Scientific Research Publishing

American Journal of Analytical Chemistry, 2018, 9, 423-437
http://www.scirp.org/journal/ajac
ISSN Online: 2156-8278
ISSN Print: 2156-8251

Application of Desert Date (*Balanites aegyptiaca*) Seed Oil as Potential Raw Material in the Formulation of Soap and Lotion

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How to cite this paper: Zang, C.U., Jock, A.A., Garba, H.I. and Chindo, Y.I. (2018) Application of Desert Date (*Balanites aegyptiaca*) Seed Oil as Potential Raw Material in the Formulation of Soap and Lotion. *American Journal of Analytical Chemistry*, **9**, 423-437.
https://doi.org/10.4236/ajac.2018.99033

Received: July 30, 2018
Accepted: September 17, 2018
Published: September 20, 2018

Abstract

Balanites aegyptiaca has multiplicity of uses and almost every part of the plant is useful including its flowers, leaves, bark, root and fruit. In this study, oil from Desert date (*Balanites aegyptiaca*) kernel seed was extracted, analyzed and used in the formulation of soap and lotion. The physical parameters determined were oil content, specific gravity, refractive index and moisture content. These were found to be 45.32% ± 0.0026%, 0.90 ± 0.03, 1.45% and 0.114% ± 0.04%, respectively. The chemical parameters evaluated include saponification value (200.02 ± 0.12 mg KOH/g), acid value (2.14 ± 0.28 mg KOH/g), iodine value (104.39 ± 0.00 100/g), peroxide value (2.95 ± 0.00 mEq/kg) and free fatty acid (0.82% ± 0.01%). The oil quality assessments test indicates %FFA content of 0.84% and the fatty acids composition of the oil was evaluated using GC-MS as FAME; the oil contains about 47.52% unsaturated fatty acids. The seed kernel of *Balanites aegyptiaca* is a good source of vegetable oil. Soap formulated from the oil is considered a good soap based on the soap quality parameters determined. Lotion formulated has a good stability when subjected to lotion stability test.

Keywords

Balanites aegyptiaca, Oil, Formulation, Soap

1. Introduction

Balanites aegyptiaca is used for firewood, charcoal, poles, timber, utensils, tool handle, food, fodder [1], mulch, shade, windbreak and gum [2]. The plant may be grown for its fiber, oil and for medicinal values; it is also used in treatment of

several diseases and disorders since ages. *Balanites aegyptiaca* seed kernel oil falls in the group of such oils termed as vegetable oils since it is extracted from a plant source. The chief importance of vegetable oils lies in their food value [3]. The seed kernel is considered as an extremely useful edible product, it is rich in oil, protein, minerals and it has been reported to be used for over thousands of years [4].

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 [5]. The term lipid is the scientific name for fatty acids and similar chemicals often found in oils produced by living things. They may contain diethyl-glycerol, free fatty acids, phosphatides, sterols and fat-soluble vitamins like tocopherol, pigments, waxes and fatty alcohol are present but as minor components [6]. Oils may be sourced from animal, vegetables or petrochemicals [7]. All oils and fats are made up of a mixture of these triglycerides [8]. The character of a particular oil or fat depends on the actual fatty acids present in the individual triglyceride molecules. Some of these fatty acids have longer carbon chains than others and exist as saturated, mono-unsaturated or polyunsaturated fatty acids. Fats are chiefly made up of saturated fatty acids while oils are chiefly made up of unsaturated fatty acids. Although many different parts of plants may yield oil, in commercial practice, oil is extracted primarily from seeds of plants which grow in many different parts of the world [9]. The commonest fats and oils are obtained from various domesticated plants and animals. They are important in food industries, Oleo-chemical industries and in other industries.

The largest vegetable oil sources are the oil seed crops of soya bean, rape seed, sun flower and cotton seed. These are grown in tropical or warm climates as well as temperate climates [10]. Many compounds in oil seeds have proven nutritional benefits with great possibilities for using them to develop new functional vegetable oils. Vegetable oils are now available with improved levels of vitamin E and phytosterols (Sterols derived from plants). They are present in all plants and in food products of plant origin. Vegetable oils are the richest natural sources of phytosterols. Among the vegetable oils, corn and rapeseed contain the highest amounts of phytosterols [8]. Vegetable oils are very important ingredient in many manufactured products; it acts as emulsifiers, lubricants, plasticizers, surfactants, plastics solvents and resins.

