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NUTRITIONAL PROFILE OF *BALANITES AEGYPTIACA* FLOWER

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ABSTRACT: Nutrient and antinutritional content of *Balanites aegyptiaca* flower was investigated; and found to have the following compositions; moisture content (43.3 ± 2.89%); ash content (6.67 ± 0.29%), crude lipid (4.5 ± 0.50%), crude protein (10.8 ± 0.49%) available carbohydrate (74.2 ± 0.49%), crude fibre (3.8 ± 0.29%), and calorific value (380.5kcal/100g), Na (42.1mg/100g), K (81.8mg/100g), P (5.91mg/100g), Ca (49.8mg/100g), Mg (19.36mg/100g), Mn (0.35mg/100g), Fe (31.46mg/100g), Cu (0.42mg/100g), Zn (3.69mg/100g), Cd (0.19mg/100g), Co (0.33mg/100g), Cr (0.35mg/100g) and Ni (6.33mg/100g). The *B. aegyptiaca* flower have sufficient amount of valine, and isoleucine. Moderate amount of leucine, methionine and threonine. Lysine is the most limiting amino acid in the flower. The concentration of antinutritive factors was observed to be phytate (1.63mg), oxalate (0.15mg), hydrocyanic acid (0.04mg), saponin (4.67mg), nitrate (0.02mg) and alkaloid (28.7mg); were lower than the reference toxic standard levels. Therefore, *Balanites aegyptiaca* flower could contribute in supplementing human nutrient requirement.

Keywords: nutrient, antinutrient, *Balanites aegyptiaca* flower, Edible wild plant

INTRODUCTION

In most developing nations like Nigeria, numerous types of edible wild plants are exploited as sources of food hence provide an adequate level of nutrition to the inhabitants. Edible wild plants are primary sources of medicines, food, shelters and other items used by humans every day. Their roots, stems, leaves, flower, fruits and seeds provide food for humans (Edem and Miranda, 2011). Currently, edible wild plants and their products have played a substantial role in tackling the ever – increasing gap between population growth and food supply (Madhumita and Naik, 2010; Rajeev *et al.*, 2010). However, to tackle the problem, more attention has been given on the exploitation and utilization of unusual edible wild plants especially edible flowers which can be a source of nutrient to general populace.

Many flowers of wild plants are consumed in Africa, but Mexico and Central America are probably some of the few areas where flowers are also used as food (Kislinchenko and Velma, 2006; Sotelo, 1997). Hassan *et al*. (2011) reported that, flowers of *Parkia biglobosa* are used as food in North – Western Nigeria especially by rural dwellers when mixed with groundnut cake and other ingredients to make a delicious salad.

Balanites aegyptiaca flowers are 5 – 6mm diameter, greenish white fragnant and axillary in few flowers cyme or fascicle (Vinod and Tarun, 2012). Flowering behaviour varies, there is no definite time for flowering in the Sahel, although flowering most likely takes place in the dry season. Flowering in Nigeria varies between November and April with ripe fruits becoming available in December (Orwa *et al.*, 2009). Many parts of the plant are used as famine foods in Africa; flowers can be eaten fresh, when cooked and eaten when incorporated with other ingredient as well as supplementary food in West Africa and an ingredient of dawa – dawa flavouring in Nigeria (Prashant *et al.*, 2011). It is therefore, the aim of the study is to determine the nutritional and antinutritional potential of the flower of *Balanites aegyptiaca* to ascertain its contribution to the world of food.

MATERIALS AND METHODS

Sample Collection and Treatment

The flower of *Balanites aegyptiaca* were obtained from branches of *Balanites aegyptiaca* tree at Wamakko Local Government Area of Sokoto State, Nigeria. Identification of the sample was carried out at Botany Unit, Usmanu Danfodiyo University, Sokoto. The food samples were washed, oven dried, and finely ground or used fresh for moisture analysis.

Proximate Analysis

The samples was analysed in triplicate using standard AOAC (2006) methods. The determination of crude nitrogen was based on the Kjeldahl procedure and crude protein values were obtained by multiplying the nitrogen value by a factor of 6.25. Estimation of the available carbohydrate was done by the difference method and crude lipids were extracted using soxhlet apparatus. The crude fibre values were determined by treating sample with dilute solution of H_2SO_4 and NaOH, the energy calculated using the equation: [energy Kcal/100g= (%CHO x 4) + (%CP x 4) + (%CL x 9)] (Hassan *et al.,* 2008) and ash was obtained after incineration of sample in a Murfle furnace.

