

Physicochemical and Phytochemical Characterization of Seed Kernel oil From Desert Date (*Balanites Aegyptiaca*)

DOI: 10.25177/JCEBC.2.1.1

Research

September 2017

Zang, C. U.¹, Jock, A. A.^{1*}, Garba, I. H.², Chindo, I. Y.²,¹Chemical & Petroleum Techniques, Department of Science Laboratory Technology, University of Jos-Nigeria²Department of Chemistry, Abubakar Tafawa Balewa University, Bauchi-Nigeria**CORRESPONDENCE AUTHOR**

Jock Asanja Alexander
 Email: alsanja@gmail.com
 Phone: +2348036055325

CONFLICTS OF INTEREST

There are no conflicts of interest for any of the authors.

Received Date: 23th Aug 2017Accepted Date: 15th Sep 2017Published Date: 25th Sep 2017

Copy rights: © This is an
 Open access article distributed
 under the terms of Creative
 Commons Attribution 4.0
 International License.

ABSTRACT

The seed oil of *Balanites aegyptiaca* was extracted and its physical, phytochemical and chemical properties which accounts for the oil quality parameters were investigated. The elemental composition of the oil revealed high metal concentration of sodium (5.9178 ± 0.2 mg/g) in the seed kernel, magnesium (2.2242 ± 0.007 mg/g) and calcium (1.4643 ± 0.5) in the seed oil. The chemical parameters evaluated include saponification value (200.02 ± 0.12 mgKOH/g), acid value (2.14 ± 0.28 mgKOH/g), iodine value (104.39 ± 0.00 100/g), peroxide value (2.95 ± 0.00 mEq/kg) and free fatty acid ($0.82 \pm 0.01\%$). The physical parameters determined were oil content, specific gravity, refractive index and moisture content. These were found to be $45.32 \pm 0.0026\%$, 0.90 ± 0.03 , 1.45 and $0.114 \pm 0.04\%$, respectively. The oil quality parameters showed that the oil is of edible quality with highest %FFA content of 0.84 % and considered non-drying oil. The fatty acids composition of the oil was evaluated using GC-MS as FAME, the oil contains about 47.52 % unsaturated fatty acids. Phytochemical screening of the oil also showed the presence of alkaloid, steroid, cardiac glycoside and carbohydrate. The seed kernel of *Balanites Aegyptiaca* is a good source of vegetable oil.

KEYWORDSSeed oil, *Balanites aegyptiaca*, Physiochemical and Phytochemical composition**INTRODUCTION**

Balanites aegyptiaca has multiple applications and almost every part of the plant is useful such as its flowers, leaves, bark, root and fruit. The tree is actually valued more for its fruits and seeds. The fruits and kernel are widely used in many countries including Nigeria especially during the dry season and drought periods (Lockett *et al.*, 2000). *Balanites aegyptiaca* is used for firewood, charcoal, poles, timber, utensils, tool handle, food, fodder (Elseed *et al.*, 2002), mulch, shade, windbreak and gum (Guinand *et al.*, 2001). The plant may be grown for its fiber, oil and/or for medicinal values. It is also

used in treatment of several diseases and disorders since ages.

Oils are heterogeneous biochemical substances which have in common, the property of being soluble in most organic polar solvents (chloroform, benzene, diethyl ether, etc) and insoluble in water (Author, 1995). Oils may be sourced from animal, vegetables or petrochemicals (Oxford, 2005). Oils are often divided into three categories according to their qualities and these categories are non-drying oils, semi drying oils and drying oils (Gunstone, 2002). Non-drying oils are slow to become oxidized, they remain liquid for a long time, and this quality makes them particularly useful as lubricants and as a fuel for lamps. Drying oils are quite quick to become oxidized and turn to solid after their oxidation. Thus, they are often used in paints and varnishes. A good example of a drying oil is linseed oil. Semi-drying oils have qualities intermediate between non-drying oils and drying oils (Mohammad and Syed, 2005). Based on the source, there are two types of oils, organic oils and mineral oils. Organic oils are produced by plants, animals and other organisms through natural metabolic processes. Organic oils which are generally laid down by plants and animals are called triglycerides and are mainly energy reserves (Albert *et al.*, 2002). Mineral oil is a type of oil which includes crude oil or petroleum and its refined components collectively termed petrochemicals (DiNardo, 2005).

The oil that is considered in this research is organic oil, a triglyceride extracted from a plant source (seed kernel of *Balanites aegyptica*) and is generally referred to as vegetable oil. These oils have been part of the human culture for millennia (McCullough, 2006). Vegetable oils apart from meeting the dietary needs of man, are also widely used in bioresources and biodiesel in recent times.

Balanites aegyptiaca seed kernel is readily available in northern Nigeria and the seed which is obtained after it is being sucked is seen as a nuisance along markets and settlements in communities. This is because no suitable application for the seed kernel has been found in most developing countries. However, the seed kernel oil of *Balanites aegyptiaca* is a good source of raw material for food, cosmetic and pharmaceutical industries.

