Determination of Phytochemical and Proximate Constituents of Two Varieties of *Hibiscus sabdariffa*

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Authors’ contributions

This work was carried out in collaboration among all authors. Author NOP designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors VIC and CEP managed the analyses of the study. Authors OAB and CIF managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Phytochemical and proximate were carried out in the petals and seeds of two varieties of *Hibiscus sabdariffa* Linn. using standard methods. The phytochemical analysis showed that the red variety contained a high amount of steroids (6.32±0.430) and anthocyanins (1.22±0.090) in its petals while its seeds have a high saponin content (3.24±0.670). The white variety contained a high amount of flavonoids (8.24±0.340) in its petals while its seeds have a high glycoside content (1.23±0.750). Based on this study, the presence of flavonoids shows its usefulness as a powerful antioxidant. The proximate composition also showed that the white petals also have high moisture (5.76±0.190) and ash (10.20±0.500) contents compared to red variety, which was neutral in all aspects. The white variety was also found to have a low carbohydrate content (60.09±0.290) than a red variety (68.09±0.750). The seeds of the white variety were found to contain the highest protein content (16.19±0.030). These results show that the seeds of *Hibiscus sabdariffa* could serve as a good food supplement for man and livestock if further processing methods are employed to eliminate the little toxicant inherent in the seeds.
Keywords: Phytochemical; proximate; petals; seeds; Hibiscus sabdariffa.

1. INTRODUCTION

Hibiscus sabdariffa Linn. is a plant in the genus Hibiscus of the family Malvaceae. The genus consists of about 300 species, some of which are widely distributed as tropical herbs and shrubs [1] or as an annual erect, bushy, herbaceous sub-shrub Amin et al. [2]. It is cultivated for its stem, fibre, calyx, leaves and seeds. It is usually taken as a drink made from the calyx, esp. in the western part of Africa and has been recommended as remedy for various ailments such as hypertension, pyrexia and liver disorders [3], blood pressure [4].

With the onset of research in medicine, it was concluded that plants contain active principles, which are responsible for curative action of the herbs [5] commonly known as phytochemicals. Plant-based foods, such as fruits, vegetables, and whole grains, which contain significant amounts of bioactive phytochemicals, may provide desirable health benefits beyond basic nutrition to reduce risk of chronic diseases [6].

One of the impediments of herbal products in the world is the lack of standard quality control profile which is essential in order to assess the quality of drugs, based on the concentration of their active ingredients [7]. The proximate and nutrient analysis of medicinal plants, edible fruits and vegetables plays a crucial role in accessing their nutritional significance [8]. Hibiscus sabdariffa has been found to be very important and beneficial especially in West Africa, yet the knowledge of the nutritional composition of the two common varieties found in South Eastern Nigeria is less. Hence the objectives of this study are to determine the phytochemical and proximate compositions of two different varieties commonly found in South Eastern Nigeria.

2. MATERIALS AND METHODS

2.1 Sample Collection

The calyces and seeds of Hibiscus sabdariffa were purchased from a local market in Yankura (Sabongari, Kano) and identified in the Department of Plant Science and Biotechnology, Micheal Okpara University of Agriculture, Umudike.

2.1.1 Preparation of sample

The calyces were cut, cleaned, washed thoroughly, drained and oven-dried at 55°C for 12 hrs as well as the seeds. After drying, the leaves were grounded into a fine powder using a grinding machine, sieved and stored in air-light containers.

2.2 Phytochemical Analysis

The extracts were obtained using ethanol and water as solvents. 50 g of the powdered calyces of Hibiscus sabdariffa was soaked in 50 ml of distilled water and left for 48 hrs before filtration. Same process was repeated using ethanol.

2.2.1 Qualitative analysis

2.2.1.1 Test for alkaloids

5 g of the powdered sample was treated with Wagner’s reagent. A formation of brown/reddish precipitate indicates the presence of alkaloids.

2.2.1.2 Test for flavonoids

5 g of the powdered sample was treated with few drops NaOH solution as described by Harborne [9]. Formation of intense yellow colour, which becomes colorless on addition of dilute HCl indicates the presence of flavonoids.

2.2.1.3 Test for tannins

2 ml of 10% ferric chloride solution was added to 5 g of the powdered sample. Blue-black, green or blue-green ppt was taken as evidence for the presence of tannins as described by Evans [10].

