[Downloaded free from http://www.ijfans.org]

ORIGINAL ARTICLE

Characterization of Oils Extracted from Shelled Seeds and Seed Coats of Two Species of Cucurbitaceae Cultivated in Korhogo, North of Côte d'Ivoire

Libra Michel Archange[1*], Diby N'Nan Affoué Sylvie[1], Assoi Sylvie[1], Dué Ahipo Edmond[2] and Kouamé Lucien Patrice[2]

[1]Department of Biochemistry-Genetics, UFR of Biological Sciences, Peleforo Gon Coulibaly University of Korhogo, PO Box 1328 Korhogo Côte d'Ivoire.
[2]Laboratory of Biocatalysis and Bioprocessing, UFR of Sciences and Food Technologies, University of Nangui Abrogoua Abidjan, PO Box 02 BP 801 Abidjan Côte d'Ivoire.

ABSTRACT Oils of shelled seeds and seed coats of *Cucumeropsis mannii* and *Cucumis melo* were extracted and characterized. Results showed that yield of extracted oil as well as acid index, saponification index and iodine index values of the extracted oil were significantly different ($p<0.05$) in the shelled seeds and seed coats of the two Cucurbitaceae. In the shelled seeds of *Cucumeropsi manni* these values were 45.03±0.42%, 12.16±0.05 mg KOH/g oil, 235.34±0.47 mg of KOH/g of oil and 110.56±1.92 respectively while in the seed coats values of 18.74±0.85%, 15.31±0.28 mg KOH/g oil, 265.70±5.09 mg of KOH/g of oil and 120.14±0.49, were respectively obtained. In the case of *Cucumis melo*, values obtained for shelled seeds were 65.20±2.09%, 11.25±0.08 mg of KOH/g of oil, 183.91±2.11 mg of KOH/g of oil and 146.27±0.3 respectively and those for the seed coats were 14.42±0.02%, 7.40±0.06 mg of KOH/g of oil, 117.76±0.14 mg of KOH/g of oil and 85.25±1.68 respectively. Linoleic acid was the main fatty acids found in these oils. Shelled seed and seed coats oils of *Cucumis melo* (45.15% and 47.26%) exhibited higher linoleic acid content than *Cucumeropsi mannii* shelled seed and seed coats oils (41.75% and 44.52%). *Cucumis melo* variety contained more of the oleic acid in the shelled seeds (37.48%) and seed coats (32.45%) oils as compared to the shelled seeds (34.15%) and seed coats (30.35%) of *Cucumeropsis mannii* variety. These extracted oils could be considered as nutritious and could possibly be introduced in human diet only after proper refinement.

Keywords: Oils, Cucurbitaceae, shelled seeds, seed coats

Address for correspondence: Libra Michel Archange, Department of Biochemistry-Genetics, UFR of Biological Sciences, Peleforo Gon Coulibaly University of Korhogo, PO Box 1328 Korhogo Côte d'Ivoire. E-mail: libra_michel_archange@yahoo.fr

Submited: 24-Feb-2022 **Accepted:** 13-Jun-2022 **Published:** 26-Jul-2022

INTRODUCTION

Oils or fatty are substances that are liquid at a temperature close to 20 °C and insoluble in water but soluble in organic solvents (petroleum ether, hexane, chloroform, benzen, etc.) (Adrian *et al.,* 1995). They are mainly composed of saponifiable lipids with a small unsaponifiable lipids and contaminants. The unsaponifiables are represented by sterols, tocopherols, carotenoids, etc. Saponifiable lipids are classified into simple lipids and complex lipids. Complex lipids are represented by glycerophospholipids and sphingolipids. Simple lipids consist mainly of triglycerides formed from fatty acids (90-95%) and glycerol (3-5%). Fatty acids (FA) are molecules formed from a linear hydrocarbon chain of very variable length and having a carboxylic acid group at one end (hydrophilic head) and a methyl group at the other end (hydrophobic tail). According to their fatty acid composition, oils are classified into four families (Morin *et al*., 2012; and Dubois *et al*., 2008):

Access this article online
Website: www.ijfans.org
DOI: 10.4103/ijfans_121-22

This is an open access journal, and artiles are distributed under the terms of the Creative Commons Attributi-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations ae licensed under the idential terms.

How to cite this article: Libra Michel Archange, Diby N'Nan Affoué Sylvie, Assoi Sylvie, Dué Ahipo Edmond and Kouamé Lucien Patrice. Characterization of Oils Extracted from Shelled Seeds and Seed Coats of Two Species of Cucurbitaceae Cultivated in Korhogo, North of Côte d'Ivoire. Int J Food Nutr Sci 2022; 11:6-16.

© 2022 International Journal of Food and Nutritional Sciences

[Downloaded free from http://www.ijfans.org]

- Family of oils rich in saturated fatty acids. The main representatives are lauric acid (C12:0), palmitic acid (C16:0), and stearic acid (C18:0).
- Oleic family. The main fatty acid is a mono unsaturated fatty acid represented by oleic acid (C18:2 cis or omega 9). It is abundant in olive oil (74.3%), peanut oil (47.5%).
- Linoleic family. The main fatty acid is polyunsaturated and is represented by linoleic acid (LA, 18: 2n-6, or omega-6). It is abundant in corn oil (59.6%), soybean oil (63.6%), sunflower oil (64.3%) and walnut oil (72.3%).
- Linolenic family. The major fatty acid is á-linolenic acid (ALA, 18: 3n-3, or omega-3). It is a polyunsaturated fatty acid. It is abundant in rapeseed oil.

LA and ALA are termed "essential fatty acids" because human body cannot synthesized them *in vivo*, therefore, they have to be provided through diet (Percheron *et al*., 1991; and Nordoy, 1991). Both of these fatty acids are precursors of other omega-6 and omega-3 long-chain polyunsaturated fatty acids (LC-PUFAs). Thus, human organism can synthesize from LA, long-chain (20 carbons or more) of omega-6 fatty acids such, as dihomo-γ-linolenic acid (DGLA, 20: 3n-6) and arachidonic acid (AA, 20: 4n-6); and from ALA, long-chain (22 carbons or more) of omega-3 fatty acids such, as eicosapentaenoic acid (EPA, 20: 5n-3) and docosahexaenoic acid (DHA, 22: 6n-3) (Tosi *et al*., 2014). Oils play an important role in food and culinary operations. Indeed, they help to improve the texture, color, flavor and taste of food. Also, oils have a nutritional and therapeutic attributes. The fatty acids provide energy in the form of calories to the body, while polyunsaturated (FA) have anti-inflammatory, anti-diabetic and anti-cancer properties (Diaz *et al*., 2004). In sub-Saharan Africa, conventional sources of vegetable oil are mainly palm seeds, palm kernels, peanuts, shea nuts and dried coconuts. Nowadays, with the high increase in human population, as well as the high cost of oils in the market on one hand, and the resurgence of cardiovascular disease and diabetes on the other hand, studies are increasingly directed towards new sources of available and inexpensive plant rich in oil as seeds of Cucurbitaceae called "Pistache" in Côte d'Ivoire and "Egusi" in Benin, Nigeria and Cameroon (Zoro *et al*., 2006; Achigan-Dako *et al*., 2008; Johnson, 2012; and Kolawole and Ayeoba, 2019).

Before use, the Cucurbitaceae seed coat of is removed through shelling. The shelled seeds are usually ground and utilized as ingredient in soup preparation (Pistache soup) while seed coats is considered as a waste.

