

Production and Characterization of Biodiesel from Moringa Olifera Seed Oil Using Alkaline Catalyst

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Abstract:- Biodiesel is an alternative to conventional petroleum diesel. This is a monoalkyl ester from vegetable oil or animal fat. Biodiesel is derived from many oilseeds such as rapeseed, palm oil and castor oil. In this work biodiesel from Moringa Oleifera seed oil is examined. Moringa oleifera oil was extracted on a laboratory scale using a Soxhlet extractor, which was connected to a reflux condenser via a heating jacket at 60°C. After acid treatment, the oil is transesterified using methanol, with potassium hydroxide as a catalyst. The synthesized biodiesel is also characterized by flash point, cloud point, pour point, kinematic viscosity and amount of acid from biodiesel, which are 135°C, 18°C, 17°C, 4.85 mm²s⁻¹ and 0.26 mg KOH/g respectively. The results are in accordance with ASTM D6751 and EN 14214 biodiesel standards. It was concluded that Moringa oleifera oil has major prospect to be a source for biodiesel production, which can serve as another means of fuel for petro diesel owing to the number of common qualities that they both possess.

I. INTRODUCTION

➤ Background of Study

The demand for humanity and the thirst for energy has not been satisfied for some time. Humanity is researching various forms of energy in various ways to improve living standards. These include better lifestyles, portable water, increased agricultural productivity, improved health and education. As a result, global energy consumption is increasing rapidly, which is also being debated in connection with increasing global population growth. Global energy needs are mostly met from crude oil, coal and natural gas sources. Hydropower and nuclear energy also make a significant contribution. With the exception of the last two sources, all of these sources are limited to current use. Therefore, they cannot be reclaimed. Also, the application of conventional fuels has a number of other pitfalls, including increased greenhouse gas emissions and high production costs. For this reason, alternative energy sources for fossil fuels must be sought (Zubairu & Ibrahim, 2014).

Renewable energy is energy obtained from natural resources that are replenished organically at the human level, e.g. Solar, wind, rainfall, tides, natural waves, biomass, and energy from the earthcrust. These natural sources of energy generally makes energy available in areas such as: electricity generation, air and water heating or cooling, transportation, and rural energy services (offline) (Ellabban et al., 2014).

Biodiesel is liquid biofuel that is obtained by chemical processes from vegetable oils or animal fats and alcohols and can be used in diesel engines alone or in blends with diesel oil (Knothe et al., 2004). The use of non-consumption raw materials such as Moringa Oleifera for biodiesel production has been spoken of more because of the problem of avoiding threats to food supplies. While oleifera Moringa seeds have many medicinal uses, this makes it less economical to use to make biodiesel. The transesterification process using KOH as a catalyst is instrumental for the derivation of biodiesel from moringa seed oil.

II. LITERATURE REVIEW

A. What is Biodiesel?

Biodiesel is the mono alkyl ester of long chain unsaturated fats got from vegetable oil and creature fat (Strong et al., 2010). Biodiesel is pure and an inexhaustible fuel that can be sourced from different biomass feedstocks, for example, squander vegetable oil, yellow oil, creature fats and virgin oils. The way that biodiesel is gotten from vegetable oils and creature fats, possibly, makes it a limitless wellspring of vitality, henceforth inexhaustible. Biodiesel is a fuel with lower pace of outflow contrasted with petro diesel since it discharges next to zero ozone depleting substances on burning in start motors (Zubairu and Ibrahim, 2014).

It is protected to deal with in view of its moderately high glimmer point. Besides, biodiesel has a low ash discharge as it contains practically zero sulfur just as the cancer-causing polyromantic segments. Furthermore, biodiesel has higher greasing up property than petro diesel subsequently exceptionally encouraging upkeep possibilities to enterprises that utilization diesel as fuel. Biodiesel is biodegradable, non-poisonous and has low discharge profiles when contrasted with oil based diesel. By and large, the utilization of biodiesel will permit equalization to be looked for between farming, monetary improvement and the earth. The most widely recognized sort of feedstock use for biodiesel creation are the palatable vegetable oils, for example, soybean oil, rapeseed oil, coconut oil, palm oil and sunflower oil (Strong et al., 2010). The nourishment grade vegetable oil known as the refined oil holds the significant offer as feedstock for biodiesel generation as a result of low free unsaturated fat and water content (Abdoulmoumine, 2010). In any case, the decision of feedstock relies upon the accessibility of oil crops in a specific district. Oilseed yields, for example, soybean are especially valuable in the delivering biodiesel. Biodiesel creation from these sources in any case, had progressively put strain on their costs and accessibility for use in nourishment generation. In this way,

the quest for extra local biodiesel feedstock is a significant goal.

➤ *Considerable Merits in the Application of Biodiesel*

A portion of the benefits of utilizing biodiesel as a swap for diesel fuel seem to be (Knothe G et al., 2004):

- Inexhaustible fuel, acquired from vegetable oils.
- Reduced poisonous quality, relative to the convention diesel fuel.
- Lower wellbeing hazard, because of decreased discharges of cancerous materials.
- Low sulfur dioxide (SO₂) discharges.
- Increased glimmer value than diesel (100°C least).
- Amazing properties as an oil.
- It is the most effective source of energy for customary diesel motor, without alterations.

➤ *Considerable Demerits in the Application of Biodiesel*

There are sure disservices of utilizing biodiesel as a swap for diesel fuel that must be mulled over, they are (Van Gerpen J. et al., 2004):

- Somewhat higher fuel consumption.
- Marginally increased nitrous oxide (NOx) outflows.
- Higher the point of solidification than diesel fuel.
- Not very efficient in chilly environment
- It is less steady than diesel fuel, and along these lines long haul stockpiling (over a half year) of biodiesel isn't prescribed.
- It may corrupt plastic and common elastic gaskets and hoses when utilized in unadulterated structure, in which case supplanting with Teflon parts is suggested.

B. Raw Materials for Biodiesel Production

The natural materials for biodiesel creation are vegetable oils, creature fats and short chain alcohols. The oils commonly utilized for by and large biodiesel age are rapeseed (for the most part in the European Union nations), soybean (Argentina and the United States of America), palm (Asian and Central American nations) and sunflower, but various oils are moreover used, including nut, linseed, safflower, utilized vegetable oils, and furthermore creature fats. Methanol is the most much of the time utilized alcohol in spite of the fact that ethanol can likewise be utilized. In

spite of the fact that the properties of oils and fats utilized as crude materials may vary, the properties of biodiesel must be the equivalent, consenting to the necessities set by universal principles.

C. Moringa oleifera Oilseed

Moringa oleifera usually alluded to as drum stick tree is otherwise called 'okwe oyibo' in Igbo language, 'zogale' in Hausa language and 'Adagba maloye' or 'Ewe igbale' in Yoruba language (Rashid et al., 2008). It is a lasting softwood tree of around 5 - 10m in stature is famous for its assortment of conventional and mechanical uses (Ogbunugafor et al., 2011). When completely develop, moringa oleifera piece is encompassed by a softly lush shell with three papery wings.

