

Nutritional Quality of Olives and Olive oil Produced in the Serra Da Mantiqueira from Brazil

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Abstract

The olive tree (*Olea europaea* L.) is one of the oldest fruits grown by man. Its fruit can be processed into olive oil or treated properly and serve directly for the *in natura* consumption in the form of olives. Extracted from the olive, the olive oil is highly valued in the market, for its nutritional benefits and also for its unique and delicate flavor. Brazil is the second largest importer of olive oil in the world, but technology is already available and the expansion of the crop has been taking place in the south-southeast regions, where the climate is favorable, in order to serve this market. The objective of this work was to evaluate the physical and chemical qualities of the olives and characterize, sensorially and chemically, olive oils from different olive cultivars planted in the Region of Serra da Mantiqueira. The olives and olive oils produced from the cultivars Arbequina, Arbosana, Grapolo 541, Koroneiki and Maria da Fé were evaluated at the EPAMIG Experimental Field of Maria da Fé, Minas Gerais, and Brazil. In the first experiment the olives harvested in February of 2015 were analyzed in terms of weight, volume, transverse and longitudinal diameter of the fruit and the lump and the relation of the olive/lump and the chemical (protein, lipid, moisture and ashes). In the second experiment the olives were processed by the grinding, beating and centrifugation method to obtain the oils. The olive oils were analyzed for acidity, peroxide index and absorbance in the ultraviolet region at 274 nm, 270 nm, 266 nm and 232 nm. After this characterization the olive oils produced in the Serra da Mantiqueira were then submitted to sensorial analysis. The results were submitted to analysis of variance and the means were compared by the Tukey test at 5% of probability. The interpretation of the data from the sensorial analysis was done using the software sensomaker. Differences were observed between olives and olive oils

produced by different cultivars in the Serra da Mantiqueira. The cultivar Grappolo 541 produces larger fruits, indicated for the preparation of olives and *in natura* consumption. Due to the small size of the fruit, the cultivar Maria da Fé is more suitable for olive oil production. The oils of all cultivars are within the parameters established by the Brazilian legislation in force, being classified as Extra Virgin Olive Oil. The oils of all cultivars were well accepted by consumers, especially the cultivars Maria da Fé and Grappolo 541.

Keywords

Diet, Health, Diet, Cooking

1. Introduction

The olive tree (*Olea europaea* L.) together with the vine is one of the oldest fruits grown by man. Although there is some doubt, its cultivation is believed to have begun about 4000 years BC in the northern Dead Sea and spread to the West through the Mediterranean Sea [1].

Although olive trees have been introduced in Brazil for many decades, only in recent years have oliviculture started to arouse interest, especially among the businessmen and rural producers of the South of Minas, now based on technical and scientific knowledge generated by the experiences and researches made in its vast majority by the Agricultural Research Company of Minas Gerais—EPAMIG [2].

Brazil is the second largest importer of olive oil in the world, with the United States the first and Canada the third in this classification [3]. It is estimated that for the supply of the domestic market, at current consumption levels, it would be necessary to plant 62,000 hectares, which could generate billions of R\$ for the Brazilian economy, besides generating countless jobs in all the links of the productive chain [1].

The fruit of the olive tree can be processed and transformed into olive oil or treated properly and serve directly for the consumption *in natura* in the form of olives. The physico-chemical characteristics of the different cultivars determine their best destination, whether for olive production or olive production. The climate also directly interferes in these factors determining the final quality of the product. Oliveira [2] characterized 35 olive cultivars in the southern region of Minas Gerais agronomically and carpmetrically, concluding that all cultivars have great potentials, either for olive production or olive production, which can be classified as virgin or extra virgin. Olive oil is the main source of oleic acid in the diet, as well as being a source of several other substances that exert antioxidant activity in the body due to its phenolic compounds [4].

Olive oil is probably one of the oldest agricultural products recorded in history. Extracted from the olive, it is highly valued in the market, for its nutritional benefits and, also, for its unique and delicate flavor. The product represents the

main edible oil of Mediterranean countries and is already an important commodity in other countries, such as New Zealand, Chile and the United States [5]. Due to its chemical constitution, its use brings health benefits, as they are rich in natural antioxidants, besides being a natural source of monounsaturated fatty acids [6]. Numerous studies have now provided evidence that nutrients and bioactive compounds in foods, such as olive oil, can contribute positively to disease prevention [7]. For these reasons, consumption of per capita olive oil is increasing worldwide and research has been carried out aiming at improving olive production techniques, obtaining olive oil and sensorial quality to obtain better quality products [1] [2] [8].

Brazilian legislation defines olive oil as a product derived solely from olives, extracted by physical or mechanical processes and cold, *i.e.*, temperature not above 28°C [9].