Previous studies have shown that seeds of Cucurbitaceae cultivated in West Africa are especially rich in fat. Indeed, according to Martin (1993) and Fuku *et al.* (2004) seeds of Cucurbitaceae contain about 42 to 57% of oils.

The aims of this study were to determine the physicochemical parameters (percentage of oil, acid index, saponification index, iodine index, peroxide index) and the different fatty acids present in the shelled seeds and seed coats of *Cucumeropsis mannii* and *Cucumis melo* cultivated in the northern part of Côte d'Ivoire. This study will help intensify cultivation of these cucurbitaceae and therefore increase the productivity, consumption and sale of these cucubitaceae seeds especially in rural areas where agriculture is women's main occupation, this will thus help improve their income.

MATERIAL AND METHODS

Biological Material

The biological materials consisted of two varieties of shelled seeds and seed coats of Cucurbitaceae: *Cucumeropsis mannii* Naudin and *Cucumis melo*. Seeds were identified at the National Floristic Center of University Félix Houphouët Boigny (Abidjan Côte d'Ivoire).

Methods

Collection of Cucurbitaceae

The fruits of Curcubitaceae were collected from a local farm located in Korhogo in the northern part of Côte d'Ivoire.

Obtaining Shelled Seeds and Seed Coats

To obtain the seeds, the fruits were cut horizontally and heaped for 6 to 7 days so that the seeds can be freed from the flesh. The free seeds were washed with plenty of water to remove dirt and matured seeds were collected and then sun-dried for three days. The seeds were shelled and winnowed in order to separate shelled seeds and seed coats. Each sample, shelled seeds or seed coats, was oven-dried at 45 °C for 72 hours, grounded into powder with a kitchen grinder (Moulinex, France) and stored in hermetic bags at 4 °C until use.

Oil Extraction

Oil extraction was carried according to AOAC procedure (2005). A sample of 40 g was placed into the extractor of a Soxhlet apparatus and subjected to extraction by hot percolation method. The extraction was carried out for 8 hours with 2 liters of petroleum ether as solvent. The extracted oil was concentrated using a rotary and stored at 4 °C until use.

Yield of the Extracted Oils (%)

The percentage composition of the oil was calculated using the following expression (should come before the Equation (1)).

The fraction bar does not appear in equation (1)

$$Oil\ content\ (\%) = \frac{\text{Weight of oil}}{\text{Weight of sample used}}\ x\ 100 \quad ...(1)$$

[Downloaded free from http://www.ijfans.org]

The percentage composition of the oil was calculated using the following expression:

Oils Characterization

Oils were characterized by determining their acid, saponification, iodine and peroxide index according the methods used by Anderson-Foster *et al.* (2012)

Determination of Acid Index

Were V_{KOH} represents the difference in the volume of KOH (potassium hydroxide) used for the titration and W is the mass of the oil sample used.

$$Acid\ index = \frac{5.610 \times VKOH}{W} \quad ...(2)$$

Five (5) g of oil sample were weighted and put into an Erlenmeyer flask containing 12.5 ml of mixture of diethyl ether and ethanol solvent (v/v). The flask was shaken vigorously and 0.5 ml of phenolphthalein was added as an indicator and was shaken again. Then the mixture was titrated using 0.1 M of KOH until persistent pink coloration, which lasted for at least 15 s, was observed. The Acid index was calculated using the following expression:

Determination of Saponification Index

Two (2) g of the oil sample were weighed into round bottom flask. Twenty five (25) ml of ethanolic-hydroxide potassium (0.5 M) were added and boiled for 30 minutes in a reflux condenser. The mixture was removed from the heat source and then 0.5 ml of phenolphthalein was added which changed the color of the mixture into a pink color. The mixture was then titrated with hydrochloric acid (0.5 M) until the pink color disappeared. The Saponification index was calculated using the following expression.

$$Saponification\ index = \frac{2805 \times VHCl}{W} \quad ...(3)$$

Where V_{HCl} is the difference in volume of hydrochloric acid consumed and W is the mass of the oil sample used.

Percentage of Impurity

The percentage of impurity of the extracted oil was calculated following the expression:

$$Percentage\ of\ impurity = \frac{\text{Acid Index}}{\text{Saponification index}}\ x\ 100 \quad ...(4)$$

Peroxide Index

An amount 0.4 g of oil sample was weighed into a conical flask and 10 ml of chloroform were added and the mixture was stirred. Fifteen (15) ml of acetic acid were added with 1 ml of freshly prepared saturated potassium iodine solution and the flask was immediately closed, stirred for one minute and kept at room temperature for over 5 minutes away from light. Seventy-five (75) ml of distilled water were then added and this was shaken vigorously. A few drops of starch solution (1%) were added as indicator to give blue-black coloration. The mixture was then titrated with sodium thiosulfate solution (2.10^{-3} N) until a clear/white color appeared. The peroxide index was expressed in meq of active oxygen/kg of oil, based on the following formula.

$$Peroxide\ index\ (meq\ of O2/kg\ of\ oil) = \frac{(V - V0) \times C \times T \times 100}{W} \quad ...(5)$$

Where V is the volume (ml) of sodium thiosulfate solution consumed in the main test, V_0 the volume (ml) of sodium thiosulfate solution consumed in the blank test, C is the concentration (mol/l) of the sodium thiosulfate solution, T is the titer of the sodium thiosulfate solution and W the mass of the sample oil in grams.

Iodine Index

The Iodine index was determined using the procedure of AOAC (2005). 0.4 g of oil sample was weighed into 250 ml conical flask. Ten (10) ml of chloroform were added. The mixture was stirred and 5 ml of Wij's reagent were added. The flask was immediately closed, stirred for one minute and kept at room temperature for one hour away from light. Four (4) ml of freshly prepared saturated potassium iodine solution (10%) was then added with 50 ml of distilled water. The mixture was titrated with sodium thiosulfate solution (0.1 N) with vigorous shaking. Towards the end of the reaction, when the color become pale yellow, few drops of starch solution (1%) were added, as indicator, to give a blue-black coloration, then the titration was continued until the color becomes clear. A blank titration was equally carried out. The Iodine index was expressed following this formula.

$$Iodine\ index = \frac{126.69 \times N \times (V0 - V)}{10W} \quad ...(6)$$

Where V is the volume (ml) of sodium thiosulfate solution consumed in the main test, V_0 the volume (ml) of sodium thiosulfate solution consumed in the blank test and W the mass of the sample oil in grams

Fatty Acids Composition

The fatty acid composition was evaluated by HPLC using an analytical HPLC system unit (Shimadzu Corporation, Japon) in conjunction with a column heating device set at 35 °C with the aid of an oven Meta Therm TM (Interchrom, France) and ions exclusion column ICSep ICE ORH-801 (40 cm x 5 µm, Interchom, France). The system was also coupled to a pump (Shimadzu LC-6A Liquid Chromatograph), an UV detector (Shimadzu SPD-6A UV Spectrophotometric Detector) and

[Downloaded free from http://www.ijfans.org]

an integrator (Shimadzu Chromatopac CR 6A). Elution was carried out isocratically with sulphuric acid (0.04 N), at a solvent flow rate of 0.6 ml/min and detection was performed at 210 nm. The fatty acids were identified by comparing their retention times to those of a standard mixture of fatty acids and the peak areas were integrated. The reference area of the peaks which was assimilated to triangles gave the fatty acids composition of the mixture injected.

