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RESEARCH ARTICLE

EFFECT OF THE TECHNIQUE OF EXTRACTING OIL FROM THE FRESH ALBUMEN OF RIPE COCONUT PALM (COCOS NUCIFERA L.) ON ITS PHYSICOCHEMICAL CHARACTERISTICS

Kodjo Noëlle Françoise[1], Deffan Zranseu Ange Bénédicte[2], Yao Saraka Didier Martial[1], Konan Konan Jean-Louis[3] and Ahonzo Niamkey Sebastien[4]

1. UFR Biological Sciences, Peleforo Gon Coulibaly University, BP 1328 Korhogo, Ivory Coast.
2. Agrovalorization Laboratory, Jean Lorougnon Guédé University, BP 150 Daloa (Ivory Coast).
3. CNRA-Station Marc Delorme, Coconut Program, 07 BP 13 Abidjan 07, Ivory Coast.
4. UFR Biosciences, Félix Houphouët Boigny University, Laboratory of Biochemistry and Food Sciences, 22 BP 582 Abidjan 22, Ivory Coast.

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Abstract

The present study aims to demonstrate the influence of extraction processes on the oil obtained from the mature albumen of the nut of the coconut hybrid NJM x GVT. Three oil extraction processes were studied. These are the traditional variable temperature extraction methods, at constant temperature (105 ° C) and then the soxlhet extraction method (control method). The physicochemical characteristics of the extracted oil such as pH, density, acid number (Ia), iodine number (Ii), peroxide number (Ip), index of saponification (Ip) and the contents of two major fatty acids, lauric acid (C12) and myristic acid (C14), were determined there. The results indicated that the oil yield obtained with the soxlhet reference method (65.79%) is high than that of the two traditional methods at variable and constant temperature (respectively 38.28 to 39.9%). The oil extracted using these three techniques is acidic (pH<7) with a more pronounced acid number compared to traditional variable temperature extraction (10.41 mg KoH / g). The traditional constant temperature method has an acid number close to that of soxlhet (1.34 mg KoH / g oil); This acidity thus obeys the standards of the Codex Alimentarius (Ia ≤ 4 mg KoH / g of oil). The extraction methods had no influence on the peroxide value. Thus, traditional extraction is best at constant temperature.

Introduction:-

The coconut palm is a perennial oilseed crop, native to the ocean basins of the Pacific and Indo-Atlantic (Gunn *et al.*, 2011). In Côte d'Ivoire, coconut cultivation is mainly located along the coast where it is cultivated over 50,000 ha (Yao, 2014). This important coconut grove provides around 75,000 tonnes of copra per year. This places the Ivory Coast in the first rank of African copra producing countries (Anonymous, 2014). The economic interest represented by the Ivorian coconut palm has for a long time been based on the extraction of oil from dried albumen given its use in food and cosmetics (Deffan *et al.*, 2012).

Corresponding Author:- Kodjo Noëlle Françoise
Address:- UFR Biological Sciences, Peleforo Gon Coulibaly University, BP 1328 Korhogo, Ivory Coast.

In the Asian producer environment, there are many artisanal or even family-based coconut palm processing processes leading to the implementation of a certain number of industrial processes (Konan, 2015). In Côte d'Ivoire, peasant transformations of the coconut palm are more focused on the coconut albumen through the production of oil. This flourishing sector required existing know-how around which a market was created (Assa *et al.*, 2006). Today, it is a question of developing this sector to make it an activity that generates additional income for small producers and a tool for sustainable development. This artisanal processing technology involves both dried and fresh albumen. However, little is known about the oil obtained by the wet process from fresh albumen. It would therefore be probable that the oil extracted from fresh albumen by the wet process presents interesting physicochemical characteristics that are appreciable both by the cosmetic and food industry market and by the general public. she will offer an oil for culinary use. This still marginalized field of activity could be developed in order to bring added value to the nuciculture sector. It is in this context that our study was initiated. It aims to know the physicochemical characteristics of the oil from fresh albumen extracted using two traditional methods. Such knowledge will make it possible to improve these artisanal methods of extraction and to propose ways of valuing the oil thus obtained.

