EXTRACTION AND PHYSICO-CHEMICAL PARAMETER ANALYSIS OF DESERT DATE (*Balanite aegyptiaca)* OIL FROM DUTSIN-MA

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ABSTRACT
Desert date (Balanites aegyptiaca) is perennial plant with a variety of application in vegetable oil, food preparation, condiment and medicine. This work covers extraction and physico-chemical parameters analysis: acid value, iodine value and saponification value of Balanite aegyptiaca seed oil samples obtainable at Dutsin-Ma Area, Katsina State. Soxhlet extraction method was used in order to extract oil from the samples followed by its analysis according to standard protocols. The result shows that the seeds have high oil content, percent yield of 39.58% with the density of 0.91 g/cm³, acid value 2.66, iodine value 98.74 g/100g, saponification value of 186.5 mgKOH/g and low moisture content of 2.6% was obtained. This shows that the seeds of Balanite aegyptiaca oil of Dutsin-Ma local area have high oil yield and good qualities making it suitable for use in a variety of applications to improve its value chain.

Keywords: Balanite aegyptiaca, oil extraction, Physico-chemical analysis, percent yield, Dutsin-Ma

INTRODUCTION

Edible oils are major dietary component and plays important nutritional role as concentrated source of energy and carrier of fat –soluble vitamins. They also impart flavour and taste to foods, provide essential fatty acids and fats are required for normal functions of the body (Frezzotte *et al.,* 1956). The term oil is used in generic sense to describe all substances that are greasy or oily fluids at room temperature. They are non-volatile and are insoluble in water but are soluble in organic solvents. Oils from seeds or kernels or nuts along with proteins and carbohydrates, constitute the majority of foodstuffs. They are also found in wide industrial applications, like formulation of soap toiletries, paints, varnishes, bio-diesel and lubricant.

Balanites aegyptiaca (B. aegyptiaca) commonly called Desert date (also known as Aduwa in 'Hausa') is a semi-evergreen, usually spiny, extremely variable shrub or small tree of the Zygophyllaceae family that grows up to 12m high. The bowl is usually straight with a 60 cmdiameter, often fluted, the branches are generally spread irregularly or pendulous, and sometimes form a round crown. The tree produces yellow date-like fruit. The trees bear heavy yields as many as 10,000 fruits annually on a mature tree in good condition each fruit, weighing 58 g, consists of an epicarp (5-9%), a mesocarp or pulp (28-33%), an endocarp (49- 54%), and a kernel (8-12%). The oil content of *B. aegyptiaca* seed approaches 50% (Chapagain and Wiesman, 2005).

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 (Elfeel, 2010). *B. aegyptiaca* is perhaps one of the most wide-spread woody plants of the African continent. It is distributed through much of Africa from costal Mauritania and Senegal to Somalia and Egypt, southwards to Zambia and Zimbabwe, as well as in the Middle East from Yemen to Jordan and Israel (Sands, 2001). Benin, Burkina Faso, Cameroon, Chad, Djibouti, Ethiopia, Gambia, Ghana, Guinea, Bissau, Guinea, Ivory Coast, Kenya, Mali, Mauritania, Nigeria, Niger, Senegal, Sudan, Somalia, Tanzania, Togo, Uganda, Zaire, and Zambia are the primary African countries where *Balanites* are grown (Booth and Wickens, 1988). Algeria, Angola, Burundi, Central African Republic, Libya, Morocco, and Rwanda are the other African countries where Balanites are found (Hall and Walker, 1991). Both fruits and seed were widely used in many countries during the dry season and drought periods including Nigeria (Ladipo, 1989; Lockett *et al.,* 2000), Ethiopia and Sudan (Grosskinsky and Gullick, 2001).

