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Valorization of Olive Industry Through the Application of Two-Phase Process for Extraction and Improvement of Physical and Chemical Properties of Avocado Oil

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The objective of this work fits into the framework of sustainable development and environmental protection for a comprehensive management of agribusiness waste, including olive industry in Morocco. Several opportunities for recycling such wastes have the dual benefit of solving the environmental problems and particularly increasing the profitability of olive oil extraction units after the olive season that lasts 100 days only. This gives the possibility of using the same equipment to extract the other varieties of oils *i.e.*, avocado oil, according to the ecological process that we present in this contribution. In this study, we have given, by means of the HPLC analysis, the fatty acid composition of isolated avocado oil and compared the physical and chemical analysis of avocado oil by measuring the electrical resistivity.

Key Words: Vegetable oils, Avocado oil, Fatty acid, Saponification, Soap, Resistivity.

INTRODUCTION

Due to its high price value, the price of exotic avocado fruit was considered out of reach by the common Moroccan consumers. It's costed more than 50 MAD (7 USD) for one kg, which was more expensive than one kg of meat. Now days, avocado, as well as banana fruit is abundant in the market and available as juice in all milk shops[1].

This achievement is attributed to the increasing of surface plantation and the improvement of local production. Actually, surface devoted to this plantation jumped from 10 ha in 1970 in Skhirat area to more than 1800 ha for 10000 metric tons. On another hand the convenient local climate conditions, soil properties, the maintenance easiness and low production cost stand behind the increasing development of this plantation mainly along the north Atlantic coast strip (Larache-Casablanca), Khemisset and Souse Massa region.

However, this production (September to May) is not always sufficient to face local demand estimated to 12000 tons compensated by importation from international market though in good season 20 % of the production could be exported. In terms of perspectives, increasing demand by international market (EEC), the encouraging offer prices, low and weak completion are promising stimulus for the development of the plantation.

Oven varieties of avocado are planted in Morocco with different harvested time: zutano (mid-October to mid-December), bacon, fuerte and hass commonly known under the appellation "harcha" (in rough Arabic) harvested at the beginning of March to the mid-May. It is also most appreciated by Moroccan and European consumers for its resistance to stressing conditions of transportation and its higher content and its size/weigh varying from 150 to 200 g per piece compared with 200 to 500 g for the smooth varieties (zutano) and fuerté.

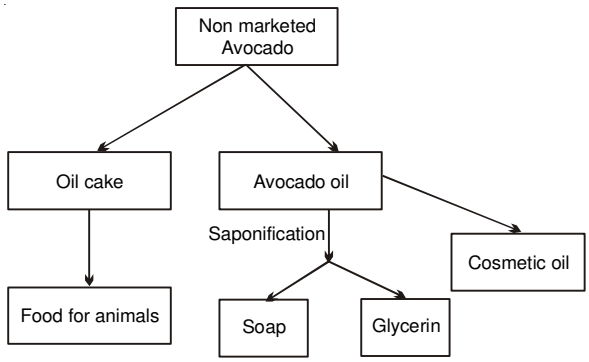
Though exportation generates appreciable cash income to growers, valorization of this commodity could be achieved by extraction of oil from non exported production. In this respect we propose a new ecological process of extraction of the avocado oil. Previous analysis by our team has estimated to 30 % the content of oil in avocado fruit. As it well known this oil is characterized by its nourishing and cosmetic value.

The process proposed consists on the adaptation of the same facilities used for the extraction of the olive oil of based on two phases by centrifugation[1-5]. The main objectives are as follows:

- Adapt the process to extraction of the avocado oil.
- Manufacture of soap from the extracted avocado oil.
- Extraction of glycerin.
- Use of avocado oil cake as food for the animals.
- Assess the electric resistance of the avocado oil.

Clarification of the different methods of extraction of the oil of avocado: 1-Steps of the process.

Finalized process will be axed on the following diagram:



Process of extraction of the oil of avocado: Due to the difficulty encountered in traditional olive oil extraction (emulsion formation) it has been necessary, the introduction of some modification as follows.