2.2.1.4 Test for saponins

Using Harborne [9] method, 5 g of the powdered sample was diluted in 50 ml of distilled water was shaken vigorously. A strong frothing conforms the presence of saponins.

2.2.1.5 Test for anthocyanins

2 ml of 2N HCl was added to 5 g of the plant extract. The appearance of pink-red color which later turns purple-blue upon addition of NH₃ indicates the presence of anthocyanins.

2.2.1.6 Test for cyanogenic glycosides

This was done using Keller killiani test for glycosides. 5 g of the filtrate was dissolved in 2 ml of glacial acetic acid containing one drop of
ferric chloride solution. This was underlayed with 1 ml of conc. sulphuric acid. A brown ring obtained at the interface indicates the presence of desoxysugar characteristics of cardenolides.

2.2.1.7 Test for steroids

Using Salkowski’s test as described by Harborne [9]. 2 ml of the extract was added to 2 ml of chloroform in a test tube and then 2 ml of conc. H$_2$SO$_4$ was added. The formation of reddish-brown color at the interface shows the presence of steroids.

2.2.2 Quantitative analysis

2.2.2.1 Determination of alkaloids

This was done by alkaline ppt gravimetric method described by Harborne [11]. 5 g of the sample was dispersed into 50 ml of 10% acetic acid sol in ethanol. The mixture was shaken and allowed to stand at room temp for 4hrs. It was filtered using Whatman No. 42 grade of filter. The filtrate was concentrated to a quarter of its original volume by evaporation over a steam bath. Alkaloid in the extract was precipitated by drop wise addition of NH$_4$OH until full turbidity was obtained. The alkaloid ppt was recovered using a weighed filter paper, and washed with 1% ammonia solution, dried in the oven at 80ºC for an hour. It was cooled in a desiccator and reweighed. By weight difference, the weight of the alkaloid was determined and expressed as a percentage of the sample analyzed, using the formula

$$\text{Alkaloid} \% = \frac{W_2-W_1}{W_1} \times 100$$

Where,

$W_1$ = weight of sample
$W_2$ = weight of empty filter paper.

2.2.2.2 Determination of saponins

Double solvent extraction gravimetric method was followed as described by Harborne [11]. 5 g of the powdered sample was weighed out and mixed with 50 ml of 20% aqueous ethanol solution. The mixture was heated on a water bath for 90 mins at 55ºC. It was filtered and the residue re-extracted with 50 ml of 20% ethanol, both extracts were combined together. The combined extracts were reduced to 40 ml over a water bath at 90ºC. The concentration was transferred into a 250 separating funnel where 40 ml of diethyl ether was added and shaken vigorously. Separation was by partition during which the aqueous layer was recovered and the ether layer discarded. Re-extraction by partition was done repeatedly until the aqueous layer became clear in color. The saponins were extracted with 60 ml of normal butanol. The combined n-butanol extract was washed with 5% aqueous NaCl sol. and was evaporated to dryness in a pre-weighed evaporating dish. It was dried at 60ºC in the oven and weighed. The experiment was repeated twice so as to get an average. The saponin content was determined and expressed as a percentage of the weight analysed. Given by the formula

$$\text{Saponin} \% = \frac{W_2-W_1}{W_1} \times 100$$

Where,

$W_1$ = weight of sample
$W_2$ = weight of empty filter paper.

2.2.2.3 Determination of tannins

The tannin content was determined using Folin-Dennis spectrophotometric method described by Pearson [12]. 1 g of the sample was dispersed in 10 ml of distilled water and was shaken. This was left to stand for 30 mins at room temperature while being shaken every 5 mins. It was then centrifuged and the extract gotten. 2.5 ml of the supernatant was dispersed into a 50ml volumetric flask. Similarly, 2.5 ml of standard tannic acid solution was dispersed into a separate 50 ml flask. 1 ml of folin-denis reagent was measured into each flask, followed by 2.5 ml of saturated Na$_2$CO$_3$ solution. The mixture was diluted and incubated for 90 mins at room temperature. The absorbance was measured at 250 nm in a UV VIS spectrophotometer, readings were taken with the reagent blank at zero. The tannin content was given as

$$\text{Tannin} \% = \frac{100 \times A_n}{W \times A_s \times V_t/V_a}$$

Where,

$A_n$ = absorbance of test sample
$A_s$ = absorbance of standard solution
$C$ = concentration of standard solution
$W$ = weight of sample used
$V_t$ = total volume of extract
$V_a$ = volume of extract analyzed.

