



ORIGINAL RESEARCH ARTICLE

PROXIMATE COMPOSITION, MINERAL AND PHYTOCHEMICAL CONTENTS OF
WHOLE FRUITS, RINDS AND SEEDS OF GUNA (*Citrullus vulgaris*) FRUIT

T. E. Ndahi*, M. H. Badau, A. L. Kassum, L. P. Mshelia and D. Peter

Department of Food Science and Technology, University of Maiduguri, Nigeria.

*Corresponding author's email address: ndahitarhyel10@yahoo.com

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ABSTRACT

The consumption of fruit and vegetables contribute significantly to nutrient intake. However, the concentration of nutrients in whole fruits, rinds and seeds of a produce may differ. The objective of this study was to determine the proximate composition, minerals and phytochemical contents of guna (*Citrullus vulgaris*) whole fruits, rinds (peels) and seeds. The proximate composition (moisture, ash, protein, fat, fibre and carbohydrate), mineral contents (Ca, Mg, P, Fe, Na, K, and Zn) and Phytochemical contents (flavonoids, phenols, tannin, alkaloid, saponin, glycosides and steroids) of whole fruit, rinds and seeds of guna were determined using standard methods. The results show that moisture, ash, protein, fat, fibre, carbohydrate and energy contents ranged from 11.44-82.69%, 1.43 - 2.64%, 0.52-21.82%, 0.45-26.58%, 8.15-18.21%, 5.32-19.31% and 33.37 - 403.74Kcal/100g respectively. Additionally, guna seeds sample recorded the highest value in ash, protein, fat, fibre, carbohydrate and energy contents. Similarly, guna seeds was observed to have the highest Ca (5.52mg/100g), Mg (349.52mg/100g) and P (155.66mg/100g) contents while it has the least Fe (0.117mg/100g) and Na (18.74mg/100g) contents respectively. The phytochemical contents of whole fruits, seeds and rinds samples of guna differed significantly ($p < 0.05$). The flavonoid, phenol, alkaloid, tannin, saponin and glycoside contents ranged from 6.23 - 55.18mg/100g, 4.61 - 38.11mg/100g, 642.69 - 785.12mg/100g, 0.52 - 44.79mg/100g, 15.75 - 131.79mg/100g and 0.068 - 0.255mg/100g respectively. Furthermore, guna seeds recorded the highest flavonoid, phenol, tannin and saponin contents and the least in glycoside content. The steroid content of guna seeds (62.05mg/100g) was higher than in the whole fruits (8.97mg/100g), and was not detected in guna rinds samples. Therefore, it could be concluded that guna seeds contained high protein, fat and energy values for nutrition compared to the whole fruits and rinds as well as relative high amount of mineral and phytochemical contents. Thus, guna seeds could be used for nutritional and therapeutic purposes.

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1.0 Introduction

Survival and well-being of all life forms depend directly or indirectly on plants and their products. This is because plant and plant products can provide man with basic necessities such as food, clothing and shelter. However, malnutrition is a global challenge due to inadequate intake of a balanced diet (FAO, 2013). It is noteworthy that, consuming appropriate fruits and vegetables can contribute significantly to a balanced diet. Studies have shown that fruits and vegetables contains macro nutrients (carbohydrate, protein and fat), vitamins, minerals, fibre and phytochemicals in

their pulp, seeds and peels (rinds) which can serve as a food supplement (Lim and Rebeta 2013; Niyi et al., 2018; Opara et al., 2019; Ezekaibeya et al., 2020). Olayinka and Etejere (2017) showed that the pulp and rinds of watermelon and cucumber fruits samples have adequate dietary nutrients which could be used to supplement some of the deficient nutrients. In addition, the distribution of chemical constituents in plants is important and significant in traditional medicine (Edeoga et al., 2005; Agatemor et al., 2018). Some of these fruits and vegetables are underutilized. Hence, creating awareness of usefulness in terms of nutrition and medicinal value is important. Kaana and Samuel (2018) had shown that, proper utilization of these plants will help as substitute for some food nutrients.

In recent years, several studies have been carried out on underutilized plant seeds and fruits for their nutrient and anti-nutrient compositions (Augustine et al., 2015; Kaana and Samuel 2018; Aremu et al., 2019). Some of the recent works directed towards increasing the utilization of plant seeds and fruits include the determination of the proximate composition, amino acid profile, vitamins, minerals, phytochemicals of whole fruit, pulp, peels and seeds of some fruits (Olayinka and Etejere, 2017; Agatemor et al., 2018; Niyi et al., 2018; Opara et al., 2019).

