

Physicochemical Properties of *Balanites aegyptiaca* (Laloub) Seed Oil

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Abstract

The main goal of this research was to study the physical and chemical properties of *Balanites aegyptiaca* (laloub) oil. Two kilograms of *Balanites aegyptiaca* fruit were purchased from local market in Khartoum, Sudan. Fruits were then crushed using a steel hammer and seeds were then obtained. One kilogram of seeds was collected and was then ground using grinding machine. Processed ground seeds were then eventually ready for further analysis. The results revealed that *B. aegyptiaca* seed contain considerable percentage of moisture (3.10%), oil (42.95%), protein (31.08%), fiber (12.64%), ash (3.19%) and carbohydrate (7.04%) on dry matter basis. Also the seeds contained different minerals e.g calcium (0.41mg), sodium (0.09mg), magnesium (0.13mg) phosphorus (0.30mg) and potassium (1.09mg) per 100g dry matter (DM). Also, the results of the physicochemical evaluation of *B. aegyptiaca* oil showed that it contains viscosity 19.63 cp, density 0.9109, refractive index 1.483, colour 7.633 (R.y.b), free fatty acid 3.06%, peroxide value 1.18 (meq O₂/kg), saponification value 224.63 (mg KOH/g), iodine value 122.42 and acid value 1.53 (mg KOH/g). The fatty acid profile of *B. aegyptiaca* seed oil showed that it contains linoleic acid 34.36%, palmitic acid 13.37%, stearic acid 15.03% and oleic acid 28.57%.

From the previous physicochemical tests of *B. aegyptiaca* oil could be used for edible purpose.

Introduction

Balanites aegyptiaca (Laloub) tree is indigenous to all dry lands south of Sahara and extending southwards (Sands, 2001; Hall and Walker, 1991; Shanks, 1991; Sidiyenebb, 1996). It is also found in Arabian Peninsula, India, Iran and Pakistan (Amalraj and Shankanarayan, 1998). In Sudan it is more likely the species with widest natural range, occur in all zones, except in very high altitudinal areas or when the rainfall exceeds 1100 mm/annum (Badi *et al*, 1989). It makes up to one third of the total tree population in central region of the Sudan (NRC, 2008). *B. aegyptiaca* had been used over thousands of years (Von Maydell, 1986). The 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 minerals (Abu Al-Futuh, 1983). All parts of the tree have medicinal uses including fruits, seeds, barks and roots. The most important is a steroidal saponins, which yield diosgenin, a source of steroidal drugs, such as corticosteroids, contraceptives and sex hormones (Farid *et al.*, 2002; and FAO, 1985). Balanites seed is considered as an extremely useful edible product. It contains good quality oil and high protein content (Mohamed *et al.*, 2002; Abu AlFutuh, 1983). The de-bittered seed is used as snacks (nuts) by humans.

The extracted oil is used for many uses and it is used in Western Sudan for food purposes, while the remaining cake is used as animal feed. Both fruits and seed were widely used in many countries during the dry season and drought periods including Nigeria (Locket *et al.*, 2000), Ethiopia, (Guinad and Lemess, 2001) and Sudan (Grosskinsky and Gullick, 2001).

The need for vegetable oil is rising worldwide so it has to be to look for new sources for the production of high-quality vegetable oil which can be exploited for different industrial purposes. This study was conducted on the physical and chemical properties of *Balanites aegyptiaca* (laloub) seed oil as a good source for the production of oil.

The objectives of the study

- To determine the chemical composition, the physicochemical properties of *Balanites aegyptiaca* (laloub) seed oil and to estimate the nutritional value of the seed.

Materials and methods

Two kilograms of *Balanites aegyptiaca* fruit were purchased from local market in Khartoum, Sudan. Fruits were then crushed using a steel hammer and seeds were then obtained. One kilogram of seeds was collected and was then ground using grinding machine. Ground seeds were then eventually ready for further analysis.

Moisture content, refractive index (RI),oil density , peroxide value (PV) ,free fatty acids (FFA) , iodine value , saponification value, oil content, protein content, crude fiber, ash content, minerals content colour were determined according to the AOAC method (2008). The viscosity of oil samples was determined by using Oswald — u- Tube, viscometer No 7647 (A.O.C.S, 2006). Fatty acid composition of oil was determined by gas chromatography apparatus (Py E-UNICAM model GCD). (ACMLT, 1990).