The objective of the present study is to quantitatively determine the chemical composition, the physico-chemical properties of *Balanites aegyptiaca* seed oil and to also investigate the antimicrobial and industrial potentials of the seed kernel oil.

2. MATERIALS AND METHODS

2.1 Sample collection and preparation

The dried seeds of *Balanites aegyptiaca* were purchased from a vendors at Kwararafa market in Jos, Plateau State-Nigeria. The sample was spread under shade and sorted to remove unwanted materials. The seeds were manually crushed to remove the seed kernel from the husk shell and the kernel was then milled into powder using a ball mill.

2.2 Oil extraction

The seed kernel oil of *Balanites aegyptiaca* was extracted according to the method adopted by Mor-tadha *et al.* (2015). The solvent extraction was done using soxhlet apparatus and petroleum ether as the solvent. 200 g of the milled seed kernel was packed into a porous thimble and placed in a soxhlet extractor, using 250 mL of petroleum ether (with boiling point of about 60 – 80 °C) as extracting solvent for 8 hours repeatedly until the required quantity was obtained. A rotary evaporator was used to remove the excess solvent from the extracted oil. The oil was kept in the refrigerator without further treatment until needed for further analysis.

2.3 Ash content

The ash content was determined according to the method described by Pearson (1981). A clean dried crucible was weighed and 5 g of sample was placed on the empty crucible. The sample was heated in a Muffle furnace at 600 °C for 7 hours. The procedure was carried out in triplicate and mean was calculated. The ash content was collected as follows;

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

Where;

W_1 = Weight of crucible + sample before heating

W_2 = Weight of sample + crucible after heating

2.4 Elemental composition of oil and seed kernel

The composition of the elements were according to the method described by (AOAC, 2006). 2 g of oil sample was transferred into 100 mL beaker and 5 mL each of conc. sulphuric and nitric acids were added. 2 mL of hydrogen peroxide was also added and the mixture was heated until a clear solution was obtained. The mixture was allowed to cool down to room temperature and was filtered. The resulting solution was transferred into a 50 mL volumetric flask and then made up to the mark point with distilled water prior to AAS analysis. Similarly, 5 g of the powdered seed kernel sample was heated at 700 °C for 8 hrs. The sample was removed from the furnace after 8 hrs and placed in the desiccator to cool. The ash was then dissolved in 50 mL 2 N HCl and transferred into 100 mL volumetric flask and made up to the mark point with distilled water for elemental analysis.

2.5 Moisture content

Seed moisture content, expressed as percentage by mass, was determined by adapting the AOAC method 934.06 (AOAC, 1990). A clean dried petric dish was weighed empty and 5 g of the sample was put on it. The petric dish containing the sample was then placed in the oven at 105°C for 24 hrs. This also was done in triplicate and the mean was calculated.

$$\% \text{ Moisture} = \frac{a - b}{a} \times 100$$

where

a = Weight of petri dish + sample before drying in oven

b = Weight of dish + sample after drying.

2.6 Refractive index

The refractive index of the oil sample was determined according to the method of Cocks and VanRede (1997). The refractometer was connected to a thermostatically controlled water bath and the temperature maintained at 40°C. The oil sample was spotted onto the slide of the refractometer and viewed by rotating the knobs while the refractive index was recorded.

2.7 Specific gravity

The specific gravity of the oil was determined using a density bottle according to the methods described by (AOAC, 2000). The oil was vacuum filtered to remove any suspended particles. The weight of 50 mL empty density bottle was recorded W_o and the density bottle filled with water W_1 . Equivalent quantity of oil was replaced with the water in the same bottle and weighed W_2 . The specific density of the oil was calculated using the expression;

$$\text{Specific density} = \frac{W_1 - W_o}{W_2 - W_o}$$

Where;

W_o = Weight of empty density bottle (g)

W_1 = weight of density bottle filled with water (g)

W_2 = weight of density bottle filled with oil (g)

2.8 Saponification value

Saponification value was determined in accordance to the methods described by AOAC, 1990. 2 g of the oil sample was weighed into a 250 mL quick fit flask and 25 mL of 0.5 methanolic KOH was added. The flask was connected to an air condenser and boiled for 1 hour until all the fat was completely saponified. While the solution was still hot, it was then titrated with 0.5M HCl using phenolphthalein indicator to a colourless end point. A blank titration was carried out concurrently. The saponification value (SV) was calculated as;

$$SV = \frac{(B-S) \times N \times 56.10}{wt}$$

where;

SV = Saponification Value (mgKOH/g)

S = volume of HCl used (mL)

B = volume of HCl use for blank (mL)

N = normality of HCl

wt = weight of oil sample (g)

56.10 = Molar mass of KOH

2.9 Acid value

The acid value was determined using the method adopted was described by the British Standards Institution (BS EN ISO 660: 2009). 3 g of the oil sample was weighed into a conical flask and 50 mL of absolute alcohol added. This was heated on a water bath at 40 °C for half an hour to dissolve the oil completely. It was allowed to cool and then titrated against 0.1 M ethanolic KOH using phenolphthalein indicator until a pink colour which lasted for about 30 seconds was observed. A blank titration was carried out concurrently. The acid value was then calculated using the expression:

$$AV = \frac{(a-b)M \times 56.1}{W}$$

Where;