Statistical Analysis

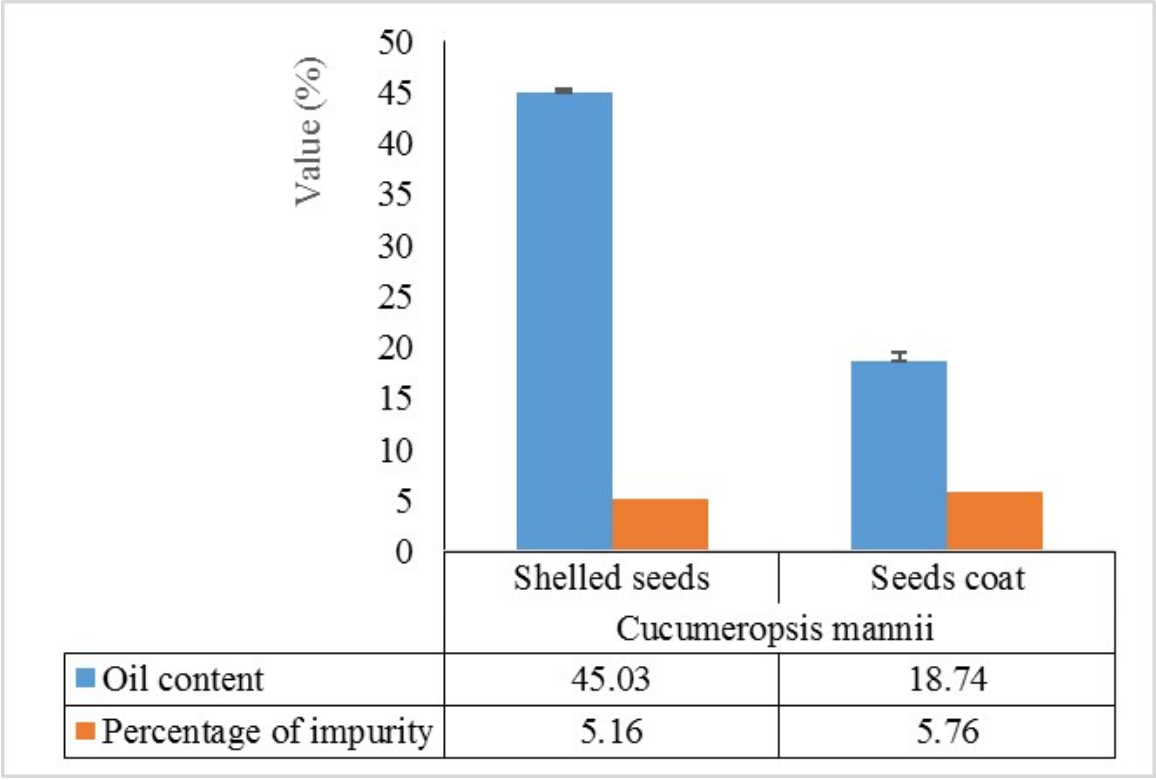
All experiments were performed in triplicate and the results were expressed as mean values and standard deviation. One-way analysis of variance (ANOVA) was used to determine significant differences among means and Tukey's test was used to perform multiple comparisons among means using SPSS software (version 20.0; SPSS Inc, Chicago, Il, USA). The significance level was defined as $p<0.05$.

RESULTS AND DISCUSSION

Oil Content

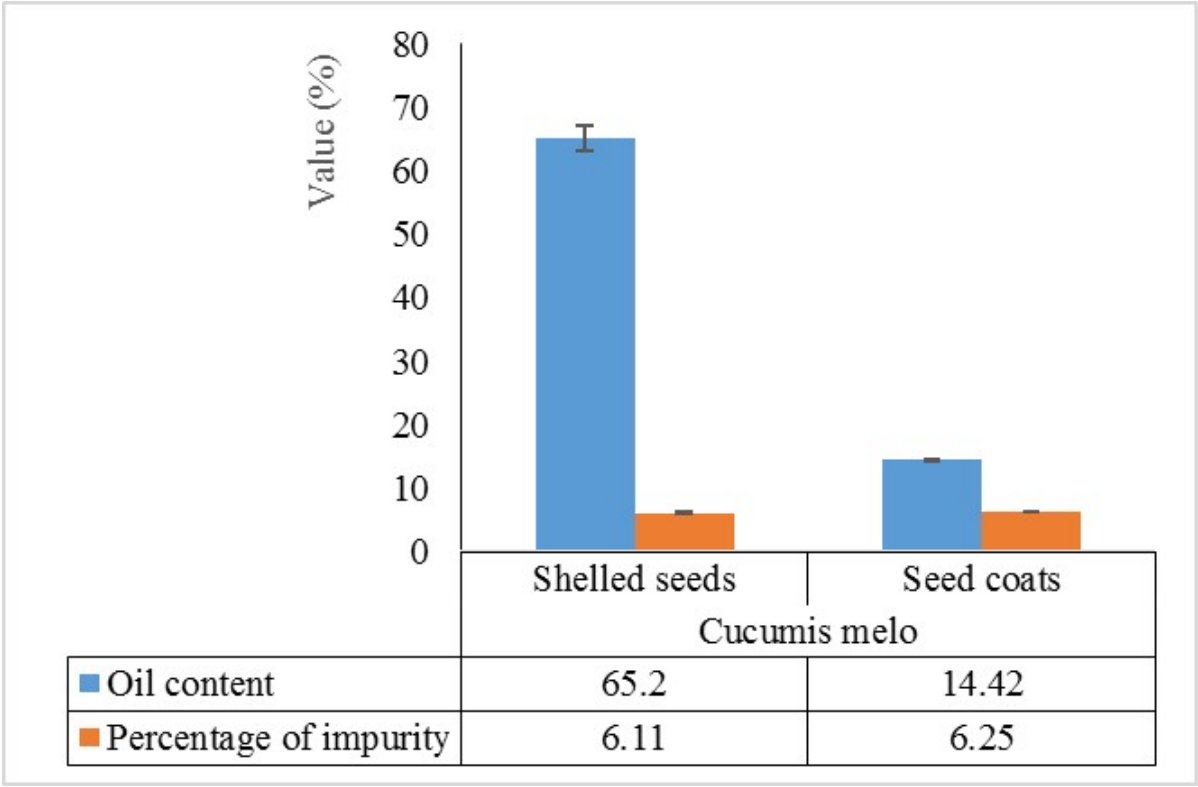
The oil content of shelled seeds and seed coats of *Cucumeropsis mannii* and *Cucumis melo* are presented in Figures 1 and 2. On dry weight basis, oil content of *Cucumeropsi manni* was 45.03±0.42% and 18.74±0.85% for shelled seeds and seed coats respectively and that of *Cucumis melo* was 65.20±2.09% and 14.42±0.02% for the shelled seeds and seed coats respectively. As regards to the shelled seeds, result collected for the oil extracted from the *Cucumeropsi manni* variety was comparable to the values obtained by Fokou *et al.* (2009) and Ndukwe and Chahul (2016), and Diby *et al.* (2020) who reported about 48% of oil content of the seeds of *Cucumeropsi mannii*. Oil content reported in this study for *Cucumis melo* was lower than the results of 30.65% and 51.46% reported by Mallek-Ayad *et al.* (2018) and Olatundji *et al.* (2021) respectively. Oil content of shelled seeds of *Cucumeropsi mannii* was significantly lower than that of *Cucumis melo* and this could be attributed to their botanical origin. Compared to conventional oil seeds such as peanut where oil content of varieties varied between 46.96-52.12% (Gulluoglu *et al.*, 2016; and Zahran and Tawfeuk, 2019), corn (3.1-5.7%) and soybean (18-20%) (O'brien, 2004), such level of oil found in C*ucumeropsis mannii* and *Cucumis melo* seeds may be considered as economically important for commercial production. For the seed coats, the results indicated that seed coats of both species contained an appreciable quantity of oil, representing about 20 to 40% of the total oil content produced by the whole seeds. This could represent an added value for each species. So, in order to maximize oil extraction from Cucurbitaceae seeds, the seed coats should not be detached from the almonds.

