IJSGS

ISSN: 2488-9229
FEDERAL UNIVERSITY
GUSAU-NIGERIA

INTERNATIONAL JOURNAL OF SCIENCE FOR GLOBAL SUSTAINABILITY

Oil Extraction and GC-MS Analysis of the Seeds oil of three Nigerian Cucurbits

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Received on: August, 2021 **Revised and Accepted on:** September, 2021 **Published on:** October, 2021

ABSTRACT

Extraction and quantification of the yield (percentage) of the seed oil was performed on the seeds of three species of Cucurbitaceae family. Analyses of the oil properties as well as the GC-MS analysis of the seed oil were carried out using standard biochemical procedures. Oil extraction was carried out using n-hexane as the solvent of extraction. The percentage seed oil obtained was subjected to Physico-chemical analysis which revealed the percentage oil yield to be highest in the seeds of *Cucumeropsis mannii* with (53.88±2.23), followed by *Lagenaria breviflora* with (51.43±1.20) while seeds of *Cucurbita pepo* had (44.92±0.98). With significant difference P≤0.05 between the oil yield in the seeds of *C. mannii*, *L. breviflora* and that obtained in the seeds of *C. pepo*. Acid value (mg/KOH/g) was evaluated and revealed the highest in the seeds of *L. breviflora* with (41.78±1.26) *C. mannii* and *C. pepo* had (40.93±1.21) and (37.03±0.78) respectively. With significant difference only between the obtained value in *L. breviflora* and the duo of *C. mannii* and *C. pepo* respectively. Saponification value was evaluated and results obtained indicated *L. breviflora* was the highest (41.78±1.26) while *C. mannii* had (40.93±1.21) while the least value of (36.52±0.97) was obtained in the seeds of *C. pepo.* Kinematic viscosity analysis also revealed the values as (0.75±0.06), (0.69±0.06) and (0.71±0.07) for *C. pepo*, *C. mannii* and *L. breviflora* respectively. There was no significant difference (P≤0.05) in the three specimens studied. For iodine value, (112.94±2.64) was recorded for *C. pepo*; (120.05±3.00) was for *C. mannii* while (104.06±1.78) was recorded for *L. breviflora* with significant difference (P≤0.05) among the three species. Analysis for specific gravity revealed that *C. pepo* had (0.9±0.09) while *C. mannii* had (0.92±0.09) and *L. breviflora* had (0.90±0.08). For Cetane number, (43.00±1.79) was obtained for *C. pepo*, while (41.00±1.50) was *C. mannii* while (39.99±1.21) with no significant difference (P≤0.05) in the specific gravity and Cetane number among the three species studied. Results of Gas Chromatography Mass Spectrometry analysis of the seed oils have been presented on retention time, compounds names, chemical formulae, molecular weights as well as the respective peak area percent of each of the compounds identified. A total of four compounds have been identified as present in *Cucurbita pepo* with oleic acid and 9, 12-Octadecanoic acid and Squalene being the predominant. In *Cucumeropsis mannii*, five compounds have been identified with 1, 8, 11-Heptadecatriene, 10, 13-Octadecanoic acid methyl ester, Linoelaidic acid and Oleic acid being present. In *Lagenaria breviflora*, eight compounds have been found to be present. n-Hexadecanoic acid, Conjugated Linolaidic acid, 9,12-Octadecadienoic acid and 2-Hydroxy-1-(hydroxyl methyl) ethyl ester. Others were 9-Heptadectriene, Saturated Tetradec-13-en-11-yn-1-ol, Squalene as well as gamma-Tocopherol. Based on the obtained results on oil yields and the Physico-chemical analysis and the Gas Chromatography Mass Spectrometry (GC-MS) analysis of the seed oils, it can be said that the studied cucurbits have exhibited an excellent status in serving the quest for alternative biofuel that gives them unique characteristic for use as they could greatly help reduce overdependence on the fossil fuel. More so, the GC-MS analysis of the seed oils revealed a number of active compounds with wide applications that could be harnessed to better the lots of humanity.

Keywords: Cucurbitaceae, Biodiesel, GC-MS, Soxhlet-extractor, n-hexane, overdependence

1.0 INTRODUCTION

The rapidly growing global demand for petroleum products and the consequent depletion of the crude reserves in addition to adverse environmental concerns and unstable nature of the international market make imperative the need to explore alternative sources of fuel. Biodiesel stands to be the key promising renewable energy options

already exploited by various countries. Categories of feedstock as source of suitable oil for biodiesel production include seeds, nuts, leaves, wood, and even bark of trees. Nigeria is very well endowed with various edible and non-edible oils (Cynthia *et al*., 2012).

