EXTRACTION AND PHYSICOCHEMICAL ANALYSIS OF DESERT DATE (*BALANITE AEGYPTIACA*) SEED OIL

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Abstract

The seeds of *Balanite aegyptiaca* were collected, washed and prepared by decocting, drying and pulverizing. The seed oil was extracted using soxhlet apparatus with n-hexane as solvent. The percentage yield of oil extraction was (36.5 %). Physicochemical analysis of the seed oil was conducted using standard procedures and the following results were obtained; specific density (0.88 g/cm^3), moisture content (7.16 %), refractive index at 25^{o}C (1.34), iodine value (43.1 g/100g), saponification value (136 mg KOH/g) and peroxide value (37 meq/kg), acid value (12.1 mg KOH/g), free fatty acid value (12.2 %). This reveals that *Balanite aegyptiaca* seed oil could be a rich source of oil for domestic and industrial purposes if richly exploited.

Keywords: *Balanite aegyptiaca,* soxhlet, physicochemical, extracted, seed oil.

Introduction

Plant oils represent one of the key materials that can be obtained cheaply from biomass and processed readily to supply the appropriate raw material for chemical industries (Akintayo, 2009). Plants oils have both edible and non-edible applications such as: lubricants, soap production, cosmetics, insulating materials and biodiesel (Okpako *et al*, 2017; Akakuru *et al*, 2017; Sunday, Israel and Magu, 2016).

Most of the time in this country, oils are manufactured from groundnut, coconut, Moringa, castor, jatropha etc. But there are other potential sources of oil in which the country still didn't utilize them. *Balanites Aegyptiaca* plants fruit is one of the sources of oil rich fruit product that must be used in order to increase the oil yield to fulfill the demand of the people, and to upgrade the oil quality in order to protect people from health risk.

Balanites Aegyptiaca is a species of tree, classified either as a member of the zygophyllaceae or Balanitaceae. It is multi branched, ever green, and the flowers are small (Dubey, *et al*., 2011). 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, Chantani and Vagshasiya 2011). It is allowing land species, growing up to 1000m altitude (Chantani and Vagshasiya 2011).

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 and as a purgative and sucked by schools children as a confectionary in some countries. It is Edible fruit and its seed have 40-87% of edible oil; leaf and fruits are eaten by goats, sheep and camels. *Balanites Aegyptiaca* seed kernel is considered as an extremely useful edible product. And it is used for extraction and the oil is used for human consumption and cosmetics. The *Balanites Aegyptiaca* seed oil has been used in many countries as ingredient and substituent to groundnut oil in the preparation of local food (Mohammed and Hamza 2008, Nardo, Obida, W and Tiyato, 2009).

Balanites aegyptiaca (L.) Del. belongs to the family Balanitaceae. It is a multi branched, evergreen tree native to the Sudano-Sahielian region of Africa, the Middle East and South Asia.

As described by Hines and Eckman (1993) the plant is known by different vernacular names in different parts of the world. For instance, Arabic names: Heglig (tree), lalob (fruit); trade name: zaccone, zachun, desert date (dried fruit); (Rathore, Arya, Meena and Kumar 2005) in India: Hindi name is Hingot and English name is thorn tree/desert date and in Ethiopia, Amharic name is Bedeno. Rathore *et al*., (2005) reported that *B.aegyptiaca* is thorny species, spiny shrub or tree with 10m in height. Flowers are greenish white fragrant with 5-6 mm in diameter, axillary in few flowers cyme or fascicles. Flowering and fruiting occurs during October (Bhandari, 1990). Seeds are pendulous and ex-albuminous The leaves are alternate, two foliate, petioles are 3-6 mm long, leaflets are elliptic and have broadly pointed petioles

up to 5mm long. According to Abu Al-Futuh (1983), *B.aegyptiaca* has a wide range of nutraceutical applications. Fleshy pulp of the fruit is eaten fresh or dried. It contains 64 – 72% carbohydrates, plus crude protein, steroidal saponins, vitamin C, ethanol and other essential minerals for human.

Moreover, Mohammed, Wolf, and Speiss (2002) pointed out that, the seed kernel is edible product. It contains good quality oil and high protein content. Previous finding of Hall and Walker, (1991); Tesfay, Afework and Unnithan (2014); Varshney and Vyas (1982) indicate that, all parts of the tree have medicinal uses including fruits, seeds, barks and roots. The most important is steroidal saponins, which yield diosgenin, a source of steroidal drugs, such as corticosteriods, contraceptives and sex hormones as described by Farid, Haslinger, Kunert, Wegner and Hamburger (2002); Pettit *et al.*,(1991).

According to Tesfay *et al.* (2014), as a multipurpose tree, *B. aegyptiaca* provides food, medicinal products and fuel-wood valued for subsistence living in arid and semi-arid areas where other options are few.

The potential of *B. aegyptiaca* under management remains unexplored and it is a priority to construct a picture of variation within the natural range and to generate the capacity to raise plants with desirable features as described by Chothani and Vaghasiya, (2006). Thus, the present paper points out the overall potential of *B. aegyptiaca* and its nutraceutical application.

