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CHEMICAL COMPOSITION OF FOUR ACCESSIONS OF SABA (*SABA SENEGALENSIS*) FRUITS FROM KOGI STATE, NIGERIA

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ABSTRACT

This study was undertaken to determine the chemical content of Saba senegalensis fruits sourced from Kabba, Okoro, Unosi and Oforachi in Kogi State. The pulp was extracted and assayed for proximate, mineral, vitamin and phytochemical constituents in a replicated trial using standard procedures. Data collected were subjected to the analysis of variance (ANOVA) in completely randomized design (CRD) using GENSTAT Discovery edition 3 Release 7.22 DE (GENSTAT, 2008). The results obtained indicated that some proximate, mineral, vitamin and phytochemical traits varied significantly ($p < 0.05$) across the accessions. Carbohydrate was highest (34.9 %) in Okoro accession but similar to Kabba accession (28.2 %). Moisture content (86.5 %) and protein (0.18 %) were highest in accession from Unosi but moisture was lowest (63.6 %) in Okoro accession. Kabba accession had the highest iron content (0.08 mg/100ml) which was statistically similar to Okoro accession (0.05 mg/100ml). Accession from Oforachi possessed the highest vitamin B_{12} (0.07 mg/100ml) but statistically similar to Kabba and Okoro accessions (0.063 and 0.065 mg/100ml respectively). Vitamin B_2 and B_6 were significantly highest in Okoro accession with 4.85 and 14.43 mg/100ml, respectively. Oxalate, phytate, saponin and tannin were higher in Okoro accession with 18.84, 2.36, 2.50, 1.503 mg/100ml, respectively. The observed variation in proximate, mineral, vitamin and phytochemical of the four accessions assessed might have resulted from genetic variability and environmental differences which suggest the need for selection. This could provide basis for genetic improvement of this wild fruit specie for optimum nutrition and health of the rural dwellers.

Key words: Mineral, phytochemical, proximate, vitamin contents

INTRODUCTION

Saba senegalensis is an indigenous tree crop belonging to the family Apocynaceae. It is one of the most important non-timber forest products found as wild plant in many African countries such as Burkina Faso, Côte d'Ivoire, Gambia, Guinea, Guinea-Bissau, Ghana, Mali, Niger, Senegal, Nigeria and Tanzania (Fatim *et al.,* 2019). In Nigeria, it is found largely in North central and Southern parts of the country. It is known as 'Utu' by the Igbo of southeastern Nigeria and 'Ibo' by Okun-Yoruba of north central Nigeria (Baiyeri *et al.,* 2019). Fruits of *S. senegalensis* are known as zaban in Mali, malombo in the Congo Basin, maad in Senegal, wèda in Burkina Faso and côcôta in Côte d'Ivoire (Tiendrebeogo *et al.,* 2020). *Saba senegalensis* is a hardy crop that can thrive in various ecological conditions and it is resistant to bush fire. It is a climbing plant that usually seeks support from the host plant to cling and grow. The plant can produce stems of over 40 metres long by 47 cm girth (Tropical Plants Database (TPD), 2020). *Saba senegalensis* is a globulous envelope which contains seeds coated with yellow juicy pulp (Fatim *et al.,* 2019). The fruit is tasty, sweet-sour with yellow pulp when ripe and is consumed by the rural populations. In Nigeria, the fruits are available between April to August. The fruit is highly prized and in parts of Africa, they are important to the rural economy and are openly hawked in the cities (TPD, 2020).

Saba senegalensis is a medicinal food plant and has the potential in soil and water conservation (Boamponsem *et al*., 2013). The pulp can be mashed and used for porridge (Bandoma, 2009; Boamponsem *et al.,* 2013). The latex is used to treat pulmonary diseases and tuberculosis. The leaves are prepared in sauces and condiments as an aperitif with a salty or sweet taste (Berhaut, 1971; Sar*r et al.,* 2018). *Saba senegalensis* pulp is used for jam and juice production in Senegal and Burkina Faso (Boamponsem *et al.,* 2013). It can improve nutrition and health of the household. Ethnobotanic alludes that leaves, roots and fruit of Saba are used for treatment of certain diseases such as dysentery, diarrhoea and cough (Koné*et al*., 2002).