D. Transesterification Process

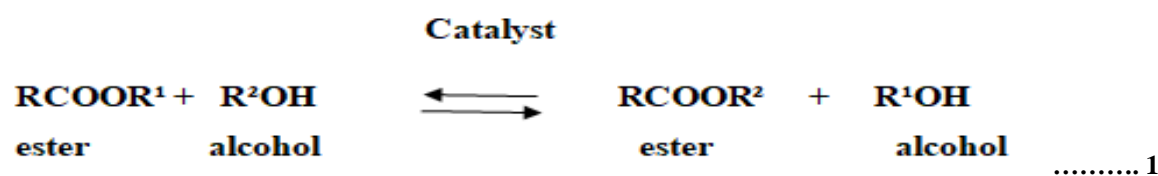
The chemical process by which biodiesel is produced is known as transesterification reaction. It involves a (TAG) triacylglycerols reaction with a short-chain monohydric alcohol normally in the presence of a catalyst at elevated temperature to form fatty acid alkyl esters (biodiesel) and glycerol. It is primarily the displacement of alcohol from an ester by another in a process similar to hydrolysis, except that alcohol is used instead of water.

The reaction reduces the high viscosity of triglycerides present in vegetable oil or animal fat. Largely dictated by price; sometime ethanol is cheaper than methanol in some regions.

Although the most common alcohol used for the production of biodiesel is methanol, other alcohols like ethanol, iso-propanol, propanol and butanol are often used to produce biodiesel.

The choice of the alcohol to be used is largely dictated by price; sometime ethanol is cheaper than methanol in some regions. The type of alcohol used also determines the biodiesel grade that is to be produced.

Equation 1 illustrates the general form of transesterification reaction.



III. METHODOLOGY

A. Materials and Equipment

The materials and equipment used in the extraction of moringa seed oil and in the production of biodiesel include:

➤ *Materials*

- Moringa oleifera seeds.
- Solvent (n-hexane)

- Alcohol selection (methanol)
- Catalyst selection (Potassium Hydroxide, KOH)
- Phenolphthalein

➤ *Catalyst selection:*

A catalyst is required to increase reaction rate between the oil and the alcohol. For conducting this experiment, Potassium Hydroxide (KOH) was used due to its high yield, availability, and price.

- Hot plate with stirrer: To heat the potassium hydroxide.
- Separating funnel: To separate two layer of glycerol and biodiesel.

B. Method

Some *Moringa oleifera* seeds were collected domestically and others were purchased from the local market. These seeds were allowed to dry for three or four days. Other chemicals and reagents (methanol, n-hexane, and Potassium hydroxide), of analytical grade, were purchased at a chemical store.

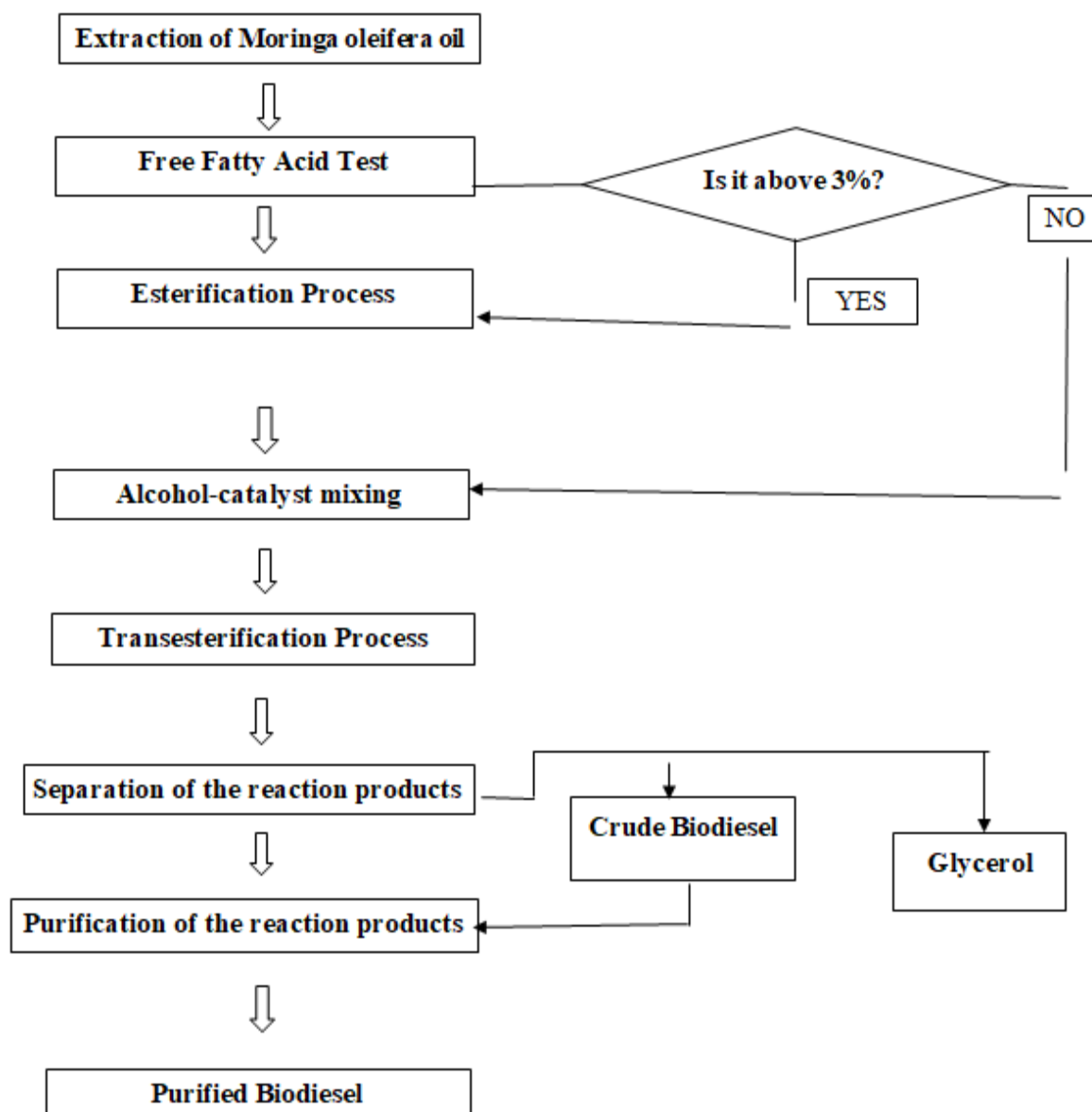


Fig 1:- Stages involved in producing biodiesel

➤ Extraction of *Moringa oleifera* Oil

The *moringa oleifera* dried seeds of total weight 475 g were de-husked and dried in the oven at 100°C, after which they were blended into powder form with the use of an electric blender, to allow for better and finer particles which facilitates easy extraction. The powdered seeds were weighed using an electronic scale, and 150g of the powdered seeds was poured into a white piece of muslin cloth which was tied at the mouth, and this was inserted into the soxhlet extractor. The extraction was carried out at 60°C for three hours. The extraction process was repeated for two samples

of powdered moringa seeds, with each sample weighing 150g.

