December 31, 2021

Effects of Storage on Fatty Acids Composition and Chemical properties of Sudanese Baobab *(Adansonia Digitata L.)* Seed Oil in Kordofan and Blue Nile states

Author's Details:
Alia Mutatis Ali Ibrahim, Kamal Eldin Eltayeb Yassien
Department of Chemical Engineer, Faculty of Engineer, University of Khartoum, Khartoum, Sudan
Correspondence-Alia Mutatis Ali Ibrahim
Email: alo1914@hotmail.com; Phone: +249916321004

Received Date: 13-Dec-2021 Accepted Date: 29-Dec-2021 Published Date: 31-Dec-2021

Abstract
Coordinating attempts to turning waste into wealth, and the search for alternative nutrition sources. Baobab *(Adansonia digitata L.)* seeds are one of the most abundant seeds in Africa. Most of the previous studies on Sudanese Baobab properties have been execute isolation from each other, which making difficult to compare obtained results through different types. The aim of this investigation was to determine the effect of storage on fatty acids composition and Chemical properties of Sudanese Baobab seed oil grown in Kordofan and Blue Nile states for three years (2017-2018-2019), in order to evaluate relationship between the geographical region and storage period. Baobab seeds oil have been analyzed using gas chromatography (GC-MS). Obtained results showed that oil content and saponification value were decreased with storage, while iodine, acid and peroxide value were increased when the storage period increased. Baobab oil contain the three major fatty acids oleic, linoleic and palmitic acid. The highest rates of tricosylic acid 81.19% was found in Blue Nile seed oil, while Kordofan oil was rich in docosadienoic acid 73.45%. Poly and monounsaturated fatty acids were found higher than saturated fatty acids. Fatty acid of Baobab oil showed significant verities under the same storage conditions and over the different geographical location. However, evident variation on chemical properties and fatty acid profiles composition according to seeds oil types, they are significantly impact by soil, storage and climate conditions. It is therefore recommended to make advance comparison of more types of Baobab seeds.

Keywords: *Baobab* oil*, Adansonia digitata,* storage, fatty acid.

INTRODUCTION

Baobab *(Adansonia digitata L.)*, is a tree species commonly found in Africa. It is woody plant characteristic of the dry tropical forest ecosystems of Sub-Saharan Africa, the North-West of Australia and the west coast of Madagascar. Baobab is widespread throughout the hot, drier regions of tropical Africa, it extends from northern Transvaal and Namibia to Ethiopia, Sudan and the southern fringes of the Sahara. In Sudan, the Baobab is most frequently found on sandy soils and by seasonal streams 'khors' in short grass savannas. It forms belts in Central Sudan, in Kordofan, Darfur, Blue Nile, Upper Nile and Bahr El Ghazal (EL AMIN, 1990). It is often found associated with the tamarind. Baobab seed oil has been used for many years by local population for medicine and as food supplement. Oil pressed from Baobab seeds is semi fluid, gently scented and golden yellow. Alone or in combination, it is traditionally used to treat various ailments such as fever, diarrhea, cough and dysentery. Various authors have considered Baobab seed oil to be an essential food source for dietary supplementation, additionally the seeds have been classified as both oil and protein rich. Fatty acids profile of Baobab seed oils is formed by mixture of saturated and unsaturated fatty acids classified according to the number of unsaturated bonds as monounsaturated or polyunsaturated fatty acid (Muthai et al., 2019). Previous studies, some of which are old have shown that Baobab seed oils contain saturated (particularly palmitic acid) and unsaturated fatty acids (especially oleic, and linoleic acids). The aim of this investigation was to determine

the effect of storage on fatty acid composition and Chemical properties of Sudanese Baobab seed oil grown in Kordofan and Blue Nile states for three years (2017-2018-2019).

MATERIAL AND METHODS

Kordofan state Location and Agro climate

Kordofan state is one of the central state of Sudan, it occupies the center part although trends to be a little western between longitude 16,30 - $30,9^{o}$’ north 32,35 - $40,36^{o}$’ east, it bordered to the north by Northern state, from the north-east by Khartoum state, from the east by White Nile state, from the west by Darfur state and from south by South Sudan. Kordofan state occupies a land area of 240,974 km^2. 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 is concentrated in a single short season which increases in reliability and length from May to October (Alabadi, 1975).