B. aegyptiaca is perennial plant used in food preparations, mainly in Africa and developing nations. It has variety of uses and most part of the plant is utilized including leaves thorns, back of root and fruit. The fruit is applied in the treatment liver ailments and as a purgative. It is edible fruit and its seeds have 40-87% edible oil; leaf and fruits are used in the rearing of animals like goats, sheep and camel, the oil is used for human consumption and cosmetics. The *B. aegyptiaca* seed oil is used in many places as ingredient and substituent to groundnut oil in the preparation of local food (Mohammed and Hamza 2008; Nardo *et al.,* 2009). The seed oil of *B.aegyptiaca*is reported to be rich in saturated fatty acids and is used as cooking oil (Hall and Walker, 1991; NRC, 2008). Reports on studies of *B.aegyptiaca* seed oil (Hussain *et al.,* 1949; Cook *et al.,* 1998; Mohamed *et al.,* 2002) indicated that the seed oil consists of four major fatty acids: linolein, olein, stearic and palmitic acid but in varying proportions across study sites. This shows a variation of the oils' quantity with locations where the plant was found. In Nigeria, the seed oil obtained from *B. aegyptiaca* has been used especially in the Northwest part, as substitute to groundnut oil which is usually relatively expensive. This is in addition to medicinal uses such as treatment of skin diseases and rheumatism. *B. aegyptiaca* seed is considered as an extremely useful edible product. It contains good quality oil and high protein content (Mohamed *et al.,* 2002; Abu-Al-Futuh, 1983). Despite such wide spread use, there is limited literature on the possible effects of long term consumption of the oil (Abdel-Rahim *et al.,* 1986).

Also it is important to note that, differences in environment contribute to changes in both physical and chemical

composition of plant extracts including oil. From available literature, there is limited attention and no work was carried out on extraction and physico-chemical parameters analysis was carried out to evaluate the *B. aegyptiaca* oil around this area despite the availability and abundance of this tree species in the northwest part, in particular Katsina State.

MATERIALS AND METHODS
The methods and procedures carried out in this research work are presented below

Sample collection and preparation
B. aegyptiaca fruits were bought from market in Dutsin-Ma, Katsina State. In order to remove the seeds, the fruits were crushed in steel pestle. The seeds were air dried and ground using mortar and pestle.

Oil Extraction
The extraction of oil was carried out by measuring 150 mL n-hexane into a round bottom flask. A sample weighing 100g was placed in the thimble and then inserted in the centre of the extractor. The solvent was heated to maximum temperature of 68˚C and when the solvent boiled, resulting in rising the vapour through the vertical tube into the condenser at the top. The liquid

condensate dripped into the filter paper thimble in the centre which contained the solid sample to be extracted. The extract seeped through the pores of the thimble and filled the siphon tube, where it flowed back down into the round bottom flask. This was allowed to continue for about 4 hours so as to maximize the oil yield.

FTIR Analysis
The oil samples extracted were analyzed using Shimadzu FTIR-8400S at the range of 4000-650cm^{-1} and the resolution of 8 cm^{-1} and spectra was generated. Characterization by FTIR was carried out for functional groups identification. The functional groups in *B. aegyptiaca* oil were analyzed to confirm the identity of the extracted oil.

Determination of Moisture Content of the Seed
Sample of the seeds are dried by weighing 30g of a clean sample and introduced into the oven set at 80˚C for 7 h. sample weight was recorded after every 2 h. until the reading become constant. The sample was then removed from the oven and placed in the desiccator for 30 minutes to cool then removed and re-weighed. The percentage moisture content in the seeds was calculated using the formula in equation (1) (Capreda, 2013).

$$Percent\,moisture = \frac{w_1 - w_2}{w_1} \times 100\% \dots\dots\dots\dots\dots (1)$$

Where w_1 = original weight of the sample before drying; w_2 = weight of the sample after drying.

Determination of the Percentage yield
After the oil is obtained from the extraction process, it was transferred into a measuring cylinder which was placed over a water bath for 30 minutes set at 70ºC in order to ensure complete evaporation of the solvent. The volume of the oil was recorded and then its weight measured, percent yield is then calculated using equation (2) (Capreda, 2013).

$$Percentage\,Yield = \frac{w_1}{w_2} \times 100\% \dots\dots\dots\dots (2)$$

Where: w_1 = weight of oil extracted; w_2 = weight of sample used

Determination of Specific Density
Density of oil is related to its fatty acid composition and minor components. An oil with low density value means it contains low molecular weight fatty acids; likewise, thus, it will have high saponification value, making it suitable for use in soap production (Capreda, 2013, John, 2008).

