SUST Journal of Agricultural and Veterinary Sciences (SJAVS)
Vol. 20 No.(2)
ISSN: 1858 6775

December 2019

SUST
Journal of Agricultural and Veterinary Sciences
Journal homepage:
http:// journals.sustech.edu

Chemical composition and minerals content of Sudanese baobab (*Adansonia digitata L*) fruit pulp

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Article history: Recieved: January 2019
Accepted: February 2019

Abstract
This study was conducted to determine the chemical composition and minerals content of baobab fruit pulp collected El Obeid, Umm Ruwaba, Damazin and Nyala. The fruit pulp was abtained by breaking the capsules manually, then the seeds were removed and dry pulp powder was sieved using appropriate mesh. Samples of pulp were analyzed for proximate chemical composition, minerals, total and reducing sugars. The chemical compositions of baobab fruit pulp from the different locations differ significantly. The mineral contents have ranges of 33.99 -89.67 mg/100g Na, 16.68-37.59 mg/100g K, 51.57 -87.62 mg/100g P, 308.98-398.20 mg/100g Ca, 70.95 -186.68 mg/100g Mg and 6.81 - 27.21 mg/100g Fe. Baobab pulp from El Obeid has the highest contents of total sugars of 38.55g/100g, reducing sugars (10.88/100g) and non –reducing sugars (27.68mg/100g),while baobab pulp from Nyala exhibited the lowest levels of total sugars (27.72 mg/100g),reducing sugars (10.51 mg/100g) and non- reducing sugars (17.14 mg/100g).The finding of this study revealed variations in proximate chemical composition, mineral content and sugars for baobab fruit pulp collected from different locations in Sudan. All samples of baobab fruit pulp contain sufficient amounts of minerals that might enhance the health benefit upon consumption.

Keywords: *Adansonia digitata*, chemical composition, minerals, total sugars, Sudanese baobab fruit

Introduction
Baobab (*Adansonia digitata*) belongs to the family Malvaceae and is a deciduous tree native to arid Central Africa (Yazzie *et al*., 1994). Its distribution location is big and this species may be found in most of sub-Saharan Africa semi-arid and sub-humid regions in addition to eastern Madagascar (Diop *et al*., 2005). In Sudan, baobab is most frequently found on sandy soils and by seasonal streams `khors' in short grass savannas foring belts in Kordofan, Darfur, and Blue Nile (El Amin, 1990).
The baobab fruit pulp is probably one of the most commercially important foodstuffs. It can be dissolved quickly in water or milk, the liquid is then used as a drink, a sauce for food, a fermenting agent in local brewing, or

as a substitute for cream of tartar in baking (Sidibe and Williams, 2002). According to Manfredini *et al*.(2002) baobab dry fruit pulp includes 0.27% lipids, 2.3% protein, 5.2% soluble and insoluble fiber and 75.6% carbohydrates. Fruit pulp proved to be true source for soluble and non- soluble fiber, carbohydrate and mineral. Furthermore, it is rich in water-soluble pectin, with a low content of pro-pectin, which has a small level of esterification and intrinsic viscosity values of about one-fifth of that of commercial apple pectin (Nour *et al*., 1980).

The baobab fruit has ten times the antioxidant level of an oranges, six times the vitamin C of an orange, six times antioxidant components compared with blueberries, cranberries, and blackberries, six times extra potassium than a banana, extra iron than meat, more magnesium than spinach, two times the calcium content of milk(Ramadan *et al*.,1990). Baobab pulp extract contains anti bacterial, anti-inflammatory, antifungal, antipyretic and painkiller properties (Manfredini, 2002).

Baobab fruit can be used in different energetic cosmetic uses, such as antioxidants activity for anti-aging, pores and skin tightening, moisturizers, and hair and nail strengthening products (Sidibe and Williams, 2002). Limited information is available about the composition of baobab pulp from diverse regions in Sudan. The objectives of this study were to determine the proximate composition, mineral contents and sugars of baobab pulp collected from different locations in Sudan.

