Studies on *Lagenaria Breviflora* Seed Oil for its Potentials as Feedstock for Fatty Acids Methyl Esters Production in Nigeria

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Abstract. The utilization of energy has risen to 12 billion tons/year due to the ever-increasing population and urbanization which has directly led to more energy demand. Therefore, there is an obvious need for an alternative source of fuel energy. One of the best alternatives is the use of renewable fuel energy. Fatty acids methyl esters (biodiesel) is a source of a renewable fuel energy that is produced from biomass by different technologies such as direct blending of oil, emulsification, pyrolysis, and transesterification. This research studied the potentials of the seed oil of *Lagenaria Breviflora* for fatty acids methyl esters production. The oil was extracted using Soxhlet extractor with n-hexane as a solvent, esterified and then transesterified to methyl esters. The results obtained showed that the oil has high acid value of 26.16 mgKOH/g, which indicated high free fatty acid content and the percentage yield of the biodiesel produced was 89.32%. Fuel properties (colour, density, flash point, cloud point, pour point, kinematic viscosity and specific gravity) determined showed compliance with American Standard Testing and Material (ASTM) and European standard specifications. The GC-MS profile of methyl esters showed that unsaturated oleic acid methyl ester was dominant. The results suggested that *Lagenaria Breviflora* seed oil possesses some properties that are suitable for biodiesel production.

Keywords: biodiesel, methyl esters, transesterification, *Lagenaria breviflora*

Introduction

Several international conventions have been organized within the past three decades to globally address the potentialities and plans of replacing fossil fuels by other alternative energy sources and technologies such as the renewable energy (Estevez *et al.*, 2019). There has been a very high consumption of energy leading to fast depletion of the sources of these fossil fuels and oil reserves which have additionally been found to be one of the major contributors of the greenhouse gases (GHG) emissions that has led to loss of biodiversity, rise in sea level, climate change, amongst other environmental concerns (Manley *et al.*, 2017; Martins *et al.*, 2019, Yerima *et al.*, 2021). The high demand for fossil fuel has led to an increase in the price of crude oil which also affects global economic activities (Gaurav *et al.*, 2017). Affordable and clean energy provision is one of the seventeen Sustainable Development Goals (SDGs) and it is economically and environmentally important in many African countries such as Nigeria (Antwi-Agyei *et al.*, 2018; Davies *et al.*, 2019; Adewuyi, 2020). For energy stability, the best alternative of fossil fuels from social, economic and environmental point of view is biofuel (Ayadi *et al.*, 2016; Mizik & Gyarmati, 2021). Moreover, the annual world energy consumption has been projected to hit, by 2050, over 900 EJ, which is close to 1100 EJ in 2100 (Moriarty & Honnery, 2019). In principle, the energy enriched chemicals that are produced through biological processes or that are basically obtained from biomass of living organisms such as plants, bacteria etc. are termed “biofuels” (Rodionova *et al.*, 2017). Globally, great attention by the scientific community has been given to biofuel as an alternative fuel because of its ability to be blended with gasoline for as much as 80% volume blend without any engine modification (Hossain *et al.*, 2019).

Biofuels that are majorly produced from biomass can be in solid, liquid and gaseous fuel forms (Afolalu *et al.*, 2021). They can be classified into three generations i.e., the first, second and third generations based on complex and chemical nature of the biomass used in the biofuel production (Sharma & Sharma, 2018). Biodiesel produced from crop plants is of the first-generation fuels, bioethanol and bio-hydrogen produced from agricultural by-products and energy that needs a lush land for growth is of the second-generation biofuel and cyano-bacteria, seaweeds, marine resources are examples of the third-generation biofuels which produces large biomass within a short period of time and no lush land is needed for growth (Gaurav *et al.*, 2017; Adewuyi, 2020). Samuel and Adekomaya (2012) stated that, Fatty acids methyl esters (FAME) is a renewable fuel for diesel engines that meet the specification of ASTM D 6751. It is produced from oils like jatropha, canola, palm kernel, waste cooking oil etc. It has been reported severally as a type of fuel that can serve as a replacement for diesel fuel in engines. It produces lesser carbon dioxide and reduced emission to the atmosphere when compared to fossil diesel. The increasing interest and the used of FAME necessitate the search for other viable feedstocks from the abundant and versatile renewable resource especially plant seeds. Cucubitacea family is among the abundant crop domesticated and grown at wild in most tropics (especially in Nigeria). Cucurbitaceae is a plant family, also known as the gourd family, which includes crops like cucumbers, squashes, luffas, and melons. *Lagenaria breviflora* is a member of such family, commonly known as spotted melon (Yerima *et al.*, 2021).