2.2.2.4 Determination of flavonoids

This was done by the method of Boham and Kocipai [13]. 10 g of the sample was extracted...
repeatedly into 100 ml of 80% aqueous methanol at room temperature. The whole solution was filtered, the filtrate transferred into a crucible and evaporated to dryness over a water bath and weighed. The weight was calculated as

\[ \text{Flavonoid} \% = \frac{W_2 - W_1}{\text{Weight of the sample}} \times 100 \]

Where,
\[ W_1 = \text{weight of empty filter paper} \]
\[ W_2 = \text{weight of paper + flavonoid ppt} \]

2.2.2.5 Determination of steroids

This was determined using the method described by Okeke and Elekwa [14]. A 0.5 g weight of each sample was dispersed in 100 ml freshly distilled water and homogenized in a laboratory blender which is then filtered and the filtrate eluted with normal NH\textsubscript{4}OH solution at pH 9. 2 ml of the eluted sample was put in a test tube and mixed with 2ml of chloroform, 2 ml of acetic anhydride and 2 drops of conc. H\textsubscript{2}SO\textsubscript{4} was cautiously added to the mixture. Standard steroid solution was prepared and treated. The absorbance of standard and prepared samples was measured in a spectrophotometer at 420 nm wavelength, with the reagent blank at zero. The experiment was repeated to get an average. Steroid content was calculated as

\[ \text{Steroid} \% = \frac{100}{W} \times \frac{A_u}{A_s} \times \frac{C}{1000} \times \frac{V_f}{V_a} \]

Where,
\[ W = \text{weight of sample analysed} \]
\[ A_u = \text{absorbance of test sample} \]
\[ A_s = \text{absorbance of standard solution in mg/ml} \]
\[ V_f = \text{total volume of extract} \]
\[ V_a = \text{volume of extract analyzed} \]

2.2.2.6 Determination of cyanogenic glycosides

This was done using Onwuka [15]. 5 g of ground sample was dissolved in 50 ml of distilled water in a conical flask which was left overnight and filtered the next day. 4 ml of alkaline picrate was added to 1 ml of the sample filtrate in a corked test tube and boiled in a water bath for 5 min. After color development, the filtrate was read in a spectrophotometer at 490 nm. Also, the absorbance of the blank containing 1 ml of distilled water and 4ml of alkaline solution. Then the cyanide content was extrapolated using a standard curve.

2.2.2.7 Determination of anthocyanins

The total anthocyanin content were determined by the differential pH method [16] based on the property of anthocyanin pigments to change the color. Two dilution of the two samples were prepared, the first in KCl (0.025M pH 1.0) and the second in a sodium acetate buffer (0.4M pH 4.5) pH being adjusted with HCl 0.24. After equilibrium at room temperature for 15min, the absorbance of two dilutions was read at 510nm and 700nm. A= \((A_{510}-A_{700})_{\text{pH}1} - (A_{510}-A_{700})_{\text{pH4.5}}\).

2.3 Proximate Analysis

This denotes the evaluation of the nutritional value and organic content of the plant materials.

2.3.1 Determination of ash content

The furnace incinerator gravimetric method (AOAC, 2000) was used to determine the ash content. 5 g of each sample was put in a weighed porcelain crucible. The sample was put in a muffle furnace for about 3 hours at 550ºC. The crucible was carefully removed from the furnace, cooled in a desiccator and reweighed. The difference in weight of ash was obtained and expressed as a percentage of the sample weight analyzed:

\[ \text{Ash} \% = \frac{W_2 - W_1}{W} \times 100 \]

Where,
\[ W = \text{weight of sample} \]
\[ W_1 = \text{weight of empty crucible} \]
\[ W_2 = \text{weight of crucible + ash} \]