Biodiesel could be described as the mono-alkyl esters of long-chain fatty acids synthesized by transesterification of triglyceride in vegetable oils or animal fats with alcohol, and is therefore a renewable energy resource. Biodiesel is superior to conventional diesel in terms of its sulphur, aromatic contents and flash point. It is essentially sulfur-free and non-aromatic while conventional diesel can contain up to 500 ppm, SO_2 and 20–40 wt% aromatic compounds. These advantages could be a key solution to reduce the problem of urban pollution since transport sector is an important contributor of the total gas emissions. Biodiesel is an alternative fuel made from renewable biological sources such as vegetable oil and animal fats (Raja *et al*., 2011).

Due to the depleting world's petroleum reserves, threatening to run out in the foreseeable future and the increasing environmental concerns, there is a great demand for alternative sources of petroleum-based fuel including diesel and gasoline. The annual worldwide demand for diesel fuel approaches 1.0 billion tons. This far exceeds the current and future biodiesel production capabilities of the vegetable oil and animal fat industries. Worldwide, vegetable oil feedstock is estimated to be 100 million tons, which would supply only 10% of the demand for diesel fuel even if none were diverted to other uses (Munack *et al*., 2001).

Cucurbits refer to those plant species placed in the large family of Angiospermae, known as Cucurbitaceae. Members of the gourd family that includes hundreds of species of vines with coiled climbing tendrils characterized by production of the most unusual fruits in the world. Cucurbitaceae family is among the abundant crop domesticated and grown at wild in most tropics (especially in Nigeria). Members of the Cucurbitaceae are known to be very useful, serving as food, ornamental purposes, utensils, fuel as well as medicinal purposes (Abscal and Yarmell, 2005; Manandhar, 2002). In Nigeria, Cucurbitaceae is represented by 21 genera, many of which are of considerable economic importance. Indigenous people of Nigeria traditionally utilize a wide range of these plant species as food and medicine. Archeological evidence has indicated that cucurbits were present in ancient and prehistoric cultures. *Lagenaria* for instance, was associated with man as early as 12, 000 BC in Peru. Archeological expeditions in the Oaxaca region of Mexico have reported *Cucurbita pepo* to be associated with man as early as 8500 BC and cultivated by 4050 BC (Elquinas-Alcazar and Gulic, 1983). Similarly, written Chinese records describing the use of cultivated cucurbits have been found as from as early as 685 BC. American Indians cultivated squash in pre-Columbian times. Cucurbits are among the economically most important vegetable crops worldwide and are grown in both temperate and tropical regions (Pitrat *et al.*, 1999; Bisognin, 2002). Despite their agronomic, cultural and culinary importance, there is scanty of information on these species from research and development and are often categorized as orphan crops (Haim, 2007).

2.0 MATERIALS AND METHODS

2.1 Samples Collection and Preparation

Fresh fruits of *C. pepo* and *C. mannii* were purchased at Kasuwan Daji market within the Sokoto municipal. Ripe and fully grown fruits of *L. breviflora* were obtained from the roadsides in the outskirts of Sokoto township where the species grows as a wild one. The three samples were taken to the Department of Biological Sciences Herbarium, Usmanu Danfodiyo University, Sokoto for authentification by a taxonomist where voucher specimens were deposited. Seeds were removed from the fruits by cutting the individual fruit longitudinally and scrapping out the seeds using cleaned knife immature seeds were removed from the good ones. The seeds were dried to a constant weight in an oven at 70^0C, ground using mechanical blender, placed in three air-tight containers and stored in desiccators for further analysis.

2.2 Extraction of the Cucurbits Seed Oil

2.2.1 Extraction procedure

Adopting the method as reported by Ajibola *et al*. (2018), two hundred (200) g of air dried and

pulverized seeds of each of the sampled seeds will be weighed and packed into thimble, which will in turn be placed into Soxhlet extractor. The extraction solvent (n-hexane 500 cm3) and anti-bumping chips are to be put into 1000 cm3) round bottomed flask and heated on heating mantle at 60 ^{0}C. The extraction will be allowed to continue for one hour (1 hr). The solvent in the round bottomed flask will be collected and concentrated in vacuum using a rotatory evaporator at 40 ^{0}C. The above process was repeated to get means of percentage extraction and enough oil for further analyses.

