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A Note on the Effect of Storage on Physicochemical Properties of Baobab *(Adansonia digitata L.)* Seeds' Oil from Kordofan and Blue Nile States

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Abstract: Baobab *(Adansonia digitata L.)* is an indigenous forest tree related with the Savannah dry lands of sub-Saharan Africa. Local communities utilize the leaves, pulp, and seeds of Baobab as a source of nutrition and for income generation. Seed oil has been used for centuries by rural communities as food and medicine. The global demand for Baobab seed oil in industrial applications has increased in recent years. The present study was conducted to determine physicochemical properties, mineral content and effect of storage on seeds from two different geographical locations (Kordofan and Blue Nile States). Six different samples of Baobab seeds were collected, prepared and stored in 2017 at room temperature until analysis in 2019. The oil was extracted by cold pressing process and its physicochemical properties were evaluated by standard and established methods. The results showed that the Baobab oil color was golden yellow/ reddish yellow and it showed resistance to change in color and seeds contained reasonable amount of oil. Oil density, PH, refractive index and acid value showed negligible change with the storage. However the peroxide value increased when the storage period increased, while the iodine value, saponification and viscosity of the oil decreased markedly with the storage time. Kordofan seed oil was higher than Blue Nile in density, oil content and saponification value, while Blue Nile seed oil showed higher viscosity, peroxide value and minerals especially potassium content.

Keywords: Baobab oil, physicochemical properties, oil content, saponification value, mineral content.

African baobab *(Adansonia digitata L).* Malvaceae Family, is an important indigenous forest tree species important for food security, nutrition, and income generation for the rural population in Africa. Baobab occurs in the dry lands of sub- Saharan Africa, and it is a representative of the wooden "Big Five" which also include *Tamarindus indica, Zizyphus mauritiana, Sclerocarya birrea, and Mangifera indicia.* Baobab fruit in Sudan called "Gonglase" and trees are called "Tabaldi" which are found on sandy soils and along seasonal streams in low grassland Savannas. It forms belts in different regions such as Kordofan, Darfur, Blue Nile and Central Sudan. Baobab products such as fruits, seeds, leaves, bark contribute to the livelihood of many populations in Africa. Seed oils have been used by various societies as nutrition; medicine, cosmetics, and fuel. Traditionally, Baobab oil is used to treat fever, diarrhea, cough, dysentery and other diseases. Oil is used in many ways for food texturing, frying, manufacture of soap, cosmetics, detergent and oils paint (Babiker *et al.*2015).In recent years, due to search by industry for natural alternatives, demand for seed oils as ingredients for food, cosmetics and biofuel has been greatly increasing. The utilization of oil for various applications is largely determined by the yield, composition and physicochemical properties of the oil. To date, there have been no reports of adverse health effects in the indigenous population who use this oil in cooking. Various types of Sudanese Baobab seeds oil have not sufficiently been studied, to be sold as oil in local markets or inclusion in products. Therefore, this study aimed to determine the physicochemical properties, mineral content and effect of storage (2017-2019) of two seed oils from different locations (Kordofan and Blue Nile States).

The study area was in Kordofan (El-Nuhud city) and Blue Nile (El-Rosaires city) states, Sudan. Baobab fruits were collected for three years on November 2017, 2018, 2019. The climate of Kordofan is hot and semi-arid with mean annual rainfall varying from 300 mm in the north to over 900 mm in the south; rainfall duration extends from May to October. The climate of Blue Nile is savanna climate which is hot and dry especially in the period from March to June, while winter is moderately cold; with mean annual rainfall varying from 40 mm to 700 mm. The area is characterized by mountain series

of which "Ingassana" is the main geographical feature which extends about 72 km. Mature, unblemished Baobab fruits used in this study were manually cracked open using hammer. Seeds were soaked in water for about 1 hr, washed by hand to remove residual pulp and fiber, and then seeds were spread on the drying trays mantled with an absorbent (paper towels) and left overnight on the laboratory bench to lose moisture gained during washing. Seeds were put on the dryer at 70^{o}C for 1 hr, and then packed in polyethylene bags; Baobab seeds were stored from 2017 until 2019. The 2019 sample was extracted fresh. Baobab oil was labeled from 1 – 6 for the two sites for three years storage. Seeds were stored under the same conditions at room temperature (30-35^{o}C) and away from the sun light. Dried seeds were crushed and milled into fine powder using the laboratory crusher (Kinwod MODEL-100, China). Baobab powder was pressed with the hydraulic extractor (Cold Pressing).