Soaps are compounds that consist of long chain of hydrocarbons attached with a carboxylic acid which is ironically bonded to the metal ion usually sodium or potassium, it is a combination of animal fat or plant oil with caustic soda. Soaps are therefore called the salts of fatty acids which are usually used as surfactants for washing, bathing and cleaning [11]. Soaps are obtained by the treatment of vegetable oils or animal fats with a strong alkaline solution. The three molecules of fatty acids in the triglyceride gets attached to a single molecule of glycerol and results in a chemical reaction termed saponification [12]. Soaps are used on a day to day basis in households and their physicochemical properties

will be determined its quality, efficiency and cleaning properties [13]. Lotions are low to heavy viscosity topical substances that are intended for application to unbroken skin. They are formulated not as medicines but simply to smoothen, moisturize and soften the skin. Most lotions are oil in water although water in oil formulations is also possible. The key components of a skin care lotion, cream or gel emulsion are the aqueous and oily phases [14].

Balanites aegyptiaca seed kernel is readily available in northern Nigeria and the use of the seed is not popular in areas where it is produced. This research attempts to use the seed kernel oil of *Balanites aegyptiaca* as a good raw material for the production of soap and body lotion.

2. Materials and Methods

2.1. Oil Characterization

The dried seeds of *Balanites aegyptiaca* (100 kg) were purchased from 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.

The fresh seed kernel oil of *Balanites aegyptiaca* was extracted by both solvent and mechanical methods. The solvent extraction was done using soxhlets apparatus and petroleum ether as the solvent. The milled seed kernel (200 g) was packed in the thimble; 250 ml of petroleum ether (boiling point 60˚C - 80˚C) was transferred into a 500 ml round bottom flask which was place on a heating mantle and temperature maintained at 80˚C. The entire set-up was allowed for continuous extraction for 8 hrs. After exhaustive extraction the content of the round bottom flask was transferred into a quick fit flask of a rotary evaporator and oil separated from the solvent.

2.1.1. Moisture Content of Oil

The moisture content was determined according to [15]. A clean dried Petri dish was weighed and 5 g of the sample was placed in it. It was then placed in the oven at 105˚C for 24 hrs. This also was done in triplicate after which the average was calculated.

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

where

W_1 = Weight of sample before drying.

W_2 = Weight of sample after drying.

2.1.2. Refractive Index

The refractive index of the oil sample was also determined according to the method prescribed [16]. The refractometer was connected to a thermostatically controlled water bath that maintained the temperature of the refractometer 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.

2.1.3. Specific Gravity

The specific gravity of the oil was determined by conventional method. The oil was vacuum filtered to remove any suspended particles. The weight of 50 mL empty density bottle was taken and recorded, w_o. The density bottle was first filled with water, weighed and recorded, w_1. An equivalent quantity of oil was replaced with the water in the same bottle and weighed as w_2. The specific density of the oil was determined as follows;

$$\text{Specific density} = \frac{w_1 - w_0}{w_2 - w_0}$$

where;

w_0 = 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).

2.1.4. Saponification Value

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 with 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 0.5 M 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 (mg KOH/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.

2.1.5. Acid Value

3 g of the oil sample was weigh into a conical flask and 50 mLof 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 at least 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 (mg KOH/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.

2.1.6. Iodine Value

The oil sample 0.2 g was dissolved in 15 mL carbon tetrachloride in a conical flask and 25 mL WIJ'S solution was added and stopper. The content was mixed vigorously and 20 mL of 10% potassium iodide solution and 15 mL water was 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 as follows;

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

where;

IV = 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.

2.1.7. Peroxide Value

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 (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 $Na_2S_2O_3{\cdot}5H_2O$. 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;

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

where;

PV = Peroxide value (m_{eq}/kg).

