THE PHYSICOCHEMICAL AND NUTRITIONAL ANALYSIS OF COCONUT OIL (*Cocos nucifera*) EXTRACTED FROM THE TALL TREE VARIETY

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ABSTRACT

Aims: Coconut (*Cocos nucifera*) known as the 'tree of life' is an ancient fruit belonging to the palm family Arecaceae family and the only species in the genus *Cocos*. This study aims to characterize and show the nutritional qualities of coconut oil from the tall tree variety.

Methodology: The production methods include natural Fermentation, centrifugation, freeze-thawing, and solvent extraction. In physical and chemical properties, the moisture content, impurity, specific gravity, refractive index, oil yield, flash, fire, smoke point, melting point, thiobarbituric acid number, saponification, peroxide, iodine, and fatty acid value were analyzed and all fall within close ranges.

Results: The fat-soluble vitamins ranged from 18.65 ± 5.09 (vitamin A), 4.28 ± 0.68 (vitamin E), 4.11 ± 3.11(vitamin D) and 1.03 ± 0.21 (vitamin K) all in mg/100ml. Mineral analysis shows that coconut oil contains calcium, zinc, and iron with concentrations of 2.53 ± 0.23, 1.21 ± 0.19, and 0.53 ± 0.13 in mg/100ml respectively. Fatty acid analysis shows that coconut oil contains lauric, myristic, palmitic, caprylic, oleic, capric, stearic, linoleic, and caproic acid of which lauric acid was the highest with a range of 48.40 ± 0.23.

Conclusion: The result shows that coconut is a good source of nutrients and the fatty acids make it a good moisturizer.

Keywords: coconut oil, fatty acids, centrifugation, characterization

1. INTRODUCTION

Coconut (*Cocos nucifera*) known as the 'tree of life' has been the preferred raw material for the production of cosmetics. Coconut oil is the edible oil extracted from the kernel or meat of mature coconuts harvested from the coconut palm (1) (2a). The culinary and pharmaceutical industries use coconut oil (2a). This is so that patients with specific skin disorders may benefit from the antibacterial properties that coconut oil contributes to lotions and moisturisers. Coconut oil is applicable in hair care not just because it has a high attraction for hair proteins, but because of lauric acid's low molecular weight and straight linear chain, which can infiltrate inside the hair shaft. Coconut oil decreases protein loss for both unspoiled and spoiled hair when used as a pre-wash and post-wash grooming product (3) (4)

Coconut oil is composed mainly of fatty acids some of which are saturated and others monounsaturated fatty acid. Coconut oil does not contain dietary cholesterol. The main fatty acids are lauric, myristic, and palmitic acids. Virgin coconut oil has been found to contain more concentrations of polyphenols than standard coconut oil. The reasons for lower levels in standard coconut oil may be because minor components were destroyed during the

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manufacturing process and also because polyphenols which are polar compounds have a higher affinity for liquid coconut milk and fresh copra as opposed to dried copra (5) (6).

Some coconut oil products are referred to as "virgin" coconut oil. Unlike olive oil, there is no industry standard for the meaning of "virgin" coconut oil. The term has come to mean that the oil is generally unprocessed. For example, virgin coconut oil usually has not been bleached, deodorized, or refined.

Some coconut oil products claim to be "cold pressed" coconut oil. This generally means that a mechanical method of pressing out the oil is used but without the use of any outside heat source. The high pressure needed to press out the oil generates some heat, but the temperature is controlled so that temperatures do not exceed 120 degrees Fahrenheit (45^{o}C).

People use coconut oil for eczema (atopic dermatitis). It is also used for scaly, itchy skin (psoriasis), obesity, and other conditions.

Given that coconut oil is being produced on small scale bases there is a need to improve the processing method and quality to help boost the marketing of the oil. Coconut oil contains medium-chain triglycerides'' and when applied to the skin, has a moisturizing effect, it is important to assess the physicochemical properties. Therefore, this study aims to produce and characterize coconut oil.