Percentage yields was calculated using equation 1:

2.2.2 Biodiesel yield (%)

$$= \frac{\text{weight of the biodiesel}}{\text{weight of the sampled oil}} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

2.3 Transesterification

A modified method of biodiesel reaction was employed in terms of timing, catalyst, temperature, methanol to oil ratio and a biodiesel reactor, which differed from the convectional biodiesel method by (Sokoto, 2013). One hundred (100) g of the pretreated oil was heated to 60 ^{0}C and transferred into the jerk of a master cheep blender. Twenty (20) g methanol containing potassium hydroxide 1 % w/w (1 g) of oil to form potassium methoxide was added. The stirring speed was also kept constant at 10000 rpm using a time interval of 2, 4 and 6 mins to avoid over heating the blender. Sixteen (16) g potassium methoxide solution to be initially added representing 80% and stirred for 4 min and the remaining 4 g will be added at the 4 th min representing 20% to complete the 6th min, as the reaction might be very slow at the beginning due to mixing and dispersion of alcohol into the feedstock.

2.4 Determination of Biodiesel Properties

Fuel properties of the produced Fatty Acid Methyl Esters (Biodiesel) were determined according to ASTM (1998).

2.4.1 Experimental Design for Optimization of Biodiesel Production from Seed oil of sampled cucurbits seeds

Transesterification of each of the sampled cucurbits seed oil will be optimized using the Central Composite Design (CCD) and Surface Response Model (RSM). This experimental design predicts the response (yield) and interaction among the reacting variables. A three level–three factors central composite will be adopted for the variables, consisting of 8 factorial points, 6 axial points and six replicates at the center points. The numbers of runs performed were calculated using equation 2 below.

$$\mathbf{N = 2^n + 2n + 6} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where **N** is the total number of experiments required and **n** is the number of factors. Temperature, oil methanol molar ratio and catalyst concentration were chosen as the independent variables in the experiment, each considered at two levels: low (-1) and high (+1). Table 1 lists the range and levels.

2.5 Physicochemical Properties of the Seed oil

2.5.1 Determination of the saponification value

The American Standard for Testing and Material (ASTM) method- (D 5558-95) was employed for the determination of the saponification values of the vegetable oil. The oil (5 g) was weighed into Erlenmeyer flask and 0.5 M ethanolic KOH to be prepared by dissolving 7 g of KOH in 250 cm ethanol and 25 cm3 of the prepared 0.5 M ethanolic KOH was added and the resulting mixture refluxed for 60 minutes. The resulting solution was subsequently titrated against 0.5 M HCl by diluting 10.7 cm HCl in 250 cm3 of distilled water using phenolphthalein as indicator. The resulting end points were obtained when the pink colour changed to colorless. The same procedure was used for the blank. The Saponification value (SV) was calculated using the following expression;

Saponification value (S.V.) =

$$\frac{\mathbf{5.61\,(B\text{-}S) \times M \text{ of } HCl}}{\mathbf{\text{Weight of Sample}}}$$

Where; *B* – Vol. of HCl required by blank, S – Vol. of HCl required by sample. M – Molarity of HCl, 5.61– Molar mass of KOH

2.5.2 Determination of acid value

Small quantity of the oil (0.5 g) was weighed into 250 cm3 conical flask and 50 ml of neutralized ethyl alcohol was added, prepared by neutralizing a solvent mixture of 25 cm3 5.61 (B-S) x M of HCl Weight of sample ethanol and 25 cm3 diethyl ether with 0.1M ethanolic KOH was prepared by dissolving 1.4 g KOH in 250 cm3 of ethanol using

phenolphthalein as indicator. The mixture was added to the oil and heated on a water bath to dissolve the oil. The solution was then titrated against 0.1 M KOH prepared by dissolving 1.4 g of KOH in 250 cm of distilled water using phenolphthalein as indicator. The acid value was determined after which the free fatty acid was respectively calculated using the following equations;

$$\textbf{Acid Value} = \frac{A \times Mx\ 56.10}{W}$$

Where, A = ml of 0.1M KOH consumed by sample, M = Molarity of KOH, W = weight in grams of the sample