Figure 1: Oil Content and Percentage of Impurities of Shelled Seeds and Seed Coats of *Cucumeropsis manii*



[Downloaded free from http://www.ijfans.org]

Figure 2: Oil Content and Percentage of Shelled Seeds and Seed Coats of *Cucumis melo*



Acid Index and Percentage of Impurities

Figures 3 and 4 present the acid index of oils extracted from shelled seeds and seed coats of *Cucumeropsis mannii* and *Cucumis melo*. Values obtained for *Cucumeropsis mannii* were 12.16±0.05 mg KOH/g of oil and 15.31±0.28 mg KOH/g of oil for shelled seeds and seed coats oils respectively; and for *Cucumis melo*, values of 11.25±0.08 mg of KOH/g of oil and 7.40±0.06 mg of KOH/g of oil were obtained for shelled seeds and seed coats oils respectively. All values found in this study were very high and were greater than the standard range of 4 mg of KOH/g of oil reported by the AOAC (2005). Likewise, these results were not in agreement with value of 7.09 mg of KOH/g of oil reported by Essien *et al.* (2012) for the seeds of *Cucumeropsis mannii*, and 0.3±0.04-0.4±0.05 reported by Rabadan *et al.* (2020) for the seeds of *Cucumis melo* cultivars. This high acid index values could be due to the presence of free fatty acid which could probably be attributed to the area of cultivation, climatic factors, post-harvest management, methods of obtaining seeds, temperature and storage duration (Achigan-Dako *et al.*, 2008). Thus it could be suggested that, when conditions are favorable, hydrolysis of triglycerides by lipases is triggered and free fatty acids are released in the seeds.

Acid index is a measure of the amount of free fatty acids in oil and it can be used to assess the oil quality by the determination of the percentage of impurities. According to the Codex alimentarius (1999), in refined vegetable oils, the lower the percentage of impurities the more stable the oil is and the more acceptable it is to the human palate. In this study, the percentage of impurities in the oils extracted from Cucurbitaceae seeds was quite high as showed in Figures 1 and 2. Values were 5.16±0.12 and 5.76±0.03% for shelled seeds and seed coats oils *Cucumeropsis mannii* respectively and 6.11 and 6.25 for shelled seeds and seed coats oils *Cucumis melo* respectively. These values were higher than the ones found by Opoku-Boahen (2013) for oil extracted from the seeds of *Cucumeropsis mannii*. The high values obtained could be attributed to the presence of elevated amount of fatty acids in the extracted oils. Therefore, these oils must be properly refined before consumption.

Saponification Index

The saponification index of the oils extracted from shelled seeds and seed coats are presented in Figures 3 and 4. For *Cucumeropsis mannii*, values obtained for shelled seeds and seed coats oils were 235.34±0.47 mg of KOH/g of oil and 265.37±5.09 mg of KOH/g of oil respectively. These values were not far from values (219.36 mg of KOH/g of oil, 241.62 mg of KOH/g of oil) reported for *C. mannii* seeds oil from high savanna of Cameroon (Fokou *et al.*, 2009). However, values obtained in this study were higher than the values of

[Downloaded free from http://www.ijfans.org]

Figure 3: Parameters Value for Shelled Seeds and Seed Coats of *Cucumeropsis mannii*

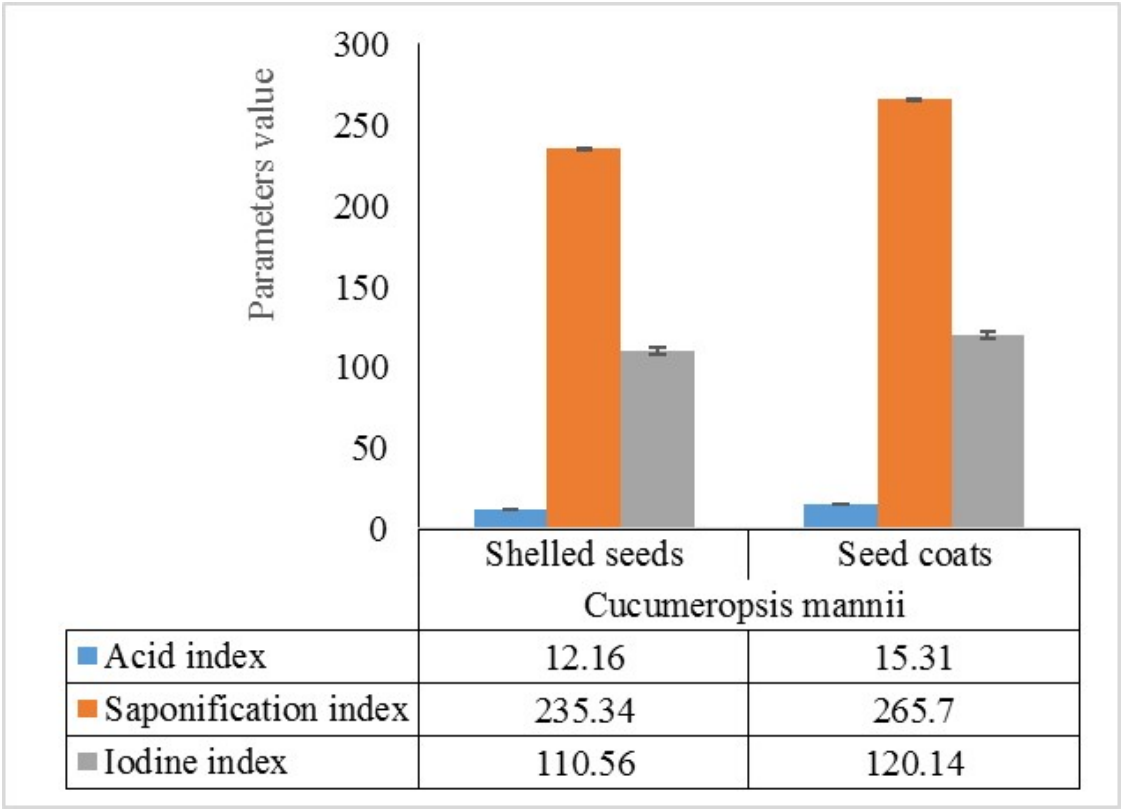
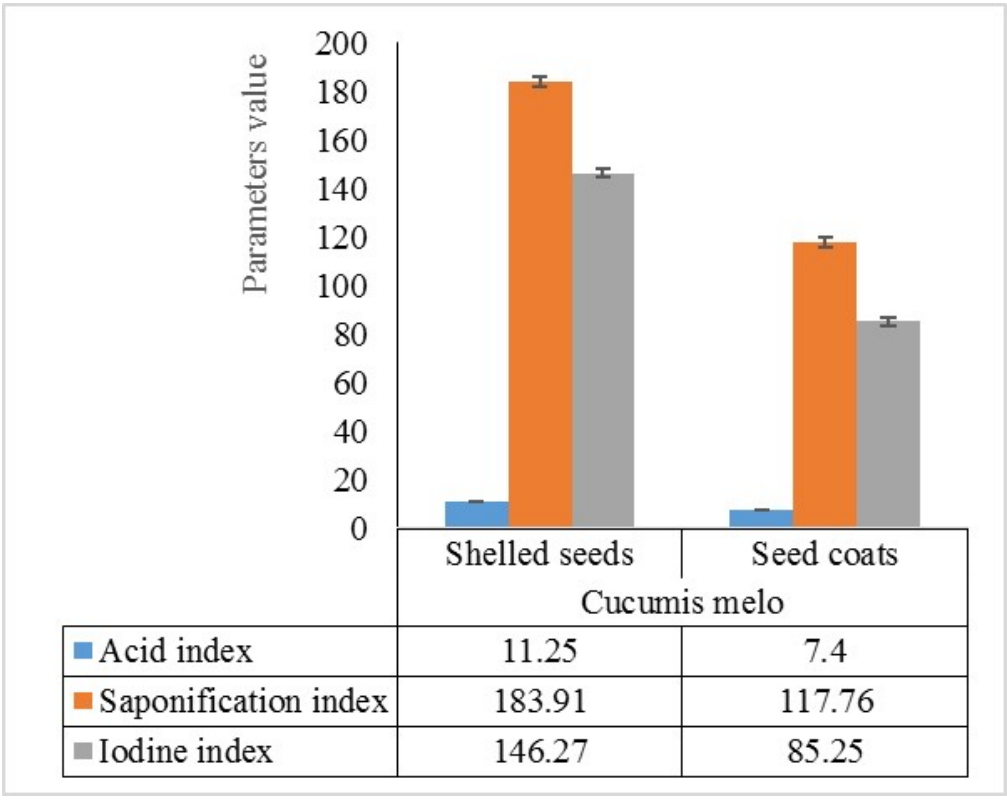