2.3.2 Determination of moisture content

Following the process of gravimetric method as described by AOAC (1990), 5 g of the fresh sample was weighed and dried in the oven at 105ºC for 3 hrs. It was cooled in a desiccator and reweighed. The weight was recorded and sample returned to the oven for further drying. This was done at intervals and repeatedly until a constant weight was obtained. By weight difference, the weight of moisture lost was determined and was a percentage of the sample weight analyzed using the formula:

\[ \text{Moisture} \% = \frac{(W_2-W_3)}{(W_2-W_1)} \times 100 \]

Where,
\[ W_1 = \text{weight of empty moisture can} \]
\[ W_2 = \text{weight of moisture can + sample before drying} \]
\[ W_3 = \text{weight of moisture can + sample after drying} \]
$W_3$ = weight of moisture can + sample after drying to constant weight

### 2.3.3 Determination of fat content

The method described by Pearson [12] and James [17] was used to determine the fat content. 5 g of each sample was wrapped with a weighed porous paper. The wrapped samples were put in a Soxhlet reflux flask which was mounted onto a weighed oil extraction flask containing 300 ml of petroleum ether (40-60°C boiling point). The upper end of the reflux flask was connected to a condenser. The sample was heated, it boiled, vaporized and condensed into the reflux flask. Soon the samples in the thimbles were covered with the solvent until the reflux flask filled up and siphoned over, carrying its oil extract down to the boiling flask. This process was allowed to go on for 4 hrs before the defatted samples were removed, the solvent covered and oil extract was left in the flask. The defatted wrapped samples was dried in the oven at 100°C for 1 hr, cooled in a desiccator and weighed. The experiment was repeated to get an average. By difference, the weight of oil (fat) extract was determined and expressed as a percentage of the weight of sample analyzed.

### 2.3.4 Determination of crude fibre

This was done using the method described by James [17]. 5 g of each of the defatted sample was boiled in 200 ml of 1.25% H$_2$SO$_4$ solution under reflux for 30 mins. The boiled samples were washed in several portions of hot water using a two-fold muslin cloth to trap the different particles. They were returned to the flask and boiled again in 200 ml of 1.25% NaOH for another 30 min under the same condition. After washing in several portions of water, these samples were allowed to drain dry before being transferred quantitatively to a weighed crucible where they were dried in the oven at 105°C to a constant weight. It was thereafter taken to a muffle furnace at 550°C until it became ash. The loss in weight after incineration was used to determine the crude fibre content and expressed as a percentage of the weight of the sample analyzed.

Crude fibre % = $\frac{(W_2-W_3)}{W_1} \times 100 / 1$

Where: $W_1$ = weight of sample 
$W_2$ = weight of crucible + sample before drying 
$W_3$ = weight of crucible + sample ash (after ashing)

### 2.3.5 Determination of crude protein

This was done by the Kjeldahl method as described by James [17]. The total N$_2$ was determined and multiplied by the factor 6.25. 1 g of each sample was mixed with 10 ml of conc. H$_2$SO$_4$ in a digestion flask. A tablet of selenium catalyst was added to it before it was heated under a fume cupboard until a clear solution was obtained. Each of the digest was carefully transferred to a 100 ml volumetric flask and made up to the mark with distilled water. A 10 ml of each digest was mixed with an equal volume of 45% NaOH sol in a kjeldahl distilling unit. The mixture was distilled into 10 ml of 4% boric acid containing 3 drops of mixed indicator. A total of 50 ml distillate was collected and titrated against 0.02N H$_2$SO$_4$ from green to deep red end point. A reagent blank was also digested, distilled and titrated. The N$_2$ and protein content was calculated as

$N_2$ % = $\frac{100/W}{(N*14)/1000 \times V_f/V_a \times T - B}$

Where,

N = normality of titrant (H$_2$SO$_4$) 
$V_f$ = total volume of digest 
$V_a$ = volume of digest distilled 
T = titre volume of sample. B = titre vaue of reagent blank.

### 2.3.6 Determination of carbohydrate

This was done by elimination using the arithmetic difference method as described by Pearson [12] and James [17].