AV = Acid Value (mgKOH/g)

a = volume of KOH in mL for blank

b = volume of KOH in mL for test

M = molarity of KOH

W = weight of the oil sample (g)

56.1 = molar mass of KOH

2.10 Iodine value

Iodine value was determined according to AOCS recommended practice (AOCS, 1998). 0.2 g oil sample was dissolved in 15 mL carbon tetrachloride in a conical flask and 25 mL WII'S solution was added. The content was mixed vigorously then 20 mL of 10 % potassium iodide solution and 15 mL water were added. A blank was also prepared concurrently, both were placed in a dark room and allowed to stand for at least 1 hr. This was to allow for complete addition reaction between the double bonds of the oil and the liberated iodine to a pale yellow colour. At this point, a few drops of starch indicator solution were added and titrated against standard 0.1N Sodium thiosulphate to a blue end point. The iodine value was then calculated using the expression;

$$IV = \frac{M(a-b) \times 126.9 \times \frac{100}{1000}}{W}$$

where;

$I V$ = Iodine Value

126.9 = Molar mass of iodine.

M = Molarity of Sodium thiosulphate.

a = Volume (mL) of Sodium thiosulphate used for blank.

b = Volume (mL) of thiosulphate used for the test.

100/1000 = Multiplication factor as define for iodine value.

w = Weight of oil sample.

2.11 Peroxide value

The peroxide value was also determined according to AOCS recommended practice (AOCS, 1998). 5 g of the oil sample was weighed into a 250 mL round bottom flask containing 20 mL of the solvent mixture of glacial acetic acid and chloroform in a ration 2:1 v/v. The content was swelled until the sample dissolved completely and then 0.5 mL of saturated potassium iodide solution was added followed by stirring with a glass rod for one minute. The resultant homogenous solution was allowed to stand in the dark room for about 1 min after which 30 mL of distilled water was added and titrated with standard 0.01 N $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$. As soon as the yellow colour turns colourless, starch indicator 0.5 mL was added and titration continued until the blue colour changed to colourless. A blank titration was also carried out. The peroxide value was calculated by;

$$P V = \frac{1000 \times (v_1 - v_2) \times N}{W}$$

where;

$P V$ = Peroxide value (m_{eq} /kg)

W = weight of oil

V_1 = volume of $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ used for test

V_2 = volume of $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ used for blank

N = normality of the $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$

2.12 Free fatty acid

The free fatty acid of the oil was determined using the method described by Harold *et al.* (1990). 50 mL of the oil sample was placed in a beaker, neutralized methylated spirit (0.1 M NaOH was added to methylated spirit to a pink colour and then heated) and heated on a hot plate for 10 min. Phenolphthalein indicator (3 drops) was added and then titrated against 0.1 N HCl to the appearance of the first permanent pink colour which lasted for at least 30 seconds, with the same intensity as that of the neutralized alcohol before the addition of sample. The %FFA is calculated as follows;

$$\%FFA = \frac{\text{Titre value} \times M \times 28.2}{W}$$

Where,

28.2 = conversion factor in relation to oleic acid

W = Weight of sample

M = Molar concentration of HCl

2.13 Fatty acids composition of the oil

The percentage fatty acid composition of the oil was determined using the method adopted by Eqbal *et*

al., (2011). Fatty acids methyl esters of the oil were prepared by dissolving 0.5 mL of the oil in 5 mL hexane and 5 mL sodium methoxide solution was added. The mixture was stirred vigorously using a vortex stirrer for 10 seconds. The solution was allowed to stand for 10 minutes to separate out the clear solution of fatty acids methyl esters from the cloudy aqueous layer. The upper layer was then collected carefully into a sample bottle and the fatty acids composition of the oil was determined by injecting its fatty acids methyl esters into a gas chromatographic mass spectrophotometer analyzer according to the conditions prescribed by Hale and Belgin (2011). GC-MS incorporated with an auto sampler and Real Time Analysis software system was used for analysing FAME. The split ratio was 1:20 and the flow-rate of carrier gas (helium) 2 mL/min. The injector and detector temperatures were fixed at 250°C. The temperature programme for the column was: held at 60°C for 1 min and increased by 13°C/min to 175°C. Thereafter, it was increased at 4°C/min to 215°C, and then held at 215°C for 35 min., the total runs were 86 minutes. The mass spectrometer was operated in EI mode at 70 eV scanning at a range 30-500 m/z in a 1 s cycle, in a full scan acquisition mode. Comparing with the MS self-contained chromatogram library, the species of every group were identified, and the relative proportion of each species (%) was obtained by dividing the individual peak area with the total peaks areas.

