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Characteristic of Some Indigenous Sudanese Forest Fruits and Their Chemical and Antioxidant Compounds

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Abstract

In this study characterizations of *Piliostigma reticulatum* (Croup), *Vangueria madagascariensis* (Kirkir), *Hyphaene thebaica* L (Doum), and *Azanza garkeana* (Jagjag) forest fruits were carried out. Whole fruits were subject to characterization whereas., the edible portions of fruits were subject to proximate composition (Moisture, fats, crude protein, ash, crude fiber), minerals Na, K, Ca, Mg, Fe and antioxidants. The result recorded significant difference in different components between fruits. Moisture content ranged from 6.50 in croup fruits to the maximum level of 22.85% in jagjag fruit. In fat content, the highest level of fat 5.800 ± 0.14% was recorded in croup fruit where the lowest level of 0.474 ± 0.037 % was recorded for jagjag fruit. Jagjag fruits recorded the highest protein content of 7.250 ± 0.35 %**.** while Doum fruits recorded the lowest (2.400 ± 0.00 %). The highest level of ash content (7.15± 0.00 %) was recorded for Doum fruit. The lowest fiber content (13.935 ± 1.223%) was absorbed in Kirker fruits, While the highest level of 18.60 ± 0.00 % was calculated for croup fruits. The highest level of carbohydrate (64.850 ± 0.495 %) was recorded for Doum fruits while the lowest (49.210 ± 0.127 %) was recorded for Jagjag fruits. Doum contained the highest total and non-reducing sugar while kirker recorded the highest level of reducing sugar. Jagjag fruits recorded the highest level of Vitamin C 18.800 ± 0.424 mg/100 ml, kirker fruits recorded the lowest level of Vitamin C 0.4220 ± 0.00 mg/100 ml. The highest Na, K, Mg, Ca and Fe were recorded in kirker, Doum and Jagjag fruits and croup fruits, respectively. Forest fruits also had excellent quantities of antioxidants. The highest antioxidant, phenol and flavonoid were recorded for croup, croup and doum, respectively. The levels of flavonoids ranged between 46.33 ±0.00 and 1223.06 ±0.07 mg of QE/g dry extract. recorded for Kirker and Doum respectively.

Keywords: Indigenous, Sudanese, forest, fruits, Characterization, Antioxidants.

Introduction

Indigenous fruit trees although undomesticated play many important roles in people living in rural areas. Indigenous fruit trees are important traditional sources of nuts, fruits, spices, leafy vegetables, edible oil and beverages (Okafor, 1985). Like vegetables, indigenous fruit trees provide vitamins and minerals essential for the proper maintenance of human health (Saka et. al., 1994). According to FAO (1982), the nutritional value of indigenous fruit bearing tree species indicate that many are rich in sugars, essential vitamins and minerals while others are high in vegetable oil

and proteins. In addition to fruit production and cash, the extensive list of benefits includes firewood, fodder, building material, shade and medicine to rural communities. Indigenous fruit trees are particularly used during periods of seasonal food shortages and are often the only available fruit source of high nutrients. In some African counters indigenous fruit trees yield a crop in poor rainfall years when arable agriculture fails, thereby improving food security for rural households. (Mojeremane, 1999). On the other hand, before the development of modern medicine forest fruits were used in the healing of various diseases and are well-known in folk-medicine (Landete, 2012 and Paredes et. al., 2010). It is becoming increasingly apparent that antioxidants are very important in health and disease prevention. Therefore, the interest in food products and supplements as sources of antioxidants is growing worldwide (Hsu et. al., 2006). Phenolic compounds are widely distributed in such plants where they act as attractants for certain insects, as free radical scavengers, and in defense against ultraviolet radiation, pathogens and predators (Zimmer et.al., 2014). In this context, forest fruits are known for being rich in bioactive compounds, including flavonoids, phenolic acids, tannins and anthocyanin's (Okan et.al., 2018).
The fruits of forest plants species played an important role in the diet of people in the savanna belt of Sudan especially during food shortages and famines (Kordufan and Darfur,1983). During this time, the forest fruits were the main ingredients given as a gesture of hospitality and generosity (Abdel Muti, 2002). However, the information on physical properties and chemical composition of ingenious fruits is still limited. It is high time to conduct research for further assessment targeting their maximum utilization as fresh or processed products and this will improve their economic value (Abdel-Rahman, 2011). Because Sudan is regarded as one of the highest producer of forest fruits which has high nutrition value and health benefit compounds but unfortunately it uses has limited and it is not exploited industrially for Processing novel food to facilitate the consumption. Therefore, this study was undertaken to study physical characteristics of whole fruits, chemical and antioxidant components of some selected indigenous Sudanese forest fruits.