Citrullus vulgaris locally known as *guna* is a member of the *Cucurbitaceae* or the *cucurbit* family, commonly referred to as the gourd, melon, cucumber or pumpkin (Penuel et al., 2013). *Cucurbitaceae* are creeping in nature and are found in warmer regions of the world (Bates et al., 1990). The fruit is a fleshy berry that is round to ellipsoid and smooth at maturity, which varies in colour, from green to yellow and is somewhat crispy when chewed. Melon seeds are oilseeds and potential protein source (Penuel et al., 2013; Kiin-Kabari and Akusu 2014). *C. vulgaris* (*guna*) seeds have been found to contain high fats and protein contents that make the seeds valuable as nutrients source (Penuel et al., 2013; Ndahi et al., 2019). *Cucurbit* family has been documented to contain phytochemicals such as phenols, alkaloids, flavonoids, saponins, glycosides, phytates, oxalates and tannins which can affect the bioavailability and utilization of nutrients therein (Penuel et al., 2013; Olayinka and Etejere 2018; Opara et al., 2019). Nonetheless, there is need for more data as species, variety, environment and seasons can affect nutrient content.

Hence, this present study was aimed at determining the proximate composition, minerals and phytochemical contents of the whole fruits, rinds (peels) and seeds of *guna* found in the North-Eastern part of Nigeria.

2.0 Materials and Methods

2.1 Sample Collection

Guna (*Citrullus vulgaris*) fruits of varying sizes were purchased from a farm at Kwaya Kusar Local Government Area of Borno State, Nigeria. The fruits were identified at the Department of Biological Science, University of Maiduguri, Maiduguri, Borno State, Nigeria.

2.2 Sample Preparation

The collected samples were prepared at the Food Processing Laboratory of the Department of Food Science and Technology, University of Maiduguri. The fruit samples were washed and portioned into two parts as shown in Figure 1. The first portion was taken as a whole fruit sample which was chopped into small pieces and blended. Secondly, the other portion was sliced, seeds were gradually extracted from the slice, used as seed samples while the rinds of the slices were cleaned from pulp adherence and chopped into smaller pieces and both seeds and rinds samples were blended separately. Each sample was packaged, labelled appropriately and preserved in a laboratory fridge at 4°C before subjecting them to further analysis.

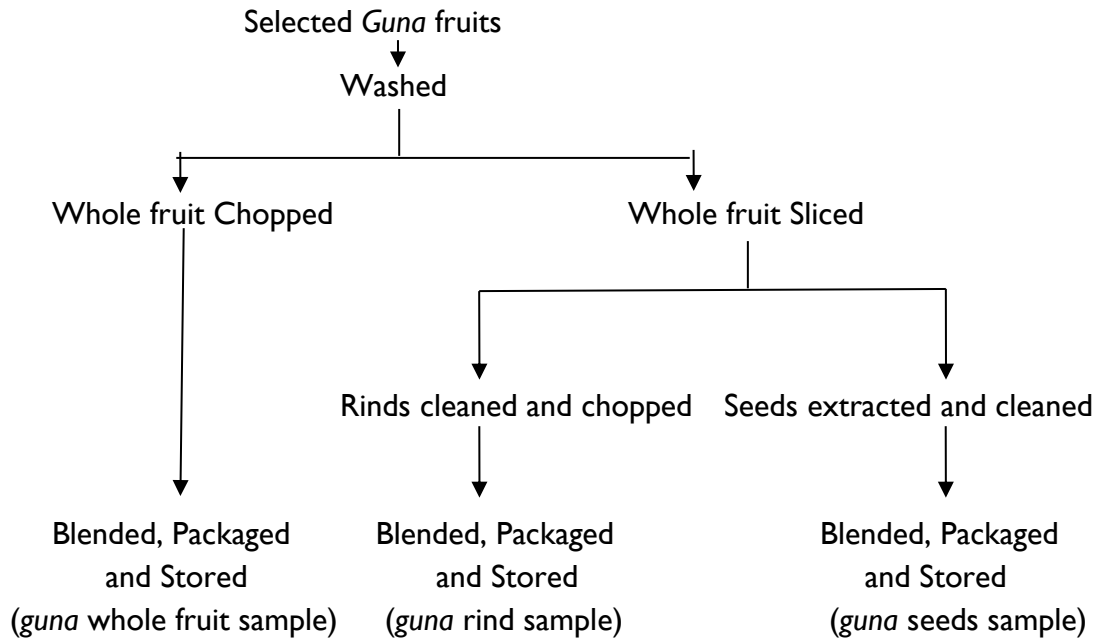


Figure 1. Flowchart for the Guna Whole fruit, Rind and Seeds Sample Preparation



A: Selected *Guna* Fruits



B: Sliced Whole Fruits



C: Sliced Rinds



D: Extracted Seeds



E: Blended Rinds Sample



F: Blended Seeds Sample



G: Blended Whole Fruit Sample

Figure 2: Pictures Showing the *Guna* Whole fruits, Rinds and Seeds Samples.