2.14 Phytochemical screening of the seed kernel oil

Phytochemical analysis of the oil was carried out using standard procedures prescribed by Vishnol (1979), Sofowora (1993) and Harborne (1998). The phytochemicals determined include; alkaloid, saponin, tannin, anthraquinone, cardiac glycoside, flavonoids, carbohydrate and steroid.

2.15 Bacteria Sensitivity Test

Two methods were used for the bacteria sensitivity test i.e, Well and Disk methods. In the Well method, the agar well dilution method was used as prescribed by Lino *et al.* (2006). A colony of individual organisms was emulsified in 5 mL of sterile nutrient broth and incubated at 37 °C for 3 hrs. This was diluted out to have a faint turbidity to avoid heavy inoculum and over growth. The inoculum was flooded on sterile Mueller Hinton Agar plates for each organism and was tested for with direct extract and solvent extract. The all four plates were used for each organism. The plates were then swirled to allow the inoculums to spread over the entire surface of the Agar. After allowing absorption of the inoculum onto the media, the Agar was allowed to dry in an incubator (Aboaba, *et al.*, 2006). Wells of 6 mm were punched into the agar with a sterile corn borer for each organism. Using a sterile pasture pipette, each well was filled with 0.1 mL of the oil at dilution concentrations of 1/10, 1/100 and 1/100 mL. The same volumes of the undiluted oil and 10 ug/mL *penicillin* anti-biotic were filled into the respective holes bore; this was labeled at the back of the plates (Jorgensen and Turnidge, 2007). The entire preparation was allowed to stand on the bench for 3hrs for the extract to settle and possibly diffused into the medium. The plates were inverted and incubated at 37 °C for 24 hrs for bacterial growth and observation.

The Disc method was done using a filter paper which was perforated into small circles to make a paper disc. It was then sterilized by autoclaving. Each disc was soaked in the diluted extract and placed on the plate flooded with the inoculums according to the dilution factor labeled at the back of the plates. The same was done for the neat and the antibiotic. The plates were incubated immediately at 37 °C for 24 hrs for observation.

Table 1: Trace elements concentration in the seed kernel and seed kernel oil of *Balanites aegyptica*.

Element		
	Seed kernel (mg/g)	Seed oil (mg/g)
Co	0.2623±0.0002	0.1714±0.0003
Pb	0.0021±0.0002	0.0022±0.0001
K	0.5929±0.0003	0.2074±0.0004
Na	5.9178±0.2000	0.6262±0.0200
Zn	4.1864±0.2000	0.0500±0.0010
Mg	0.3109±0.0040	2.2242±0.0070
Cu	0.0225±0.0020	0.0038±0.0001
Ca	2.4977±0.0700	1.4643±0.5000
Cr	0.3224±0.0200	0.1055±0.0001
Mn	0.5189±0.0800	0.0230±0.0004

3. RESULTS

The results of the concentration of trace metals in seed kernel and seed kernel oil of *Balanites aegyptiaca* are shown in Table 1. The presence of trace metals is an important factor as far as the quality of edible oil is concerned. Metallic elements such as Na, K, Ca, Mg, Fe, Cu, Zn and Mn are essential human nutrients mainly for growth. Cd, Cr, Co, Ni and Pb pose detrimental effects on health of plants and animals even in relatively small amounts (Pehlivan *et al.*, 2008). The metal with highest concentration in the seed kernel was sodium (5.92±0.20 mg/g), followed by zinc (4.19±0.2 mg/g) while the highest in the seed kernel oil was magnesium (2.220±0.007 mg/g) and followed by calcium (1.46±0.5 mg/g). These metals are required in the body for certain metabolic functions. Lead has the lowest concentration 0.0021±0.0002 mg/g and 0.0022±0.0001 mg/g in the seed kernel and seed kernel oil respectively. Lead is one of the most toxic heavy metals. The toxicity of lead to human is well known, it replaces calcium and consequently, can accumulate in the skeletal system. Exposure of human to lead is associated with various neurodevelopmental effects, cardiovascular diseases, impaired renal function and fertility, hypertension and adverse pregnancy outcomes (Jock *et al.*, 2016). However, lead concentration in the seed kernel and seed kernel oil was within admissible limit of 0.01 mg/g by World Health Organization (Gebrekidan and Samuel, 2011).

The quality assessment of *Balanites aegyptiaca* seed kernel oil was analyzed by evaluating the physico-chemical properties such as oil content, specific gravity, refractive index, free fatty acid, peroxide, iodine and saponification values as presented in Table 2. The oil content was found to be 45.32% above the limit for most oil seed crops (Pritchard, 1991). This shows that the oil content is high and is a factor that is favourable for industrial application.

The specific gravity of the seed kernel oil of *Balanites aegyptiaca* was 0.90±0.00 while the refractive index was 1.45. These values are in close agreement with the FAO/WHO international standard for edible oil shown in Table 2.

Table 2: Oil quality assessment of *Balanites aegyptiaca* seed kernel oil and Comparison with FAO/WHO Standard values.

