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Evaluation of Biometric Characteristics of Hazelnuts

Paula M.R. Correia[1,2*], Claudia Rodrigues[2], Ana M.C. Filipe[2], Raquel P.F. Guine[2]

[1] CI & DETS, Polytechnic Institute of Viseu, Campus Politecnico, Repeses, Viseu, Portugal
[2]Dep. Food Industry, Agrarian School of Viseu, Quinta da Alagoa, Ranhados, Viseu, Portugal

Abstract

The objective of this work was to develop a biometric record for application to hazelnuts in order to complement their morphological and physical characterisation as well as evaluate differences between varieties. The development of a standard biometric record was done, with several parameters for the whole fruit (nut) and the core (kernel) such as width, height and thickness. Based on these measurements, the shape ratio, the compression ratio and the volume were calculated. The width and height of the hilum and the ratio between them were also determined. It was further registered the number of hollow fruits and the calibre of each sample. The record was applied to 50 fruits, in two varieties (Grada de Viseu and Longa de Espanha), from the same orchard located in Penela da Beira region, Portugal. The fruits presented significant differences in height, mainly for the fruits with shell, with Longa de Espanha presenting the highest value. The shape and compression ratios were also very different, with Grada de Viseu presenting the highest scores for fruits with shell (0.99 ±0.06 and 0.94±0.18) and for the core (1.22±0.04 and 1.15±0.19). From the application of the biometric record, it was possible to determine the nut and the core weight, and for these varieties, the weight of the nut was approximately double of that of the kernel. The proposed biometric record holds the potential to be applied in quality control processes. These results could be useful in hazelnut varieties' evaluation and choice for growers, breeders, and food industry.

Keywords: Biometric, hazelnut, shape ratio; compression ratio

I. Introduction

The world production of hazelnut is almost 800 thousand tones, with Turkey the top producer, guaranteeing more than 70% of the total production (FAOSTAT, 2017). European hazelnut (*Corylus avellana* L.) is a major nut crop that is fifth in global importance after cashew, almond, walnut and chestnut (Petriccione et al., 2010). The hazelnut production in Europe ranges from 100 to 200

*Corresponding author e-mail:paulacorreia@esav.ipv.pt

thousand tones, with a relative constant production in the last 10 years (FAOSTAT, 2017). In Portugal the production of hazelnut represents about 1% of nuts, around 450 tones per year, and practically all production is for internal consumption (INE, 2016; Correia et al., 2017). Hazelnuts are consumed in several forms, raw, roasted, and blanched but they can also be used as an ingredient in processed foods, like bakery, dairy or chocolate. These fruits are recognized as a food with capacity to supply high energetic level and nutritive value. The amount of fat and fatty acids justifies the high energetic value and their relevance in health dietetic programmes due to the high level of polysaturated and unsaturated fatty acids (linoleic, linolenic, oleic, palmitic and stearic), which decrease the cholesterol levels in the blood and also control the adverse hypertension effects (Savage et al., 1997; Amaral et al., 2006). These nuts have some health benefits, decreasing the risk of certain chronic diseases, like hearth disease and type 2 diabetes and they may help fighting some negative aspects related with aging (Koksal et al., 2006).

The *C. avellana* L. presents a highly heterozygous nature and substantial genetic diversity due to its out-crossing (Mohammadzedeh et al., 2014). Thus, morphological traits are commonly used to quantify genetic variations in between varieties. These nut and kernel traits are important yield and quality parameters for hazelnuts, but they are scarce. The evaluation of physical properties is important because it allows the determination of several parameters pivotal in the control and characterization of the products' quality, as well as hazelnut growing potential. Biometrics is a technique used to make measurements and calculations, and is applied in several contexts, such as foodstuff. Often, the biometric parameters are valued by consumers when they buy food products, like nuts, and these could influence their choices. Hence, the objective of this work was to develop a biometric record applied to hazelnut fruits for their morphological and physical characterisation.

II. Material and Methods

Samples

The samples used were collected from the same orchard located in Penela da Beira, situated in the Centre-North region of Portugal. They were harvested in the year 2017. The hazelnut varieties selected for the study were Grada de Viseu and Longa de Espanha (Figure 1). One kilogram of fruits from each variety was collected from 6 different hazelnut trees.

Figure 1. Hazelnut evaluated: Grada de Viseu (left) and Longa de Espanha (right).

