PHYSIOCHEMICAL ANALYSIS OF DESERT DATE (*BALANITE AEGYPTIACA*) SEED OIL FOR INDUSTRIAL AND DOMESTIC PURPOSES

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Abstract

The desert date seeds were collected from Gomo, washed, decocted, dried, and pulverized. The seed oil was extracted using soxhlet apparatus with n- hexane as solvent. The percentage yield of the extracted oil was found to be 40.5%. While the physicochemical analysis of the seed oil was conducted using standard procedures with the following results; specific density 0.98g/cm³, saponification value 134mgKOH/g, peroxide value 38meq/kg, acid value 12.6mgKOH/g, free fatty acid value 12.7mgKOH/g. These results indicate that Desert date seed oil could be a rich source of oil for industrial and domestic purposes if exploited richly.

Key words: Balanites Aegyptiaca, soxhlet apparatus, n- hexane, biomass, edible.

1.0 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 (Ogala, Elinge, Wawata, Adegoke, Muhammad, & Ige, April, 2018). Plant oils have both edible and non edible applications e.g lubricants, cosmetics, soap production, biodiesel and insulating materials (Ogala, Elinge, Wawata, Adegoke, Muhammad, & Ige, April, 2018). But in our country Nigeria, oils are produced from groundnut, coconut, moringa, jatropha, castor etc. while there are other potential sources of oil in which the country still is not utilizing. *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 fulfil 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, deep rooted ever green or semi deciduous tree up to 12m high. Classified either as a member of the *zygophyllaceae* or *Balanitaceae*. It is multi branched and the flowers are small. The plant grows in tropical and desert areas. It can be found in many kinds of habitats, tolerating a wide variety of soil types from sand to heavy clay and climatic moisture (Ogala, Elinge, Wawata, Adegoke, Muhammad, & Ige, 2018). *Balanites Aegyptiaca* is perennial plant used in food preparations, especially in Africa and developing countries. It has multiplicity of uses and almost every part of the plant is useful including, leaves, thorns, bark of root and fruit. The fruit is used to treat liver disease.

It is very tolerant to drought and thrives with an annual rainfall of 200mm or less where there is an additional water supply e.g. banks of Nile in Sudan. It spreads from the margin of the desert to the woody Savannahs with up to 900mm of annual rainfall. It prefers deep sandy loam soils and uninterrupted access to water such as valley floors, riverbanks or the foot of rocky slopes. It can run wild in abundant environments and become a weed. *Balanites Aegyptiaca* seed kernel is considered as an extremely useful edible product. The *Balanites Aegyptiaca* seed oil has been used in many countries as ingredient and substituent to groundnut oil in the preparation of local food (Ogala, Elinge, Wawata, Adegoke, Muhammad, & Ige, 2018).

2.0 Material and Method

2.1 Sample collection and treatment

The desert date fruits were obtained from Gomo in Sumaila Local Government of Kano State. After collection they were sundried and their shells cracked using metal hammer to obtain their seeds. The dried seeds were crushed into cake using motor and pestle in order to weaken the cell walls to release fat for extraction.

2.2 Extraction of Desert date seed oil

About 200ml 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 then flowed back down into the round bottom flask. This was allowed to continue for about 5hours so as to maximize the oil yield (Ogala, Elinge, Wawata, Adegoke, Muhammad, & Ige, April, 2018).

$$\% \text{Yield} = \frac{\text{Weight of oil extracted}}{\text{Weight of seed used}} 100\% \quad (1)$$

2.3 Determination of Physical Parameters

2.3.1 Colour

The colour of the extracted seed oil was observed visually.

2.3.2 Determination of Moisture Content of the Seeds

30g of the clean sample was weighed and then dried in the oven at 80⁰C for hours and the weight was recorded after every 2hour. The same procedure was repeated until a constant weight was obtained. The sample was then removed from the oven and placed in the desiccator for

30minutes to cool then removed and reweighed. The % moisture content in the seeds was calculated using equation (1).

$$\% \text{ Moisture} = (W_1 - W_2 / W_1) \times 100 \dots\dots\dots 1$$

Where W_1 = Weight of the sample before drying and W_2 = Weight of the sample after drying.

2.3.3 Determination of Percentage Yield

The percentage yield can be obtain using the relation of the below equation as reported by (Ogala, Elinge, Wawata, Adegoke, Muhammad, & Ige, April, 2018). The oil obtained from the extraction was transferred into a measuring cylinder which was placed over a water bath for 30minutes at 70°C so as to ensure complete evaporation of the solvent and then the volume of the oil was recorded using equation (2).

$$\% \text{ Yield} = (W_1 / W_2) \times 100 \dots\dots\dots 2$$

Where W_1 = Weight of oil extracted and W_2 = Weight of sample used

2.3.4 Refractive index

The refractive index was determined using the Abbe's refractometer. It measures the index of refraction by measuring the critical angle of total refraction. 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. The pointer on the scale pointed the refractive index at no parallax error.

2.3.5 Determination of Specific Density

Density is the ratio of mass to volume and depends on the fatty acid composition and minor components as well as on the temperature (Ogala, Elinge, Wawata, Adegoke, Muhammad, & Ige, April, 2018). If an oil has low density, it indicates that it contain low molecular weight fatty acids and it will have high saponification value which means 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 the cylinder. The specific density of the oil is obtained using equation (3) (John, 2008).

$$S.D = \frac{W_1 - W_2}{V_o} \dots\dots\dots 3$$

Where W_1 = Weight of empty measuring cylinder + oil; W_2 = Weight of measuring cylinder and V_o = Volume of oil.