The oil content from the research is promising (Essien *et al.*, 2013; Yerima *et al.*, 2021) because according to Food and Agricultural Organization (FAO), any seed containing greater than 17% of oil is considered to be an oil seed and can be utilized as feedstock for FAME (biodiesel) production (Satya *et al.*, 2015).

Recently, environmentalists have started to debate on the negative impact of FAME production from edible oil due to large-scale production of FAME from edible oils which may bring global imbalance to the food supply and market demand (Butler, 2006). The fruits of *Lagenaria breviflora* (Figure 1) contain vast number of inedible seeds and oil that have no commercial application (Essien *et al.*, 2013, Yerima *et al.*, 2021) in the locality they are produced. Therefore, this study tends to explore the potentials of these seeds, *Lagenaria breviflora* oil (LbSO) oil for the production of biodiesel especially in terms of oil content, methyl esters profile of the FAME produced and fuel properties.

Materials and Methods

Sample Collection and Preparation

Sample was collected from ripped fruits (Figure 1) of spotted melon (*Lagenaria breviflora*) in Okada of Ovia North – East Local Government Area, Edo State, Nigeria. The leaves and seeds were identified in the Herbarium section of Biological Sciences Department, Igbinedion University, Okada. The fruits processed like melon (Essien *et al.*, 2013; Yerima *et al.*, 2021) which was air dried and pulverized to a fine powdered form and stored in an air tight plastic container.

Figure 1. *Lagenaria breviflora* fruits

Extraction Procedure of *Lagenaria breviflora* seeds oil (LbSO)

The procedure used is as reported somewhere in Yerima *et al.* (2021).

Characterization of LbSO

Determination of the saponification value

The American Standard for Testing and Material (ASTM) method (D 5558-95) (ASTM, 2006) was used for the determination of the saponification values of the vegetable oil. The oil (5 g) was weighed into Erlenmeyer flask and 0.5M ethanolic KOH was prepared by dissolving 7 g of KOH in 250 cm^3 ethanol and 25 cm^3 of the prepared 0.5M ethanolic KOH was added and the resulting mixture was refluxed for 60 minutes. The resulting solution was subsequently titrated against 0.5M HCl prepared by diluting 10.7cm^3 HCl in 250 cm^3 of distil water using phenolphthalein as indicator. The resulting end point was obtained when the pink colour changed into colourless. The same procedure was used for the blank. The saponification value (SV) was then calculated using the expression;

$$S.V = \frac{5.61(B-S)x\ M\ of\ HCl}{Weight\ of\ sample} \quad (1)$$

Where;

B = Vol. of HCl required by blank

S = Vol. of HCl required by sample

M = Molarity of HCl

56.1 = Molar mass of KOH

Determination of acid value

Acid value of the oil was determined by ASTM method (ASTM – D 974(00) (ASTM, 2006). The oil (0.5 g) of the oil was weighed into 250 cm3 conical flask and 50 ml of neutralized ethyl alcohol was added, prepared by neutralizing a solvent mixture of 25 cm^3 ethanol and 25 cm^3 diethyl ether with 0.1M ethanolic KOH prepared by dissolving 1.4 g KOH in 250 cm^3 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 0.1M KOH prepared by dissolving 1.4 g of KOH in 250 cm^3 of distill water using phenolphthalein as indicator. The acid value was determined after which the free fatty acid was calculated as in equations 2 and 3 respectively.

$$Acid\ Value = \frac{A\ x\ M\ x\ 56.10}{M} \quad (2)$$

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

$$Free\ Fatty\ Acid\ (FFA) = \frac{Acid\ Value}{2} \quad (3)$$

Determination of iodine value

The oil (0.5 g) was weighed into conical flask and 20 cm^3 of carbon tetrachloride was added to dissolve the oil. 25 cm^3 of Wijs 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. Exactly 20 cm^3 of 10% aqueous potassium iodide prepared by diluting 10 cm^3 of potassium iodide in 90 cm^3 of distill water was added into the content of the flask using a measuring cylinder. The content was titrated with 0.1M sodium thiosulphate solution prepared by dissolving 3.95g of anhydrous $Na_2S_2O_3$ in 250 cm^3 of distill water. Few drops of 1% starch indicator were added and the titration continued by adding the sodium thiosulphate drop wise until coloration disappeared after vigorously shaking. The same procedure was used for the blank test. The Iodine Value (I.V) was given by the equation 4 (ASTM, 2006).

