International Journal of Innovation and Scientific Research
ISSN 2351-8014 Vol. 76 No. 1 Dec. 2024, pp. 39-47

http://www.ijisr.issr-journals.org/

Avocado Oil Extraction (Persea Americana Mill) by Laboratory and Artisanal Methods

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ABSTRACT: The aim of this study was to extract avocado oils using the laboratory method (Soxhlet) and the artisanal method. To achieve the research objective, an artisanal oven was used to dry the avocado pulp and a device was adapted for artisanal oil extraction. The oils obtained by hand were compared to those extracted in the laboratory on the basis of organoleptic, physical and chemical analyses. The following parameters were assessed: colour, density (d), saponification index (IS), iodine index (II), acidity index (IA), ether index (IE), peroxide index (IP) and unsaponifiable matter. Volumetric methods were used for the quantitative determination of these indices. The oil analyses were carried out in duplicate and the following results were obtained: The oils extracted in the laboratory and by hand showed a dark green colour. With regard to the physical and chemical parameters, the following averages were obtained: density - laboratory oil (OL): 0.912 g/cm3; artisanal oil (OA): 0.911 g/cm3; -acidity index OL: 5.609 mg KOH/g; OA: 4.515 mg KOH/g; -iodine index OL: 88.706 g I2/g; OA: 82.357 g I2/g; -saponification index OL: 190.68 mg KOH/g; OA: 189.14 mg KOH/g; -ester index OL: 185.071 mg KOH/g; OA: 184.62 mg KOH/g; -peroxide index OL: 10.12 mEqO2/kg; OA: 9.89 mEqO2/kg; -unsaponifiable matter content OL: 1.506%; OA: 1.5204%.

KEYWORDS: Persea american Mill, extraction, analysis.

1 INTRODUCTION

Throughout history, plants have played a fundamental role in the lives of both humans and animals. They are often present in our daily lives and are frequently consumed [14].

Among the various plants, oilseeds stand out, as they have a high oil content in their seeds and fruits and can be used to produce vegetable oil and for different purposes [22]. The avocado, one of these oilseeds, is widely consumed in Angola's Uíge province in the fresh form of its fruit, known as avocado.

As well as being eaten fresh, the population can benefit from the avocado fruit in processed form, with oil extraction being an important aspect of its industrialisation [17]. Avocado oil is a vegetable oil extracted from the avocado tree and is used in a variety of applications, including food, the production of pharmaceutical products and cosmetics. It can also be applied directly to the skin and hair, thanks to its richness in vitamins and bioactive compounds, helping to treat healthy skin and hair.

The avocado tree, which belongs to the Lauraceae family and the Persea genus, is found in all tropical and subtropical areas of the world. Among the species of this genus, Persea americana is the most relevant and studied, according to [12].

The chemical composition of avocado pulp ranges from 67 to 78% moisture, 13.5 to 24% lipids, 0.8 to 4.8% carbohydrates, 1.0 to 3.0% protein, 0.8 to 1.5% ash, 1.4 to 3.0% fibre and an energy density of between 140 and 228 kcal (Soares et al., 2000). In addition, studies indicate that avocado oil has excellent nutritional quality, with high lipid, protein, vitamin and mineral content, and has great economic potential for the pharmaceutical, food, cosmetics and biofuel industries [3], [20].

However, the avocado is a highly perishable fruit with a short shelf life, which means that it cannot be stored for long periods as it deteriorates quickly. This characteristic represents one of the difficulties faced by consumers and sellers. Given the socio-economic importance of avocados, processing them into oil could be an alternative for meeting the needs of the population of Uíge.

This work is structured as follows: Section 1 is an introductory part. Section 2 details the materials and methods. Section 3 presents the results of the oil extraction and analysis. Section 4 details the discussion of results. Finally, section 5 presents the final considerations.

