



Research Article

Biodiesel Production using *Balanite aegyptica* (Desert Date) Seed as Raw Material

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ABSTRACT

Biodiesel is a substitute to diesel fuel prepared from renewable resources and it is becoming popular because of its nontoxic and biodegradable nature. This study was to investigate the Potential of *Balanite aegyptica* (Desert date) seed for biodiesel production along with the assessment of its performance in Internal Combustion engine. The *Balanites aegyptiaca* kernels were crushed using pestle and mortar to obtain the seeds for further analysis. The seeds were collected, washed and prepared. The results after proximate analysis revealed that *B. aegyptiaca* seed contain considerable percentage of Crude lipid content with a percentage mean of 39.37 %, followed by Crude protein Content with 33.14 %, Crude Fiber content 13.56 %, Carbohydrate content 7.46 %, Moisture 3.1 %, and Ash content 2.85 %. The results also show the mean concentration of some elements with Potassium 1.150 (mg/g), Sodium 0.940 (mg/g), Calcium 0.313 (mg/g), Zinc 0.018 (mg/g) while Iron and Manganese have a mean concentration of 0.010 (mg/g) and 0.010 (mg/g) respectively. Magnesium was found to have least concentration of 0.004 (mg/g). The seed oil was extracted using soxhlet apparatus with n-hexane as solvent. The extracted oil was then subjected to trans-esterification through the addition of catalyst (potassium hydroxide). The percentage yield of oil extraction was 41.9%. The GCMS analysis identified the presence of seven components in the oil as shown by the peaks on the chromatogram. The identified components were $C_8H_{16}O$ (Octanal), $C_9H_{16}O_2$ (Lactone), $C_{16}H_{32}O_2$ (Palmitic acid), $C_{18}H_{34}O_2$ (Elaidic acid), $C_{19}H_{38}O_2$ (Methyl stearate), $CH_3 C_{18}H_{34}O_2$ (Oleic acid) and $C_{18}H_{36}O_2$ (Stearic acid). Similarly, the spectrum of all the components was studied. The density of the produced biodiesel was also determined and the results showed that 0.83 g/ml was the density obtained after the seed oil undergoes transesterification. This study reveals that *Balanites aegyptiaca* seed is a good biomass for biodiesel production and the oil can be used for domestic and industrial purposes if richly exploited.

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INTRODUCTION

As the world population increases, the energy consumption also increases. In any nation, energy is the most fundamental requirement for human existence and activities Ribeiro *et al.*, (2011). Unfortunately, the non-renewable energy sources that contribute over 86% of the global energy supply are depleting Atadashi *et al.* (2011). In addition, apart from price hike in the depleting petroleum based products, greenhouse gas emission being emitted as a result of the products contributes significantly to climate change and ozone depletion. This problem has resulted to intense search for alternative feedstock and sustainable technology that can counter the shortcomings of non-renewable energy sources. One of the alternative energy types considered to replace the dwindling conventional transportation fuel is biodiesel Moser (2009).

Balanites Aegyptiaca is a species of tree, deep rooted ever green or semi deciduous tree up to 12m high. Classified either as a member of the *zygophyllaceae* or *Balanitaceae*. It is multi branched and the flowers are small. The plant grows in tropical and desert areas. It can be found in many kinds of habitats, tolerating a wide variety of soil types from sand to heavy clay and climatic moisture (Ogala *et al.*, 2018). *Balanites Aegyptiaca* is perennial plant used in food preparations, especially in Africa and developing countries. It has multiplicity of uses and almost every part of the plant is useful including, leaves thorns, back of root and fruit. The fruit is used to treat liver disease (Ogala *et al.*, 2018).

Biodiesel, derived from vegetable oil or animal fats by transesterification with alcohol like methanol and ethanol, is recommended for use as a substitute for petroleum based diesel mainly because biodiesel is an oxygenated, renewable, biodegradable and environmentally friendly biofuel with similar flow and combustion properties and also low emission

profile (Abdul and Abdul, 2008). It helps to reduce global warming gas emissions such as carbon dioxide (Manji, 2014).