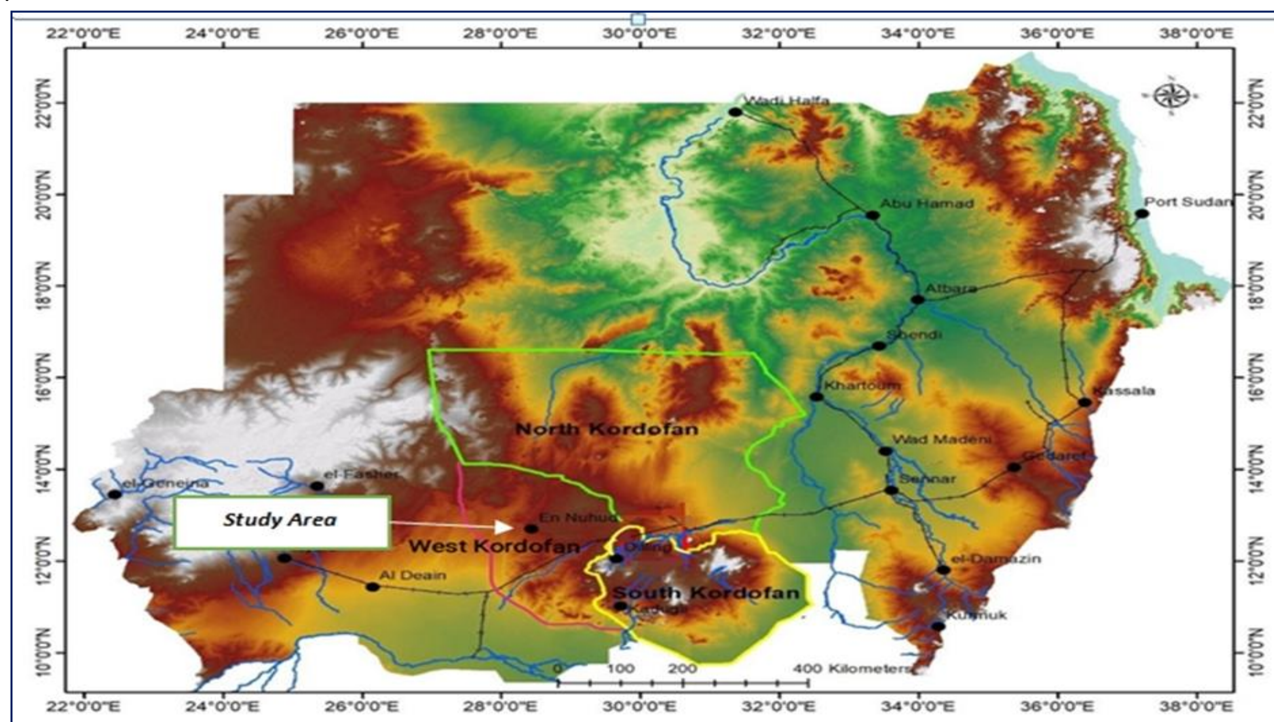

Figure 1. Sudan Map showing North, South and West states of Kordofan and Study Area.

Blue Nile state Location and Agro climate

Blue Nile state is from the southern states of Sudan, according to the division of Sudan after the secession of the south. It is located between latitude 3° and 10°’ north, and longitudes 33° and 35° east, borders Ethiopia to the east and southeast, Sinnar to the north and northeast and Upper Nile to the south and southwest. The Blue Nile runs through the state from far south to far north. The state covers 38,500 km^2. The climate of Blue Nile is savanna climate which is hot and dry especially in period from March to June, while winter is moderately cold with mean annual rainfall varying from 40 mm to 700 mm. It is characterized by mountain series of which Ingassana is the main geographical feature which extends about 72 km (BNSI, 2004).