Materials and methods

Materials

Piliostigma reticulatum (Croup), Vangueria madagascariensis (kirker), Hyphaene thebaica (doum) and Azanza garckeana (Jagjag). were obtained from Elabasia in South Kourdufan State at the harvesting season. Fruits were peeled, crushed, their seeds were removed and the remaining packed in tide containers.

Physical characteristics

Size of whole different forest fruit dimensions (thickness and diameter) in this study were measured by using Vernier Caplier (Vernier, 1.00 – 150 mm, Mituroyo, Japan).
Weight was recorded using a sensitive balance (No.AR2140, OHAC SCORO, USA).

Colour

The colour intensity of forest fruits were recorded using a lovibond Tinto-meter as units according to the AOAC. (2000). 1 g of forest fruits was crushed dissolved in 10 ml water, filtered through a filter paper and filled in the Tinto-meter cells. The instrument was switched on and the yellow colour was adjusted to 25. After that, the slides were adjusted to match the sample colour by a combination of red and blue colours.

Proximate composition

Determination of moisture content

The moisture content of the forest fruits was determined following the standard method described by the Association of Official Analytical Chemists (AOAC, 2003).

The moisture content in a weighed sample was removed by heating in an oven (under atmospheric pressure) at 105 ˚C. Then, the difference in weigh before and after drying was calculated as moisture.

Determination of fat content

The fat content of samples was determined by using petroleum ether in a continuous extraction apparatus (Soxhlet type) as described by Pearson (1970).

Determination of crude protein

The crude protein content in the sample was determined by the micro-Kjeldahl method following the method of the AOAC (2003). Sample was digested with a strong acid (sulphuric acid) so that the sample releases its nitrogen content determined by a suitable titration technique. The amount of protein present in the sample was calculated from the nitrogen concentration using a conversion factor of 6.25 (equivalent to 16 g nitrogen per 100 grams of protein).

Determination of ash content

The ash content of the sample was determined according to the AOAC (2003) method. Weighed sample was ashed in a muffle furnace (LEF- 103S, watts: 29 2KW10A serial No. 07033002, Korea) at 550◦ to 700◦ C for more than 6 hours until white to grey ash was obtained. the difference in weigh before and after ashing was calculated as ash percentage.

Determination of crude fiber

The crude fiber of the forest fruits was determined following the standard method described by the Association of Official Analytical Chemists (AOAC, 2003). The crude fiber was determined gravimetrically after the sample was chemically digested. The weight of the residue after ignition for ash was considered as crude fiber.

Determination of available carbohydrates

The available carbohydrates were calculated by subtracting the total sum of moisture, fat, crude protein, crude fiber and ash as percentages from 100% following West, *et. al*. (1988) method.

Total sugars, reducing sugars and non-reducing sugars

The total sugars, reducing and non-reducing sugars were determined according to Lane and Eynon titrimetric method as described by the Association of Official Analytical Chemists AOAC, (1984) using copper sulphate as oxidizing agent in a standard Fehling's solution.

Determination of ascorbic acid (Vitamin C)

Ascorbic acid was determined according to the method by Nweze *et. al. (*2015) Forest fruits were crushed and weighed, water was added and putted in water bath 70◦C for

10 min. then filtered through fresh cotton. 25 ml of filtered juice was taken in 10 ml of 1 M sulphuric acid and titrated with a standard iodine solution using 2 ml starch as indicator till the appearance of blue color then the amount of ascorbic acid was calculated-

Every 1ml of iodine 0.1 M = 0.008806 g ascorbic acid

Every TF= x g ascorbic acid

TF= Titer figure

Determination of minerals

Ferrous (Fe^{++}) was determined according to Perkin Elmer (1994) using Atomic Absorbance Spectroscopy (JENWAY 3110, UK). Sodium (Na) and potassium (K) were determined using Flame Photometer (Model PEP7 JENWAY). While, calcium (Ca), magnesium (Mg), were determined as described by Chapman and Pratt (1961).

Determination of antioxidants

Samples preparation

Forest fruits crushed, weighed and soaked in hot water 100◦C at a ratio of 1:4 (w/v) for 24 hours. The obtained fruits extracts filtered through fresh cotton and dried by using freeze dryer.

