

## Quantification and Analysis of the seed oil of three Nigerian Cucurbits

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### ABSTRACT

Extraction and quantification of the percentage oil yield of the seed of three Nigerian Cucurbits was performed using standard biochemical procedures. Analysis of the physicochemical properties of the seed oil and the GC-MS analysis of the seed oil were carried out with the oil extraction done using n-hexane as the solvent of extraction. Percentage seed oil obtained were subjected to study of Physico-chemical properties and the results indicated, highest percentage oil yield was for *Lagenaria siceraria* with (59.66±2.21) which was followed by (51.35±2.04) obtained for *Citrullus lanatus* while the least (45.93±1.54) was obtained for *Cucurbita maxima*. Moisture contents were evaluated with (2.21±0.58) in *Citrullus lanatus*, (2.03±0.53) was obtained in *Cucurbita maxima* while *Lagenaria siceraria* had (1.98±0.51) respectively. Analysis for acid value revealed (35.17±1.38) to (37.44±1.19) with the least value was obtained in *Citrullus lanatus* while *Cucurbita maxima* had (37.44±1.29) and *Lagenaria siceraria* had (36.47±1.24). Saponification value was evaluated with the range of values from (31.80±1.23) to (39.60±1.86) with the highest value for *Lagenaria siceraria*; *Citrullus lanatus* had least value and *Cucurbita maxima* had (34.23±1.30). Analysis for the oils' kinematic viscosity revealed the range of values from (0.76±0.07) to (0.92±0.09) with the highest in *Lagenaria siceraria* while the least value was in *Cucurbita maxima*. Iodine value was determined and the highest value (125.18±3.15) obtained in *Lagenaria siceraria* while the least (105.58±2.93) was obtained in *Cucurbita maxima*, and (119.74±2.98) was obtained in *Citrullus lanatus*. Specific gravity was determined and the following results were obtained, (0.87±0.06) was the least value found in *Cucurbita maxima*, (0.89±0.12) was found in *Citrullus lanatus* while the highest value (0.93±0.18) was identified in *Lagenaria siceraria*. For Cetane number evaluation, results obtained indicated that (38.00±1.23) was obtained in *Citrullus lanatus*; *Lagenaria siceraria* had the highest (46.00±1.12) while *Cucurbita maxima* had (42.00±1.44). Oil colour was determined and the results indicated the colour range from yellow (Y), golden yellow (GY) and pale yellow (PY) for *Citrullus lanatus*, *Cucurbita maxima*, *Lagenaria siceraria* respectively. State of the fuels at room temperature was determined and the results indicated that the three were all liquid at room temperature. There was significant difference ( $P \leq 0.05$ ) in the percentage oil yield, iodine value, saponification value, and Cetane number among the studied species. Gas Chromatography Mass Spectrometry (GC-MS) analysis of the seed oils revealed the composition of the various compounds with numerous potent applications. In *Citrullus lanatus*, seven compounds have been isolated with predominant ones as polyunsaturated and saturated fatty acids. Squalene, 9, 12-Octadecadienoic acid, and 2-Hydroxy-1-droxyhyl methyl ethyl ester, gamma-Tocopherol, 2, 6, 10, 14-Tetramethyl (-7-3methyl) and 17-Pentatriacotane. For *Cucurbita maxima* seeds, fourteen compounds have been isolated with n-Hexadecanoic acid, 10, 13-Octadecanoic acid methyl ester and 9-Octadecenoic acid methyl ester as the predominant ones. Others include Linoelaidic acid, oleic acid, Cis-Vaccenic acid, Heptadecane and Tetracosane. 1, 8, 11-Heptadecatriene, 9-Octadecenoic acid, n-Propyl 9, 12 Octadecadienoate, Glacidyl 9-nonadecenoate, Pentacosane and Heptadecane. In *Lagenaria siceraria*, eight compounds have been isolated and they include n-Hexadecanoic acid, conjugated linoleic acid, 9, 12-Octadecadienoic acid with others being 1, 3, 12-Nonadecatriene, Linolaidic acid, Squalene as well as gamma-tocopherol. Looking at the appreciable quantities of the seed oils as well as their fuel qualities, it can be ascertained that cucurbits seeds look quite promising in the quest for alternative fuels to fuel human developmental strategies in a near future. This is in addition to other valuable compounds laden in the studied species.