2 Materials And Methods

2.1 Origin Of The Raw Material

The Fuerte avocado variety is a Guatemalan-Mexican hybrid that is very popular in many parts of the world. It is a large, round fruit with a smooth, dark green skin that becomes a little lighter when ripe. The flesh of the Fuerte avocado is creamy and soft, with a pale green colour that is mild on the palate. The taste of the Fuerte avocado is slightly sweet, but with a rich, smooth flavour, making it a popular choice for many recipes, including guacamole and salads. In addition, the Fuerte variety is known for its high productivity and resistance to disease, making it a popular choice among avocado growers.

The avocados were purchased from local markets in the city of Uige, where good quality fruit ideal for consumption was chosen. We used the Fuerte variety, a Guatemalan-Mexican hybrid, which is easily found in markets, supermarkets and the rural areas of Uige. The fruit's vernacular names are: avocat or poire d'avocat (French); avocado (English); divoka, voka or savoka (Kikongo).

Fig. 1. Fuerte avocado

2.2 Sample Preparation

- Choose ripe and healthy avocados. Make sure there are no signs of deterioration;
- Wash with tap water;
- Cut the avocados in half using a stainless steel knife and remove the pit;
- Remove the avocado pulp from the skin using a spoon;
- Grind the pulp with a blender;
- Pour the crushed pulp onto an aluminium tray and dry in a homemade oven (± 50º C) for 48 hours;
- After drying, store the dried material until the extraction process.

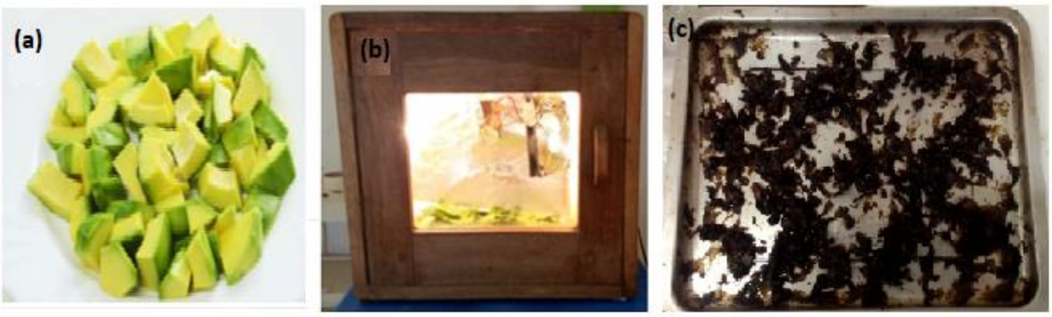

Fig. 2. (a) Fresh avocado pulp (b) Drying of the pulp in an artisanal oven (c) Dried avocado pulp

2.3 Oil Extraction

2.3.1 Laboratory Extraction

The Soxhlet method was explored, an effective and simple technique without altering the properties of lipid substances.

Fig. 3. (a) Soxhlet extraction (b) Solvent evaporation

2.3.1.1 Principle

The Soxhlet method is a gravimetric process based on the weight loss of the material extracted with solvent (chloroform).

2.3.1.2 Experimental Procedure

- Weigh the sample (10g);
- Place 10g of the sample (dried avocado pulp) inside the Soxhlet cartridge (filter paper);
- Place the cartridge containing the sample inside the Soxhlet extractor;
- Connect the Soxhlet extractor to a round-bottom flask (250 ml) and add 150ml of chloroform;
- Connect the setup to a condenser;
- Turn on the heating mantle and start the extraction (8 hours);
- After 8 hours, turn off the heating mantle;
- Allow the solution to cool while maintaining water circulation through the condenser;
- Disassemble the system to recover the solution (oil - solvent) from the flask;
- Distill the solution to separate the solvent from the oils using a rotary evaporator;
- Recover the oil and store it in an airtight container in the refrigerator until analysis.
- Determine the extraction yield using the equation:

$$Oil\ content\ (\%) = \frac{mass\ of\ oil\ obtained\ from\ extraction}{dry\ mass\ df\ the\ sample} * 100$$

2.3.2 Artisanal Extraction

2.3.2.1 Description of the Artisanal Extractor

The extractor is a cylindrical device made of steel and supported by three legs. Its upper opening, where the up and down movements of the metal disc occur, has a shaft supported by an arm similar to a car steering wheel, used to apply pressure. At the bottom of the extractor is a sieve used to filter the pressed paste, which is then poured into a container below to collect the oil.