Developing countries such as Nigeria have a comparative advantage for biofuel production because of greater availability of land, favourable climatic conditions for agriculture and lower labour cost, but yet many of the present problems of Nigeria are closely related to the problem of energy distribution. Energy plays a vital role in the economic, social and welfare development of any nation. Insufficient supply of energy restricts socio economic growth and adversely affects the quality of life (Manji, 2014). Biodiesel is advised for use as an alternative fuel for conventional petroleum based diesel chiefly because it is a renewable, domestic resource with an environmentally friendly emission profile and is readily biodegradable (Chapagain and Saharan, 2008).

MATERIALS AND METHODS

Chemicals and Reagents used for the Research

All chemicals and reagents used i.e methanol of 99.5% purity, sodium hydroxide with 95% purity, sulphuric acid with 98% purity, hydrochloric acid of 36% purity, potassium hydroxide, n-hexane and phenolphthalein indicator were of analytical grade manufactured by British Drug House (BDH, London, United Kingdom). They were used as procured without further purification.

Sample Collection

The Desert date kernels were obtained from Gamboru Market located in Maiduguri, Borno State of Nigeria. It was collected in a sterile polythene bag, and transported to the Microbiology laboratory, University of Maiduguri for the research purpose.

Proximate and Elemental Composition of the Desert Date Seed

The proximate and elemental composition of the sample was carried out according to AOAC

methods to determine the following compounds and elements.

- i. Ash Content
- ii. Carbohydrate
- iii. Crude Fiber Content
- iv. Crude Protein
- v. Lipids Content
- vi. Moisture Content
- vii. Zinc
- viii. Manganese
- ix. Calcium
- x. Magnesium
- xi. iron

Preparation of the Sample

After the fruits were obtained, they were screened to remove the defective ones and soaked in a large bowl of water overnight to remove the glycoside pulp from seed coat. The washed seeds were sundried and their shells was cracked using metal hammer to obtain its kernel. The kernels of the dried seeds were ground using mortar and pestle and then separated with the aid of a sieve shaker into two types of particle size, viz. 0.6mm and 1.8 mm.

Pre-treatment of raw materials:

The Desert date (*Balanites aegyptica*) were washed, sun-dried for two days and crushed to small particle size. The crushed samples were washed well with distilled water till the wash water becomes colourless which was then dried at 110°C in an oven for 8 hours to get rid of moisture and other volatiles. The pretreated samples were kept in a sample container for carbonization and activation process (Ibrahim *et al.*, 2018).

Physical activation:

This was carried out according to the method used by Abdul *et al.* (2008). Five (5) g of the pre-treated sample was placed in a crucible and carbonized at temperature of 1000 C for 2 hours. The sample was allowed to cool in a desiccator then removed and grind, sieved with a 300 µm sieve and stored in an air tight bottle (Ibrahim *et al.*, 2018).

Oil Extraction

In order to get oil from the prepared seeds of the desert date, 10g of the ground desert date seed of 0.6mm particle size was carefully poured into a labelled thimble, after which it was placed in the extraction chamber of a 250 mL Soxhlet apparatus fitted with a condenser. The 500 mL distillation flask of the apparatus was containing 250 mL of n-hexane, which was the solvent for the extraction. Using a temperature of 55 °C and refluxing for a period of 4 hr. Desert date seed oil was extracted. The thimble was carefully removed and the collected n-hexane in the top container of the apparatus was drained into another container for reuse. The oil was then dried using atmospheric air so that it would be totally free of n-hexane. The same procedure was repeated for the particle size of 1.8 mm at the same temperature but for 7 hr (Dangoggo *et al.*, 2018).

Preparation of catalyst

The catalyst potassium hydroxide was used heterogeneously according to the method describe by Ibrahim *et al.*, (2018).

Transesterification of the oil into biodiesel

The treated sample (10 g) was placed in two necked round bottom flask, placed on hot plate magnetic stirrer heated to 50°C and stirring at 600 rv/m. The methanol was mixed with 0.6 g of potassium hydroxide in a beaker and heated to 40°C in water bath, then transferred into two necked round bottom flask containing oil. The reaction mixture under the same condition was allowed for 2.15 hrs. The mixture was then transferred into a separating funnel and allowed to separate overnight under gravity. Two distinct layers were observed, a dark bottom layer which is the glycerol and the light upper layer which is the biodiesel, in some cases when the layer did not separate distinctly enough, equal amount of distilled water and n-Hexane is added to aid the separation. After which the biodiesel was washed by adding 20% volume of warm

distilled water and agitated gently for 5 minutes. The mixture was allowed to settle into a two layer from which the biodiesel was separated from the impurities, glycerol and water. The washing was done in order to remove impurities and any remaining residue methanol (Dangoggo *et al.*, 2018). The biodiesel yield was calculated using equation 3.

$$\text{Biodiesel yield} = \frac{\text{Actual weight}}{\text{theoretical Weight}} \times 100 \dots\dots\dots (3)$$

The oil was weighed and the percentage of oil yield was calculated using the equation below:

$$Y_{\text{oil}} = \frac{W_{\text{oil}} \times 100}{W_{\text{sample}}} \dots\dots\dots 2$$

Where, W_{oil} = weight of extracted oil, W_{sample} = weight of sample (g).