Materials and Methods

Preparation of baobab fruit pulp:

Baobab fruits were obtained from El Obeid, Um Ruwaba, Nyala and Damazin. The Fruit pulp was obtained by breaking the capsules manually; seeds were removed and pulp powder was sieved using appropriate mesh. The resulting fruit pulp was stored in a dark polyethylene bag at -18ºC until used.

Analytical methods:

Chemical composition of baobab fruit pulp:

Proximate chemical composition was determined according to the standard methods of AOAC (2003). Total and reducing sugars were determined according to Lane and Eynon titrometric method (AOAC, 2003).

Minerals contents:

Potassium (K), Sodium (Na) and calcium (Ca) were determined by a flame photometer (Sherwood Flame Photometer i410, Sherwood Scientific Ltd. Cambridge, UK) according to AOAC method (2003).

Statistical analysis:

One - way ANOVA was performed to examine significant differences between normally distributed data of replicated independent runs. A possibility level of less than 0.05 was believed significant ($p<0.05$). All data were analyzed using vision 17 MINITAB statistical software for windows (2013).

Results and Discussion

Proximate composition of baobab fruits from different locations in Sudan

Moisture content: The Moisture content of baobab fruit pulp from different regions is shown in Table (1). It was found to be 6.52, 6.40, 6.95 and 6.79% for baobab fruit from El Obeid, Umm Ruwaba, Damazin and Nyala, respectively. There is significantly different in moisture content ($P\leq 0.05$) .These values were in agreement with the value of 6.7% reported by Nour *et al*. (1980), but lesser than the range of 11.1-13.6% reported by Gaydou *et al*.(1982) . Value of moisture in Table 1 is also lower than the value of 10.4% reported by Osman (2004).

Protein content: The Protein content of baobab fruit pulp is shown in Table (1). Protein values of 5.44, 5.34, 5.56 and

ISSN: 1858 6775

5.11%were a found for baobab from El Obeid, Umm Ruwaba, Damazin and Nyala ,respectively .There is significant difference (P≤ 0.05) in protein amid the four baobab fruit pulps. Results in Table (1) were slightly lower than the value of 6.2% reported by Nour *et al*.(1980) for Sudanese baobab, but higher content than 2.3% concentration reported by Manferdini*et al*. (2002).

Oil content: As showed in Table (1), oil values in baobab were 0.70 %for Umm Ruwaba and 0.64% for Damazin with no significant differences (P> 0.05).while oil values were 0.83% for El Obeid and 1.20% for Nyala baobab fruits which is significantly different (P≤ 0.05).These results were noticeably higher compared to the value of 0.3%given by Osman (2004).

Fiber content: Table (1), displayed the Fiber contents of baobab fruits pulp from El Obeid ,Umm Ruwaba**,** Damazin and Nyala were 8.10, 6.83, 8.29 and 11.21%, respectively. Baobab fruit from Nyala showed significantly higher difference (P≤ 0.05) in fiber content. Result obtained for baobab fruit from Darfur was higher as compared to the values between 5.4 to 9% reported previously by Nour *et al*., (1980); Arnold *et al*., (1985) and Osman (2004).

Table (1): Chemical composition (%) of baobab pulp from different locations in Sudan

Locations of samples	Moisture	Protein	Oil	Fiber	Ash	Carbohydrate
El Obeid	6.52 ± 0.00 [c]	5.44 ± 0.05[ab]	0.83 ± 0.00 [b]	8.10 ± 1.61[b]	5.02 ± 0.03[b]	74.09 ± 1.56[a]
Umm Ruwaba	6.40 ± 0.00[d]	5.34 ± 0.06 [b]	0.70 ± 0.01 [c]	6.83 ± 0.90[b]	4.85 ± 0.13[b]	75.31 ± 0.50[a]
Damazin	6.95 ± 0.05 [a]	5.56± 0.04 [a]	0.64 ±0.00 [c]	8.29 ± 0.0[7b]	5.013 ± 0.01[b]	73.54 ± 0.06[a]
Nyala	6.79 ± 0.07[b]	5.11 ± 0.05 [c]	1.20 ±0.06[a]	11.21 ± 0.46[a]	5.53 ± 0.05 [a]	70.16 ± 0.56[b]