W = weight of oil.

v_1 =volume of $Na_2S_2O_3 \cdot 5H_2O$ used for test.

v_2 = volume of $Na_2S_2O_3 \cdot 5H_2O$ used for blank.

N = normality of the $Na_2S_2O_3 \cdot 5H_2O$.

2.1.8. Free Fatty Acid

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) was added to the oil sample and heated on a hot plate for 1.0 min. Phenolphthalein indicator (3 drops) were added and then titrated against 0.1 N HCl vigorously 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.

2.1.9. Fatty Acids Composition of the Oil

The percentage fatty acid composition of the oil was determined using the method adopted by [17]. Fatty acids methyl esters of the oil were prepared by dissolving 0.5 mL of the oil in 5 mL hexane, 5 mL sodium methoxide solution was also 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 analyzing 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 chromato-gram 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.

2.2. Soap Formulation

The soap was formulated according to the method prescribed by [18]. 100 g of

Balanites aegyptiaca seed kernel oil was weighed into a 500 mL beaker and heated to 100˚C. 20 mL of 60% NaOH solution was gradually added while stirring until complete saponification was achieved. The soap paste was then transferred into a cast and allowed for complete drying.

2.2.1. Performance Evaluation of Soap

The performance evaluation test of the soap was carried out by the blender method of determining foam volume, density, stability and lubricity [19]. The soap solution 10% was prepared and transferred into a blender and agitated for 10 seconds at medium speed. The foam generated was then transferred into a calibrated measuring cylinder and a rubber stopper which is slightly smaller than the diameter of the measuring cylinder was gently dropped into the foam. The time for the rubber stopper to pass between two points (100 and 80 mL) was measured. The rate at which the stopper falls was dependent on the upward pressure and this upward pressure is inversely proportional to the size of the bubbles. It implies that the denser the foam, the slower the fall of the rubber stopper.

2.2.2. Total Fatty Matter (TFM)

The method described by [18] was used. The total fatty matter test was carried out by reacting soap with acid in the presence of hot water and measuring the fatty acids obtained. 10 g of finished soap was weighed and 150 mL distilled water was added and heated. The soap was dissolved in 20 mL of 15 % H_2SO_4 while heating until a clear solution was obtained. Fatty acids on the surface of the resulting solution was solidified by adding 7 g of bee wax and reheated. The set up was allowed to cool to form cake which was removed and blotted to dryness and the total fatty matter was obtained as follows;

$$\%TFM = \frac{(A - X) \times 100}{W}$$

where;

A = weight of wax + oil.

X = weight of wax.

W = weight of soap.

2.2.3. Total Alkali

The total alkali was determined by titrating excess acid contained in the aqueous phase with standard volumetric NaOH solution [20]. 10 g of the finished soap was weighed and 100 mL of neutralized alcohol was added to it, 5 mL of 1 N H_2SO_4 solution was added to the mixture and heated till the soap sample dissolved. The test solution was titrated against 1 N NaOH using phenolphthalein as indicator. The total alkali was obtained using the formula;

$$\%\text{Total alkali} = \frac{V_A - V_B \times 3.1}{W}$$

where:

VA = Volume of acid.

VB = Volume of base.

W = weight of soap.

3.1 = milliequivalent of Na_2O.

2.2.4. Free Caustic Alkali

A method prescribed by [21] and modified by [18] was used. 5 g of the finished soap was weighed and dissolved in 30 mL of ethanol. Few drops of phenolphthalein indicator were added and 10 ml of 20% $BaCl_2$ was also added. The resulting solution was titrated against 0.05 M H_2SO_4. Free caustic alkali was calculated as follows;

$$\text{NaOH} = \frac{3.1 \times V_A}{W}$$

where;

V_A = Volume of acid.

W = weight of soap.

3.1 = milliequivalent of Na_2O.