Material And Methods:-

Plant material

The work was carried out using 24 samples of albumin or almond from 96 mature 12-month-old nuts collected from 24 NJM x GVT hybrid individuals due to 4 mature nuts per bunch and one bunch per tree. These 12-year-old individuals were planted at a density of 160 tree ha-1 following a randomized full block arrangement with 6 replicates on plot # 034 (5 ° 15'.591"N latitude and between 3 ° 50'.026 " West longitude) from the Marc Delorme station of the National Agronomic Research Center (CNRA) of Côte d'Ivoire. The hybrid NJM x GVT, has been shown to be tolerant to the Fatal Yellowing (JM) disease of coconut palms under agro-climatic conditions in the West African sub-region, more specifically in Ghana, a country neighboring Côte d'Ivoire.

Methods:-

Sampling of mature nuts and albumens

Twenty-four healthy productive trees were randomly selected from the NJM x GVT hybrid trees. On each tree, 4 mature nuts 12 months old were taken from the row 25 bunch. A total of 24 bunch are considered and 96 mature nuts were harvested and transported to the laboratory. Laboratory analyzes on the albumen samples were performed 24 hours after harvesting the mature nuts in the field as recommended by Assa *et al*. (2007) to avoid the effects of sun and rain. The nuts were broken open and then broken, and the albumen was isolated from the shell. The albumens from these coconut palms were used for oil extraction.

Oil extraction methods

Three methods of extracting the oil from the fresh albumen obtained from the mature coconut nut were studied. This is the Soxhlet extraction method (AFNOR, 1986) using hexane as the solvent considered in this study as the reference method and traditional extraction techniques at variable and constant temperature (Figure 1). The extraction of the oil from the Soxhlet-dried albumen was carried out according to the ISO 659 standard. Regarding the two traditional methods of oil extraction, first the albumen was grated manually with using an artisanal grater. Then, the milk was collected after filtering the mixture of 250 g of scraped albumen with lukewarm water at 40 ° C (3/4 the weight of the scrapings). The milk was left to stand for 24 hours to obtain an emulsion. Finally, the extraction of the oil consisted of boiling an emulsion at variable temperature, that is to say uncontrolled, as carried out in a village environment and at a constant temperature of 105 ° C. In the case of the traditional constant temperature method, the cooking temperature of the fresh albumen milk emulsion at 105 ° C was done in an oven.

The density of the oil was determined using a pycnometer previously calibrated with distilled water according to the IUPAC method (1979).

The determination of the hydrogen potential (pH) of oils was carried out using a pH meter according to Afane *et al* (1997).

The extraction of the oil with soxlhet was carried out according to AFNOR (1986).

The extracted oil was characterized by the determination of acid, peroxide, iodine and saponification numbers (AOAC, 1997).

The identification of the constituent fatty acids of the oil was carried out using a Gas Chromatograph (GC) with emphasis on the quantification of the contents of the two major fatty acids of coconut palm oil, lauric acid and myristic acid (Assa *et al.*, 2010).