$$Iodine\ Value = \frac{126.9\ (V_1 - V_2)}{M} \quad (4)$$

Where,
C = concentration of sodium thiosulphate
V_1 = volume of sodium thiosulphate used for blank
V_2 = volume of sodium thiosulphate used
M = mass of sample

Determination of refractive index

Abbey refractometer was used in this determination. A drop of the sample was transferred into a glass slide of the refractometer. Water at 30^oC was circulated round the glass slide to keep its temperature uniform. Through the eye piece of the refractometer, the dark portion viewed was adjusted to be in line with the intersection of the cross. At no parallax error, the pointer on the scale pointed to the refractive index. This was repeated and the mean value noted and recorded as the refractive index.

Production of Biodiesel

Esterification Reaction

Exactly 300g of oil (LbSO) sample in a 1.0 L flat bottom flask glass reactor is esterified with 25wt% of methanol using 1.0wt% H_2SO_4 as catalyst to reduce the free fatty acids to less than 3% FFA. The mixture was placed on a constant temperature magnetic stirrer set to heat at a constant temperature 60^oC for 1.0hour reaction time. The FFA is again determined to ensure it reduced to less than 3% before it is transesterified.

Transesterification Reaction

The production of biodiesel from the esterified oil sample with methanol was carried out in a 1000ml flat bottom flask reactor equipped with condenser and placed on a constant temperature magnetic stirrer at atmospheric pressure. 300g of esterified oil in the 1000ml flask is heated to constant temperature of 60^oC about 23wt% of methanol which is equivalent to molar ratio of 6:1 of methanol to oil is weighed into 250 ml beaker and added 1.0wt% of NaOH pellets catalyst and stirred to dissolved. The mixture was added to the heated oil with

constant stirring at about 400rpm. This was allowed to react for 1.0hour to give FAME (biodiesel).

The products from the reactions are poured into a separating funnel and allowed to settle into two very distinct layers of FAME and glycerol. The FAME was separated, weighed and washed with warm water at 60^{o}C to remove impurities such as unreacted methanol, dissolved glycerol, catalyst and soap.

Crude FAME purification

After obtaining the maximum separation, the crude FAME was purified by washing with warm distilled water in a separatory funnel. Since both glycerol and methanol are highly soluble in water, crude FAME was mixed with distilled water and agitated gently to avoid formation of emulsion, then slowly percolating droplets of water through the ester. The process was repeated until colourless wash water is obtained, indicating complete removal of impurities.

Determination of Fuel Properties of Biodiesel

Determination of Pour Point

The oil sample (150 cm^3) was poured into the test jar to the level mark. The test jar was closed with the cork carrying the high – pour thermometer. The position of the cork and the thermometer were adjusted for the cork to fit tightly, the thermometer and the jar were coaxial and the thermometer bulb was immersed 3mm below the surface of the sample. After this, the test jar was placed into the cooling medium. The sample was cooled at a specified rate and examined at interval of 3^{o}C for flow characteristics until a point was reached at which the sample showed no movement when the test jar was held in a horizontal position for 5seconds. The observed reading of the thermometer was recorded. Exactly 3^{o}C was added to the recorded temperature and the result was recorded as the pour point.

Determination of kinematic viscosity

The temperature of the viscometer bath was adjusted to 38.9^{o}C. A calibrated thermometer was held in upright position and inserted into the bath by a holder. A clean dry calibrated viscometer was selected and carefully flushed with a dry nitrogen gas to remove the moist room air. A sample of the FAME was drawn up into the working capillary of the viscometer and the timing bulb was then allowed to drain back as an additional safeguard against moisture condensing or freezing on the walls. The charged viscometer was inserted into the bath at a depth such that at no time during the measurement of the flow time was any portion of the sample in the viscometer less than 20 mm below the surface of the bath. The viscometer together with its content was allowed to remain in the bath for 30 minutes to reach the test temperature (38.9^{o}C). A suction bulb was used to adjust the head level of the biodiesel to a position in the capillary arm of the viscometer about 7 mm above the first timing mark. The FAME was then allowed to freely flow and the time required for the meniscus to pass from the first to the second timing marks was noted with a stop watch. The procedure was repeated to make a second measurement of flow time and the average of these determinations was used to calculate the kinematic viscosity. The viscometer was thoroughly cleaned with sample solvent and dried by vacuum. The procedure was repeated for the other samples of the biodiesel (ASTM D 445-97) (ASTM, 2006).