2.2.5. Moisture Content of Soap

5 g of each sample was accurately weighed using analytical balance (sensitivity 0.1 mg) into dried, tarred moisture dish and dried in an oven (Memmert, Germany) for 2 hours at 110˚C and repeated until a constant weight (difference between two measurements not exceeding 0.5 mg/g of sample) was reached. The percent moisture was then calculated using method adopted by [21].

$$\%\text{Moisture} = \frac{C_s - C_h \times 100}{C_s - C_w}$$

where;

C_w = weight of crucible.

C_s = weight of crucible + sample.

C_h = weight of crucible + sample after heating.

2.2.6. Soap pH

10 g of powdered soap was weighed and dissolved in distilled water in a 100 mL volumetric flask. This was made up to the make to prepare 10% soap solution. The pH of the 10% soap solution was determined using a pH meter.

2.3. Lotion Formulation

The lotion was formulated according to the method prescribed by [22]. In this formulation, 80 g of water was transferred into a beaker. 14 g of *Balanites aegyptiaca* seed kernel oil was also transferred into a separate beaker and 4 g of E-wax emulsifier was added into the oil. The mixture was placed on the hot plate and heated to 120˚C holding for 15 minutes. The beaker containing distilled water was placed on a separate hot plate and heated to 100˚C holding for 13 minutes. The mixture of hot oil and emulsifier was transferred into a plastic bowl which

was placed in cold water and immediately the hot water was slowly added while still blending. Blending was continued until mixture thickens, addition of other additives followed as desired when the temperature of the mixture was about 50˚C or below.

2.3.1. Creaming Index (CI)

The dispersed phase (of an oil-in-water emulsion) has a tendency to separate and rise to the top of the emulsion forming a layer of oil droplets. This phenomenon is called creaming. Creaming is one of the first signs of impending emulsion instability and should be taken seriously. A good test method to predict creaming is centrifugation. The lotion was heated to 50˚C and centrifuged for thirty minutes at 3000 rpm. The resultant product was inspected for signs of separation.

2.3.2. Effect of Temperature on Lotion Stability

The lotions, experimental and control were placed in the refrigerator at −10˚C for 24 hours for the minimum temperature. It was removed, kept at room temperature for 24 hours then analyzed. For maximum temperature, the product was placed in the oven at 45˚C for 24 hours, removed and also kept at room temperature for 24 hours then analyzed for colour, odour, PH, viscosity, texture and signs of separation.

2.3.3. Effect of Light Exposure on Lotion Stability

The products both neat and one with additives were exposed to sunlight for 8 hours and the analysis for any change in colour, odour, pH, viscosity, texture and signs of separation were carried out.

3. Results and Discussion

The results of physicochemical characteristics of the seed kernel oil of *Balanites aegyptiaca* are summarized in **Table 1**. The oil yield was found to be 45.32% and is within the range of 45% - 46% reported [23]. This indicates that the processing of the oil for industrial or edible would be economical feasible.

The moisture content of the seed kernel oil of *Balanites aegyptiaca* was 0.114% ± 0.04% while the specific gravity was 0.90 ± 0.00 and these low values guaranteed the stability of the oil [24]. The observed low moisture content serve as an indication that the activities of the micro-organisms would be reduced and thereby increases the shelf life of *Balanites aegyptiaca* seed [25]. The viscosity and refractive index of the oil are 0.92 cp and 1.45 respectively. The refractive index was in close agreement with the values of most crude vegetable oils and fats shown in **Table 2**.

The saponification value of the oil is 200.02 ± 0.12 168.67 mg KOH/g which is comparable to the values of certain vegetable oils like; sesame, neem, groundnut, palm fruit and soya beans, while iodine value (104.39 ± 0.00) in the present work is within the range for sesame seed (**Table 2**). The saponification value of oil serves as an important parameter in determining the suitability of the oil for

Table 1. Physicochemical characteristics of *Balanites aegyptiaca* oil.

Parameter	Desert date
Oil yield (%)	45.32 ± 0.0026
Moisture content (%)	0.114 ± 0.04
Viscosity (cp)	0.92
Specific gravity	0.90 ± 0.03
Refractive index	1.45
Saponification value (mg KOH/g)	200.02 ± 0.12
Peroxide value (m Eq/kg)	2.95 ± 0.00
Acid value (mg KOH/g)	2.14 ± 0.28
Iodine value 100/g	104.39 ± 0.00
Free fatty acid (%)	0.82 ± 0.01

Table 2. Analytical properties of some crude vegetable oils and fats used for the manufacture of liquid soap and shampoo.