Parameter	Desert date	*FAO/WHO Standard
Oil content (% w/w)	45.32±0.0026	-
Specific gravity	0.90±0.03	0.9-1.16
Refractive index	1.45	1.4677-1.4705
Saponification value (mgKOH/g)	200.02±0.12	181.4±2.60
Peroxide Value (mEq/kg)	2.95±0.00	<10
Acid Value (mgKOH/g)	2.14±0.28	4
Iodine Value 100/g	104.39±0.00	80-106
Free Fatty Acid (%)	0.82±0.01	5.78-7.28

*Adegbe *et al.* (2016)

The Free fatty acids (FFA), acid value and peroxide values are important parameters in evaluating the quality of fats and oils with respect to rancidity and oxidation. The acid value of *Balanites aegyptiaca* seed kernel oil was 2.14±0.28 mg KOH/g while the free fatty acids value was 0.82±0.01 mg KOH/g. Acid value was determined to quantify the fatty acid found in the oil as it measures the free fatty acids of oil. The acid value was low (2.14±0.28 mg KOH/g) and this shows that the oil is stable (Haftu, 2015). Oils with high acid value, also implied high % FFA and will undergo rancidity due to the hydrolysis of the free fatty acids on storage. The acid value and % FFA of *Balanites aegyptiaca* seed kernel oil are lower than FAO/WHO standard for edible oils (Table 2). The low %FFA reduces the tendency of the oil to undergo hydrolytic activities. In most oils, the level of free fatty acid which causes deterioration is noticed when the %FFA calculated as oleic acid falls within the range of 0.5 - 1.5% (Manji *et al.*, 2013).

Saponification value is an index of average molecular mass of fatty acid in the oil sample. The saponification value obtained for *Balanites aegyptiaca* seed kernel oil was 200.02mgKOH/g. The value is within the range of 195–205 mg KOH/g for edible palm oils (Erum, *et al.*, 2017). The saponification value of oil serves as an important parameter in determining the suitability of the oil for soap making.

Peroxide value is used as a measure of the extent to which rancidity reactions have occurred during storage it could be used as an indication of the quality and stability of fats and Oils. The peroxide value determined for the seed kernel oil of *Balanites aegyptiaca* is 2.95 mEq/g and is lower than FAO/WHO standard shown in Table 2. A low peroxide value in the present study increases the suitability of the oil for a long storage due to low level of oxidative and lipolytic activities (Adegbe *et al.*, 2016).

Iodine value measures the degree of unsaturation in a fat or vegetable oil. It determines the stability of oils to oxidation and allows the overall unsaturation of the fat to be determined qualitatively. The iodine value of the seed kernel oil was 104.39 gI/100g which is within the range of FAO/WHO standard shown in Table 2. Generally, oils having iodine value below 100 are non-drying, those having values between 100 -130 are semi-drying and those having values above 130 are termed drying oils (Asuquo, 2008). The oil of *Balanites aegyptiaca* will then serve as semi-drying oil which is also com-

Table 3: Comparison of the physical characteristics of seed kernel oil of *Balanite aegyptiaca*

Moisture content (%)	Ash content (%)	Oil content (%)	Specific gravity	Refractive Index	Reference
7.23±0.06	8.65±0.11	-	-	-	Ajayi & Folorunsho (2013)
	3.98	-	-	-	Lohlum, <i>et al.</i> , (2012)
8.45±0.03	4.40±0.02	-	-	-	Ajayi & Ifedi (2014)
-	-	-		1.46	Okia <i>et al.</i> (2013)
3.74 ± 0.69	2.88± 0.13		0.9132±0.0006		Elbadawi <i>et al.</i> (2017)
3.10 ± 0.03	3.19 ±0.06	42.95±0.48	0.9109±0.9109	1.483±0.0153	Sara & Mahdi (2016)
17.65	-	87	0.90	-	Haftu, 2015
0.27	-	49.9	0.927	1.4784	Manji <i>et al.</i> (2013)
0.114±0.04	4.77±0.01	45.32±0.0026	0.90±0.03	1.45	Present study

Table 3 shows comparison of the physical characteristics of seed kernel oil of *Balanite aegyptiaca* by different authors and present studies. The seed contains low moisture content (0.114±0.04 %) as compared to other studies (Table 3). This means, the seed kernel of *Balanites aegyptiaca* can be stored for an extended time under suitable condition without deterioration. The moisture content of the oil is low, an indication that its stability is guaranteed. Oil seeds deteriorate as a result of high moisture content; this happens when heat is generated by oxidation reaction and increases the temperature of the stored seed thereby accelerating deterioration even to the point of charring the seed. Moisture content gives an indication of a food shelf life and nutritive value, hence low moisture content is a requirement for long storage life (Aurang *et al.*, 1987).

The ash content of the seed kernel is 4.77±0.01 % and is similar with previous studies shown in Table 3. This is the measure of the total amount of minerals present in a food. The mineral content of a food is a measure of the amount of specific inorganic components present and ash is the inorganic residue remaining after the water and organic matter have been removed. *Balanites aegyptiaca* seed kernel ash content is lower when compared with cotton seed (4.56%) as reported by Muhammad *et al.*, (2012). This shows a reasonable amount of mineral content in the seed kernel.