Calculation:

$$\vartheta = C\ x\ t \quad (5)$$

Where ϑ = kinematic viscosity, mm^2/s

C = calibration constant of the viscosity, (mm^2/s)

t = mean flow time.

Determination of cloud point

The cloud point was determined using ASTM D2500 (ASTM, 2006). A cylindrical test tube was filled with the FAME to a specific level (5 cm^3) and clamped with a wooden clamp bearing thermometer. The test tube was placed on the ice/salt bathe and the set up inspected at intervals for cloud formation. The temperature at which a distinct cloudiness appeared at the bottom of the test tube was observed and recorded as the cloud point of the biodiesel.

Determination of flash point

The flash point was determined using ASTM D93 (ASTM, 2006). Seta Multiflash Pensky-Martens Flash Point Module Part Number 34100-2 was used to determine the flash point. The automatic PMCC module conforms precisely to national and international Pensky-Martens Closed Cup flash point test methods. It comprises a heated cup and lid, and a DIPS pod containing the dipping mechanism, gas and electric ignitors, fire detection system and a stirrer. The Pensky- Martens module was used with the Multiflash Universal Base unit (p/n 34000-0). The base unit recognizes the Pensky-Martens module was connected and instantaneously sets up standard test parameters and calibration data

Determination of specific gravity

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

$$Specific\ gravity = \frac{W_2 - W_1}{W_3 - W_1} \quad (6)$$

Where,

W_1 = weight of empty bottle

W_2 = eight of bottle + oil

W_3 = weight of bottle + water

Determination of colour

The visual determination of the colour of the biodiesel was done using ASTM D – 1500 (98) (ASTM, 2006). The readings of the colour were made with Lovibond Tintometer. Prior to this, a sample container filled to a depth of 50mm with distilled water was placed in the compartment of the colorimeter with the standard glasses to facilitate color adjustment. The FAME sample was then placed in its container in the middle of the compartment. The containers were covered to exclude all exterior light. The light source was switched on and the colour of the sample compared with the standard glasses ranging from 0.5 to 4.5. When an exact colour match was not found and the sample colour was between two standard colours, the higher of the two colours was reported.

Gas Chromatography-Mass Spectroscopy (GC-MS)

The extraction of the active ingredient was carried out by dissolving 10g of the milled powdery plant in 20mls 99.999% pure n-hexane in a well-corked reagent bottle. This was thoroughly mixed using an ultra sonicator for five hours. The mixture was allowed to stand for 72 hours and filtered into a beaker; the mixture was rewashed with 20mls n-hexane for two more consecutive times. The combined aliquots were evaporated on a steam berth to 5mls and filtered through a pasture pipette stocked with glass wool (membrane) with packed anhydrous sodium sulfate to remove the leftover moisture. The filtrate was concentrated to 1ml in the vial bottle and was taken to analyze on Gas chromatography for the chemical composition.

The gas chromatographic Model: 7890A (GC) analysis was performed on Agilent Technologies interfaced with Mass Selective Detector model: 5975C (MSD). The electron ionization was at a 70v with an ion source temperature at 250^{o}C. Highly pure helium gas (99.9% purity) was used as the carrier gas, while HP-5ms (30mm x 0.25mm x 0.320µm) was used as the stationary phase. The oven temperature was at 80^{o}C held for 4 minutes and ramped to 270^{o}C at the rate of 3.5^{o}C/min holding for 6 minutes. 1µ/l was auto injected.