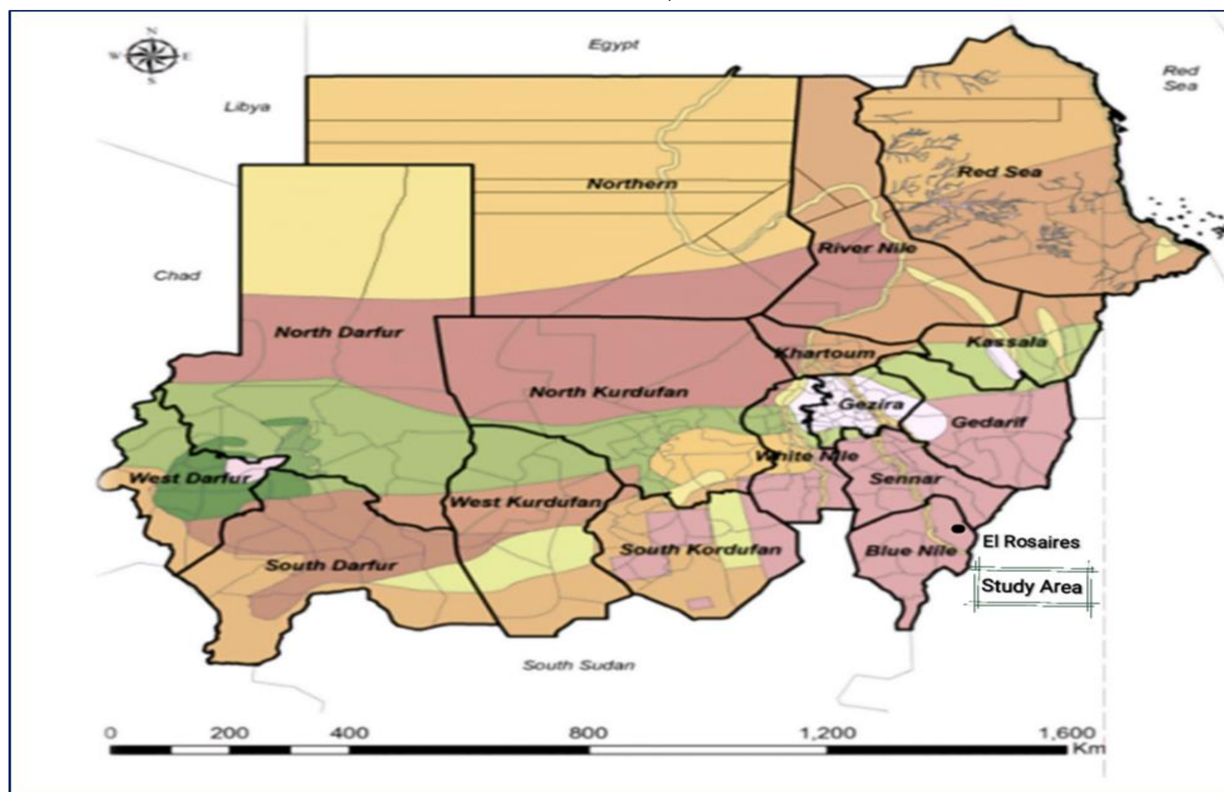

Figure 2. Sudan Map showing Sudanese states and Study Area in Blue Nile state.

Land Use in Study Area

The region depends on rain fed agriculture, Kordofan lands are known to be agricultural, and the most important product Arabic gum, peanuts, sesame, Baobab, hibiscus and it is at the forefront in the export of watermelon, cotton, millet and corn. Blue Nile state depends mainly on agriculture and the area suitable for cultivation is 2.5 million feddans. In Blue Nile gathered Acacia sengal, Acacia seyal, Baobab, Tamarindus, Ziziphus spinachristi, Acacia nilotica and Balanites aegyptiaca.

Baobab Seeds Collection

The required quantity of Baobab fruits were collected on November (2017-2018-2019) from Kordofan (El-Nuhud city) and Blue Nile state (El-Rosaires city), Sudan. Sampling was collected randomly without consideration of tree fruit amount, fruit size or tree height characterize 3-7 trees in each source from each Baobab tree, a compound shell fruit (that includes pulp and seeds) consist 5-10 fruit from the same tree.

Baobab Seeds Preparation

Fruit shell was manually cracked using hammer. Seeds were immersed in water for about 1 hr, then washed by hand to remove residual pulp and fiber in order to obtain the seeds, then they were dried, packed in polyethylene bag, labeled and storage. The storage property of the Baobab oil seeds studied over a period under conditions of light and darkness (ambient). Dried seeds were crushed and milled into fine powder using the electrical crusher. Baobab powder pressed with the hydraulic extractor (Cold Pressing), it was poured into the bridge press manually screwed and pressed to obtain oil with all phytoconstituents intact.

Rename Baobab Seeds

1, 2, 3 for Kordofan (2017-2018-2019) and 4, 5, 6 for Blue Nile (2017-2018-2019) respectively.

Determination of Oil Content

Lipid was determined according to the method of (AOAC, 1990) using Soxhlet apparatus follows: An empty clean and dry exhaustion flask was weighed. About 2 that were used in the extraction and expressed in percentage. Extraction continued for eight hours with petroleum ether. The heat was regulated to obtain at least fifteen siphoning per hour. The residual ether was dried by evaporation. The flask was placed in an oven at 105°C till it dried completely and then cooled in a desiccators and weighed.

$$\text{Oil \%} = \frac{\text{Oil Weight (g)}}{\text{Seed Sample Weight (g)}} * 100$$

Determination of Saponification Value

Determining of saponification value method by (AOAC, 1990), a 2 g of the oil was weighed in a 25 ml conical flask to which 5 ml of 0.5 N alcohol and 20 ml of 0.5 N alcoholic KOH solution were added. Also 5 ml of 0.5 alcoholic KOH solution were added, then the flask and content was refluxed for one hour. The condenser connected and the content heated gently, but steadily for one hr. After the condenser and the flask has cooled. Then a few drops of phenolphthalein solution added to the flask and the sample titrated with hydrogen chloride, HCl (0.5N) until the pink color disappeared. The difference in titre between that of the blank and the sample solution is equivalent to the fatty acid present.

$$SV = \frac{[56.1 \times N(HCl)\ M\ \times (V0 - V1(ml))]}{Ws\ (g)}$$

Where, V0 , V1, are the volume of hydrogen chloride required by blank and sample, respectively, ***N*** is the concentration conversion coefficient of hydrogen chloride and ***Ws***, sample weight.

Determination of Iodine Value

300 ml conical flask with ground in stopper 0.1g sample was added. 20 ml of carbon tetrachloride were added and the flask was sealed. 25 ml Hanus solution also added and the flask also sealed. The flask content shake for 1 minute. And kept sealed and left in a dark room (about 20°C) for 30 min with continuous shaking every 5 minutes. 10 M of 15% potassium iodide and 100ml of water were added, and the flask sealed and shake for 30 seconds. The flask content titrated with 0.1mol/L sodium thisulphate to obtain iodine value. Likewise, perform blank test to obtain blank level (AOAC, 1990).

$$IV = \frac{1.269 \times [T - Sample\ (ml)] \times M}{Ws\ (g)}$$

Where T, Titration of blank, ***M*** Molarity of stander and ***Ws,*** sample weight.

