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CHARACTERIZATION AND LIPID PROFILE OF MACADAMIA NUTS (*MACADAMIA INTEGRIFOLIA* AND *MACADAMIA TETRAPHYLLIA*).

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ABSTRACT

A study on the physical and chemical characteristics and the lipid composition of the Macadamia nuts from Andalucía was carried out. Fruit size, cracking point, relative humidity, ash percentage, content and lipid composition was also characterized. Regarding the nutritional composition of the fruit, it was obtained a high content on vegetable fats in whose lipid profile stands out the oleic and palmitoic acid.

KEYWORDS: Macadamia nuts, cracking point, lipid profile, palmitoic acid.

INTRODUCTION

The purpose of this study is the characterization of the Macadamia nut cultivated in Andalucía (**figure 1**), emphasizing the fruit size, cracking point and lipid profile.

Macadamia is a tree naturally found in the tropical and sub-tropical rainforests. Shape and size vary, from 10 to 20m high in wooded areas, although it only reaches 10m high in open spaces (1).

There are ten species from which only two of them, *Macadamia integrifolia* and *Macadamia tetraphyllia* are commercially important.

In Spain, the varieties *Integrifolia* and *Beaumont* are being cultivated nowadays. This last variety is a hybrid between the *Integrifolia* and *Tetrafillia* (2). Although the beginning of the cultures may not be determined precisely, their location is found in the tropical and sub-tropical area of Andalucía, Algarrobo Coast (Málaga) and Marbella (Málaga) (3).

In order to measure the shell size, both the *Macadamia Integrifolia* and the *Macadamia Beaumont*, a slide caliper was used. The cracking point was calculated on the basis of the study *"Mechanical Behaviour of Macadamia Nut under Compression Loading".* According to it, the operation of cracking Macadamia nuts is the most critical and delicate step for achieve high-quality kernels.

The nuts, usually at high moisture content, are dried to recommended moisture, before cracking, in a process that takes from 3 to 4 weeks at the expense of large energy consumption (4).

To conclude with this study, the lipid percentage was obtained for both varieties. Macadamia nut is rich in monounsaturated fatty acids (oleic and palmitoic acids) (MUFA) which significantly reduce cholesterol (7) when being included in human diet.

Recent studies examine the effects of consuming macadamia nuts in hypercholesterolemic male individuals. Seventeen hypercholesterolemic male subjects were given macadamia nuts (40-90 g/day), equivalent to 15% energy intake, for a period of 4 weeks. Once finalized this study, it was shown that macadamia nut consumption modified favorably the biomarkers of oxidative stress, thrombosis and inflammation (8).

Macadamia oil has also cosmetic applications, especially for the palmitoic acids presence. These cosmetic applications include lipbalms (7), creams to the skin, face soap (9),

sun creams (7), anti-cellulite (10), anti-wrinkle (11), hands cream crema para shampoo (12), etc.

For all their beneficts Macadamia nut is globally use in the sweet industry to make chocolate, biscuits, bread, ice-creams and desserts (13). This nuts can be consumed raw, roast, salted…

On the negative side, high content of unsaturated fatty acids leads to oxidative reactions, which result in rancidity that decreases the quality of the nut. Drying is thus needed to reduce the nut moisture content and hence alleviate the above-mentioned problem (14).

MATERIALS AND METHODS

Three samples of Macadamia nuts were used. Two of them of the variety Integrifolia (cultivated in Algarrobo Coast and Experimental Center la Mayora) and one of the variety Beaumont (cultivated in Marbella).

Shell size, cracking point, % relative humidity, ash content as well as the lipid content and profile were measured.

In order to measure the shell diameter, a slide caliper was used, Stainless Hardened.

Cracking of the shell was carried out on the basis of the study "Mechanical Behaviour of Macadamia Nut under Compression Loading". According to the study, the operation of cracking Macadamia nuts is the most critical and delicate step for achieve high-quality kernels (15). For that the nut was subjected to a uniform pressure along three directions (**figure 2**): axis numbered 1, axis numbered 2 and axis numbered 3. A hydraulic press was used loaned by the company Argos S.L.-, Mod. E181. Hydraulic Oil Hydrus Oil H146, whose load speed is 0.35 KN/s.

There are two main basic mechanisms which are commonly used to remove the nut shell. One of them is really important because consists in cracking and breaking the shell piece by piece.