Biometric evaluation

In a first step, it was done a deep bibliographic research in order to define the most important measures to apply to hazelnuts to morphologically characterize a variety (Yao and Meklenbacher, 2001; Petriccione et al., 2010; Mohammadzedeh et al., 2014; Lopes et al., 2016; Ozturk et al., 2017). Moreover, other studies, considering other dried fruits, were also taken in consideration (Silvanini et al., 2014; Poljak et al., 2016; Mapelli et al., 2017). After this step, the biometric parameters were established and a biometric record was created. The biometric parameters evaluated were width (wider equatorial zone), height (distance between centres) and thickness (narrow equatorial zone perpendicular to the latter) of the whole fruit (nut) and the core (or kernel) (Figure 2). Based in these measurements, the shape ratio (Eq. 1) and the compression ratio (Eq. 2) were determined according to Lopes et al., (2016). The volume was also calculated according to Eq. 3, comparing the hazelnut to an ellipsoid.

$$\text{Shape ratio} = (a+b)/2*c \quad \text{Eq. 1}$$

$$\text{Compression ratio} = a/b \quad \text{Eq. 2}$$

$$\text{Volume} = 4/3*\pi*(a/2*b/*c/2) \quad \text{Eq. 3,}$$

where a is the width, b the thickness and c the height.

The width and height of the hilum and the ratio between them were also determined. Nut and kernel weights were recorded in grams (g). All the measurements were done using a caliperrule with a precision scale (±0,0002 g). Kernel percentage was calculated as (kernel weight/nut weight) x 100 (Ozturk et al, 2017).

Fifty nuts of Gradade Viseuand Longa de Espanhavarieties were analysed: the whole nuts (the whole fruit) and the respective kernels (Figure 1). It was also registered the number of hollow fruits.

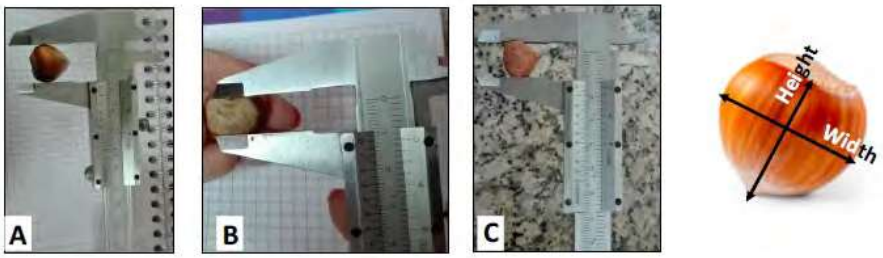


Figure 2. Hazelnut measures: A- Nut thickness; B- Hilum width; C- Kernel thickness.

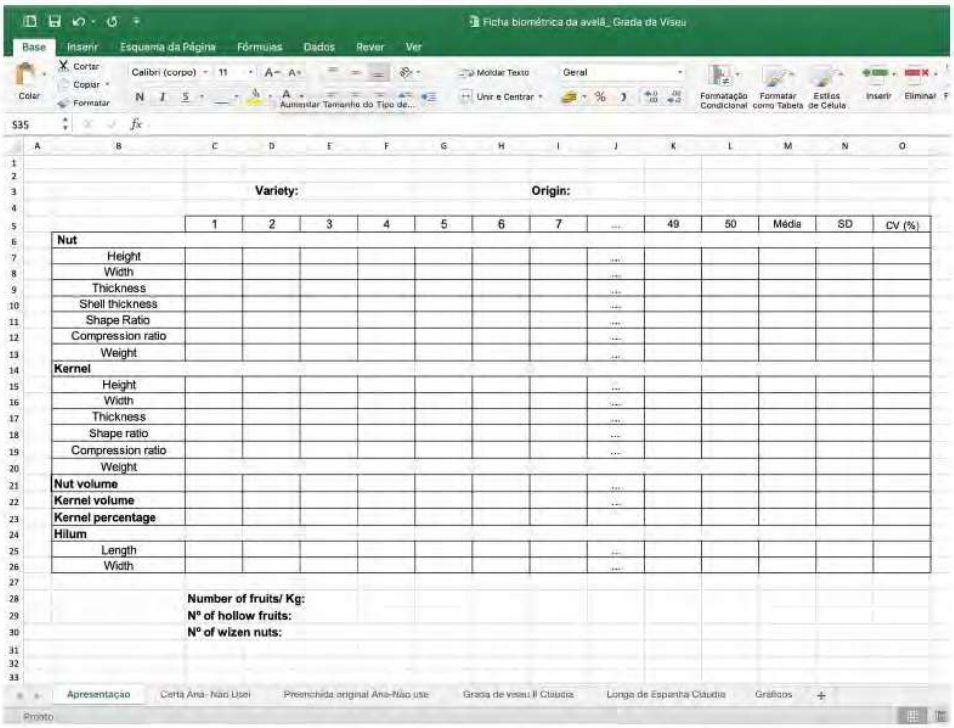
Statistical analysis

To assess the biometric characterization of hazelnuts, standard descriptive statistical parameters were calculated: arithmetic mean, standard deviation (SD) and coefficient of variation (CV).