Figure 4: Parameters Value for Shelled Seeds and Seed Coats of *Cucumis melo*



[Downloaded free from http://www.ijfans.org]

143.0±0.21 mg of KOH/g of oil and 179.4 mg of KOH/g of oil reported by Ajayi *et al.* (2013) and Okwundu *et al.* (2021) respectively. For *Cucumis melo variety*, the oils extracted from the shelled seeds and seed coats of had saponification values of 183.91±2.11 mg of KOH/g of oil and 117.76±0.14 mg of KOH/g of oil respectively. The result obtained for shelled seeds was in line with the value of 182.26 mg of KOH/g of oil reported by Olatunji *et al.* (2021) for *Cucumis melo* seeds oil while result found for the seed coats was lower. According to AOAC standard (1990), oil with saponification value ≥180 mg of KOH/g of oil, possesses low molecular weight fatty acid. Since the saponification index values of the oils extracted from shelled seeds and seed coats of *Cucumeropsis mannii* were higher than the value of 180 mg of KOH/g of oil, it could be inferred that these oils had low molecular weight fatty acid and could be useful in soap making. However, oils extracted from shelled seeds and seed coats of *Cucumis melo*, exhibited a saponification index lower than the value of 180 mg of KOH/g of oil. It could thus be suggested that these oils contained high molecular weight fatty acids and were therefore useful for consumption but not for soap making.

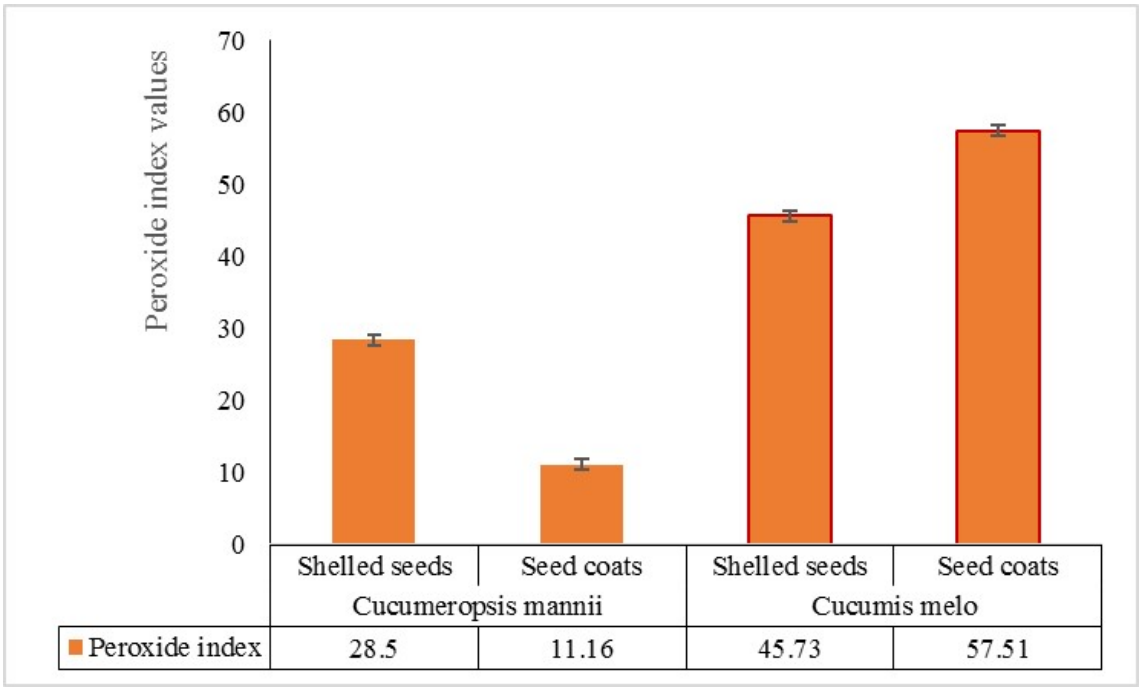
Iodine Index

For *Cucumeropsis mannii* (Figure 3), the iodine index values of the oils extracted from the shelled seeds and seed coats were 110.56±1.92 and 120.14±0.49 respectively and for *Cucumis melo* shelled seeds and seed coats (Figure 4), values were 146.27±0.3 and 85.25±1.68 respectively. In this study, results obtained for *Cucumeropsis mannii* were closer to the values reported by Asen *et al.* (2010) for *Citrullus lanatus* (113.69±0.98) and *Cucumeropsis mannii* (119.82±1.19) and lower than the value (132.6) reported by Okwundu *et al.* (2021). For *Cucumis melo*, the values found were lower than the value (115.03) reported by Gbogouri *et al.* (2011). A significant difference ($p \leq 0.05$) in the iodine index of shelled seeds and seed coats oils from *Cucumeropsis mannii* and *Cucumis melo* was observed, thus suggesting that the iodine index of oil depends on the botanical origin (species) and the part used for oil extraction. Iodine index is a measure of the degree of unsaturation of fatty acids or theirs esters. It is used to quantify the amount of double bonds present in oil and therefore reflects the susceptibility of the oil to oxidation meaning that the lower the iodine index is the lesser are the number of unsaturated bonds and the lower is the susceptibility of such oil to oxidative rancidity (Naghshineh *et al.*, 2010). For *Cucumis melo* seeds, it was observed that the iodine index of the oil extracted from shelled seeds was higher than that of the seed coats, suggesting that shelled seeds contained more unsaturated fatty acids than seed coats. However, for *Cucumeropsis mannii* seeds, oil extracted from the seed coats contained more unsaturated fatty acids than the one obtained from the shelled seeds.