Oils/Fats	Refractive index	Saponification value	Iodine value
Sesame seed	1.465 - 1.469	167 - 195	104 - 120
Neem	1.465	194.5	71
Groundnut	1.460 - 1.465	187 - 196	80 - 106
Palm kernel	1.460 - 1.472	230 - 254	14.5 - 19
Castor bean	1.466 - 1.473	176 - 187	81 - 91
Mustard seed	1.461 - 1.469	170 - 184	92 - 125
Bone tallow	1.456 - 1.457	189 - 200	31 - 38
Coconut	1.448 - 1.450	248 - 265	6.11
Olive	1.467 - 1.471	184 - 196	-
Soya bean	1.467 - 1.470	188 - 195	120 - 143
Palm fruit	1.449 - 1.455	190 - 209	50 - 55
Babassis kernel	1.448 - 1.457	245 - 256	10 - 18
Present studies	1.45	200.02 ± 0.12	104.39 ± 0.00

Source: Manji *et al.* (2013), [23].

soap making. Iodine value is the measure of the degree of the unsaturation of the oil. Higher Iodine value indicates higher unsaturation of fats and oils. Oils having iodine value below 100 are non-drying, those having values between 100 - 130 are semi-drying while those having values above 130 are termed drying oils [26].

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 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 this oil is stable [25]. Oils with high acid value, which will also mean high % FFA 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 [26]. 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% [23].

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 was lower than FAO/WHO standard. A low peroxide value as seen in our study increases the suitability of the oil for a long storage due to low level of oxidative and lipolytic activities [27].

The composition of the fatty acid content of the seed kernel oil of *Balanites aegyptiaca* is shown in **Table 3**. The oil mainly contained saturated fatty acids (36.48%) and monounsaturated fatty acids (30.25%) and a low amount of polyunsaturated fatty acids (19.20%). The most abundant fatty acids of *Balanites aegyptiaca* seed oil were oleic (28.32%) and palmitic (20.51%) acids followed by linoleic (19.20%), stearic (15.97%) acids and palmitoleic (1.93%) acid, which together comprised 85.93% of the total fatty acid. The fatty acid composition of the seed oil is similar to the values reported by [28].

The quality assessment of the soap formulated from the seed kernel oil of *Balanites aegyptiaca* are shown in **Table 4**. The soap tends to have good leathering, stable foam, small foam size and a creaming feeling when used to wash hands.

The physicochemical properties of the soap are summarized **Table 5**. These include the percent total fatty matter, percent total alkali, percent free caustic alkali, percent moisture content and the pH. There was no any reasonable change between soap A which was without any additives and soap B were colour, perfume and preservatives where added. The result was also comparable with two other common soaps found in the market (Standard 1 and 2).

The moisture content is a parameter that is used in assessing the shelf-life of a product. The moisture content of 11.85% recorded for the soap is within the

Table 3. Fatty acid content of the seed kernel oil of *Balanites aegyptiaca*.

Peak No	Fatty acid esters	Percent composition	Proposed fatty acid esters
11	Palmitic Acid Methyl Ester	20.51	C16 Saturated fatty acid
12	Linoleic Acid Methyl Ester	19.20	C18 Polyunsaturated fatty acid
13	Oleic Acid Methyl Ester	28.32	C19 Monounsaturated fatty acid
14	Stearic Acid Methyl Ester	15.97	C18 Saturated fatty acid
16	Palmitoleic Acid Methyl Ester	1.93	C17 Monounsaturated fatty acid

Table 4. Quality evaluation of the soap.

Parameter	Soap A (without additives)	Soap B (with additives)
Foam size	Small and think	Small and think
Lather texture	Creaming	Creaming
Colour	White	White
Foam stability	Stable	Stable
Leathering	Good	Good

Table 5. Physicochemical analysis of the soap.