2. MATERIAL AND METHODS

2.1 Sample Preparation

The fresh and mature coconut fruits were obtained from Isinweke, Ihitte Uboma Local Government Area of Imo State, and the National Research Institute Umudike. The coconut fruits with herbarium number NOFOR NGCN-00-2 were identified and analyzed at the Food Science and Technology Laboratory in Micheal Okpara University of Agriculture Umudike, Abia State, International Institute of Tropical Agriculture Ibadan, and Ahmadu Bello University, Zaria. The fresh and matured coconut fruits were peeled, washed, size reduced, and crushed with a Q-link China Model blender and mixed with water, then squeezed out the milk.

2.2 Physical properties Analysis

The oil yield (%) was calculated relative to the total weight. Other physical properties of smoke, flash, fire, melting, and cloud points, as well as refractive index, specific gravity, impurities, and moisture contents of oil samples, were determined by the methods described by (7a).

$$\left({}^{mg}/_{100g}\right) = \frac{100}{w} x \frac{\alpha\mu}{\alpha s} xC$$

Where:

αμ = absorbance of the test sample

αs = absorbance of standard solution

C= concentration of the test sample

w = weight of sample.

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2.3 Determination of percentage oil yield

Oil yield by each of the test methods of extraction was determined gravimetrically as the percentage ratio of the weight of the extracted oil to the quantity of the coconut meat used. The equation below was used in calculating the percentage oil yield of the oil sample.

$$yield\ (\%) = \frac{weight\ of oil}{weight\ of\ copra} \times \frac{100}{1}$$

2.4 Determination of the cloud point of the coconut oil sample

This was determined as the temperature at which a cloud is formed in the oil due to the onset of crystallization (8). The test oil sample was dispersed into a clear glass test tube with the aid of a retort stand, and a Celsius thermometer was held over the oil with its bulb immersed into the oil. The oil was heated to a temperature of 130^{o}C. The heat source was removed and the oil was allowed to cool under ambient conditions. The temperature at which the thermometer bulb was no longer visible was recorded as the cloud point of the oil.

2.5 Determination of the refractive index of the coconut oil sample

The refractive index was determined as the ratio of the speed of light in air to that of light in oil. Abbe's refractometer was used to determine the refractive index (7b). The meter was first set at 20^{o}C and a smear of the test oil was made on the lower prism. A light beam was passed through it such that the reflection formed a visible dark background. Then the instrument was adjusted to the telescope tube until the shadow appeared in the cross-wine indicator. The refractive index value was read directly from the screen.

2.6 Determination of moisture content of the coconut oil samples

Five grams (5g) of the coconut oil were weighed in duplicate using an electronic balance into dried, cooled, and weighed in dishes (9a). The samples in the dishes were then placed into a moisture extraction oven set at 105^{o}C for 30 minutes after which the samples were transferred into desiccators and allowed to cool down. The samples were then weighed and recorded accordingly. The process was repeated for each sample until a constant weight was obtained. The percentage moisture content for each sample was calculated as stated below.

$$\%\ moisture = \frac{\mathrm{w2} - w1}{w2 - W3} \times \frac{100}{1}$$

Where,

w_1= initial weight of the empty dish

w_2 = weight of dish + sample before drying

w_3= weight of dish + sample after drying

2.7 Determination of the specific gravity of the coconut oil sample

The pyrometer gravimetric method was used as described by (8). The specific gravity bottle was calibrated to standardize it using distilled water. After which it was emptied and dried. Afterward, the specific gravity bottle was filled with the respective test oil up to its stopper capillary. The outside was wiped clear and dried with blother cloth soaked in ether and then weighed. The specific gravity was calculated as the ratio of the weight of the test oil to that of an equal volume of pure water (in the pyrometer) using the equation below.