Peroxide Index

The peroxide index of oils extracted from shelled seeds and seed coats of *Cucumeropsis mannii* and *Cucumis melo* is presented in Figure 5. For *C. mannii*, values of 28.50±1.40 and

Figure 5: Peroxide Index of Shelled Seeds and Seed Coats of *Cucumeropsis manii* and *Cucumis melo*



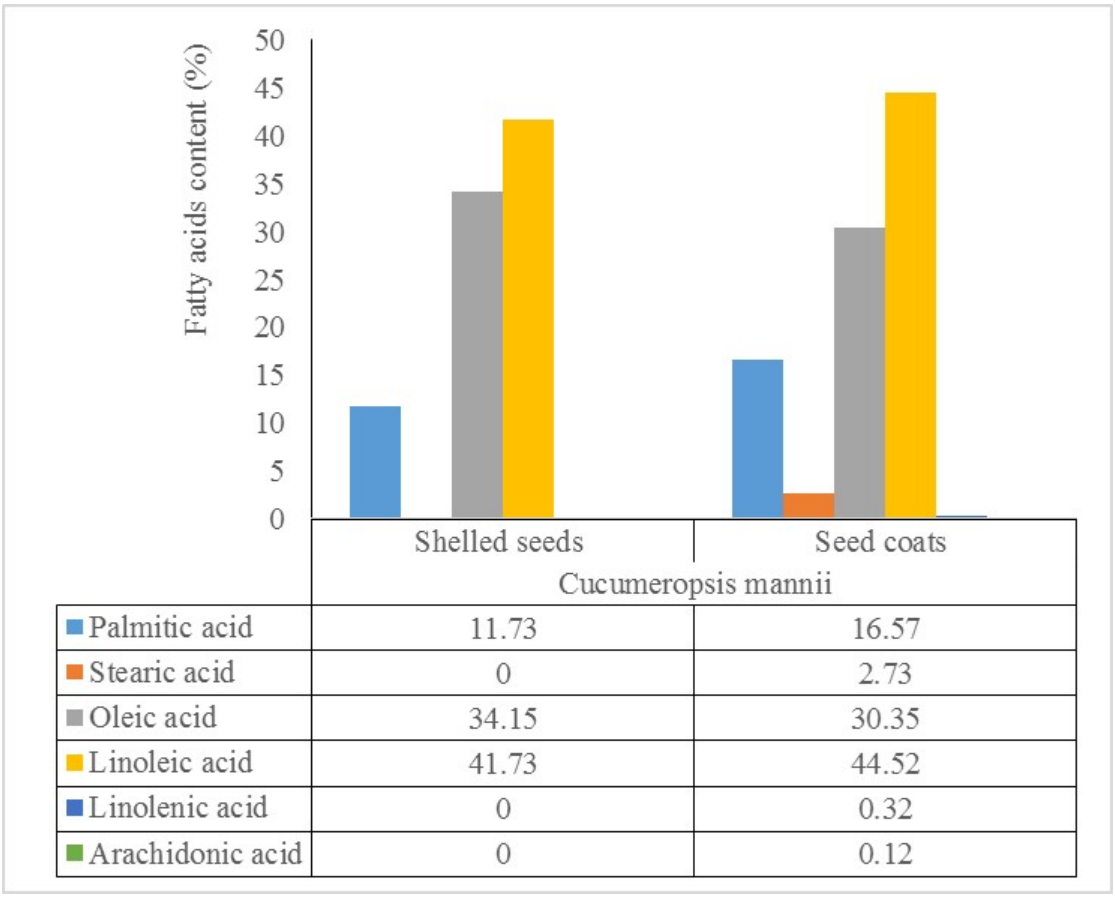
[Downloaded free from http://www.ijfans.org]

11.16±0.76 meq of O_2/kg of oil were observed for oils extracted from shelled seeds and seed coats respectively; and for *C. melo,* values of 45.73±1.96 and 57.31±2.15 meq of O_2/kg of oil were obtained for oils extracted from shelled seeds and seed coats respectively. In this study, all the values obtained were higher than the international standard value of 10 meq of O_2/kg of oil recommended by the Codex Alimentarius for refined vegetable oil (Codex Alimentarius, 1999). A high level of peroxide index (20.00±0.3 meq of O_2/ kg of oil) was also reported by Essien (2012) for oil extracted from *Cucumeropsis mannii.* Moreover, Aremu (2015) indicated that unrefined vegetable oils were characterized by a greater peroxide index value as compared to refined oils. The peroxide index is a measure of the oxidative rancidity of oil and depends on a number of factors such as the state of oxidation (quantity of oxygen consumed), the method of extraction used and the unsaturated FA present in the oil. In this study, the observed high value of peroxide index could be due to too much exposure of the seeds to the sun during the drying process, which might have caused lipid oxidation as a result of oxygen absorption and therefore the formation of high level of peroxide. This high amount of peroxide could also be attributed to the heating applied to the plant material during the oil extraction process. In fact, heat favors oxidation of FA and thus the increase of the formation of peroxide. In addition, oil contains mostly MUFA (monounsaturated fatty acid) and PUFA (polyunsaturated fatty acid) which can undergo oxidation and consequently increase the peroxide index value of the oil.

Fatty Acids Composition

The fatty acids composition of oil extracted from shelled seeds and seed coats of *Cucumeropsis mannii* and *Cucumis melo* is presented in figure 6 and 7. I could be seen that the extracted oils contained saturated fatty acids (SFA) which consisted of palmitic acid (C16:0) and stearic acid (C18:0), monounsaturated fatty acid (MUFA) composed of oleic acid (C18: 1, n-9) and polyunsaturated fatty acid (PUFA) such as linoleic acid (C18:2, n-6), linolenic acid (C18:3, n-3) and arachidonic acid (C20: 4, n-3). Stearic acid, linolenic acid and arachidonic acid were not found in the oil extracted from the shelled seeds of *Cucumeropsis mannii* while only palmitic acid and linolenic acid were not found in the oil extracted from the shelled seeds of *Cucumis melo*. As regards to the seed coats of the two Curcubitaceae species, all the above-mentioned fatty acids were found in the oil extracted from them.

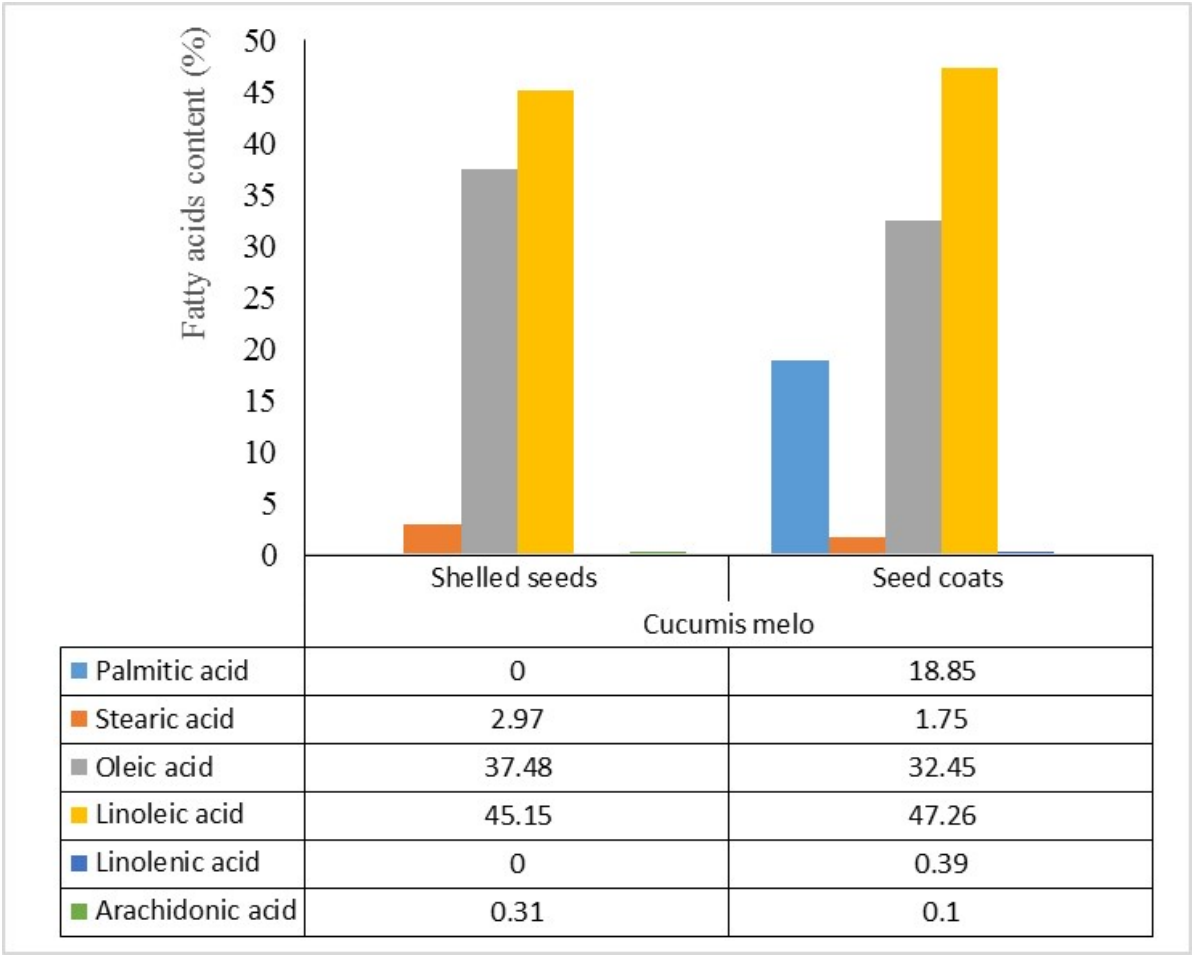
Figure 6: Fatty Acids Content of Shelled Seeds and Seed Coats of *Cucumeropsis manii*