2.3 Proximate Analyses

The proximate composition of the samples was carried out according to the methods described by AOAC (2005) at Chemistry Laboratory, Chemistry Department, Yobe State University, Yobe State, Nigeria. All the samples were analyzed for moisture, crude protein (%N x 6.25 conversion factor), crude fats, ash and fibre contents (as percentage of the weight of sample used in each content analysis) and the carbohydrate content was obtained by difference using Equation (1):

$$\%CHO = 100 - (\%moisture + \%fat + \%protein + \%ash + \%fibre) \quad (1)$$

Where: %CHO = percent carbohydrate content

%moisture = percent moisture content

%fat = percent fat content

%protein = percent protein content

%ash = percent ash content

%fibre = percent fibre content

2.4 Caloric Value Determination

The caloric values (Kcal) of the samples was calculated by applying at water factors 4, 9, and 4 for each gram of protein, lipid, and carbohydrate, respectively (Adebowale and Maliki, 2011) as shown in Equation (2).

$$\text{Caloric value (Kcal/100g)} = (4 \times \%CHO) + (4 \times \%Protein) + (9 \times \%Fat) \quad (2)$$

2.5 Mineral Analysis

Determination of mineral content was carried out according to AOAC (2000) method. Each sample was ashed at 550°C in a muffle furnace to grey and dissolved in 10 ml of 0.1 M HCl, filtered into a 100 ml volumetric flask and made up to mark with distilled water. This was used to determine the Calcium, Phosphorus, Sodium, Potassium, Magnesium, Iron and Zinc contents using atomic absorption spectrophotometer (AAS).

2.6 Phytochemical Analyses

The quantitative determination of the phytochemical contents was adopted from Ezekaibeya et al. (2020), except phenol content which was done as described by Edeoga et al. (2005).

2.6.1 Determination of flavonoid content

This was carried out using the method of Bohn and Kocipal-Abyassan (1994). A 1.0g sample was repeatedly (three times) extracted with 100 ml of 80% aqueous methanol at room temperature. The solution was shaken for 30 min and filtered using Whatman no 1 filter paper. The filtrate was transferred into a weighed beaker and evaporated to dryness over a water bath and weighed again. The time of the first extraction was 1 hour, 45 min for the second extraction and 30 mins for the third extraction. Flavonoids were determined using the following formula in Equation (3)

$$\text{Concentration of Flavonoid} = \frac{w_3 - w_2}{w_1 \times 100} \quad (3)$$

Where;

w_1 = weight of sample, w_2 = weight of empty beaker, w_3 = weight of beaker + sample after drying.

2.6.2 Determination of phenol content

Phenol content was determined according to Edeoga et al. (2005). Two (2) g of the sample were defatted with 100 ml of diethyl ether using a Soxhlet apparatus for 2 h to obtained a free fat sample. The fat free sample was boiled with 50 ml of ether for the extraction of the phenolic component for 15 min. 5 ml of the extract was pipetted into a 50 ml flask, then 10 ml of distilled water was added. 2 ml of ammonium hydroxide solution and 5 ml of concentrated amyl alcohol were also added. The samples were made up to mark and left to react for 30 min for colour development. This was measured at 505 nm using spectrophotometer.

2.6.3 Determination of alkaloid content

Alkaloid content was assessed using the method of Harbone (1973). A sample (1.0g) was weighed using electric weighing balance into a 250 ml glass beaker; 100 ml of 10% acetic acid in ethanol

was added to the sample and covered. The mixture was allowed to stand for four hours for extraction to take place. The sample was filtered with Whatman no 1 filter paper and the extract was concentrated on a water bath (70°C) to one quarter of the original volume. 20 ml of ammonium hydroxide was added drop-wise to form precipitate of the alkaloid in the filtrate. The filtrate was washed with 20 ml of 0.1 M NH₄OH and then filtered with Whatman no 1 filter paper. The filter paper was weighed before using it to filter. After filtering, the filter paper and the precipitate were dried in an oven at 40°C and weighed. The alkaloid content was determined using the following formula in Equation (4).

$$\text{Concentration of alkaloids} = \frac{W_3 - W_2}{W_1 \times 100} \quad (4)$$

Where;

w₁ = weight of sample; w₂ = weight of filter paper; w₃ = weight of the alkaloid and filter paper

2.6.4 Determination of tannin content

This was done according to the method of Van-burden and Robinson (1981). A sample was weighed (1.0g) into a plastic bottle and 50 ml of distilled water was added and shaken for 3 hours in a vibrator. The sample was filtered into a 50 ml volumetric flask and made up to mark. 5 ml of the filtrate was dispensed into a test tube and mixed with 2 ml of 0.1M FeCl₂ in 0.1N HCl and 0.008 M potassium ferrocyanide. The absorbance was measured at 120 nm for 10 mins. The tannin concentration was determined using the following relation in Equation (5).