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$$Specific\ gravity\ (\mathrm{g/cm^3}) = \frac{ws - w\alpha}{ww - w\alpha}$$

Where,

$w\alpha$ = weight of empty pyrometer

ws = weight of pyrometer filled with sample test oil

ww = weight of pyrometer filled with distilled water

Evaluation of chemical characteristics: The oil quality characteristics such as acid value, iodine value, free fatty acid, thiobarbituric acid number, and saponification value, were evaluated according to the methods described by (9b).

2.8 Determination of acid value or free fatty acid value of the coconut oil sample

The method of (7a) was adopted in the determination of free fatty acid and acid values. Ten grams (10g) of the extracted coconut oil was weighed into a pre-weighed conical flask and the oil was dissolved with 25ml petroleum ether and 25ml ethanol. The solution was slightly heated and shaken to dissolve properly. It was then titrated with 0.1N sodium hydroxide while warm until a permanent slight pink color was obtained and persisted for some minutes. The titer volume difference of the 0.1N sodium hydroxide used was noted. This is calculated as follows:

$$FFA\ = titre\ value(ml) \times \frac{2.82}{weight\ of\ sample\ used}$$

$$acid\ value = titre\ value\ (ml) \times \frac{5.61}{weight\ of\ sample\ used}$$

2.9 Determination of the iodine value of the coconut oil sample

Wiji's method as described by (7a) was adopted in determining the iodine value. One gram or less (0.65g) of the extracted crude coconut oil sample was weighed into a glass bottle with a round neck and stopper. This was dissolved in 10ml of carbon tetrachloride. The glass was wrapped with carbon paper to avoid sunlight, 20ml of Wiji's solution was added and the bottle was sealed effectively by moistening the stopper with a minimum quantity of 10% potassium iodide solution. It was allowed to stand for 30 minutes at a temperature of 15-20^{o}C (by immersing in an ice container) in a dark place. Afterward, 15ml of 10% potassium iodide and 100ml of water were added and mixed by swirling. Free iodide in the solution was titrated with standardized sodium thiosulphate solution, when it became pale yellow, the starch indicator was added and the titration continued until the color changed from blue to colourless. The titer value was recorded. A blank determination was done at the same time with the same quantities of reagent but without the sample. The iodine value is calculated as follows:

$$Iodine\ value = (x - y) \times I \times \frac{100}{w}$$

Where x = volume in ml of 0.1N thiosulphate solution required for the blank

y = volume in ml of 0.1N thiosulphate solution required for the test sample

w = weight (g) of sample

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I = weight (g) of iodine, equivalent to 1ml of the thiosulphate solution

2.10 Determination of the saponification value of the coconut oil sample

The acid titration method described by (7a) was used. Two grams of each oil sample was weighed into a conical flask and 500ml of alcoholic potassium hydroxide solution was added to it and mixed. The mixture was boiled under reflux for 30 minutes with occasional shaking. Thereafter, 3 drops of phenolphthalein indicator were added to it while still hot and it was titrated against 0.5ml HCl solution until the disappearance of the pink colouration. A blank reagent consisting of the alcoholic potassium hydroxide without an oil sample was treated as described above and titrated as well. The saponification value is calculated as follows:

$$Saponification\ value\ \left(\frac{mgKOH}{g}\right) = B - T \times N \times \frac{56.1}{w}$$

Where,

w = weight of sample

T = titre value of sample

B = titer value of blank reagent

N = normality (concentration) of titrant (0.5M HCl)

2.11 Determination of the peroxide value of the coconut oil sample

This was done using the thiosulphate titrimetric method described by (7a). One gram of each oil was put in a conical flask and 1g of potassium iodide was added and was mixed thoroughly followed by 20ml of mixed solvent containing glacial acetic acid and chloroform in the ratio 2:1 (v/v). Then mixture with the sample was boiled briefly (< 1 minute) and then quickly, 20ml of 5% potassium iodide solution was added to it and thoroughly mixed followed by the addition of 50ml of distilled water and then titrated against 0.002M sodium thiosulphate using 1% starch as indicator. The peroxide value is calculated as follows:

$$PV\left(\frac{MEQ}{kg}\right) = 1000\ \times \mathrm{N} \times \frac{\mathrm{Titre}}{\mathrm{w}}$$