* Each value is mean of three replicates expressed on wet matter basis.
Values are (mean) ± standard deviation.
** Values that bear different superscript letter in the same column are significantly different at p<0.05.

Ash content: As shown in Table (1), ash content was 5.02% of baobab fruits from El Obeid, 4.85 %for Umm Ruwaba and 5.01 %for baobab fruits pulp from Damazin. Results showed no significant (P ≥ 0.05) difference in ash among three baobab fruits pulp. While that of Nyala had significantly (P≤ 0.05) higher ash content to 5.53%. Present values in Table 1were lower than the value of 7% reported by Okoho (1984).

Carbohydrates: As shown in Table (1) the carbohydrates of baobab fruit pulp from El Obeid, Umm Ruwaba, Damazin and Nyala were 74.09, 75.31, 73.54 and 70.16 %, respectively. Results displayed no significant difference (P≥ 0.05) between baobab fruits pulp from El Obeid , Umm Ruwaba ,and Damazin in carbohydrates .While baobab fruit from Nyala had significantly (P≤ 0.05) lower carbohydrates content than that of other samples. Data were in agreement with values of 73.7 to 81%reported by Gaydou *et al*., (1982); Okoho, (1984); Arnold, (1985) and Osman, (2004).

Total sugars: Total sugars were presented in Table (2), values obtained were 38.55, 37.98, 28.96 and 27.72 mg/100g baobab fruit from El Obeid, Umm Ruwaba, Damazin and Nyala respectively, which were slightly higher than the range of 16.9-25.3% reported by Gaydou *et al*., (1982). No significant differences (P≥ 0.05) were observed among the four samples.

Reducing sugar and Non reducing sugars: Results of reducing sugars are shown in Table 2. Fruit pulps of Umm Ruwaba, Damazin baobab were found to be similar in their reducing sugars content (13.16 and 13.13mg/100g respectively. However, El

Obeid and Nyala baobab fruit pulp showed lower values 10.88 and 10.51 respectively compared with other locations .Also in Table(2) the fruit pulp from El Obeid, Umm Ruwaba, Damazin and Nyala contained non reducing sugars concentrations of 27.68 , 24.82 , 15.83 and17.14mg/100g, respectively. These differences in sugar (reducing and non-reducing) content may be attributed to climatic reasons and soil factors difference between the study locations.

Table (2): Total, reducing and non reducing sugars (mg/100g) of baobab fruit pulp from different locations in Sudan

Locations of samples	Total Sugars	Reducing Sugars	Non Reducing Sugars
El Obeid	38.55 ± 9.43[b]	10.88 ± 0.55[a]	27.68 ±8.88[a]
Umm Ruwaba	37.98 ± 5.69 [b]	13.16 ± 0.81[a]	24.82 ± 4.87[a]
Damazin	28.96 ± 1.3[a]	13.13 ± 1.68[a]	15.83± 2.99[a]
Nyala	27.72 ± 2.39[a]	10.51 ± 0.87[a]	17.14 ± 1.58[a]

* Each value is mean of three replicates expressed on wet matter basis
Values are (mean) ± standard deviation.
** Values that bear different superscript letter in the same Column are significantly different at p<0.05.

Minerals content: Table 3 shows minerals content (Ca, Na, K, Mg, P and Fe) of baobab fruit pulp from different locations in Sudan.