Previous studies established that the fruits have high nutritional content including minerals, phytochemicals and vitamins. Boamponsem *et al*. (2013) reported that *S. senegalensis* contains 810 ppm of calcium, 357.5 ppm of phosphorus and 47.5 ppm of magnesium. It contains phenol (264.76 mg $100g^{-1}$), phytate (31.18 mg $100g^{-1}$), oxalic acid (381.33 mg $100g^{-1}$) and tannin (198.94 mg $100g^{-1}$) (Fatim *et al.,* 2019). Sarr *et al.* (2018) reported it to contain 11-74.23 g $100g^{-1}$ carbohydrates, 0.2 g $100g^{-1}$ lipid, 0.8 to 0.3 g $100g^{-1}$ protein. Nafan *et al.* (2013) found that the fruit is a rich source of vitamin C ranging from 34.8 to 67.5 mg $100g^{-1}$. According to Kini *et al.* (2012) the fruit contains β-carotene which is estimated at 1.559 mg $100g^{-1}$.
Despite its nutritional potential, medicinal and economic value, *Saba senegalensis* is still under-exploited. Many studies have reported the nutritional characterization of *Saba senegalensis* fruit in Ghana (Boamponsem *et al.,* 2013), Côte d'Ivoire (Nafan *et al.*, 2013 and Fatim *et al.,* 2019), Senegal (Sarr *et al*., 2018) and Congo (Enzonga *et al.,* 2019) but not on different accessions. In Nigeria, there is little documented information on nutritional quality of accessions of *Saba senegalensis* fruit. The hypothesis was to determine the accession with more nutrient in an attempt to remedy food insecurity, improve the diet of the people and provide evidence-based information that could be used to encourage the cultivation of such valuable accession to prevent the crop from going into extinction. The information will also be useful to the food industries and pharmaceutical companies. It will unravel the accession's potential in genetic improvement as well. The objective of this study was to determine the chemical potential of the pulp of *Saba senegalensis* accessions collected from different locations in Kogi State, Nigeria.

MATERIALS AND METHODS

Collection of plant material

Fully matured Saba fruits (see Fig. 1) for the analysis were harvested from the wild in four Local Government Areas (LGAs), they are Kabba in Kabba Bunu LGA, Okoro in Ijumu LGA, Unosi in Ajaokuta LGA and Oforachi in Igala Mela/Odollu LGA of Kogi State as shown in Fig. 2. The fruits from each location were collected from different liana in the same forest. Three fruits per accession with similar sizes, maturity and stage of ripening replicated thrice were used inthe study. The fruits were packaged in ventilated envelop and taken to Simuch Scientific Analytical Laboratory, Nsukka for chemical analysis in June, 2020. The distance between the collection centers is shown in Table 1.

Extraction of saba fruit pulp

Saba senegalensis fruits were cut into two halves and the pulp separated from the seeds with stainless steel knife. The pulps obtained were stored at -4^0 C for the various analyses.

Chemical Analyses of Saba Fruit Pulp

Proximate Composition

Proximate were analyzed as recommended by AOAC (2005).Ash was determined byweighing 2g of sample into a silica dish and placed in a muffle furnace set at 600^0C for 3hours till a white greyish matter was obtained. The amount of residual white greyish matter was obtained by difference. The carbohydrate content was estimated by differences, subtracting the sum of moisture, protein, fat, crude fibre and ash percentages from one hundred. The crude fat content was determined by Soxhlet extraction with petroleum ether as solvent and crude fibre content by the acid and alkaline digestive methods. The moisture content was determined by calculating the difference in weight after drying. Five grammesof the ground sample was dried to a constant weight at 600^0C in a hot air circulating oven. Crude protein in the samples was determined by the routine micro Kjeldahl procedure/technique.

Analysis of Minerals

The official method of AOAC (2005) was adopted for the mineral analysis of the samples. Two gram of the ground sample was weighed into a silica dish, then placed in a muffle furnace and heated at 600^0C for three hours, allowed to cool in a desiccator and weighed. The samples were dissolved with HCl and prepared for reading using atomic absorption spectrometry (AAS).At a wavelength of 422.7 nm, calcium was determined using atomic absorption spectrometer (AA-7000). Iron, potassium, magnesium and zinc were determined using atomic absorption spectrometer (AA-7000) and absorbance read at 248.3, 766.5, 285.2 and 213.9 nm respectively. Phosphorus was determined using spectrophotometer (752P) at a wavelength of 92.25 nm.