It was found that the optimum speed of the knife varied not only with the physical condition of the nuts, such as moisture content, but also with the variety. Nuts of different moisture content, different varieties and different curing time after harvest required different knife speeds to minimize the amount of unhusked and cracked nuts (16).

The relative humidity is determined drying the sample in an oven Selecta Dry-Big 200297 at 105ºC.

The lipid content was obtained through the extraction procedure SOXLHET, according to the UNE 55030 standard.

In order to determine the lipid profile, a gas chromatograph with flame ionization detector Varian CP-3800 Gas Chromatograph with column was used: 60mx0.25 mmx0.2 µm. Stationary phase VF-624ms. Type WCOT Fused Silica. Injection volume 1µL., carrying out the analysis of the three copies of each sample.

The temperature program is shown in **table 1**.

RESULTS

Size, moisture and ash results from the analyzed samples, as well as the variety appear in **table 2.**

As it can be seen, the size of the variety Beaumont is smaller than this of the variety Integrifolia; the ash content is similar and the relative humidity is between 1,78 % and 1,86 %.

The variety Integrifolia contains more moisture that the Beaumont one.

According to (14) Macadamia nut quality depends significantly on its moisture; (17) reported that when the moisture content is in the range 1.2-1.6% (d.b.) macadamia nut has higher stability against lipid oxidation. (18) suggested that macadamia nut should not be dried at temperatures higher than 40ºC when the nut moisture content is higher than 8.7-11.1% (d.b).

Figures 3, 4 and 5 represent the force (KN) to be supplied, in the three directions (axis x, y, z), in order to break the shell.

A high content in lipids (62-74%) was obtained (**table 3**).

The lipid profile of the three analyzed samples appears in **table 4** and a cromatogram – shell sample in **figure 6**.

These samples show the predominant content in oleic acid (64.7-65.1%). The other predominant

fatty acid is the palmitoic with quantities between (9-12.7%).

DISCUSSION

Macadamia nut is not very common in Spain, but it is commercialized by different brands. Most of them come from South America and Australia.

The nuts cultivated in the south of Spain (Andalucía) are located in the southern Mediterranean area of semiarid subtropical climate, specifically in the Algarrobo Coast and Marbella (Málaga) and correspond to the varieties Integrifolia and Beaumont.

The ashes percentage is practically similar in all the samples.

The variety Beaumont is the smallest one, with 20.7 mm., which represents 11.8% of the 1 and 7.13% of the sample 3, both from the variety Integrifolia.

As well, the relative humidity shows a slight difference of 0.52% between the values of the samples (3.87-3.35%) from the variety Integrifolia comparing to the variety Beaumont. This is really important considering its influence in the drying process and its subsequent cracking (19). These authors state that low moisture content helps the shell cracking to improve the better extraction of the fruit.

Figures 3, 4 and 5 indicate that the cracking values regarding the axis x are between 0.7 y 1,8 KN, regarding y between 1.1 and 4.2 KN and z between 0.6 and 2 KN with a small standard deviation and a covariance which only reaches 3%. This shows that the preferred cracking direction is the axial one (axis z), which has a minimum value of 0.6 KN. Technologically recommended direction for the cracking of the different commercial nuts. A representation which shows the relation among the three cracking directions demonstrates the importance of the appropriate choice in order to eliminate the shell for its marketing.

The kernel has high lipid content, with a (majority) average value of 74.28% and composed of oleic acid 65.1% and 12.7% in palmitoic acid.

The Macadamia oil prevents the oxidation of cells due to its content in palmitoic acid. This fatty acid is naturally found in the babies' skin. As we age, the quantity of this acid decreases. The Macadamia acts as an antioxidant and delays aging. This anti-aging action is of the main cosmetic use (20).

Recent studies use the Macadamia nut as one of the main ingredients for the preparation of the food products for the human consumption. Optimum values from nuts (24.8%) and honey (75.2%) were mixed, because the nuts is rich in unsaturated fatty acids (MUFA) and the honey is rich in sugars as fructose (38.7 %), glucose (31.4%) and sucrose (1.50%), (21).

CONCLUSIONS

- The size range (diameter) of the different samples shows values between 20.0-23.0mm. for the shells. The natural variety Beaumont is the smallest.
- There is a slightly difference, the relative humidity (0.5%), between the samples of the two studied varieties.
- The preferred cracking point for both varieties of shells is the axial direction, showing a higher cracking value in the variety Beaumont due to the physical characteristics of the shell.
- The kernel has high lipid content, with an average value of 74.28% and mostly composed of oleic acid 65.1%. It also has a high content in palmitoic acid (12.7%) in relation with the variety Beaumont.
- According to the physical, chemical and stability characteristics of the macadamia oil, this oil can be used in food and cosmetic industry besides to the nutraceutic field.