CHO% (N$_2$ free extracted) = 100-%

$(A+B+C+D)$

Where,

A = protein, B = fat, C = ash, D = fiber

### 2.4 Experimental Design and Statistical Analysis

The experiment was carried out to determine the phytochemical composition of the petals and seeds of two varieties of *Hibiscus sabdariffa*, as well as proximate composition. SPSS software (21) was used for statistical analysis. One-way-Anova was used to analyze the data. Thereafter, Duncan’s multiple range test was used to compare the means.
3. RESULTS

3.1 Qualitative Phytochemical Composition of Seed and Petal Extracts of Two Varieties of Hibiscus sabdariffa

Result of petals of the red variety revealed that anthocyanin, saponin and steroid were presence in aqueous and ethanol extracts while tannin and glycoside were present only in ethanol extract. There was absence of alkaloid and flavonoid in all the extracts.

Result of seed of the red variety revealed that glycoside, anthocyanin, tannin and saponin were present in aqueous and ethanol extracts. Alkaloid was only present in the aqueous extract while glycoside and steroids were only present in ethanol extracts. Result of petals of the white variety revealed that flavonoid and saponin were present in aqueous and ethanol extracts while alkalioid and glycoside were only present in the ethanol extract. There was no anthocyanin, steroid and tannin in the white petals. Result of seed of the white variety also revealed that alkalioid and saponin were both present in aqueous and ethanol extracts while glycoside and steroids were only present in the ethanol extract. There was no flavonoid, anthocyanin and tannin in the white seed.

3.2 Quantitative Phytochemical Composition of Seed and Petal Extracts of Two Varieties of H. sabdariffa

Table 2 shows the result of quantitative phytochemical composition of seed and petal extracts of two varieties of H. sabdariffa which revealed that petals of the red variety gave highest composition of steroid (6.32±0.430 mg/100 g) and anthocyanin (1.22±0.090 mg/100 g), while petals of the white variety gave highest composition of flavonoid (8.24±0.340 mg/100 g). The seed of the red variety gave highest composition of saponins (3.24±0.670 mg/100 g) and tannin (2.33±0.150 mg/100 g), while seed of the white variety gave high compositions of alkaloid (1.51±0.400 mg/100 g) and glycoside (1.23±0.750 mg/100 g).

3.3 Proximate Composition of Seed and Petal Extracts of Two Varieties of H. sabdariffa

The result in Table 3 revealed that seed of the red variety gave highest composition of crude fibre (17.28±0.400%) and crude fat (8.34±0.100%). Flower of the white variety gave highest moisture content (5.76±0.190%) and ash content (10.20±0.500%) while the seed of the white variety gave highest composition of crude fibre (15.80±0.200%).

### Table 1. Qualitative phytochemical composition of seed and petal extracts of two varieties of Hibiscus sabdariffa

<table>
<thead>
<tr>
<th>Sample</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Red petals</td>
<td>Red seed</td>
<td>White petals</td>
<td>White seed</td>
</tr>
<tr>
<td>Alkaloids</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Glycosides</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Flavonoids</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Anthocyanins</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Saponins</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Steroids</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tannins</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

Key: (+): presence; (-): absence

### Table 2. Quantitative phytochemical composition of seed and petal extracts of two varieties of H. sabdariffa

<table>
<thead>
<tr>
<th>Extract</th>
<th>Alkaloid (mg/100g)</th>
<th>Glycoside (mg/100g)</th>
<th>Flavonoid (mg/100g)</th>
<th>Anthocyanin (mg/100g)</th>
<th>Saponin (mg/100g)</th>
<th>Steroid (mg/100g)</th>
<th>Tannin (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red flower</td>
<td>0.18±0.40a</td>
<td>-</td>
<td>1.22±0.090a</td>
<td>1.12±0.184a</td>
<td>6.32±0.430a</td>
<td>1.94±0.830a</td>
<td></td>
</tr>
<tr>
<td>Red seed</td>
<td>0.35±0.023a</td>
<td>0.29±0.21a</td>
<td>0.87±0.065a</td>
<td>3.24±0.670b</td>
<td>-</td>
<td>2.33±0.150</td>
<td></td>
</tr>
<tr>
<td>White flower</td>
<td>0.47±0.120</td>
<td>1.14±0.360b</td>
<td>8.24±0.340c</td>
<td>-</td>
<td>3.17±0.920b</td>
<td>0.45±0.34</td>
<td></td>
</tr>
<tr>
<td>White seed</td>
<td>1.51±0.400</td>
<td>1.23±0.750b</td>
<td>2.13±0.820b</td>
<td>1.04±0.730a</td>
<td>3.22±0.380b</td>
<td>0.12±0.023b</td>
<td>1.59±0.350</td>
</tr>
</tbody>
</table>

