confirm this fact, since nearly all the groves from the region of Monterrei are situated in schistose sectors and chestnuts grown in them have a high protein content.

It is generally accepted that the lipidic content of chestnuts is low (Beaubatie, 1979; Demaison & Tixier, 1984). Samples from the region of Monterrei, showed lipid content ranges between 1.3% (*Foleiro*, *Blanca* and *Soutiña*) and a maximum of 3% (*Corronchuda* and *Monfortiña*), which confirms the previous statement. Values of lipid content reported by French (Desmaison & Adrian, 1986) and Italian (Bassi & Marangoni, 1984) researchers are somewhat higher (between 4 and 6% and 5.5%, respectively).

The mineral content of chestnuts was low, ranging between 1.8 and 3%. These values were below those reported for Portuguese varieties (Gomes et al., 1997; Torres-Pereira Gaspar et al., 1992).

The intravarietal homogeneity (Table 2) of the nutritional parameters of the chestnuts obtained from different trees was studied. *Monfortina* and *Longal* are remarkable for the homogeneity of their composition, with coefficients of variation which are—except for proteins of *Monfortiña* and sucrose of *Longal*—lower than 13%. The fruits of *Blanca, Corronchuda* and *Inxerta* showed a coefficient of variation higher than 20% in four of the seven parameters.

Intervarietal comparison of results showed that, with the exception of starch, all of the nutrient composition variables were significantly different. Lipid and mineral contents were the parameters that permitted differentiation into more pairs of varieties, whilst fibre was only different in *Bermella* and *Calva* (Table 3).

Table 3
Pairs of varieties for establishing the significant differences, according to nutritional parameters

Variable (test)	Pairs of varieties with significant differences
Humidity (Dunnett)	Blanca–Vilamaesa
	Inxerta–Soutiña
	Soutiña–Vilamaesa
Sucrose (Dunnett)	Bermella–Calva
	Bermella–Casarella
	Calva–casarella
	Calva–Soutiña
	Calva–Vilamaesa
	Casarella–Famosa
	Casarella–Longal
	Casarella–Soutiña
	Longal–Vilamaesa
Fibre (Tuckey)	Bermella–Calva
Proteins (Dunnett)	Bermella–Das Viñas
	Calva–Soutiña
	Casarella–Soutiña
	Das Viñas–Soutiña
	Longal–Soutiña
	Soutiña–Vilamaesa
Lipids (Mann–Whitney)	Bermella–Corronchuda
	Bermella–Longal
	Bermella–Monfortiña
	Blanca–Corronchuda
	Blanca–Longal
	Blanca–Vilamaesa
	Calva–Corrunchuda
	Calva–Monfortiña
	Corrunchuda–Das Viñas
	Corrunchuda–famosa
	Corrunchuda–Longal
	Corrunchuda–Vilamaesa
	Das Viñas–Longal
	Das Viñas–Monfortiña
	Das Viñas–Touro
	Das Viñas–Vilamaesa
	Longal–Monfortiña
	Famosa–Monfortiña
Minerals (Mann–Whitney)	Bermella–Casarella
	Bermella–Das Viñas
	Bermella–Famosa
	Bermella–Longal
	Bermella–Touro
	Bermella–Vilamaesa
	Calva–Monfortiña Das
	Corronchuda–Das Viñas
	Viñas–Monfortiña
	Longal–Monfortiña
	Monfortiña–Vilamaesa

4. Conclusions

The varieties studied showed a moisture adequate for industrial application. Starch is the major nutrient and in practically all varieties due to growth in soils in which schist predominated, the content of protein is high. The lipid content is lower than that obtained for fresh varieties and the mineral values are below those reported for Portuguese varieties.

So, concluding, the composition of chestnuts in the diet furnishes the highest content in polymeric carbohydrates and acceptable content in lipids and adequate minerals.

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