Determination of antioxidants activity

Di (4-tert-octylphenyle)-1-picrydrazyl (DPPH) radical scavenging assay:

DPPH radical scavenging assay was determined according to the method of Shimada *et. al.*, *(*1992). In 96-wells plate, the test samples were allowed to react with 2.2Di(4-tert-octylphenyle)-1-picryl-hydrazyl stable free radical (DPPH) for half an hour at 37 ˚C. the concentration of DPPH was kept as (300 Mm). The test samples were dissolved in DMSO while DPPH was prepared in ethanol. After incubation, decrease in absorbance was measured at 517 nm using multi plate reader spectrophotometer. percentage radical scavenging activity by samples were determined in comparison with a DMSO treated control group. All tests and analysis were run in triplicate.

Total Phenol content

Total phenol content of extract was determined with Folin- Ciocalteu colormeteic method (Ainsworth and Gilespie,2007). Briefly ,25 ml of the sample, stander or blank was mixed with 50 ml folin –Ciocalteu reagent in clear 96- well microplate. The content was mixed by manual shaking for 15-20s then 200 ml 700 mM sodium carbonate solution was added. The reaction mixture was incubated in dark at room temperature for 2 hours and its absorbance was measured at 765nm using mutilate reader spectrophotometer. All tests and analysis were run in triplicate. The total phenolic content was determined using calibration curve prepared with garlic acid standard (100-0 mg/l) as a reference. Total phenolic expressed as milligrams of garlic acid equivalents per gram dry weight of residues (mg GAE/g of dried extract) using the regression equation between garlic acid stander and A765.

Total Flavonoids Content

Total flavonoids Content were measured according to the aluminum chloride colorimetric assay as described by wulandari *et. al.*, (2007) with some modification, in which 25 ml of each sample or slandered was mixed with15ml of 0.05 mg/ml sodium acetate. After 5 min, 15 ml of 10%AiCI3 solution was added, 5 min later,100ml IM NaOH was added to the mixture. The reaction mixture was incubated in dark at room temperature for 45 min, the absorbance was measured at 415 nm using multi plate reader spectrophotometer. The total flavonoids content was determined using a calibration curve prepared with quercetin standard (100-0 mg/l) as a reference. The total flavonoids were determined as quercetin equivalents (mg of QE/g dry extract. The experiment was conducted in triplicate analysis.

Statistical analysis

One-way ANOVA was performed for normally distributed data of replicated independent analysis, Probability level of less than 0.05 was considered significant ($p \leq 0.05$). All data were analyzed using vision 17MINTTAB statistical software for windows (2006).

Results and discussion

Physical characteristic of forest fruits

As presented in Table1 the colour of whole fruits from brown to yellow brown. Fruits of croup, doum, kirker and jaggag colours range were of brown, brown red, bright yellow brown and yellow to brown, respectively. Where's colors of edible part were bright yellow (croup, kirker and doum) and brown (jagjag). The results explored that croup whole fruit was brown in colour with acidic taste similar finding (brown colour and acidic taste) for Croup fruit was reported by Vodouhê, (2010), However brownish-red colour for Kirker fruit was mentioned by Bishay *et.al*.(2011) and Schmidt *et. al*, (2004). While shiny brown colour of Doum fruit was reported by World Agroforestry Centre. (2014). Yellowish to brownish green colour for Jagjag presented in table 1 was similar to that recorded by Palgrave, (1988) and ICRAF, (1992). On the other hand, doum and jagjag fruits had sweet taste while Croup and kirker were acidic. The sweaty taste of Jagjag was also mentioned by Palgrave, (1988) and ICRAF, (1992).__Regularly seed of doum fruits was single. Kirker and jagjag having 4 to 5 seeds but croup contained numerous.