*Results are reported in mean ± SD. Means with same letter in a column are not significantly different (P>.05)*

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Table 3. Percentage proximate composition of seed and petal extracts of two varieties of H. sabdariffa

<table>
<thead>
<tr>
<th>Extracts</th>
<th>Moisture (%)</th>
<th>Ash (%)</th>
<th>Crude fibre (%)</th>
<th>Crude protein (%)</th>
<th>Crude fat (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red flower</td>
<td>2.50±0.080c</td>
<td>5.72±0.900b</td>
<td>11.96±0.810a</td>
<td>7.44±0.610b</td>
<td>6.29±0.720a</td>
</tr>
<tr>
<td>Red seed</td>
<td>1.36±0.020a</td>
<td>3.43±0.390a</td>
<td>17.28±0.400c</td>
<td>15.87±0.390c</td>
<td>8.34±0.100c</td>
</tr>
<tr>
<td>White flower</td>
<td>5.76±0.190d</td>
<td>10.20±0.500b</td>
<td>12.01±0.540a</td>
<td>4.82±0.390a</td>
<td>7.12±0.510b</td>
</tr>
<tr>
<td>White seed</td>
<td>1.95±0.280b</td>
<td>5.76±0.440c</td>
<td>14.32±0.210b</td>
<td>16.19±0.030c</td>
<td>7.46±0.030b</td>
</tr>
</tbody>
</table>

Results are reported in mean ± SD. Means with same letter in a column are not significantly different (P>.05).

4. DISCUSSION

The qualitative phytochemical screening of the two varieties of H. sabdariffa revealed that most of the phytochemical assayed to include alkaloid, saponin, steroids, tannin, glycoside among others were present more in the seed than flower. Ethanol however, showed superiority as extractive medium for the phytochemicals than aqueous. This could be due to high volatility of ethanol which tends to extract more active compounds than water [18].

From the study, the quantitative phytochemical composition revealed that flower of the red variety gave highest compositions of steroid and anthocyanin, seed of the red gave highest compositions of saponin and tannin, flower of the white variety gave highest composition of flavonoid while seed of the white gave highest compositions of alkaloid and glycoside. These chemical constituents could serve useful medicinal purposes for treatment of various infections and diseases like fever and leukemia, and for cure of some cancer and diabetes. This implies that flower and seed extracts of two varieties of H. sabdariffa could be useful in the production of analgesics, anti-pyretics and antibiotics [19]. Flavonoids according to Pietta [20], have a wide range of therapeutic activities such as cure of hypertension and tumor. Thus, the presence of excess flavonoids in the petals of the white variety shows that it could be used in antihypertensive drugs and can act as powerful antioxidants, which can protect the free radicals and reactive oxygen. Steroid has been associated with sex hormone in the body, suggesting that petals of the red variety can be used as aphrodisiac. The high content of anthocyanin in the flower of the red variety is evident in its unique color when boiled in water thus, its common usage as food drink and a potential source of natural colorant for manufacture of jams, wines and other acidic foods. Alkaloids, which has been found in more quantity of the white seed, can be extracted as cancer chemotherapeutic agents [21] and also for their antiplasmodial activity and their absence of toxicity of immunity markers [22].

In proximate composition, the results showed that seed extract of the red variety gave highest compositions of crude fibre and crude fat, flower of the white variety gave highest moisture and ash content while seed of the white variety gave highest composition of crude protein. This clearly shows the abundance of uses of the seed of the red variety, as the high crude fibre content suggests its use to ease constipation. In addition, the crude fat extract of the seed of red variety could be employed in the manufacture of body creams, body lotions, pomade and ointment. High protein in the seed of the white variety indicates that eating the seed often provides one with necessary amino acid that the body needs, hence it’s good for the diabetics.

5. CONCLUSIONS

This study has been able to throw more light on the medicinal uses of H. sabdariffa and as well encourage the use of already relevant parts of the plant for food. Also, the seed of the red variety is recommended as a better source of crude fibre and crude fat while the seed of the white variety is recommended for crude protein in the development of food supplements.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES


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