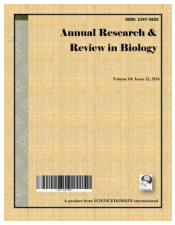

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# Nutrient Composition and Phytochemical Screening of Crushed, Toasted and Fermented Roselle (*Hibiscus sabdariffa* L) Seeds

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Authors MMA and SEA designed the study, wrote the protocol and interpreted the data and produced the initial draft. Authors BDL, IA, AHU, SMK and JPO conducted the field study, gathered the initial data and performed preliminary data analysis. All authors read and approved the final manuscript*

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## ABSTRACT

**Aims:** To examine the effects of crushing (CRRS), Toasting (TRS) and fermentation (FRS) on the nutrient composition and phytochemical constituents of Roselle seeds (*Hibiscus sabdariffa*).
**Study Design:** Rosselle (*Hibiscus sabdariffa* L) seeds were divided into three (3) and subjected to crushing, toasting and fermentation processing methods. Duplicate samples of 100 grams each of the processed Roselle seeds were subjected to proximate analysis, amino acid evaluation, mineral determination and phytochemical screening while data collected were analysed using one-way ANOVA
**Place and Duration of Study:** Livestock Unit of Faculty of Agriculture, Nasarawa State University Keffi, Shabu- Lafia Campus and the Nutrition Laboratory of the university between October 2014

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and November 2014.
**Methodology:** Raw Roselle seeds were subjected to three (3) processing methods viz: crushing (T1), toasting (T2) and fermentation (T3).Duplicate samples of each of the processed Roselle seeds were subjected to proximate analysis, amino acid evaluation, mineral determination and phytochemical screening.
**Results:** Crude Protein (CP), Crude Fat (EE), Crude Fibre (CF), Total Ash, Dry matter (DM), Nitrogen Free Extract (NFE), Methionine, Lysine and Tryptophan values showed significant (P=0.05) increase with fermentation. Na, K, Ca and P were significantly (P=0.05) affected by processing. Phytochemicals screening indicates the presence of alkaloids, saponin, and phenols in an appreciable amount in the crushed and fermented while tannin, flavonoids and glycosides are present in moderate amounts; phlobatannin was found to be moderately present only in fermented Roselle seeds.
**Conclusion:** Nutrient improvement and the preservation of most phytochemical constituents of Roselle seeds was best achieved through fermentation process.

*Keywords: Feed processing; nutrient composition; phytochemical screening; roselle seeds.*

## 1. INTRODUCTION

The nutritional potentials of *Hibiscus sabdariffa* in the diets of humans and as an alternative plant protein source for monogastric animals and fisheries are fast gaining prominence [1,2,3]. This is on account of the cost, nutritional composition and agronomic disposition that allow these annual herbs to be extensively cultivated in tropical Africa, Asia, Central America and the Caribbean [4]. Roselle seed meal is presently sold in some Nigeria markets at one third of the cost of soybean meal, and thus Roselle seed meal represent attractive replacements for soybean meal in the diets of broilers from the standpoint of economics, availability and nutritional value.

Other nutritional benefits of Roselle seeds include the bioavailability of its nutrients such as digestible protein (DP) and digestible energy (DE) [5,6]. The therapeutic and bioprotective properties of the Roselle plants have been reported in several studies [7,8]. This is on account of its rich nutrients and antioxidants constituents. Therefore, phytochemical screening of the Roselle seeds underscores its usage as an antibacterial, antifungal, hypocholesterolemic, diuretic, mild laxative and antihypertensive substance. However, these benefits are dependent on various factors which include source and species of hibiscus and the processing method used before inclusion in the diets.

In spite of the wide application of Roselle seeds as unconventional plant protein source [5,9,10, 11,12,13], the nutritional compositions of calyces of Roselle as well as their functional properties were more investigated and reported when compared to the seeds [14].

Therefore, the objectives of this study is to evaluate the effects of various processing methods, namely crushing, toasting and fermentation on the nutrient, amino acids and minerals composition and phytochemical constituents of Roselle seeds.

## 2. MATERIALS AND METHODS

### 2.1 Experimental Site

This study was conducted at the Livestock Unit of Faculty of Agriculture, Nasarawa State University Keffi, Shabu- Lafia Campus. The test ingredients were processed at both the Livestock unit and the Nutrition Laboratory of the university.