Determination of Acid Value

Acid value determined by methods (AOAC, 1990). The oil mixed thoroughly before weighing. About 5 of cooled oil sample accurately was weighed in a 250 ml conical flask and 50 ml added to 100 ml of freshly neutralized hot ethyl alcohol and about one ml of phenolphthalein indicator solution. The mixture was boiled for about five minutes and titrated while hot against standard sodium hydroxide shaking vigorously during the titration. The weight of the oil taken for the estimation and the strength of the alkali used for titration against standardized potassium hydroxide (0.24 M), for the titration does not exceed 10 ml.

$$AV = \frac{56.1 \times T(ml) \times M}{Ws\ (g)}$$

Where, T Titration of stander, ***M*** Molarity of stander and ***Ws,*** sample weight.

Determination of Peroxide Value

The method described by (AOAC, 1990), 5 g of sample were delivered into conical flask with stopper. About 25 ml of solvent (15 ml acetic acid+10 ml chloroform) were added (0.11 M) and gently shake to dissolve the sample completely. The air inside flask gently replace with nitrogen to remove remaining oxygen. One ml of

saturated potassium iodide was added and immediately seals the flask and gently shakes it for one minute. The flask left at room temperature 15 to 20°C in dark room. 30 ml water added, and the flask sealed and stirred. Titration with 0.01mol/L sodium thiosulphate was performed to measure peroxide value.

$$PV = \frac{T(ml) \times M \times 100}{Ws\ (g)}$$

Where T, Titration of stander, ***M*** Molarity of stander and ***Ws,*** sample weight.

Determination of Fatty Acids Composition

The crude oil was analyzed as methyl ester to determine the fatty acid composition. The oil was converted into fatty acid methyl ester through trans-esterification reaction. A solution of KOH (Methanolic potassium hydroxide) (2M) was prepared. An amount of 2 ml of oil sample was dissolved in 10 ml of hexane in a test tube. An amount of 1 ml of KOH was added into the same test tube and vortexed. The hexane phase was collected and washed twice with 4 ml of water after 15 min and further dried over anhydrous sodium sulphate. The fatty acids composition analysis was performed on GC-MS (SHIMADZU HP-5840A, Kyoto, Japan - Gas CHROMATOGRAPHY), GC Systems coupled with MS detector. The percentages of saturated and unsaturated fatty acids were calculated by totaling the percentage of fatty acids detected via the analysis of fatty acid composition. The sum percentage of saturated fatty acids was represented as total saturated fatty acids, whereas the sum of all unsaturated (mono and polyunsaturated) was represented as total unsaturated fatty acids **(Metcalf and Schmitz, 1966).**

Figure 3. Gas Chromatography (GC-MS).

Statistical Analysis

The Statistical analysis of Baobab seeds oil results were achieve using Microsoft Excel (2007) - version 12.0.4518.1014. The results officiated in three duplicating.

RESULTS AND DISCUSSION

The obtained results showed that gained oil was (reddish yellow) golden yellow color, fixed and liquid at room temperature 25 ^{o}C.

Figure 4. Baobab Seed oil samples.

Table 1 shows physicochemical properties of Baobab seeds oil, the oil properties of Baobab seed showed that the seed was a good source of fat, results appeared that Baobab seed was found to be rich of oil with an average yield 21.40% - 22.75% (w/w), that indicating it was an overgrown source of oil, this value was represented in terms of lipid content, the obtained yield was accordant with a literature review which appeared that Baobab seed contains 22% - 45% oil on dry matter basis (Nkafamiya et al., 2007), with storage oil content was decreased, when seeds were preserved this within study by (Wilson et al., 2015) who 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 were ranged 133-200 mgKOH/g of oil according to (Nkafamiya et al., 2007). This refers to oil be also be used in soap making since its saponification value falls within the range of these oils the term "Unsaponifiable Matter" in oils or fats. Effect of storage on saponification value was decreased. The acid values obtained in this study were within the studies recorded by (Erwa et al., 2019) and (Nkafamiya et al., 2007) they reported acid values were 0.33 and 2.5 mg KOH/g, respectively, acid value was increased with storage. The iodine value was considered factors of oil classification the drying quality of the oil, whereby it could be drying, semi-drying or non-drying oil through the analysis, obtained oil was non-drying edible oil, when comparable of the standard less or more than with its physical state, for oil that it contain low degree of unsaturation and can therefore be classified as non-drying edible oil because 80-115g/100g, iodine was increased with storage. Peroxide value found 3.22-5.5 meq.Kg these values was lower than that reported by (Erwa et al., 2019) which is 6.6 meq O_2/kg, it was increased with the storage. The low value of peroxide is an indication of low level of acidity of the oil. Kordofan seed oil was higher than Blue Nile seed oil in oil content, saponification and iodine value, while Blue Nile seed was distinction by acid and peroxide value.

