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Evaluation of Some Physical and Chemical Properties of Hazelnuts

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Abstract

In this work were evaluated some physical and chemical properties of hazelnuts from two varieties (Buttler and Longa), namely colour, texture and density at the physical level and moisture, total fat, fat oxidation, ash, protein and crude fibre as concerns the chemical composition, following established procedures. The results obtained showed that the colour of the hazelnuts varied according to the point of measurement and also depending on the variety, being the Longa clearer in all points except for the core, in which the colour was equal to Butler. Regarding texture, the Butler was harder in the shell but softer in the core as compared to Longa, which in turn showed higher friability. Regarding density, no visible differences were found between varieties, but the bulk density was naturally lower than the true density in all cases, i.e., for measurements made with and without the shell, respectively. The moisture content was higher for Butlervariety, 7.13%, and this also had the highest water activity. The fat content was high, as expected, around 60% in both cases, and the time for fat oxidation was lower for the Butler variety, thus indicating a lower stability to oxidative degradation. The ash content was higher for Longavariety, which was also richer in terms of protein, 15.60%. The fibre content, however, was higher for Butlervariety, 11.11%.

Keywords: Nut, chemical composition, colour, texture, density

I. Introduction

Hazelnut (*Corylusavellana* L.) is one of the most popular nuts consumed worldwide as a nut or incorporated in many types of foods and deserts. Due to its pleasant nutty taste and flavour, hazelnut is a very popular ingredient in chocolate and confectionary industry (Durmaz and Gokmen, 2019).

Hazelnuts can be consumed in natura or

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preferably roasted (with or without the skin also called seed coat). The skin constitutes a co-product of the roasting process but is a rich source of fat-soluble bioactives and phenolics. In fact, it represents about 2.5% of the total hazelnut mass and is discarded in the roasting operation (Lainas et al., 2016).

Among the hazelnut components, the oil is the most abundant, over 50%, followed by protein and carbohydrates(Brufau et al., 2006). Furthermore, it also contains important vitamins, minerals, organic acids, phenolic compounds, phytochemicals and fat-soluble bioactive compounds. Owing to this composition profile, hazelnut has proven as very important for a healthy diet(Alasalvar and Bolling, 2015; Alasalvar et al., 2003; Chang et al., 2016).

The Food and Drug Administration (FDA) as well as the European Food Safety Authority (EFSA) recommend a daily consumption of nuts (42.5 g and 30 g, respectively), including hazelnut, as a means to diminish the risk of coronary heart disease (EFSA, 2011; FDA, 2003).

Because of the considerably high oil content, hazelnuts can also be used for the production of edible oil. The hazelnut oil is characterized by a high oleic acid content (over 80%), which provides high oxidative stability besides its nutritional value (Alasalvaret al., 2003; Koksalet al., 2006).

The analysis of the physical and chemical properties of hazelnut are important because they allow the determination of several important parameters of interest for the control and characterization of the products' quality. The evaluation of these characteristics make it possible, for example, to determine the use to be given to the fruit, such as eat raw or transformation to include in chocolates for example, as well as verify the level of oxidation of fatty acids and evaluate the nutritional potential of the hazelnut. Hence, the objective of this work was to compare the physical and chemical properties in two of the most representative varieties of hazelnuts cultivated in Portugal.

II. Material and Methods

Samples

The samples used were obtained from producers with farms situated in the Centre-North region of Portugal, harvested in the year 2017. The hazelnut cultivars selected for the study were Butler and 'Longa de Espanha' (designated as Longa).

Colour evaluation

A hand held tristimulus colorimeter, model CR400, from Konica Minolta (Tokyo, Japan) was used for colour evaluation. The colour coordinates L∗, a∗ and b∗ were measured in the outer shell (brown part and clearer head) and in the inner fruit (seed coat and inner core) (Figure 1). The L∗ coordinate quantifies the brightness variation, varying between black (0) and white (100). The coordinate a∗ and b∗ are chromaticity coordinates. The coordinate a∗ corresponds to red for positive values and green for negative values. In turn, the coordinate b∗ sets the yellow to positive values and blue to negative values.