Various factors such as the type of solvent, solid to solvent ratio, temperature, and extraction time affect oil extraction efficiency depending on the kind of oil seed. For the extraction, n-hexane was used as the solvent, and the 1 litre round bottom flask was filled to three-quarter of its volume. The powdered form of the seeds was fed to the Soxhlet extractor; the system was connected to a 1 litre round bottom flask and a reflux condenser.

The extraction was carried out for about 3 hours per sample, after which a good amount of the solvent was recovered. After this, the free fatty acid (FFA) value of crude moringa oleifera oil was determined, which indicates if there will be a need for acid pretreatment before transesterification.

Calculation:

$$\text{Acid Value} = \frac{\text{Titre value on Burette} \times \text{Molarity of KOH} \times \text{Molar}}{\text{Weight of Sample}}$$

$$\text{Free Fatty Acid Value} = \frac{\text{Acid Value}}{2}$$

➤ Alcohol-Catalyst Mixing:

The catalyst and the alcohol was mixed thoroughly before the addition of oil. It was then mixed carefully ensure total dissolution of the catalyst. 0.7g of Potassium Hydroxide was measured into a beaker on an electronic scale. 100ml of methanol was measured and mixed with the oil and mixed until complete dissolution of potassium hydroxide.

➤ Transesterification Process

• Alkaline Pretreatment of the Oil Sample

The moringa seed oil has a high FFA content of 5.69%, a value which makes it unable to undergo direct transesterification. The oil was esterified to reduce the FFA value.

Reagents: Oil sample, catalyst (KOH), methanol, conical flask, water bath, aluminium foil, weighing balance, measuring cylinder.

Procedure: 50g of the oil sample was measured, 0.875g of potassium hydroxide and 120ml of methanol. The content was covered by aluminium foil and it was transferred to water bath for 15 minutes. The contents were later poured into separating funnel for an hour, later it was washed with warmed water three times then oven dried for an hour. Therefore, titration was conducted to recheck the free fatty acid.

• Homogeneous Transesterification of the Pretreated Oil

FFA number reduced to 2%, the homogenous base-catalyzed transesterification of the pretreated oil was carried out using methanol with potassium hydroxide (KOH) as catalyst to obtain monoesters of fatty acids. A three round neck bottom flask incorporated with thermometer was clamped and refluxed was used as laboratory scale reactor vessel, magnetic-stirrer bar, magnetic-stirrer hot plate. The controlling parameters for the alkaline transesterification were oil to methanol ratio (5:1), catalyst concentration (1%wt/wt. of oil), reaction temperature of (65-70°C), and rate of agitation at 450rpm. The mixture was agitated continuously, once the thermometer attained the reaction temperature, which was 64°C, timing was started for 2

➤ Free Fatty Acid Test

A high fatty acid content in the moringa oil indicates that there is a need for the esterification process.

hours, after which it was transferred to separating funnel and allowed to stand for overnight. The mixture was separated into two layers. The liquid settled at the top was the relatively light biodiesel while the liquid settled below was the relatively heavy glycerol. The biodiesel was decanted and washed with warm distilled water, oven dried for one hour to get pure biodiesel.

• Acid and Alkaline catalysis Transesterification

Both acid and alkaline catalysis method were used for the second transesterification reaction so as to reduce the FFA and raise the yield

➤ Acid Catalysis

Set-up:

- ✓ The thermometer (with a cork around it) was placed into the left neck of the three necked flask and the opening is sealed properly.
- ✓ The three necked flask was held in place by the tripod stand and placed on the magnetic stirrer.
- ✓ The water circulator was placed into the half bucket of water and the hoses were connected appropriately to the condenser.
- ✓ The block of ice was placed into the half bucket of water.
- ✓ The magnetic bar was inserted into the three necked round bottom flask.
- ✓ The paper foil was wrapped around the second opening of the three necked flask to prevent escape of methanol during reaction.

Procedure:

- ✓ A beaker was used to measure 40ml of oil.
- ✓ 1.2ml of conc. H₂SO₄
- ✓ 120ml of methanol and H₂SO₄ was mixed together.
- ✓ The mixture of conc. H₂SO₄ and methanol was poured into the beaker of oil.
- ✓ This mixture was then poured into the three necked round bottom flask.
- ✓ The magnetic bar was placed into the three necked round bottom flask.
- ✓ The three necked flask's second opening was covered with a foil paper wrapped around it.
- ✓ The magnetic stirrer and water circulator were turned on.
- ✓ The magnetic stirrer speed and temperature were regulated to fast and 100°C respectively.
- ✓ The temperature of the reaction was monitored by checking the thermometer placed in the mixture.

- ✓ The temperature of the magnetic stirrer was then regulated to 64°C when the thermometer reads 64°C.
- ✓ The reaction was allowed to continue for (2 to 3) hours after that.
- ✓ After (2 to 3) hours, the reaction was stopped and the product poured into the separating funnel.
- ✓ The product of the reaction was left in the separating funnel to decant or separate for 2 hours.

After 2 hours, the layer of acid-pretreated oil, which settled below, was removed into a conical flask or beaker.

Alkaline-catalysis transesterification

The transesterification of moringa oleifera oil was conducted using methanol. The process was conducted for a period of about 3 hours at 64°C. KOH was used as the catalyst. As illustrated, the higher the catalyst concentration the higher the biodiesel yield. A fresh solution of methanol and Potassium hydroxide was prepared to maximize catalyst usage. An established amount of the catalyst-methanol solution is then added to the oil and the reaction is timed. The chemical reaction takes place when the oil is mixed with the alkoxide (alcohol–catalyst mix).

Procedure:

- ✓ The esterified oil was poured into a beaker.
- ✓ 0.7g of KOH was measured into a beaker.
- ✓ 100ml of methanol was measured and poured into the beaker containing KOH.
- ✓ The mixture of KOH and methanol was poured into the beaker of oil.
- ✓ This mixture was then poured into the three necked round bottom flask.
- ✓ The magnetic bar was placed into the three necked round bottom flask.
- ✓ The three necked flask's second opening was covered with a foil paper wrapped around it.
- ✓ The magnetic stirrer and water circulator were turned on.
- ✓ The magnetic stirrer speed and temperature knobs were regulated to fast and 100°C respectively.
- ✓ The temperature of the reaction was monitored by checking the thermometer placed in the mixture.
- ✓ The temperature control knob of the magnetic stirrer was then regulated to 64°C when the thermometer reads 64°C.
- ✓ The reaction was allowed to continue for (2 to 3) hours after that.
- ✓ After (2 to 3) hours, the reaction was stopped and the product poured into the separating funnel.
- ✓ The product of the reaction was left in the separating funnel to decant or separate for 2 hours.
- ✓ The glycerol which was settled at the bottom of the separating funnel was drained into a beaker or conical flask.
- ✓ A beaker containing distilled water for washing the biodiesel was placed on the hot plate to heat it up for a minute.
- ✓ The warm water was then gently poured into the separating funnel containing the biodiesel.
- ✓ This washing step was repeated two to three times.
- ✓ The biodiesel was then collected in a beaker to be dried in the oven for an hour.