**Keywords:** Alternative-fuel, Cucurbits, Fuel-qualities, n-Hexane, Saponification, Specific gravity.

### 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 is diesel fuel derived from animal or plant lipids (Demirbas, 2007). It is defined as a biofuel consisting of mono alkyl esters that are derived from organic oils of plant or animal fat through the process of transesterification. The most common biofuels are biodiesel and bioethanol which can replace diesel and gasoline respectively in today's cars with or no modification of vehicle engines (Mata *et al.*, 2010). Biodiesel stands to be the key promising renewable energy options already exploited by various developed countries. Categories of feedstock as source of suitable oil for biodiesel production include seeds, nuts,

leaves, wood, and even bark of some good number of trees. Nigeria is very well endowed with various edible and non-edible oils (Cynthia *et al.*, 2012). Biodiesel fuel 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<sub>2</sub> 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). Biofuel is biodegradable, non-

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toxic as has low emission profile as compared to petroleum diesel (Hossain *et al.*, 2008). Complementing biodiesel petroleum diesel result in substantial reduction of sooth, sulphur, unburned hydrocarbons and polycyclic aromatic hydrocarbon emission (Aresta *et al.*, 2005; Rakopoulos *et al.*, 2006; Demirbas *et al.*, 2007).

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). Thus, the vegetable oil can be used as fuel for combustion engines. According to the United States Energy Information Administration (United States Energy Information Administration, 2015), most Nigerians especially the rural dwellers use biomass waste from wood, charcoal, and animal dung to meet their energy needs. In spite of this, the Food and Agricultural Organization (FAO) statistics on crop production shows Nigeria is among the top producing countries for the promising energy crops (FAO, 2009). Major energy crops with high biofuel yield for feedstock include sugar cane, sugar beet, maize, wheat, rapeseed, palm oil, *Jatropha*, switch grass and willow (FAO, 2008). In all these crops, Nigeria is a major producer of maize, palm oil, *Jatropha*, Cassava, and ground nuts. Biodiesel production from vegetable oil is based on transesterification of vegetable oil through the addition of methanol (or other alcohol) and a catalyst, giving glycerol as a co-product. Advanced process includes the replacement of methanol of fossil origin, by bioethanol to produce fatty acids ethyl ester instead of fatty acid methyl ester (Idris, 2020).

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 (including Nigeria). It is the family of economically important species of which the fruits are used for nutrition and medicinal purposes (Jeffrey, 1990). Members of the Cucurbitaceae are known to be very useful, serving as food, ornamental purposes, utensils and fuel (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).

## MATERIALS AND METHODS

### Samples Collection and Preparation

Fresh fruits of *Citrullus lanatus* and *Cucurbita maxima* were purchased at Kasuwan Daji market within the Sokoto municipal. Ripe and fully grown fruits of *Lagenaria siceraria* were obtained from Gummi market, Zamfara state, Nigeria. The three samples were taken to the Department of Biological Sciences Herbarium, Usmanu Danfodiyo University, Sokoto for authentication by a taxonomist where voucher specimens were also deposited. Seeds were manually removed from the fruits by cutting the individual fruit longitudinally and scrapping out the seeds using cleaned knife immature seeds were removed from the fully ripe ones. The seeds were dried to a constant weight in an oven maintained at 70°C. The seeds were separately ground using mechanical blender, placed in three air-tight containers and stored in desiccators for further analysis.

### Extraction of the Cucurbits Seed Oil

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 cm<sup>3</sup>) and anti-bumping chips are to be put into 1000 cm<sup>3</sup> round bottomed flask and heated on heating mantle at 60 °C. The extraction will be allowed to continue for one hour (1 hr). The above process will be repeated to get means of percentage extraction and enough oil for further analyses as reported by Ajibola *et al.* (2018).

$$\text{Biodiesel yield (\%)} = \frac{\text{weight of the biodiesel}}{\text{weight of the sample}} \times 100$$

### Transesterification

A modified method of biodiesel reaction was employed in terms of timing, catalyst, temperature, methanol to oil ratio and a biodiesel reactor, which differs from the convectional biodiesel method by Sokoto (2013).