Results and discussion

1- Chemical composition of *B. aegyptiaca* seed

Table (1) shows the chemical composition of *Balanites aegyptiaca* seed. Moisture, oil, protein, fiber, ash and total carbohydrate contents were found to be 3.10, 42.95, 31.09, 12.64, 3.19 and 7.04% respectively. Moisture content was found to be 3.10% which is similar with that reported by both Babeker (2013) and Lohlum *et.al.* (2012). Oil content was noticed to be 42.96% which is in agreement with that mentioned by Lohlum *et.al.* (2012) but it was lower than that reported by Elfeel (2010) which was 50%.

Protein content was found to be 31.09% which is lower than the 39% reported by both ELfeel (2010) and Lohlum *et.al.* (2012). Fiber content was 12.64% which is higher than the 9.4% reported by Babeker (2013) but it is lower than the 17.18% reported by Lohlum *et.al.* (2012). Ash content was noticed to be 3.19% which is lower than the 3.98% reported by Lohlum *et.al.* (2012) but its higher than the 2.98% reported by Babeker (2013). Total carbohydrate content was recorded to be 7.04 % which is nearly similar to 7.72% reported by Babeker (2013).

2 - Minerals content of *B.aegyptiaca* seed

Table (2) shows that the minerals content of *Balanites aegyptca* seed, the potassium, calcium, phosphorus, magnesium, sodium content were found to be 1.09, 0.41, 0.30, 0.13 and 0.09 mg/100g respectively.

Table (1) Chemical composition of *B. eagyptiaca* seed

Constituent (%)	Mean	Std. Deviation	Minimum	Maximum
Moisture	3.10	0.0300	3.07	3.13
Oil	42.95	0.4843	42.40	43.30
Proten	31.08	0.10263	31.00	31.20
Fibre	12.64	0.05132	12.60	12.70
Ash	3.19	0.05568	3.14	3.25
Carbohydrate	7,04	0.0301	7.02	7.06

Table (2) Minerals content of *B.eagyptiaca* seed (mg/100g)

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Minerals	Mean	Std. Deviation	Minimum	Maximum
Calcium	0.41	0.032	0.390	0.450
Sodium	0.09	0.005	0.090	0.099
Magnesium	0.13	0.186	0.025	0.350
phosphorus	0.30	0.015	0.280	0.310
Potassium	1.09	0.015	1.070	1.100

Potassium content was found to be 1.09 mg/100g which is lower than 1.95,1.88 mg/100g reported by Elfeel (2010) and Omar(2002) respectively but is in full agreement with that 1.09 mg/100g which was reported by Lohlum *et.al.* (2012).Calcium content was found to be 0.41mg/100g which is lower than 1.95,1.88 mg/100g reported by both Elfeel (2010) and Lohlum *et.al.* (2012) respectively but is higher than the 0.12 mg/100g reported by Omar (2002). Phosphorus content was registered to be 0.30 mg/100g which is higher than the 0.28, 0.16 and 0.28 mg/100g mentioned by Elfeel (2010) Lohlum *et.al.* (2012) and Omar (2002) respectively.

Magnesium content was recorded to be 0.13mg/100g which is lower than the 0.14 mg/100g reported by Elfeel(2010) but is higher than the 0.02 and 0.10 mg/100g found by both Lohlum *et.al.* (2012) and Omar (2002) respectively .Sodium content was suggested to be 0.09 mg/100g which is lower than the 0.90, 0.93 and 0.20 mg/100g reported by Elfeel(2002), Lohlum *et.al.* (2012) and Omar (2002) respectively.

3 - Physical properties of *B.aegyptiaca* oil

Table (3) shows that physical properties of *Balanites aegyptiaca* oil. Viscosity, density, refractive index and colour were found to be 19.63, 0.9109, 1.483 and (7,633R.y.b) respectively.

Viscosity was said to be 19.63 which is lower than the 34, 22.60 and 37cp. mentioned by Babagana *et.al* (2011), Oklai *et.al.* (2013) and Babeker (2013) respectively. Density was noticed to be 0.9109 which is similar to 0.92 reported by Babeker (2013) but is higher than the 0.277 reported by Babagana *et.al* (2011) and is lower than the 1.001 reported by Manji *et.al.* (2013). Refractive index was found to be 1.483 which is completely agreed with that reported by both Oklai *et.al.* (2013) and Manji *et.al.* (2013) but it is higher than the 1,46 reported by Babeker (2013) .

Table (1) Physical properties of *B.aegyptiaca* oil

		Mean	Std. Deviation	Minimum	Maximum
Viscosity [40°C] (cp)		19.63	0.000	19.63	19.63
Density		0.9109	0.9109	0.9109	0.9109
Refractive index [40°C]		1.483	0.0153	1.47	1.50
Colour (degree of colour mixtures)*	R.y.b	0	0	0	0
		7.633	1.097	6.40	8.50
		0	0	0	0

*(R.y.b) red, yellow and blue colour

4 - Chemical properties of *B.aegyptiaca* oil

Table (4) shows that the chemical properties of *Balanites aegyptiaca* oil free fatty acid, peroxide value, saponification value, iodine value and acid value were found to be 3.06%,1.18 (mg Eq O₂/kg) , 224.63, 122.42 and 1.53 respectively.