Results and Discussion

Table 1. Comparative Analysis of *Lagenaria* Seed Oil Properties

Oil Characteristics	***L.siceraria*[1]**	***L.breviflora*[1]**	***L.cylindrica*[1]**	***L.siceraria*[2]**	***L.siceraria*[3]**	***L.breviflora*[4]**	***L.breviflora*[5]**
% Yield	26.80	22.50	28.30	44.83±2.3	59.1	29.50	22.15
Odour	Pleasant	Slightly Pungent	Pleasant	Pleasant	Pleasant	-	Pleasant
Colour	Light yellow	Greenish brown	Greenish	Brownishyellow	-	Brown	Greenish yellow
State(28^{o}C)	Liquid	Liquid	Liquid	Liquid	Liquid	Liquid	Liquid
Peroxide Value (meq.O_2/kg)	4.83	5.60	5.30	1.85±0.12	38± 0.2	7.50	3.94
Acid value (mgKOH/g)	2.20	2.50	2.47	26.30±0.34	0.28±0.00	5.57	26.162
Iodine Value (mgI_2/g)	106.00	110.70	153.00	102.82±0.45	17± 0.40	110.00	112.23
Saponification value (mgKOH/g)	238.50	211.78	202.00	127.35±0.06	126±0.05	213.18	253.571
FFA (% Oleic acid)	1.90	2.20	2.88	2.32±0.05	0.14±0.00	2.80	13.08
Density(g/cm^3)	-	-	-	-	0.9± 0.01	-	0.8953

Source: Essien *et al.* (2013)[1]; Taiwo, *et al.* (2019)[2]; Mahmoud *et al.* (2020)[3]; Umoren *et al.* (2016)[4]; Yerima *et al.* (2021)[5]

Properties of *Lagenaria Breviflora* Seed Oil

The oil quality parameters of *Legenaria breviflora* (Yerima *et al.*, 2021) in comparison with those of Umoren *et al* (2016); Taiwo *et al* (2019) are shown on Table 1. The average oil content obtained from *Legenaria breviflora* seed oil was 22.15% which is in close agreement with 22.50% (Essien *et al* 2013) but below that of 29.50% (Umoren *et al.*, 2016). The oil content of *Legenaria siceraria* seed is 59.1% (Umoren *et al.*, 2016) this positions *Legenaria siceraria* seed amongst the richest oil seeds. The iodine value (I. V) of (112.23%) recorded for *Legenaria breviflora* indicates that the oil is a semi drying type with a very high degree of unsaturation. Oils are classified in their iodine value as non- drying oils (I.V less than 100), drying (I.V. 130 and above) and semi drying oils (I.V. between 100 and 130). Based on research facts, the more unsaturated, the higher the iodine value and the more prone the oil to rancidity by oxidation.

The peroxide value of an oil or fat is used as a measure of the extent to which rancidity reactions have occurred during storage in an oil and fat (Danjuma *et al.*, 2009). The peroxide value of *Legenaria breviflora* seed oil was 3.94 meq/kg which is below that of *Lagenaria siceraria*, 38 meq/kg. For fresh vegetable oil the peroxide value is known to be lower than 100meq/kg which may be due to the freshness of the seed. This indicates that the oils would not easily go rancid when properly stored and show a good potential for production of biodiesel. The acid value is used to quantify the amount of acid present in a chemical substance. The acid value of *Legenaria siceraria* was 26.126mgKOH/g, higher than that of 2.50mgKOH/g (Essient *et al.*, 2013), 5.57 mgKOH/g (Umoren *et al.*, 2016). This indicates that it contains fatty acid composition of 13.08 mgKOH/g which is above the acceptable range (0 – 0.8 max) specified by the ASTM and that of European standard (0 – 0.5 max). This result reveals that the acid value is good enough for *Lageneria breviflora* seed oil to serve as a good feedstock for the production of biodiesel. Oil with higher acid value has a greater tendency to corrode fuel tank, lining and pipeline (Farm energy., 2015). The saponification value of *Lageneria breviflora* seed oil was 253.571mgKOH/g which is lower than that of 211.78mgKOH/g (Essient *et al.*, 2013) and 213.18 mgKOH/g (Umoren *et al.*, 2016). Aliyu *et al* (2011) showed that f or a vast majority of oils used in biodiesel production, their saponification value is within the range of 130 to 193 meq/kg. This shows that the oil has to be pretreated esterified/trans esterified and suitable for use in biodiesel production.

