



SELECTED MINERAL AND ANTI-NUTRIENT COMPOSITION OF THREE VARIETIES OF *Hibiscus sabdariffa* Linn (ROSELLE) CALYCES

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ABSTRACT

*The mineral and anti-nutrient composition of Hibiscus sabdariffa linn calyces of dark red, red and white varieties from three sites in Zuru, Kebbi State, Nigeria. The sun dried samples were analysed for proximate, mineral, anti-nutrient and ascorbic acid. Ca, Mg, Fe, Cu, Mn and Zn were analysed using AAS, while flame photometer was used for K and Na. P was determined by the vanadomolybdate method and ascorbic acid by spectrophotometric method. Phytic acid, oxalate and nitrate were determined using titration method. Saponin and cyanogenic glycoside were determined by gravimetric and spectrophotometric methods respectively. Only the concentrations for Ca and Mg (among the macro elements) showed no significant difference ($p < 0.05$) among the three varieties. Only the concentrations for Fe and Cu (among the micro elements) showed no significant difference ($p < 0.05$). The concentrations for ascorbic acid also showed no significant difference ($p < 0.05$). Similarly, the concentrations for Phytate and saponins showed no significant difference ($p < 0.05$). Therefore, there is no much difference in the choice of dark red, red or white calyces of *H. sabdariffa* collected from Zuru for the purpose of supplying to the body Mg, Ca, Fe, Cu and Ascorbic acid.*

Keywords: mineral, anti-nutrient, dark red, red and white, roselle, calyces,

INTRODUCTION

Traditional African vegetables are extremely important for nutrition and are source of farm income, as they often supply most of the daily requirements for proteins, minerals and vitamins to the poor rural people (Okafor, 1995). It has been reported that nutrient deficiency diseases such as night blindness, scurvy and rickets common among Africans, can be avoided by greater consumption of nutritious vegetables (Mnzava, 1997). *Hibiscus sabdariffa linn* commonly called roselle is an annual erect, bushy herbaceous sub shrub with smooth or nearly smooth, cylindrical red stem. The plant is widely grown in the North and middle belt regions of Nigeria probably because of the climate (Babalola *et al.*, 2001). The plant has been found to thrive on a wide range of soil conditions. It can perform satisfactorily on relatively infertile soils but for economic purposes, a soil well supplied with organic materials and essential nutrients is required (Adanlawo and Ajibade, 2006). It can tolerate relatively high temperature throughout the growing and fruiting periods. The plant requires an optimum rainfall of approximately 45-50cm³ distributed over a 90-120 days growing period (Amin *et al.*, 2008). The plant is gaining wide acceptance, being consumed by several millions of people from different socio-economic classes and background in the West African sub-region,

especially amongst the youths, who sees zobo drink as an alternative source of cheap and relaxing non-alcoholic drink in social gathering. It also, served as resources of food, medicine, food supplement, fibre and other organic compounds (Ogiehor and Nwafor, 2004).

The nutrients composition of *H. sabdariffa* leaves, seeds and calyces being the exploited parts varies between studies, probably due to difference in variety, genetic, environmental, ecology and harvest conditions of the plant (Atta *et al.*, 2013). The most exploited part of a roselle plant is the calyces, which are obtained by removing the calyces or petals of the flower from its capsules containing the seeds. Calyces are used for the preparation of herbal drink, cold and warm beverages, jams and jellies (Tsai *et al.*, 2002). The calyces of *H. sabdariffa* have been reported to be rich in Vitamins, natural carbohydrate, protein and Vitamin C and other antioxidants and also minerals, which constitute the major reason(s) for consuming soft drink and fruit juiced (Olayemi *et al.*, 2011). The roselle calyces are reported to be nutritious, although they also contained anti-nutritional factors, that are naturally found, such as phytic acid, saponin, oxalic acid, tannin, nitrate, which interfere with the absorption of vitamins, minerals and other nutrients.