Where,

w = weight of sample

N = normality (concentration) of titrant

2.12 Determination of thiobarbituric acid number (TBA)

The calorimetric method described by (7a) was used. Accordingly, 10g of each sample was mixed with 50 ml of distilled water and boiled for 2 minutes in a micro blender. Approximately, another 50ml of distilled water was used to wash out the mixture into a distillation flask. Exactly 2.5ml of 4M HCl solution was added to it and the pH was confirmed to be 1.5 with a pH meter. Then some drops of amyl alcohol were added to it as antifoam and it was distilled. The distillate was collected (50ml). An aliquot 5ml of the distillate was

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treated with an equal volume 5ml of TBA reagent consisting of TBA prepared 90% of glacial acetic acid solution (0.288g/100ml). A reagent blank was prepared with all the reagents but without an oil sample. Both the sample and blank were heated in boiling water for 35 minutes and the absorbance of the sample was read in a spectrophotometer at 538nm while the blank was used to set the instrument at zero. The TBA number was given by the relationship in the equation below:

$$\boldsymbol{TBA}\left(\boldsymbol{mg}\frac{\boldsymbol{MDA}}{\boldsymbol{kg}}\right) = \boldsymbol{absorbance} \times \mathbf{7.8}$$

2.13 Analysis of fatty acid composition

Fatty acid composition was examined using the Gas Chromatography (GC) protocol (9). The oil was converted to their fatty acid methyl esters (FAMEs) and was identified with the pure standards. The results were expressed as % of individual fatty acids.

Procedure

The fat was saponified, which liberated the fatty acids from triglycerides, phospholipids, etc producing free acids. The free acids were trans-esterified to form fatty acid methyl esters. Matrices that were not pure fats and oils will require an extraction step to liberate the fat for analysis. Most solid samples were hydrolyzed by strong acid and/or alkali and then extracted with organic solvents. To accurately quantify the fatty acid content of the sample as a weight percentage of the sample, a synthetic fatty acid (typically C13:0, C19:0, C21:0, or C23:0) was added to the sample before extraction as an internal standard. The use of the internal standard compensates for variability in both the preparation and analysis of the sample.

The fatty acid methyl esters were separated on the GC and quantified using a flame ionization detector (FID). Separations were performed with wax-type capillary columns when only basic chain length and saturation were needed. To quantify cis versus trans-isomerization specialized, highly-polar capillary columns were used. The FID burns the FAMEs producing ions generating an electrical current which is measured and plotted as the response in the chromatogram.

2.14 Determination of zinc and iron contents

The Zn and Fe were determined according to the method described by (10). To determine this, 5g of the sample was weighed in a crucible and then placed in a muffle furnace for ashing at a temperature of 500°C for two hours. To obtain a uniform solution, 10cm3 of 6M Nitric acid (HNO_3) was added and agitated. The digests were analyzed using an Atomic Absorption Spectrophotometer (AAS). The zinc and iron content was determined using the formula:

$$Zn = \frac{Vf}{Vs} x \frac{1}{10} x \frac{100}{W} xDf$$

Where:

W = Weight of sample analysed

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Vf = Volume of extract

Vs = Volume of extract used

Df = Dilution factor

Vitamin A assay

2.15 Extraction of vitamin A

Weigh 5-10g of the previously crushed food substance into a 1L round flask. Add 20ml of a 50% NaOH solution and warm the mixture in a water bath. Then add 100ml of diethyl alcohol and 2ml of a hydroquinone solution that was obtained by dissolving 20g in 100ml of pure alcohol. Maintain the water bath at 90oC for 30 minutes. Pour the contents of the round flask into a decanting vial and add 100ml of water. Add 50ml of ethylic ether and shake. Add 50ml of petroleum ether, shake, and allow it to decant. Extract once or twice with 50ml of petrol ether. Wash the ether phase three times with 100ml of water. Filter, evaporate, and concentrate until 1ml is obtained (10).