Description of *Balanite aegyptiaca*

Taxonomic position of Desert date

Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Sapindales
Family	Zygophyllaceae
Genus	BalaniteDelile
Species	Balaniteaegyptiaca (L:) Delile

Materials and Method

Sample collection and treatment

The desert date fruits used for this work were obtained from Rafin Bauna in Aliero local government area in Kebbi state of Nigeria. After collection, they were sundried and their shells cracked using metal hammer to obtain its seed. The dried seeds were crushed into cake using mortar and pestle in order to weaken the cell walls to release fat for extraction.

Extraction of Desert date seed oil

About 150mL *n*-hexane was measured and then poured 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 70˚C and when the solvent boiled, the vapour rose 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 (Schneider *et al.*, 2004).

Determination of Physical Parameters

Colour

The colour of the extracted seed oil was observed visually.

Determination of Moisture Content of the Seeds

About 30g of a clean sample was weighed and then dried in the oven at 80˚C for 7 hrs and the weight was recorded after every 2 hrs. The same procedure was repeated until a constant weight was obtained. After which the sample was 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 equation (1)

$$\%\, Moisture = \frac{W1-W2}{W1} \times 100 \ldots\ldots\ldots\ldots\ldots \text{equation (1)}$$

Where $W1$ = original weight of the sample before drying; $W2$ = weight of the sample after drying.

Determination of the Percentage yield

Determination of percentage yield (Warra, Wawata, Gunu and Aujara 2011). The oil obtained from the extraction was transferred into a measuring cylinder which was placed over a water bath for 30 minutes at 70^{o}C so as to ensure complete evaporation of the solvent and then the volume of the oil was recorded. Using equation (2)

$$\%\, Yield = \frac{W1}{W2} \times 100 \ldots\ldots\ldots\ldots\ldots \text{equation (2)}$$

Where: $W1$= weight of oil extracted; $W2$= weight of sample used

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 water where the refractive index of water at that temperature was obtained (Warra et al., 2011).

Determination of Specific Density

Density depends on fatty acid composition and minor components as well as on the temperature (Gunstone, 2008). If an oil has low density, it indicates that it contain low molecular weight fatty acids, likewise it will have high saponification value, which means that it can be used for soap production (Afolabi, 2008).

About 25ml of the oil was measured in a pre-weighed measuring cylinder. The weight of the cylinder and the oil was taken; the weight of the oil was obtained by subtracting the weight of the cylinder from the weight of the oil and cylinder. The specific density of the oil is obtained using the equation (3) (John, 2008).

$S.D = \frac{W1 - Wo}{Vo}$ ... ... equation (3)

Where W_1 = weight of empty measuring cylinder + oil,

W_o= weight of measuring cylinder,

V_o= 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 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) (Kyari, 2008).

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

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

Iodine Value

About 0.25 g of the oil sample in a 250 mL conical flask was added 10 mL of chloroform followed by 30 mL of Hanus iodine solution. The flask was securely closed and the solution was left shaken for 30 minutes in the dark. This was followed by adding 10 mL of 15% potassium iodide solution and then shaken, after which 100 mL of distilled water was added. The mixture was then titrated with the iodine solution against 0.1 M Sodium thiosulfate

solution till a yellow color formed. This was followed by addition of 2 - 3 drops of starch solution after which a blue solution formed. The titration continued until the blue color disappeared while the volume of $Na_2S_2O_3$ at end point was recorded. The Iodine value (I.V) was calculated using equation (5) (AL-Hamdany and Jihad, 2012).

$$I.V = \frac{12.69 \times C \times (V1 - V2)}{m} \ldots\ldots\ldots\ldots\ldots \text{equation (5)}$$

Where C = Concentration of $Na_2S_2O_3$ used; $V1$ = volume of $Na_2S_2O_3$ used for the blank; $V2$ = volume of $Na_2S_2O_3$ used for sample; m = mass of the sample.

Saponification Value

About 2g sample of the oil was weighed into a 250 mL glass conical flask, and then 10 mL of ethanolether mixture (2:1) was added to the same flask followed by 25 mL of 0.5 N ethanolic potassium hydroxide. The flask was then fitted to a reflux condenser and refluxed using a boiling water bath for 30mins with occasional shaking. To the warm solution were added 3 - 4 drops of phenolphthalein indicator and the warm solution was titrated against 0.5 M HCl to the end point. The same procedure was used for other samples and blank. The expression for saponification value (S.V) is calculation using equation (6) (Kyari, 2008).

$$S.V = \frac{56.1 \times M \times (B - R)}{m} \ldots\ldots\ldots\ldots\ldots\ldots\ldots equation. (6)$$

Where B = the volume of the solution used for blank test; R= the volume of the solution used for determination;

M = Molarity of the HCl used; m = Mass of the sample.