The objective of this work was to evaluate the physical and chemical qualities of the olives and to characterize, sensorial and chemically, olive oils from different olive cultivars planted in the Brazilian region of “Serra da Mantiqueira”.

2. Material and Methods

Experiment 1: Evaluation of olives

Homogeneous samples with approximately 500 grams of olives from five olive cultivars (Arbequina: Spanish cultivar origin, produces small fruit suitable for manufacturing olive oil; Arbosana: Spanish cultivar, similar to “Arbequina”, produces small fruit suitable for manufacturing olive oil; Grappolo 541: Brazilian clone obtained from the Italian cultivar Grappolo, whose fruits can serve both for the production of olive oil and also for the consumption *in natura*; Koroneiki: Greek cultivar that produces fruits that give rise to a fruity olive oil spicy and slightly bitter; and Maria da Fé: Brazilian clone coming from the cultivar Galega of Portuguese origin, indicated for the manufacture of olive oil) were collected in February 2015 at the time of harvest. The plants are part of the cultivar collection of the Experimental Farm of the EPAMIG of Maria da Fé, MG, which is located in the South of Minas at an altitude of 1258 meters, presenting tropical climate type Cwb [10].

The fruits were frozen immediately after harvesting and transported in Styrofoam boxes to Lavras-MG, where they were analyzed at the Quality Laboratory of the “Dr. Alcides Carvalho” by EPAMIG.

For the carpometric analysis, ten repetitions were made and the following characteristics were evaluated: weight, volume, transverse and longitudinal diameter of olive and the lump, and the ratio of olive/lump.

Regarding the chemical quality, analyzes of protein, lipid, moisture and ash contents were done for the five cultivars in triplicate.

The experiment consisted of 5 treatments (cultivars) distributed in 10 repetitions for the carpometric evaluation and in 3 repetitions for chemical evaluation of the constituents of the fruit.

The results were submitted to analysis of variance and the means were compared by Tukey's test at 5% of probability, using statistical software Sisvar® [11].

Experiment 2: Evaluation of olive oils

This experiment was carried into the Department of Food Science (DCA) and the Center for Chemical Analysis and Prospecting (CAPQ), Department of Chemistry, Federal University of Lavras (UFLA), Lavras, MG.

The samples of olive oil were produced by the Agricultural Research Company of Minas Gerais (Epamig), from fruits harvested from olive trees with 8 years of age in the harvest in the year 2014/15. Olive oil samples from five different cultivars were used: A—Koroneiki; B—Arbequina; C—Maria da Fé; D—Grapolo 541; and E—Arbosana.

The oils were extracted in a continuous system of operation, which is divided into three stages: Crushing, thumping and spinning. After these steps the oil remains stored in stainless steel and are packed in amber or green glass bottles [1].

According to the rules established by current Brazilian legislation [12], olive oils must be subjected to chemical analysis in order to ascertain their quality and authenticity, so that it can be classified.

The determination of the acidity was carried out by titration with ethyl alcohol solution and phenolphthalein indicator, according to AOAC [13] and Adolfo Lutz Institute [14] and the result was expressed as % oleic acid (m/m).

The peroxide content was determined by the Association of Official Analytical Chemists [13], for the ability of the peroxides present in the sample to oxidize potassium iodide. The results were expressed in meq O₂/Kg.

Specific extinction was determined by measuring the absorbance in the ultra-violet region at 274 nm, 270 nm, 266 nm and 232 nm, using the methodologies of the Adolfo Lutz Institute [14].

After the physical and chemical characterization, the olive oils produced in the Serra da Mantiqueira were then submitted to sensory analysis. The sensorial analysis was carried out in the Laboratory of Sensory Analyzes of the Department of Food Sciences of the Federal University of Lavras by consumers. The oil samples of the 5 cultivars were evaluated by 50 evaluators for taste, visual appearance, odor and overall appearance.

The results were submitted to analysis of variance and the means were compared by the Tukey test at 5% of probability, using statistical software Sisvar® (FERREIRA, 2008). The interpretation of the data from the sensorial analysis was done using the methodology proposed by Pinheiro *et al.* [15].

3. Results and Discussion

Experiment 1: Evaluation of olives

The analysis of variance showed that there was a significant difference among the olive cultivars for all carpometric characteristics evaluated.

Table 1 shows the results of the carpometric evaluations made on the five olive cultivars.

In relation to the weight, volume and longitudinal and transverse diameters of the fruit, Grappolo 541 showed the highest values, showing its vocation for the production of table olives for *in natura* consumption, since for this purpose, the size of the fruit added large commercial value to the product. On the other hand, the cultivar Maria da Fé presented the lowest values for these characteristics, being the most suitable for the manufacture of olive oil. The other cultivars, although in an intermediate situation, are more adequate to the production of olive oil, because they present values closer to the cultivar Maria da Fé.