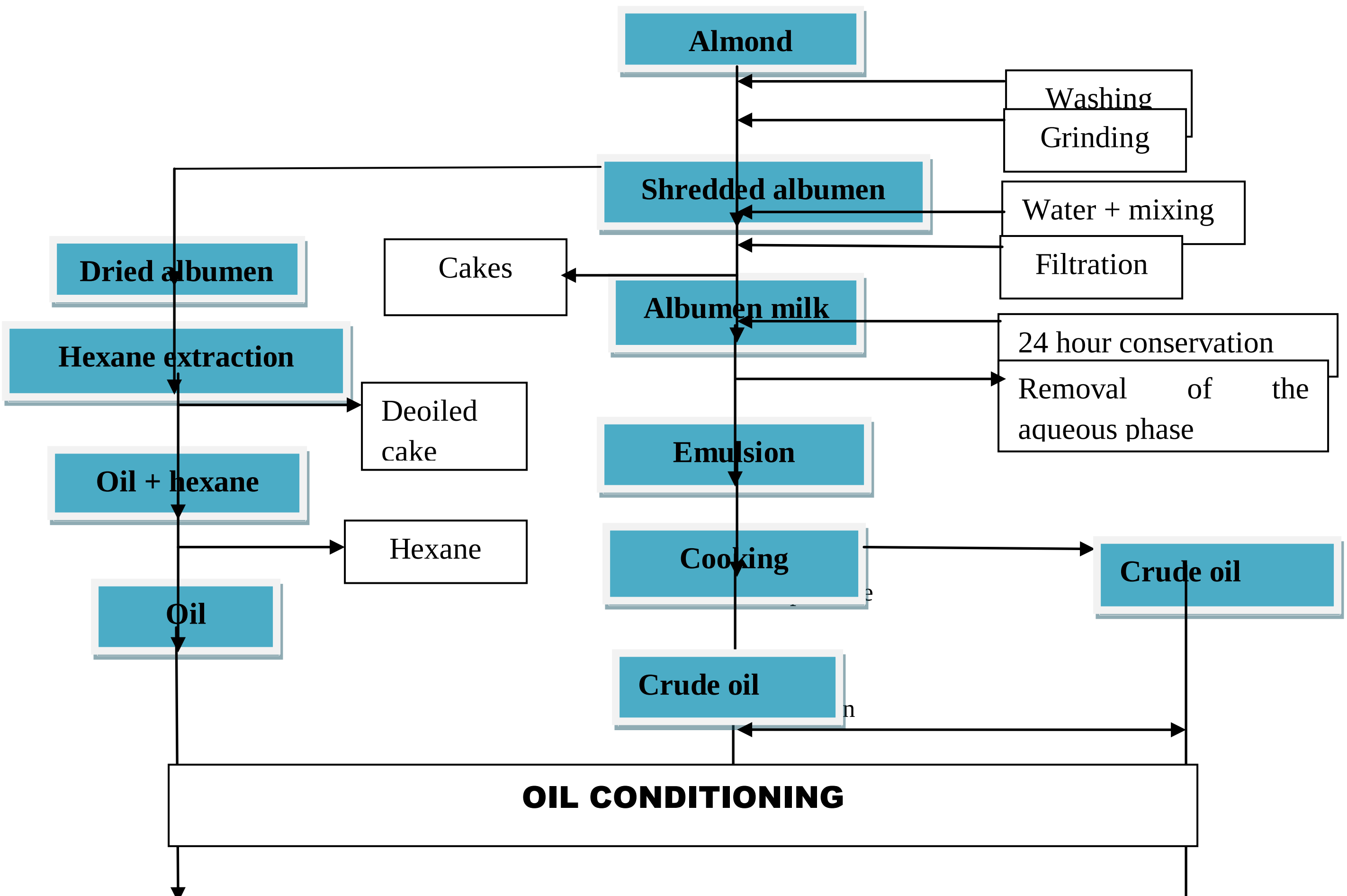

Figure 1:- Summary diagram of the three coconut oil extraction methods.