$$\text{Concentration of tannins} = \frac{\text{Abs} \times \text{D.F}}{1000 \times w_1 \times 100} \quad (5)$$

Where;

Abs = value of absorbance read, D.F = dilution factor, w₁ = weight of sample

2.6.5 Determinations of saponin content

Availability of saponin was carried out using the method adopted by Obdoni and Ochuko (2001). The sample (1.0g) was weighed using an electric weighing balance into a 250 ml conical flask and soaked in 100 ml of 20% ethanol for three (3) min and heated for three (3) hours at 55°C for extraction then filtered. The residue was re-extracted with additional 100 ml of 20% ethanol. The two samples were combined, heated and reduced to 40 ml at 90°C in a water bath. The concentrate was transferred into a 500 ml separating funnel and 20 ml of diethyl ether was added and shaken vigorously; the upper layer was discarded. The purification process was repeated three times and 60 ml of n-batanol was added. The combined n-butanol mixture was washed twice with 10 ml of 5% aqueous NaCl and the lower layer was discarded while the upper layer was collected in a weighed beaker and heated to a constant weight. The beaker was allowed to cool in a desiccator and re-weighed. The saponin content was determined using the following formula in Equation (6).

$$\text{Concentration of saponins} = \frac{W_3 - W_2}{W_1 \times 100} \quad (6)$$

Where;

w_1 = weight of sample; w_2 = weight of empty beaker; w_3 = weight of beaker + sample after heating

2.6.6 Determination of glycoside content

The determination of glycoside content was done using the method of Harborne (1973). A sample (0.1 g) was weighed out, macerated with 20 ml of distilled water and 2.5 ml of 15% lead acetate was added and filtered. Chloroform (2.5 ml) was added to the filtrate, shaken vigorously and the lower layer collected and evaporated to dryness. Glacial acetic acid (3 ml) was added together with 0.1 ml of 5% ferric chloride and 0.25 ml of concentrated H₂SO₄. The mixture was shaken and put in the dark for 2 hours. Absorbance was measured at 530 nm using the formula in Equation (7).

$$\text{Concentration of glycosides} = \frac{\text{Abs} \times \text{Path length}}{100 \times w_1 \times 100} \quad (7)$$

Where;

Abs = value of absorbance read, w_1 = weight of sample

2.6.7 Determination of steroid content

This was carried out according to the method of Okeke and Elekwa (2003). A sample (1.0 g) was dispersed in 100 ml of distilled water into a conical flask, the mixture was shaken for 3 hours and allowed to stand overnight. It was filtered and the filtrate was eluted with 10 ml normal ammonium hydroxide solution, 2 ml of the elute was put into a test tube and mixed with 2ml of chloroform. Additionally, 3 ml of acetic hydride was also added to the mixture, followed by 2 ml of concentrated H₂SO₄ drop-wise. The absorbance was measured at 420 nm using a Spectrophotometer at 420nm.

The steroid concentration was determined using the following relationship in Equation (8)

$$\text{Concentration of Steroids} = \frac{\text{Abs} \times \text{Path length}}{100 \times w_1 \times 100} \quad (8)$$

Where;

Abs = value of absorbance read, w_1 = weight of sample

2.7 Statistical Analyses

The data obtained were subjected to a one-way analysis of variance (ANOVA) at 0.05 significance level and means separated using Duncan Multiple Range Test using Statistical Package for Social Science 23 version (SPSS).

3.0 Results and Discussions

3.1 Proximate Composition of Guna Whole fruits, Rinds and Seeds

Table I shows the proximate composition of whole fruit, rinds and seeds samples of *guna* fruit. The results show a significant difference ($p < 0.05$) in moisture, ash, protein, fat, fibre carbohydrate

and energy value. The moisture content ranged from 11.44-82.69% while that of the whole fruit is significantly higher compared to the seeds with lowest moisture content. This is because plants in the *Curbitaceae* family are known to contain a high amount of water in their fruits compared to the seeds (Olayinka and Etejere, 2018). Similar to the moisture content of *guna* seeds (11.44%) obtained in this study, Adua et al. (2019) reported 14.29g/100g as the moisture content for *C. vulgaris* seeds and Gabriel et al. (2018) noted 10.92g/100g as the moisture content for watermelon seeds. Contrarily, higher moisture content was obtained for *Citrullus lanatus* seeds (48.75g/100g) (Fila et al., 2013). The moisture content of *guna* rinds (75.16%) in this study was similar to the watermelon rinds (67.75g/100g) (Fila et al., 2013) while higher moisture content was noted for the rinds of *C. lanatus* and *Cucumis sativus* (Olayinka and Etejere, 2018). Agatemor et al. (2018) recorded higher moisture content of *C. sativus* fruit (94.2g/100g) as compared to the moisture content of *guna* whole fruits (82.69%) obtained in this study.