Table 4 shows GC-MS and identities of the fatty acids present in the seed kernel oil of *Balanites aegyptiaca*. The most prominent of the fatty acids are palmitic acid (16:0) (20.51%), oleic acid (18:1) (28.32%), linoleic acid (18:2) (19.20%) and stearic acid (18:0) (15.97%). The oil contains about 47.52% unsaturated fatty acid which makes it a good edible oil. Moreover, there are some compounds not included which were in minor and traced amounts while others may be due to complication in their chemical nature. However, oils with high degree of un-saturation are considered good for the heart because it decreases total cholesterol and low density lipoproteins. A high dietary intake of saturated fatty acids (SFAs) is a risk factor for development of obesity and cardiovascular disease (Gillian *et al.*, 2008).

Table 4: GC-MS analysis of the seed kernel oil of *Balanites aegyptiaca*

Peak No	Retention Time (Mins)	Percent Composition	Masses of fragment ions (M/Z) (% Abundance) in order of decreasing abundances
11	18.87	20.51	EI 270(M ⁺ ;20), 74(100), 87(60), 41(25), 227(20), 57(20), 101(10), 143(10).
12	20.58	19.20	EI 294(M ⁺ ;5), 67(100), 81(75), 54(40), 95(35), 109(20), 122(5), 136(5),.
13	20.72	28.32	EI 296(M ⁺ ;10), 41(100), 55(80), 74(55), 69(55), 96(35), 264(30), 266(20) 222(20),123(15), 180(10), 137(5).
14	22.17	15.97	EI 279(M ⁺ ;2), 81(100), 55(95), 67(90), 41(60), 99(50), 121(35), 136(20), 164(10), 149(10).
15	22.47	1.93	EI 326(M ⁺ ;35), 74(100), 87(75), 43(40),, 57(20), 283(15), 143(10), 101(10), 227(5), 129(5), 241(3), 295(2), 255(2).

The result of phytochemical screening test of the seed kernel oil of *Balanite aegyptiaca* is shown in Table 5. The oil revealed strong presence of steroids. Carbohydrates, cardiac glycosides and alkaloids were also present, while anthraquinones, saponins, tannins and flavonoids were absent in the seed kernel oil. These phytochemicals may be responsible for the application of the oil in treating certain skin infections (Daya *et al.*, 2011).

Table 5: Phytochemical screening of *Balanite aegyptiaca* seed kernel oil

Phytochemicals	Observation
Steroids	+++
Anthraquinones	-
Saponins	-
Tannins	-
Flavonids	-
Carbohydrates	+
Cardiac glycosides	+
Alkaloids	+

Key: + = present; +++ = strong presence; - = absent

Table 6: Bacteria sensitivity test of *Balanites aegyptiaca* seed kernel oil

Bacteria	Dilution Factors				Penicillin
	1/10	1/100	1/1000	Neat	
<i>Proteus mirabilis</i>	-	-	-	-	++
<i>Escherichia coli</i>	-	-	-	-	++
<i>Pseudomonas aeruginosa</i>	-	-	-		+
<i>Staphylococcus aureus</i>	-	-	-	-	+++

The bacteria and fungi sensitivity test carried out on the four fungi and bacteria is summarized in Table 6. There was no inhibition of any of the microorganism by the seed kernel oil of *Balanites aegyptiaca*. Daya and Vaghasiya (2011) reported the use of this oil in the treatment of some bacteria and the lack of inhibition shown in the analysis could be as a result of the difference in the method of oil extraction and variation in the properties of the seed kernel oil of *Balanites aegyptiaca* as reported by Elfeel (2010). Elfeel *et al.* (2006) also reported a morphological variation and chemical characteristics of fruits and seeds of *Balanite aegyptiaca* within different geographical source in Sudan. Variation in diosgenin level was also reported by Bishnu *et al.*, (2005) within different province.

CONCLUSION

The present study on the chemical composition, physicochemical properties, and phytochemical characterization of oil from *Balanites aegyptiaca* seeds suggest that the seed of this plant has high oil content and it can be a good source of raw material for many oil based products (soap, shampoo, biodiesel, lubricants, etc). The oil could also be utilized successfully as a source of edible oil for human consumption as it makes a good dietary source of magnesium and calcium. Generally, the seed oil exhibited good physio-chemical properties and could be useful for industrial applications