Refractive Index

Abbe's refractometer was used in the determination of refractive index. This instrument measures the index of refraction by measuring the critical angle of total reflection. In this case, a few drops of the sample were transferred into the glass slide of the refractometer. Water at 30°C was circulated round the glass slide to keep its temperature uniform. Through the eyepiece 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. The refractometer was calibrated using distilled

$$\text{Density} = \frac{W2 - W1}{V} \dots\dots\dots 1$$

where:

W1 = Weight of Empty Density Bottle

W2 = Weight of Density Bottle + Oil

W3 = Weight of Density Bottle + Water

V = Volume of Oil.

Determination of specific gravity

A clean dry empty 50 ml density bottle was weighed, it was then filled up with distilled water and weighed, the mass of the bottle and water was taken. *Balanites aegyptiaca* seeds oil

Determination of Physical Parameters

Colour

The colour of the extracted desert date seed oil was observed visually (Dangoggo *et al.*, 2018).

Determination of oil yield (%)

The percentage yield was carried out according to the method adopted by Babagana *et al.*, (2012). *Balanite egyptiaca* seeds oil extracted was purified to remove solvent.

water where the refractive index of water at that temperature was obtained (Ogala *et al.*, 2018).

Determination of Density

The density of the desert date oil was determined using prewashed, dried and labeled density bottles. The density bottled was then filled up to the volume mark with the oil sample, and the weight of the density bottle with the oil was determined. The density bottled was also filled up to the volume mark with the water, and the weight of the density bottle with the water was determined (Datti *et al.*, 2020). The density and the specific gravity of the oil were calculated using the formulae:

was also weighed in a separate density bottle which was weighed, the weight of bottle and oil, the specific gravity was evaluated (Jerekias and Clever 2011). The Density was calculated using the following formular

$$\frac{W_1 - W_2}{V_0} \dots\dots\dots 3$$

Where W_1 = Weight of empty measuring cylinder + oil;

W_2 = Weight of measuring cylinder and

V_0 = Volume of oil.

Determination of Chemical Parameters

Acid Value

Into a dried 250 mL conical flask was placed 2.0 g of the oil sample followed by 25 mL of absolute ethanol and 3 drops of phenolphthalein indicator. The mixture was heated in a shaking water bath for 5 minutes. While hot, it was

$$A.V = \frac{56.1 \times V \times M}{m} \dots\dots\dots \text{equation (4)}$$

Where V = volume of KOH used;

M = molarity of KOH and

m = mass of sample.

Determination of Saponification Value

This was carried out according to the AOCS (2017) Method as adopted by Ogala *et al.* (2018). 2.0 g of the crude oil was weighed into a 250 ml conical flask and 10% alcoholic KOH was added. It was refluxed over steam for 1 hour with occasional swirling. 1 ml of phenolphthalein indicator was added at the end of the refluxing time and solution titrated with 0.5 M HCl.

Determination of Iodine Value

This was carried out as describe by Nielsen and adopted by Ogala *et al.* (2018). 2.0 g of the crude oil was measured into a 100 ml conical flask and 5 ml Dam's iodine was added. The flask was corked and placed in a dark cupboard for 5 min. 5 ml of 10% KI was added followed by 20 ml of distilled water. The solution was titrated with 6.6% sodium thiosulphate in the presence of 1 ml of 1% starch indicator until the blue colour turned colourless.

Determination of Free Fatty Acid

This is the percentage by weight of specific fatty acid. The method described by Ogala *et al.*, (2018) was used. Two (2.0) g of the crude

titrated against 0.1 M KOH until pink color appeared. Vigorous shaking was done when approaching the end point to ensure thorough mixing. The volume of 0.1 M KOH consumed by an acid was recorded. The acid value was calculated as reported using equation (4) ((Ogala *et al.*, 2018).

oil was weighed into a conical flask and neutralized with 1:1 mixture of 95% ethanol and 10 ml diethyl ether was added and mixed thoroughly. The solution was titrated using 0.1 M NaOH and phenolphthalein indicator with constant stirring until a pink colour which persisted for 15 seconds was observed.