2.5.3 Determination of iodine value

The oil (0.5 g) was weighed into conical flask and 20 cm3 of carbon tetrachloride was added to dissolve the oil. 25 cm3 of Wigs reagent was added into the flask using a measuring cylinder in a fume chamber and a stopper was inserted, the content of the flask was vigorously swirled and kept in the dark for 35 minutes. 20 cm of 10 % aqueous potassium iodide was prepared by diluting 10 cm3 of potassium iodide in 90 cm3 of distilled water was added into the content of the flask using a measuring cylinder. The content was titrated with 0.1 M sodium thio-sulphate solution prepared by dissolving 3.95 g of anhydrous $Na_2S_2O_3$ in 250 cm3 of distilled water. Few drops of 1 % starch indicator were added and the titration continued by adding the sodium thio-sulphate drop wise until coloration disappeared after vigorously shaken. The same procedure was used for the blank test. The Iodine Value (I.V) is given by the expression;

$$\textbf{Iodine Value (I.V)} = \frac{126.9\ C\ (V1 - V2)}{M}$$

Where, C = concentration of sodium thiosulphate, V1 = volume of sodium thiosulphate used for blank, V2 = volume of sodium thiosulphate used, M = mass of sample while 12.69= Constant.

2.5.4 Determination of specific gravity

Specific gravity bottles were washed, rinsed with acetone and dried at room temperature in a desiccator and the weights of the empty bottles determined using an electronic weighing balance. The weight of the bottle filled with water was also recorded. The same procedure was repeated with the oil and the specific gravity computed as follows;

$$\text{Specific gravity} = \frac{W2 - W1}{W3 - W1}$$

Where: W1 = weight of empty bottle, W2 = eight of bottle + oil, W3 = weight of bottle + water

2.6.1 Gas Chromatography-Mass Spectrophotometry (GC-MS) analysis

GC-MS analysis was carried out using Gas chromatograph interfaced to a mass spectrometer GC-MS—QP 2010 Plus Shimadzu system (GC-MS) employing the following conditions: Colum Ellite-1 fused silica capillary column (30 m x 0.25 mm 1D x µl df, composed of 100% dimethyl polyslloxame). For GC-MS detection, an electron ionization system with ionization energy of 70 e V was used. Helium gas (99.99%) was used as the carrier gas at constant flow rate of 1 ml/minute and an injection volume of 2 µl was employed (split ratio of 10:1) injector temperature -250^0 C; ion-source temperature 280^0 C. The oven temperature was programmed from 110^0 C (Isothermal for 2 min) with an increase of 10^0 C/min to 200^0 C then 5^0 C /min to 280^0 C/min, ending with a 9 min isothermal at 280^0 C. Mass spectra were taken at 70 eV; a scan interval of 0.5 s and fragments from 40 to 550 Da. Total GC running time was 36 min. The relative percentage amount each component was calculated by comparing its average peak area to the total areas. Software adopted to handle mass spectra chromatogram was a turbo mass (Olujuyigbe *et al*., 2019).

2.6.2 Identification of compounds

The mass spectrum of GC-MS was interpreted using the database of National Institute of Standard and Technology (NIST) having more than 62,000 patterns by comparing the mass spectrum of the unknown components with those of the known elements stored in the (NIST) library. The name, molecular mass and the chemical structure of the test material were ascertained (Olujuyigbe *et al*., 2019).

2.7 Statistical Analysis

Treatments were replicated three times and the data obtained has been presented as means± S.E. of the means. Results obtained were subjected to one way Analysis of Variance (ANOVA). Same

superscripts means that there was no significant difference (P≤0.05) and where the superscripts differ, it means that there was a significant difference (P≤0.05).

3.0 RESULTS

Results of Seeds oil percentages as well as some physicochemical properties of the oil of three Nigerian cucurbits germplasm have been presented in the Table 1.

Table 1: Oil yield (%) as well as some physicochemical properties of the oil of three cucurbits species

Parameters	*Cucurbita pepo*	*Cucumeropsis mannii*	*Lagenaria breviflora*
1. Oil yield (%)	44.92±0.98[a]	53.88±2.23[b]	51.43±1.20[b]
2. Moisture (%)	1.60±0.09[a]	1.40±0.34[a]	2.00±0.45[a]
3. Acid value (mg/KOH)	37.03±0.78[a]	27.95±0.68[b]	33.10±0.74[a]
4. Saponification value (mg KOH/g)	36.52±0.97[a]	40.93±1.21[b]	41.78±1.26[b]
5. Kinematic viscosity (mm^2/s)	0.75±0.04[a]	0.69±0.06[a]	0.71±0.07[b]
6. Iodine value (g l_2 /100 g oil)	112.94±2.64[a]	120.05±3.00[b]	104.06±1.78[c]
7. Specific gravity	0.91±0.09[a]	0.92±0.09[a]	0.90±0.09[a]
8. Cetane number	47.00±1.45[a]	46.00±1.00[a]	47.00±0.87[a]
9. Oil colour	Light Yellow	Yellow	Dark Brown

GC-MS Analysis of the Seed Oil of three Cucurbits Germplasm

Results of GC-MS analysis of the seed oil of three cucurbits germplasm have been presented in Tables 2-4 below. The Tables present results on retention time, names of compounds, chemical formulae, molecular weights, types of fatty acids as well as the respective peak are percent of each of the compounds.