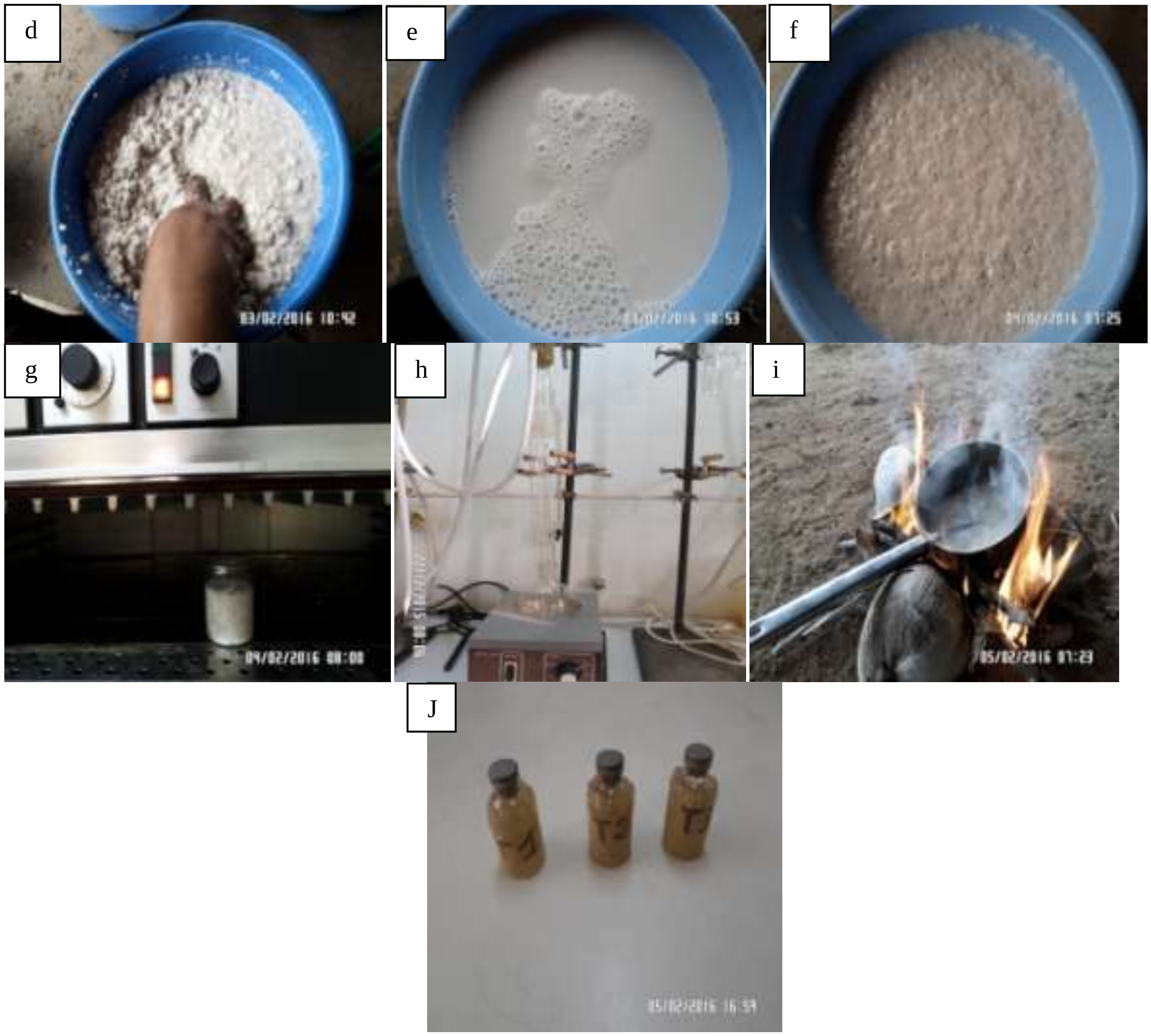

Figure 2:- Extraction technique. (a) albumin matures; b) artisanal grating; c) rasping of ripe albumen; (d) mixing (rapure + water); (e) ripe albumen milk; (f) emulsion; (g) traditional extraction at constant temperature; h) extraction with soxlhet; (i) traditional variable temperature extraction; (j) oil conditioning.

Statistical analyzes

STATISTICA version 7.1 software (StatSoft France, 2005) was used for the statistical analysis of the data. The Kruskal-Wallis non-parametric test at the 5% threshold was used to compare the three methods of extracting the lipid fraction from fresh albumen according to their effects on the physicochemical characteristics of the oils obtained.

Results:-

Effect of the extraction method on the physical characteristics of the albumen oil of the mature coconut palm

The oil yields of the two traditional methods at constant temperature (39.80 ± 0.90%) and variable (38.22 ± 0.98%) although identical were statistically low compared to the yield provided by the method of 'Soxhlet extraction (65.79 ± 3.87%) (Table 1). Regarding the pH, the variable temperature extraction produced an oil significantly more acidic (pH = 5.27 ± 0.39) than that obtained from traditional methods at constant temperature (pH = 5.62 ± 0.24) and soxlhet (pH = 5.61 ± 0.02) (Table 1).

The density of the oils did not vary significantly depending on the extraction methods. The average density values of the oil obtained varied between 0.83 ± 0.03 (traditional variable temperature method), 0.85 ± 0.01 (traditional variable temperature method) and 0.84 ± 0.01 (modern soxlhet method) (Table 1).

Table 1:- Variation of the physical characteristics of the oil of the albumen of the mature coconut palm according to the extraction technique.