Table 2. Properties of FAME from *Lagenaria breviflora* Seed oil

Analysis	**Method**	**Result**	**Standard, ASTM D6751**
Yield vol. %		89.32 %	
Colour	ASTMD – 1500 (98)	Greenish-Yellow	
Density, g/cm^3		0.874	0.86 – 0.90
Specific Gravity	ASTMD- 1298	0.87	0.875 – 0.90
Kinematic Viscosity @ 40^{o}C mm^2/s	ASTMD-445 -97	4.426	3.5 – 5.0
Cloud point, ^{o}C	ASTMD - 2500	3.5	-1
Pour point, ^{o}C	ASTMD -	0	-15 - 10
Flash point, ^{o}C	ASTMD – 93	147	> 130
Fire point, ^{o}C		165	> 145
Acid Value, mgKOH/g		0.539	<0.8

Properties of *Lagenaria Breviflora* Fatty Acids Methyl Esters (LbFAME)

Density

The density of the LbFAME was 0.874 g/cm^3, which is within the ASTM standard 0.86-0.9 g/cm^3. The density of the *Lageneria Breviflora* seed oil was found to be 0.895g/cm^3. This shows that the LbFAME possess the required density for a good biodiesel according to ASTM D6751 biodiesel requirement.

Kinematic Viscosity

Viscosity is one of the most important properties of a fluid lubricant, which determines the fluid friction involved in lubrication, the load-carrying capacity of the lubricant film, its resistance to the initiation of relative movement of moving parts and the sealing capacity, pumpability and heat transfer properties of the lubricant. It is a measure of the internal friction taking place in a fluid – the mutual resistance to relative motion of the fluid molecules. The kinematic viscosity of LbFAME was determined to be 4.426 mm^2/s which is within acceptable standard of ASTM D6751 of 3.5-5.0mm^2/s.

Flash Point

The flash point is used in assessing the overall flammability of a material. Higher flash point indicate material that is less likely to ignites accidentally (Aliyu *et al.*, 2011). The flammability of lubricants becomes important when they are used in an environment where they can easily catch fire, or where the prevention of fire is essential. ASTM standard requires a minimum 100°C. the flash point of *Lageneria Breviflora* methyl esters (LbMES) (147°C). This indicate that fatty acid methyl ester LBFAME will be safe for use since it will not ignite easily.

Fire Point

The fire-point, is a temperature above the flash point in which vapours are generated at a sufficient rate to sustain a fire once it has been ignited. The LbFAME is 165^{o}C which is within the ASTM D6751 AND EN14214 standards.

Cloud Point

FAME tends to freeze at higher temperatures than fossil fuel diesel. This is one of the major factors that hinders the use of FAME in extremely cold regions. The cloud point (CP) is the temperature of the fuel at which small solid crystals can be observed as the fuel cools. The observed cloud point of *Lageneria breviflora* fatty methyl esters (FAME) was 3.5°C which is found to be within the international standard for biodiesel for countries like Germany, Austria, Italy France and Sweden and also conforms which revealed its feasibility to be used in these countries.

Acid Value

The concentration of free acidic constituents in both fresh and oxidised (used) oils can be identified by the acid or neutralisation number or total acid number (TAN), expressed in terms of the number of milligrams of KOH required to neutralise unit mass. The acid value indicates the level of free fatty acids present in the FAME (biodiesel) which signifies the corrosive effects of the FAME during application. The LbFAME acid value produced (Table 2) was 0.539 mgKOH/g which is less than ASTM D6751 and EN14214 standards (<0.8 mgKOH/g) which shows that it is less corrosive than specified by standards. Thus, can able to provide protection to the metallic surfaces against rusting. Clearly, lubricants which are intended to provide protection against an aggressive environment or rusting must not themselves be corrosive.

Gas Chromatography- Mass Spectroscopy (GC-MS)

The profile of the composition of LBFAME (Figure 3) is shown in Table A1.