Mineral Analysis

The minerals were determined after the sample wet digestion with a mixture of nitric/perchloric/sulphuric acids in the ratio of 9:2:1 v/v respectively. Ca, Na, K, Mg, Fe, Cu, Zn, Ni, Cd, Cr, Mn, Co, and Pb were determined by atomic absorption spectrophotometer and phosphorus by colorimetric method (AOAC, 2006).

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Antinutritional Analysis

The method of Ola and Oboh (2000) was adapted for the determination of phytate. Hydrocyanic acid was determined by the AOAC (2006) method. Oxalate and nitrate were determined by the methods of Krishna and Ranjhan (1980). Total alkaloids were estimated in the samples according to the USP XX (USP, 1980).

Amino Acid Analysis

Two grammes each of the defatted sample was dried and made into a powder. A 30mg of the fine powder was put into a glass ampoule, and to it 5cm^3 of 6MHCl and 5µmoles norleucine (2 – amino Hexanoic acid) as internal standard were added. The ampoule was evacuated by passing nitrogen gas to avoid oxidation of some amino acid during hydrolysis. The ampoule was sealed with a flame and hydrolyses in an oven at 110^{0}C for 24 hours. The ampoule was cooled, opened at the tip and the contents filtered. The filtrate was evaporated to dryness at 40^{0}C under vacuum in a rotary evaporator. The residue was dissolved to 5µL (for acid and neutral acids) or 10µL (for basic acid) with acetate buffer, pH 2.2. The aliquot was then taken into the catridge of the amino acid analyser. The chromatograms appeared with the help of automatic pen recorder indicate amino acids peaks which correspond to the magnitude of their respective concentrations. The quantity of each amino acid was estimated by comparing the peak area of each amino acid in the sample with the area of the corresponding amino acid standard of the protein hydrolysate (Adeyeye and Afolabi, 2004).

Data Analysis

The Data generated from the study were expressed as mean ± standard deviation using SPSS version 15 statistical package.

RESULTS AND DISCUSSION

Proximate composition:

The result of proximate analysis (Table 1) showed that the *B. aegyptiaca* flower had moisture content (43.3 ± 2.89%) which is low when compared to (73.6 - 93.2 ± 2.6%) reported for some edible flowers (Richard *et al.,* 1996; Sotelo *et al.,* 2007; Madhumita and Naik, 2010 and Hassan *et al.,* 2011). Hassan *et al.,* (2009) reported that high moisture content is associated with the rise of microbial activities during storage. The ash content of the flower (6.67 ± 0.29%) compares favorably to 6.50 ± 1.00% in *Parkia biglobosa* flower (Hassan et al., 2011), but within the range of 5.8 – 8.6% reported for some edible flowers (Sotelo *et al.,* 2007).

The crude protein content of *B. aegyptiaca* flower (10.8 ± 0.49%) is higher than 6.77% reported for *Parkia biglobosa* flower (Hassan *et al.,* 2011) and that of the commonly consumed edible flowers (Sotelo *et al.,* 2007). The value is also lower than 14.9% reported for *C. esculenta* flower (Richard *et al.,* 1996). This result shows that *B. aegyptiaca* flower contains appreciable amount of protein content. As expected, the crude lipid was low (4.5 ± 0.50%). The value observed is similar to that of *Aloe vera* (4.2%), *Euphorbia radians* (4.9%) as reported by Sotelo *et al.* (2007) and (4.66%) for *P. biglobosa* flower (Hassan *et al.,* 2011). This indicates that *B. aegyptiaca* flower contains low level of crude lipid. The crude fibre content obtained is the same as that reported for *P. biglobosa* flower (Hassan *et al.,* 2011). This value is lower than (17.3%) *Erythrina Americana,* (13.8%) *Aloe vera*, (12.7%) *Agave salmiana* (Sotelo *et al.,* 2007) and *C. esculenta* (20.4%) (Richard *et al.,* 1996). Fibre plays a role to a reduction in the incidence of certain diseases like colon cancer, coronary heart diseases, diabetes, high blood pressure, obesity and other digestive disorders (Ekpo, 2007). The flower of *B. aegyptiaca* have high carbohydrate content (74.2%). This was in close range with 78.9% reported for *P. biglobosa* flower (Hassan *et al.,* 2011) and 70.4% reported for *C. esculenta* flower (Richard *et al.,* 1996). The caloric value (380.5kcal/100g) is in close range to 388.9kcal/100g reported in *Colocasia esculenta* flower (Richard *et al.,* 1996), but higher than 34kcal/100g in broccoli flower (Bushway *et al.,* 2006) and 111kcal/100g in *Madhuca indica* flower (Madhumita and Naik, 2010). This result shows that *B. aegyptiaca* flower is a good source of energy human populace.