The physicochemical analysis of Baobab seeds oil was determined *i.e.* specific gravity (30^{o}C), refractive index, PH, colour, oil content, saponification value, iodine value, acid value and mineral (Na, Ca and K),using the procedures described by (AOAC 1990), while the procedure described by (Nkafamiya *et al.* 2007) was used for the determination of Peroxide Value. Viscosity measurement was performed by using a Lamy Viscometer RM 100 (Lamy, France), a rotating viscometer with coaxial cylinder.

Table 1 shows various physicochemical properties and mineral elements composition of Baobab seeds oil. The results showed that the obtained oil was reddish yellow in color fixed and liquid at room temperature of 25°C.The density recorded for the Baobab oil agreed to the result, 0.195-1.024 g/ml reported by (Radha and Manikandan 2011), The storage period showed no significant effect on oil density, which agreed with that obtained by (Wilson *et al.* 2015).RI value obtained for this study ranged from 1.4666-1.4678 which is close to that (10459) reported by Nkafamiya *et al.* (2007).Storage had insignificant effect on refractive index. Obtained Density, PH and refractive index were within the range of vegetable oils (Oyeleke *et al.* 2015). Kordofan oil was slightly higher than Blue Nile oil in density and refractive

index, while Blue Nile oil was higher in viscosity. PH was not affected by location or storage in the two sites.
The oil content of Baobab seed showed that the seed was a good source of fat and results showed that Baobab seed was rich in oil with an average yield of 21.40 %-22.75 % (w/w), indicating it is a potential source of oil. This value is within the range of 22-45 % reported in the literature (Nkafamiya *et al.* 2007). Oil content decreased with storage in Kordofan seed but not in Blue Nile seed. Wilson *et al.* (2015) reported that ageing process naturally affects the quality of seeds during storage at various conditions. Saponification value of Baobab oil was agreeable to that reported in literature which ranged 133-200 mgKOH/g of oil according to Nkafamiya *et al.* (2007).This reflects the suitability of Baobab oil in soap making. Effect of storage on saponification value slightly increased. The acid values obtained in this study were much higher than indicated by Erwa *et al.* (2019) and Nkafamiya *et al.* (2007) who reported values of 0.33 and 2.5 mg KOH/g, respectively. As the iodine value is considered the factor for oil classification, as drying, semi-drying or non-drying oil, the obtained oil in this study was non-drying edible oil. It falls within the range of 80-115g/100g iodine suggested for most edible oils (Pearson 1981). Peroxide value range found (3.22-5.5 meq.Kg) was lower than that reported by Erwa *et al.* (2019) (6.6 meq O_2/kg). Results showed that it decreased with the storage. The low value of peroxide is an indication of low level of acidity of the oil and also suggests the high level of antioxidant. General Kordofan seed had higher values of oil density, oil content and saponification value, while Blue Nile seed was more in peroxide and acid values.

Mineral macro elements (Na, Ca, K) of Baobab seed from Kordofan and Blue Nile are presented in Table 1,Baobab seed oil contained significant amounts of mineral content (Babiker *et al.* 2017).

Among the macro elements, potassium and calcium were most abundant, while sodium was the least one in the Baobab seed oil. Regarding mineral composition, main points were:

- Mean value of Na content was higher in Blue Nile (24.76 µg/g) than Kordofan (22.42 µg/g). It decreased with storage in Kordofan and increased with storage in Blue Nile.
- Mean value of Ca in Kordofan oil was lower (293.32 µg/g), than that of Blue Nile (366.96 µg/g). It increased with storage in Kordofan oil and was stable with storage in Blue Nile.
- Mean value of K content in Kordofan oil was much lower (368.88 µg/g) than that of Blue Nile (602.12 µg/g) and decreased with storage in both sites.

The content of potassium and calcium are low, but sodium concentration was very close to literature (Osman, 2004). Potassium in Blue Nile was the most abundant mineral element of the seed; *i. e.* was two times more than those found in Kordofan. Generally, baobab seeds are a rich source of nutritionally essential minerals, particularly potassium and calcium, which are the most abundant elements as evidenced by results. High potassium content can be used as a supplement for maintenance of human body, as it prevents hyperacidity in the stomach. It is also necessary for the contraction of the muscles and to keep the heart beat normal. Potassium also helps hormone secretion and aids in the kidneys', detoxification of blood. Minerals investigated in this study showed variation between the two states, which could be attributed to the environment specifically soil properties and climate.

Table 1. Physicochemical properties and mineral composition of Baobab seeds oil from Kordofan and Blue Nile State.