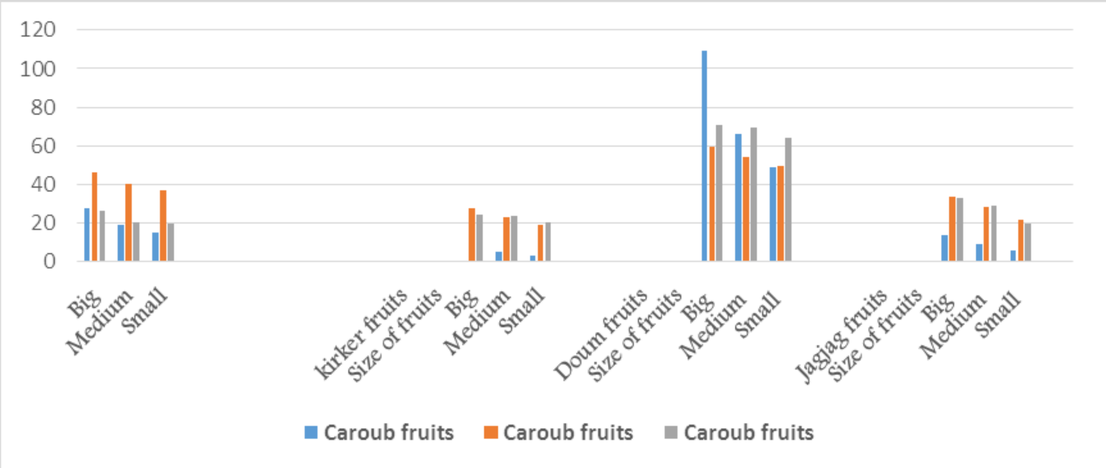
Table 1. Physical characteristics of forest fruits , Type of Fruits

Parameter	***Croup***	***kirker***	**Doum**	**Jagjag**
Skin colour of whole fruit	Brown	Bright yellow-brown	Brown to red	yellowish to brownish
Edible part colour	Bright yellow	Bright yellow-brown	Bright yellow	Brown
Taste	Acidic	Acidic	Sweetly	Sweetly
Seeds count	Numerous	4	Single	4 – 5

Measuring parameters of whole forest fruits

Different measuring parameters for forest fruits were showed in chart1. There were significantly different ($P \leq 0.05$) in weight, diameter and length between different forest fruits and within each speeches type of fruits. Whole Doum fruit recorded the highest weight and diameter followed by Croup and then Jagjag and finally Kirker in descending order. Whole fruits length of Doum was the first followed by Jagjag and then kirker and finally Croup in descending order. Jagjag diameter in this study was higher than that recorded by Palgrave, (1988) and ICRAF, (1992) which ranged between 2.5cm to 4cm.

Chart 1 Parameter of whole forest fruit



Nutritional value of forest fruits
Proximate composition of forest fruits

The results presented in table 2 recorded significant difference ($P \leq 0.05$) in proximate composition of different components between fruits. Moisture content ranged from 6.50 % in croup fruits to a maximum level of 22.85 % in jagjag fruits. The values of moisture content in this study were higher than the findings of FA0 (2006) for African Doum which was 4.00 %. the deference in moisture content could be due to cultivation type and post-harvest conditions (Bates, 2001). The highest level of fat 5.800 ± 0.14 % was recorded in croup whereas the lowest level of 0.474 ± 0.037 % was recorded in jagjag fruits. No significant different ($P \leq 0.05$) between forest fruits in fat content except for croup. In fact, level of fat in this study were in range of Doum (1.2 and 8.4%) recorded by Auwal *et. al.*, (2013). Jagjag fruits recorded the highest protein content (7.250 ± 0.35 %)**,** while Doum fruits recorded the lowest level of 2.400 ±0.00 %. There was no significant different ($P \leq 0.05$) in protein between kirker and Doum fruits (Table 2). The value of protein obtained for doum fruit was lower than (3.80 %) reported by Layman (2003). The changes in protein contents might, indicate variations in metabolic activity during the different development stages (Wills, 1981**).** There were significant different in ash content between different fruits.

The highest level of ash content recorded for Doum fruit. However, no significant difference ($P \leq 0.05$) in ash content between Croup, and kirker. Ash values of those fruits were similar to value 4.37 for Haraz fruit was reported by Lawal and Kabiru. (2007). Ash content of Doum was exactly coinciding to 7.17 % and higher than 2.03 % recorded by Abdel Rahman (2007) for other two Sudanese varieties of mangos. This increase in ash content gives a sign to increase of minerals content of doum fruit.

The lowest fiber content of (13.935 ± 1.223 %) was absorbed in Kirker fruits. While the highest level of 18.60 ± 0.00 % was in croup fruits. Kirker, Doum and Jagjag had similar fiber level of 16.41% as reported by Lawal and Kabiru. (2007). The highest level of carbohydrate was 64.850 ± 0.495 % recorded for Doum fruits while the lowest level 49.210 ± 0.127% was in Jagjag fruits. No significant difference ($P \leq 0.05$) in carbohydrates were observed between kirker and Doum fruits. These results in (Table 2) were lower than 89.25% carbohydrate level recorded by Nwosu *et al.*, (2008). It was stated that the most important carbohydrates component was mannose varied between 13 and 75.9%, (Auwal *et,.al* 2013).