Table 2. Results GC-MS analysis of the seed oil of *Cucurbita pepo*

Peak No.	Ret. Time	Name of Compound	Chemical Formula	Molar Mass	Peak Area (%)
1.	38.92	Oleic acid/6-Octadecenoic acid	$C_{18}H_{34}O_2$	282.65 g/mol	21.76
2.	43.69	9, 12-Octadecadienoic acid	$C_{18}H_{32}O_2$	280.43 g/mol	12.52
3.	44.44	9-Heptadecatriene/5-Dodecyne	$C_{17}H_{30}$	234.40 g/mol	8.34
4.	49.66	Squalene	$C_{30}H_{50}$	410.73 g/mol	57.37

Table 3. Results GC-MS analysis of the seed oil of *Cucumeropsis mannii*

Peak No.	Ret. Time	Name of Compound	Chemical Formula	Molar Mass	Peak Area (%)
1.	43.69	1, 8, 11-Heptadecatriene	$C_{16}H_{32}O_2$	258.40 g/mol	12.24
2.	44.43	10, 13-Octadecanoic acid methyl ester	$C_{19}H_{34}O_2$	294.55 g/mol	0.87
3.	38.28	9-Octadecenoic acid methyl ester	$C_{19}H_{36}O_2$	296.50 g/mol	2.00
4.	39.02	Linoelaidic	$C_{18}H_{32}O_2$	280.45 g/mol	27.63
5.	39.13	Oleic acid	$C_{18}H_{34}O_2$	282.47 g/mol	40.95

Table 3. Results GC-MS analysis of the seed oil of *Lagenaria breviflora*

Peak No.	Ret. Time	Name of Compound	Chemical Formula	Molar Mass	Peak Area (%)
1.	35.72	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	256.40 g/mol	11.86
2.	38.97	Conjugated Linoleic acid	$C_{18}H_{32}O_2$	294.55 g/mol	53.07
3.	39.03	Linolaidic acid	$C_{19}H_{34}O_2$	282.46 g/mol	18.67
4.	39.38	9, 12-Octadecadienoic acid	$C_{18}H_{32}O_2$	280.40 g/mol	2.53
5.	43.69	2-Hydroxy-1-(hydroxyl methyl) ethyl ester 43.29	$C_{19}H_{38}O_4$	330.50 g/mol	0.37
6.	44.44	9-Heptadecatriene/5-Dodecyne	$C_{17}H_{30}$	234.40 g/mol	8.34
8.	44.45	Tetradec-13-en-11-yn-1-ol	$C_{14}H_{24}O_2$	208.34 g/mol	0.31
9.	49.65	Squalene	$C_{30}H_{50}$	410.73 g/mol	3.02
8.	52.62	gamma-Tocopherol	$C_{18}H_{48}O_2$	416.60 g/mol	1.38