Characterization of biodiesel using GC-MS

Characterization of the highest yield 97.91% of the biodiesel produced was carried out using GC-MS model QP-2010 PLUS machine for the characterization, the biodiesel was injected into the gas chromatography at injection temperature which was programmed for 70°C to 280°C for 5 minutes and at 280°C for 5 minutes. The analysis was done based on software matching with standard mass spectra (Dangoggo *et al.*, 2018).

RESULTS

Table 1 shows Proximate and Elemental Composition of Desert date seed kernels. The results shows that Crude lipid contents has the highest percentage mean of 39.37 %, followed by Crude protein Content with 33.14 %, Crude

Fiber content 13.56 %, Carbohydrate content 7.46 %, Moisture 3.2 %, and Ash content 2.85 % respectively. The results also show the mean concentration of some elements with Potassium 1.150 (mg/g), Sodium 0.940 (mg/g), Calcium

0.313 (mg/g), Zinc 0.018 (mg/g) while Iron and Manganese have a mean concentration of 0.010 (mg/g) and 0.010 (mg/g) respectively. Magnesium was found to have least concentration of 0.004 (mg/g).

Table 1: Proximate and Elemental Composition of Desert Date seed kernel Contents (all values are mean \pm standard deviation (S.D) of triplicate measurement)

PARAMETERS	COMPOSITION
Moisture Content (%)	3.10 \pm 0.21
Ash Content (%)	2.85 \pm 0.38
Crude Protein Content (%)	34.1 \pm 0.17
Crude Lipid Content (%)	39.37 \pm 0.31
Carbohydrate Content (%)	53.4 \pm 0.43
Crude Fiber Content (%)	13.56 \pm 0.32
Zinc (mg/g)	0.018 \pm 0.02
Manganese (mg/g)	0.010 \pm 4.00
Potassium (mg/g)	1.150 \pm 0.02
Calcium (mg/g)	0.313 \pm 0.01
Sodium (mg/g)	0.904 \pm 0.01
Iron (mg/g)	0.010 \pm 2.15
Magnesium (mg/g)	0.004 \pm 0.03

Table 2 shows the results of Physical properties of the *Balanite aegyptiaca* seed oil.

Table 2: Physical properties of *Balanite aegyptiaca* seed oil

S/No.	Parameters	Properties	FAO/WHO STANDARD
1.	Color	Pale Yellow	Pale Yellow
2.	Odour	Mild	Mild
3.	% Yield	41.9	44.5
4.	Density g/cm ³	0.835	0.909
5.	Specific Gravity	0.904	0.9 – 1.16
6.	Refractive Index	1.36	1.4677 – 1.4705
7.	Viscosity	19.67	19.79

Table 3: Chemical Characteristics of *Balanite aegyptiaca* Kernel Seed Oil

S/No.	Parameter	Desert Date Kernel Oil
1.	Saponification Value	136
2.	Iodine Value	41.4
3.	Peroxide Value	37
4.	Acid Value Value	12.4
5.	Free Fatty Acid Value	13.1

Table 4 shows the GCMS analysis identified the presence of seven components in the oil as shown in table 4. The identified components were C₈H₁₆O (Octanal), Lactone, Palmitic acid,

Elaidic acid, Methyl stearate, Oleic acid and Stearic acid. Similarly, the spectrum of all the components were studied and the identified components are shown in Table 4.

Table 4: GCMS Analysis of the identified seven components in the oil

S/No.	COMMON NAME	CONCENTRATION %
1	Octanal	3.90
2	Lactone	0.97
3	Palmitic acid	25.36
4	Elaidic acid	1.23
5	Methyl stearate	0.48
6	Oleic acid	40.41
7	Stearic acid	27.65