	Shelled seeds	Seed coats
Palmitic acid	11.73	16.57
Stearic acid	0	2.73
Oleic acid	34.15	30.35
Linoleic acid	41.73	44.52
Linolenic acid	0	0.32
Arachidonic acid	0	0.12

[Downloaded free from http://www.ijfans.org]

Figure 7: Fatty Acids Content of Shelled Seeds and Seed Coats of *Cucumis melo*



	Shelled seeds	Seed coats
Palmitic acid	0	18.85
Stearic acid	2.97	1.75
Oleic acid	37.48	32.45
Linoleic acid	45.15	47.26
Linolenic acid	0	0.39
Arachidonic acid	0.31	0.1

In *Cucumeropsis mannii*, the palmitic acid level in shelled seeds and seed coats were 11.73% and 16.57% respectively. In *Cucumis melo*, palmitic acid inexistent in shelled seeds while its value was 18.85% in seed coats. The results obtained in this study were closed to the values (11.2%-15.1%) reported for oil extracted from *Cucumeropsis edulis*, *Lagenaria siceraria* and *Citrulus lanatus* (Salifou *et al.*, 2016).

The levels of oleic acid of the shelled seeds and seed coats for *C. mannii*, were 34.15% and 30.35% while those of the linoleic acid were 41.73% and 44.52% respectively. As regards to *C. melo*, the levels of oleic acid in shelled seeds and seed coats were 37.48% and 32.45% while those of the linoleic acid were 45.15% and 47.26% respectively. Oleic acid was the only monounsaturated fatty acid (MUFA) found in all of the oils extracted from the two Curcubitaceae species. This result was in agreement with the work conducted by Olubi *et al.* (2019). Moreover, the shelled seeds and the seed coats of both species exhibited higher amount of linoleic acid than oleic acid, and this was in agreement with the study reported by Redrouthu *et al.* (2020). Linoleic acid (PUFA), called also omega 6 ($\omega 6$) is an essential fatty acid. The presence of Linoleic acid and oleic acid in the oil extracted from shelled seeds and seed coats indicated that these oils were highly nutritious. Moreover, it has been indicated that food containing MUFA and PUFA were receiving increased attention due to their impact on human health in prevention of cardiovascular diseases, cancer, type 2-diabetes and hypertension (Santos *et al.*, 2017).

CONCLUSION

The present study showed that shelled seeds of *Cucumeropsis mannii* Naudin and *Cucumis melo* contained higher amount of oil as compared to the seed coats. Therefore, in order to maximize the yield of the extracted oil, the whole seed should be used during the extraction process meaning that the seed coat should not be separated from the almond. Oils extracted from shelled seeds and seed coats were excellent sources of palmitic acid, oleic acid and linoleic acid and the latter one was the most abundant fatty acid among all. Owing to the high amount of omega-6 fatty and oleic acid of these oils, they could be considered as nutritious and could be introduced in human diet which may contribute to the reduction of the risk of cardiovascular diseases, cancer, type 2-diabetes and

[Downloaded free from http://www.ijfans.org]

hypertension. It must be stressed out that, to get all the benefit, these oils must be properly refined before any consumption.