REFERENCES

1. Aboaba, O. O., Smith, S. I. and Olude, F. O. (2006). Antibacterial effect of edible plant extracts on *Escherichia coli*, Pakistan Journal of Nutrition, 5(4):325 – 237.
2. Adegbe, A. A., Larayetan, R. A. and Omojuwa, T. J. (2016). Proximate Analysis, Physicochemical Properties and Chemical Constituents Characterization of *Moringa Oleifera* (Moringaceae) Seed Oil Using GC-MS Analysis. American Journal of Chemistry, 6(2): 23-28
3. Ajayi, I. A. and Ifedi, E. N. (2014). Short toxicological analysis and effect of total replacement of wheat with *Balanite aegyptiaca* seed cake on albino rats. Journal of applied Chemistry, 7(7):74 – 79.
4. Ajayi, I. A. and Folorunsho, A. F. (2013). Evaluation of the toxicological status of *Balanite aegyptiaca* seed oil. Advances in life science and Technology journal, 10(1): 2224 – 2225.
5. Albert, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. (2002). Molecular Biology of the cell. Garland sciences New York, 62(1):118–119.
6. AOAC, 1990. Official method of analysis of the Association of Official Analytical Chemist. AOAC International, Arlington (USA), No 934.06.
7. AOAC, 2006. Association of Official Methods of Analytical Chemists, W. Horwitz Editor Eighteen Edition, Washington, DC, USA.
8. AOAC, Official Methods of Analysis, 2000, 13th ed. Association of Official Analytical Chemist Pub., Washington D.C., USA.
9. AOCS, 1998. Official Methods and Practices of the AOCS, fifth ed. AOCS Press, Champaign, USA.
10. Aurand, L. W., Wood, A. E. and Wells, M. R. (1987). Food composition and Analysis. Van Nostrand Reinhold, New York, 20-23

11. Asuquo, J. E. (2008). Studies on the Adsorption of Some Selected Metallic Soaps onto Hematite. Ph.D. Dissertation, University of Port Harcourt, Nigeria.
12. Author, C. C. (1995). Lipid-based fats substitutes. Critical Review Science Nutrients journal, 35(5):4-5.
13. Bishnu, C. and Zeev, W. (2005). Variation in diosgenin level in seed kernels among different provenances of *Balanite aegyptiaca* Del (Zygophyllaceae) and its correlation with oil content. African Journal of Biotechnology, 4(11):1209-1213.
14. Cocks, L. V. and VanRede, C. (1997). Laboratory Handbook for oil and fats analysis. Academia press London. 67
15. Daya, L. C. and Vaghasiya, H. U. (2011). A review on *Balanite aegyptiaca* Del (Desert date) phytochemical constituents, traditional uses and pharmacological activity. Journal of Pharmacogn Rev, 5(9): 55-62.
16. DiNardo, J. C. (2005). Is mineral oil comedogenic? Journal of cosmetic Dermatology, 4(1): 2-3.
17. Elbadawi, S.M.A., Ahmad, E.E.M., Mariod, A.A. and Mathaus, B. (2017). Effects of thermal processing on physicochemical properties and oxidative stability of *Balanites aegyptiaca* kernels and extracted oil, GRASAS Y ACEITES 68 (1): 1-7
18. Elfeel, A. A. (2010): Variability in *Balanites aegyptiaca* var. *Aegyptiaca* seed kernel oil, protein and minerals contents between and within locations. Agricultural Biotechnological journal of North America, 1(2): 170 – 174.
19. Elfeel, A. A. and Warrang, E. I. (2006). Variation in morphological and chemical characteristics of fruits and seeds among eleven geographical sources of *Balanite aegyptiaca* (L). Dell. Sudan Silva, 12(1): 21-40
20. Elseed, A. M. A. F., Amin, A. E., Khadija, A. A., Ali, J. S., Hishinum, M. and Henana, K. (2002). Nutritive evaluation of some fielder tree species during the dry season in Central Sudan. Asian Aust. Journal Animal Science, 15(6): 844-850.
21. Eqbal, M.A. D., Halimah, A.S., Abdulah, M.K. and Zalifah, M.K. (2011). Fatty acids composition of four different vegetable oils (Red palm olein, olein, corn oil and coconut oil) by GC. 2nd International Conference on Chemistry and Chemical Engineering, 14(1): 31–34.
22. Erum, Z., Rehana, S., Mehwish, A. H. and Anjum, Y. (2017). Study of physicochemical properties of edible oil and evaluation of frying oil quality by Fourier Transform-Infrared (FT-IR) Spectroscopy. Arabian Journal of Chemistry, 10: S3870–S3876.
23. Gebrekidan, M., and Z. Samuel. (2011). Concentration of heavy metals in drinking water from urban areas of the Tigray region, Northern Ethiopia. Momona Ethiopian Journal of Science 3 (1): 105–21.
24. Gillian, B. H., Jacob, N., Tina, S., Chris, S., Mick, D. E., Roy, S. and Carlo, L. (2008). Fatty acid and fat soluble antioxidants concentrations in milk from high and low- input conventional and organic system: Seasonal variation. Journal of Science, Food Agriculture, 88: 1431 – 1441.
25. Guinand, Y. and Lemessa, D. (2001). Reflection on the role of wild food and famine foods at a time of drought. Wild foods plants in Ethiopia. Workshop proceedings. USAID/OFDA. Mombassa, Kenya. <http://www.africa.upenn.edu/faminefood/> Retrieved on 3/09/2014.
26. Gunstone, F. D. (2002): Vegetable oils in food Technology: Composition properties and uses. Blackwell Publishing. 87.
27. Haftu G.A. (2015). Physico-chemical characterization and extraction of oil from *balanites aegyptiaca* plant (seed). World Journal of Pharmaceutical Research, 4(11): 1723-1732.
28. Hale, S. and Belgin, B. (2011). Determination of Fatty Acid, C, H, N and Trace Element Composition in Grape Seed by GC/MS, FTIR, Elemental Analyzer and ICP/OES. SDU Journal of Science, 6 (2): 140-148
29. Harborne, J. B. (1998): Phytochemical methods. A guide to modern technique of plant analysis. Chapman & Hall London. 260-269.
30. Harold E, Ronald JK, Sawyer R (1990). Pearson's Chemical Analysis of Food (18th ed). Longman Science Technology: 513-514.
31. International Union of Pure and Applied Chemistry. (1990). Technical Reports and Recommendations
32. Jock, A.A., Muhammad, Z.A.A., Abdulsalam, S., El-Nafaty, U.A. & Aroke, U.O. (2017). Insight into kinetics and thermodynamics properties of multicomponent lead(II), cadmium(II) and manganese(II) adsorption onto Dijah-Monkin bentonite clay. Particulate Science and Technology: 1-10.
33. Jorgensen, J. H. and Turnidge, J. D. (2007): Antibacterial susceptibility tests, dilution and disk diffusion methods manuel. Clinical Microbiology 9th ed. Washington DC. American Society for Microbiology, 1152-72.
34. Lino, M. C. R., Radman, R.; Bert, B., Misula, L., Lenon, G., Holmbom, B., Locke, I. C., Locke, S., Thompson, S. and Keshavarz, T. (2006). Biological activity of industrial wood and bark waste from *pinus migra*. Post-presented at the X International congress phytopharm, 27–30 Russai.
35. Locket, C. T., Calvert, C. C. and Grivetti, L. E. (2000). Energy and micronutrients composition of dietary and medicinal wild plants consumed during drought. Study of rural Fulani, North eastern Nigeria. Interna-