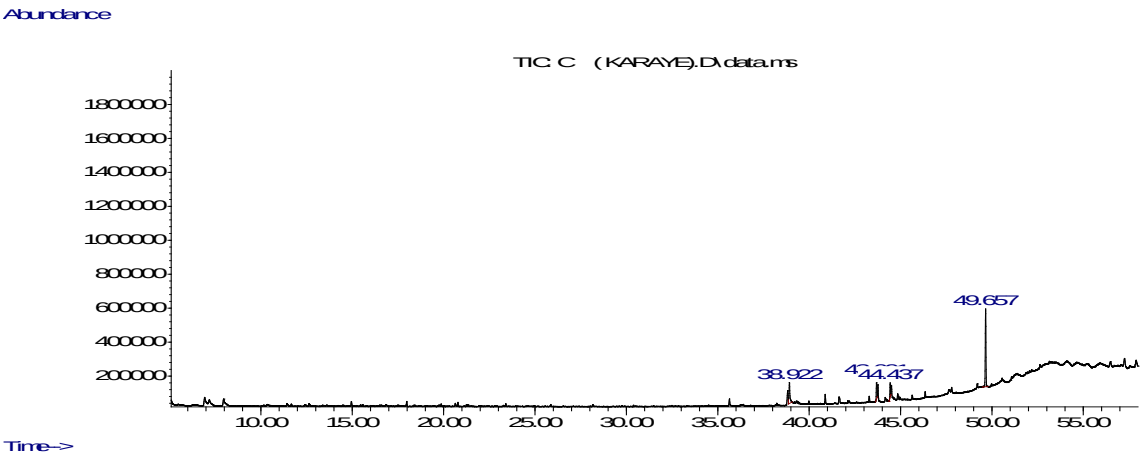

Figure 3: Chromatogram from GC-MS analysis of *Cucurbita pepo*

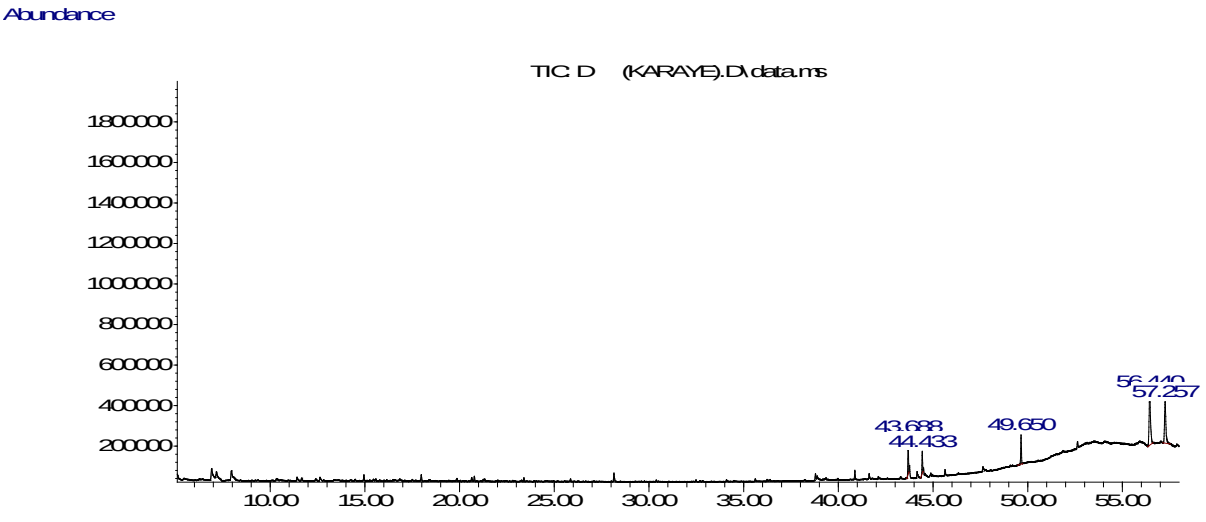

Figure 4: Chromatogram from GC-MS analysis of *Cucumeropsis mannii*

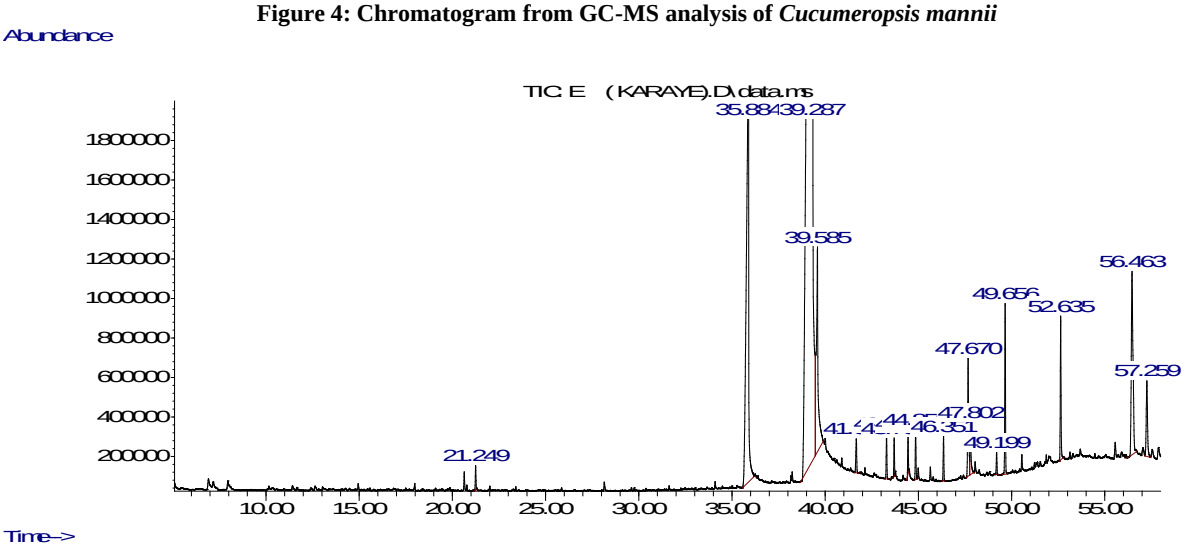

Figure 6: Chromatogram from GC-MS analysis of *Lagenaria breviflora*

4.0 DISCUSSION

From the results above, range of oil yield was (44.92-53.88%) with the highest for the seeds of *C. mannii* (53.88%). *L. breviflora* had (51.43%) while the least value (44.92%) was obtained for the seeds of *C. pepo*. Thus, taking into consideration the percentage yields of the three species, it can hold that species of Cucurbitaceae could be regarded as novel that are quite promising as veritable tools in the quest to satisfy the need for alternative fuel. This is specifically as it relates to the quest for biodiesel production to power human drive of development. In another report by Wara (2015)[a], percentage yield was 42.23% for castor seed, a higher value than 19.23% for *Ipomea* seed oil as reported by Wara (2015)[b]. Similarly, obtained results in the current study could be considered to be within the narrow range of 44.85% for *Lagenaria siceraria* as reported by Fokou *et al*. (2009) and 45% as reported by Chimonyo and Modi (2013). Also, within the range of the reported 44.85% on *Cucurbita pepo* by Cynthia *et al*. (2012). In another study by Karaye *et al*. (2020), percentage oil yields of 48.4% and 58.6% were reported for Watermelon (*Citrullus lanatus*) and Sesame (*Sesamum indicum*) seeds respectively. Also, the range of the reported values (42%) by Essien *et al*. (2013). The yields can be considered very good when compared with the known vegetable oils of plant origin such as those of cotton seeds (18%) as reported by Akbar *et al*. (2009), *Chrysophyllum albidum* (15%) as reported by Adeola *et al*. (2012), Shea butter (16.85%) as reported by Umar *et al*. (2013), soy bean (34%) as reported by Kyari (2008), mango (7.42%) as reported by Sam *et al*. (2018) and (13%) as reported by Nzikou *et al*. (2011) for Shea butter. However, yields obtained in the current study are low if compared with the reported (64.4%) by Wara *et al*. (2015)[b] and (58.6%) for sesame seeds as reported by Karaye *et al*. (2020).