Table 2 proximate composition of forest fruits, type of fruits

components	***Croup***	***kirker***	***Doum***	***Jagjag***
Moisture	6.500 ± 0.00^{d}	13.70 ± 0.00^{b}	7.400 ± 0.00^{c}	22.85 ± 0.00^{a}
Fat	5.800 ± 0.141^{a}	1.750 ± 0.071^{b}	2.500 ± 0.283^{b}	0.474 ± 0.037^{b}
Protein	4.50 ± 0.00^{b}	2.610 ± 0.0141^{c}	2.400 ± 0.00^{c}	7.250 ± 0.354^{a}
Ash	4.900 ± 0.00^{b}	4.500 ± 0.14^{b}	7.1500 ± 0.070^{a}	3.46 ± 0.0141^{c}
Fiber	18.60 ± 0.00^{a}	13.935 ± 1.223^{b}	15.550 ± 0.49^{b}	16.60 ± 0.00^{ab}
Carbohydrate	59.700 ± 0.14^{b}	63.30 ± 0.629^{a}	64.850 ± 0.495^{a}	49.21 ± 0.127^{c}

***Values are mean ± SD for replicate independent analysis**

****Values that bear different superscript letter in each row are significantly different at $p \leq 0.05$**

Levels of sugar in different forest fruits

Doum contained the highest total and non-reducing sugar while kirker recorded the highest level of reducing sugar. There was no significant different ($P \leq 0.05$) in total sugar of forest fruits except for Croup (chart 2). These differences could be attributed to the difference between fruits type.

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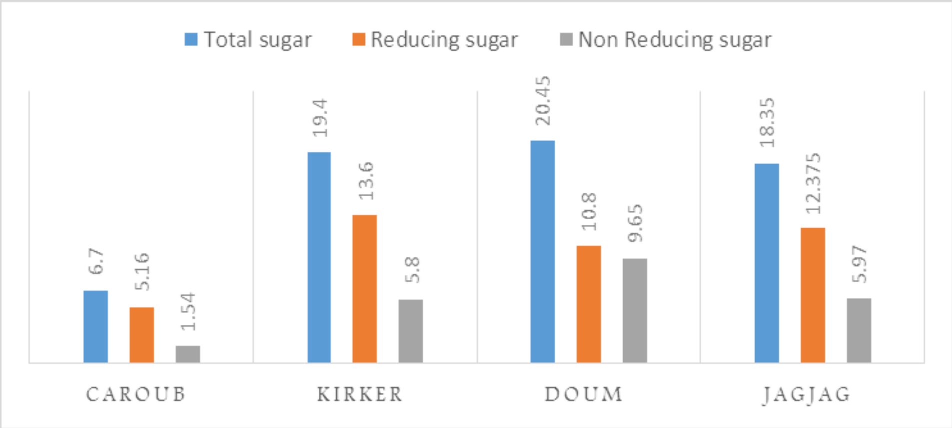
Chart 2 levels of sugar in forest fruits



Level of vitamin C of forest fruits

Jagjag fruits recorded the highest level of Vitamin C (18.800 ± 0.424). While kirker fruits recorded the lowest level of Vitamin C. Significant difference ($P \leq 0.05$) in vitamin C between forest fruits were observed. However, the values of vitamin C in this study were lower than (30.00 mg /100g) recorded for orange by Rathore, (2009).

Table 3 level of vitamin C in forest fruits, type of fruits

Parameter	Croup	kirker	Doum	Jagjag
Vitamin C mg/100 ml	2.202.02 ± 0.00 ^{c}	0.422 ± 0.00^{d}	3.52 ± 0.001 ^{b}	18.80 ± 0.42^{a}

***Values are mean ± SD for replicate independent analysis**

****Values that bear different superscript letter in row are significantly different at p≤0.05.**

Minerals element content of forest fruits

As present in table 4, There were significant difference ($P \leq 0.05$) in minerals elements between different selected forest fruits. The highest Na, K, Mg, Ca and Fe were recorded in Kirker, Doum, Jagjag and Croup -, respectively. This variation in elements level was due to type of forest fruits variation. In fact, these types of fruits are source of mineral element as revealed in Table 4. K, Ca and Fe in this study were lower than K level 236.45 mg/100 for doum fruits obtained by Nwosu *et. al*., (2008). The highest Na, K, Mg, Ca and Fe were recorded for kirker, Doum, Jagjag and croup fruits, respectively.

