



Original Research Article

Traditional pastry with chestnut flowers as natural ingredients: An approach of the effects on nutritional value and chemical composition



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ABSTRACT

Portuguese traditional pastry known as *económicos* with satiating qualities have been elaborated with chestnut (*Castanea sativa* Mill.) flowers and their decoctions. The complete nutritional profile, mineral content, free sugars, organic and fatty acids, and tocopherols were determined immediately after baking and also after 15 and 30 days of storage. The results were processed through a 2-way ANOVA, followed by a linear discriminant analysis to conclude that only slight effects were detected even in the assayed parameters, after 30 days. The amount of water decreased with time, resulting in a raise of ash, carbohydrates, energy and insoluble fiber over time. In terms of organic acids, succinic acid was the most abundant molecules, with the samples incorporated with the decoction showing the highest amounts of these acids. Sucrose was the highest sugar, although a decrease was detected overtime. Sodium and potassium were the most abundant minerals while zinc was the least. Finally, α -tocopherol was the most abundant isoform of tocopherols and palmitic acid the most abundant fatty acid. Polyunsaturated fatty acids tended to decrease along storage time. The use of dried flowers seemed to better preserve the original profile (control) of the *económicos* in comparison with the decoctions.

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1. Introduction

The food industry is, not surprisingly, one of the most important markets in the world, which struggles to get food from producer to consumer in the best possible conditions at the least expense (Cheng et al., 2010). To maintain food products in conditions that are acceptable for consumption, the industry relies on different treatments (heat, pasteurization, water immersion, irradiation, among others) and on the introduction of food additives, which are used especially to maintain the best conditions during the final steps of preparation, expedition and shelf-life (Carocho et al., 2014a).

Nowadays, centuries after the exclusive use of salt, the oldest preserver, the conservation relies mainly on 3 principal types of additives: antimicrobials, like benzoates, sulphates and propionates; antioxidants, like ascorbic acid or butylated hydroxytoluene (BHT); antibrowning agents, like sulphites, ascorbic acid and cysteine (Carocho et al., 2014a). Some of these additives have legal

constraints which vary among countries; in fact, it is possible to indicate specific additives allowed in the European Union and simultaneously forbidden in the United States of America (USA). Examples of these ambiguities are cyclamates, some color additives, *p*-hydroxybenzoate, or sodium sorbate (Fennema, 1987; Sindelar and Milkowski, 2012).

Due to the mentioned setbacks, many companies have searched for alternatives to chemical preservers, namely natural extracts from plants, which can display the same properties, often presenting the additional advantage to possess various bioactive properties or even synergistic effects (Si et al., 2006; Rasooli, 2007; Ye et al., 2013). Although there are many examples of food products in which incorporated plant extracts have been used as preservers and/or functionalization agents (McCarthy et al., 2001; Stojković et al., 2013; Reihani et al., 2014), none of those deal with the effects on the nutritional profile of the pastry, which is studied in this work. In Portugal, traditional cakes known as *económicos*, are quite appreciated for their taste. These products are offered in groceries and food retailers and their preparation still follows the original recipe: flour, sugar, margarine, olive oil, eggs, brandy, cinnamon, orange juice and zest.

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In this work, dried chestnut flowers and flower decoctions were added to the original recipe aiming to preserve their nutritional and chemical properties, and extending their shelf life. Chestnut flowers were chosen for their high antimicrobial and antioxidant capacity (Carocho et al., 2014b,c), which could delay fat oxidation, rancidity and growth of moulds and/or bacteria, during storage. In addition, using chestnut flowers might boost the local agriculture with an increasing demand for these presently discarded by-products. From the consumers' point of view, the functionalized *económicos* might also deliver beneficial molecules (Carocho et al., 2014c), besides eliminating the use of chemical preservers. In fact, there have been studies claiming that infusions of chestnut flowers have beneficial effects against various illnesses, namely as mucolytic, antispasmodic and anti-dysenteric treatments, among others, due to the high antioxidant and antimicrobial properties of this matrix (Neves et al., 2009). They also proved to bring antioxidant potential to *económicos* after their use as natural ingredients (Carocho et al., 2014d), but until now there were no studies evaluating the effects of their incorporation on nutritional and chemical characteristics of the final product.

2. Materials and methods

2.1. Standards and reagents

Acetonitrile 99.9%, *n*-hexane 95% and ethyl acetate 99.8% were of HPLC grade, acquired from Fisher Scientific (Lisbon, Portugal). The fatty acids methyl ester (FAME) reference standard mixture 37 (standard 47885-U) was purchased from Sigma (St. Louis, MO, USA), as also other individual fatty acid isomers, standards of sugars, tocopherols, and organic acids, and trolox (6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid). Racemic tocol, 50 mg/mL, was purchased from Matreya (PA, USA). Micro (Fe, Cu, Mn and Zn) and macroelements (Ca, Mg, Na and K) standards (>99% purity), as well as LaCl₃ and CsCl (>99% purity) were purchased from Merck (Darmstadt, Germany). Anthrone was obtained from Panreac (Barcelona, Spain). All other reagents were purchased from specialized retailers. Water was treated in a Milli-Q water purification system (TGI Pure Water Systems, Greenville, SC, USA).