Table 2 shows the carpometric assessments of the olive stones of the 5 cultivars studied.

It is possible to observe a very large correlation between the values reached by the lumps in relation to those obtained previously for the olive, resulting in practically the same classification as in “Grappolo 541” with the highest values and “Maria da Fé” with the lowest, with the remaining cultivars being intermediate.

As for the pulp/lump ratio, due to this previously mentioned correlation, no statistical differences were observed among the cultivars, since the cultivar that presented the largest pulp, also presented the largest olive.

Table 1. Weight (WO, g), volume (VO, mm³), longitudinal diameter (LDO, mm) e transverse diameter (TDO, mm) of olives from different olive cultivars. Epamig, Lavras, Minas Gerais, Brazil, 2016.

Cultivar	WO	VO	LDO	TDO
Arbequina	1.65 b	1.76 b	12.14 bc	14.38 bc
Arbosana	1.75 b	1.87 b	12.45 b	13.93 c
Grappolo 541	3.01 a	2.86 a	12.25 a	19.16 a
Koroneiki	1.35 bc	1.16 c	10.96 c	15.44 b
Maria da Fé	0.95 c	0.88 c	9.39 d	13.02 c
C.V (%)	21.28	19.44	8.27	7.68

Means followed by the same letter in the columns do not differ from each other by the Tukey test at 5% probability.

Table 2. Weight (WL, g), volume (VL, mm³), longitudinal diameter (LDL, mm) e transverse diameter (TDL, mm) of lump and Ratio olive/lump (ROL) from different olive cultivars. Epamig, Lavras, Minas Gerais, Brazil, 2016.

Cultivar	WL	VL	LDL	TDL	ROL
Arbequina	0.40 b	0.55 a	7.33 b	10.43 bc	0.75 a
Arbosana	0.38 b	0.44 ab	7.10 b	10.65 bc	0.77 a
Grappolo 541	0.59 a	0.55 a	8.00 a	13.83 a	0.80 a
Koroneiki	0.26 c	0.45 ab	5.90 c	11.02 b	0.79 a
Maria da Fé	0.23 c	0.33 b	5.76 c	9.63 c	0.77 a
C.V (%)	24.22	33.30	6.50	9.90	5.18

Means followed by the same letter in the columns do not differ from each other by the Tukey test at 5% probability.

However, it is necessary to consider the chemical and productive characteristics of the cultivars in order to be able to define their vocation for the production of olive oil, olive, or for both purposes.

For the quantified chemical characteristics, the analysis of variance also showed significance among all analyzed characteristics. **Table 3** shows the values of moisture, ash, lipids and proteins found in the olives of the different olive cultivars in the 2014/15 harvest.

Regarding moisture, the highest content was observed in “Koroneiki” (59.8%) and lowest in “Maria da Fé” (54.56%), which was statistically detected due to the low coefficient of variation ($CV = 0.56\%$), very common in laboratory analysis, where the conditions are quite homogeneous between the repetitions (triplicate).

Regarding the contents of ashes and proteins, the cultivar Maria da Fé was highlighted, with the highest values among the others. As for the lipid contents, the highest values were found in “Grappolo 541” and “Koroneiki”.

The work carried out by Silva [1] also detected differences in the olives harvested in the same collection in previous years, but which provided the elaboration of excellent quality olive oil, classified as virgin and extra virgin.

Experiment 2: Evaluation of olive oils

The acid value in oleic acid ranged from 0.29% (“Arbequina”) to 0.65% (“Maria da Fé”) (**Table 4**). This index reflects directly on the quality of olive oil, especially on post-harvest care, using healthy fruits and fast processing. In order for the oil to be classified as extra virgin it must have a maximum acidity of 0.8%, according to the norms established by the current Brazilian legislation [16].

However, it is important to note that this parameter can be changed according to time and storage conditions [9] [12].

The peroxide index presented results ranging from 7.18 $\text{mmol}\cdot\text{kg}^{-1}$ (“Koroneiki”) to 11.61 $\text{mmol}\cdot\text{kg}^{-1}$ (“Maria da Fé”). This index refers to the same cares observed for the acidity, being measured how much oxidized the oil is, being considered extra virgin which presents up to 20 meq of O_2 per kg of olive oil.

It is important to emphasize that there is no obligation to express on the label both the acid value and the peroxide index, since it is understood that the oil that has the label extra virgin already has these indexes within the maximum

Table 3. Centesimal composition of olives of different olive cultivars. Epamig, Lavras, Minas Gerais, Brazil, 2016.