Mineral Composition

The concentrations of different mineral elements in the flower of *B. aegyptiaca* analyzed were reported in Table 2. The potassium content (81.8mg/100g) is low when compared to 325mg/100g in *broccoli* flower (Bushway *et al.,* 2006). The contents of calcium and magnesium were 49.8 and 19.36mg/100g respectively and were higher than values reported in *Colocasia esculenta* flower 8.9 and 3.6mg/100g respectively (Richard *et al.,* 1996). Sodium content obtained is low when compared to 139.2mg/100g for *P. biglobosa* flower (Hassan *et al.,* 2011) and 104mg/100g for *Colocasia esculenta* flower (Richard *et al.,* 1996). However, manganese, zinc, copper, cobalt and chromium contents were 0.35, 3.69, 0.42, 0.33 and 0.35mg/100g respectively which were lower than respective values reported in *P. biglobosa* flower (5.3, 17.8, 3.37, 0.7 and 0.7mg/100g) (Hassan *et al.,* 2011). The *B. aegyptiaca* flower also contain a reasonable amount of phosphorus (5.91mg/100g), iron (31.36mg/100g), cadmium (0.19mg/100g) and nickel (6.33mg/100g). Earlier research on humans and livestock has shown that optimal intakes of elements such as Na, K, Mg, Ca, Mn, Cu, and Zn can reduce individual's risk factors for health problems such as cardiovascular diseases (Mielcarz *et al.*, 2005).

Amino Acid Composition

The amino acids concentration of *B. aegyptiaca* flower is presented in Table 3. The result shows higher concentration of arginine, glutamic acid, aspartic acid and leucine. All the values obtained except Proline, Glycine and Tyrosine, are higher than values reported for consumed edible flowers (Sotelo *et al.,* 2007). The proline content obtained in this study was (2.33 ± 0.07g/100g) which is similar to values obtained in *Yucca filifera* and *Agave salmiana* flowers (Sotelo *et al.,* 2007). The flower has Glycine content of (0.82 ± 0.08g200/g), which is within the range (0.60 – 1.15g/100g) reported for some edible flowers (Sotelo *et*

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al., 2007). However, Tyrosine content obtained is within the range of 0.39 – 0.92g/100g) reported for some edible flowers (Sotelo *et al.,* 2007). Leucine with the help of isoleucine and valine promote the healing of muscle tissue, skin and bones and lowers blood sugar (Kislinchenko and Velma, 2006).

The result of the comparison of the essential amino acids content of the *B. aegyptiaca* flower with the reference standard (FAO/WHO /UNU, 1991) indicated that the seeds have sufficient amount of valine, and isoleucine. Moderate amount of leucine, methionine + tyrosine and threonine. Lysine is the most limiting amino acid in the flower.

Antinutritional Composition

The levels of the antinutritional factors are reported in Table 4. The results show that phytate (1.63mg), oxalate (0.15mg), hydrocyanic acid (0.04mg), nitrate (0.02mg), saponin (4.67mg) and alkaloid (28.7mg) are all below the toxic levels caused by the presence of antinutritional factors (Birgitta and Gullick, 2000). The phytate value is similar to that of *Parkia biglobosa* flower (1.41mg/100g) reported by Hassan *et al.* (2011). The oxalate content is higher than (0.03mg/100g) reported for *Parkia biglobosa* flower (Hassan *et al.,* 2011). High concentration of phytate causes adverse effect on digestibility (FAO, 1990). The HCN value obtained was quite low compared to (0.17mg/100g) reported for *Parkia biglobosa* flower (Hassan *et al.,* 2011). The nitrate content of this flower is also lower than 1.32mg/100g reported for *Parkia biglobosa* flower (Hassan *et al.,* 2011). The alkaloid content of the flower (28.7mg/100g) is higher than those reported for some edible flower (Sotelo *et al.,* 2007). The saponin value obtained is 4.67 ± 1.16mg/100g. Saponins are known to reduce the uptake of certain nutrients like glucose and cholesterols at the gut through intra – luminal physiochemical interaction (Price *et al.,* 1987). Esenwah and Ikenebomeh, (2008), and El – adway. (2002) reported that, high contents of some of the antinutrients can be reduced through soaking, boiling and fermentation process.