Extraction of the oil after drying of the fruit: The presence of oil as fine emulsion makes its extraction very difficult. A drying step would facilitate its extraction. The fruit is cut on lamella is dried in oven at 80 ºC during 24 h, or under sun light 3 days. After dehydration (residual humidity: 5 to 9 %) three time extraction are performed by hexane as avocado oil is recuperated after vacuum evaporation of solvent[6] (Table-1).

Two phases process: This process applied in the same conditions as in olive oil sector has been revealed of important economical and ecological benefit for its higher rate in oil extraction, low acid properties and free pollutant generation[7].

Results: Extraction of 1 kg of dried avocado has generates 250 g of oil. The main physical and chemical properties are presented in Table-1 compared with olive oil drawn from a literature survey. Comparison of avocado oil characteristiques such as iodine, peroxide and saponification indexes with international standards has shown better fit to these standards while acidity remained little bit higher.

Chromatography analysis has allowed the determination of the composition of avocado oil in fatty acid which are compared to the composition of olive oil from the literature (Table-2).

TABLE-2
VALUES OF FATTY ACIDS CONTAINED IN AVOCADO OIL EXTRACTED FROM AVOCADO WASTES AND COMPARISON OF THE PREVIOUS RESULTS WITH THE LITERATURE FOR OLIVE OIL AND AVOCADO OIL

Fatty acids	Avocado oil (extracted from avocado wastes) (%)	Avocado oil (literature results) (%) [Ref. 8]	Olive oil (literature results) (%) [Ref. 9]
Myristic C14:0	0.3	Trace	< 0.1
Linoleic C18:2	11.2	6 à 16	9-24
Palmitic C16:0	19.6	7 à 29	8-21
Palmitoleic C16:1	11.1	3 à 12	< 4
Linolenic C18:3	0.7	Trace à 5%	< 2
Stearic C18:0	0.8	0.1 à 1.5	1-4
Oleic C18:1	55.0	42 à 73	53-75

Manufacture of soap from the avocado oil

Saponification of the oil of avocado: Saponification is the result of alkaline attack of fatty acid. Avocado oil wad treated at reflux conditions with sodium hydroxide (30 %). The two phases obtained are well separated by adding sodium chloride. The solid phase constitutes the soap and the aqueous phase is rich in glycerin. Soap is washed with water and left to dry at room temperature. Soap obtained was of clean aspect, left green, smooth touching, smooth to the touch, consistent and foamy.

Extraction of the glycerin: The aqueous solution was neutralized with concentrated chlorhydric acid. After vaporization and distillation glycerol is obtained with a recovery of 40 %. The characteristics are as follows: colourless liquid; pure and anhydrous; syrupy, to sugary flavour; density of 1.24; high distillation point.

Electrical resistance property: In this work, we tried to make complementary comparisons on electrical resistance between avocado oil and olive oil. Several studies have associated the quality of given oil with its physical properties such as resistance properties. Thus, Pace *et al.*[10]; Risman et Bengtsson[11]; El-Al Shami *et al.*[12] suggested that the electrical properties can be used like indicators of the state and the quality of the vegetable oils.

EXPERIMENTAL

The called “two point method” was used to measure the resistivity of the oil. It's obtained by the mesure of the current and the potential recorded (Fig. 1).

General procedure: Calculation of the resistivity was based on the following formula:

$$\rho = R \times \frac{S}{L}$$

TABLE-1
CHARACTERISTICS OF AVOCADO OIL EXTRACTED FROM AVOCADO WASTES AND COMPARISON OF THE PREVIOUS RESULTS WITH THOSE OF THE LITERATURE FOR OLIVE OIL AND AVOCADO OIL

Characteristics	Avocado oil (extracted from avocado wastes)	Avocado oil (literature results) [Ref. 8]	Olive oil (literature results) [Ref. 9]
Acidity	2 %	< 6	0
Iodine index	87	80 - 95	75-94
Saponification index	177	180-195	184-196
Peroxide index	0.2 meq/kg	–	–
Refractive index	1.4679	1.4650-1.4740	1.468-1.470
Density (to 20 ºC)	0.915	0.915-0.920	0.910-0.916