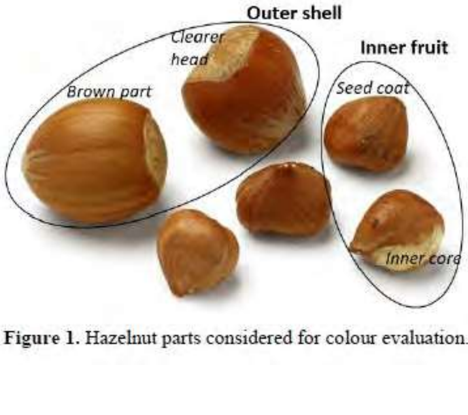

Figure 1. Hazelnut parts considered for colour evaluation.

Texture analysis

The texture analysis for all samples was made by a texturometer(model TA-XT Plus from manufacturer Stable Micro Systems, Godalming, Surrey UK). The texturometer used has a connection interface for online data acquisition and remote control through the Stable Micro Systems Exponent Texture version 2.0 program.

For the assessment of the textural properties 30 fruits from each variety were analysed by two independent tests: shell crushing through compression and core cutting.

Shell crushing test

The test consisted in a compression between parallel plates, using a flat 75 mm diameter probe (P/75) and a 500 N force load cell. The pre-test speed was 1 mm/s and the test and post-test speeds were 0.5 mm/s. The compression distance was 3 mm and trigger force was 0.2 N. The textural profiles obtained were force versus time curves as exemplified in Figure 2 and allowed calculating the hardness as the force at the highest peak.Hardness is the mechanical strength necessary to crush (Guine and Marques, 2013; Santos et al., 2013). It is important as it ensures the physical integrity of the product, allowing it to support the mechanical stress in the process of packing and transportation (Guine et al., 2015).

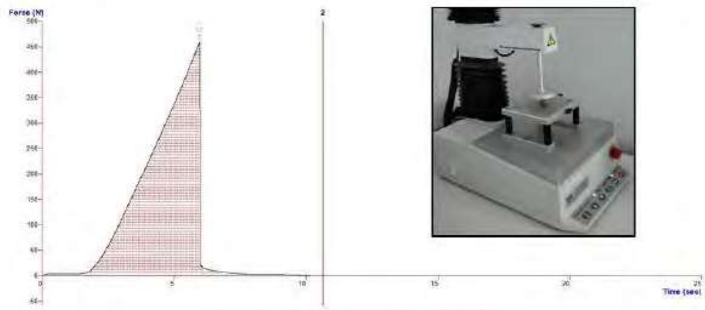

Figure 2. Shell crushing test for hazelnut.

Core cutting test

The test performed also consisted in measuring the force in compression, but in this case the probe used was a Blade Set HDP/BS (Warner-Bratzler). The load cell used was 500 N and the trigger force was 0.15 N. The compression speed was 1 mm/s and the distance was 25 mm. The obtained force versus distance curves allowed calculating the hardness (the force at first peak) and friability (the distance of first peak)(Figure 3).

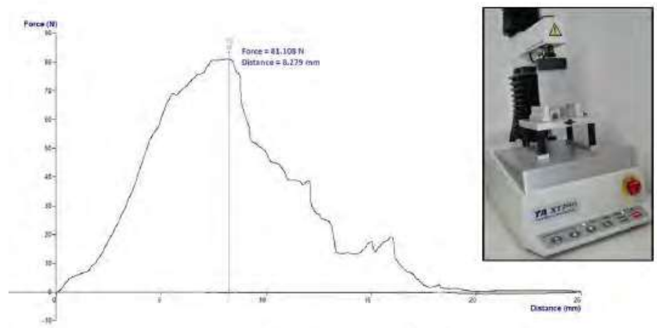

Figure 3. Core cutting test for hazelnut.

The friability respects to the ease with which the fracture occurs in the products (Almeida, 2013; Gharibzahedi et al., 2012), corresponding to a lower friability value, a greater facility of fruit breakage.

Analysis of density

Both the true density and apparent (or bulk) density were measured. For assessing the bulk density, two samples of 100 g of fruit were weighed (one with the shell and one without the shell), and then placed in a beaker with 500 mL capacity when determining the bulk density of the whole hazelnut (with shell) and 250 mL in the case of the unshelled fruits, to read the volume. The bulk density was calculated as the ration between the mass and the volume measured.

For the true density, a sample of one hundred grams of fruit was weighed. Then, 250 mL of water were placed in a 500 mL beaker and to this were added the hazelnuts, and the final volume was registered. The true density was calculated as the mass divided by the differences observed in the volume. This procedure was repeated for the fruits with and without the shell. All measurements were performed in triplicate.