However, some of these anti-nutritional compounds have benefits as opposed to mostly harmful effects, as some are reported to be anti-cancer agents (Adanlawo and Ajibade, 2006). Adanlawo and Ajibade (2006) reported the presence of Na, K, Mg, P and Ca (macro elements) and Fe, Cu, Zn, Mn and Ni (micro elements) in red and green calyces of *H. sabdariffa* and observed K to be the most abundant. They also reported the presence of very low levels of phytic acid, oxalate, tannic acid and hydrocyanic acid. Babalola *et al.*, (2001) observed in high concentration the presence of Ca, Mg, and Zn in the dark red calyx but did not varied significantly with that of the red colour type. Shrawan *et al.*, (2013) observed the presence of nitrate, phytate, oxalate and saponin in the mature and immature seeds, flower, fruit, calyx and leaf of *H. sabdariffa*. The highest concentrations for nitrate and oxalate were in the calyx, while for phytate and saponin were in the flower and fruit respectively. This study was aimed to investigate the mineral, ascorbic acid and anti-nutrients composition of three varieties of *H. sabdariffa* calyces (red, dark red and white) with a view to provide data for dietary planning.

MATERIAL AND METHODS

Sampling site

The samples were obtained from Zuru Local Government Area of Kebbi State. Zuru is one of the twenty one (21) local government areas of Kebbi State. It is located within latitudes 11°35' to 11° 55'N and longitudes 4° 45' to 5° 25' E of the equator, at the extreme south eastern part of Kebbi State and covers an area of approximately 32, 626 square kilometer. (Kebbi State Government, 2003).

Sample Collection and Preparation

A 600g (200g x 3) of fresh calyces for each of the three varieties of *H. sabdariffa* cultivated by the local farmers were collected randomly from three agricultural fields in Gwammawa, Rikoto and Zanga sites, in Zuru, Kebbi State, Nigeria. The collections made in the months of October and November, 2017, when calyces were fully matured and ready for harvest. After cleaning by removing visually observed non-calyces matter, the calyces for each of the varieties were sun dried for a period of two weeks. The dried samples were then crushed into fine powder before storing in clean and clearly labeled polythene bags. The powdered samples were used in all the analyses (Hassan *et al.*, 2008; Miroslav and Vladimír, 1999).

Proximate Analyses

The proximate analyses of the *H. sabdariffa* calyces were determined according to AOAC

(2005). The moisture content was determined by drying in oven (SM 9053 Uniscope, England) at 105°C until a constant weight was obtained. Ash was determined by weighing the incinerated residue obtained in a furnace (Lenton Furnace SN 4422, England) at 600°C for 3 hrs. Total crude protein content was determined using the Kjeldahl method (kjeltec 2100, Foss, Sweden) and percentage crude protein was calculated as % N₂ (Nitrogen) x 6.25. The total lipid in the samples was determined by Soxhlet method. The available carbohydrate was estimated using anthrone reagent method as described by (Kumar *et al.*, 2012).

Mineral Analyses

The samples were digested using dry digestion method by taking 2.0 g of each in a crucible and placed into a muffle furnace at 600°C for three hours. After cooling ten milliliters of 5.0 N HCl was then added to the ash and dissolved it, then filtered the mixture into a 50 cm³ volumetric flask. The volume was made to the mark with distilled water and the digest was used directly for the elemental determination. Ca, Mg, Fe, Cu, Zn and Mn were determined using Atomic Absorption Spectrophotometer (AA 6300 Shimadzu Model, England). Flame photometer (Model 400, Corning U.K.) was used for K and Na determination, while phosphorous was determined by the vanado-molybdate method using spectrophotometer (optima sp-300 model) at 660 nm according to the method described by AOAC (2005).

Ascorbic Acid Analysis

The ascorbic acid (vitamin C) content of the samples was determined spectrophotometry (optima sp- 300 model) at 660 nm according to Rutkowski and Grzegorzczak (2007) method.

Anti-nutritive Analyses

The Anti-nutrients which include. phytate, nitrate, cyanogenic glycoside, saponin and oxalate were estimated in the three different varieties of *H. Sabdariffa* calyces. The phytic acid, oxalate and nitrate content were determined using titration method as described by Hassan *et al.*, (2008). The saponin content was determined using gravimetric methods and cyanogenic glycoside content was determined using spectrophotometric method as described by AOAC (2005).

Statistical Analysis

The data obtained from the analyses were subjected to analyses of variance (ANOVA) and were expressed as Mean ± standard deviation of triplicate analyses. All data were analysed using the startview statistical package (SAS, 2002). A p-value of < 0.05 was considered as statistically significant between mean values.

RESULTS AND DISCUSSION

The results of the proximate, mineral, vitamin C and anti-nutritive composition of the three varieties of *H. sabdariffa* (roselle) calyces are presented in Tables 3.1, 3.2 and 3.3 respectively.