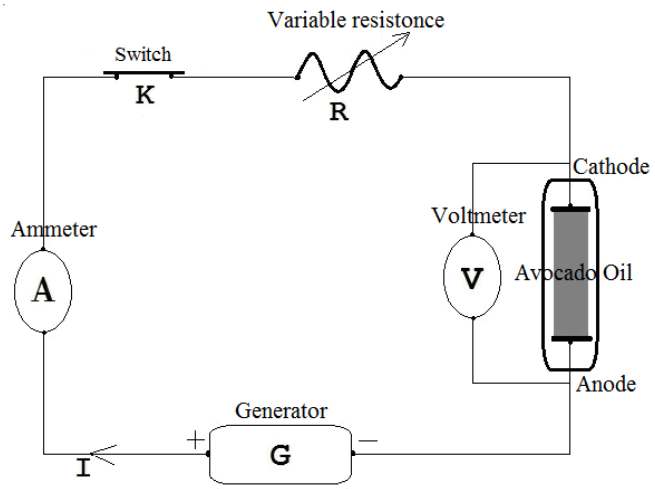


Fig. 1. Assembly for measuring resistivity

where (ρ: resistivity (Ω cm); R: resistance (Ω); S: section (cm^2); L: length (cm).

RESULTS AND DISCUSSION

Records of the electric resistance of the avocado and olive oils are presented Table-3.

TABLE-3
MEASURES OF ELECTRICAL RESISTIVITY OF AVOCADO OIL AND OLIVE OIL ACCORDING TO TEMPERATURE

Temp. (ºC)	Electrical resistivity of avocado oil in (10^6 Ω cm)	Electrical resistivity of olive oil in (10^6 Ω cm)
25	11.700	12.470
50	11.263	12.217
65	11.057	11.975
80	10.857	11.742
100	10.123	11.519

The effect of the temperature on the electrical resistance of the avocado oil and olive oil are presented in the Figs. 2 and 3.

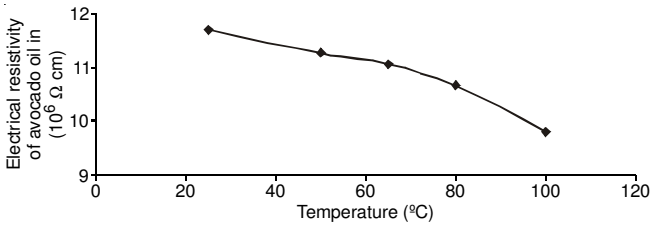


Fig. 2. Electrical resistivity of avocado oil according to temperature

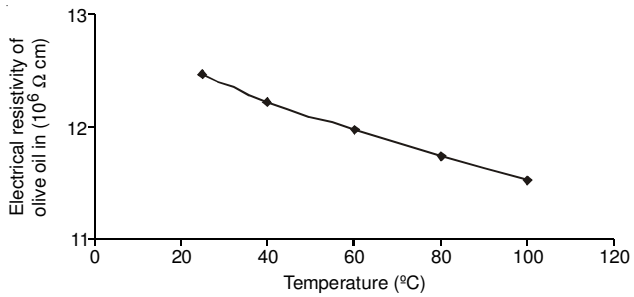


Fig. 3. Electrical resistivity of olive oil according to temperature

Interpretation of results showen in Tables 1 and 2 suggest that the palmetic acid content is higher in avocado oil than olive oil. On another hand Figs. 2 and 3 showed that electrical resistance decreased with increasing temperature. This decrease could be attributed to eventual chemical changes in the oil, probable changes in orientation of the molecules constituting the oil (decrease in viscosity) that enhance the current circulation as it was suggested by for soya oil[13]. This results are corroborated by previous results[13,14].

Conclusion

As conclusion we can assess that higher temperatures enhance electrical conductivity of the studied oil. Comparison of our results on with similar results from the literature showed good agreements. However we plan to extend our study to thermal resistivity and viscosity of this oil.

On another hand this study allowed us to suggest the usage of two phases process used in olive oil sector after which is more economically and ecologically beneficial to the growers and consumers.

In addition, avocado oil could be used in the cosmetic after purification or in the manufacture of some medicinal compounds or rich in protein soap, as well as glycerin. The remaining residues could be used as food complement for livestock.

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