Fig. 4. Homemade extractor

2.3.2.2 Principle

The method consists of introducing the paste into the cylinder and selecting a group of three people with sufficient physical strength to apply pressure to the handmade extractor.

2.3.2.3 Experimental procedure

- Weighing the sample;
- Lightly heat the sample and insert it into the extractor;
- Press continuously with your hands until the oil stops flowing;
- Weigh the quantity of oil obtained.

3 Results

3.1 Laboratory And Artisanal Extraction Of Avocado Oil

The experiment was repeated five times for both extraction methods.

3.1.1 Laboratory Extraction

Fig. 5. Oil extracted by soxhlet

Table 1. Oil yield using the soxhlet method

Test number	1	2	3	4	5	Average
Mass (g)	6,59	6,41	6,74	6,76	6,84	6,668
Yield (%)	65,9	64,1	67,4	67,6	68,4	66,68

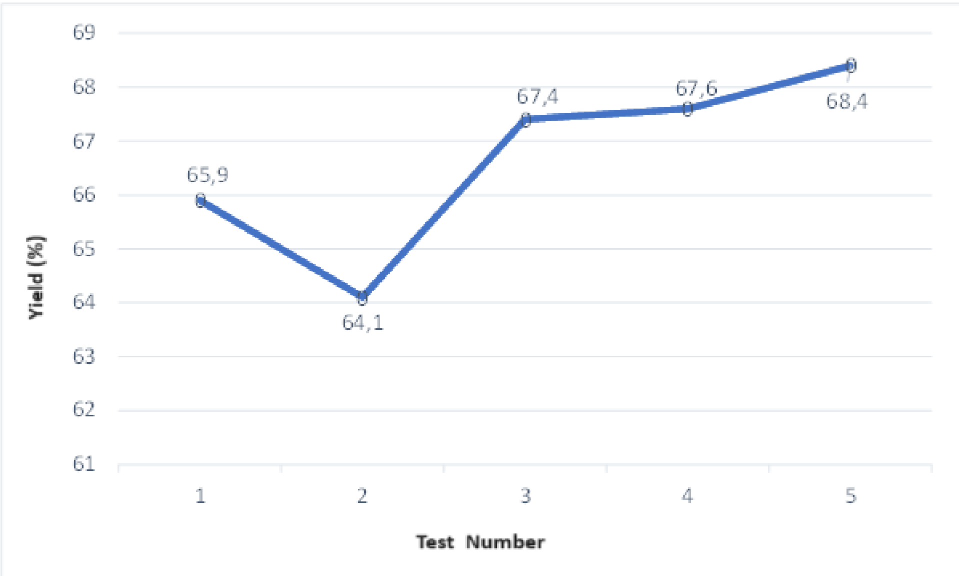

Fig. 6. Soxhlet extraction yield

Using 10g of sample for each extraction, an oil mass ranging from 6.59 to 6.84g was obtained, with a final average of 6.668g, corresponding to 66.68% of the total. The results confirm that the avocado variety used contains a significant lipid content in its pulp. During the extraction process, it was noted that the fat content increases proportionally with the number of siphons. Thus, the amount of oil obtained depends both on the number of siphons used in the extraction system and the variety of the material used.