Table I. Proximate Composition of *Guna* Whole fruits, Rinds and Seeds Samples

Composition	Whole fruit	Rinds	Seeds
Moisture (%)	82.69 ± 0.05 ^a	75.16 ± 0.10 ^b	11.44 ± 0.03 ^c
Ash (%)	1.87 ± 0.02 ^b	1.43 ± 0.02 ^c	2.64 ± 0.02 ^a
Protein (%)	1.01 ± 0.03 ^b	0.52 ± 0.02 ^c	21.82 ± 0.09 ^a
Fat (%)	0.96 ± 0.02 ^b	0.45 ± 0.01 ^c	26.58 ± 0.03 ^a
Fibre (%)	8.15 ± 0.06 ^c	15.63 ± 0.04 ^b	18.21 ± 0.03 ^a
Carbohydrate (%)	5.32 ± 0.12 ^c	6.81 ± 0.16 ^b	19.31 ± 0.14 ^a
Energy (Kcal/100g)	33.96 ± 0.15 ^b	33.37 ± 0.10 ^c	403.74 ± 0.71 ^a

Values are means of triplicate analysis and their standard deviation. In any row, means bearing similar superscripts are not significantly different ($p > 0.05$).

The protein contents reported in the whole fruits, rinds and seeds ranged from 1.01-21.82%. It is noteworthy that the seed contain higher protein content than the fruit as shown in Table I. This is similar to protein value in watermelon seeds (19.43g/100g) (Gabriel et al., 2018) and *C. vulgaris* as 20.30g/100g (Adua et al., 2019). However, a lower value of protein content was reported for the rinds and pulp of *C. lanatus* and *C. sativus* with 0.34-0.53% and 0.77- 0.86% respectively (Olayinka and Etejere 2018). Considering the rinds and the whole fruits, the protein content obtained was lower (0.52 and 1.01% respectively) as compared to values of protein content obtained from *C. sativus* fruit at 3.01g/100g (Agatemo ret al., 2018) and fresh watermelon rinds at 2.51g/100g (Fila et al., 2013). The fat content of the seed (26.58%) was significantly higher ($p < 0.05$) as compared to the rinds and the whole fruits as 0.45% and 0.92% respectively. The higher fat content of the *guna* whole fruit compared to its rinds might be due to the presence of its seeds. Lower fat content values have been observed for the rinds and pulp of *C. lanatus* and *C. sativus* having 0.13-0.21% and 0.14-0.23% respectively (Olayinka and Etejere 2018), *C. sativus* fruit, 0.55g/100g (Agatemor et al., 2018) and watermelon seeds, 21.54g/100g (Gabriel et al., 2018). This shows that fruits are not very good sources of fat as reported by Ngoddy and Ihekeonye (1985).

The fibre content obtained in *guna* whole fruits (8.15%) and rind sample (15.63%) were lower compared to *guna* seeds (18.21%). The noted fibre content in *guna* seeds was lower compared

to the previous study by Gabriel et al., (2018), who reported a higher fibre content of 26.10g/100g for watermelon seeds. Contrary to that observed for *guna* whole fruit, Agetemor et al. (2018) reported lower fibre content of *C. sativus* fruit (1.02g/100g). Thus, *guna* seeds and rinds could be used as a source of fibre in food and feed applications.

The ash content provides an estimate of the mineral content of a product which was observed to be higher in the seed (2.64%) as compared to the whole fruits (1.87%) and the rinds (1.43%). Similar value of ash content was reported for *C. vulgaris* seeds (2.273g/100g) (Adua et al., 2019). Different results on ash content were noted for watermelon seeds (5.03g/100g) (Gabriel et al., 2018), *C. sativus* fruit (0.94g/100g) (Agetemor et al., 2018) and that of fresh watermelon seeds and rinds with 1.01 and 0.41g/100g respectively (Fila et al., 2013) as compared to the result in this study.

The carbohydrate contents in *guna* whole fruits, rinds and seeds ranged from 5.32-19.31% where the seeds sample (19.31%) was significantly higher compared to the whole fruit (5.32%) and the rinds (6.81%). This is similar to the carbohydrate value in rinds and pulp of *C. lanatus* (4.23-5.22%) (Olayinka and Etejere, 2018), *C. vulgaris* seeds as 20.86g/100g (Adua et al., 2019) and watermelon seeds as 16.98g/100g (Gabriel et al., 2018).