Table 4 Minerals content of forest fruits, type of fruits

Type of fruits	*Na*	*K*	*Mg*	*Ca*	*Fe*
Croup	5.4 ± 0.01 ^{b}	59.6 ± 0.00 ^{c}	2.4 ± 0.02 ^{d}	22.0 ± 0.00 ^{a}	0.931 ± 0.00 ^{a}
Kirker	5.8 ± 0.0 ^{a}	67.0 ± 0.01^{b}	4.8 ± 0.00 ^{c}	18.0 ± 0.06 ^{b}	0.377 ± 0.02 ^{b}
Doum	4.8 ± 0.07 ^{c}	67.4 ± 0.03^{a}	12.0 ± 0.30 ^{b}	14.0 ± 0.02 ^{c}	0.167 ± 0.00 ^{c}
Jagjag	3.2 ± 0.00 ^{d}	34.8 ± 0.00^{d}	13.2 ± 0.00 ^{a}	14.0 ± 0.00 ^{c}	0.129 ± 0.10 ^{d}

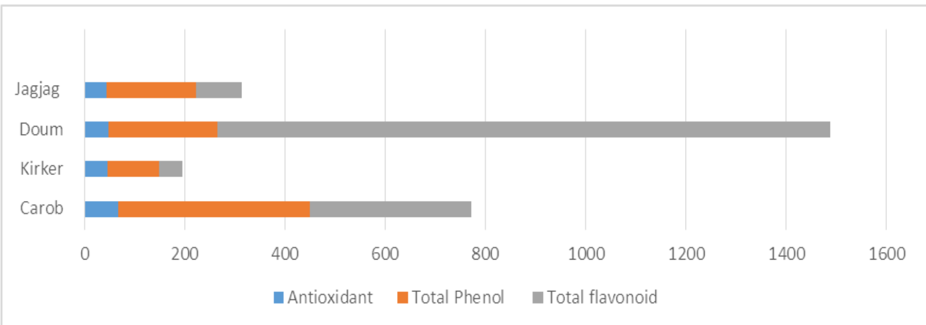
***Values are mean ± SD for replicate independent runs.**

****Values that bear different superscript letter in each Column are significantly different at p≤0.05.**

Antioxidants activity, total phenols and flavonoids content of forest fruits

The results in chart 3 revealed significant difference (P≤0.05) in antioxidant activity, total phenols and total flavonoids between different types of forest fruits. The highest level of antioxidants, phenols and flavonoids were recorded in croup, croup and doum respectively. They were lower than antioxidant activity measured for doum extracts (343.4 µ moles trolox equivalents/g DW in hydrophilic extract) and higher than 42.67 µ moles trolox equivalents/g DW in lipophilic extract when using DPPH (Salih, Yahia,2015). The antioxidant activity increased with the increases in concentration of doum thus cold exert several beneficial besides effects and antimicrobial properties (Mohamed, et.al., 2010). The levels of total phenols in this study for different types of forest fruits were higher than values, recorded for doum which ranged between 45.08 to 64.90 mg GAE/g DW as reported by Mohamed, et., al, (2010). Furthermore, total phenol levels in (chart 3) were higher than values 116.26 to 139.48 mg GAE/g DW stated for Doum extract (Aboshora, et. al ,2014). Phenolic compounds antioxidant activity is associated with the presence of functional groups in the ring and the annular structure of the molecule, conjugated double bonds (Dzialo et.al., 2016). On other hand the levels of flavonoids ranged between 46.33 ±0.00 and 1223.06 ±0.07 mg of QE/g dry extract. recorded for Kirker and Doum respectively. The level of total flavonoids showed significant difference (P≤0.05) between different type of forest fruits (chart 3). The total flavonoids content of doum fruit extracts ranged from 24.04 to 47.17 mg rutin/g DW (Aboshora et, .al 2014). while the results in (chart 3) were higher than 46.28 mg/g DW stated by the study emphasized that indigenous Sudanese forest fruits had excellent physical characteristics and chemical composition, they rich in sugars, minerals and bioactive compounds, including antioxidants, flavonoids and phenolic, which they play a significant role in human health as a highly nutritional and functional food.