Table 1- Physicochemical Properties of Baobab Seed Oil.

Parameters	1	2	3	4	5	6
Oil Content (%)	21.82	22.21	22.75	21.40	21.40	21.41
SV (mg.KOH/g)	187.38	188.77	189.06	186.79	186.93	187.56
IV (g/100g)	115.97	97.47	96.95	98.58	104.27	98.45
AV (g/100g)	0.79	0.74	0.43	0.84	0.71	0.53
PV (meq.Kg)	4.98	3.25	3.22	5.5	4.1	3.33

Fatty acids are considered to be a combination of triglycerides of higher saturated and unsaturated fatty acids, from samples of Baobab seeds oil fatty acid methyl esters (FAME) were analyzed by gas chromatography (GC-MS), change in fatty acids profile (g/100g of total fatty acids) shown in Table 2. Twenty seven fatty acids were identified in Baobab seeds oil, includes both saturated and unsaturated fatty acids. The major fatty acids oleic, palmitic and linoleic were detected. Baobab seed oil was contained oleic acid in all oil samples except sample (1). Palmitic acid was found only in sample (6), linoleic acid was present in sample (1). The main saturated fatty

acid were tricosylic acid 0-81.19% and pentadecylic acid 0-32.66%. Among the monounsaturated fatty acids gondoic acid 0-0.72% was present, but the most abundant were palmitoleic acid 0-34.85%, pentadecylic acid 0-23.66%, heptadecenoic acid 0-20.27%, oleic acid and elaidic acid 0-28.68%. Docosadienoic acid 0-73.45% was the major polyunsaturated fatty acid. Observed, linoleic acid and oleic acid the highest content were obtained from Kordofan samples (1) and (3), respectively. The highest palmitic acid content was obtained in sample (6) from Blue Nile.

The minor fatty acid present were palmitic, myristic and tridecylic. While eicosadienoic acid was detected in all Baobab seed oil samples. Eighteen fatty acids were found to represent more than 0.5% of seed oil. Oleic acid was appeared conjugated with Elaidic acid in Baobab seeds oil. Furthermore, mean pentadecylic acid, heptadecenoic acid, erucic acid and eicosadienoic acid in Blue Nile oil were significantly higher than Kordofan seeds oil. On other hand, myristoleic acid, palmitoleic acid, oleic acid, elaidic acid, linolelaidic acid and docosadienoic acid in Kordofan seed oil accessions were profoundly higher values. Regarding the fatty acids were reveal in Kordofan, stearic acid, arachidic acid, heneicosanoic acid, behenic acid and linoleic acid. While, tricosylic acid, α- linoleic acid and arachidonic acid were detected in Blue Nile. Baobab oil contains highest rates of tricosylic acid in Blue Nile oil, while Kordofan oil is rich in docosadienoic acid. Sample (4) from Blue Nile was highest source of α- linoleic acid, which is essential fatty acid of unsaturated fatty acid compared to the other five samples, while oleic acid found with a valuable amount in fresh seeds of Kordofan sample (3).

The results also showed that the Baobab seeds oil are good source of polyunsaturated fatty acids. Fatty acids were affected by storage, some were gone and others were clearly lacking. This means that storage reduces the fatty acid content in Baobab seeds, which shows its effect by increasing the duration, longer storage period of the seed result decreased fatty acid concentration. Beyond any doubt that is better to extract fresh seeds than storage seeds to obtain the highest concentration of fatty acid composition. However, only thirteen fatty acids were found to represent more than 0.5% in Blue Nile, while they were fourteen fatty acids detected more than 0.5% in Kordofan seeds oil. Poly and monounsaturated fatty acids were found higher than saturated fatty acids. Baobab seeds were distinguished by oil rich in oleic acid up to 28.68 % and linoleic acid 16.11 %, this results accordant with that reported by (Razafimamonjison et al., 2017). Myristic acid was found with small quantities less than 0.1% as found with other authors (Modiba et al., 2014) this is agreement with the results obtained. Also Baobab seeds exhibited appreciable level of linoleic acid making up to 28% and palmitic acid in a percentage of 22% of total fatty acids (Salih and Yahia, 2015). These values are comparable to those reported by (Osman, 2004) who found 35.8% oleic acid, 30.7% linoleic acid and 24.2% palmitic acid in Baobab seed oil, respectively. The oil sample contained linoleic acid which has been shown to contribute towards maintaining a healthy skin particularly when topically applied in case of acne.