III. Results and Discussion

A biometric file was developed (Figure 3), after an accurate research about the characteristics which should be considered for morphological characterization of hazelnuts. The two varieties, Grada de Viseu and Longa de Espanha, were tested and all the data were recorded in a biometric sheet. The results of the descriptive statistical analysis are shown in Figures 4, 5 and 6, as well as in Table 1.

The samples presented a similar profile considering the height, width and thickness, with major differences between them when the whole nut was considered. The variety Longa de Espanha had a higher height, and was less thick and long.



Ficha biométrica da avelã_ Grada de Viseu

Variety: Origin:

	1	2	3	4	5	6	7	...	49	50	Média	SD	CV (%)
Nut													
Height								...					
Width								...					
Thickness								...					
Shell thickness								...					
Shape Ratio								...					
Compression ratio								...					
Weight								...					
Kernel													
Height								...					
Width								...					
Thickness								...					
Shape ratio								...					
Compression ratio								...					
Weight													
Nut volume								...					
Kernel volume								...					
Kernel percentage													
Hilum													
Length								...					
Width								...					

Number of fruits/ Kg:
Nº of hollow fruits:
Nº of wizen nuts:

Apresentação | Certa Ana- Não Usei | Preenchida original Ana-Não use | Grada de viseu II Claudia | Longa de Espanha Claudia | Gráficos

Pronto

Figure 3. Biometric sheet for morphological characterization of hazelnuts.

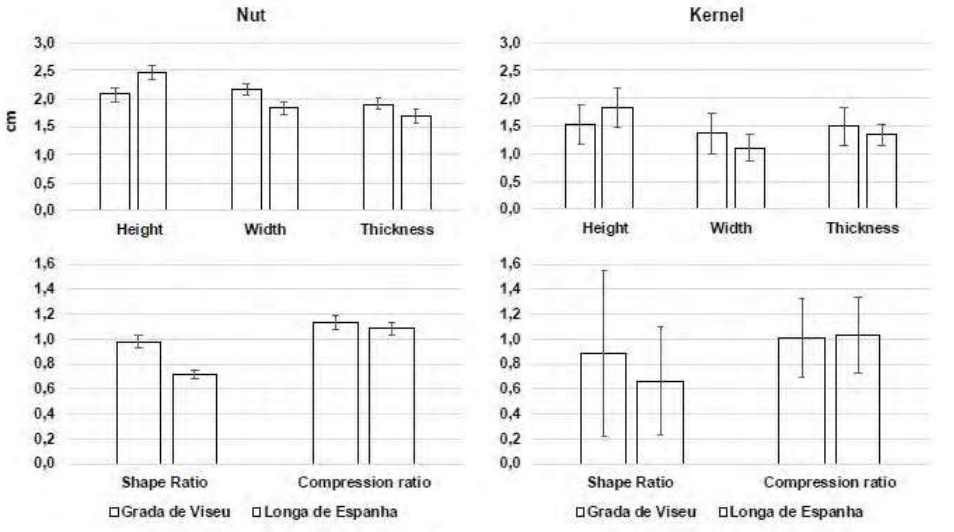
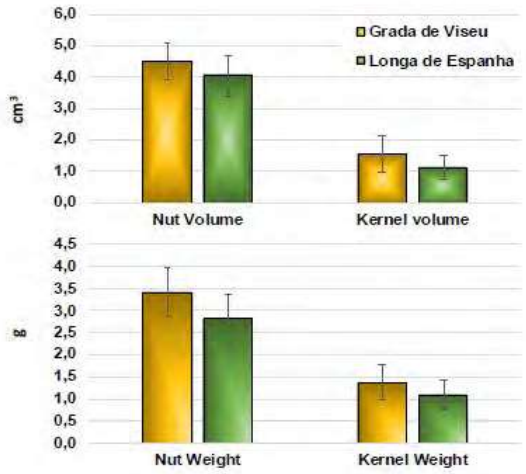


Figure 4. Hazelnut height, width, thickness, shape ratio and compression ratio of nuts and kernels of Grada de Viseu and Longa de Espanha varieties

As for the shape and compression ratios, the variety Longa de Espanha has shown the lower shape ratio, which means that it is more elongated that the Grada de Viseu, with highest value of the shape ratio, mainly when the whole nut is considered. These results are supported by Yao and Meklenbacher (2001), which mentioned that the nut shape index (in our case is shape ratio) was 0.50-0.89 for long nuts, 0.90-1.00 for round nuts, and 1.01-1.3 for oblate nuts. This was also corroborated by Lopes et al.,(2016) and Silvanini et al.,(2014).

Both varieties have shown similar values of compression ratio close to 1, indicating that these fruits are more rounded in the equatorial zone. Nut size is an important trait for whole nut and kernel markets due to the fact that nut size reflects usually the kernel size (Yao and Meklenbacher, 2001). These authors also recorded that the world kernel market needs kernels 11-13 mm in diameter. Thus, considering the studied varieties, both are good fruits for commercial market.