Proximate Composition

The results of the mean proximate composition of the three varieties of *H. sabdariffa* calyces are presented in Table 1. The varieties had mean protein content ranged from 7.70 to 9.86 %, fibre from 9.33 to 11.0%, available carbohydrate from 22.67 to 37.67 %, lipid from 2.07 to 2.36 %, ash from 5.50 to 9.50 % and moisture from 8.00 to 8.83 %. There were significant differences ($p < 0.05$) in the mean values of protein, fibre and available carbohydrate among the three varieties of *H. sabdariffa*.

Minerals composition

The results of the mean minerals composition of the three varieties of *H. sabdariffa* calyces are presented in Table 2 in mg/100g. The varieties had mean Na content ranged from 3.63 to 4.20, K from 117.00 to 133.33, Ca from

91.04 to 208.46, Mg from 199.49 to 203.68, P from 4.10 to 4.30, Fe from 2.06 to 2.27, Zn from 1.75 to 3.56 and Mn from 3.42 to 5.31. There were significant differences ($p < 0.05$) in the mean values of Na, K, P, Zn and Mn among the three varieties. The difference was observed between dark red and red for Na, dark red and white as well as red and white for K. Similarly, the difference was observed between dark red and white as well as dark red and red for Zn and Mn. For P, the difference was observed between the red and white.

Anti-Nutrients and Ascorbic acid Composition

The results of the mean antinutrients composition of the three varieties of *H. sabdariffa* calyces are presented in Table 3 in mg/100g. The varieties had mean Cyanogenic glycoside content ranged from 147.44 to 355.88, nitrate from 27.50 to 51.00, oxalate from 180.00 to 405.00, phytate from 1.41 to 2.28, saponin from 7.33 to 7.67 and ascorbic acid from 77.13 to 108.66. There were no significant differences ($p < 0.05$) in the mean values of phytate, saponin and ascorbic acid among the three varieties.

Table 1: Proximate Composition of the three varieties of *H. sabdariffa* calyces in percentage (%) sun dry basis

| Parameter | Calyx types | | |
|---------------------------|--------------------------|--------------------------|--------------------------|
| | Dark red | Red | White |
| Moisture | 8.33±2.47 ^a | 8.00±1.32 ^a | 8.83±2.93 ^a |
| Ash | 6.83±2.02 ^a | 5.50±0.50 ^a | 9.50±2.65 ^b |
| Crude Lipid | 2.36±0.31 ^a | 2.33±0.29 ^a | 2.07±0.40 ^a |
| Crude Fibre | 9.33±0.29 ^a | 11.00±0.87 ^b | 10.33±0.58 ^{ab} |
| Crude Protein | 9.86±0.20 ^a | 7.70±0.18 ^b | 9.63±0.76 ^a |
| Available Carbohydrate | 37.67±0.58 ^a | 22.67±0.58 ^b | 33.67±1.53 ^c |
| Caloric Value (kcal/100g) | 211.12±3.01 ^a | 142.48±3.12 ^b | 191.71±6.05 ^c |

Data reported as Mean ± SD. Means followed by different letters (a-c) in the same row are significantly different from each other ($p < 0.05$). Values are means ± standard deviations of triplicate determination.

Table 2: Macro and Micro Minerals composition of the three varieties of *H. sabdariffa* calyces in mg/100g sun dry basis

| Mineral Element | Calyx types | | |
|-----------------|--------------------------|---------------------------|----------------------------|
| | Dark red | Red | White |
| Sodium (Na) | 4.20±0.17 ^a | 3.73±0.12 ^b | 3.63±0.57 ^{ab} |
| Potassium (K) | 133.33±2.89 ^a | 131.67±2.89 ^a | 117.00±2.65 ^b |
| Calcium(Ca) | 91.04±21.56 ^a | 208.46±30.16 ^b | 129.85±39.74 ^{ac} |
| Magnesium (Mg) | 201.20±4.48 ^a | 203.68±7.85 ^a | 199.49±2.64 ^a |
| Phosphorus (P) | 4.17±0.10 ^a | 4.10±0.08 ^b | 4.30±0.10 ^c |
| Iron (Fe) | 2.27±0.72 ^a | 2.06±1.04 ^a | 2.13±0.32 ^a |
| Copper (Cu) | 0.36±0.21 ^a | 0.17±0.10 ^a | 0.20±0.06 ^a |
| Zinc (Zn) | 3.56±0.37 ^a | 1.75±0.50 ^b | 2.30±0.47 ^b |
| Manganese (Mn) | 5.31±0.68 ^a | 3.42±0.50 ^b | 4.09±0.12 ^b |

Data reported as Mean ± SD. Means followed by different letters (a-c) in the same row are significantly different from each other ($p < 0.05$). Values are means ± standard deviations of triplicate determination.