### Determination of Biodiesel Properties

Fuel properties of the produced Fatty Acid Methyl Esters (Biodiesel) were determined according to ASTM (1999 and 2001) and EN 14214 (2003) standard methods. Kinematic viscosity was also measured according to ASTM D 445 method.

### Analyses of the Transesterified Products using GC-MS

GC-MS was used to quantify the fatty acids methyl esters (FAMES) mixture from the produced biodiesel using a QP-2010 model GC-MS machine. Two microlitres (2 µl) of the produced biodiesel sample were injected into the gas chromatograph at injection temperature of 250 °C. The column oven temperature was programmed between 60-280 °C at 5 °C/min; hold 5 min at 280 °C. The acquired chromatograph was scanned and the components identified based on software matching with mass spectra.

### Physicochemical Properties of the Seed oil

Determination of the saponification value, acid value, iodine value, specific gravity, cetane number, oil colour were all determined using the American Standard for Testing and Material (ASTM) method- (D 5558-95) and by ASTM method (ASTM – D 974(00)), while the oil physical state at room temperature was estimated by sensory evaluation.

**Gas Chromatography-Mass Spectrophotometry (GC-MS)****Analysis**

The GC-MS analysis was carried out at the Central laboratory, Usmanu Danfodiyo University, Sokoto-Nigeria. It was carried out using Gas chromatograph interfaced to a mass spectrometer GC-MS—QP 2010 Plus Shimadzu system (Olujuyigbe *et al.*, 2019).

**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).

**Data Analysis**

Treatments were replicated three times and results have been presented as means  $\pm$  S.D. of the values. The results obtained were subjected to one way Analysis of Variance (ANOVA). Same superscripts means that there was no significant difference ( $P \leq 0.05$ ) and where the superscripts differ, it means that there was a significant difference ( $P \leq 0.05$ ).

**RESULTS AND DISCUSSION**

Results of physicochemical properties of the oil of three Nigerian cucurbits are presented in Table 1. Percentage oil yields of studied samples indicated that appreciable contents of the oil yields was recorded for each of the three species with the highest in *Lagenaria siceraria* (59.66 $\pm$ 2.21%) *Citrullus lanatus* had (50.88 $\pm$ 2.34 %) while the least value (48.93 $\pm$ 2.00 %) was for *Cucurbita maxima*. Percentage moisture was determined and the results indicated the range of values between (1.98 $\pm$ 0.23) to (2.21 $\pm$ 0.43) with the highest in *Citrullus lanatus* while the least value was obtained in *Lagenaria siceraria*, in *Cucurbita maxima*, (2.03 $\pm$ 0.38) was evaluated. Acid value was determined with (35.17 $\pm$ 1.08) in *Citrullus lanatus*, (36.47 $\pm$ 1.19) in *Lagenaria siceraria* while (37.44 $\pm$ 1.19) was identified in *Cucurbita maxima*. Saponification value of the seed oils was evaluated with the range of values from (32.80 $\pm$ 1.23) obtained in the seeds of *Citrullus lanatus* while (36.47 $\pm$ 1.49) was identified in *Lagenaria siceraria*, however, the highest saponification values was obtained in the seeds of *Cucurbita maxima*. Kinematic viscosity was evaluated with (0.76 $\pm$ 0.28) obtained in *Cucurbita maxima*, (0.89 $\pm$ 0.06) obtained in *Citrullus lanatus* while the highest value (0.92 $\pm$ 0.78) was obtained in *Lagenaria siceraria*. Iodine value was determined with the range of values as (105.58 $\pm$ 3.00) obtained in *Cucurbita maxima*, (119.74 $\pm$ 3.37) obtained in *Citrullus lanatus* while the highest value (125.18 $\pm$ 3.45) obtained in the seeds of *Lagenaria siceraria*.