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TABLES

Table 1. Temperature program.

Rate (ºC/min)	Step (ºC)	Time (min.)
Initial	155	2,00
1,0	182	12,00
3,0	210	10,00

Total time: 60,33

Carrier gas: He (Helio)
Column flow: 1.2mL/min

Table 2. Average size values and % of moisture and ashes.

Sample	Size (mm.)	Moisture (%)	Ashes (%)
1	23.47±0.45	1.86±1.21	**0.037±0.006**
2	20.70±0.49	1.79±0.95	**0.052±0.008**
3	22.29±0.45	1.85±1.20	**0.037±0.005**
	n= 25 (number samples)		

Sample 1,3 (*Variety Integrifolia*)
Sample 2 (*Variety Beaumont*)

Table 3. Lipid content of the three analyzed samples.

Sample	Lipid percentage
1	62.02±0.30
2	68.62±0.60
3	74.28±0.43
	n=7 (number of samples)

Table 4. Lipid profile of the three analyzed samples.

Fatty acid	% (M.1)	% (M.2)	% (M.3)
Myristic	0,4	0,6	0,5
Palmitic	8,4	9,5	8,8
Palmitoic	**11,4**	**12,7**	**9,0**
Stearic	5,8	3,7	7,0
Oleic	**64,7**	**64,8**	**65,1**
Linoleic	2,5	1,5	1,7
Arachidic	3,4	3,0	3,9
Linolenic	0,2	0,2	0,1
Behenic	0,8	0,8	0,9

FIGURES

Figure 1. Macadamia nut from the tree.

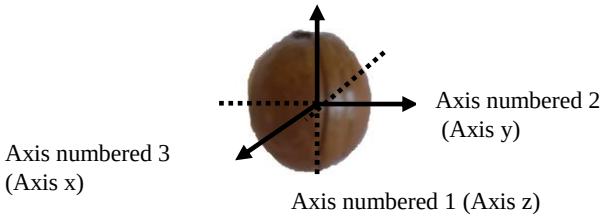

Figure 2. Representation of the three directions of the nut.

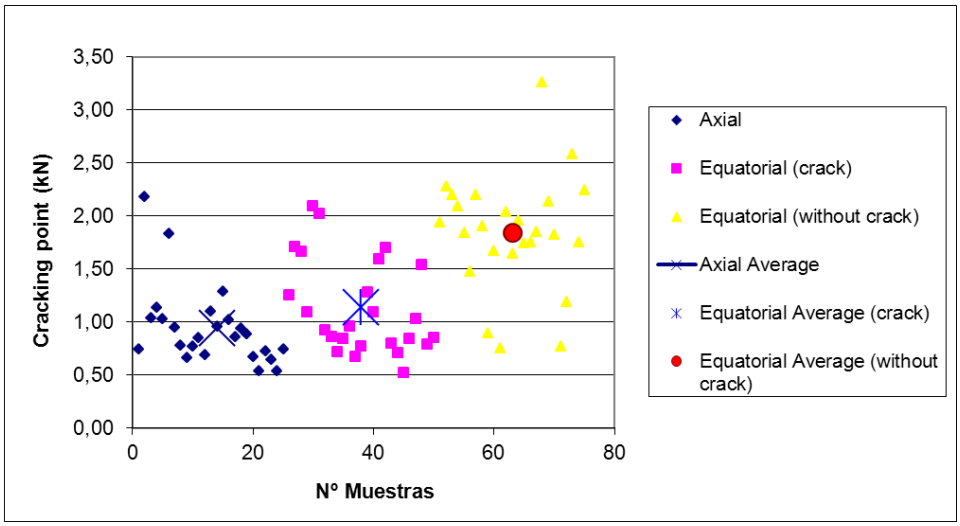

Figure 3. Cracking point in the three directions of the sample 1.