### 2.2 Roselle Seed Collection and Processing

Roselle seeds *(Hibiscus sabdariffa)* were procured from a local market in Langtang South of Plateau State, Nigeria. The collected seeds were cleaned by winnowing and hand picking of stones and debris. The raw Roselle seeds were subjected to three processing methods viz: crushing of raw Roselle seeds (T1), toasting (T2) and fermentation (T3) as described as thus:

#### 2.2.1 Crushing of raw rosselle seeds (CRS) - (T1)

Roselle seeds were cleaned by removing dust, stones and plant debris. The seeds were milled using a laboratory scale hammer miller and sieved through a 30 mm mesh screen according to the methods described by [1]. The milled and

bagged Roselle seed represents experimental treatment (1) (CRS).

#### 2.2.2 Toasting rosselle seeds (TRS) –T2

The method adopted by [15] was used. The cleaned seeds were poured into a hot metal dry pan (common driers). The Roselle seeds were toasted at an approximate temperature of $100^0$C for 30 minutes. The toasted Roselle seeds were spread to cool before grinding. The toasted, milled and bagged Roselle seed represents experimental treatment (2) (TRS).

#### 2.2.3 Fermented rosselle seeds (FRS) –T3

The raw Roselle seeds were sorted to ensure cleaned grains. The cleaned Roselle were poured into a drum of 50 litres of boiling water per batch of 50 kg Roselle seeds and allowed to boil for 30 minutes according to the method described by [16]. The boiled grains were drained, cooled to room temperature and placed in a leaf-lined basket covered with further leaves and kept for 48 hours. The products were sun dried and milled. The anaerobically fermented, milled and bagged Roselle seed represents experimental treatment (3) (FRS).

### 2.3 Chemical Analysis

#### 2.3.1 Proximate analysis

Proximate compositions of each of the experimental samples were analyzed in duplicates using standard methods of determination [17]. A spectrophotometric method described by [18] was used in the determination of Methionine while lysine determination was conducted according to the methods described by [19]. Phytochemicals screening were carried out on the extract of the experimental samples using standard procedure to identify the constituents as described by [20,21,22].

### 2.4 Statistics

Data collected from each of the duplicate samples used for proximate, mineral and amino acids determination in each of experimental samples were subjected to One-way of Variance (ANOVA), means were separated (P=0.05) where there were significant differences using Duncan's Multiple Range Test [23] using [24].

## 3. RESULTS

### 3.1 Proximate Composition

The chemical compositions of the crushed, toasted and fermented Roselle Seeds (*Hibiscus sabdariffa*) are presented in Table 1. There were significant (P=0.05) difference on the proximate composition of the crushed, toasted and fermented Roselle seeds. The crude protein percentage ranged from 21.79% to 23.20%, crude fat values ranged from 3.77% to 4.29%, crude fibre values ranged from 5.55% to 6.16%, NFE values ranged from 52.42 to 54.65% while Total ash and dry matter percentage ranged from 4.80% to 5.88% and 90.31% to 94.39% respectively.

### 3.2 Amino Acids

Table 1 presents the profile of amino acids (g/100 g protein) of the crushed, toasted and fermented Roselle Seeds (*Hibiscus sabdariffa*). Amino acids values significantly (P=0.05) differ among treatments (processing of Roselle seeds). The values for methionine ranged from 1.54 to 1.67 while lysine and tryptophan ranged from 5.35 to 5.70 and 1.12 and 1.40 respectively.

### 3.3 Minerals Composition

The effect of crushing, toasting and fermentation on the minerals composition of Roselle Seeds is presented in Table 1. Trends in the values of the minerals showed significant (P=0.05) difference. Na values ranged from 0.17 in the raw to 0.30 in fermented Roselle. Similarly, K, Ca and P ranged from 0.39 to 0.62, 0.07 to 0.14 and 0.22 to 0.36 respectively in the raw and fermented Roselle. The values of $Cl^-$ were not significantly (P>0.05) affected by processing of the Roselle seeds.

### 3.4 Phytochemical Screening

Table 2 presents the assessment of the phytochemical screening of crushed, toasted and fermented Roselle Seeds (*Hibiscus sabdariffa*). The following phytochemicals are present in an appreciable amount in the crushed and fermented and moderately and minutely present in toasted Rosselle seeds (alkaloids, saponin, and phenols) while tannin, flavonoids and glycosides are similarly present in moderate amounts in the crushed and fermented Roselle seeds. Phlobatannin is however moderately present in fermented and minutely present in