The specific density was determined by measuring 25 ml an already measuring cylinder, followed by taking the weight of the cylinder and the oil. Actual the weight of the oil was obtained from difference in the weight of the cylinder with the weight of the oil and cylinder. The specific density of the oil is calculated using the formula in equation (3).

$$S.D. = \frac{(w_1 - w_o)}{v_o} \dots\dots\dots\dots\dots (3)$$

Where W_1 = weight of empty measuring cylinder + oil,
W_o= weight of measuring cylinder,
V_o= volume of oil

Determination of Acid Value
The oil sample (2.0 g) was placed into a dried 250 mL conical flask. Then, 25 mL of absolute ethanol was added followed 3 drops of phenolphthalein indicator. Shaking water bath was then

used in heating the mixture for 5 minutes. The mixture was it was titrated against 0.1 M KOH while it was still hot with vigorous shaking in order to achieve thorough mixing until pink color was observed. The volume of 0.1 M KOH consumed by an acid was recorded. The acid value was calculated as using equation (4) (Capreda, 2013).

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

Where V = volume of KOH used; M = molarity of KOH and m = mass of sample.

Determination of Iodine Value
The oil sample (0.25 g) was weighed into a 250 mL conical flask. Thereafter, 10 mL of chloroform and 30 mL of Hanus iodine solution were sequentially added. The solution was allowed to shake for 30 minutes in securely closed flask under darkness. After that, 10 mL of 15% potassium iodide solution was added, then shaken, followed by addition of 100 mL distilled water. The mixture was then titrated with the iodine solution against 0.1 M Sodium thiosulfate ($Na_2S_2O_3$) (Capreda, 2013). The iodine value was calculated using the formula in equation (5)

$$I.V. = 12.69 \times C \times \frac{(v_1 - v_2)}{m} \dots\dots\dots\dots\dots (5)$$

Where C = Concentration of Na2S2O3 used; V_1 = volume of Na2S2O3 used for the blank; V_2 =
Volume of Na2S2O3 used for sample; m = mass of the sample.

3.2.5 Saponification Number of Oil
Two grams of the oil sample was added to a flask containing 30 mL ethanolic KOH which was attached to a condenser for 30 minutes under reflux to enable the sample to dissolve fully. After sample was cooled, 1 mL of phenolphthalein was added

and titrated with 0.5M HCl until a pink endpoint has reached (Capreda, 2013, AOAC, 1998).

Saponification value was calculated from the formula in equation

$$S.V. = \frac{(S-B)xMx56.1}{Sample\ weight(g)} \dots \dots \dots \dots \dots (6)$$

Where S = sample titre value
B = blank titre value
M = molarity of the HCl
56.1 = molecular weight of KOH

RESULTS AND DISCUSSION
FTIR Analysis
The band 3007 cm^{-1} corresponds to C-H stretch typical of alkene. The peak at 2921 cm^{-1} corresponds to C-H stretch of alkane, whileabsorption at1745 cm^{-1} observed is attributable to C=O stretch for esters. This is supported by absorptions at 1210-1163 cm^{-1} corresponds to O-C stretch for the same functionality (ester). Band at 724cm^{-1} is assignable to C=C bend of alkenes. From the FTIR results analyses, all the functional groups detected represent those commonly found in naturally occurring oils.
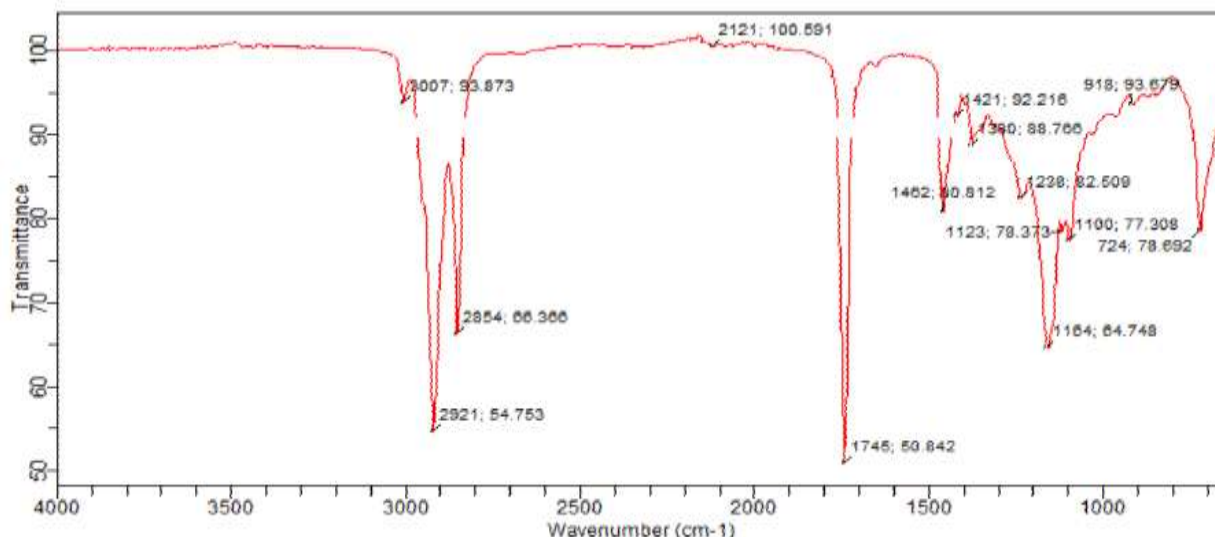