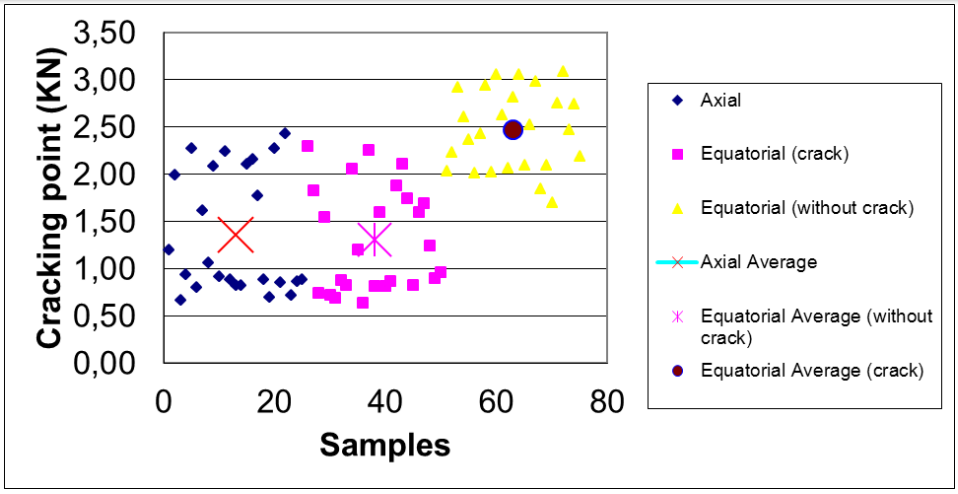

Figure 4. Cracking point in the three directions of the sample 2.

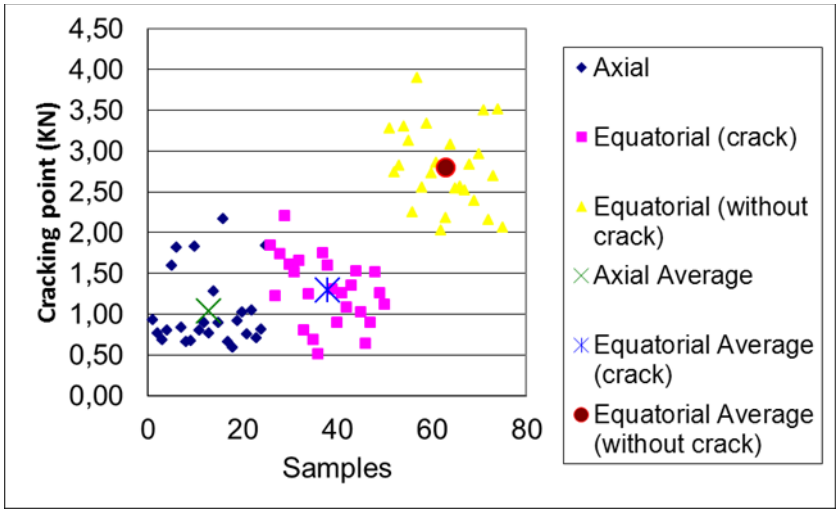

Figure 5. Cracking point in the three directions of the sample 3.

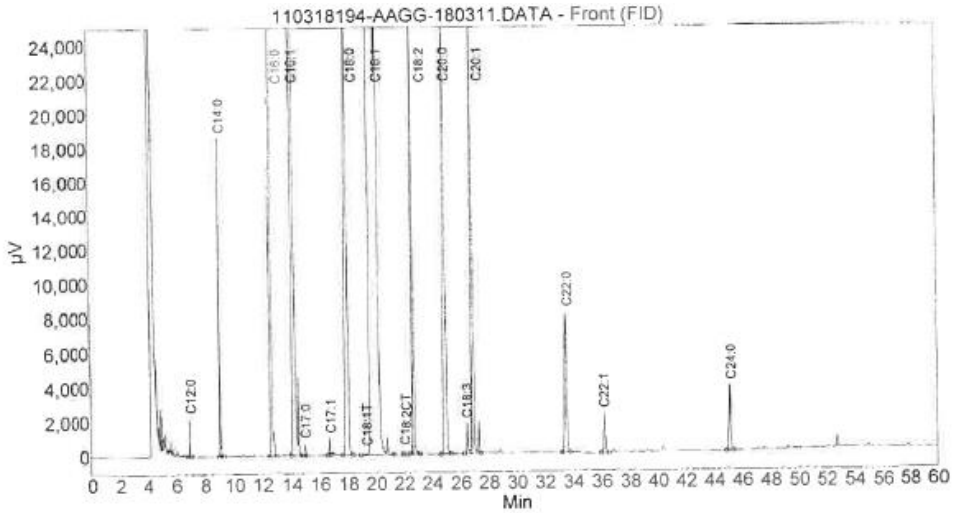

Figure 6. Cromatogram – shell sample.