3.1.2 ARTISANAL EXTRACTION

Fig. 7. Oil extracted by hand

Table 2. Lipid content by the artisanal method

Test number	1	2	3	4	5	Average
Mass (g)	167,42	163,98	167,06	161,30	165,69	165,09
Yield (%)	55,80	54,66	55,68	53,76	55,23	55.03

Source: Authors

Fig. 8. Yield from artisanal extraction

Using 300g of sample in five consecutive extractions, a mean oil mass of 165.09g was obtained, corresponding to 55% oil. Compared to Soxhlet extraction, the artisanal oil yield is low. This can be attributed to two reasons:

1. Extracting all the oil present in the sample during this extraction process can be challenging, as it depends on the physical strength of the individual applying the necessary pressure.
2. The extraction was performed at room temperature, as the artisanal extractor does not have a heating system to generate heat during the process, making it impossible to keep the sample warm.

3.2 ANALYSING OILS

Remember that the principles, materials and reagents used to analyse the oils extracted in the laboratory are the same as those used to analyse the oils obtained by hand.

The oil samples were analysed in duplicate, following the classic analytical methods described in the Analytical Standards of the Adolf Lutz Institute [2].

The following characteristics were assessed: colour, density (d), acidity index (AI), saponification index (IS), ester index (IE), iodine index (IO), peroxide index (IP) and unsaponifiable matter (I.ins).

Table 3. Average values obtained from oil analysis [1], [24]

Parameters	**Calculated and obtained values**		**Bibliographical data**
	OL	**OA**	**Dark green**
Colour	**Dark green**	**Dark green**	
d (25ºC) g/cm^3	0,912	0,911	0,910 -0,920
IA (mg KOH/ g	5,609	4,515	1 - 7
II (g I_2/100g)	88,706	82,357	75,0-100,0 82,0 - 90
IS (mg KOH/g)	190,68	189,14	177- 198
IE (mg KOH/g)	185,071	184,62	176- 191
I Ins (%)	1,506	1,5204	1,0 -6,0
IP mEq/ Kg	10, 12	9,89	10,0

4 Discussion Of Results

The physicochemical characteristics of the oils (both laboratory and artisanal) were analysed in duplicate. The values shown in Table 3 represent the average of the values for each parameter analysed.

The laboratory oils and the handmade oils were dark green in colour. On consulting the literature, it was found that, according to the standards established by the Codex Alimentarius Committee on Fats and Oils (2019), crude avocado oils should have a green colour, and the oils obtained by the two extraction methods observed were within the expected standard for this category of oil.

The density of a lipid is defined as the mass of material required to occupy a given volume. For liquid oils, the density tends to be between 0.91-0.93 g/mL at room temperature, and decreases with increasing temperature [18].

This variable is used to standardise and control the process and the quality of the processed product. In the food industry, density is commonly used as a process control parameter [15].

The values found for the density of the oils analysed in this study are within the range of values required by legislation at 25 ºC, indicating that the oil samples maintained their quality.

The acidity index corresponds to the amount of base needed to neutralise the free fatty acids present in the oil or fat.

A high acidity index indicates that the oil is undergoing triacylglycerol hydrolysis, releasing fatty acids and glycerol, which may indicate that the product is undergoing an accelerated deterioration process [19].

According to the results obtained, the acidity index of the laboratory oil and the artisanal oil are 5.609 and 4.515 respectively. The values obtained are within the permitted limit according to the literature, which is between 1-7 [1].

It is known that the acidity index is an important factor in oil quality, providing valuable information about the state of conservation of the oil. Higher acidity index values can indicate accelerated deterioration of the oil. However, the values obtained for the extracted oils indicate that they are in good quality condition and can be used.

The iodine index is an indicator of the degree of unsaturation of the fatty acids present in the oils, and the higher the index, the greater the possibility of oxidative rancidity [7].

The peroxide index is a measure of the degree of oxidation of the oil, indicating how far oxidation has progressed. The peroxides present indicate the development of rancidity [4]. This index reveals the degree of lipid oxidation, which is the main cause of oil deterioration, altering the organoleptic quality of the product [21].