Table 3: Anti-Nutrient and Ascorbic acid Composition of the three varieties of *H. sabdariffa* linn calyces in (mg/100g) sun dry basis

| Parameter | Calyx types | | |
|----------------------|---------------------------|---------------------------|---------------------------|
| | Dark red | Red | White |
| Cyanogenic glycoside | 355.88±61.64 ^a | 147.44±7.52 ^b | 156.11±32.52 ^b |
| Nitrate | 51.00±3.46 ^a | 27.50±1.73 ^b | 32.33±6.51 ^b |
| Oxalate | 195.00±51.96 ^a | 180.00±45.00 ^a | 405.00±45.0 ^b |
| Phytate | 2.28±0.25 ^a | 2.11±0.25 ^a | 1.41±0.49 ^a |
| Saponin | 7.33±1.53 ^a | 7.33±1.53 ^a | 7.67±4.04 ^a |
| Ascorbic acid | 77.13±27.73 ^a | 91.99±21.56 ^a | 108.66±13.69 ^a |

Data reported as Mean ± SD. Means followed by different letters (a-c) in the same row are significantly different from each other ($p < 0.05$). Values are means ± standard deviations of triplicate determination.

DISCUSSION

Proximate Composition of the three varieties of *H. sabdariffa* calyces

The values for moisture content were in agreement with the values of 7.60 % and 6.24 % reported by Adanlawo and Ajibade (2006) on red and green calyces respectively and also 9.20 % showed by Shivali and Pradeep (2009). But, lower when compared with the values of 15 % reported by Tee *et al.*, (2002), 11 % in red calyx and 9.30 % in white reported by Adam, (2005) and 12.81±0.03 % indicated by Azza *et al.*, (2011). The values for the ash content compared well with 6.5-6.8% previously reported by Babalola *et al.* (2001) on red, green and dark red roselle calyces, but were lower than the values of 11.24±0.02% reported by Azza *et al.*, (2011) and 10.60% in red and 9.50% in white by Adam (2005). Since the ash content gives an idea of the inorganic composition of a sample, the observed values indicated that the three varieties may be rich in mineral content.

The crude lipid content were higher than the values of 0.16% in red and 0.12% in white calyces reported by Adam, (2005) and 0.46±0.03% showed by Azza *et al.*, (2011) on red and white calyces. The fibre contents were found to be in agreement with the results 9.8% in dark red, 8.5% in red and 11.2% in green obtained by Babalola *et al.*, (2001) and 11.17±0.02% in red calyx reported by Azza *et al.*, (2011). On the other hand, the values were lower than 13.2% in red and 12% in white reported by Shivali and Pradeep (2009), 12% by Tee *et al.*, (2002) and 13.2% in red and 12% in white as reported by Adam, (2005). The crude protein content were within the range of 7.5±0.02% reported by Azza *et al.* (2011) and 9.8% in dark red, 8.5% in red and 11.2 % in green by Babalola *et al.*, (2001 which is in agreement with the literature. The available carbohydrate results were inconsistent with the values of 12.3% reported by Gabb, (1997),

11.2%, by Atta, (2002), 15% by Tee *et al.*, (2002) and 57.16% in red and 61.55% in white by Adam (2005). This may be as a result of the method of analyses used in this work.

Mineral Composition of *H. sabdariffa* calyces

The values for Na were lower when compared with 57.16% in red and 61.55% in white reported by Adanlawo and Ajibade (2006), 9.5mg/100g in green, 5.5 mg/100g in red and 6.5mg/100g in dark red by Babalola *et al.*, (2001) and 6.62±0.02mg/100g by Azza *et al.* (2011). Since sodium plays an important role in osmotic regulation of the body fluids and transmission of nerve impulses and is normally required in very small amount, the observed low values makes the calyces of the three varieties suitable as part of antihypertensive diet (McDonald *et al.*, 1995). The values of potassium were higher when compared with 49.35mg/100g in red calyx and 49.59mg/100g in green reported by Adanlawo and Ajibade (2006) and 20.60±0.02mg/100g in red calyx by Azza *et al.*, (2011). On the other hand, Babalola *et al.*, (2001) reported higher values of 1850 mg/100g in green calyx, 2060 mg/100g in red calyx and 2320 mg/100g in dark red calyx. The low concentration of sodium and the presence of high amount of potassium in the three varieties suggest their safety in term of health risk. The calcium contents were lower when compared with 1209 mg/100g in green calyx, 1583 mg/100g in red calyx and 1602 mg/100g in dark red calyx as reported by Babalola *et al.*, (2001). However, lower values of 12.65mg/100g in red and 21.58mg/100g in green calyx were also reported by Adanlawo and Ajibade, (2006) and also, 12.62mg/100g by Shivali and Pradeep (2009). Calcium strengthens bones, teeth and maintain proper bone health, Ca and Mg are use to achieve proper muscle contraction as well as nerves function (McDonald *et al.*, 1995).