Table 1: Distance between the collection centers

S/N	Location	Distance
1.	Kabba to Okoro	11.0 km (6.9 miles)
2.	Kabba to Unosi	65.5 km (40.69 miles)
3.	Unosi to Oforachi	84.0 km (52.1 miles)
4	Kabba to Oforachi	149.5 km (92.9 miles)

Source: www.google.com

Table 2: Effect of accession on proximate composition ($^0/_0$) of *Saba senegalensis* fruit pulp

Accession	Ash	CHO	Fat	Fibre	Moisture	Protein
Kabba	1.00	28.20	0.27	Trace	70.40	0.11
Oforachi	1.03	17.90	0.27	Trace	80.80	0.09
Okoro	1.14	34.90	0.27	Trace	63.60	0.09
Unosi	1.40	11.60	0.33	Trace	86.50	0.18
LSD (0.05)	Ns	7.98	Ns		7.68	0.05

CHO= Carbohydrate. Ns= non-significant

Fig. 1: *Saba senegalensis* whole fruit and yellowish fruit pulp ith seeds Fe= Iron, K= Potassium, Mg= magnesium, P= Phosphorus and Zn= Zinc

Vitamins and β–carotene determination

Vitamins were determined following the analytical procedure of AOAC (2007). Concentration of vitamin B_{12} was determined by using Spectrophotometer (Labomed spectronic 21D) and the absorbance of samples were read at a wavelength of 510 nm.At a wavelength of 460 nm, absorbance, the standards and samples were read using fluorescent spectrometer to determine vitamin B_2. At wavelength of 540 nm, vitamin B_6 was determined using Spectrophotometer (752P).β–Carotene was determined using Spectrophotometer (752P), the resulting solution was then taken at wavelength of 620 nm at 15 seconds and 30 correspondingly.Spectronic 21D spectrophotometer at a wavelength of 15 seconds and 30 seconds was employed to determine vitamin C. Vitamin E was also determined using Spectrophotometer (752P) and absorbance taken at wavelength of 520 nm.

Phytochemical factors analysis

Phytochemicals were analyzed as recommended by Harborne (1973). Oxalate was determined using Spectrophotometer (752P) at wavelength of 490 nm. Phenols and phytate were determined using spectrophotometer (752P) at wavelengths of 425 and 520 nm, respectively. Saponin was determined at wavelength of 620 nm using Spectrophotometer (752P). UV-VIS spectrophotometer at a avelength of 720 nm was employed to determine the concentration of tannin in the samples.

Data analysis

Data were collected across the accessions in triplicates and subjected to the analysis of variance (ANOVA) in completely randomized design (CRD) using GENSTAT Discovery edition 3 Release 7.22 DE (GENSTAT, 2008). Significant treatment means were compared using least significant difference (LSD) at 5 % level of probability.

Table 3: Effect of accession on mineral content (mg $100ml^{-1}$) of *Saba senegalensis* fruit pulp Ca= calcium,

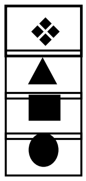
Accession	Ca	Fe	K	Mg	P	Zn
Kabba	12.70	0.08	0.97	0.39	15.96	2.01
Oforachi	14.20	0.02	0.13	0.29	10.16	1.91
Okoro	13.30	0.05	0.27	0.28	15.85	2.15
Unosi	19.20	0.03	0.23	0.17	12.19	2.16
LSD (0.05)	Ns	0.03	Ns	Ns	Ns	Ns

Ns= non-significant.