The application of linoleic acid for oily and problematic skin may result in improved sebaceous gland function and the prevention of comedo-acne formation. Therefore, most of the obtained results in this study were acceptable and similar to previous studies. The high content of linoleic acid present in Baobab seed reflects the nutritive significance of the seed and the potential as healthy food oil, these properties make the Baobab seed oil a good option for preparing healthier foods and as both additive and preservative. Depending on their fatty acid percentages they may exhibit a variety of properties which could be beneficial to the skin during daily cosmetics use. With high percentage of palmitic (unsaturated fatty acid), oleic (monounsaturated fatty acid) and linoleic (polyunsaturated fatty acid) acids were detected in Baobab seed oil, the findings could suggest that the seed oil is of great importance as a cosmetic base to prevent trans epidermal water loss by creating a protective layer on the epidermis (Salih and Yahia, 2015).

In addition, linoleic acid is a natural component of sebum and plays a significant role in strengthening the lipid barrier of epidermis and normalizes the skin metabolism. (Kanlayavattanakul and Lourith, 2011) reported that Baobab seed oil could be regarded as a potential therapeutic topical application for acne treatment due to the

high percentage of linoleic acid present. Linoleic and linolelaidic acids, which are essential in human nutrition, since they cannot be synthesized by the body, formed considerable proportion of total fatty acids in Baobab oil, both acids prevent skin diseases in the same way as eicosapentaenoic acid. Eicosapentaenoic acid has attracted great attention because it was found in diet of Eskimos virtually free from atherosclerosis. Other investigations have documented that eicosapentaenoic acid in the blood is an extremely potent antithrombotic factor (Harris, 2004).

Table 2- The contents and profiles of different types of fatty acids in Baobab Oil.

Fatty Acid	Formula	Systematic Name	Structure	1	2	3	4	5	6
Saturated									
Caprylic	$C_8H_{16}O_2$	Octanoic acid	C8:0	0	0	0	0	0	0.01
Capric	$C_{10}H_{20}O_2$	Decanoic acid	C10:0	0	0	0	0	0.01	0
Tridecylic	$C_{13}H_{26}O_2$	Tridecanoic acid	C13:0	0.002	0	0	0	0.001	0
Myristic	$C_{14}H_{28}O_2$	Tetradecanoic acid	C14:0	0.07	0.02	0	0	0.002	0
Pentadecylic	$C_{15}H_{30}O_2$	Pentadecanoic	C15:0	0	0.02	0	0.01	0	0
Palmitic	$C_{16}H_{32}O_2$	Hexadecanoic acid	C16:0	0	0	0	0	0	0.003
Margaric	$C_{17}H_{34}O_2$	Heptadecanoic acid	C17:0	0	0	0.06	0	0	0
Stearic	$C_{16}H_{36}O_2$	Octadecanoic acid	C18:0	0.22	0	0.16	0	0	0
Arachidic	$C_{20}H_{40}O_2$	Eicosanoic acid	C20:0	0.16	0.06	0.72	0	0	0
Heneicosanoic	$C_{21}H_{40}O_2$	Heneicosanoic	C21:0	0	0	1.53	0	0	0
Behenic	$C_{22}H_{44}O_2$	Docosanoic acid	C22:0	0	0	14.88	0	0	0
Tricosylic	$C_{23}H_{46}O_2$	Tricosanoic acid	C23:0	0	0	0	0	0	81.19
Monounsaturated									
Myristoleic	$C_{14}H_{26}O_2$	9-tetradecanoic acid	C14:1	12.30	0	0.18	0.21	0.04	0
Pentadecylic	$C_{15}H_{30}O_2$	Pentadecanoic acid	C15:1	0	7.95	0	32.66	10.03	0.03
Palmitoleic	$C_{16}H_{30}O_2$	9-Hexadecenoic acid	C16:1	34.85	0	34.59	0.15	0	5.05
Heptadecenoic	$C_{17}H_{32}O_2$	cis-10-heptadecenoic acid	C17:1	0.75	5.97	0	20.27	7.47	0
Oleic	$C_{18}H_{34}O_2$	cis-9-Octadecenoic acid	C18:1	0	1.46	14.34	3.16	0.70	2.93
Elaidic	$C_{18}H_{34}O_2$	9-Octadecenoic acid (E)	C18:1	0	1.46	14.34	3.16	0.70	2.93
Gondoic	$C_{20}H_{38}O_2$	cis-11-Eicosenoic acid	C20:1	0.16	0.06	0.72	0	0	0.58
Erucic	$C_{22}H_{42}O_2$	cis-13- Docosenoic	C22:1	0.09	0	0	11.59	0	0
Polyunsaturated									
Linoleic	$C_{18}H_{32}O_2$	9,12-Octadecenoic acid	C18:2	16.11	0	0	0	0	0
Linolelaidic	$C_{18}H_{32}O_2$	9,12-Octadecenoic acid	C18:2	0	0.83	16.91	0	0	3.53
α- Linolenic	$C_{18}H_{30}O_2$	9,12,15-Octadecatrienoic	C18:3	0	0	0	5.05	1.68	0
Eicosadienoic	$C_{20}H_{36}O_2$	11,14-Eicosadienoic acid	C20:2	4.83	8.62	1.53	23.63	11.65	1.85
Arachidonic	$C_{20}H_{32}O_2$	5,8,11,14-Eicosateraenoic	C20:4	0	0	0	0	0	1.85
Eicosapentaenoic	$C_{20}H_{30}O_2$	5,8,11,14,17-pentenoic	C20:5	0.09	0	0	0	0	0
Docosadienoic	$C_{22}H_{40}O_2$	13,16-docosadienoic acid	C22:2	30.30	73.4	0	0	67.69	0
Cervonic	$C_{22}H_{32}O_2$	Docosahexaenoic acid	C22:6	0	0.05	0	0	0	0