Parameters	Soaps		Standard	
	A	B	1	2
%Total Fatty Matter	65.68 ± 0.7	65.68 ± 0.07	67.00 ± 0.15	62.25 ± 0.02
%Total Alkali	0.22 ± 0.02	0.22 ± 0.04	0.46 ± 0.02	1.05 ± 0.02
%Free Caustic Alkali	0.08 ± 0.02	0.08 ± 0.02	0.17 ± 0.01	0.38 ± 0.02
%Moisture Content	11.85 ± 0.4	11.85 ± 0.2	8.25 ± 0.03	15.46 ± 0.03
pH	8.37 ± 0.1	8.27 ± 0.05	6.20 ± 0.006	5.80 ± 0.005

recommended percentage 10% - 15% [29]. The implication of high moisture content in soap is that the excess water could possibly react with any unsaponified neutral fat to give free fatty acid and glycerol in a process called hydrolysis of soap on storage [30].

The total fatty matter (TFM) of soap is a measure of its suitability for bathing or launderings purpose. The minimum recommended values are 20.0% and 50.0% for laundry and toilet soaps respectively. The value obtained for the soap, which is 65.68%, indicated that this soap will be most suitable for bathing rather than for laundry due to its high total fatty matter. In addition, the British Industrial Standard (BIS) norms reveal that such soaps can be categorized as Grade III Soap and are used for general bathing purpose.

Onyekwere (1996) reported that the free caustic alkali content is one of the parameters that determine the abrasiveness of any given soap [31]. This mostly results from improper or incomplete saponification. The recommended value is 0.25% for laundry soap and 0.2% for toilet soap [32]. The value of the free caustic alkali recorded for this soap is 0.08%, this is very low indicating that it was highly saponified.

The pH of the soap was determined to be between 8.27 ± 0.05 to 8.37 ± 0.1 which places the soap as a moderately basic soap. High alkalinity in soap could pre-expose the skin to various diseases because of the saponification of the fats and oils on the skin during bathing, producing a soluble organic salt which will be washed away by the bath water.

The stability test of the lotion formulated from the seed kernel oil of *Balanites aegyptiaca* are presented in Table 6 and Table 7. There was no significant

Table 6. Lotion stability test A.

Parameter	Temperature		LE	CI	Control
	Low	High			
Colour	Cream	Cream	Cream	Cream	Cream
Odour	Neutral	Neutral	Neutral	Neutral	Neutral
P^H	5.49	5.44	5.3	5.44	3.8
Viscosity	34	33	31	31	33
Texture	Smooth	Smooth	Smooth	Smooth	Smooth
Sign of Separation	None	Mild	None	Mild	None

Note: LE—light exposure, CI—creaming index.

Table 7. Lotion stability test B.

Parameter	Temperature		LE	CI	Control
	Low	High			
Colour	Pink	Pink	Pink	Pink	Pink
Odour	Perfumed	Perfumed	Perfumed	Perfumed	Perfumed
pH	5.4	5.1	5.3	5.1	5.4
Viscosity	34	33	31	31	34
Texture	Smooth	Smooth	Smooth	Smooth	Smooth
Sign of Separation	None	Mild	None	Mild	None

variation of the results of lotion A without any additives and lotion B were perfume, colour and preservatives where added except for the pH. The pH of lotion A (control without additives) and was left on the bench tends to decrease, the lotion became more acidic, growth of microorganisms was also observed on the control. The pH of the emulsion formulated is between 5.09 to 5.26, which is close to the pH of the mantle of the skin of 5.5 showing that it will be more skin compatible [33].

4. Conclusion

The present study on the physicochemical properties, formulation of soap and lotion from *Balanites aegyptiaca* seeds suggests that the seed of this plant has high oil content as was revealed by the % yield (45.32% ± 0.0026%). Thus it can be a good source of raw material for many oil based products (soap, shampoo, bio-diesel, lubricants, etc.). The soap and body lotion formulated from the oil of these seeds has good property and therefore can be applicable in the soap and cosmetic industry. The seed oil is stable and similar to the palm oil and it can also be a sustainable alternative to palm oil in food industries.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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