RESULTS

Table 2 revealed that accession had significant ($p<0.05$) influence on carbohydrate, moisture content and protein while ash and fat were not different statistically. Percent carbohydrate values ranged from 11.60-34.90. Carbohydrate content (34.9%) was highest in accession from Okoro while accession from Unosi recorded the least (11.60%). Moisture content varied from 63.60-86.50% while protein ranged from 0.09-0.18%. Highest moisture and protein values were obtained in accession sourced from Unosi with 86.50 and 0.18%, respectively. Moisture was lowest in fruits sourced from Okoro (63.60%). The least protein values were obtained from Oforachi, and Unosi accessions (0.09% each). The concentration of iron was significantly ($p<0.05$) influenced by accessions while calcium, potassium, magnesium, phosphorus and zinc were statistically similar across the accessions (Table 3). It was evident that the iron content varied from 0.02-0.08 mg $100ml^{-1}$. Fruits from Kabba accession had higher iron value (0.08 mg $100ml^{-1}$) which did not differ statistically from the value (0.05 mg $100ml^{-1}$) obtained in fruits from Okoro accession. Accession from Oforachi had the least iron content (0.02 mg $100ml^{-1}$). Vitamin B_{12}, B_2 and B_6 were significantly ($p<0.05$) affected by accessions but there was no significant effect of accessions on β-carotene, vitamin C and E as presented in Table 4. Vitamin B_{12} varied from 0.05-0.07 mg $100ml^{-1}$.

Key



Ijumu LGA
Kabba/Bunu LGA
Ajaokuta LGA
Igalamela Odolu LGA

Fig. 2: Map of Nigeria and Kogi State showing site of collection of Saba fruits
Source: Pediainside.com and Wikipedia

Table 4: Effect of accession on vitamin and β–Carotene content (mg 100ml^{-1}) of *Saba senegalensis* fruit pulp
Ns= non-significant

Accession	Vitamin B_{12}	Vitamin B_2	Vitamin B_6	β-Carotene	Vitamin C	Vitamin E
Kabba	0.06	3.61	9.61	0.56	35.50	0.01
Oforachi	0.07	3.21	9.74	0.56	55.60	0.01
Okoro	0.06	4.85	14.43	0.56	34.30	0.01
Unosi	0.05	0.77	2.75	0.56	66.90	0.01
LSD (0.05)	0.01092	2.274	4.948	Ns	Ns	Ns

Table 5: Effect of accession on phytochemical constituent (mg 100ml^{-1}) of *Saba senegalensis* fruit pulp

Accession	Oxalate	Phenol	Phytate	Saponin	Tannin
Kabba	15.92	13.41	1.11	1.48	0.68
Oforachi	17.67	11.28	1.19	1.71	0.78
Okoro	18.48	13.24	2.36	2.50	1.50
Unosi	14.08	12.41	0.70	0.48	0.81
LSD (0.05)	1.52	Ns	0.98	0.91	0.40

Ns= non-significant

Vitamin B_{12}, B_2 and B_6 were significantly ($p<0.05$) affected by accessions but there was no significant effect of accessions on β-carotene, vitamin C and E as presented in Table 4. Vitamin B_{12} varied from 0.05-0.07 mg 100ml^{-1}. Vitamin B_{12} was highest in fruit from Oforachi (0.07 mg 100ml^{-1}) which was statistically similar to 0.06 mg 100ml^{-1} obtained from Kabba and Okoro accessions. Vitamin B_2 and B_6 ranged from 0.77-4.85 and 2.75-14.43 mg 100ml^{-1}, respectively. Regarding vitamin B_2 and B_6, Okoro accession took the lead with 4.85 and 14.43, respectively. Values obtained for vitamin B_2 and B_6 in accession from Okoro were not statistically different from the values obtained from Kabba (3.61 and 9.61 mg 100ml^{-1}) and Oforachi accessions (3.21 and 9.74 mg 100ml^{-1}). The least vitamin B_{12}, B_2 and B_6 was recorded in Unosi accession with respective values of 0.05, 0.77 and 2.75 mg 100ml^{-1}. Table 5 shows that accession significantly ($p<0.05$) influenced oxalate, phytate, saponin and tannin while phenol did not differ significantly across the accessions. Oxalate, phytate, saponin and tannin varied from 14.08-18.48, 0.70-2.36, 0.48-1.48 and 0.68-1.50 mg 100ml^{-1}, respectively. Notably was that Okoro accession had the highest oxalate, phytate, saponin and tannin content with respective values of 18.48, 2.36, 2.50 and 1.50 mg 100ml^{-1}. Oxalate and saponin were statistically similar with the values (17.67 and 1.71 mg 100ml^{-1}) recorded in Oforachi accession. Unosi accession gave the least oxalate, phytate and saponin values (14.08, 0.70 and 0.48 mg 100ml^{-1}, respectively). The least tannin value (0.68 mg 100ml^{-1}) was recorded in Kabba accession.