2.16 Determination of vitamin A

The hexane phase obtained earlier is taken again and concentrated in a vacuum. Redissolve the extract in a chloroform. Add 4v of the trifluoroacetic acid reagent prepared by mixing 1v of trifluoroacetic acid with 3v of chloroform. Then observe the absorbance at 620nm.

2.17 Determination of vitamin D

Weigh between 5-10g of the sample food substance. Add 1g of propanol, 90 ml of a mixture of 60 ml of absolute ethanol, and add 30 ml of a 50% potash solution. Extract three times, each time with 50ml of petroleum ether. Wash the ether extract and mineral three times with water. Filter, evaporate, and concentrate until 1ml is obtained. If the sample contains all the vitamin D metabolites (D2 or D3), then you can carry out a liquid chromatography under the following conditions: fatty acid analysis column, MeCN (acetonitrile), 55% mixture of water/acetic acid (4ml of acetic per liter) 45% which is a solvent, flow rate of 1ml/min, wavelength of 265nm, solvent temperature at 25^{o}C and temperature of oven at 40oC (10).

2.18 Vitamin E assays

2.18.1 Extraction of vitamin E

Weigh between 5 and 10g of the food substance that you crush. Add 100ml of ascorbic acid, 4ml of water, and 20ml of ethanol brought to 100ml with methanol. Keep in boiling water for 15-20minutes. Add 15 ml of a 70% KOH solution, and place again in the water bath for 40 minutes. Decant the contents of the flask into a separation flask vial, washing the flask with 50ml of water. Add 120ml of ethylic ether and stir the mixture. Decant and filter Na_2SO_4. Extract again with 120ml of ethyl ether. Filter, evaporate, and concentrate to 1ml.

2.18.2 Determination of vitamin E

Colorimetric determination: after extraction and evaporation, re-dissolve the residue using n-heptane. Add 1 ml of dipyridil solution, and then determine the absorbance at 460nm. Methods derived from this one have been recommended for use with ferric chloride with a reading at 510nm.

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Determination by liquid chromatography: the extract prepared as described earlier, proceed with an HPLC determination under the following conditions: Lichrosorb R P 8, 25cm × 4.6mm/5um column, methanol/water (92:8) a solvent, flow rate of 1.5ml/min. The wavelength of 288nm, the solvent temperature at 25^{o}C, temperature of the oven at 40^{o}C (10).

3. RESULTS AND DISCUSSION

3.1 RESULTS

3.1.1 The physical characteristics of the coconut oil samples.

The physical characteristics of coconut oil presented in Table 1 revealed that flash point is the highest with (266.65 ± 2.25^{o}C), followed by fire point (176.6±2.06oC), smoke point (24.05±0.5 ^{o}C), Oil yield (23.12 ± 0.63^{o}C), Refractive index (1.45 ± 0.01), Specific gravity (0.93± 0.01), Impurity (0.42± 0.23%), Moisture content (0.41± 0.03%).

3.1.2 The chemical characteristics of the oil samples

The chemical characteristics of coconut oil presented in Table 2 show that saponification value has the highest composition of (261.33 ± 4.41 mgKOH/ml) followed by Iodine value (11.15 ± 1.14 g/100g), Peroxide value (9.63 ± 1.88 mEq/ml), Thiobarbituric acid number (0.77 ± 0.13 mgKOH/g), and Fatty acid (0.39 ± 0.07 %oleic acid).

3.1.3The vitamin characteristics of the oil samples.