**Table 1:** Yield (%) and Some Physicochemical Properties of the Seed Oils of three Nigerian Cucurbits

Parameters	<i>Citrullus lanatus</i>	<i>Cucurbita maxima</i>	<i>Lagenaria siceraria</i>
Oil yield (%)	51.35 $\pm$ 2.04 <sup>a</sup>	45.93 $\pm$ 1.54 <sup>b</sup>	59.66 $\pm$ 2.21 <sup>c</sup>
Moisture (%)	2.21 $\pm$ 0.58 <sup>a</sup>	2.03 $\pm$ 0.53 <sup>a</sup>	01.98 $\pm$ 0.43 <sup>a</sup>
Acid value (mg/KOH)	35.17 $\pm$ 1.38 <sup>a</sup>	37.44 $\pm$ 1.29 <sup>a</sup>	36.47 $\pm$ 1.24 <sup>a</sup>
Saponification value (mg KOH/g)	31.80 $\pm$ 1.23 <sup>a</sup>	34.23 $\pm$ 1.30 <sup>a</sup>	39.60 $\pm$ 1.86 <sup>b</sup>
Kinematic viscosity (mm <sup>2</sup> /s)	0.89 $\pm$ 0.07 <sup>a</sup>	0.76 $\pm$ 0.07 <sup>a</sup>	0.92 $\pm$ 0.09 <sup>a</sup>
Iodine value (g I <sub>2</sub> /100 g oil)	119.74 $\pm$ 2.98 <sup>a</sup>	105.58 $\pm$ 2.93 <sup>b</sup>	125.18 $\pm$ 3.15 <sup>c</sup>
Specific gravity	0.89 $\pm$ 0.12 <sup>a</sup>	0.87 $\pm$ 0.06 <sup>a</sup>	0.93 $\pm$ 0.18 <sup>a</sup>
Cetane number	38.00 $\pm$ 1.23 <sup>a</sup>	42.00 $\pm$ 1.44 <sup>a</sup>	46.00 $\pm$ 1.12 <sup>b</sup>
Oil colour	Yellow	Golden yellow	Pale yellow

Results have been presented as means  $\pm$  S.D. of the means. The results obtained were subjected to one way Analysis of Variance (ANOVA). Same superscripts means that there was no significant difference ( $P \leq 0.05$ ) and where the superscripts differ, it means that there was a significant difference ( $P \leq 0.05$ ).

Specific gravity of the oils ranged from (0.79  $\pm$ 0.06) to (0.93 $\pm$ 0.08) with the least value obtained in *Citrullus lanatus* while the highest was obtained in *Cucurbita maxima*. *Lagenaria siceraria* had (0.89 $\pm$ 0.07). For Cetane number evaluation, range of values obtained was (38.00 $\pm$ 1.23) to (46.00 $\pm$ 1.12) with the least value obtained in *Citrullus lanatus* while highest value obtained in *Lagenaria siceraria*, *Cucurbita maxima* had (45.00 $\pm$ 1.44). There is significant difference ( $P \geq 0.05$ ) in the oil yield and saponification value, iodine value and cetane number. For oil colour, the colour of the oil was yellow to golden yellow and brown for *Citrullus lanatus*, *Cucurbita maxima* and *Lagenaria siceraria* respectively. The obtained seed color in the current study was in conformity with the reported yellow, dark brown and light yellow colors of *C. pepo*, *L. cylindrica* and *C. melo* respectively as reported by Hassan *et al.* (2020). 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 a 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) and (58.6%) for sesame seeds as reported by Karaye *et al.* (2020).

Seed oil obtained in the current study were however higher than that reported by Sokoto *et al.* (2013) on *Lagenaria*