DISCUSSION

Moisture content is one of the most important components of food processing, preservation and testing of foods. The amount of dry matter in a food is always inversely proportional to the amount of moisture it contains as such moisture content is of direct economic importance to both the consumer and processor. Of even greater significance, however, is the effect of moisture on the stability and quality of foods, with foods that contains too much water easily subjected to rapid deterioration from mold growth, bacterial attack, insect damage and sprouting (Pomeranz and Meloan 1994). The moisture content of the desert date kernel was found to be 3.1%, and this was found to be below as reported by Datti *et al.*, (2020) and Ogala *et al.*, (2018) who respectively reported moisture contents of 3.19% and 7.16%. However, the findings of this study agree with reports by Sara and Mahdi (2016) who reported a moisture content of 3.74%; Elbadawi *et al.*, (2017) reported 3.13%, and Alhassan *et al.*, (2018) also reported 4.08%. The differences could be attributed to the variety of the plant available and the soil it was grown on (Datti *et al.*, 2020).

Ash content refers to the inorganic residue remaining after either ignition or complete oxidation of organic matter in the food sample. The ash content is the measure of the total amount of minerals present within a food, with its determination along that of the mineral contents of the foods important in nutritional labelling of the food, microbiological stability and processing. It is also an important quality attribute for some food ingredients, as well as the first step in the preparation of a sample for specific elemental analysis (Datti *et al.*, 2020). The ash content of the sample analyzed was found to be 2.85%. This result was found to be in agreement with reports by (Datti *et al.*, 2020), Kibiya *et al.*, (2018) and Ogala *et al.*, (2018). Fat is an important foodstuff for many forms of life, and serves both structural and metabolic functions. They are a necessary part of the diet of both humans and animals, and the most efficient form of energy storage (Datti *et al.*, 2020). The crude fat or oil content of the kernel of the desert date was found to be 39.37% and this result is supported by similar reports by Datti *et al.* (2020) Ogala *et al.* (2018) and Kibiya *et al.* (2020). Datti *et al.* (2020) found the fat contents of Desert date seed to be 39.67. The

result is however lower than that reported by Elfeel (2010) who reported 50% fat content. Oil provides concentrated energy in the diet and enhanced palatability (Datti *et al.*, 2020). The high fat content of the kernel of the desert date is an indication that it can be a good source of fat.

Proteins are some highly complex substances present in all living organisms. They are said to be of great nutritional value, and directly involved in nearly all the chemical processes essential for life. They are also involved in growth and maintenance of the body; they cause biochemical reactions; they act as messengers; they provide structure to the body; they help in maintaining proper pH; they maintain the balance of the body fluids; they bolsters the immune health; they transport and store nutrients; they also provide energy to the body (Datti *et al.*, 2020). In this study, the percentage protein content of the kernel of the desert date was found to be 33.14% and this agrees with similar reports by Datti *et al.* (2020), Jock (2011); Lohlum (2012); Sara and Mahdi (2016); Elbadawi *et al.* (2017); Alhassan *et al.* (2018) and Ogala *et al.* (2018). Protein being an essential component of the diet required for the survival of both humans and animals (Datti *et al.*, 2020), then kernel of the desert date can serve as a source of this important nutrient.

Crude fiber is usually a measure of the quantity of indigestible lignin, cellulose and other components. It consists largely of 60-80% cellulose and 4-6% lignin, in addition to other mineral matter. There is an increasing need to include food rich in fibre diet, as they help to prevent colon cancer (Rock 2007; Haritha and Ayona 2017). Fibers also are essential in treating or preventing diverticulosis, hemorrhoids, coronary heart diseases and constipation (Chandaka *et al.*, 2017). The kernel seed analyzed in this study was found to contain an appreciable amount of crude fibre (13.56%), and this was found to agree with that reported by Datti *et al.* (2020), Jock (2011); Lohlum (2012);

Sara and Mahdi (2016); Elbadawi *et al.* (2017); Alhassan *et al.* (2018) and Ogala *et al.* (2018). Crude fiber is known to expand the inside walls of the colon, easing the passage of waste, and this makes it quite effective against constipation (Betty *et al.*, 2016).

Carbohydrates, alongside fats and proteins, are one of the three macronutrients in our diet with their main function being to provide energy to the body. Carbohydrates come in many different forms, ranging from sugars to dietary fibres, and in many different foods, such as whole grains, as well as fruit and vegetables (Datti *et al.*, 2020). The carbohydrate content of the desert date kernel analyzed in this study was found to be 7.46% and this agrees with that reported by Datti *et al.* (2020) and Ogala *et al.* (2018) who to be 7.48%. The low carbohydrate content the kernel of the desert date means that the kernel is not an excellent source of carbohydrate.