Analysing the results shown in Figure 5, the variety Grada de Viseu presented the highest volumes and weight, both for nut and kernel. Percent kernel is one of the most important nut processing parameters (Petriccione et al., 2010). The kernel percentages were 37.5±12.1 and 38.6±8.6 respectively for Grada de Viseu and Longa de Espanha, which means that this biometric parameter is similar in both varieties, corresponding to a similar percentage of edible kernel. Moreover, Miletic et al., (2005) recorded 34.70% for kernel percentage of European hazelnuts, and Mohammadzedeh et al.,(2014) mentioned an average kernel percentage of 37.02%, which is in accordance with our results. Yao and Meklenbacher, (2001) reported that nut weight is a function of shell thickness and kernel weight. Our results have shown that both varieties presented the same shell thickness, 0.2 cm. Thus, for these varieties the nut weight is influenced by kernel weight, as supported by the results.

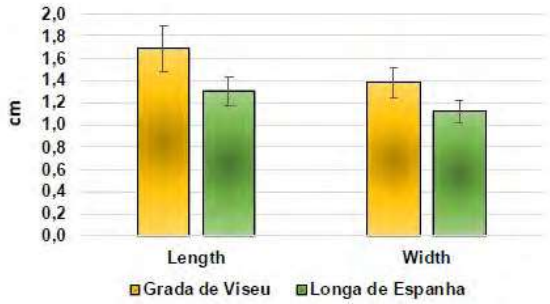


Figures 5. Hazelnut height, width, thickness, shape ratio and compression ratio of nuts and kernels of Grada de Viseu and Longa de Espanha varieties

Grada de Viseu variety presented highest dimensions of hilum, with values of 1.7 cm and 1.4 cm for length and width respectively (Figure 6). Moreover, the dimensions of hilum are quite different between varieties. Thus, if the objective of a study is the variety characterization, this parameter could be a good marker to distinguish varieties. However, more studies

must be done to make sure that is possible.

Coefficient of variation was the lower for height, width, thickness, shape ratio and compression ratio, for both hazelnut varieties in the whole nut, as shown in Table 1. However, some authors mention high percentages of coefficient of variation (CV%) for these parameters and for other morphological parameters evaluated (Mohammadzedeh et al., 2014). The CV% showed the highest value for kernel volume, 35.88% and 32.77% for Grada de Viseu and Longa de Espanha, respectively.



Figures 6. Hazelnut length and width of the hilum of Grada de Viseu and Longa de Espanha varieties

Table 1. Coefficient of variation of Grada de Viseu and Longa de Espanha hazelnuts.

	CV (%)	
Nut	**Grada de Viseu**	**Longa de Espanha**
Height	5,97	5,13
Width	5,07	6,53
Thickness	5,55	7,03
Shell thickness	18,20	18,20
Shape ratio	5,44	4,64
Compression ratio	5,15	4,72
Weight	15,83	20,38
Kernel		
Height	22,92	19,75
Width	27,02	21,76
Thickness	26,85	18,08
Shape ratio	29,93	24,48
Compression ratio	27,86	22,90
Weight	29,46	29,79
Nut volume	13,21	16,52
Kernel volume	35,88	32,77
Kernelpercentage	32,41	22,23
Hilum		
Length	12,80	10,22
Width	9,91	9,48

The predominant number of kernels pernut wasone, and the variety Grada de Viseu presented 2 and 4 hollow fruits and wizen nuts, respectively, in 50 fruits evaluated. Grada de Viseu had lower number of fruits per kg, 294, in opposition to Longa de Espanha with 357 fruits/kg, meaning that Grada de Viseunuts are heavy, which is corroborated by the results.

IV. Conclusions

The results obtained with this work allowed concluding that it was possible to create a biometric record, which can be used to deeply characterize hazelnut's varieties. Moreover, this tool has a big importance for the industry, growers and breeders, since they can evaluate the fruit quality and take more profits from the market. Two hazelnut varieties, Grada de Viseu and Longa de Espanha, were characterized in terms of biometry, considering their morphological and physic parameters, and the results revealed that they have differences but also similarities. The main differences were in the whole nut for height, width, thickness and shape ratio, as well as the length and width of the hilum, with the highest values presented by Grada de Viseu variety (2.16 cm, 1.91 cm, 0.98, respectively), with exception for height, where Longa de Espanha showed highest value (2,47 cm). Morphological characterization can be useful for fast, simple and not expensive varietal identification. Finally, more studies must be done in order to apply this tool and optimize it, considering the biometric characterization of hazelnut varieties, with the possibility of creating a database at national and international levels.

V. Acknowledgements

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