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The values for magnesium contents were higher when compared with the values of 38.65mg/100g in red calyx and 47.54mg/100g in green reported by Adanlawo and Ajibade, (2006), but were lower when compared with the values of 315.21±1.0mg/100g in red calyx reported by Azza *et al.* (2011) and 235mg/100g in green, 316mg/100g in red and 340mg/100g in dark red by Babalola *et al.*, (2001). Mg plays fundamental roles in most reactions involving phosphate transfer, believed to be essential in the structural stability of nucleic acid and intestinal absorption while its deficiency is responsible for severe diarrhea, hypertension and stroke (Onibon *et al.*, 2007). The observed values indicate that the calyces of the three varieties of *H. sabdariffa* could be good source for Mg. The values for phosphorus content were lower than 36.22±1.0mg/100g in red calyx reported by Azza *et al.*, (2011), 273.2mg/100g by Shivali and Pradeep, (2009) and 36.60mg/100g in red and 15.05mg/100g in green by Adanlawo and Ajibade (2006). Phosphorus is responsible for cell division, reproduction and the transmission of hereditary traits (Adeyeye, 2002). Phosphorus is related to calcium for bones, teeth and muscles growth and maintenance (Umar *et al.*, 2007).

The concentrations of the micro mineral (Fe, Cu, Zn and Mn) composition in the calyces of the three varieties of *H. sabdariffa* expressed in mg/100g are also contained in Table 3.2. The values for Fe closely relate with the 3.22mg/100g in red and 3.37mg/100g in green calyx reported by Adanlawo and Ajibade, (2006), but lower than 37.80±1.0 in red calyx reported by Azza *et al.* (2011) in red calyx and 32.8mg/100g in green, 37.8mg/100g in red and 34.6mg/100g in dark red calyces by Babalola *et al.*, (2001). Iron is an important element in the diet of pregnant women, nursing mothers and infants; it is known that adequate iron in a diet is very important in order to decrease the incidence of anaemia (Oluyemi *et al.*, (2006). Therefore, the calyces of roselle could be a good source of iron. The copper contents were lower when compared with the value of 4.32±0.03mg/100g reported in red calyx by Azza *et al.*, (2011) and 0.70 mg/100g in red and 0.78 mg/100g in yellow calyx by Nnam and Onyeke, (2003). However, Adanlawo and Ajibade (2006) reported the absence of Cu in their work. Deficiency of copper causes cardiovascular disorders as well as anaemia and disorders of the bone and nervous systems (Mielcarz *et al.*, 1997).

The values obtained for Zn in the samples were lower compared with the values of 12.12mg/100g for red and 16.28mg/100g in green calyx reported by Adanlawo and Ajibade

(2006) for red and green calyces. The differences in the values may be due to soil, genetic factor or harvesting period. The zinc content in the samples implies that roselle calyces could play a major role in normal body development, since zinc is essential element in protein and nucleic acid synthesis (Mielcarz *et al.*, 1997). The values obtained for manganese were in agreement with the 2.39mg/100g in red calyx and 5.61mg/100g in green reported by Adanlawo and Ajibade (2006) and .39±0.03mg/100g in red calyx by Azza, *et al.*, (2011).

Anti-Nutrient Composition of *H. sabdariffa* calyces

The cyanogenic glycoside (hydrocyanic acid) contents were higher when compared with the values of 132mg/100g reported by Okereke *et al.*, (2015) and 0.16mg/100g in red calyx and 0.13mg/100g in green by Adanlawo and Ajibade (2006). The values for the nitrate contents were lower when compared with the value of 89.34 mg/100g in calyx and 64.28 mg/100g in roselle leaf reported by Shrawan *et al.*, (2013). The values were adequate to provide the recommended daily intake level of 3.7 mg/kg body weight equivalent to 220 mg for 60 kg person. Nitrate as source nitrous oxide, an important molecule for functioning of muscle cells (Hassan, *et al.*, 2011).