DISCUSSION

Food composition is often the basis for selection and overall acceptance by informed onsumers. Proximate attributes were revealed in Saba fruit such as ash, carbohydrate, fat, moisture and protein. Concentration of ash, carbohydrate, fat and protein contents obtained in this work were lower than those of Boamponsem *et al*. (2013) who found ash, carbohydrate, crude fat and crude protein to be 2.80, 74.23, 8.92, and 0.53%, respectively in Saba pulp sourced from Ghana. Baiyeri *et al*. (2019) reported higher values 3.41% of ash, 50.36% of carbohydrate, 3.53% of crude fat and 5.73% of protein in pulp of Saba fruit from North Central Nigeria compared to the values recorded in this study but moisture content found in this study was higher than 36.96 % recorded in their findings. Moisture content obtained from this current study ranged from 63.6-86.5%, in comparison with 74.08% reported by Omujal *et al.* (2014) on the pulp of *Saba comorensis* from Uganda, we noted that our value was higher. Moisture content is important to both the stability and quality of foods. Saba fruits assayed contains high amount of water, they are subject to rapid deterioration from mold growth. Fruits that contain high amount of water are subject to rapid deterioration from mold growth and insect damage (Boamponsem *et al.*, 2013). Therefore, processing the pulp into juice and other products will reduce spoilage and make it available throughout the year. The low ash content across all the accessions evaluated was indicative of low mineral contents of the fruit. In this study, crude protein values were low across the accessions indicating that *S. senegalensis* may not be a good source of protein. Proteins are body builders, they replace worn out tissues (Okeke and Elekwa, 2006). Carbohydrates are hydrolyzed in the body to yield glucose, which can be utilized immediately or stored as glycogen in the muscles and liver for future use. Fats are important in energy production. The variability in proximate traits assessed in this study could be explained by climatic conditions, the genetic constitution and nature of the soil. Genetic and location (environment) effect might cause differences in composition of some nutrients (Agbo and Baiyeri, 2019).

The results showed that minerals were present in the pulp of *Saba senegalensis*. Among the mineral contents, calcium and phosphorus were present in higher amount indicating that *Saba senegalensis* is a good source of calcium and phosphorus. The combination of calcium and phosphorus are associated with growth and maintenance of bones, teeth, and muscles (Turan *et al.*, 2003). Although, the values recorded for calcium, iron, potassium and magnesium in this study were lower than those obtained by Baiyeri *et al*. (2019) who found 1261.8 mg 100g^{-1} for calcium, 24.95 mg 100g^{-1} for iron, 648.42 mg 100g^{-1} for potassium, 239.66 mg 100g^{-1} for magnesium and 66.39 mg 100g^{-1} for zinc in Saba pulp from North Central Nigeria. Enzonga*et al.* (2019) reported 460 mg 100g^{-1} of calcium, 25 mg 100g^{-1} of iron, 35 mg 100g^{-1} of potassium and 1090 mg 100g^{-1} of magnesium in *Saba comorensis* fruit from Congo which were higher than the results of this current study. Phosphorus value recorded in this work was higher compared to 7.25 mg 100g^{-1}reported by Souza *et al.*(2014) in fresh blackberry fruit pulp from São Paulo. Values for zinc across the accessions were higher than 0.38 mg 100g^{-1}as reported by Fatim *et al*. (2019) in Saba fruit pulp from Côte d'Ivoire. These minerals are important for healthy living. The human body requires some essential minerals in order to maintain good health. The result of this study showed variation in mineral contents of the accessions evaluated which could be as a result of differences in the genetic makeup of the accessions and environmental variabilities. Differences in nutritive values may be related to the variability of climatic conditions and nature of the soil (Baiyeri *et al.*, 2019).