In this study, the energy value of the *guna* seeds (403.74Kcal/100g) varied significantly ($p < 0.05$) from that of the whole fruit (33.37Kcal/100g) and rinds (33.96Kcal/100g) even as the later did not differed significantly ($p > 0.05$). The high value of energy content observed in *guna* seeds was due to the high caloric nutrients (carbohydrates, proteins and fats) compared to the whole fruit and rinds. The obtained energy value for *guna* seeds indicates its nutritional quality as other oil seeds and may be utilized as high protein and energy sources in some food formulation as suggested by Penuel et al. (2013). Interestingly, animal ration supplemented with *guna* seeds has been reported to increase the nutrient contents and caloric density of the ration (Ndahi et al., 2019).

3.2 Mineral Contents of Guna Whole fruits, Rinds and Seeds Samples

Table 2 shows the mineral contents of whole fruits, seeds and rinds samples of *guna*. There was significant difference ($p < 0.05$) in the calcium (Ca), magnesium (Mg), zinc (Zn), iron (Fe), sodium (Na), potassium (K) and phosphorus (P) contents and Na/K ratio of the studied samples. The Ca, Mg and P contents ranged from 3.84-5.52mg/100g, 206.35-349.52mg/100g and 87.48-155.66mg/100g respectively and the highest values observed were in *guna* seeds followed by whole fruit while the rinds had the least values. Furthermore, the content of K and Zn ranged from 144.28-268.44mg/100g and 4.58-rinds and seeds. The *guna* rinds had the highest value followed by whole fruit and seeds in Fe, Na and Na/K ratio contents ranging from 0.117-0.143mg/100g, 18.74-47.17mg/100g and 0.13-0.27 respectively.

Table 2. Mineral Contents(mg/100g) of *Guna* Whole fruits, Rinds and Seeds Samples

Mineral Contents	Whole fruit	Rinds	Seeds
Calcium (Ca)	4.16 ± 0.02 ^b	3.84 ± 0.02 ^c	5.52 ± 0.02 ^a
Magnesium (Mg)	273.13 ± 0.08 ^b	206.35 ± 0.06 ^c	349.52 ± 0.11 ^a
Iron (Fe)	0.139 ± 0.003 ^b	0.143 ± 0.002 ^a	0.117 ± 0.002 ^c
Zinc (Zn)	5.59 ± 0.02 ^a	4.95 ± 0.02 ^b	4.58 ± 0.01 ^c
Sodium (Na)	43.58 ± 0.03 ^b	47.17 ± 0.03 ^a	18.74 ± 0.04 ^c
Potassium (K)	268.44 ± 0.15 ^a	175.23 ± 0.12 ^b	144.28 ± 0.09 ^c
Phosphorus (P)	123.96 ± 0.15 ^b	87.48 ± 0.10 ^c	155.66 ± 0.07 ^a
Na/K ratio	0.16 ± 0.04 ^b	0.27 ± 0.02 ^a	0.13 ± 0.01 ^c

Values are means of triplicate analysis and their standard deviation. In any row, means bearing similar superscripts are not significantly different ($P > 0.05$).

Higher Ca content was reported in *C. vulgaris* seeds (14.80mg/100g) (Adua et al., 2019) and that of watermelon seeds (27.0mg/100g) (Gabriel et al., 2018) compared to *guna* seeds (5.52mg/100g) in this study. Considering the rinds, lower value of Ca content was reported for the rinds and pulp of *C. lanatus* and *C. sativus* ranging 0.95-1.36mg/100g and 1.02-1.14mg/100g respectively (Olayinka and Etejere 2018). Ca helps to regulate muscle contraction, transmit nerve impulses and bone formation (Okwu and Emenike, 2006). The Ca value range obtained in this study falls far below the recommended dietary allowance (RDA) of 800mg /day for both adults and children (NRC 1989).

The Mg content obtained in this study was higher compared to the values documented for *C. vulgaris* seeds (Adua et al., 2019), watermelon seeds (Gabriel et al., 2018) and melon husk (Akiode et al., 2018). Notably, the Mg content value in *guna* falls within RDA values for adult (350mg /day) and children (170mg/day) (NRC 1989).

The observed values of Zn content in Table 2 was close to the stated value for *C. sativus* seeds (5.46mg/100g) and pulp (5.27mg/100g) (Niyi et al., 2019) and watermelon seeds (4.80mg/100g) (Gabriel et al., 2018). However, lower value of Zn content was reported for melon husks (0.70mg/kg) (Akiode et al., 2018) and *C. vulgaris* at 0.56mg/100g (Adua et al., 2019). Peneul et al. (2013) reported higher value of Zn content in *guna* samples (49.5 - 62.5mg/100g) compared to the Zn values in this study. The RDA for Zn in adults and children are 15mg/day and 10mg/day respectively. Hence, *guna* could be significant in dietary supply of Zn in nutrition.