Peroxide Value

Into a 250 mL Erlenmeyer flask, 2 g of the oil sample, 1 mL of potassium iodide and 20 mL of solvent mixture (glacial acetic acid/chloroform, 3/2 by volume) were added and the mixture was boiled for one minute. The hot solution was poured into a flask containing 20 mL of 5% potassium iodide. Thereafter, 3 drops of starch solution were added to the mixture and the latter was titrated with 0.1 M standardized sodium thiosulphate and the peroxide value was determined following the method reported by (Akpan, Jimoh, and Mohammed 2006) using equation (7).

$$P.V = \frac{V \times M \times 100}{W} \ldots\ldots\ldots\ldots\ldots\ldots\ldots equation \ldots (7)$$

Where, V = volume of $Na_2S_2O_3$; M = molarity of $Na_2S_2O_3$; W = weight of oil sample (g).

Free fatty acid (FFA)

About 2g of the oil sample was placed in a 250mL conical flask and warmed. 2.5mL of methanol was added with thorough stirring, followed by two (2) drops of phenolphthalein indicator and a drop of 0.14M potassium hydroxide solution. The content containing the oil sample was then titrated against 0.14M potassium hydroxide solution while shaking

vigorously until a permanent light pink colour, which persisted for 1min, was observed. The end point was recorded (Afolabi, 2008). The FFA value was calculated using equation (8).

$$\%FFA = \frac{V \times M \times 28.2}{W} \ldots\ldots\ldots\ldots\ldots\ldots \text{equation (8)}$$

Where: V= volume of KOH used; M= molarity of KOH; W= weight of the sample

Results and Discussion

Table 1. Results on Physical properties of *Balanite aegyptiaca* seed oil

Analysis	Results
Colour	pale yellow
Odour	Mild
State at room temperature	Liquid
Percentage yield (%)	36.5
Moisture content (%)	7.16
Specific density (g/cm^3)	0.87
Refractive index	1.34

Table 2. Results on Chemical properties of *Balanite aegyptiaca* seed oil

Analysis	Results
Saponification value	136
Iodine value	43.1
Peroxide value	37
Acid value	12.1
Free fatty acid value	12.2

Percentage yield

The percentage yield of *B. aegyptiaca is* 36.5%. This is comparable to those of various seed oils by other works. Idourain, Kohlhepp, Weber, Warid and Martinez (1996) reported a yield of 34.5-45.5% for *C. pepo* seeds and Martin (1998) reported a yield of 50% for melons, squashes and pumpkins. Food and Agriculture Organization of the United Nations (FAO) (1992) reported for sun flower (45.6%) and peanut (47.5%) but less than that for melon (*C.*

lanatus) 59% by cherry (1998), and higher than cotton seed (18-28%), soya been (11-25%), rubber (21-25%) (Kirschenbauer, 1995; Norris, 1995) *A. breviflorus* seed oil (22.9%) (Umerie, Onuagha and Nwobi 2009). It also had a specific density of 0.87 g/cm^3 indicating that it is less dense than water.

The result of the refractive index 1.34, is slightly lower than the value of 1.46 obtained for *B. sapida* (Akintayo, Adebayo and Arogundade, 2002) and 1.45 obtained for *C. lanatus* (Oluba *et al*, 2008). This shows that the oil is not as thick as most drying oils whose refractive index were between 1.48 and 1.49 (cherry, 1998).

Saponification value

High saponification values indicate high proportion of lower fatty acid. The saponification value of *B. aegyptiaca* seed oil is 136 mg KOH/g. 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, Achu and Tchouanguep (2009). Nevertheless, the saponification value of the oil (136 mg KOH/g) is comparable to 192.0 mg KOH/g in *B. aegyptiaca* as presented by Chinyere, Akugwo, Chineye and Ugbogu (2009).

Iodine value

B. aegyptiaca seed oil can be classified as a non-drying oil as a result its iodine value (43.1g / 100g) which 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 in this work (43.1 g / 100 g) agrees with 41.05 g / 100 g in *B. aegyptiaca* reported by Chinyere *et al*, (2009). Higher values were found in peanut oil (86.0g / 100g) and soya bean oil (124.0g / 100g) (Aremu, Olonisakin, Bako and Madu, 2006).

Acid value and free fatty acid value

The acid value and free fatty acid value obtained from *B. aegyptiaca* seed oil were 12.1 mg KOH/g and 12.2 % respectively. The acid value of *B. aegyptiaca* (12.1 mg KOH/g) was relatively lower than 22.3 mg KOH/g reported by Fokou *et al* (2009). High acid values can result from high amounts of free fatty acid due to the method adopted in the seed processing. Duration of storage and drying of the seeds can increase the acid index. According to Aremu *et al* (2006), acid index can also be increased as a result of increase in temperature.

Peroxide value

Peroxide value depends on a number of factors such as state of oxidation (quantity of oxygen consumed), method of extraction and type of fatty acid present in the oil. *B. aegyptiaca* seed oil has a peroxide value of 37 meq/kg. This value is higher than the values recorded for *Citrullu slanatus* (8.34 meq/kg) and *L. siceraria* (4.83 meq/kg) as reported by Chniyere *et al*, (2009).

Conclusion

The results obtained from the preliminary investigation carried out in this work revealed that desert date seed oil is an economically viable oil source because its oil content was found to be high. Also, the oil parameters showed that the oil was composed of moderately long chain fatty acids with a degree of unsaturation, making it a good feedstock for domestic and industrial purposes.

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