- tional journal of food sciences, 51(3): 195-208.
36. Lohlum, S. A., Forcados, E. G.; Agida, O. G., Ozele, N. and Gotep, J. G. (2012). Enhancing the chemical composition of Balanite aegyptiaca seeds through ethanol Extraction for use as a protein source in feed formulation. Sustainable Agriculture Research journal, 1(2):1927-1932.
 37. Mortadha, A. A., Tahseen, A. A., Imad A. A. (2015). Extraction of date palm seed oil (phoenix dactylifera) by soxhlet apparatus. International Journal of Advances in Engineering & Technology, 8(3): 261-271
 38. Manji, A. J., Sarah, E. E. and Modibo U. U. (2013). Studies on the potentials of Balanites aegyptiaca seed oil as a raw material for the production of liquid cleansing agents. International Journal of Physical Science, 8(33):1655-1660.
 39. McCullough, B. (2006). Indiana Archaeo News, 4000-year-old Kitchen unearthed. <http://www.stonepages.com/news/archives>. Retrieved 24/08/2014.
 40. Mohammad, A. and Syed, M. N. (2005). Taxonomic perspective of plant species yielding vegetable oils used in cosmetics and skin care productions. African journal of Biotechnology, 4(1): 36–44.
 41. Muhammad, A. N., Tariq, M. and Syed, S. S. (2012). Evaluation of oil seeds for their potential Nutrients. ARPN Journal of Agricultural and Biological Sciences, 7(9): 1990 -6145.
 42. Okia, C. A., Kwetegyeka, J., Okiror, P., Kimondo, J. M., Teklehaimanot, Z. and Obua, J. (2013). Physicochemical characteristic and fatty acid profile of Desert Date kernel oil. African crop science journal, 21 (3):723 – 734.
 43. Oxford English Dictionary 3rd ed. (2005).Oxford University press.
 44. Pearson, D. (1981).The Chemical Analysis of Food (8Ed).J. A. Churchill London .535.
 45. Pehlivan, E., Arslan, G., Gode, F., Altun, T., Musa, M. and Özcangrasas, Y. A. (2008). Determination of Some Inorganic Metals in Edible Vegetable Oils by Inductively Coupled. julio-Septiembre, 59(3): 239-244.
 46. Pritchard, H.W. (1991). Water potential and embryonic axis viability in recalcitrant seeds of Quercus rubra. Ann Bot 67:43–49
 47. Sara, M.E.F and Mahdi, A.S.S. (2016). Physicochemical Properties of Balanites aegyptiaca (Laloub) Seed Oil. Journal of Biological Science, 2(4):1-10.
 48. Sofowora, A. (1993). Medicinal plant and Traditional Medicine in Africa 2nd ed. John Wiley and sons. New York USA. 6 – 65.
 49. Vishnoi, N. R. (1979). Advanced practical chemistry. Ghaziabad – India. Yikab Publication house. 47-449.