In Fe content, higher values was documented by Adua et al. (2019) for *C. vulgaris* seeds (4.08mg/100g) and Olayinka and Etejere (2018) for the rinds and pulp of *C. lanatus* and *C. sativus* ranging from 1.44 -2.42mg/100g and 0.74-1.31mg/100g respectively compared to the Fe content in *guna* (Table 2). The RDA for Fe in male adult and children is 10mg/day while for a female adult is 15mg/day (NRC 1989). This study indicated that the Fe content of *guna* is far below the recommended standard which was in disagreement to the remark made by Peneul et al., (2013) for Fe content in *guna* samples (115.5 - 180.0mg/100g).

Sodium regulates fluid balance in the body and helps in the proper functioning of muscles and nerves (Jacob et al., 2015). Niyi et al. (2019) obtained higher value of Na content in *C. sativus*

peels, seeds and pulp as 113.00, 156.00 and 151mg/100g compared to the Na content value in *guna* noted this study. On the other hand, lower value of Na content was reported for *C. colocynthis* L. seeds (12.10mg/100g) (Akansha et al., 2018). The recommended daily intake by WHO for Na is 500mg for adults and 400mg for children (WHO, 1973).

Potassium (K) is essential in maintaining the body's pH, fluid volume and osmotic equilibrium and regulation of muscles and nerve irritability (NRC 1989). This result indicates that *guna* (144.28-268.44 mg/100g) falls below the recommended daily intake (3500mg). Higher value of K content was reported for the peels, pulp and seeds of *C. sativus* ranging from 437.00-541.00mg/100g (Niyi et al., 2019) likewise bitter melon fruits (413.02mg/100g) and fruit pulp of ebony tree (332.22mg/100g) (Aremu et al., 2019).

Phosphorus and calcium are significant in the formation of strong bones and teeth, for blood clotting, heart function, growth, normal nerve and muscle action and cell metabolism (Roth and Townsend, 2003; Rolfes et al., 2009). Lower value was reported for Phosphorus (P) content in *C. colocynthis* L. seeds, rinds and pulp of *C. lanatus* and *C. sativus* and *C. vulgaris* seeds compared to the result obtained in this study (Akansha et al., 2018; Olayinka and Etejere 2018; Adua et al., 2019). The recommended daily intake for phosphorus is 700mg for adults and 1250mg for teenagers (9 -18 years) and the P content of *guna* (87.48-155.66 mg/100g) in this study fall below it.

Na/K ratio in the body is of great concern for the reduction of the effect of high blood pressure. Niyi et al. (2019) reported that the Na/K ratio for the seeds, pulp and peel of *C. sativus* as 0.29, 0.36 and 0.25 respectively which was close to the range obtained (Table 2). However, higher Na/K ratio value was stated for bitter melon fruits (1.26) (Aremu et al., 2019) and *Hibiscus safdariffa* seeds (4.0) (Chukwu et al., 2019) compared to the result in this study. This implies that consumption of *guna* notably, *guna* seeds (0.13) would have a positive effect on blood pressure because they had Na/K ratio that was less than one (FNB, 2005).

3.3 Phytochemical Contents of *Guna* Whole fruits, Rinds and Seeds Samples

In Table 3, the phytochemical contents of whole fruit, seeds and rinds samples of *guna* differed significantly ($p < 0.05$) from each other in flavonoid, phenol, tannin, alkaloid, saponin, glycoside and steroid contents. The quantified phytochemicals in *guna* of this study agreed with the report on the determination of alkaloids, flavonoids, phenols, tannins, steroids, glycosides and saponins for sweet melon seeds (Gabriel et al., 2018), water melon seeds (Opara et al., 2019), *C. sativus* fruit (Agatemor et al., 2018) and *Cucum metuliferus* rinds (Ezekaibeya et al., 2020). Contrastingly, tannin was not detected in defatted, protein concentrate and protein isolate of *guna* seed flours (Penuel et al., 2013), tannins and alkaloids were not detected in *C. colocynthis* L. (Akansha et al., 2018) and likewise tannin and phenol in the melon husk (Akiode et al., 2018). This discrepancy could be due to the different analytical methods and samples used and their processing methods (Natumanya et al., 2021). It is noteworthy that the phenol, flavonoid, tannin, saponin and steroid contents are more concentrated in *guna* seeds than other parts of the fruit (Table 3).