Sodium content: Chemical analysis exposed significant (P≤ 0.05) difference in Na contents of the four baobab fruits pulp. Values obtained were found to 89.67 mg/100g from El Obeid, 75.08 mg/100g from Umm Ruwaba33.99 mg/100g from Damazin and 37.59 mg/100g from Nyala, this value was higher as compared with 27.8 mg/100g and 28mg/100g which was reported for baobab fruit pulp by (Osman, 2004) and (Nasreldin *et al* .,2016), respectively. The variation of the Na contents of the pulp between different locations may be explained by the environmental factors and the effect of soil type on fruit compositions.

Potassium content: Potassium values obtained were 16.68, 18.74, 37.59 and 28.71 mg/100g of baobab fruits pulp from El Obeid, Umm Ruwaba, Damazin and Nyala, respectively. The baobab fruits pulp from different locations were significantly (P≤ 0.05) different in their K content. This value was lower as compared with (575-617 mg/100g) which was reported for baobab fruit pulp by (Nasreldin *et al*., 2016).

Phosphorus content: Phosphorus content in baobab fruit pulp from EL Obeid and Umm Ruwaba were found to have almost the same level of P (51.80 -51.57 mg/100g) with a mean value of 51 mg/100g,these values are similar to the value of 50.8 mg/100g reported by Nour *et al*, (1980). Phosphorus content in baobab fruit pulp from Damazin and Nyala were found to (81.71 -87.62 mg/100g), which were lower than the range of 96-118mg/100g and 1240mg/100g of reported by Baobab Fruit Company, (2002) and (Osman, 2004) respectively.

Calcium content: Calcium content of baobab fruit pulp ranged from 308.98 to398.20 mg/100g with average value of 358.67 mg/100g.There is significant differences (p≤0.05) in Ca among the four baobab fruit samples. Nour *et al*. (1980) , Manfredini *et al.* (2002) and Nasreldin *et al*.(2016) reported higher values of 655 , 670 mg/100g and (500-620mg/100g), respectively, however Osman, (2004) obtained a lower value of 295 mg/100g for baobab fruit.

Magnesium content: Magnesium values obtained were 104.10, 70.95, 142.10 and 186.68 mg/100g for El Obeid, Umm Ruwaba, and Damazin and (Nyala) baobab fruits, respectively. All baobab fruits pulp were significantly ($P \leq 0.05$) different in their Mg content. This value was lower as compared with 574.2mg/100g which was reported for baobab fruit pulp by (Nasreldin *et al*., 2016).

Iron content: Investigation showed that Fe content of baobab fruit was7.02 mg/100g for El Obeid sample, 6.81 mg/100g for Umm Ruwaba and 17.21mg/100g for Damazin and 27.21 mg/100g for Nyala. Iron content was significantly different ($P \leq 0.05$) among baobab fruits pulp from different locations. The results from El Obeid and Umm Ruwaba are within the range reported by Nour *et al*. (1980) and Osman (2004) who reported iron value of 8.6 and 9.3 mg/100g, respectively.

All mineral of baobab pulp in this study were recorded different levels between locations in Sudan. This indicated that mineral composition of the fruit pulp is significantly influenced by the location of origin which is consistent with that reported by Parkouda *et al.* (2007) for baobab in Mali and Burkina Faso. One probable explanation for the differences is that fruit composition is a disclosure of the soil characteristic of the microsite of each plant (Izhaki *et al*, 2002). It is claimed that the accessibility of nutrients in soil is very heterogeneous; demonstrating a strong spatial and temporal difference that is frequently linked to seasonal and climatic conditions (Monokrousos *et al*., 2004).