Both the iodine index and the peroxide index are related to the degree of lipid oxidation [12]. In relation to the results obtained and compared with the international standards, [1], [9], and the results of other researchers [24], it was observed that the iodine index values of the oils analysed are within the recommended values. As for the peroxide index, there was a small, non-significant difference and no unpleasant changes in the colour or odour of the oils. This indicates that the drying and extraction methods adopted were adequate and did not allow oxidative degradation of the product.

According to [16], the saponification index is the amount of alkali required to saponify a defined quantity of oil and/or fat. It is one of the important characteristics, providing an indication of the relative amount of high and low molecular weight fatty acids. Although it is not suitable for identifying oils and fats, it is useful for checking the average molecular weight and adulteration by other oils with different saponification indices [7]. The values found in this study were 190.68 for the laboratory oil and 189.14 for the artisanal oil, which is close to and within the standard range established by the [2]. The high value of this index suggests the presence of long-chain, high molecular weight carbon compounds.

The ester index (I.E.) is defined as the difference between the number of milligrams of potassium hydroxide consumed to saponify (I.S.) and the number of potassium hydroxide consumed to neutralise 1 gram of fat (I.A). This index is influenced by the saponification index, the acidity index and the content of fatty acids present in the oils.

The values obtained in this study are satisfactory, with an average of 185.071 for the laboratory oils and 184.62 for the artisanal oils, which is within the desirable range according to the literature. These results indicate a high content of unsaturated fatty acids, which justifies the liquid state of the oils.

Unsaponifiable matter: corresponds to the total amount of substances dissolved in oils and fats after saponification, which are insoluble in aqueous solution but soluble in common fat solvents. The experimental values obtained for unsaponifiable matter were 1.506 for laboratory oils and 1.520 for artisanal oils, within the range observed by Tango and Turratti in 1992. The results show that the content of unsaponifiable matter, being the natural antioxidants present in the oils analysed, protects them from degradation and guarantees their nutritional and organoleptic quality.

5 Conclusion

This study compared two methods of extracting avocado oil: one carried out in a laboratory and the other by hand. The artisanal extraction used in this work is a simple, effective and less expensive technique, allowing a purely natural product to be made available to the population of Uíge, while preserving its nutritional quality.

An artisanal oil extractor was created that resulted in a virgin product, and its quality was compared with that of avocado oils extracted in the laboratory using the Soxhlet method. Various physical and chemical parameters such as colour, density, saponification index, iodine index, acidity index, ether index, peroxide index and unsaponifiable matter were assessed. The results were satisfactory and indicated that the oils extracted by the artisanal method had physical and chemical properties comparable to those extracted in the laboratory.

Based on the results of the oil analyses carried out in this study, we can say that the oil extracted by hand is of good quality. The oil is dark green in colour and has the desired density according to oil standards. In addition, the quality indices were satisfactory.

References

[1] A.O.A.C, 15 ed, Official methods of analysis of the Association Analytical Chemists., v.2, 1990.

[2] AOCS, 5th ed. American Oil Chemists Society; Official Methods and Recommended Practices of the AOCS,.,Champaign: EUA. 2000.

[3] Bhuyan, D. J., Alsherbiny, M. A., Perera, S., Low, M., Basu, A., Devi, O. A., Barooah, M. S., Li, C. G., Papoutsis, K.,.The odyssey of bioactive compounds in avocado (Persea americana) and their health benefits. Antioxidants, Basel, v. 8, n. 10. 2019.

[4] Caires, L. G., Óleos vegetais como matérias-primas para coletores, 1992.

[5] Carvalho, C. R. L., Soares, N. B., Tango, J. S., Caracterização física e química de frutos de abacate visando a seu potencial para extração de óleo. Revista, 2002.

[6] Cecchi, H. M., Fundamentos teóricos e práticos em análise de alimentos. Campinas: Editora da Unicamp. 1999.

[7] Cecchi, H. M., 2.ed. Fundamentos Teóricos e Práticos em Análise de Alimentos. Universidade Estadual de Campinas. São Paulo: UNICAMP. 2003.