The values of oxalate were lower when compared with the 6150mg/100g in red calyx and 6050mg/100g in green reported by Adanlawo and Ajibade (2006). However, the results obtained were found to be high compared with 4.39 mg/100g in calyx and 3.16 mg/100g in roselle leaf reported by Shrawan *et al.*, (2013). The values for the phytate (phytic acid) contents were lower when compared with the values of 174.81 mg/100g in calyx and 175.23 mg/100g in roselle leaf reported by Shrawan *et al.*, (2013, 0.32% (320mg/100g) in red calyx and 1.13% (1130mg/100g in green Adanlawo and Ajibade (2006) and 1.16 mg/g by Ijeoma *et al.*, (2012). Phytate in the white calyx was lower than in the dark red and red calyx (Table 3. 3).

Since phytate and oxalate are known to decrease the bioavailability of minerals, such as calcium, magnesium, iron and zinc by chelating with them to form strong binding affinities, and thus significantly reducing their bioavailability (Hassan *et al.*, 2011).

The calculated molar ratios of [oxalate] / [Ca] and [oxalate] / [Ca +Mg] of three varieties of roselle calyces were below the critical level of 2.5, these indicates good bioavailability of Ca and Mg due to oxalate (Hassan *et al.*, 2011),

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also, the calculated molar ratios of [Ca] [phytate] / [Zn], [phytate] / [Zn], [phytate] / [Ca] and [phytate] / [Fe] of the three varieties of roselle calyces were below the critical level of 0.5, 10, 0.2 and 0.4 respectively and these indicates good bioavailability of Ca, Fe and Zn due to phytate (Hassan *et al.*, 2008, Hassan *et al.*, 2011). The observed values in this work indicated that consumption of the three varieties is not likely to have health risk.

The values for the saponin content were lower when compared with the values 75.00 mg/100g in calyx and 121.24 mg/100g in roselle leaf reported by Shrawan *et al.*, (2013) and 0.96% by Okereke *et al.*, (2015). Since saponin reduced body cholesterol by preventing its reabsorption and cholesterol in the protozoa cell membrane thereby causing it to lyses (Umar *et al.*, 2007).

Vitamin C Composition of *H. sabdariffa* calyces

The vitamin C contents were lower when compared with the values of 139.51mg/100g reported by Shrawan *et al.*, (2013), 280-360mg/100g by Tee *et al.*, (2002) and 140.13±3.0mg/100g in red calyx by Azza *et al.*, (2011). However, the values were higher when compared with the values of 16.67mg/100g in red calyx and 12.50mg/100g in green reported by Adanlawo and Ajibade (2006) and 6.70mg/100g by Shivali and Pradeep (2009). The differences in the values may be due to genetic factor and harvesting condition. The recommended dietary allowance of vitamin C is 60 mg/day for adults (FAO/WHO, 2001). Based on the results obtained, roselle calyces can supplement the daily vitamin C requirement.

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CONCLUSION

This study has shown that, the calyces of the three varieties (dark red, red, and white) of *H. sabdariffa* collected from Zuru contained the selected minerals (macro and micro nutrients), vitamin C and the anti-nutrient substances. The composition of the macro elements with the exception of Mg and Ca in the three varieties indicated significant difference at $p < 0.05$, while for the micro elements, only for Zn and Mn indicated significant difference. The compositions of the Vitamin C in the three varieties were similar. With the exception of phytate and saponin, the concentrations for the anti-nutrients were not similar. Since the concentrations for oxalate and phytate were below the critical levels, it therefore indicates the bioavailability of the minerals. Therefore, there is no much difference in the choice of dark red, red or white calyces of *H. sabdariffa* collected from Zuru for the purpose of supplying Mg, Ca, Fe, Cu and Ascorbic acid in the body.

Acknowledgement

The authors wish to appreciate the efforts of Dr. Muhammad Nasiru and Ahmad Modi of Faculty of Agriculture, Usmanu Danfodiyo University Sokoto, Dr. Ibrahim K Kwaifa of Department of Haematology, School of Medical Laboratory Sciences, Usmanu Danfodiyo University Sokoto and Dr. Ibrahim Garba Wawata of Department of pure and applied chemistry, Kebbi state University of Science and Technology, Aliero, Nigeria.

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