*vulgaris* as (36.7±0.15). 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) and that reported by Cynthia *et al.* (2012) with 44.85% on *Cucurbita pepo*. In a 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 and the reported value of 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)<sup>b</sup> and (58.6%) for sesame seeds as reported by Karaye *et al.* (2020). Also, the yield obtained in the current study is a bit higher than (45.16) as reported on *Lagenaria siceraria* by Hassan and Sani (2006). More so, specific gravity reported by the same author (0.89) compares favorably with the range of values obtained in the current study. Iodine value was however higher than that as reported to be (14.86±0.04) by same author. According to a reported by Hassan and Sani (2006), iodine values of (96.6) and (103.62) for locally and Soxhlet extracted *Lagenaria siceraria* seeds were lower than obtained in the current study. In another study by Cynthia *et al.* (2012), higher saponification

values were reported on *C. pepo*, *L. cylindrica* and *C. melo* as (162.69), (65.92) and (148.67) respectively. Kinematic viscosity as obtained in the current study was however in close agreement with the report of the same authors on *C. pepo*, *L. cylindrica* and *C. melo*. In another report by Karim *et al.* (2014), higher cetane numbers were reported on locally sourced sesame, corn flour and sunflower seeds (69.30, 74.80 and 69.2) respectively. Higher iodine values were reported by Cynthia *et al.* (2012) on *C. pepo* (150.47) and (135.36) for *C. melo* respectively. In the same report, physical state of the oils of *C. pepo*, *L. cylindrica* and *C. melo* have been reported to be liquid which compares favourably with the finding in the current study. Acid value in diesel determines the level of free fatty acids or processing acids that may be present in biodiesel and it is an indicator of biodiesel quality (Schinas *et al.*, 2009). Viscosity is the most important property of biodiesel since it affects the operation of fuel injection equipment, particularly at low temperatures when the increase in viscosity affects the fluidity of the fuel. High viscosity leads to power atomization of the fuel spray and less accurate operation of the fuel injections (Karim *et al.*, 2014).

### Results of GC-MS Analysis of the Seed Oil of three Nigerian Cucurbits

Results of GC-MS analysis of the seed oil of three cucurbits germplasm have been presented in Table 2. The Table present retention time, names of compounds, chemical formulae, molecular weights, as well as the respective peak area percent of the compounds.

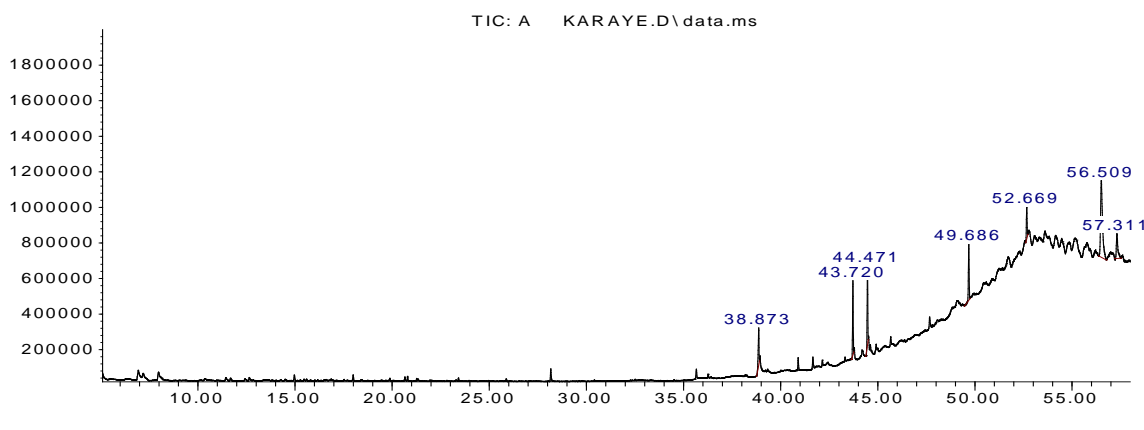
**Table 2:** Oil of seeds of three Nigerian Cucurbitaceae members showing the respective Retention Time (Min), Names of Compounds, Chemical Formulae, Molecular Weight (g/mol) and Peak (%) across the species