Chart 3 Antioxidants activity, total phenol and flavonoids of forest fruits



On other hand the levels of flavonoids ranged between 46.33 ±0.00 and 1223.06 ±0.07 mg of QE/g dry extract. recorded for Kirker and Doum respectively. The level of total flavonoids showed significant difference (P≤0.05) between different type of forest fruits (chart 3).The total flavonoids content of doum fruit extracts ranged from 24.04 to 47.17 mg rutin/g DW (Aboshora *et, .al* 2014). while the results in (chart 3) were higher than 46.28 mg/g DW stated by Mohamed, *et., al*, (2010).

Conclusion

The study emphasized that indigenous Sudanese forest fruits had excellent physical characteristics and chemical composition, they rich in sugars, minerals and bioactive compounds, including antioxidants, flavonoids and phenolic, which they play a significant role in human health as a highly nutritional and functional food.

Recommendation

The study recommends conducting more research for further assessments targeting their maximum utilization as fresh or processed products and this will improve their economic value (exploited industrially for processing novel food to facilitate the consumption.

References

Aboshora, W; Lianfu, Z; Dahir, M; Qingran, M; Qingrui S;Jing,L (2014) Effect extraction

AOAC (2000). Association of Official Analytical Chemists. Official Methods Analysis. 17th ed., Gaithersburg, MD, USA

AOAC (2003) Association of Official Analytical Chemists. Official Methods of Analysis.17th ed. Arlington, Virginia, USA.

AOAC (1984) Association of Official Analytical Chemists. Official Methods of Analysis.14th ed., Published by the AOAC Inc., North Nineteenth Street, Suite 210 Arlington. Virginia 22209. USA.

Abdel Muti, OMS. (2002) Nutritive Value of Wild Plants of the Sudan. Arab Journal for Food and Nutrition. 3(3): 6-67.

Abdel Rahman, NA. El-Mubarak, A. and Mohamed, BE (2007) Characterization of Pectic Substances of Two Mango (Mangifera indica L.) Cultivars. Journal of Food Science and Technology (Sudan), 2:32-45.

Agriculture and Consumer Protection. FAO. Rome. Italy

Ainswotth, E.A. and Gillespie, K. M (2007) Estimation of total phenolic content and other oxidation substrates in plant tissues using folin- Ciocalteu reagent: 2(179337), pp.875-877.

Auwal, MS; Sanda, KA; Mairiga, IA.; Lawan, FA; Mutah, AA;Tijjani ,AN. (2013) The Bates, RB; Morris, JR and Gandall, PG. (2001). Priciples and Practices of Small and Chapman, H. D. and Parratt, F. P. (1961) Ammoniumvandate" Mmolybdate method for determination of phosphorous method of analysis for soils, plant. Puplic Division of Agri. Science, University of California, USA, pp 169-176.

Dzialo, M; Mierziak, J; Korzun, U; Preisner, M; Szopa, J and Kulma A (2016) The potential of plant phenolic in prevention and therapy of skin disorders. International Journal of Molecular Sciences. 172-42. Egypt. pharm Bull pharm Sci.; 34 (1): 53-76.

FAO (1982) Fruit bearing forest species. Technical notes. Food and Agricultural Organization, Forestry Paper No. 34. Rome.

FAO (2006) Composition and Characteristics of Selected Palm Products. FAO Corporate Document Repository. Forestry Department.Tropical Palm. FAO. Rome. Italy.

Hsu, B; Coupar, I.M;Ng, K (2006) Antioxidant activity of hot water extract from the fruit of the doum palm, Hyphaene thebaica. Food Chem. 98, 317–328.

ICRAF (1992) A selection of useful trees and shrubs for Kenya. International Centre for Research in Agroforesty. Nairobi.

Landete, J.M. (2012) Updated knowledge about polyphenols: Functions, bioavailability, metabolism, and health. Critical Reviews in food Science and Nutrition. 52, 936-948.

Lawal, G. and Kabiru, J (2007) Nutritional evaluation of Faidherbia albida seeds and pulp assource of feeds for livestock**.** African Journal of Food, Agriculture, Nutrition, and Development.vol. (7).

Layman, DK. (2003) The Role of Leucine in Weight Loss Diets and Glucose Homeostasis. Journal of Nutriton. 133(1): 261-267.Mart Arecaceae doum fruit, and its antioxidant and antibacterial activities Tropical Journal Marteials For Livestock Feed. Department of chemistry, University of llonin P1515

MINITAB, (2006). Statistical software, Release 14 for Windows, Minitab Inc,USA.

Mohamed, AA; Khalil, AA and El-Beltagi (2010) HES. Antioxidant and antimicrobial properties of kaff maryam Anastatica hierochuntica and doum palm Hyphaene thebaica. Grasas y Aceites.; 61-75.