[8] Cecchi, H. M., 2º Ed. Fundamentos teóricos e práticos em análise de alimentos. Editora da UNICAMP: rev.- Campinas, SP, editora da UNICAMP. 2003.

[9] Codex alimentarius commission.,. Codex-Stan 210: codex standard for named vegetable oils. Roma: FAO/WHO Food Standards. 2009.

[10] Ding, H., Chin, Y. W., Kinghorn, A. D., Chemopreventive characteristics of avocado fruit. Net, Columbus, v. 17 n. 5. 2007.

[11] Ding, H., Chin, Y. W., Kinghorn, A. D., D'ambrosio, S. M.,. Chemopreventive characteristics of avocado fruit. Seminars in Cancer Biology, v.17. 2007.

[12] Fernández, E. H., Guitié, A. F., Pancorbo, A. C., Avocado fruit - Persea americana. Exotic Fruits Reference Guide. Elsevier. 2018.

[13] Instituto Adolfo Lutz, Métodos físico-químicos para análise de alimentos/coordenadores Odair Zenebon, Neus Sadocco Pascuet e Paulo Tiglea -- São Paulo. 2008.

[14] Kingsley R. Stern; - Introductory Plant Biology WCB Publishers. 1994.

[15] Laurindo, J. B., Larotonda, F. D. S., Matsui, K. N., Paes, S. S., Um dispositivo simples para a determinação simultânea e contínua da densidade de líquidos e da concentração de suspensões líquidas. Ciência e Tecnologia de Alimentos. v.24, n.2. (2004).

[16] Lutz., 4ª ed. Instituto Adolfo. Normas Analíticas do Instituto Adolfo Lutz. Métodos físico-químicos para análises de alimentos. (1ª Edição digital). 2008.

[17] Martin, Z. J. et al., 2ªed, Abacate: cultura, matéria-prima, processamento e aspectos econômicos. Campinas, SP: ITAL,. 1991.

[18] Mcclements, J. D., Decker, Éric A. L. I., Damodaran, S., Parkin, K. L., Fennema, O. R., 4ª ed, Química de alimentos de Fennema. Porto Alegre: Artmed Editora. 2009.

[19] Ordonez, Juan A. et al., Tecnologia de alimentos: Componentes dos alimentos e processos (vol. 1). Porto Alegre: Artmed. 2005.

[20] Qin, X., Zhong, J. A., Review of extraction techniques for avocado oil. Journal of Oleo Science, v. 65, n. 11,. http://dx.doi.org/10.5650/jos.ess16063. PMid: 27725362. 2016.

[21] Ribeiro, E. P., Seravalli, E. A. G., Química de alimentos. São Paulo: Instituto Mauá de Tecnologia, Edgard Blucher. 2004.

[22] Sluszz, T., Machado, J. A. D., Culturas matérias-primas para biodiesel e o potencial de adoção pela agricultura familiar nas diferentes regiões brasileiras. In: PADILHA, A. C. M.; GOLLO, S. S.; SILVA, M. N. (Org.). Estudos na Cadeia Produtiva do Biodiesel. 1.ed. Jaguarão: Unipampa, v.1. 2012.

[23] Soares, H. F., Ito, M. K., The monounsaturated fatty acid from avocado in the control of dyslipidaemia. Revista Ciencia Médica, v. 9, n. 2. 2000.

[24] Tango, J. S., Turatti, J. M., Óleo de abacate. In: ABACATE – cultura matéria-prima, processamento e aspectos econômicos. Campinas: ITAL. 1992.

[25] Guillén, M. D., Uriarte, P. S., Simultaneous control of the evolution of the percentage in weight of polar compounds, iodine value, acyl groups proportions and aldehydes concentrations in sunflower oil submitted to frying temperature in an industrial fryer. Food Control, v. 24, n. 1-2. 2012.