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Comparative Studies on Chemical Profile of Red Soko (*Celosia Trigyna*) and Green Soko (*Celosia Argentea*)

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Abstract

Chemical profile of leafy vegetables enable researchers to affirm the constituents present in them as well as knowing their possible usefulness for consumption and medicinal applications. Red and green soko were obtained, rinsed in water and cut into smaller pieces, air dried, grounded and sieved to give 40mm mesh size powder. The powdered samples were analyzed for proximate composition and mineral contents using standard methods. The antioxidant properties such as reducing power, ferrous ion chelating activity 2,2- diphenyl-1picrylhydrazyl (DPPH) radical scavenging activity and 2,2-azinobis (3-ethylbenzothiazoline-6-sulphonic acid (ABTS) of samples were determined. Red soko had the higher value of crude lipid (2.36 ± 0.06%), ash content (16.45 ±0.15%), protein (17.06 ±0.06%), and dry matter (89.74 ±0.24%) while green soko had higher value of moisture content (10.86±0.33%), crude fibre (13.66±0.20%), carbohydrate (54.81.81±0.21%) and energy value (297.38±0.89 Kcal/100g). Red soko had the higher values of Mg (25.16 ± 0.22 mg/kg), Fe (2.86±0.05 mg/kg), Zn (0.10 ± 0.02 mg/kg), Mn (0.56 ±0.08 mg/kg), and Cu (0.20 ±0.01 mg/kg) while green soko had higher value of Ca (180.16 ±1.00 mg/kg), Na (73.44 ±0.00 mg/kg), K (694.14 ± 0.96 mg/kg), Pb (0.23 ±0.00 mg/kg) and Se (0.20 ±0.03 mg/kg). Green soko had higher value of ferric reducing antioxidant power (0.36±0.04%), Fe^{2+} Chelating Activity (4.46±0.09%), DPPH radical scavenging activity (11.75±0.74%) and $ABTS^{+}$

Radical Scavenging Activity (10.18±0.44%) than red soko. The antioxidant properties (TRAP, Fe^{2+}, DPPH and $ABTS^{+}$) of green soko were higher than red soko. Green soko is richer in antioxidant properties than red soko.
Keywords: Proximate; Mineral; Antioxidant; Red soko; Green soko.

1. Introduction

Food plants (majorly leafy vegetables) have played an important role in human nutrition especially in the aspect of food security and micronutrient deficiencies [1]. Medicinal herbs are very rich and good sources of antioxidants compounds [2] and leafy vegetables contain anti-nutrients, most of these acts as antioxidants and are responsible for their therapeutic properties [3, 4]. Antioxidants are biomolecules which help to destroy free radicals and scavenge diseases [5, 6]. However, anti- nutrients substances such as phytic acid, flavonoids, tannins, saponins, oxalates and alkaloids are present in most vegetables [7]. Vegetables are part of plants that are consumed by humans and animal as food [8].They can be eaten either raw or cooked and they play important roles in human nutrition because they are low in fat and carbohydrates and also high in some food nutrients like minerals, vitamins and proteins .Vegetables contain and supply dietary fiber and they are very important sources of essential vitamins, minerals). African vegetables are a staple in West African cuisine and go by many different names [9]. These leafy greens are commonly used in cooking traditional soups and stews. They are also very affordable and native to the West African region. [10]. When vegetables are included in the diet, they protect the body against the incidence of cancer, stroke, cardiovascular disease, and other chronic ailments and all other diseases [11, 12]. Vegetables contain minerals and traces of oligoelements, mainly K, Ca, Mg, P, Cr, Cu, I, F, Zn, Mo, and Se and Fe [10], which are absorbed from the soil together with water; therefore, their proportions vary [13-15].

Healthy eating requires a balanced and varied diet that includes large quantities of vegetables, fruits, fiber-rich cereals, protein, and moderate amounts of f in the elderly [16].

Celosia species (red soko and green soko), is known as "Lagos spinach" in English or "Sokoyokoto" in Yoruba. It is an erect, short-lived annual herbaceous plant that belongs to the Amaranthaceae family [17, 18]. Sometimes it may grow up to 150 cm in height with alternate leaves. The spikes are pink but later turn white when the seeds are mature. Seed propagation is the conventional method for producing *Celosia argentea*. [19]. The seeds are sown directly or transplanted after seedling emergence [20, 21]. *Celosia argentea and celosia trigyna* (green and red variants) are leafy vegetables which are found in Asia, Africa and South America, also known as the plumed cockscomb or silver cock's comb [22] and possess a characteristic sweet taste when used to cook vegetable soup [22-24]. They are commonly consumed as food and serve as important ingredients in traditional medicine in Africa and Asia [22]. They are African spinach contains important nutrients such as fiber, vitamins (niacin, vitamin A, folate, vitamin C and B_6), minerals (calcium, iron, manganese, potassium, zinc, and magnesium), riboflavin and thiamine, including carotenoids such as beta-carotene among others which have been studies and found beneficial to human health in several ways [15].

Traditionally and folk uses *Celosia species* in the management and treatment of several ailments such as diabetes, diarrhea, and jaundice, it also serves as a blood tonic [25]. In south-east Asia, its flowers are used as medicine for dysentery, haemoptysis and menstruation problems [22]. The three species of *Celosia argentea* are cultivated in Nigeria and Benin: green broad-leaved cultivars called green "soko" and the broad-leaved cultivars with anthocyanin pigmentation of the leaf blades and part of the stem called red "soko" and cultivars with deep green narrow leaves with a hard texture and early flowering [22].