Settings physical (SI)	Oil extraction methods (Mean ± Standard deviation)			p
	Traditional at temperature variable	Traditional at constant temperature	Modern Soxhlet (Witness)	
Oil content (%)	38.22 ± 0.98 [b]	39.80 ± 0.90 [b]	65.79 ± 3.83 [a]	p < 0.001
pH	5.27 ± 0.39 [b]	5.61 ± 0.02 [a]	5.62 ± 0.24 [a]	0.015
Density	0.83 ± 0.03 [a]	0.85 ± 0.01 [a]	0.84 ± 0.01 [a]	0.051

On the same line, the indexed mean values of the same letter are statistically equal to the 5% probability threshold; pH: Potential of Hydrogen p: value of the probability associated with the Kruskal-Wallis test

Effects of the extraction method on the chemical indices of the albumen oil of the mature coconut palm

Statistical analyzes of the indices (Ia, Ip, Ii and Is) of the oils showed a significant difference between the extraction methods except for the peroxide number (Table 2). In fact, the acid number of the oil obtained from traditional variable temperature extraction was significantly higher with a value of 10.41 ± 0.13 mg.g-1 of oil. In contrast, statistically low acid numbers were noted on the oil obtained from traditional methods at constant temperature (1.84 ± 0.48 mg.g-1) and on Soxhlet (1.34 ± 0.81 mg.g-1) (Table 2).

The iodine values of the oils obtained indicate significant differences between the extraction methods. For this parameter, the soxlhet (3.32 ± 1.85 g / 100g) and traditional variable temperature (4.96 ± 0.38 g / 100g) extraction techniques record statistically identical values. Unlike the traditional constant temperature method (6.86 ± 3.42 g / 100g) which has statistically higher values than the last two (Table 2).

The saponification index of the oil obtained from traditional extraction at constant temperature (208.94 ± 4.52 $mg.g^{-1}$) is statistically higher than those of those from traditional extraction at variable temperature (180.28 ± 5.54 mg g^{-1}) and with soxlhet (199.32 ± 7.21 mg g^{-1}). The values of the control method is statistically identical to that at variable temperature (Table 2).

Table 2:- Variation of chemical indices of the oil of the albumen of mature coconut palm according to the extraction method.

Parameters	Oil extraction methods (Mean ± Standard deviation)			p
	Traditional at temperature variable	Traditional at constant temperature	Modern Soxhlet (Witness)	
Ia (mg/g)	10.41 ± 0.13 [b]	1.84 ± 0.48[a]	1.34 ± 0.81 [a]	p < 0.001
Ip (meq/kg)	25.40 ± 14.24 [a]	20.13 ± 11.91[a]	17.33 ± 5.26 [a]	0.205
Ii (g/100g)	4.96 ± 0.38 [b]	6.86 ± 3.42 [a]	3.32 ± 1.85 [b]	0.011
Is (mg/g)	199.32 ± 7.21 [b]	208.94 ± 4.52 [a]	180.28 ± 5.54 [b]	P < 0.001

On the same line, the indexed mean values of the same letter are statistically equal to the 5% probability threshold; Ia: acid number of the oil; Ip: Peroxide number of the oil; Ii: iodine value of the oil; Is: saponification index of the oil; p: value of the probability associated with the Kruskal-Wallis test.

Effect of the oil extraction method on its lauric and myristic acid contents

All three extraction methods yielded an oil with statistically identical lauric acid composition. The values are respectively 48.07 (%) ± 1.84 (variable temperature), 48.10 (%) ± 0.85 (constant temperature) and 47.83 ± 1.48% (soxlhet) (Table 3). The lauric acid composition did not differentiate the three extraction methods studied.

Regarding the myristic acid content, the two extraction methods (traditional method at variable temperature and Soxhlet) yielded oils with levels, (respectively from 18.57 ± 0.99% to 18.65 ± 1.34 %) were statistically lower than that obtained from the traditional constant temperature method (20.14 ± 0.84%) (Table 3).

Table 3:- Variation of lauric and myristic acid contents of the oil of mature coconut albumen according to the extraction technique.

Parameters	Oil extraction methods (Mean ± Standard deviation)	p

	Traditional at temperature variable	Traditional at constant temperature	Modern Soxhlet (Witness)	
C12 :0 (%)	48.07 ± 1.84 [a]	48.10 ± 0.85 [a]	47.83 ± 1.48 [a]	0.911
C14 :0 (%)	20.14 ± 0.84 [a]	18.57 ± 0.99 [b]	18.65 ± 1.34 [b]	$p < 0.001$

On the same line, the indexed mean values of the same letter are statistically equal to the 5% probability threshold; C12: 0 lauric acid content of the oil; C14: 0 myristic acid content; p: value of the probability associated with the Kruskal-Wallis test.