Rt (Min)	Names of Compounds	Chemical Formula	Molecular Weight (g/mol)	<i>C. lanatus</i>	<i>C. maxima</i>	<i>L. siceraria</i>
35.17	n-Hexadecanoic/palmitic acid	C <sub>16</sub> H <sub>32</sub> O <sub>2</sub>	258.40	---	10.28	11.86
38.17	10,13-Octadecanoic acid methyl ester	C <sub>19</sub> H <sub>34</sub> O <sub>2</sub>	294.55	---	0.87	---
38.28	9-Octadecanoic acid methyl ester	C <sub>19</sub> H <sub>36</sub> O <sub>2</sub>	296.50	---	2.00	---
38.87	9, 11-Octadecadienoic acid	C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>	280.40	7.52	---	18.63
38.96	Conjugated linoleic acid	C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>	294.55	---	---	53.07
39.02	Linoelaidic acid	C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>	280.45	---	27.63	3.42
39.03	9,12 Octadecadienoic acid	C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>	322.50	---	---	18.67
39.13	Oleic acid	C <sub>19</sub> H <sub>34</sub> O <sub>2</sub>	282.47	---	40.95	---
39.38	Octadecanoic acid	C <sub>18</sub> H <sub>32</sub> O <sub>2</sub>	410.73	---	---	2.53
39.43	Cis-Vaccenic acid	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	282.46	---	6.93	---
41.68	Heptadecane	C <sub>17</sub> H <sub>36</sub>	240.47	---	1.49	---
43.30	Tetracosane	C <sub>24</sub> H <sub>50</sub>	338.65	---	1.10	---
43.69	1,3,12-Nonadecatriene	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	416.60	---	---	2.65
43.72	2-Hydroxy-1-(hydroxyl-methyl) ethyl ester	C <sub>19</sub> H <sub>38</sub> O <sub>4</sub>	330.50	0.87	---	---
43.78	9-Octadecenoic acid	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	282.50	---	1.43	---
44.45	n-Propyl 9,12-Octadecadienoate	C <sub>21</sub> H <sub>38</sub> O <sub>2</sub>	322.50	---	1.13	---
44.47	1,8, 11-Heptadecatriene	C <sub>21</sub> H <sub>38</sub> O <sub>2</sub>	322.50	13.32	1.10	---
44.52	Glacidyl 9-nonadecenoate	C <sub>21</sub> H <sub>38</sub> O <sub>3</sub>	338.50	---	1.97	---
49.69	Squalene	C <sub>30</sub> H <sub>50</sub>	410.73	10.97	---	3.02
44.86	Pentacosane	C <sub>27</sub> H <sub>52</sub>	352.69	---	1.64	---
46.36	Tetratetracontane	C <sub>28</sub> H <sub>56</sub>	338.65	---	1.47	---
52.70	Gamma-Tocopherol	C <sub>28</sub> H <sub>48</sub> O <sub>2</sub>	416.60	6.02	---	1.38
56.51	2,6,10,14- Tetra methyl (-7-(3-methylpent-4-enylidene) Pentadecane	C <sub>19</sub> H <sub>34</sub> O <sub>2</sub>	452.70	39.56	---	---
57.31	17- Pentatriacotane	C <sub>35</sub> H <sub>70</sub>	490.90	39.56	---	---

Gas Chromatography Mass Spectrometry (GC-MS) analysis of the seed oils revealed the following composition of the various compounds with various applications. In *Citrullus lanatus*, seven compounds have been identified with predominant ones being polyunsaturated and saturated fatty acids. Gamma-tocopherol, Squalene, 2,6,10, 14-Tetramethyl (7-3-Methyl), and 17-pentatriacotane as the major ones, while 9, 12 Octadecadienic acid, 2-Hydroxy-1-(hydroxyl methyl) ethyl ester, 1,8,11 Heptadecatriene as the less abundant compounds. Squalene has been demonstrated to improve physiological and biological activity in human health (Moreau *et al.*, 2018). Squalene has some favourable health benefits such as cancer inhibition, antitumor, antioxidant in the skin, and has been applied in pharmaceutical and cosmetic industries. 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.*, 2006). Consumption of Squalene from natural sources (such as olive oil, wheat, rice husk or amaranth) can be part of an integral diet (Prades *et al.*, 2003; Reddy and Couvreur, 2009; Esra, *et al.*, 2013). Squalene could be useful addition to potentiate the effects of some cholesterol-lowering drugs. The 9, 12-Octadecadienoic acid, also known as Octadeca-9-dienoic acid, and 2-Hydroxy-1-droxyhyl methyl) ethyl ester, gamma-Tocopherol, 2, 6, 10, 14-Tetramethyl (-7-3methyl) and 17-Pentatriacotane. For *Cucurbita maxima*, fourteen compounds have been isolated with n-Hexadecanoic acid, 10, 13-Octadecanoic acid methyl ester and 9-Octadecenoic acid methyl ester as the predominant ones. Others include Linoelaidic acid, an omega of 6 trans fatty acid (TFA) and is a geometric isomer of linoleic acid. Found in partially as hydrogenated vegetable oils as a colourless (white) fat, viscous liquid. Conjugated linoleic acid is another vital dietary supplement known for its supposed anti-cancer benefits and as a body building. Oleic acid is a light yellow transparent oily liquid at normal temperature, insoluble in water but soluble in organic solvents such as ethanol, gasoline. It turns into stearic acid during hydrogenation, with chemical properties of organic carboxylic acids and unsaturated double chemical properties of the bond. Its synonyms include octadec-