➤ Separation of the Reaction Products

At the end of the reaction the mixture was allowed to cool to room temperature without agitation and settle to two phase separation under gravity. The upper phase of the mixture was moringa oleifera methyl ester (MOME), i.e. the biodiesel while the lower phase consisted of glycerol, excess methanol, the catalyst, and soap formed during the reaction, some entrained MOME and traces of glycerides. The two phases were separated by decantation. After the separation of glycerin, the (MOME) biodiesel mixture contains impurities such as remnants of alcohol, catalyst and mono-, di-, and triglycerides.

These impurities confer undesirable characteristics to the biodiesel (Aqilah, 2013), for instance, increased cloud point and pour point, lower flash point, etc. In consequence, a purification process is necessary for the final product to comply with standards.

➤ Purification of the Reaction Products

The biodiesel produced was purified by washing with warm distilled water until a desired purity was achieved, which is when there is a clear mixture of biodiesel and water in the separating funnel. Therefore, the biodiesel was washed, neutralized and dried in the oven at about (100 to 107)°C, for an hour or two. Successive washing steps with water removed the remains of methanol, catalyst and glycerin, since these contaminants are water-soluble. Finally, the traces of water was eliminated by drying the biodiesel in the oven for about two hours. After drying, the purified product was ready for characterization as biodiesel according to international standard. The biodiesel was stored in a refrigerator to prevent oxidation.

C. Physico-Chemical Properties

The physiochemical analysis of the oil involves the determination of free fatty acid (FFA), acid value, saponification value and un-saponification matter, pH value, smoke point, flash point, fire point, refractive index and specific gravity.

➤ Preparation of neutral solvent

25ml of diethyl ether was measured into a conical flask, 25ml of ethanol was added to the premeasured diethyl ether in the conical flask, 1ml of phenolphthalein indicator was added and the resulting solution was neutralized with 0.1M KOH until a pink end was observed and colour disappeared after 15minutes.

• Purpose of neutral solvent

The purpose of neutral solvent is to dissolve the oil. Ethanol/methanol allows the fat molecules to solubilize out so that the KOH will have enough surface area to react with the oil matter. The ethanol divides the oil into fine globules.

➤ Acid value Analysis

The acid value was determined by directly titrating the oil in an alcoholic medium with aqueous KOH solution. Free fatty acid was calculated as oleic acid.

Reagents: Ethylalcohol (95%) by volume and neutral solvent. Phenolphthalein indicator, 100ml of di-ethyl ether, 100ml methanol, standard aqueous 0.1M KOH solution.

Procedure: About 1g of sample oil was weighed in a conical flask. 25ml of ethyl alcohol and 25ml of di-ethyl ether, the mixture was warmed for 5 minutes before 1ml of phenolphthalein was added. The titration was carried out with 0.1M KOH.

Calculations:

$$\text{Acid Value} = \frac{\text{Titre value on Burette} \times \text{Molarity of KOH} \times 56.1}{\text{Weight of Sample (g)}}$$

➤ Determination of Free Fatty Acid (FFA)

The acid worth was controlled by titrating the oil in alcohol with watery KOH arrangement. Free unsaturated fat was determined as oleic acid.

Reagents:

Calculations:

$$\text{Acid Value} = \frac{\text{Titre value on Burette} \times \text{Molarity of KOH} \times \text{Molar}}{\text{Weight of Sample}}$$

$$\text{Free Fatty Acid Value} = \frac{\text{Acid Value}}{2}$$

➤ Determination of Moisture Content

This was determined by oven-drying, because it is more accurate and precise, allowing fast removal of residual water without changing the organic matter.

Procedure:

Clean and well labeled dishes that had been oven dried at 105°C were weighed (W_1). 1g of the oil sample was put into respective dishes, they were spread as much as possible and weighed (W_2). They were moved into desiccators following each gauging, until all the weighing was finished to keep ingestion of dampness from the air.

The dishes containing the example were moved into the broiler kept up at 105°C and dried for 4 hours after which they are placed in desiccators, to cool and gauged. The way toward warming, cooling and weighing was proceeded at 30 minutes interval until a consistent weight was acquired (W_3).

Calculation:

$$\% \text{ Moisture content} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where, W_1 = weight of empty crucible (g)

Calculation:

$$\% \text{ Oil Yield} = \frac{(\text{Initial weight of sample} - \text{Final weight of sample})}{\text{Initial weight of sample}} \times 100$$

➤ Free Fatty Acid profile Analysis

The fatty acid profile (components and composition) of the moringa seed oil was determined using GC-MS and GC-FID, respectively. The GC analysis was performed on

About 1g of test oil was measured in a cone shaped flask. 25ml of ethyl liquor and 25ml of di-ethyl ether, the blend was warmed for 5 minutes before 1ml of phenolphthalein was included. The titration was done as conceivable with 0.1M KOH.

W_2 = weight of empty crucible + sample before drying (g)

W_3 = weight of empty crucible + sample after drying (g)

➤ Determination of Specific Gravity

This is the ratio of the mass (g) of oil to that of equal volume of water. The density bottle was cleaned, weighed and filled with distilled water, then immersed in a water bath at 20°C until the water content reaches 20°C. The outside of the bottle was wiped and weighed. The bottle was emptied, dried and filled with the oil sample at 20°C. It was then kept in a water bath, wiped and weighed again.

Calculation:

$$\text{Specific gravity} = \frac{\text{Weight of oil}}{\text{Weight of equal volume of water}}$$

➤ Determination of Moringa oleifera Oil Yield

Apparatus:

- Electronic scale
- Flat Stainless plate

Procedure:

- Powdered seeds were weighed before oil extraction.
- Powdered seeds were weighed after oil extraction.

an Agilent 7890A GC equipped with a Flame Ionization Detector (FID) while the MS analysis was performed on the same Chromatography equipment but was coupled to an Agilent 5975 quadrupole Mass Selective Detector (MSD).

Separation was achieved on a fused silica capillary type column HP-5 (25m × 0.25mm x 0.40µm film thickness) with split ratio 40:1. The carrier gas was nitrogen and the oven initial temperature was at 60°C. The first ramping was at 10°C/min for 20 min and maintained for 4 minutes. The second ramping was at 15°C/min for 4 minutes and maintained for 10 minutes. The detector temperature was 320°C while hydrogen and compressed air pressures were 22 and 35 psi respectively. The results appear in APPENDIX 1, APPENDIX 2, and APPENDIX 3.