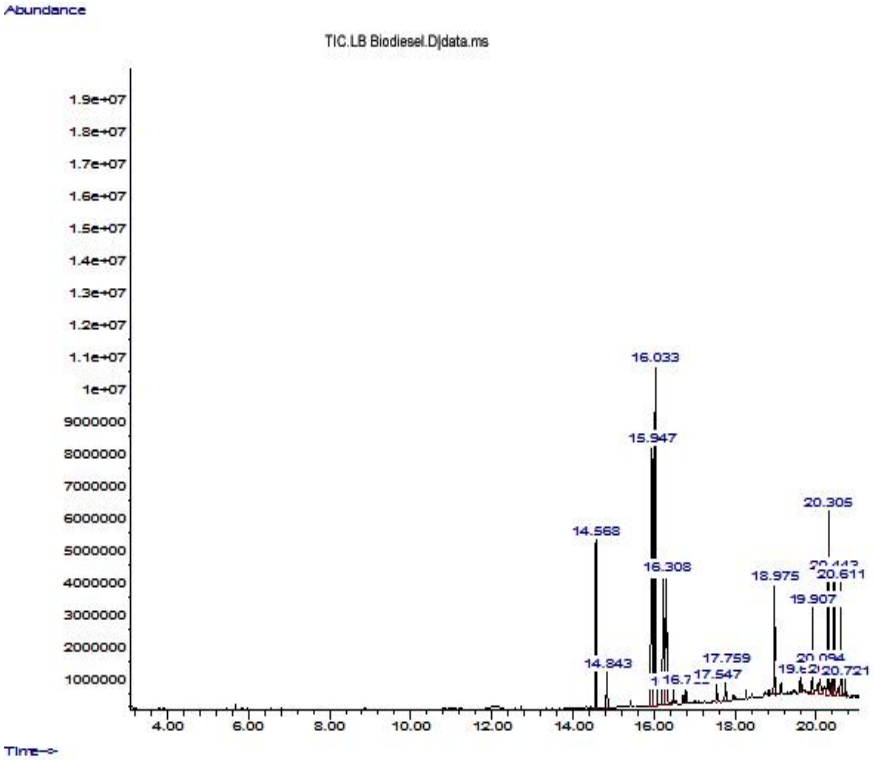

Figure 3. GC-MS Spectra of FAME from *Lagenaria breviflora* Seed Oil

Conclusion

Lageneria Breviflora is a rich source of vegetable oil. The fuel quality parameters of the *Lageneria Breviflora* FAME such as flash point, density and fire point are similar to those of the petrol-diesel (ASTM D6751 and EN 14214) and are within the general accepted standards. *Lageneria Breviflora* FAME is ultimately biodegradable (Jauro *et al*., 2011) compared to petrol-diesel which is partially degradable. Lagenaria breviflora according to Food and Agricultural Organization (FAO), any seed containing greater than 17% of oil is considered to be an oil seed and can be utilized as feedstock for biodiesel production. This suggest that *Lageneria Breviflora* seed oil is a potential source of environmentally friendly FAME.

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Appendix

Table A1. Active Ingredients in *Lagenaria breviflora* Biodiesel

Peak #	Compound	Retention Time (min)	Area%
1	Hexadecanoic acid, methyl ester	14.568	7.91
2	n-Hexadecanoic acid	14.844	1.92
3	9,12-Octadecadienoic acid (Z, Z)-, methyl ester	15.949	17.76
4	9-Octadecenoic acid (Z)-, methyl ester	16.035	22.69
5	Methyl stearate	16.235	8.31
6	9-Octadecenoic acid, (E)- cis-Vaccenic acid	16.306	8.81
7	Oxalic acid, allyl tetradecyl ester	16.482	0.63
8	1-Nonadecene	16.787	0.62
9	cis-Methyl 11-eicosenoate	17.544	0.81
10	Methyl 18-methylnonadecanoate	17.758	1.51
11	Docosanoic acid, methyl ester	18.973	3.85
12	Aspidospermidin-17-ol, 1-acetyl-19 ,21-epoxy-15,16-dimethoxy-17-Pentatriacontene	19.625	0.71
13	Tetracosanoic acid, methyl ester	19.906	3.0
14	1-Hexadecanol, 2-methyl- Octacosyl trifluoro acetate	20.097	1.70
15	1-Phenanthrenecarboxylic acid, tetra decahydro -7-(2-methoxy-2-oxoethylidene) 1,4a,8-trimethyl-9-oxo-, methyl ester, [1S-(1.alpha.,4a.alpha.,4b.beta.,8.beta.,8a.alpha.,10a. beta.)]- 9,9'-bi-1H,5H-benzo[ij]quinolizine	20.306	8.38
16	Eicosane	20.397	0.81
17	3-Methoxy-4-nitrobenzyl alcohol, n -propyl ether	20.444	5.02
18	1-Isopropenyl-4,5-dimethylbicyclo [4.3.0] nonan-5-ylmethyl phenyl sulf oxide	20.611	4.85
19	Hexacosanoic acid, methyl ester	20.720	0.71