Fig 1 FTIR spectrum of *B. aegyptiaca* oil

Physico-Chemical Parameter Analysis
The result obtained from the analysis of physical parameters is presented in Table 1. The result includes oil yield, moisture content of the sample, Color, odour, density and physical state.

Table 1: Results on Physical Parameter Analysis

Parameter	Result
Yield (%)	39.58
Color	Pale yellow
Odour	Mild
Moisture Content (%)	2.6
Density (g/ml)	0.94
Physical State	Liquid

Oil content yield was determined to be 39.58% which is lower than that reported by (Elfeel, 2010) which was 50%. However, the oil content of 39.58 % is significant for a sample to be economically suitable for use as oil source.

Moisture content was found to be 2.6% which is similar with that reported by (Sara, 2005). The yellow colour in Balanites oil is similar to that reported by Babagana et.al. (2011) and Babeker (2013). The yellow colouration is due to presence of carotene which according to FAO/WHO (1994) and WHO (2004), makes Balanites oil nutritionally important as carotenoids are highly unsaturated polyisoprene hydrocarbons lipids which are precursors for vitamin A (WHO, 2004). The light yellow colour of the oil also makes it visually attractive thus, along with other good attributes makes Balanites oil a sustainable and economical market commodity.

The density obtained (0.94 g/ml) is relatively higher than 0.87 g/ml reported by Babagana et al. (2011), and also lower than 1.001 g/ml (Manji *et al.,* 2013) but closed to the value 0.92 g/ml (Babeker, 2013).

The result obtained from the analysis of chemical parameters is as presented in Table 2. The result includes saponification value, acid value and iodine value.

Table 2: Result on Chemical Parameter Analysis

Parameter	Result
Saponification (mgKOH/g)	186.5
Acid value (mgKOH/g)	2.66
Iodine Value (mg/100g)	98.74

The acid value obtained from *B. aegyptiaca* seed oil was 2.66 mg KOH/g. This is a bit lower than 22.3 mg KOH/g reported by Fokou *et al.,* (2009). However, the relative incrses in the amounts of free fatty acid can be attributed to the method adopted in the seed processing, duration of storage or drying of the seeds. Acid value can also be increased due to relative rise in temperature during extraction, processing or storage.

Saponification value obtained in this work is 186.5mgKOH/g. High saponification values indicate high proportion of lower fatty acid. This high value indicates that the oil could be used in the manufacture of soap (Kirschenbauer, 1995). However, the saponification value was much lower than 242 mg KOH/g in *B. aegyptiaca* reported by Fokou, *et al.,* (2009).

Iodine number is the number of milligrams of iodine absorbed by one-gram fat, the iodine number gives an indication of the number of double bonds in any particular oil or fat, thus 98.74g/100g I.N indicates the high level of unsaturation. However, the iodine value 98.74 obtained is higher than the values obtained by Babagana *et.al.,* (2011), and Manji *et.al.,* (2013).

CONCLUSION

The results indicate that Balanites obtainable in Dutsin-Ma has an oil yield 39.58% with good physicochemical properties, the oil has low acid value making it to be stored for a long time, and it has high saponification value which makes it a good raw material for soap production. The overall physicochemical characteristics *B. aegyptiaca* oil makes it a potential raw material for cosmetics, soap and food processing (as edible vegetable oil) and for use as substrate in biofuels production.

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