Discussion:-

The oil yield on soxlhet extraction gives levels similar to that of Deffan (2011). The variations observed could be attributed to the extraction method used (Egbekun and Ehieze, 1997). Indeed, the traditional method would generate losses throughout the process given their rudimentary aspect.

The density values obtained in this study are within the range of those reported for palm oils (0.889-0.899; 1.454-1.456) (Rosell, 1991; codex alimentarius, 1993). The pH of the oils studied (5.27-5.62) are low. Indeed, according to John (2002) the temperature would have an effect on the variation of the pH whether it is acidic, neutral or basic. Thus, heating would promote the release of hydronium ions which would be the basis of the acidity of the oil. The lower pH value of the variable temperature extraction (30 minutes; 120 ° C) is certainly due to the high temperature applied during cooking, unlike the oils obtained with soxhlet (8 hours; 60 ° C) and by the traditional method at constant temperature (24 hours; 105 ° C).

The oils studied in the case of Soxhlet and traditional extraction at constant temperature have acid indices lower than the value imposed by the Codex Alimentarius which is 4 mg KOH / g unlike that resulting from the traditional extraction at variable temperature. The high values observed during variable temperature extraction are due to the effect of heating. Indeed, the emulsion is a mass of protein, water and oil whose formation is based on the amphiphilic properties of the proteins present (Kim *et al.*, 2002). Indeed, during defrosting after storage, lipases hydrolyze triglycerides because cold, especially temperatures below -20 ° C, do not prevent the oxidation of almond oils (Nkouam, 2007). The low acid number values of oils from soxlhet and traditional constant temperature extraction are believed to be due to the low temperature applied during extraction.

The peroxide value of the various extraction methods is higher than the limit recommended by the FAO (10 meq O_2 / kg) for vegetable oils intended for human consumption (Codex-Alimentarius, 1993). These high peroxide values are certainly due to the oxidation of our oil. The proliferation of peroxides and oxygen at low temperature is related to storage time (Kondratowicz and Ostasz, 2000). Thus, the traditional extraction being done in the presence of water and in the open air might have had to trap these elements during storage unlike solvent extraction.

The saponification indices of different oils are similar to those of palm oil (Gossa, 2014). The high index values observed would justify the foaming nature of the oil. The high values observed in the solvent extraction compared to the traditional extraction can be justified by a total leaching of the sample during the extraction with soxlhet. This leaching would allow it to contain a large amount of saturated fatty acid but also unsaturated fatty acid which in the presence of heat would lead to the rupture of the double bond to make it saturated (Assa, 2007). In the case of traditional variable temperature extraction, the increase in the index is certainly due to the high heat but also to water leading to the breakdown of unsaturated fatty acids unlike extraction at constant temperature.

The iodine value is lower than that obtained in palm oils (45 to 46) but similar to that of Assa (2007). The high iodine value in soxlhet extraction is based on the large amount of unsaturated fatty acid obtained from the hexane leaching of coconut albumen. Followed by that of traditional constant temperature extraction which in the presence of low temperature prevents the rupture of a large number of bonds. However, the low values obtained from the variable temperature oils would be due to a low value of unsaturated fatty acid caused by the breaking of bonds by water and heat.

The fatty acid chromatographic profile of the oils obtained from the three extraction methods confirmed the richness of coconut palm oils in low molecular weight saturated fatty acids, lauric and myristic acids. This is consistent with the results of Freemond *et al.*, (1966) and Berger and Ong (1985). The lauric acid contents are between 47.83 to

48.10% which is in accordance with the results of Anonymous (2014) which shows a range of 44.29% - 48.90% for the oils obtained. The myristic acid contents obtained within the framework of our study are in conformity with those of Deffan (2012) and Konan (2011).

Conclusion:-

The study of the physicochemical characteristics of the oils extracted by the traditional method at variable and constant temperature has made it possible to know that the oil resulting from the traditional extraction at variable temperature provides a low yield of oil with an acidity index. raised. An improvement in the technique currently used by small producers in rural areas by maintaining the cooking temperature constant allows for an oil with an acid index close to that of Soxlhet. The traditional oil extraction by maintaining a constant temperature of 60 ° C is therefore recommended for the supply of oil to the cosmetics industry, taking into account the compatibility of its pH values with that of the skin which is between 5.2 and 7. Also, this oil can be recommended in the food sector with its acid number lower than that of Codex Alimentarius.

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