Also, considerably lower than (182.4) mg KOH/g as reported by Orhevba *et al*. (2016) for tropical almond. Similarly, obtained saponification values in the current study were in close agreement with reported values by Eze, (2012) on pumpkin seeds as (44.88) mg/g but lower than the reported (151) mg/g and (163) mg/g by Karaye *et al*. (2020) for the seeds of sesame and watermelon respectively. In another report, higher saponification values were reported to be (189.8), (210.8), (214.2), (182.6) and (227.6) mg of (KOH/g of oil) respectively as reported by Hassan *et al*. (2020). Also, higher values of saponification values were reported (148) mg of (KOH/g of oil) for *Arachis hypogeal*, 112 mg of (KOH/g of oil) for *Cucumis melo*; *Cucurbita pepo* 65.92 mg of (KOH/g of oil) as reported by Cynthia *et al*. (2012) than obtained in the current study.

However, iodine contents obtained in the current study were in agreement with the reported range of 89.46-150 g/100 g for the seeds of some cucurbits as reported by Cynthia *et al*. (2012). The higher the saponification numbers of the oil the more soluble the soap that can be made from it (Alyas *et al*., 2006). Results obtained in the current study were in close range with that reported by the same author as 0.3-0.81 (mm^2/s). According to the Kyriakidis and Katsiloulis (2000) method, the iodine value of oil blends ranged from 99.12 to 103.82. The high iodine value is due to its high content of unsaturated fatty acids. This indicates that the seed oil has good edible and drying oil qualities (Eromosele *et al*., 1997). Acid value measures the extent to which glycerides in the oil is being decomposed by the lipase and other physical factors such as light and heat. Higher Acid value is an indication that the contents of free fatty acids in the oil sample. An important factor that influences shelf life of the oil (Alhassan *et al*., 2015; Predojective., 2008). The acid value obtained in the current study were found to be lower than 5.21 KOH/g as reported by Aremu *et al*., 2010. Viscosity is another important property of biodiesel since it affects the operation of fuel ingestion equipment particularly of low temperature when the increase in viscosity affects the fluidity of the fuel a leakage of high temperature when too thin (Bello and Agge, 2012). Therefore, the viscosity of the biodiesel must be nearly same to that of the diesel fuel (Sanyeti, 2013). Oils with low viscosity values indicate that they are highly thus probably highly unsaturated. The high value may be due to the presence of high suspended particles seemingly present in the crude oil sample