➤ Determination of Flash Point

Same oil sample test was utilized and with the guide of a clasp holder, a thermometer was hung and plunged inside the oil, guaranteeing that the thermometer doesn't contact the base of the petri dish which is set on a hot plate. The sample was warmed until an adequate fume is delivered when fire was applied, it causes burning for over one minute. The temperature is then recorded

➤ Determination of Cloud Point

Procedure

- 50ml of sample was measured into a glass bottle containing a thermometer and immersed together in a water bath.
- The water bath and the content were cooled in a refrigerator with the stirring of the oil.
- The temperature at which the thermometer was no longer visible was taken as the cloud point.

➤ Determination of Pour Point

Procedure

- 5ml of oil was drawn into a capillary tube tied to a thermometer, placed in a 250ml beaker containing distilled water immersed together in a water bath for controlled heating.
- The temperature at which the oil just begins to move downward due to its weight is called the pour point.

IV. RESULTS AND DISCUSSION

❖ Results

PARAMETERS	TEST METHOD (ASTM)	MORINGA OIL	B100	PETROL DIESEL	ASTM D6754 (For Biodiesel)	EN 14214 (For Biodiesel)	UNITS
Density		0.9472			-	0.800-0.900	(g/ml)
Specific Gravity		0.9339			-		
Acid Value	D664	11.38	0.26		<0.80	<0.50	(mg KOH/g)
Iodine Value		85.55					(gI ₂ /100g)
Cloud Point	D2500		18	-12	-	-	°C
Pour Point			17	-16	-	-	°C
Flash Point	D93	130	135	74	130 min	120 min	°C
Kinematic Viscosity	D445	42	4.85		1.9 – 6.0	3.5 – 5.0	mm ² /sec
Saponification Value	-	172.3	-		-	-	(mg KOH/g)
Moisture Content		38.01					%

Table 1:- Result of Moringa oil and Biodiesel Physico-Chemical specification in comparison with ASTM and EN standard for B100.

A. Moringa oleifera Oil Yield

The oil from moringa oleifera seed was removed with n-hexane as dissolvable in the Soxhlet extractor. The separated oil was light yellow fluid at ambient temperature with remarkable odor. The oil yield of moringa oleifera was resolved as 34.4% w/w.

B. Iodine Value of Moringa oleifera Oil

The extracted moringa oleifera oil was analyzed to decide the iodine esteem. The iodine value was acquired as 85.55 gI₂/100g. The low iodine estimation of this oil makes it reasonable for biodiesel creation since high iodine esteem prompts the arrangement of stores on engines and issue during storage of the fuel.

C. Acid Value Moringa oleifera Oil

acid estimation of oil is a significant parameter which influences the transesterification of oils. Oils which have high corrosive qualities will lead to soap production during transesterification. The extricated oil was evaluated to decide its acidic value; it was found as 11.38mg KOH/g, hence, this high acid value makes acid treatment very important.

D. Saponification Value Moringa oleifera Oil

The saponification value of moringa oleifera oil was determined as 172.3 mg of soap (as potassium oleate)/g of oil as shown in Table 1.

E. Properties of the Moringa oleifera Methyl Ester (MOME)

The properties of the biodiesel created were broke down. Properties checked were streak point, cloud point, pour point, kinematic consistency and the corrosive number. The estimations of the considerable number of properties that were resolved are in consonance with the suggested measures for biodiesel. Table 4.1 features the properties of moringa oleifera methyl ester in connection with the standard and that of oil diesel.

The flash point is a proportion of combustibility order of energizes. Commonly, unadulterated methyl esters were accounted for to have streak point in the scope of 200°C or more, accordingly making them to be emphatically non-combustible comparative with regular petro-diesel. Notwithstanding, throughout biodiesel union and purging not all the methanol utilized is changed over in to biodiesel or recuperated from the biodiesel thus as far as possible drops essentially. Abundance methanol may likewise consume motor seals and metallic motor segments when run on biodiesel.

As observed from Table 1, the flash purpose of moringa oleifera methyl ester was 135°C and the ASTM standard expresses that biodiesel might be dangerous to deal with if the flash point falls underneath 130°C. The cloud point is the temperature at which a haze of wax crystal initially shows up in the biofuel test when it's cooled. It is imperative to decide the cloud purpose of the biodiesel as higher estimations of these properties shows that biodiesel will form gel at higher temperatures which is almost certain to cause engine harm. This parameter is basic for chilly

F. Fatty Acid Profile of Moringa Oleifera Seedoil

Fatty Acid	Systematic Name	Chemical Formular	Mass %
Lauric acid	Decanoic	$C_{12}H_{24}O_2$	0.69
Myristic acid	Teradecanoic	$C_{14}H_{26}O_2$	0.09
Palmitic acid	Hexadecanoic	$C_{16}H_{32}O_2$	1 4.58
Stearic acid	Octadecanoic	$C_{18}H_{36}O_2$	0.91
Oleic acid	9- Octadecenoic	$C_{18}H_{34}O_2$	77.30
Behenic acid	Docosanoic	$C_{22}H_{44}O_2$	0.081
	Other		
	Unsaturation		77.30

Table 2:- Fatty acid profile of Moringa Oleifera Seedoil

Vegetable oils are a combination of triglycerides from various fatty acids. Mostly, the terms fatty acid profile or fatty acid composition are usually to describe the actual nature of fatty acids found in fats and oils. The chemical and physical characteristics of fats and oils, and the esters gotten from them, differ with the fatty acid profile (USA Department of Energy, 2004). Fatty acids might be saturated fatty acids (SFA) or non-saturated fatty acids (NSFA). There are just single covalent bonds in SFA particles, however there are twofold covalent bonds in the NSFA molecule. The structure of vegetable oils impacts their properties (Pryde, 1981). For example, the pour point and cloud point temperatures, cetane number and the iodine list

climate districts in biodiesel worked motors. Right now, cloud point is 18°C which shows that moringa oleifera biodiesel may not be fitting for freezing climate condition without change by mixing with petro-diesel.

Then again, the pour point is the temperature at which the fuel can never again be poured unreservedly. The pour point for moringa oleifera biodiesel was resolved as 17°C which is in agreement with the standard.

The kinematic consistency of the biodiesel which might be seen as "the opposition of the biodiesel to stream under gravity". The kinematic consistency of the moringa oleifera biodiesel was resolved as 4.85 mm²s⁻¹ as indicated by the ASTM D445 standard.

It is significant that the basic contrast between the chemical nature of transesterificated and untransesterificated biofuels is in their viscosity values. Seemingly, the significant point of creating alkyl-esters from vegetable oils and fats containing Triacylglycerols is the critical decrease in their viscosities. The high thickness estimations of the oils lead to operational issues in diesel engines.