Table (3): Mineral contents (mg/100g) of baobab fruit pulp from different locations in Sudan

Locations of samples	Na	K	P	Ca	Mg	Fe
El Obeid	89.67 ± 0.62^{a}	16.68 ± 0.51^{c}	51.80 ± 1.09^{c}	398.20 ± 1.8^{a}	104.10 ± 0.99^{c}	7.02 ± 0.03^{c}
Umm Ruwaba	75.08 ± 0.60^{b}	18.74 ± 0.55^{c}	51.57 ± 0.51^{c}	391.82 ± 0.54^{a}	70.95 ± 1.02^{d}	6.81 ± 0.05^{c}
Damazin	33.99 ± 0.14^{d}	37.59 ± 0.64^{a}	81.71 ± 1.59^{b}	308.98 ± 7.02^{c}	142.10 ± 2.94^{b}	17.21± 0.13^{b}
Nyala	37.59 ± 0.64^{c}	28.71 ± 2.07^{b}	87.62 ± 1.68^{a}	335.69 ± 1.95^{b}	186.68 ± 3.10^{a}	27.21± 0.93^{a}

* Each value is mean of three replicates.
Values are (mean) ± standard deviation.
** Values that bear different superscript letter in the same Column are significantly different at p<0.05.

Conclusion

Baobab fruit pulp from Nyala contains the highest fiber and mineral (P, Mg and Fe) compared with Elobied, Um Ruwaba and Damazin. Baobab fruit pulp from different locations in Sudan is rich in carbohydrate, fiber, Ca, P and Mg and has appreciable amount of protein content. These results indicate that Sudanese baobab fruit pulp contains sufficient amounts of nutrients of health benefit that could enhance human general health.

Acknowledgments

We duly acknowledge the Research Grant received from Deanship of Scientific Research, Sudan University of Science and Technology, Khartoum, Sudan.

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التركيب الكيميائي و محتوي المعادن للب ثمار التبلدي السوداني

سلمى الزين إبراهيم[1] ,يوسف محمد أحمد إدريس[1] , سلمى الغالي مصطفي[1] و بركة محمد كبير بركة[1]

1-كلية الدراسلت الزراعية –جامعة السودان للعلوم والتكنولوجيا–قسم علوم وتكنولوجيا الأغذية

المستخلص:

أجريت هذة الدراسة لتقدير التركيب الكيميائي ومحتوي المعادن للب ثمار التبلدي التي جمعت من الأبيض ,أمروابة, الدمازين و نيالا. تم إستخلاص لب ثمار التبلدي بالكسر يدويا ّو الحصول علي بدرة التبلدي بإستخدام غرابيل مناسبة. حللت العينات للمحتوى الكيميائي التقريبي و المعادن و السكريات الكلية و السكريات المختزلة. أوضحت النتائج وجود إختلافات معنوية في التركيب الكيميائيي ومحتوي المعادن في لب ثمار التبلدي بين المناطق المختلفة..وجد مستوي المعادن في المدي33.99-89.67مليجرام/100جرام للصوديوم16.86 و-37.59مليجرام /100جرام للبوتاسيوم و51.57-87.62 مليجرام/100جرام للفسفور و308.98-3.98.20مليجرام/100جرام للكالسيوم و 6.81-27.21مليجرام/100جم للحديد علي التوالي.سجلت أعلي مستويات للسكريات الكلية38.55 مليجرام/100جرام والمختزلة10.88مليجرام/100جرام وغير المختزلة27.68 مليجرام/100جرام في لب ثمار التبلدي لعينة الأبيض بينما أدني مستويات للسكريات27.72مليجرام /100جرام والمختزلة10.51مليجرام/100جرام وغير المختزلة 17.14مليجرام/100جرام وجدت في عينة نيالا. أظهرت نتائج هذة الدراسة إختلافات في المحتوى الكيمائيي التقريبي و مستوي المعادن والسكريات في لب ثمار التبلدي التي جمعت من مناطق مختلفة في السودان ، ومع ذلك إحتوت كل عينات التبلدي علي كميات كافية من البروتين و الحديد والكالسيوم مما يعزز من الفوائد التغذوية والصحية مع الإستهلاك.