REFERENCES

1. Achigan-Dako E. G., Fagbenissi R., Avohou H. T. Vodouhe R. S. Coulibaly O. and Ahanchede A. (2008). Importance and practices of Egusi crops (Citrullus lanatus (Thum) Matsum. & Nakai, Cucumeropsis mannii Naudin and Lagenaria siceraria (Molina) Standl. cv. Aklamkpa) in sociolinguistic arreas in Binin. Biotchnology, Agronomy, Society and Environment, 12(4), 393-403.
2. Adrián Rabadán A., M. Antónia Nunes M. A., Silvia M. F. Bessada M. F. S., José E. Pardo J. E., Oliveira B. M. and Álvarez-Ortí M. (2020). From by-product to the food chain: Melon (Cucumis melo L.) seeds as potential source for oils.
3. Aloho K. P. and Johnson O. A (2012). The quality of "Egusi-Itoo" melo (Cucumeropsis mannii Naudin.) seed harvested at different fruit ages. International journal of Scientific and research publications, 2(12), 1-5.
4. Ajayi I. A., Adeboye R. O. and Alaka O. O. (2013). Short-term toxicological evaluation of Cucumeropsis mannii seeds oil in albino rat. New York Science Journal, 6(8), 98-103.
5. Anderson-Foster E. N., Adebayo A. S. and Justiz-Smith N. (2012). Physico-Chemical Properties of Blighiasapida (ackee) Oil extract and it potential application as emulsion base. African Journal of Pharmacy and Pharmacology, 6, 200-210. DOI: 10.5897//AJPP11.696
6. AOAC (2005). Official Method of Analysis, eighteenth edition. Association of Official Analytical Chemists, Washington DC, USA.
7. AOAC (2019). Official Method of Analysis, fifteenth edition. Association of Official Analytical Chemists, Washington DC, USA.
8. Aremu M. O., Ibrahim H. and Bamidele T. O. (2015). Physicochemical characteristics of oils extracted from Nigeria plant foods—A Review. Chemical and Process Engineering Research, vol. 32, 36-52.
9. Asen A. B., Ikyenge B. A., Nyiatagner D. T. and Ageh J. T. (2010). Chemical Analysis of *Citrullus Lanatus* (Thumb), *Cucumeropsis Mannii* (Naud.) and *Telfairia Occidentalis* (Hook F.) seeds oils. Journal of Applied Sciences Research, 6(3), 265-268.
10. Codex Alimentarius (1999). *Codex Alimentarius* Standards for Fats and Oils from Vegetable Sources. Section 2. Codex Alimentarius Standards for Named vegetable oils.). *Codex Alimentarius*-Stand 210.
11. Diaz D., Lloja L. and Carbajal V. (2004). Preclinical studies of Cucurbita maxima (pumpkin seeds) a traditional intestinal antiparasitic in rural urban areas. Rev. Gastroenterol Peru, 24(4), 323-327.
12. Diby N. A. S., Assoi S., Konan N. Y., Coulibaly A. and Biego, G. H. M. (2020). Comparative Study of the Nutritive and Bioactive Compounds of Three Cucurbit Species Grown in Two Regions of Côte d'Ivoire. Asian Food Science Journal, 14(1), 27-41.
13. Dubois V., Breton S., Linder M. Fanni J. and Parmentier M. (2008). Proposition de classement des sources végétales d'acides gras en fonction de leur profil nutrionnel. OCL Vol. 15, No. 1, 56-75.
14. Egwim E. C., Akanya H. O., Onuekwusi E. C., Ossamulu I. F. and Mohammed J. M. (2015). "Physicochemical and Organoleptic Properties of Some Selected Foods Fried with Melon (Citrullus Lanatus) Seed Oil", IOSR Journal of Biotechnology and Biochemistry (IOSR-JBB) ISSN: 2455-264X, Volume 1, PP. 43-48, www.iosrjournals.org.
15. Essien E. A., Umoren S. A. Essien E. E. and Udoh A. P. (2012). Preparation and evaluation of Cucumeropsis manii Naud. Seed oil metallic soaps as driers in gloss paint. Journal of Materials and Environmental Science, 3(3), 477-484.
16. Foku E., Achu M. B. Kansci G., Ponka R., Fotso M., Tchiégang C. and Tchouanguep F. M. (2009). Chemical properties of some Cucurbitaceae oils from Cameroon. Pakistan Journal of Nutrition, 8(9), 1325-1334.
17. Gbogouri G. A., Brou K., Linder M., Tehrany E. A., Gnakri D. and Zoro-Bi I. A. (2011). Comparative study of physicochemical and thermal properties of the seeds oils of three cucurbit species. International Journal of Biological and Chemical Sciences, 5(3), 1165-1171.
18. Gulluoglu L., Bakal H., Onat B., El Sabagh A. and Arioglu H. (2016). Characterization of peanut (Archis hypogaea L.) seed oil and fatty acids composition under different growing season under Mediterranean environment. Journal of experimental Biology and Agriculture Sciences, 4(5S), 564-571.
19. Guterrez R. M. P. (2016). Review of Cucurbita pepo (pumpkin) its phytochemistry and pharmacology. Med. Chem, 6, 12-21.
20. Ketevi A., Osseyi E., Bilabina I., Creppy-Togodoe A. Batalias Y. and Lamboni C. (2015). Caractéristiques chimues et physicochimiques des graines cucurbitacée du

[Downloaded free from http://www.ijfans.org]

Togo: concombre amer *(Cucumeropsis edulis Hook F.)* et melon à pistache *(Citrullus lanatus Var)*. Journal de la Société Ouest-Africaine de Chimie, 040, 1-7.

21. Kolawole A. N. and Ayeola D. O. (2019). Chemical analysis of *Cucumeropsis mannnii* (Naud) and Citrulus lanatus (var citroides) seed oils relation to their potential as domestic and industrial oils. FUTA Journal of Research in Sciences, 15(1), pp. 113-123.
22. Mallek-Ayadi S., Bahloul N. and Kechaou N. (2018). Chemical composition and bioactive compouds of Cucumis melo L. seeds: Potential source for new trends of plant oils. Process Safety and Environmental Protection, 113, 68-77.
23. Morin O. and Pages-Xatart-Pares X. (2012). Huiles et corps gras végétaux : ressources fonctionnelles et intérêts nutritionnel. OCL, 19(2), 63-75. Doi: 10.1684/ocl.2012.0446.
24. Naghshineh M., Ariffin A. A., Ghazali H. M., Mirhosseini H. and Mohammed A. S. (2010). Effect of saturated/unsaturated fatty acid ratio on physiochemical properties of palm olein-olive blend. J. Am. Oil. Chems. Soc.
25. Ndukwe G. I. and Chahul H. F. (2016). Application and evaluation of *Cucumeropsis mannii* Naud. seed oil in methyl salicylate liniment and salicylic acid lotion formulations. Journal of Pharmacognosy and Phytochemistry, 5(5), 321-324.
26. Nordoy A. (1991). Is there a rational use for n-3 fatty acids (fish oils) in clinical medicine? Drugs, 42, 331-342.
27. O'Brien R. D. (2003). Fats and oils: Formulating and processing for application. Bocca Ration, 3rd edition, USA. Press CRC, 680 p.
28. Okwundu O. S., Chiama C. J., Chiama C. J., Ucheagwu P. C., Uzoma E. K., Okaro C. A. and Muojama O. E. (2021). The untapped industrial crop, *Cucumeropsis mannii* dry oil extraction, characterization and potential as biodisel feedstock and heavy metal sink. Sustainable Environment Research, 30, 10, 14 p.
29. Olatunji G. A., Ajerogba L., Olalekan M. I., Adegoke B. A. and Adepoju A. R. (2021). Physicochemical screeming of seed oils from some Nigerian grown Cucurbitaceae plant seeds. Journal of Applied Chemistry, Volume 14, Issue 1, pp. 01-06.
30. Olubi O., Felix-Minnaar J. V. and Ideani V. A. (2019). Physicochemical and fatty acid profile of egusi oil from supercritical carbon dioxide extraction. Heliyon, (5), 1-17.
31. Opoku-Boahen Y., Clemente R. and Wubah D. (2013). Investigation of Cucumeropsis mannii N. seed oil as potential biodiesel feedstock. International Journal of Biological and chemical Sciences, 7(4), 1767-1776.
32. Percheron F., Perlès R. and Foglietti M. J. (1991). Biochimie structurale et métabolique, 1 bioénergétique-protides – enzymologie- acides nucléiues, 3e édition, 2e tirage 26 p.
33. Redrouthu R., Prabhu V. S. and Zeru B. (2020). Extraction of essential oils from pumpkin seeds: RSM based process modeling, optimization and oil characterization. International Journal of Engineering and Advanced Technology, Volume 9, Issue 4, 1787-1797.
34. Salifou A., Alidou C., Tchobo P. F., Barea B. and Soumanou M. M. (2016). Agronmic evaluation and quality characteristics of three Cucurbitaceae varieties acclimated in Benin. African Journal of Biotechnology, 15(44), 2524-2529. DOI: 10.5897/AJB2015.14913.
35. Santos E. R. M., Oliviera H. N. M., Oliviera E. J., Azeyedo S. H. G., Jesus A. A., Medeiros A. M., Dariva C. and Sousa E. M. B. D. (2017). Supercritical fluid extraction af Pumex acetosa L.roots yield, composition, kinetics, bioactive evaluation and comparison with conventional techniques. The of Journal of Supercritical fluids, 122, 1-9.
36. Yaday M., Jaim S., Tomar R., Prasad G. B. K. S. and Yaday H. (2010). Medecinal and biological potential of pumpkin. An updated review. Nutr. Res. Rev., 23, pp. 184-190.
37. Zahran H. and Tawfeuk H. (2019). Physicochemical properties of new peanut (Arachis hypogaea L) varieties. OCL, 26, 1-7.
38. Zoro Bi I. A., Kouamé K. K., Yao D., Malice M. and Baudoin J. P. (2006). Indigenous Cucurbits of Côte d'Ivoire: a Review of their Genetic Resources. Sciences & Nature Vol. 3, No. 1, 1-9.