The fat-soluble vitamins presented in Table 3 show that vitamin A is highest with a concentration of (18.65 ± 5.09mg/100ml), followed by Vitamin E (4.28 ± 0.68 mg/100ml), Vitamin D (4.11± 3.11 mg/100ml) and Vitamin K (1.03 ± 0.21mg/100ml).

3.1.4 The mineral characteristics of the oil sample.

The mineral content of coconut oil presented in Table 4 shows that calcium is highest with a concentration of (2.53±0.23mg/100ml) followed by Zinc (Zn) (1.21 ± 0.19mg/100ml) and Iron (Fe) (0.53 ±0.13mg/100ml)

3.1.5 The fatty acids characteristics of the oil samples

the fatty acid concentrations presented in table 4 shows that lauric acid is highest with concentration of 48.40 ± 0.23, followed by myristic 19.8±1.23, palmitic 9.43± 0.29, caprylic 7.46±0.45, oleic 6.54±0.22, capric 6.17 ± 0.73, stearic 3.40 ± 0.03, linoleic 1.51 ± 0.09, caproic 0.59± 0.0.3.

3.2 DISCUSSION

The physical properties of the various coconut oils presented in Table 1 show there was no significant difference in physical qualities among the coconut oil samples evaluated at a 0.05 confidence level ($p<0.05$). The smoke point ranged from 173.3^{o}C to 176.6^{o}C. According to (11), the recommended smoke point must be above 215^{o}C. The smoke point of the coconut oil samples was below the recommended value which indicates that the oil may not be good for frying. The flash point ranged from 262.45^{o}C to 266.65^{o}C. Fire point ranged from 208.5^{o}C to 204^{o}C. In this study, the fire points were within the range of 196 to 222^{o}C and the flash point was above the range of 175-188^{o}C. The moisture content ranged from 0.17% to 0.41%. The moisture content is close to the recommended value (0.29%) according to (12). The impurity ranged from 0.06% to 0.42%. The refractive index is an indicator of the degree of purity of the oil. The range is within 1.44-1.45 of the recommended value specified by

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(12). The melting point range of 23.05^{o}C to 24.05^{o}C was lower than 36.7-48.3^{o}C reported by (13).

The chemical characteristics of the coconut sample in Table 2 show there was a significant difference ($P< 0.05$) in the chemical parameters of the coconut oil sample. The saponification value measures the number of mg of KOH necessary to saponify 1g of oil. Saponification value ranged from 248.12 mgKOH/ml to 261.33mgKOH/ml. Peroxide value ranged from 6.13 mEq/ml to 9.63 mEq/ml. The peroxide value in this study was below 15mEq/kg recommended value according to (12). Thiobarbituric acid number ranged from 0.39mgKOH/g to 0.77mgKOH/g. The acid value was lower than 2.7mgKOH/g obtained by (14). The low acid value indicates the low extent to which the glycerides in the oil had been decomposed by lipase action. Therefore, the oil samples are still edible and in good condition. The iodine value measures the level of unsaturation in the oil samples. The iodine value ranged from 7.52 g/100g to 11.15 g/100g. The values were lower than 45g/100g recommended by (12). Fatty acid values ranged from 0.19% to 0.39%. The fatty acid was lower than 2.73 - 2.89 mgKOH/g as reported by (15). The vitamin characteristics in Table 3. show the presence of fat-soluble vitamins in the coconut oil sample. Vitamin A ranged from 6.22mg/100ml to 18.65mg/100ml. Vitamin D ranged from 1.01mg/100ml to 4.11mg/100ml. Vitamin D range was close to 3.01-4.20mg/100ml as reported by (16). Vitamin D helps to absorb calcium and promote bone growth. Vitamin A plays an important role in vision, bone growth, cell division, and reproduction. Vitamin E ranged from 2.92mg/100ml to 4.28mg/100ml. Vitamin E helps the protection oxidation by free radicals (17) (18). Vitamin K ranged from 0.61mg/100ml to 1.03mg/100ml.