Chemical composition

To assess the chemical composition only the core was used, and the analyses were made following standard procedures. For moisture content the weight loss at 103 ± 1 °C until constant weight method was followed. Fat was determined by extraction with petroleum ether in a Soxlet apparatus. Fibre was determined through Dosifiber with acid and basic digestion. Ash was determined through calcination at 550 °C. Protein was determined with mineralization followed by Kjedahl distillation (AOAC, 2019). The factor considered for conversion of nitrogen into protein was 5.30 according to Zenebon et al., (2008).The oxidation stability of the hazelnut fat was evaluated by theRancimat method for oils and fats, which is an accelerated ageing test(Metrohom, 2018). Water activity was measured using a Hygroscope Rotronic at constant temperature.

III. Results and Discussion

Physical properties

Figure 4 shows the bulk and true density of the hazelnut varieties evaluated with and without the outer shell. By comparing the results obtained for the whole hazelnuts and those without the shell, it is concluded that between the shell and the core an important amount of void exists for both varieties, thus justifying the greater values of the density of the unshelled fruits. Furthermore, the results indicate that real density was approximately double of the bulk density for all cases evaluated, being this related to the round form of the elements, which do not allow a great compaction. Finally, the results obtained for both varieties were very similar, and therefore it can be concluded that these varieties were not distinct as to density.

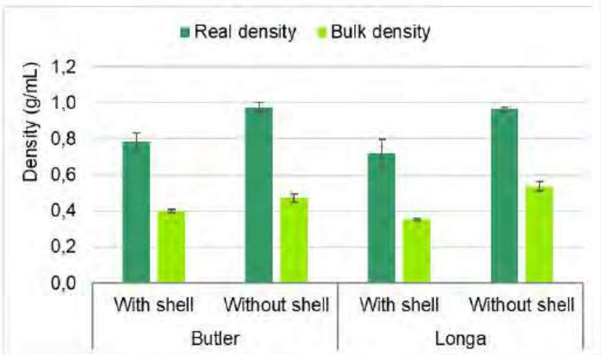

Figure 4. Density of the hazelnuts.

Figure 5 shows the colour coordinates of the hazelnut varieties studied. Regarding lightness, the values obtained for Longa variety were slightly higher than for Butler, being for that reason clearer, although the differences were not very meaningful. When comparing the different parts analysed it was observed that the brown shell was darker than the head and also that the seed coat was darker than the inner core, as expected.

As to the values of a∗ (accounting for the intensity of the red colouration) more visible differences were encountered between the varieties, with Butler hazelnuts showing a more intense red tone, indicating that the brown colouration was stronger in these fruits (Figure 5). Additionally, the differences between the red intensity in the seed coat and in the inner core were very expressive, since the inner core tends to be whitish. Finally, the yellowness (b∗) was again very similar between varieties but showing differences as to the part where the measurements were made, specifically, higher intensity of yellow in the brown shell and in the seed coat (which are typically brown) as compared with the head and the inner core (lighter).