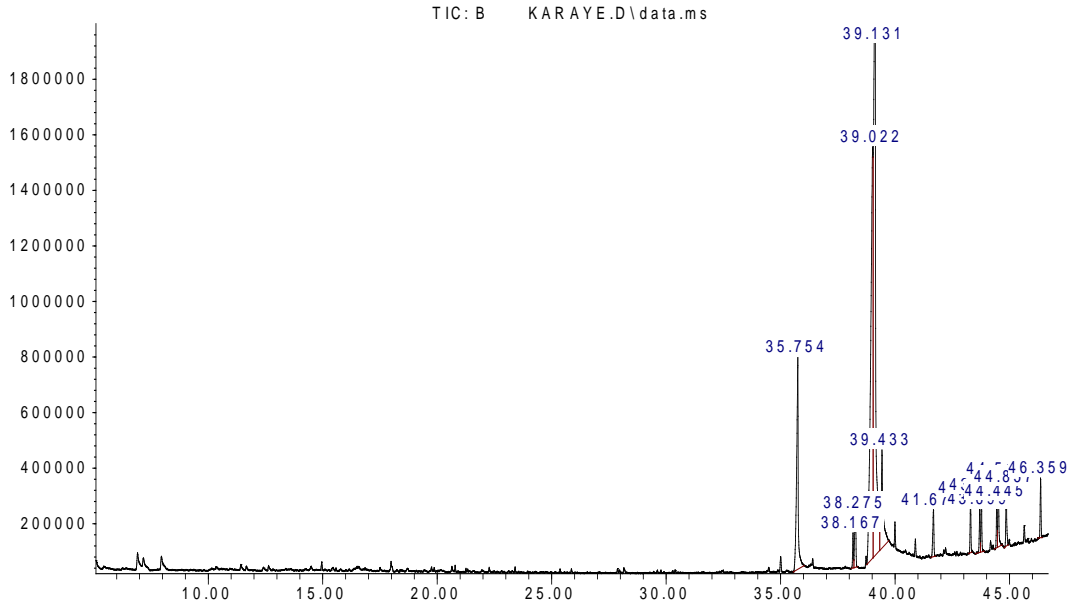
9-enoic acid, 9-Octadecenoic acid. Oleic acid is an omega-9 fatty acid which can be made by the body and it is also found in foods. Highest levels are found in olive oil and other edible oils. Oleic acid is most commonly used as for preventing heart disease and reducing cholesterol. It is also used for preventing cancer and other conditions. Cis-Vaccenic acid, Heptadecane as a straight chain alkane with 17 carbon atoms. It is a component of essential oils from plants like *Opuntia littoralis* and *Anona squamosa*; it has a role as a plant metabolite volatile oil component. Tetracosane; also known as tetracosane, is an alkane hydrocarbon with structural formula  $H(CH_2)_{24}H$ . Its name is derived from Greek for the number of carbon atoms 24 in the molecule. It has 14, 490, 245 constitutional isomers and 252, 260, 276 stereo isomers (Sloane, 2013). It is colorless, waxy crystals, insoluble in water but very soluble in benzene, toluene, ether and soluble in alcohol. 1, 8, 11-Heptadecatriene, a class of organic compounds known as alkatrienes. These are acyclic hydrocarbons that contain exactly 3-carbons to carbon double bonds. 9-Octadecenoic acid, n-Propyl 9, 12 Octadecadienoate, Glacidyl 9-nonadecenoate, Pentacosane and Heptadecane. For *Lagenaria siceraria*, eight compounds have been isolated and the predominant compounds include n-Hexadecanoic acid, conjugated linoleic acid, 9, 12-Octadecadienoic acid with others being 1,3,12-Nonadecatriene, Linolaidic acid, Squalene as well as gamma-tocopherol as the minor ones. 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. Looking at the appreciable quantities of the seed oils as well as their fuel qualities, it can be ascertained that cucurbits seeds look quite promising in the quest for alternative fuels to fuel human developmental strategies in a near future. This is in addition to the various other valuable compounds laden in the studied species. N-Hexadecanoic acid and Octadecanoic acid were among the compounds reported by Grace *et al.* (2020) on ethanol extraction of *D. elegans*. Conjugated linoleic acid, a fatty acid which presents a linoleic acid isomer ( $C_{18:2}$ ,  $n=6$ ) and has been considered an antiobesity agent, and can be useful in the weight reduction process Churruca *et al.* (2009).