(Nambes, *et al*., 2013). Analysis of moisture content indicates that the moisture contents in all the samples ranged from (1.60-2.21%) with highest 2.21% in the seeds of *C. lanatus* while the least (1.60%) was obtained in the seeds of *C. pepo.* Moisture values obtained in the current study were lower as reported for gourd seeds by Ogulede and Oshodi, 2010). Similarly, lower than those reported for pumpkin seeds (5.02%) by Fagbemi and Oshodi, 1991 and shelled lima beans as (4.42%) by Oyenuga 1968). Total of four compounds have been identified to be present in *Cucurbita pepo* with oleic acid and 9, 12-Octadecanoic acid being the major. In *Cucumeropsis mannii*, five compounds have been identified with 1, 8, 11-Heptadecatriene, 10, 13-Octadecanoic acid methyl ester, Linoelaidic acid and Oleic acid being present. In *Lagenaria breviflora*, eight compounds have been found to be present. n-Hexadecanoic acid, Conjugated Linolaidic acid, 9, 12-Octadecadienoic acid and 2-Hydroxy-1-(hydroxyl methyl) ethyl ester. Others were 9-Heptadectriene, conjugated linoleic acid is described as a group of fatty acids with 18 atoms of carbon, and the geometric isomers consists of linoleic acid (Martins *et al*., 2015). Conjugated linoleic acid has a role in lipid metabolism, especially as regards the oxidative cellular system, which explains many physiological properties of fatty acids (Tatiana *et al*., 2015)

Squalene, Tetradec-13-en-11-yn-1-ol and gamma-Tocopherol. Linolaidic acid is an omega of 6 trans fatty acid (TFA) and is a geometric isomer of linoleic acid. Found in partially as hydrogenated vegetables oils as a colourless (white) fat, viscous liquid (Nasaruddeen *et al*., 2013). Oleic acid has synonyms as 9-Octadecenoic acid. A light yellow transparent oily liquid at normal temperature. Melting point is 13.4 insoluble in water but soluble in organic solvents such as ethanol and gasoline. It turns into stearic acid during hydrogenation and it has the general chemical properties of organic carboxylic acids and unsaturated double of the bond. Squalene is also a linear triterpene synthesized in plants, animals, bacteria and fungi as a precursor for the synthesis of secondary metabolites such as sterols, hormones, or vitamins. It serves as a carbon source in the aerobic and anaerobic fermentations of microorganisms (Rohmer *et al*., 1996; Ghimite *et al*., 2016). Gamma Tocopherol is one of the four vitamin E components (alpha, beta, delta and gamma-tocopherol). While extensive literature has been published on the potential health benefits of alpha-tocopherol, quite little is known about gamma-tocopherol, one of the major forms of vitamin E in foods. Conjugated linoleic acid is another vital dietary supplement known for its supposed anti-cancer benefits (Ochoa *et al*., 2004) and as a body building aid (Talbot and Hugleb, 2007). Squalene is a linear triterpene synthesized by the plants, animals, fungi and bacteria and it serves as a precursor for the synthesis of secondary metabolites such as sterols, hormones or vitamins. It is a carbon source in the aerobic and anaerobic fermentation of microorganisms (Rohmer *et al*., 1996; Ghimite *et al*., 2006).

5.0 CONCLUSION

Cucurbits look quite promising in the finding solution to the ever-increasing desire for alternative fuel. Looking at the appreciable quantity of seed fuel as well as the fuel quality of the studied cucurbits, it can be ascertained that cucurbits could stand as an alternative source of fuel needed to provide succor to demands for fossil fuel. This is equally by the numerous valuable compounds that could be used industrially to better the lots of humanity.

6.0 ACKNOWLEDGEMENT

The first author wishes to acknowledge and appreciate the Management of Usmanu Danfodiyo University, Sokoto and Tertiary Education Trust Fund (TETFUND) Nigeria for study fellowship and financial support.

7.0 CONFLICT OF INTEREST

Authors hereby declare that there is no competing interest of any sort among them

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