The acid number of moringa oleifera methyl ester was inferred as 0.26 mg KOH/g. The acid number means that the nearness of Free Fatty Acids in the biodiesel. True to form, this worth is normally extremely low for newly arranged base-catalyzed biodiesel since dominant part of the Free Fatty Acids more likely than not been stripped up by the catalyst. This value can anyway increase as the biodiesel ages and degrades by contact with water dampness or carbon dioxide from the atmosphere.

rely upon the quantity of unsaturation and the length of the unsaturated fatty acid chains. A higher content of twofold covalent bonds, as observed in moringa oleifera seedoil, gives a lower solidification point and a higher iodine record. Unsaturation likewise adds to oxidative stability

V. CONCLUSION

Moringa oleifera oil was effectively removed from moringa oleifera oilseed utilizing a soxhlet extractor. The unsaturated fat methyl ester of the oil (biodiesel) was additionally created utilizing KOH as catalyst and methanol as the reagent, after pretreatment with H₂SO₄. The oil yield

gotten from moringa oleifera seeds utilized for the trial was 34.4% by weight. The moringa oleifera oil was characterised and the acid value of the oil was of 11.38 mg KOH/g, an iodine estimation 85.55 gI₂/100g and a saponification estimation of 172.3 mg KOH/g. The biodiesel properties; flash point, cloud point, pour point, kinematic thickness and acidic number were likewise decided. The delivered biodiesel from the moringa oleifera oil had a flash point of 135°C. The inflated flash point was because of the excess alcohol present in the biodiesel which was not expelled during washing. Additionally, the cloud point and pour point of the biodiesel delivered were seen as 18°C and 17°C individually. The kinematic viscosity was 4.85mm²s⁻¹ and acid number was 0.26 mg KOH/g.

The properties are for the most part inside the ASTM and EN boundaries. The biodiesel can subsequently be utilized as an alternative fuel for diesel engine.

RECOMMENDATIONS

Further analysis should be carried out, and also optimization on the ratio that will give the best yield in production, considering factors like stir rate, temperature, molar ratio, and the amount of catalyst used in reaction.

Also, biodiesel for use should be blended with petrol diesel to minimize the potentiality of carbon deposition combustion engine chamber and to reduce the high viscosity encountered in vegetable oil.

Lipase-catalyzed method can also be employed in place of base-catalyzed method to achieve a very good yield of biodiesel.

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APPENDIX 1

CENTRAL RESEARCH LAB., FUTA Library Search Report						
Data Path : C:\msdchem\1\5975\Crude oil\October Analysis\ Data File : Ajilo Temitope.D Acq On : 11 Oct 2018 21:57 Operator : Central Laboratory FUTA Sample : Ajilo Temitope Misc : ALS Vial : 1 Sample Multiplier: 1						
Search Libraries: C:\Database\NIST11.L Minimum Quality: 0						
Unknown Spectrum: Apex Integration Events: ChemStation Integrator - autoint1.e						
PK#	RT	Area%	Library/ID	Ref#	CAS#	Qual
1	2.304	0.05	C:\Database\NIST11.L Toluene Toluene Toluene	2449 2455 2450	000108-88-3	91 91 91
2	2.648	0.16	C:\Database\NIST11.L Octane Heptane, 2,4-dimethyl- Octane	7620 12695 7618	000111-65-9	80 72 64
3	5.680	0.06	C:\Database\NIST11.L D-Limonene D-Limonene Limonene	15682 15678 15668	005989-27-5	99 94 94
4	5.812	0.05	C:\Database\NIST11.L 2-Pyrrolidinone, 1-methyl- 2-Pyrrolidinone, 1-methyl- 2-Pyrrolidinone, 1-methyl-	3504 3503 3505	000872-50-4	83 78 59
5	6.092	0.04	C:\Database\NIST11.L 2-Octenal, (E)- 2-Dodecenal 2-Octenal, (E)-	11332 47158 11330	002548-87-0	59 59 53
6	7.986	0.05	C:\Database\NIST11.L Octanoic acid, ethyl ester Hexanoic acid, ethyl ester Octanoic acid, ethyl ester	39512 20902 39519	000106-32-1	64 60 49
7	8.638	0.04	C:\Database\NIST11.L Cyclopentane, 1-ethyl-1-methyl- Heptylcyclohexane Oxalic acid, cyclohexyl dodecyl es ter	6797 47280 176832	016747-50-5 005617-41-4 1000309-31-4	43 38 35
8	8.816	0.43	C:\Database\NIST11.L 2-Cyclohexen-1-ol 2-Cyclohexen-1-ol 2-Cyclohexen-1-ol	3186 3179 3185	000822-67-3	62 49 47
9	10.939	0.05	C:\Database\NIST11.L 2-Tetradecene, (E)- 3-Tetradecene, (E)- Cyclododecane	58285 58294 36736	035953-54-9 041446-68-8 000294-62-2	98 96 94
10	11.007	0.23	C:\Database\NIST11.L Decanoic acid, ethyl ester Decanoic acid, ethyl ester Undecanoic acid, ethyl ester	61151 61150 72679	000110-38-3	96 91 86
11	12.735	0.47	C:\Database\NIST11.L Dodecanoic acid, ethyl ester Dodecanoic acid, ethyl ester Dodecanoic acid, ethyl ester	84474 84478 84479	000106-33-2	91 90 72