Table 3 showed represent the major groups of fatty acids in Baobab seeds oil, the total percentage of fatty acid chains. All the values were represented as the relative percentage area from the sum of all identified peaks. Revealed that the Baobab seeds were good source of saturated fatty acid and monounsaturated fatty acid were higher in Blue Nile, while polyunsaturated fatty acid was louder in Kordofan. Poly and monounsaturated fatty acids were found higher than saturated fatty acids. A significant more than 0.05% increase of polyunsaturated fatty acid was observed during the storage period, while the saturated fatty acid and monounsaturated fatty acid were found to decrease. The observed highest levels of saturated fatty acid was in sample (6) Blue Nile oil, these seeds oil have a tendency to conserve highly saturated fatty acids that might be essential for their metabolic activity. The amounts of the fatty acid fractions in the fresh Baobab oil were MUFA> PUFA> SFA and SFA> MUFA> PUFA for Kordofan and Blue Nile respectively, at the end of the storage period these amounts were changed to PUFA>MUFA>SFA and MUFA> PUFA> SFA. The differences in the fatty acid composition had a decisive role in the formation of hydro peroxide. The high content of polyunsaturated fatty acids in Baobab seed qualify it to play an important role in modulating human metabolism and reducing blood cholesterol level as reported from a number of vegetable oil (De Caluwé et al., 2010). It was reported that Baobab seed oil contained 17-22% saturated fatty acids (SFA), 32-38% monounsaturated fatty acids (MUFA)

and 22-26% polyunsaturated fatty acids (PUFA). Palmitic acid was the most abundant SFA, while oleic and linoleic acid were the dominant MUFA and PUFA, respectively (Muthai et al., 2019). However, the obtained results were supported by other studies, that the major content was linoleic and followed by oleic acid. (Komane et al., 2017) reported that the major fatty acids were linoleic 36.0%, oleic 25.1% and palmitic acid 28.8%. (Apraku et al., 2019) reported that the high content of the essential PUFA is noted to meet the requirements in human nutrition.

The fatty acid profile could significantly change due to the storage and climatic conditions whether it could increase with period of storage, air, heat, traces of metal, peroxides, light, or double bonds present in the oil and thus leads towards the deterioration of the quality. Baobab seed oil has reported to be one of the most suitable feedstock for biodiesel production, according to the fatty acid methyl ester profile that becomes one of the key factors (Ali et al., 2013). The spectral analysis used GC-MS fragments revealed the following fatty acids; palmitic, stearic, linoleic and behenic acid which were reported previously as having potential in cosmetic and pharmaceutical industries (Warra et al., 2015). A wide variability in fatty acid content between the different oils was observed. The fatty acid composition could significantly change due to the difference of geographical location, whether fatty acid could decrease with increased storage period. Fatty acid composition of oils varied only slightly according to the sites and storage of seed collection. In terms of the overall quality of oil, it is said that the quality decreases as the storage lifetime is longer and the factors that influences (Goja, 2013).

Table 3- The Major groups of fatty acids (%/TFA) in Baobab seeds oil.

	1	2	3	4	5	6
SFA	0.45	0.10	17.35	0.01	0.10	81.20
MUSFA	48.15	15.44	64.17	71.20	118.94	11.52
PUSFA	51.33	82.95	18.44	28.68	81.02	7.23
TFA	99.93	98.49	99.96	99.89	99.96	99.95
SFA%	0.45	0.10	17.35	0.01	0.10	81.24
USFA%	99.54	99.89	82.63	99.98	99.88	18.75
MUSFA%	48.18	15.67	64.19	71.27	18.92	11.52
PUSFA%	51.36	84.22	18.44	28.71	80.96	7.23

CONCLUSION

In conclusion, the results of this study suggested that Baobab seeds oil could have beneficial effect for food and cosmetics application in the promotion of health. Storage affects the oil content and saponification value of seed by decreasing, while the values of iodine, acid and peroxide number increases. Fatty acids composition declined along during the storage period, the overall results analysis show that the major fatty acid compositions were tricosylic acid followed by docosadienoic acid and palmitoleic acid, fatty acid composition of Baobab oil vary according to the storage and geographical location. In terms of the totalized quality of oil, it is said that the quality of Baobab oil was decreases as the storage age is longer and the factors that impact. Therefore, further studies on Sudanese Baobabs are needed to investigate their potential as raw materials for new industrial products and applications to increase the economic feasibility of future commercial cultivation of the tree. Consumption of the Baobab oil in their raw state is recommended.

Conflict of Interest: The authors declare no conflict of intrest.