To predict the bioavailability of elements such as calcium, iron and zinc antinutrients ratios were calculated. From the results in Table 5, it was observed that, all the values are lower than the values reported for *Parkia biglobosa* flower ratios (Hassan *et al.,* 2011) and below the critical level to impaired zinc and calcium bioavailability (Hassan *et al.,* 2008).

CONCLUSION

This study showed that *B. aegyptiaca* flower contain high percentage of carbohydrate, calorific value which makes it a good source of human energy. It also contains enough essential nutrients like protein, lipid, mineral elements and amino acid. However, the result also indicates low level of antinutrients thus; the plant could be used as source of food since most of the antinutritional factors are also eliminated in the broth or inactivated during the boiling process to reduce the levels of antinutrients.

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Table 1

Proximate Composition of *Balanites aegyptiaca* flower (%)

Parameter	Composition (%)
Moisture (ww)	43.3 ± 2.89
Ash content	6.67 ± 0.29
Crude protein	10.8 ± 0.49
Crude lipid	4.50 ± 0.50
Crude fibre	3.80 ± 0.29
Available carbohydrate	74.2 ± 0.49
Energy value (Kcal/100g)	380.5 ± 0.50

All values except for moisture are the mean ± standard deviation of triplicate determinations expressed in dry weight basis.

Table 2

Mineral Composition of *B. aegyptiaca* Flower

Element	Concentration
K	81.8 ± 0.90
Na	42.1 ± 0.97
Ca	49.8 ± 1.56
P	5.91 ± 0.08
Mg	19.36 ± 0.93
Zn	3.69 ± 0.56
Fe	31.46 ± 1.12
Cu	0.42 ± 0.04
Mn	0.35 ± 0.08
Cr	0.35 ± 0.04
Co	0.33 ± 0.10
Ni	6.33 ± 0.42
Pb	LOI
Cd	0.19 ± 0.08

All values are the mean ± standard deviation of triplicate determinations expressed in dry weight basis.

LOI = Not Detected DW = Dry Weight

Table 3

Amino acid content of *B. aegyptiaca*

Amino acid (Abbreviation)	**Composition(g/100g)**	**FAO/WHO/UNU (g/100g protein)**	**Chemical score (%)**
Valine (Val)*	4.10 ± 0.10	3.5	117
Leucine (Leu)*	5.51 ± 0.07	6.6	83
Isoleucine(ile)*	3.63 ± 0.08	2.8	130
Threonine (thr)*	2.26 ± 0.13	3.4	66
Cysteine (Cys)*	0.55 ± 0.05		
Methionine (met)*	2.15 ± 0.05	2.8[a]	83
Lysine (Lys)*	0.49 ± 0.10	5.8	8
Phenylalanine (Phe)*	4.20 ± 0.10		
Tyrosine (Tyr)*	0.62 ± 0.02	6.3[b]	53
Glycine (Gly)**	0.82 ± 0.08		
Alanine (Ala)**	3.91 ± 0.09		
Serine (Ser)**	2.64 ± 0.08		
Aspartic acid (Asp)**	8.91 ± 0.10		
Glutamic acid (Glu)**	9.92 ± 0.06		
Proline(Pro)**	2.33 ± 0.07		
Arginine(Arg)***	10.20 ± 0.10		
Histidine (His)***	2.16 ± 0.14		

Data are mean ± standard deviation of triplicate result * Essnetial amino acid **Non- essential amino acid
***Essential amino acid to children [a]= Met + Cys [b]= Phe + Tyr

Table 4

Antinutritional Composition of *B. aegyptiaca* Flower

Anti-nutrient	Value (mg/100gDW)
Oxalate	0.15 ± 0.02
Phytate	1.63 ± 0.21
Saponins	4.67 ± 1.16
Alkaloid	28.7 ± 3.06
HCN	0.04 ± 0.02
Nitrate	0.02 ± 0.01

Data are mean ± standard deviation of triplicate result

Table 5

Anti-nutrient to nutrient molar ratio of *B. aegyptiaca* flower

Anti-nutrient to nutrient ration	Value	**Critical level***
[Oxalate]/[Ca]	$1.34 X10^{-3}$	2.5
[Oxalate]/[Ca + Mg]	$8.12 X 10^{-4}$	
[Ca][Phytate]/[Zn]	$5.45 X 10^{-2}$	2.5
[Phytate]/[Ca]	$1.98 X 10^{-3}$	
[Phytate]/[Fe]	$4.38 X 10^{-3}$	0.5
[Phytate]/[Zn]	$4.38 X 10^{-2}$	0.2
		0.4
		1.5

***Source:** Umar (2010).