2.4 Determination of Chemical Parameters

2.4.1 Acid Value

A 2.0 g of the oil sample was placed in 250ml conical flask followed by 25ml of the absolute ethanol and three drops of phenolphthalein indicator. The mixture was then heated in a shaking water bath for 5minutes. While hot, titrated against 0.1M KOH until pink colour appeared. Vigorous shaking was done when approaching the end point to ensure thorough mixing. The volume of 0.1M KOH consumed by an acid was recorded. The acid value was calculated as reported using equation (4) (Kyari, 2008).

$$A.V = 56.1 \times V \times M / m \dots\dots\dots 4$$

Where V= Volume of KOH used; M= Molarity of KOH and m= Mass of the sample.

2.4.2 Iodine Value

About 0.25 g of the oil sample in 250ml conical flask was added to 10ml of chloroform followed by 30ml 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 iodine solution and then shaken after which 100ml of distilled water was added. The mixture was then titrated with the iodine solution against 0.1 M Sodium thiosulphate solution till a yellow colour is formed. This was followed by addition of 2-3 drops of starch solution after which a blue solution is formed. The titration continued until the blue colour disappeared while the volume of Na₂S₂O₃ at end point was recorded. The iodine value I.V was calculated using equation (5) (AL-Hamdany & Jihad, 2006).

$$I.V = 12.69 \times C(V_1 - V_2) / m \dots\dots\dots 5$$

Where C = concentration of Na₂S₂O₃used; V₁ = volume of Na₂S₂O₃ used for the blank; V₂ = volume of Na₂S₂O₃ used for the sample and m = mass of the sample.

2.4.3 Saponification Value

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

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

Where B= volume of the solution used for blank test; R= volume of the solution used for determination; M= molarity of HCl used and m = mass of the sample.

2.4.4 Peroxide Value

Into a 250ml Erlenmeyer flask, 2g of the oil sample, 1ml of potassium iodine and 20ml 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 iodine. 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, & Mohammed, Extraction, Characterization and Modification of Castor Seed Oil, 2006) using equation (7).

$$P.V = \frac{V \times M \times 100}{W} \dots\dots\dots 7$$

Where V= volume of Na₂S₂O₃; M= molarity of Na₂S₂O₃ and W = weight of oil sample (g)

2.4.5 Free fatty acid (FFA)

About 2g of the oil sample was placed in a 250ml conical flask and warmed while 2.5ml of methanol was added with thorough stirring, followed by 2 drops of phenolphthalein indicator and a drop of 0.14M potassium hydroxide solution. The content was then titrated against 0.14M potassium hydroxide solution while shaking vigorously until a permanent light pink colour which persisted for 1minute was observed. The end point was recorded (Afolabi, 2008). The FFA value was calculated using equation (8).

$$\%FFA = \frac{V \times M \times 28.2}{W} \dots\dots\dots 8$$

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

3.0 Results and Discussion

Table 1. Physical Properties of Desert date seed oil

S/N	Analysis	Result
1.	Colour	Pale yellow
2.	Odour	Mild
3.	State at room temperature	Liquid
4.	% Yield	40.5
5.	Moisture content (%)	8.2
6.	Specific density (g/cm ³)	0.98
7.	Refractive index	1.33

Table 2. Chemical properties of Desert date seed oil

2	Analysis	Result
1.	Saponification value	134
2.	Iodine value	42.6
3.	Peroxide value	38
4.	Acid value	12.6
5.	Free fatty acid value	12.7

Percentage yield

The % Yield of the seed was found to be 40.5%. This is found to be comparable to other various seed oil (Ogala, Elinge, Wawata, Adegoke, Muhammad, & Ige, April, 2018).

The result of the refractive index 1.33 is within that obtained by (Ogala, Elinge, Wawata, Adegoke, Muhammad, & Ige, April, 2018). This indicates that the oil is not as thick as most drying oils whose refractive index is within 1.48 – 1.49 (Ogala, Elinge, Wawata, Adegoke, Muhammad, & Ige, April, 2018).

Saponification value

High saponification values indicate high proportion of lower fatty acid. The value of the saponification of the desert date seed oil was 134mg KOH/g. This indicates that the oil could be used in the manufacture of soap (Kirschenbauer, 1995) which is comparable to 136 mg KOH/g as presented by (Ogala, Elinge, Wawata, Adegoke, Muhammad, & Ige, April, 2018).

Iodine value

Desert date seed oil can be classified as a non – drying oil as a result its iodine value of 42.6g/100g indicates that the oil contains high level of unsaturated fatty acid and is responsible for the liquid state of the oil at room temperature. The iodine value obtained agrees with 43.1g/100g reported by (Ogala, Elinge, Wawata, Adegoke, Muhammad, & Ige, April, 2018).

Acid value and free fatty acid value

The acid and the free fatty acid values obtained from the desert date seed oil were 12.6mg KOH/g and 12.7mg KOH/g respectively which relatively agrees with that obtained by (Ogala, Elinge, Wawata, Adegoke, Muhammad, & Ige, April, 2018).

Peroxide value

Peroxide value depends on the number of factors such as state of oxidation that is quantity of oxygen consumed, method of extraction and type fatty acid present in the oil. The seed oil has a peroxide value of 38meq/kg.

4.0 Conclusion

The preliminary investigation on the extraction and chemical analysis of the Desert date seed oil revealed that the oil is economically viable oil source due to its oil content was found to be high, the parameters showed it composed of moderately long chain fatty acids with a degree of unsaturation. This makes it a good feedstock for domestic and industrial purposes.

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