Cultivar	Humidity (%)	Ashes (%)	Lipid (%)	Protein (%)
Arbequina	56.88 b	1.20 b	13.31 b	2.55 b
Arbosana	57.41 b	1.15 b	13.65 b	2.18 c
Grappolo 541	56.65 b	1.15 b	16.21 a	2.61 ab
Koroneiki	59.80 a	1.11 b	16.28 a	2.42 bc
Maria da Fé	54.56 c	1.45 a	9.58 c	2.91 a
C.V (%)	0.56	2.87	3.8	3.44

Means followed by the same letter in the columns do not differ from each other by the Tukey test at 5% probability.

Table 4. Chemical analysis of olive oil extracted from olive cultivars. Epamig, Lavras, Minas Gerais, Brazil, 2016.

Cultivar	Acidity (%)	Peroxide (meq O ₂ /kg)	Absorbance (nm)			
			232	266	270	274
Koroneiki	0.418 ab	7.653 a	0.650 a	0.105 ab	0.104 ab	0.101 ab
Arbequina	0.294 a	11.402 b	0.674 a	0.108 ab	0.108 ab	0.104 ab
Maria da Fé	0.584 c	11.441 b	0.791 a	0.150 b	0.142 b	0.137 b
Grappolo 541	0.545 bc	9.121 ab	0.600 a	0.091 a	0.089 a	0.087 a
Arbosana	0.317 a	11.019 b	0.778 a	0.110 ab	0.110 ab	0.107 ab
CV (%)	11.61	10.00	18.02	15.77	15.25	14.91

Means followed by the same letter in the columns do not differ from each other by the Tukey test at 5% probability.

parameters established by the legislation, i.e. acidity of less than 0.8% and peroxide of less than 20 meq O₂/kg. However, if the producer wishes to express the acidity, it must be accompanied by the peroxide index.

The absorbance at ultraviolet at 232 nm ranged from 0.501 in the Arbequina cultivar to 0.972 in the cultivar Maria da Fé. For absorbance at wavelength at 270 nm there was variation of 0.083 for Koroneiki cultivar at 0.126 for Arbosana.

All the olive oil samples presented values within the allowed limit (2.5 to 232 nm and 0.22 to 270 nm), being in agreement with the Brazilian legislation in force.

However, it is worth mentioning that there are other obligatory analyzes that must be done so that the olive oil can receive its classification as iodine index, absolute refractive index and composition of fatty acids. In addition, other non-mandatory analyzes that can assure the identity and quality of the oil, such as: composition of sterols, erythrodiol and uvaol content, stigmastadiene, ECN42, Delta-K and triacylglycerols composition, it is possible to more safely evaluate the identity and the quality [17].

Figure 1 represents the behavior of the overall assessment by the tasters. PC 1 and 2 are 2 components that best explain this acceptance, adding up to around 60%. Each line (vector) individually represents each taster. These vectors are distributed almost randomly, showing that all cultivars have a similar degree of acceptance, perhaps with a slightly higher acceptance for the cultivars Maria da Fé and Grappolo 541 and a lower acceptance for Arbosana. We also noticed that there are 4 distinct groups, where the cultivars Koroneiki and Arbequina form the same group because they are closer and the other 3 have different behavior.

4. Conclusions

The results achieved by the study allow us to:

There are differences among the olives and olives oil produced by different cultivars in the South of Minas Gerais.

The cultivar Grappolo 541 produces bigger fruits, indicated for the preparation of olives for the consumption *in natura*.

Due to the small size of the fruit, the cultivar Maria da Fé is more suitable for the production of olive oil.

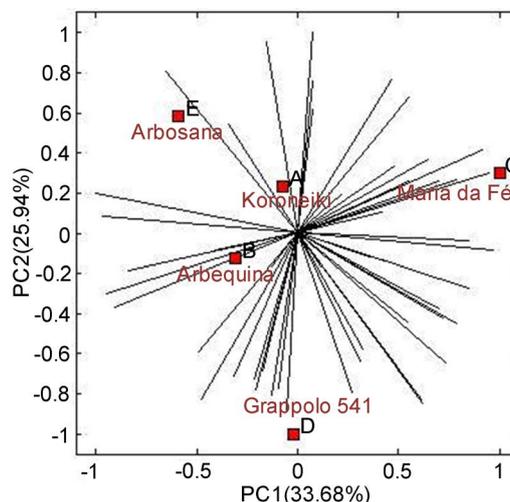


Figure 1. Sensory analysis of the global evaluation of olives oil extracted from olives (Principal Components—PC 1 and 2). A: Koroneiki, B: Arbequina, C: Maria da Fé, D: Grappolo 541 and E: Arbosana). EPAMIG/ UFLA, Lavras, Brazil, 2016.

The olive oils of all cultivars are within the parameters established by current Brazilian legislation, classified as Extra Virgin Olive Oil.

All olive oils are well accepted by consumers, especially the cultivars Maria da Fé and Grappolo 541.

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