The result of this present study indicated that vitamins were present in Saba fruit pulp. Vitamins are considerednecessary for cellular metabolism. Vitamin B_2 and B_6 recorded in this work were higher than those reported by Fatima *et al.* (2013) who observed 0.016 mg 100gm^{-1}for vitamin B_2 and 0.16 mg 100gm^{-1} for vitamin B_6in guava fruit from Pakistan. Following the recommended daily allowance of vitamin B_2 (1.1-1.3 mg day^{-1}) by Institute of Medicine, Food and Nutrition Board (1998), the daily requirements for vitamin B_2 can be met by the consumption of fresh *Saba senegalensis* pulp. Vitamin B_6 is an essential vitamin and the values obtained in this work meets the daily recommended allowances of 1.2-1.3 mg day^{-1}(McCormick, 1989 and Fatima *et al.,* 2013).The β-carotene reported in this study was higher than that of *Saba senegalensis* juice from Burkina Faso (1559 μg 100g^{-1}) as reported by Kini *et al.* (2008). The values obtained for vitamin C in this present work ranged from 34.5-66.9 mg 100ml^{-1} which is higher than 3.73 mg 100g^{-1} reported by Baiyeri *et al.* (2019) but they observed higher value for β- carotene (1.72 mg 100g^{-1}) and vitamin E (3.69 mg 100g^{-1}) in *Saba senegalensis* pulp from North Central Nigeria. The vitamin C detected in this study met the recommended daily requirement. Therefore, Saba fruit stands a good position in providing enough vitamin C to the rural people irrespective of location of collection.Vitamin C has been implicated in the hydroxylation of proline to form the hydroxyproline required in the formation of collagen which helps in the healing of wounds, fractures, bruises and bleeding gums, and reduces the liability to infections.This wild crop plant can be real sources of vitamins for rural populations. Genetic selection and domestication are important for turning the specie into fruit crops. The result of the analyses revealed the presence of various phytochemicals in *Saba enegalensis* pulp. Baiyeri *et al.* (2019) determined phenol and saponin contents in the pulp of *Saba senegalensis* fruit from North Central Nigeriaand reported (16.51 and 14.12%, respectively) which were higher than the values obtained in this work. The values for oxalate, phytate, saponin and tannin obtained in this study were lower than 1.88, 0.21, 1.06 and 2.41 mg $100g^{-1}$ as reported by Adepoju *et al.* (2009) for *S. mombin* pulp in Nigeria. The phytate value observed in this result was comparable to 1.64mg $100g^{-1}$reported by Adepoju *et al.* (2009) in *Mordii whytii* fruit pulp from Nigeria. Phytochemicals play the role of antioxidants. Antioxidant compounds in food play an important role as health protecting factor. Scientific evidence suggests that antioxidants reduce the risk of chronic diseases including cancer and heart disease. The saponin, phenol, tannin, oxalate and phytate composition of all the accessions of *Saba senegalensis* fruit pulp were within the tolerable limits of 0.2% (Codex Akimentarius, 2017), 2% (Micalowicz and Duda, 2007), 3.3% (Elfadil *et al.*, 2013), 5% (Caser, 2003) and 0.035% (Onomi *et al.*, 2004) respectively. This makes their consumption safe and healthy. The observed variation in phytochemicals might have resulted from soil, climatic and seasonal differences. Olajide *et al.* (2020) reported variability in proximate composition of 10 accessions of African walnut which suggested the probable roles of genetic diversity and variability in soils the accessions grew on. The present study has shown that fruits of *Saba senegalensis* contain protein, carbohydrate, iron, vitamin B_2, B_{12}, B_6, oxalate, phytate, saponin and tannin in varying amount which could add value to the human diet and serve as nutritional supplement. Fruits from Unosi had more protein. Fruits sourced from Kabba had significantly more iron value, Oforachi accession had higher vitamin B_{12} value while Okoro accession gave the highest oxalate, phytate, saponin, tannin, carbohydrate, vitamin B_2 and B_6. Some accessions evaluated showed distinct variability in proximate, minerals, vitamins and phytochemicals which confirmed the hypothesis that Saba can remedy the problems of malnutrition. It also suggests the need for selection and could provide basis for genetic improvement of this wild fruit specie.

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Declaration of interest statement

The authors have not declared any conflict of interests.

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