2.2. Flower collection and sample preparation

Chestnut (*Castanea sativa* Mill.) flowers of the cultivar Judia were collected near Bragança (Oleiros) in the northeastern region of Portugal in June of 2013 (41°51'02"N, 6°49'54"W). After lyophilization (FreeZone 4.5, Labconco, KS, USA) they were milled and stored at −5 °C until further analysis. Lyophilization removes water through sublimation to avoid degradation of the samples. The decoctions were prepared following the procedure previously described (Carocho et al., 2014b). For the decoctions preparation, the flowers were added to cold water and heated on a laboratorial hotplate at 105 °C until the solution reached boiling point. It was left at this state for 5 min and another 5 min without heating before filtration. After freezing the solution, it was lyophilized and stored at −5 °C until needed for the assays. This manuscript continues a study by Carocho et al. Initially a review was conducted regarding controversies surrounding food additives and the benefits of natural ones (Carocho et al., 2014a). Then, an exhaustive study was conducted on decoctions of chestnut flowers (Carocho et al., 2014b,c) namely on their antioxidant, antimicrobial and antitumor activities as well as individual molecules like polyphenols, sugars and organic acids. Finally, after incorporating the flowers in the cakes, the antioxidant activity of these samples was studied to detect the impact of the functionalization of the chestnut flowers (Carocho et al., 2014d). The samples used in this

study are the same ones used in the manuscript by Carocho et al. (2014d).

2.3. Preparation of the pastry

To prepare the cakes, a traditional recipe was followed: 6 eggs were thoroughly mixed with 500 g of sugar, 1.05 kg of flour, 45 g of margarine and 30 g of warm olive oil. Then, 230 mL of pure orange juice, 35 g of orange zest, 200 mL of milk, 45 mL of brandy and 25 g of cinnamon were sequentially added to the mixture while mixing vigorously. When the dough had the right consistency (when the dough was placed on a tray without losing its shape), it was divided into 5 lots of 500 g each.

2.4. Incorporation of dried flowers and decoctions

Of the 5 lots (i) one was used as the control sample; (ii) 2 lots were incorporated with the decoctions of the dried flowers at different concentrations: 50 mg according the EC₅₀ value (0.099 mg/mL) achieved through the DPPH (2,2-diphenyl-1-picrylhydrazil) scavenging assay for chestnut flowers decoction (Carocho et al., 2014b), and 100 mg in the other lot; (iii) the remaining 2 lots were incorporated with dried flowers, also at different concentrations: taking into consideration the yield of the decoction extraction of 20% for 1 g of flowers, 200 mg of flowers were added to 1 lot and 400 mg to the second one.

In both cases, the final concentrations of decoction in the prepared *económicos* were approximately 16 and 32 mg/mL of dough, since the used decoctions might be considered as an enriched extract in comparison to the raw flowers.

The control sample was labeled "C", the decoctions "D50" and "D100" corresponding to the quantity of extract added, and finally "F200" and "F400" for the dried flowers. After incorporation, each portion was divided into 6 cakes that were all baked at the same temperature of 170 °C for 15 min on a tray in an oven.

2.5. Storage

Immediately after baking, two cakes of each lot were frozen and immediately lyophilized (Labconco FreeZone 4.5, Kansas City, MO, USA). After this, they were milled and subjected to the assays, which are further detailed. The rest of the cakes were left for 15 and 30 days in sealed plastic bags, protected from sunlight, at room temperature ranging from 18 to 23 °C, and afterwards subjected to the same assays to determine the changes along the storage period.

2.6. Proximate composition

The nutritional value was calculated based on moisture, proteins, fat, ash, carbohydrates, and fiber, relying on the AOAC procedures (AOAC, 2012). Moisture was determined by desiccation to constant weight at 100 ± 2 °C. Total protein content ($N \times 6.25$) was calculated as nitrogen content by the Kjeldahl method. Crude fat was determined by extraction of a known weight of powdered samples with petroleum ether using a Soxhlet apparatus. The ash content was determined by incineration at 550 ± 15 °C. Total available carbohydrates (TAC) were calculated through the Anthrone method, described previously (Osborne and Voogt, 1986). After treating the samples with HClO₄ at 52% for 18 h away from light, distilled water was added and the volume was adjusted to 100 mL. Further dilutions were performed until it reached 10%, and the anthrone solution at 0.1% in H₂SO₄ was added. The samples were placed in boiling water for 12 min and the developed green coloration was measured at 630 nm in a UV/Vis Spectrophotometer (EZ210 Perkin Elmer, Waltham, Ma, USA). A calibration curve of glucose (10–100 µg/mL) was prepared to compare with the samples. TAC values are expressed as g glucose/100 g of fresh cake.

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