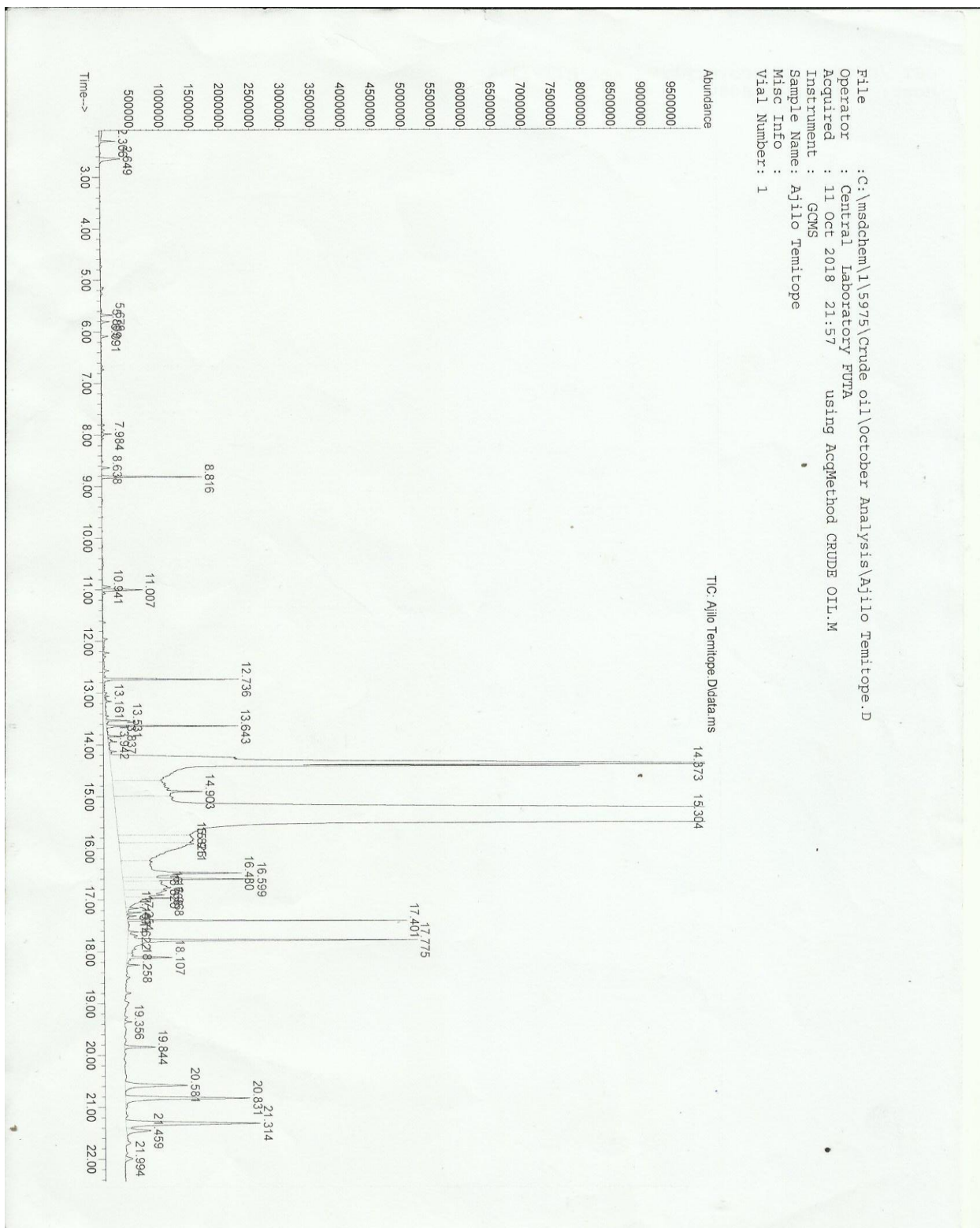
12	13.159	0.05	C:\Database\NIST11.L	3-Heptadecene, (Z)-	92568	1000141-67-3	99
				8-Heptadecene	92564	002579-04-6	99
				8-Heptadecene	92565	002579-04-6	96
13	13.531	0.09	C:\Database\NIST11.L	Tetradecanoic acid	84455	000544-63-8	99
				Tetradecanoic acid	84452	000544-63-8	99
				Tetradecanoic acid	84453	000544-63-8	92
14	13.645	0.34	C:\Database\NIST11.L	Tetradecanoic acid, ethyl ester	107591	000124-06-1	98
				Tetradecanoic acid, ethyl ester	107587	000124-06-1	90
				Tetradecanoic acid, 2-methyl-ethyl ester	107607	055554-09-1	86
15	13.840	0.05	C:\Database\NIST11.L	2-Pentadecanone, 6,10,14-trimethyl	117629	000502-69-2	91
				2-Pentadecanone, 6,10,14-trimethyl	117630	000502-69-2	91
				2-Undecanone, 6,10-dimethyl-	59806	001604-34-8	72
16	13.943	0.06	C:\Database\NIST11.L	9-Heptadecanone	105854	000540-08-9	97
				9-Heptadecanone	105857	000540-08-9	46
				9-Heptadecanone	105855	000540-08-9	42
17	14.372	14.58	C:\Database\NIST11.L	n-Hexadecanoic acid	107549	000057-10-3	99
				n-Hexadecanoic acid	107547	000057-10-3	95
				n-Hexadecanoic acid	107548	000057-10-3	62
18	14.904	3.16	C:\Database\NIST11.L	8-Octadecenoic acid, methyl ester, (E)-	141305	026528-50-7	95
				n-Hexadecanoic acid	107547	000057-10-3	95
				6-Octadecenoic acid, methyl ester, (Z)-	141304	002777-58-4	93
19	15.305	61.45	C:\Database\NIST11.L	6-Octadecenoic acid	129340	1000336-66-8	90
				9-Octadecenoic acid, (E)-	129353	000112-79-8	90
				Oleic Acid	129338	000112-80-1	87
20	15.825	2.03	C:\Database\NIST11.L	9-Octadecenoic acid, (E)-	129353	000112-79-8	99
				cis-Vaccenic acid	129339	000506-17-2	99
				Oleic Acid	129338	000112-80-1	99
21	15.911	3.26	C:\Database\NIST11.L	9-Octadecenoic acid, (E)-	129353	000112-79-8	99
				Oleic Acid	129338	000112-80-1	99
				Oleic Acid	129337	000112-80-1	99
22	16.478	2.35	C:\Database\NIST11.L	Oleic Acid	129337	000112-80-1	95
				Oleic Acid	129338	000112-80-1	95
				9-Octadecenoic acid, (E)-	129353	000112-79-8	94
23	16.598	0.95	C:\Database\NIST11.L	Hexadecanoic acid, ethyl ester	131291	000628-97-7	86
				Methyl 19-methyl-eicosanoate	177142	1000336-23-8	83
				Eicosanoic acid, ethyl ester	177141	018281-05-5	76
24	16.769	1.27	C:\Database\NIST11.L	9-Octadecenoic acid, (E)-	129353	000112-79-8	99
				Oleic Acid	129338	000112-80-1	98
				cis-Vaccenic acid	129339	000506-17-2	98
25	16.821	0.90	C:\Database\NIST11.L	9-Octadecenoic acid, (E)-	129353	000112-79-8	99
				Oleic Acid	129337	000112-80-1	98
				6-Octadecenoic acid	129340	1000336-66-8	96