The mineral content of the desert date kernel was found to be as follows; Potassium 1.150 (mg/g), Sodium 0.940 (mg/g), Calcium 0.313 (mg/g), Zinc 0.018 (mg/g) while Iron and Manganese have a mean concentration of 0.010 (mg/g) and 0.010 (mg/g) respectively. Magnesium was found to have least concentration of 0.004 (mg/g). The results show that the kernel is rich in potassium, calcium, sodium and magnesium, while other minerals are also present in appreciable amounts. The findings in this study agree with similar findings reported by Datti *et al.* (2020), Jock (2011); Lohlum (2012); Sara and Mahdi (2016); Elbadawi *et al.* (2017); Alhassan *et al.* (2018) and Ogala *et al.* (2018). Potassium and sodium are electrolytes needed for the body to function normally and help in maintaining the fluid and blood volume of the body. However, when there is an imbalance between the two, a person may develop high blood pressure, that is by consuming too much sodium and not enough potassium (USDHHS 2015). Potassium and sodium also help in regulating the water balance

and the acid-base balance in the blood and tissues (Datti *et al.* (2020). Calcium is essential to maintaining total body health. Our bodies need calcium every day not just to keep our bones and teeth strong over but to ensure proper functioning of muscles and nerves, and also help our blood to clot. Calcium deficiency is usually due to an inadequate intake of the mineral when the blood calcium levels drop too low, as such how much calcium we get is very important to our health (Datti *et al.*, (2020). Magnesium, the fourth most common mineral in the human body after calcium, sodium and potassium, is also the second most common intracellular cation after potassium. Magnesium is a cofactor in many enzyme systems and is also required for such fundamental processes as energy production and nucleic acid synthesis, and plays an important role in the synthesis of ATP (adenosine triphosphate) from ADP (adenosine diphosphate) and inorganic phosphate (Datti *et al.* (2020). Copper helps the body form collagen and absorbs iron, and plays a role in energy production. Zinc plays a role in wound healing as well as treatment to diarrhea. Iron is a mineral that serves several important functions, its main function being to carry oxygen throughout our bodies and making red blood cells (Beard and Dawson 1997). Manganese, along with vitamin K, plays a role in blood clotting and hemostasis (Aschner and Aschner 2005). It is also an essential trace element naturally present in many foods or available as a dietary supplement, and serves as a cofactor for many enzymes (Nielsen 2012; Buchman 2014). Due to the reasonable concentrations of some of these minerals in the desert date kernel, it can easily be said the kernel can serve as an excellent supplement for these minerals for human body.

The % Yield of the seed was found to be 41.15%. This is found to be comparable to other

various seed oil (Datti *et al.* (2020), Ogala, *et al.* (2018), and Kibiya *et al.* (2020).

The result of the refractive index 1.36 is within that obtained by (Datti *et al.* (2020). This indicate that the oil is not as thick as most drying oils whose refractive index is within 1.48 – 1.49 (Kibiya *et al.*, 2020).

High saponification values indicate high proportion of lower fatty acid. The value of the saponification of the desert date seed oil was 136mg KOH/g. This indicates that the oil could be used in the manufacture of soap (Kibiya *et al.*, 2020). Which is comparable to 136 mg KOH/g as presented by Ogala, *et al.* (2018)?

Desert date seed oil can be classified as a non – drying oil as a result of its iodine value of 41.4g/100g indicates that the oil contains high level of unsaturated fatty acid and is responsible for the liquid state of the oil at room temperature. The iodine value obtained agrees with 43.1g/ 100g reported by Kibiya *et al.* (2020) and Oglala, *et al.*, (2018).

The acid and the free fatty acid values obtained from the desert date seed oil were 12.4mg KOH/g which relatively agrees with that obtained by Kibiya *et al.* (2020) and Oglala, *et al.*, (2018).

Peroxide value depends on the number of factors such as state of oxidation that is quantity of oxygen consumed, method of extraction and type fatty acid present in the oil. The seed oil has a peroxide value of 37meq/kg (Bayero, *et al.*, 2019).

The GCMS analysis identified the presence of seven components in the oil.

CONCLUSION

The results obtained from the studies revealed that *B. egyptiaca* seed oil is an economically viable oil source because its oil content was found to be high. Also, the oil has the potentials to produce biodiesel after undergoing transesterification process.

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