Free fatty acid was found to be 3.06% which was higher than the 2.8 and 1.84% reported by both Babagana *et.al* (2011) and Manji *et.al.* (2013) respectively. Peroxide value was noticed to be 1.18 (mg Eq O₂/kg) which was lower than the 6.0 and 8.0 (mg Eq O₂/kg) that were reported by Manji *et.al.* (2013) and Babeker (2013) respectively. Saponification value was found to be 224,63 (mg KOH/g) which was higher than the 168.80 , 174.5 , 168.3 and 182.80 (mgKOH/g) reported by Manji *et.al.* (2013) ,Babagana *et.al.* (2011) ,Babeker (2013) and Oklai *et.al.* (2013) respectively. Iodine value was found to be 122.43 mg I₂/g which was lower than the 76.8, 56.4 and 98.28 mg I₂/g reported by Manji *et.al.* (2013), Babagana *et.al.* (2011) and Oklai *et.al.* (2013) respectively. Acid value was noticed to be 1.53(mg KOH/g) which is similar to that reported by Oklai *et.al.* (2013) but it is lower than the 2.08 (mgKOH/g) reported by Babeker.

5 - Fatty acid composition of *B.aegyptiaca* oil

Table (5) shows that the fatty acid composition of *Balanites aegyptiaca* the palmitic acid, linoleic acid , Stearic acid and Oleic acid. were found to be 13.37, 34.36, 15.03 and 28.57% respectively. Palmitic acid was recorded to be 13.37% which was near to 15.40 and14.98% reported by both Oklai *et.al.* (2013) and Chapagain *et.al.* (2009) respectively Linoleic acid was found to be 34.36 which is in agreement with that reported by Chapagain *et.al.* (2009) but it's lower than the 39.85 and 75.85% reported by Oklai (2013) and Babagana *et.al* (2011) respectively. Stearic acid was noticed to be 15.03 % which was lower than the 19.01, 19.1 and 19.40% reported by Oklai *et.al.* (2013), Chapagain *et.al.* (2009) and Babagana *et.al* (2011) respectively .Oleic acid was found to be 28.57% which higher than the 25.0 and 26.76% reported by Oklai *et.al.* (2013) and Chapagain *et.al.* (2009) respectively.

Table (4) Chemical properties of *B. egyptiaca* oil

	Mean	Std. Deviation	Minimum	Maximum
Free Fatty Acid (%), as oleic acid	3.06	0.00046	3.17	3.18
Peroxide value (mg Eq O ₂ /kg)	1.18	0.0400	1.14	1.22
Saponification value (mg KOH/g)	224.63	1.5503	223.50	226.40
Iodine value (mg I ₂ /g)	122.42	0.2000	122.375	122.475
Acid value (mg KOH/g)	1.53	0.000	1.5359	1.5359



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Table (5) Fatty acid composition of *B. aegyptiaca* oil

Saturated fatty acid					Unsaturated fatty acid				
Fatty acid	Mean	Std. Deviation	Minimum	Maximum	Fatty acid	Mean	Std. Deviation	Minimum	Maximum
Palmitic acid (%)	13.37	0.1081	13	13.62	Linoleic acid (%)	34.36	0.0541	34.11	34.57
stearic acid (%)	15.03	0.0009	15	15.06	Oleic acid (%)	28.57	0.0562	28.37	28.83
Other Fatty acid composition	8.67	-	-	-	-	-	-	-	-

Conclusion and recommendations

1 - Conclusion

The results indicate that *Balanites* seeds oil yield is high (42.95%) with good physico-chemical properties and rich in polyunsaturated linoleic acid which is an essential fatty acid. The order of fatty acids is linolenic>oleic>stearic>palmitic. Unsaturated fatty acids constituted 62.93% of the oil making it nutritionally beneficial.

The physicochemical characteristics and fatty acid profile of *Balanites aegyptiaca* oil make it a potential raw material for cosmetics, soap and food processing (as edible vegetable oil).

2 - Recommendations

- To train and supply the rural communities with the proper equipment and technology for the *B. aegyptiaca* oil production in order to improve their livelihoods through incomes generating money.
- More studies are needed for the possible effects of long term consumption of *Balanites aegyptiaca* oil.

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