**Table 1. Effects of processing methods on the chemical composition of roselle seeds (*Hibiscus sabdariffa*)**

| | Crushed | Toasted | Fermented | SEM |
|---|---|---|---|---|
| **Proximate composition (%)** | | | | |
| Dry Matter | 90.85[a] | 90.65[a] | 91.94[a] | ±0.46 |
| Crude Protein | 21.94[a] | 21.79[a] | 23.20[a] | ±0.31 |
| Crude Fibre | 5.66[a] | 5.55[a] | 6.16[a] | ±0.18 |
| Crude Fat | 3.77[a] | 3.87[a] | 4.29[a] | ±0.93 |
| NFE | 54.07[a] | 54.65[a] | 52.42[a] | ±1.32 |
| T ash | 5.43[a] | 4.80[a] | 5.88[a] | ±0.43 |
| **Some amino acids composition(g/100 g protein)** | | | | |
| Methionine | 1.61[a] | 1.54[a] | 1.62[a] | ±0.23 |
| Lysine | 5.35[a] | 5.40[a] | 5.70[a] | ±0.21 |
| Tryptophan | 1.31[a] | 1.12[a] | 1.40[a] | ±0.02 |
| **Minerals composition(g/100 g)** | | | | |
| Na | 0.17[b] | 0.25[a] | 0.30[a] | ±0.02 |
| K | 0.39[c] | 0.55[b] | 0.62[a] | ±0.04 |
| Ca | 0.07[b] | 0.10[b] | 0.14[a] | ±0.01 |
| P | 0.22[b] | 0.28[b] | 0.36[a] | ±0.03 |
| $Cl^-$ | 1.01 | 1.01 | 1.01 | ±1.53 |

***Abc*** *means in the same row with the same superscript are not significantly (P=0.05) different*
***SEM*** *Pooled Standard Error of Means, *Values are means of duplicate determinations*

**Table 2. Phytochemical screening of crushed, toasted and fermented roselle seeds (*Hibiscus sabdariffa*)**

| Parameters | Crushed | Toasted | fermented |
|---|---|---|---|
| Alkaloids | +++ | ++ | +++ |
| Saponin | +++ | ++ | +++ |
| Tannin | ++ | + | ++ |
| Phlobatannin | + | + | ++ |
| Phenol | +++ | ++ | +++ |
| Terpenes | - | - | - |
| Steroids | - | - | - |
| Anthraquinones | - | - | - |
| Flavonoids | ++ | + | ++ |
| Chalcones | - | - | - |
| Cardenolides | - | - | - |
| Glycosides | ++ | + | ++ |

*KEY: +++ = Present in an appreciable amount,*
*++ = Present in a moderate amount*
*+ = Present in a minute or trace amount,*
*- = Completely absent*

crushed and toasted Roselle seeds. The followings (terpenes, steroids, anthraquinones, chalcones and cardenolides) were completely absent in both raw and processed Roselle seeds.

## 4. DISCUSSION

The results of the chemical composition of the crushed, toasted and fermented Roselle Seeds *(Hibiscus sabdariffa*) were consistent with the reports of [25,26] who observed variations in the proximate composition of Roselle seeds subjected to different processing methods. However, [27] observed that the contents of K, Na, Cu, Mn and Fe of the Roselle seeds were decreased significantly in furundu a fermented product while the HCl extractability of these minerals was improved in furundu product. The increase in most of the nutrients recorded in the fermented Roselle seeds is an indication of the modifying effect of the fermentation process that leads to nutritional improvement [16,28].

The results obtained for amino acid profile indicates that processing methods affected the selected amino acid profile of Roselle seeds as earlier observed by [4]. Similarly, the mineral compositions of the processed Roselle seeds were observed to increase in value with fermentation. This observation were similarly reported by [1] who reported changes in the mineral composition of Roselle seeds during processing and [27,28,29,30] who observed increase in mineral bioavailability and release of bonded minerals through fermentation of Roselle seeds.

The similarities in the status of most of the phytochemicals screened for both raw and fermented Roselle seeds indicates that high amount of phytoconstituents present in Roselle seeds are more preserved through fermentation process while heat treatment destroys most of them. However, Phlobatannin was observed to

be moderately present in fermented and minutely present in raw and toasted Roselle seeds. This finding is consistent with the report of [29] who observed phlobatannin biogenesis resulting from enzymic oxidation associated with fermentation processes involving the activities of *Bacillus* species linked with traditional fermentation of Roselle and possible enzymatic activity during the fermentation processes. These combined activities impact on some phytoconstituents of Rosselle seeds and may have resulted in the nutritional improvement of the fermented Roselle seeds [30,26]

## 5. CONCLUSION

Fermentation of Roselle seeds is recommended from the findings of this study. This is on account of the nutrient improvement and the preservation of most phytochemical constituents of Roselle seeds required by the poultry feed industry.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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