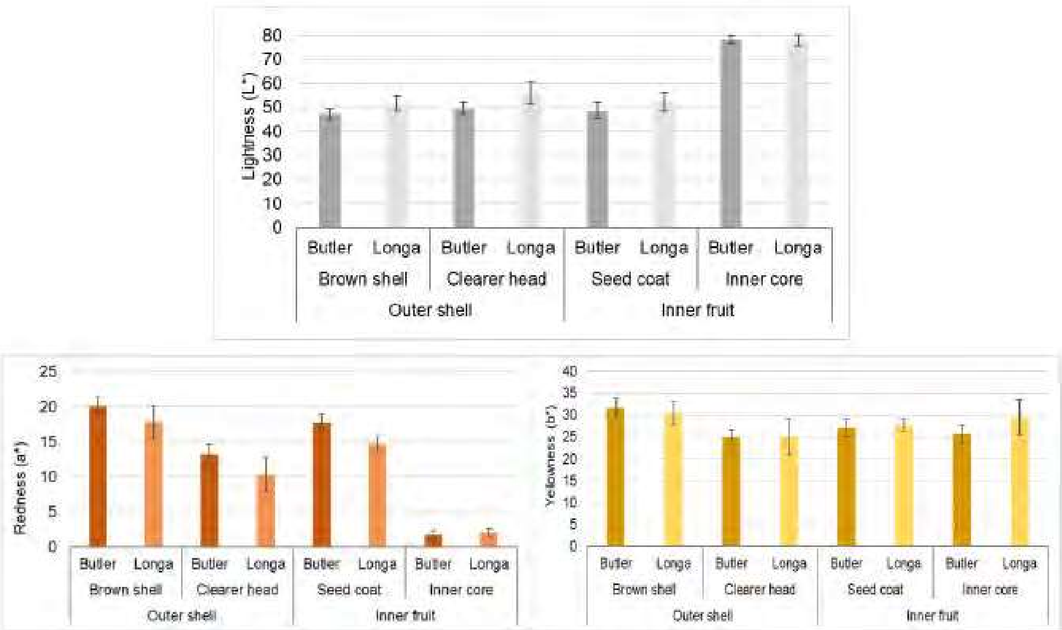

Figure 5. Colour coordinates of the hazelnuts.

Table 1 shows the mean values plus standard deviation obtained for the textural properties, as evaluated through both tests performed: crushing the shell and cutting the core. The obtained results show that the hardness of the shell was higher for Butle rvariety, but the inner core was harder for Long avariety, and also showing higher friability, meaning that this variety was more resistant. These results indicate that the transportation and mechanical operations performed to the unshelled hazelnuts from variety Butler are more prone to originate product loss due to fruit fracture and breaking.

Table 1. Textural properties of the hazelnuts.

Property	Butler	Longa
Hardness of the shell (N)	413.63±77.38	303.54± 57.74
Hardness of the core (N)	67.34± 7.76	80.09± 15.71
Friability of the core (mm)	6.54± 1.23	8.22± 2.59

Chemical properties

The results in Table 2 respect to the chemical properties of the evaluated varieties of hazelnut.While the fruits from variety Butler had higher moisture, fat and fibre, those from variety Longa had higher protein and ash contents. Although these differences were relatively small, they impart a different chemical composition and also resulting probably in different organoleptic characteristics. Besides, different nutrient richness may result in differentiated biological effects, and to this point it is important to highlight the particularly rich contents in dietary minerals and protein of the Longa variety and also the high fibre content of the Butler variety.

Table 2. Chemical properties of the hazelnuts.

Property	Butler	Longa
Moisture (g/100 g)	7.13 ± 0.24	5.86 ± 0.19
Fat (g/100 g)	61.22 ± 0.41	59.21 ± 0.49
Fibre (g/100 g)	11.11 ± 0.22	8.37 ± 0.34
Protein (g/100 g)	12.60 ± 0.19	15.50 ± 0.36
Ash (g/100 g)	2.72 ±0.05	3.81 ± 0.10

The results of the fat oxidation test (Rancimat) indicated that the stability of the hazelnuts fromLonga variety was higher when compared with that of the fruits of Butler variety (3.32 ± 0.387 and 1.65 ± 0.38 h, respectively). This is very important having in mind the preservation capacity, the shelf-life in view of the storage conditions and the possible processing operations, most especially the roasting process (Wang et al., 2018).

The water activity was found higher for Butler variety (0.77 ± 0.00) than for the hazelnuts from Longavariety(0.66 ± 0.00), being this also related with the moisture content, which was also higher for Butler. For both cultivars analysed the values of a_w are in the range 0.40-0.80, this interval being conducive to rapid chemical and enzymatic reactions (Cruz, 2013). It should also be noted that these values are in the range suitable for the development of moulds (Serol, 2017).

IV. Conclusions

The results obtained with this work allowed comparing the two hazelnut varieties as to their physical and chemical properties. Regarding the physical characteristics, it was observed that the colour varied according to the place of measurement and also depending on the variety, with variety Longa being clearer in general. The Butler hazelnuts had harder shell but softer core and were less resistant to fracture as compared to Longa. Finally, no visible differences were found between varieties as to the density, but the bulk density was naturally lower than the real density in all cases. As for the chemical components, the moisture content was higher for Butle rvariety, which also had the highest water activity. The fat content was high, as expected, around 60% in both cases, but with Longa variety showing a higher stability to oxidative degradation. The ash content was higher for Longa variety, which was also richer in protein, but poorer in fibre.

V. Acknowledgements

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