Table 3. Phytochemical Contents(mg/100g) of *Guna* Whole fruits, Rinds and Seeds Samples

Phytochemical contents	Whole fruit	Rinds	Seeds
Flavonoid	7.51 ± 0.03 ^b	6.23 ± 0.02 ^c	55.18 ± 0.04 ^a
Phenol	8.34 ± 0.04 ^b	4.61 ± 0.02 ^c	38.11 ± 0.03 ^a
Alkaloid	642.69 ± 0.03 ^c	785.12 ± 0.05 ^a	746.28 ± 0.09 ^b
Tannin	1.23 ± 0.01 ^b	0.52 ± 0.01 ^c	44.79 ± 0.03 ^a
Saponin	54.72 ± 0.02 ^b	15.75 ± 0.03 ^c	131.79 ± 0.11 ^a
Glycoside	0.15 ± 0.002 ^b	0.255 ± 0.002 ^a	0.068 ± 0.001 ^c
Steroid	8.97 ± 0.01 ^b	ND	62.05 ± 0.05 ^a

Values are means of triplicate analysis and their standard deviation. In any row, means bearing similar superscripts are not significantly different ($P > 0.05$). ND means Not Detected

The phenol, flavonoid and tannin contents in *guna* ranged from 4.61-38.11mg/100g, 6.23-55.18mg/100g and 0.52 - 44.79mg/100g respectively with *guna* seeds recording the highest and rinds having the least values. Studies reported higher values of phenol, flavonoid and tannin contents for *C. sativus* fruit (Agatemor et al., 2018) and *C. metuliferus* rinds (Ezekaibeya et al., 2020) compared to the values in this study. The phenolic and flavonoid compounds can act as reducing agents, hydrogen donors and singlet oxygen quenchers which are attributed to their antioxidant activity (Gulcin et al., 2007). Hertzler et al. (2020) reported that lower concentrations of tannins (viewed as antinutrient) in plants are found to be desirable for human and animal consumption.

Alkaloids exhibit some pharmacological activity such as antihypertensive effect, anti-malarial and anticancer (Saxena et al., 2013). In this study, the alkaloid content of the sample ranged from 642.69-785.12mg/100g where *guna* rinds and whole fruit had the highest and least values in turn. Contrary to the observation in this study, lower value of alkaloid content was stated for melon husk (Akiode et al., 2018), *C. sativus* fruit (Agatemor et al., 2018) and *C. metuliferus* rinds (Ezekaibeya et al., 2020). Interestingly, the alkaloid content of *guna* (whole fruit, rinds and seeds) falls within the range observed for some medicinal plants (0.34 -1.04%) (Edeoga et al., 2005).

Saponin content ranged from 15.75-131.79mg/100g where *guna* seeds and rinds recorded the highest and least value respectively. Higher saponin content was noted for *C. sativus* fruit (2.01mg/g) (Agatemor et al., 2018) compared to this study. The saponin content of the rinds of *C. metuliferus* (0.72mg/g) (Ezekaibeya et al., 2020) was within the range noticed in this study though remarkably higher than *guna* rinds. Saponins are known anti-nutritional factor, which reduces the uptake of certain nutrients including glucose and cholesterol in the gut through intra-luminal physiochemical interactions (Shi et al., 2004) and also as antibiotic (Saxena et al. 2013)

From Table 3, the glycoside content ranged from 0.068-0.255mg/100g. This study indicated that glycosides are more concentrated in *guna* rinds than the seeds. Agatemor et al., (2018) noted higher value of glycoside content in *C. sativus* fruit (32.23mg/g) compared to this present study. According to Xiao et al. (2016), flavonoids and C-glycosides show a significant antioxidant,

anticancer, antitumor, hepatoprotective, anti-inflammatory, anti-diabetes, antiviral, antibacterial and antifungal activities.

Steroids was found to be present in *guna* whole fruit (8.97mg/100g) and seeds (62.05mg/100g) and was not detected in the rinds. It has been reported that some investigated medicinal plants contained steroidal compounds (Edeoga et al., 2005). It should be noted that steroidal compounds are of significance due to their relationship with hormones such as sex hormones (Okwu 2001). This might be the reason *guna* seeds are used in making pap for expectant mothers or breastfeeding mothers to ensure their hormonal and nutritional balance (Wakshama, 2016) since steroidal structure could serve as potent starting material in the synthesis of these hormones (Okwu, 2001). Notably, supplementing lactating ewes ration with *guna* seeds was reported to improve their milk yield and its composition (Ndahi et al., 2019).

4.0 Conclusion

The proximate composition, minerals and phytochemical contents of *guna* whole fruit, rinds and seeds determined highlighted the potentials of the underutilized produce. *Guna* seeds contained higher protein, fat and energy values compared to whole fruit and rinds which could be a good source of plant protein, oil and a potential food supplement for nutritional purposes. Magnesium, potassium and phosphorus contents were the highest mineral contents in all the *guna* part while iron content was the least. The phytochemical contents of *guna* seeds was higher compared to the whole fruit and rinds except for alkaloid and glycoside contents. Steroid was not detected in *guna* rinds. The mineral and phytochemical contents of *guna* seeds could be used for nutritional and therapeutic purposes.

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