Parameter	Kordofan				Blue Nile			
	2017	2018	2019	Mean	2017	2018	2019	Mean
Oil (%)	21.82	22.21	22.75	22.26	21.40	21.40	21.41	21.40
Density (g/ml)	0.91502	0.91509	0.91570	0.91527	0.91367	0.91384	0.91381	0.91377
Viscosity (mm^2/s)	32.55	32.49	31.53	32.19	33.53	32.61	32.18	32.77
RI	1.4678	1.4776	1.4666	1.4706	1.4673	1.4671	1.4678	1.4674
PH	6.1	6.2	6.2	6.16	6.2	6.1	6.2	6.16
SV (mg.KOH)	187.38	188.77	189.06	188.40	186.79	186.93	187.56	187.09
IV (g/100g)	115.97	97.47	96.95	103.46	98.58	104.27	98.45	100.43
AV (g/100g)	0.79	0.74	0.43	0.65	0.84	0.71	0.53	0.69
PV (meq.Kg)	4.98	3.25	3.22	3.81	5.5	4.1	3.33	4.31
Na (µg/g)	23.23	21.54	22.50	22.42	21.54	26.79	25.95	24.76
Ca (µg/g)	268.69	277.24	334.03	293.32	364.02	374.86	362.02	366.96
K (µg/g)	399.69	346.63	360.34	368.88	625.35	567.13	613.89	602.12
Colour Yellow	34.83	34.30	34.56	34.56	35.40	36.06	30.03	33.83
Red	6.26	6.26	5.66	6.06	6.23	6.56	6.50	6.43
Blue	0	0.06	0	0.02	0.1	0	0	0.03

Baobab *(A. digitata)* seed is one of the important supplementary resources of edible oil, due to the appreciable quantity of oil extracted from seed. The oil samples analyzed showed that peroxide value, acid value and viscosity decreased with storage in both sites, while oil content and saponification value increased. Kordofan seed oil was slightly higher than Blue Nile in density, oil content and saponification value, while Blue Nile seed oil showed higher viscosity, peroxide value and minerals especially potassium content. Generally, Baobab seeds oil content varies due to differences in environmental factors, such as climate, soil type …etc. Geographical variation, environmental conditions and the storage being one of the key factors that have an impact on the physicochemical properties of the plant oil.

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تأثيرالتخزين على الخواص الفيزوكيميائية لزيت بذور "القنقليس" من ولايتي كردفان و النيل الأزرق

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المستخلص: التبلدي (القنقليس) هي ثمرة شجرة غابية أصلية مرتبطة بأراضي السافانا الجافة في جنوب الصحراء الإفريقية. غالباً تستخدم المجتمعات المحلية أوراق، لب و بذور التبلدي في التغذية و كمصدر دخل. تستخدم المجتمعات الريفية منذ عدة قرون زيت التبلدي كغذاء و دواء. مؤخراً زاد الطلب بشكل كبير عالمياً على زيت بذور التبلدي في الاستعمالات الصناعية. أجريت هذه الدراسة لتحديد الخواص الفيزيائية و الكيميائية، محتوى المعادن و مقارنة أثر التخزين لبذور من موقعين مختلفين (ولايتي كردفان و النيل الأزرق)، حيث جمعت ستة عينات مختلفة من بذور التبلدي خلال الفترة (2017-2019). عينات بذور التبلدي جمعت، جهزت و خزنت في درجة حرارة الغرفة في 2017 حتى التحليل في عام 2019. إستخلص الزيت بطريقة العصر البارد، معامل جودة الزيت تم تحليله بالطرق القياسية للتحليل. أظهرت النتائج لون زيت التبلدي الناتج أصفر ذهبي/ أصفرمحمر، لم يتغير لون الزيت مع التخزين. تحتوي بذور التبلدي على كمية كبيرة من الزيت.الكثافة، درجة الحموضة، معامل الانكسار و رقم الحامض أظهرت تغيرطفيف مع التخزين، هذا يدل على أن مدة التخزين ليس لها أثر على هذه الخواص. رقم التزرنخ يزداد بزيادة مدة التخزين، بينما رقم اليود، و لزوجة الزيت تقل بزيادة فترة التخزين. زيت بذور كردفان أعلى طفيفا من زيت بذور النيل الأزرق في كثافة الزيت، رقم التصبين و محتوى الزيت في حين أن بذور النيل الأزرق تتميز بزيادة اللزوجة، رقم التزرنخ و محتوى المعادن خصوصاً محتوى البوتاسيوم. عموماً، بذور التبلدي تحتوي على كميات مهمة غذائياً، تختلف نسبتها باختلاف الموقع الجغرافي الذي تؤثر فيه عدة عوامل كالمناخ، و نوع التربة و غيرها.