26	16.970	0.60	C:\Database\NIST11.L Oleic Acid 6-Octadecenoic acid, (Z)- cis-13-Octadecenoic acid	129337 000112-80-1 91 129348 000593-39-5 91 129347 013126-39-1 90
27	17.158	0.08	C:\Database\NIST11.L Docosanoic acid, methyl ester Docosanoic acid, methyl ester Docosanoic acid, methyl ester	186930 000929-77-1 95 186934 000929-77-1 92 186933 000929-77-1 91
28	17.256	0.05	C:\Database\NIST11.L Phthalic acid, di(2-propylpentyl) ester 2-(Nonyloxycarbonyl)benzoic acid Bis(2-ethylhexyl) phthalate	207709 1000377-93-5 64 137725 1000373-89-9 58 207665 000117-81-7 58
29	17.313	0.04	C:\Database\NIST11.L 9-Tricosene, (Z)- Cyclotetracosane Oleic Acid	163019 027519-02-4 95 174180 000297-03-0 86 129337 000112-80-1 78
30	17.399	0.91	C:\Database\NIST11.L Nonadecanoic acid, ethyl ester Heptadecanoic acid, ethyl ester Octadecanoic acid, ethyl ester	166220 018281-04-4 93 143163 014010-23-2 72 154934 000111-61-5 72
31	17.622	0.05	C:\Database\NIST11.L Difluoro(methylamino)phosphine sul fide Benzene, (1,2-dicyclopropyl-2-phen ylethyl)- 1,3,5-Trisilacyclohexane	14028 1000306-16-8 38 112676 110330-90-0 35 14123 000291-27-0 32
32	17.776	1.80	C:\Database\NIST11.L 9-Octadecenoic acid (Z)-, 2,3-dihy droxypropyl ester 9-Octadecenoic acid (Z)-, 2,3-dihy droxypropyl ester Oleic acid, 3-hydroxypropyl ester	188141 000111-03-5 90 188143 000111-03-5 78 177061 000821-17-0 74
33	18.108	0.29	C:\Database\NIST11.L Ethyl tetracosanoate Octadecanoic acid, ethyl ester Octadecanoic acid, ethyl ester	210490 024634-95-5 76 154931 000111-61-5 76 154934 000111-61-5 64
34	18.257	0.06	C:\Database\NIST11.L Squalene Squalene Squalene	215933 000111-02-4 97 215931 000111-02-4 97 215927 000111-02-4 96
35	19.356	0.04	C:\Database\NIST11.L .gamma.-Tocopherol .beta.-Tocopherol .gamma.-Tocopherol	218064 007616-22-0 91 218063 000148-03-8 70 218065 007616-22-0 60
36	19.842	0.21	C:\Database\NIST11.L Vitamin E dl-.alpha.-Tocopherol .beta.-Tocopherol, O-methyl-	222346 000059-02-9 99 222355 010191-41-0 99 222357 1000374-73-6 98
37	20.580	0.67	C:\Database\NIST11.L 5-Cholestene-3-ol, 24-methyl- Campesterol Ergost-5-en-3-ol, (3.beta.)-	212397 1000214-17-4 95 212387 000474-62-4 94 212394 004651-51-8 91
38	20.832	1.23	C:\Database\NIST11.L Stigmasterol Stigmasterol Stigmasterol	216702 000083-48-7 99 216703 000083-48-7 94 216704 000083-48-7 90
39	21.313	1.43	C:\Database\NIST11.L .beta.-Sitosterol .beta.-Sitosterol	217433 000083-46-5 96 217432 000083-46-5 86

		.gamma.-Sitosterol	217434	000083-47-6	83
40	21.461	0.29	C:\Database\NIST11.L		
		3,7-Dihydroxy-2-(3,4-dimethoxyphenyl)-4H-chromen-4-one	156109	093322-61-3	60
		Stigmasta-5,24(28)-dien-3-ol, (3.b eta.)-	216715	018472-36-1	55
		5-Androsten-17.alpha.-ethynyl-3.beta.,17.beta.-diol	156758	1000126-90-5	50
41	21.994	0.08	C:\Database\NIST11.L		
		24S--Ethyl-5.alpha.-cholesta-2,22E-dien-6-one	215919	101046-86-0	64
		4,22-Stigmastadiene-3-one	215910	020817-72-5	55
		9-Octadecenoic acid, (E)-	129349	000112-79-8	38

Oil.M Fri Oct 12 15:44:06 2018

APPENDIX 2



APPENDIX 3

CENTRAL RESEARCH LAB., FUTA		Library Search Report				
Data Path : C:\msdchem\1\5975\Crude oil\October Analysis\						
Data File : Ajilo Temitope.D						
Acq On : 11 Oct 2018 21:57						
Operator : Central Laboratory FUTA						
Sample : Ajilo Temitope						
Misc :						
ALS Vial : 1 Sample Multiplier: 1						
Search Libraries: C:\Database\NIST11.L Minimum Quality: 0						
Unknown Spectrum: Apex						
Integration Events: ChemStation Integrator - autoint1.e						
PK#	RT	Area%	Library/ID	Ref#	CAS#	Qual
1	2.304	0.05	C:\Database\NIST11.L Toluene	2449	000108-88-3	91
			Toluene	2455	000108-88-3	91
			Toluene	2450	000108-88-3	91
2	2.648	0.16	C:\Database\NIST11.L Octane	7620	000111-65-9	80
			Heptane, 2,4-dimethyl-	12695	002213-23-2	72
			Octane	7618	000111-65-9	64
3	5.680	0.06	C:\Database\NIST11.L D-Limonene	15682	005989-27-5	99
			D-Limonene	15678	005989-27-5	94
			Limonene	15668	000138-86-3	94
4	5.812	0.05	C:\Database\NIST11.L 2-Pyrrolidinone, 1-methyl-	3504	000872-50-4	83
			2-Pyrrolidinone, 1-methyl-	3503	000872-50-4	78
			2-Pyrrolidinone, 1-methyl-	3505	000872-50-4	59
5	6.092	0.04	C:\Database\NIST11.L 2-Octenal, (E)-	11332	002548-87-0	59
			2-Dodecenal	47158	004826-62-4	59
			2-Octenal, (E)-	11330	002548-87-0	53
6	7.986	0.05	C:\Database\NIST11.L Octanoic acid, ethyl ester	39512	000106-32-1	64
			Hexanoic acid, ethyl ester	20902	000123-66-0	60
			Octanoic acid, ethyl ester	39519	000106-32-1	49
7	8.638	0.04	C:\Database\NIST11.L Cyclopentane, 1-ethyl-1-methyl-	6797	016747-50-5	43
			Heptylcyclohexane	47280	005617-41-4	38
			Oxalic acid, cyclohexyl dodecyl es	176832	1000309-31-4	35
			ter			
8	8.816	0.43	C:\Database\NIST11.L 2-Cyclohexen-1-ol	3186	000822-67-3	62
			2-Cyclohexen-1-ol	3179	000822-67-3	49
			2-Cyclohexen-1-ol	3185	000822-67-3	47
9	10.939	0.05	C:\Database\NIST11.L 2-Tetradecene, (E)-	58285	035953-54-9	98
			3-Tetradecene, (E)-	58294	041446-68-8	96
			Cyclododecane	36736	000294-62-2	94
10	11.007	0.23	C:\Database\NIST11.L Decanoic acid, ethyl ester	61151	000110-38-3	96
			Decanoic acid, ethyl ester	61150	000110-38-3	91
			Undecanoic acid, ethyl ester	72679	000627-90-7	86
11	12.735	0.47	C:\Database\NIST11.L Dodecanoic acid, ethyl ester	84474	000106-33-2	91
			Dodecanoic acid, ethyl ester	84478	000106-33-2	90
			Dodecanoic acid, ethyl ester	84479	000106-33-2	72