Mojeremane, W., (1999). Azanza garckeana: a review and field evaluation in a village context in Botswana. Unpublished BSc. thesis. University of Wales, Bangor Nijeria.

Nweze, CC; Abdulganiyu, MG; and Erhabor, OG. (2015).Comparative analysis of vitamin C in fresh fruits juice of Malusdomestica, Citrus sinensi, Ananascomosus and Citrulluslanatus by Iodometric titration. Int. J. Sci. Env. Tech. 4(1): pp17-22

Nwosu, F. O.; Dosumu, O. O. and Okocha, J.O. (2008). The Potential of Terminalia catappa (Almond) and Hyphaene thebaica (*Doum palm*) Fruits as Raw of Pharmaceutical Research.;**13 pp** 2057-2063

Okafor, J.C., (1985). Selection and improvement of indigenous topical trees. J. Trop. Resour., 1: 87-95.

Okan, O.T., Deniz, I., Yaylı, N., Şat, I.G., Öz, M., Hatipoğlu, S.G. (2018) Antioxidant Activity, Sugar Content and Phenolic Profiling of Blueberries Cultivars: A Comprehensive Comparison. Notulae Botanicae Horti Agrobotanici Cluj-Napoca. 46(2), 639-652.

Palgrave, K.C., (1988). Trees of southern Africa. Struik Publishers. Cape Town

Paredes-Lopez, O., Cervantes-Ceja, M. K., Vigna-Perez, M., Hernandez-Perez, T. (2010). Berries: improving human health and healthy aging and promoting quality life a review. Plant Foods and Human Nutrition. 65, 299-308.

Pearson, D. (1970). Chemical Analysis of Food. 7th ed, published by Churchill living Stone, London, England.

Perkin-Elmer, C. (1994). Trace Metal Determination in Fruit Juice and Juice Products Using an Axially Viewed Plasma. Karen W. Barnes, 761 Main Avenue, Norwalk, CT 06859-0219, USA.

phytochemical, elemental and haematologic evaluation of crude mesocarp extract of albino

Rathore M. (2009). Nutrient Content of Important Fruit Trees from Arid Zone of Rajasthan. Journal of Horticulture and Forestry. 1(7):103-108. rats. Asian Journal of Biochemistry.;8:14-23

Saka, J., J.D. Msothi and J.A. Maghembe, (1994). The Nutritional value of edible fruits of indigenous wild trees of Malawi. Forest Ecology and Management, 64: 245-248.

Salih, NK-EM and Yahia, EM. (2015) Nutritional value and antioxidant properties of four wild fruits commonly consumed in Sudan. International Food Research Journal.;22:2389-2395

Schmidt, E. Lotter, M. Mc. Cleland W. (2004). Trees and Shrubs of Mpumalanga and Kruger National Park. Johannesburg, South Africa: Jacana.

Shimada, k; Fujikawa, K and Nakamura, T. (1992). Ant oxidative properties of xanthan on the ant oxidation of soybean oil in cyclodextrin emulsion. J Agrico Food Chem.40:945-8.

Vodouhê, F.G.**,** (2010). Laboratory of Applied Ecology, Faculty of Agronomic Sciences, University of Abomey Calavi, 02 BP 8033, Cotonou, Benin.

West, C.E; Repping, F. and Temalilwa, C.R. (1988). The Composition of Food Commonly Eaten in East Africa. Published by Wageningen, Nether Lands, Vol. 290.

Wills, RHH; Lee, TH; Graham, D; Mc Glasson, WB and Hall EG. 1981. Post-harvest: An Introduction to the Physiology and Handling of Fruits and Vegetables. AVI Publishing. Co. Westport. Connecticut.

World Agroforestry Centre. Agro Forestry Tree Database (2014). “Factsheet: Hyphaene thebaica.

Wulandari, I. Kusuma, I.W. and Kuspradini, H. (2007). Investigation of total phenolic and flavonoids content, and Evaluation of Antimicrobial and antioxidant Activates from Baeckea

Zimmer, K.R., Blum-Silva, C.H., Souza, A.L.K., Wulffschuch, M., Reginatto, H.F., Pereira, C.M.P., Macedo A.J. Lencina, L.C. (2014). The ant biofilm effect of blueberry fruit cultivars against Staphylococcus epidermidis and Pseudomonas aeruginosa. Journal of Medicinal Food. 17(3), 324-331.