The mineral characteristics in Table 4 show the presence of Iron, Zinc, and Calcium in the coconut oil sample. Iron ranged from 0.17mg/100ml to 0.53mg/100ml. Zinc ranged from 0.62mg/100ml to 1.21mg/100ml while calcium ranged from 1.90mg/100ml to 2.53mg/100ml. The presence of zinc and iron in oil samples can catalyze rancidity reactions. Calcium is an important component of a healthy diet and one of the essential minerals necessary for life. Calcium plays an important role in building stronger bones. The value obtained shows that the oil is a good source of calcium (19).

The fatty acid characteristics of coconut oil in Table 4 show the presence of fatty acids in the coconut oil sample. Lauric acid is the highest with a range of 46.22 to 48.40%. myristic acid ranged from 18.03 to 19.83%. Palmitic acid ranged from 8.90 to 9.43%. Caprylic acid ranged from 6.28 to 7.46%. Oleic acid ranged from 6.17 to 6.54%. Capric acid ranged from 5.51 to 6.17%. Stearic acid ranged from 2.90 to 3.40%. Linoleic acid ranged from 1.30 to 1.51%. While Caproic acid ranged from 0.54 to 0.57%. Low molecular weight and straight chain of the fatty acids, make coconut oil to be applicable in hair and can infiltrate inside the hair shaft.

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Table 1 shows the physical characteristics of the oil samples

Parameters	**compositions**
Moisture content	0.41± 0.03%
Specific gravity	0.93± 0.01
Impurity	0.42± 0.23 %
Refractive index	1.45 ± 0.01
Oil yield	23.12 ± 0.63 ^{o}C
Flashpoint	266.65 ± 2.25 ^{o}C
fire point	176.6 ± 2.06 ^{o}C
smoke point	24.05± 0.5 ^{o}C

values are expressed as mean ± standard error of the mean in triplicate analysis

Table 2: showing the chemical characteristics of the oil samples Parameters compositions

Saponification value	261.33 ± 4.41 mgKOH/ml
Peroxide value	9.63 ±1.88 mEq/ml
Thiobarbituric acid number	0.77 ± 0.13 mgKOH/g
Iodine value	11.15 ± 1.14 g/100g
Fatty acid	0.39 ± 0.07 %oleic acid

values are expressed as mean ± standard error of the mean in triplicate analysis

Table 3: shows the vitamin characteristics of the oil samples

Vitamins	concentrations(mg/100ml)
Vitamin A	18.65 ± 5.09
Vitamin D	4.11± 3.11
Vitamin E	4.28 ± 0.68
Vitamin K	1.03 ± 0.21

values are expressed as mean ± standard error of the mean in the triplicate analysis

Table 4: shows the mineral content of the coconut oil samples

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Minerals	concentrations(mg/100ml)
Iron (Fe)	0.53 ± 0.13
Zinc (Zn)	1.21 ± 0.19
Calcium (Ca)	2.53± 0.23

values are expressed as mean ± standard error of the mean in the triplicate analysis

Table 5: fatty acids characteristics of the oil samples

Fatty acids (%)	concentrations
caproic	0.59± 0.03
caprylic	7.46 ± 0.45
capric	6.17 ± 0.73
lauric	48.40 ± 0.23
myristic	19.83 ± 1.23
palmitic	9.43± 0.29
stearic	3.40 ± 0.03
oleic	6.54 ± 0.22
linoleic	1.51 ± 0.09

values are expressed as mean ± standard error of the mean in the triplicate analysis

4. CONCLUSION

This study shows that coconut oil is a good source of physicochemical nutrients, minerals, and vitamins. The presence of fatty acids in the coconut oil sample is a good moisturizer and is suitable for the treatment of eczema, scaly and itchy skin, and other skin conditions. For large-scale production of virgin coconut oil, it has become clear that the centrifugation method and freeze-thawing method should be adopted in commercial and industrial platforms for the recovery of high-yield products.

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