Abundance



**Figure 1:** Chromatogram from GC-MS analysis of *Citrullus lanatus*

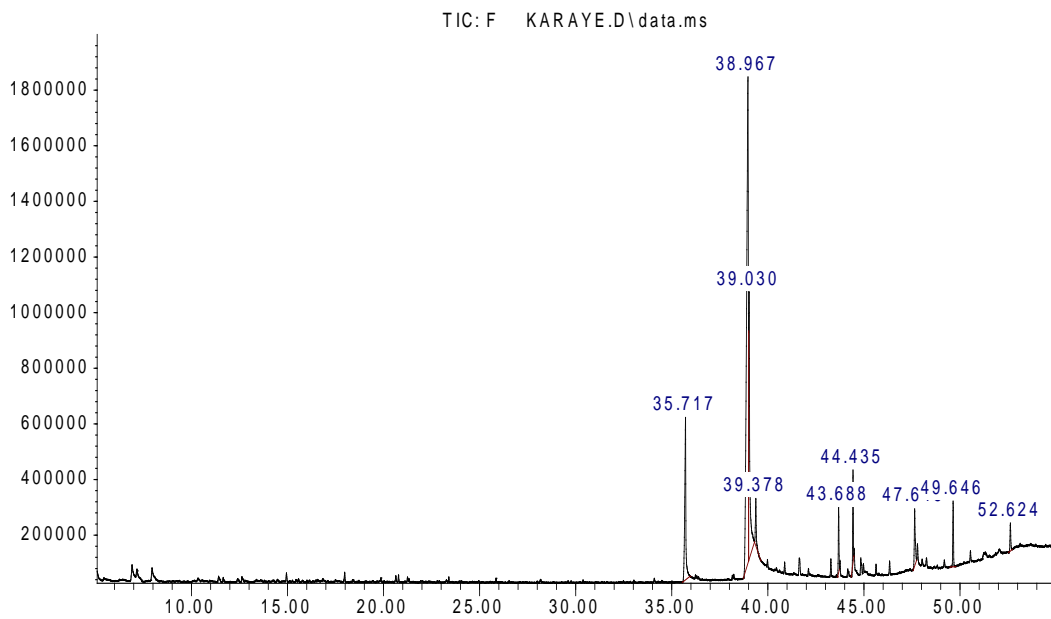
Abundance



Time-->

**Figure 2:** Chromatogram from GC-MS analysis of *Cucurbita maxima*

Abundance



Time-->

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

**CONCLUSION**

Cucurbits look quite promising in the search to the ever increasing desire for alternative fuel. Looking at the appreciable percentages of seed fuel as well as the convincing properties of 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 in addition to endowment of the seeds with equally

veritable valuable compounds that could be harnessed industrially to better the lots of humanity.

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**CONFLICT OF INTEREST:** Authors hereby declare that there is no competing interest of any sort among them.

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