REFERENCE

i. *Alabadi, A.A.H. (1975). Pattern and models of major cities in Sudan. Arab League Educational, Cultural and Scientific Organization. Institution of Arab Research and Studies: 98-99.*

ii. *Ali M.H., Mashud M., Rubel M.R., Ahmad R.H. (2013). Biodiesel from Neem oil as an alternative fuel for diesel engine. Procedia Engineering Journal 56:625-30.*

iii. *AOAC. (1990). Official Methods of Analysis, 15th edition. Association of Official Analytical Chemists, Arlington, VA, USA.*

iv. *Apraku A, Huang X, Ayisi CL, Yusuf A. (2019). Potential of corn oil as alternative dietary lipid source in aquaculture feeds. Journal Applied Sciences 19:156-65.*

v. *BNSI. (2004). Blue Nile state Investment Map. (BNSI) Ministry of Agriculture, the Blue Nile State, Sudan.*

vi. *De Caluwé, E., Halamová, K., & Van Damme, P. (2010). Adansonia digitata L.: a review of traditional uses, phytochemistry and pharmacology. Afrika Focus Journal 23(1), 11–51.*

vii. *El Amin H.M. (1990). Trees and shrubs of the Sudan. Ithaca Press Exeter, USA.*

viii. *Erwa Y.I., Ali M.A., Khalid A.E., Omer B.A., Ishag O.O. (2019). Proximate Composition, Mineral Elements Content and Physicochemical Characteristics of A. Digitata L Seed Oil. International Journal of Pharma Bio Sciences 10(4):119-26.*

ix. *Food and Agriculture Organization. (1960). Kordofan Province, Elobide 86.*

x. *Goja A.M. (2013). Physico-chemical properties of oil produced from Moringa oleifera, Jatropha curcas and Carthamus tinctorius L seeds. International Journal of Advance Research 1(4):181-7.*

xi. *Harris W.S. (2004). Omega-3 fatty acids, thrombosis and vascular disease. International Congress Series Journal, 1262:380-383.*

xii. *IFAD/WB. (2012). The performance of gum arabic auction markets; Revitalizing the Sudan gum arabic production and marketing project. Unpublished report. Khartoum IV: Northern Kordofan. Khartoum University Press, Sudan.*

xiii. *Kanlayavattanakul, M., Lourith, N. (2011). Therapeutic agents and herbs in topical application for acne treatment. International Journal of Cosmetic Science 33: 289-297.*

xiv. *Komane, B.M.; Vermaak, I.; Kamatuou, G. P.P., Summers, B. and Veljoen, A. M. (2017). Beauty in Baobab: a pilot study of the safety and efficacy of Adansonia digitata seed oil. Revista Brasileira de Farmacognosia 27:1-8.*

xv. *Metcalf L.C., Schmitz A.A., Pleca J.R. J.R. (1966). Rapid preparation of fatty acid ester from lipid for gas chromatography analysis. Analytical Chemistry Journal 38: 514–515.*

xvi. *Modiba, E., Osifo, P., Rutto, H. (2014). Biodiesel Production from Baobab (Adansonia Digitata L.) Seed Kernel Oil and Its fuel Properties. Industrial Crops and Products 59: 50-54.*

xvii. *Muthai U.K., Indieka A.S., Muchugi A., Karori S.M., Mung'omba S. (2019). Quantitative variation of fatty acid composition in seed oil from baobab (Adansonia digitata L.) wild populations in sub- Sahara Africa. South African Journal of Botany 123:1-8.*

xviii. *Nkafamiya, I., Osemeahon, S., Dahiru, D. and Umaru, H., 2007. Studies on the chemical composition and physicochemical properties of the seeds of baobab (Adasonia digitata). African Journal of Biotechnology, 6(6), 756-759.*

xix. *Osman M. A. (2004). Chemical and nutrient analysis of baobab (Adansonia digitata) fruit and seed protein solubility. Plant Foods Human Nutrition 59:29–33.*

xx. *Razafimamonjison, G., Tsy, J. M. L.P., Randriamiarinarivo, M., Ramanoelina P., Rasoarahona, J., Fawbush, F., and Danthub, P. (2017). Fatty Acid Composition of Baobab Seed and Its Relationship with the Genus Adansonia Taxonomy. Chemistry and Biodiversity 14:1-9.*

xxi. *Salih N. K-E. M., Yahia,E. M. (2015). Nutritional value and antioxidant properties of four wild fruits commonly consumed in Sudan. International Food Research Journal 22(6): 2389- 2395.*

xxii. *Warra A.A. and Sheshi F. (2015). Physico- chemical, GC-MS analysis and Cold Saponification of Onion (Allium cepa L.) Seed Oil. American Journal of Chemistry and Applications. 2(5): 108-113.*

xxiii. *Wilson L.D., Fal F.Y. Buhari M., Yoro M. (2015). Effect of Seed Storage on The Physico – Chemical Prosperities of its Oil (Adansonia digitata). International Interdisciplinary Journal of Scientific Research 1-7.*