The focus of this research is to carry out a comparative study on proximate composition, mineral composition and antioxidant properties of red and green soko with view to ascertain which of the two is richer in nutritional composition.

2. Materials and Methods

2.1. Source of Materials

The plants (green soko and red soko) were collected from a local farms in Owo, Ondo State, Nigeria. All chemicals used were of the analytical grade with the highest purity available (>99.5%) and procured from Sigma Aldrich, USA.

2.2. Preparation of Plant Materials

The plants materials used were rinsed in water, cut into smaller pieces for easy drying, air-dried, ground and finally sieved to give 40mm mesh size powder. They were put in air-tight containers and kept in a refrigerator at $4^{0}C$ prior to analysis.

3. Methods

3.1. Determination of Proximate Contents

The proximate analyses (moisture, ash, fibers, crude fats, proteins and carbohydrates) of both red and green soko were determined. The moisture and ash were determined using the weight difference method. The nitrogen value, which is the precursor for protein of a substance, was determined by micro Kjeldahl method described by Pearson [26] involving digestions, distillation and finally, titration of the samples. The nitrogen value was converted to protein by multiplying with a factor of 6.25. Carbohydrate content was determined by difference. All the proximate values are reported in percentage [27, 28]. Gross energy content was calculated using Atwater's conversion ratios: 4 kcal/g for protein, 9 kcal/g for fat, and 4 kcal/g for carbohydrates [29]. All the above-indicated parameters were reported on a dry weight basis.

3.2. Determination of Mineral Contents

Calcium, potassium and sodium were determined using Jenway digital flame photometer (PFPT model) while other minerals such as magnesium, iron, zinc, manganese, lead, copper and selenium were determined using Atomic absorption spectrophotometer as described in the Official method of Association Analytical Chemist [26].

3.3. Determination of Antioxidants

3.3.1. Ferric Reducing Antioxidant Power (FRAP)

0.1 g of extract was weighed into a sample bottle; 10 mL of 80% ethanol was added. 2.5 mL sodium phosphate buffer (0.2 M Na_2PO_3, pH 6.6) and 2.5 mL of 1% potassium ferricyanide were added and incubated at 50˚C for 20 minutes. 2.5 mL of TCA (trichloroacetic acid) was added to stop the reaction. 2.5 mL of the aliquot was taken and diluted with 2.5 mL distilled water and 0.5 mL of 0.1% ferric chloride was added and allowed to stand for 30 minutes in the dark for color development. The absorbance was read using 6850 UV/Visible spectrophotometer at wavelength 700 nm.

$$\text{FRAP (Gallic Acid Equivalent (GAE))} = \frac{\text{Absorbance} - \text{Intercept X volume of Extract X 100 X DF}}{\text{Slope of Standard X Sample weight X } 10^6}$$

DF: Dilution factor. If not diluted, then DF = 1

[30].

3.4. DPPH (2, 2-Diphenyl-1-Picrylhydrazyl) Scavenging

0.1g of extract was weighed into a sample bottle and 10 mL of ethanol was added, stirred for 15 minutes and allowed to stand for 2 hours. 1.5 mL of the extract was pipetted into a test tube and 1.5 mL of DPPH solution was added. The 6850 UV/Visible spectrophotometer was zeroed with ethanol as the blank solution. The absorbance/ optical density of the control (DPPH solution) was read. The absorbance of the test sample was read at 517 nm.

$$\text{\% DPPH} = \frac{\text{Absorbance of Sample Extract x Gradient factor x Dilution factor}}{\text{10,000 x weight of sample}}$$

[31]

3.5. Iron (Fe^{2+}) Chelation Assay

0.1g of extract was weighed into a sample bottle, 150 µL of 500 µM $FeSO_4$ was added. 168 µL of 0.1M Tris-HCl (pH 7.4) and 218 µL of saline solution was added. 100 L of the solution was taken and incubated for 5 minutes, before addition of 13 µL of 0.25% 1,10-phenanthroline. The absorbance was read using 6850 UV/ Visible spectrophotometer at wavelength 510 nm.

$$\text{\% Inhibition} = \frac{\text{Absorbance of control} - \text{absorbance of Extract X 100}}{\text{Absorbance of Extract}}$$

[32].

3.6. Determination of ABTS Radical Scavenging Assay

$ABTS^+$ (2, 2-azinobis (3-ethylbenzothiazoline-6-sulphonic acid) diammonium salt radical cational test is a spectrophotometric method widely used for assessment of antioxidant activity of various substance.

1 mL of each sample extract was pipetted into a 50 mL conical flask, 5 mL $ABTS^+$ solution (which was prepared by passing 5 mM $ABTS^+$ aqueous solution through the oxidizing reagent manganese dioxide, on Fisher Brand P8 filter paper) was added. The mixture was properly shaken and allowed to stand for 15 minutes at room temperature. Trodox which was a standard $ABTS^+$ was prepared from 100 ppm stock $ABTS^+$ solution and treated a sample above from 0-10 ppm. The absorbance of treated sample extract as well as that of Trodox standard solutions was read on a Digital Spectrophotometer at 734 nm in a 1cm cell.

$$\text{\% ABTS}^+ = \frac{\text{Absorbance of sample x Gradient x Dilution factor}}{\text{Weight of sample x 10,000}}$$

[33]

4. Results and Discussion

Table-1. Proximate composition (% dry weight) and energy value of red soko and green soko

Parameters	Red soko	Green soko
Moisture (%)	$10.26^b \pm 0.29$	$10.86^b \pm 0.33$
Dry matter (%)	$89.74^e \pm 0.24$	$89.14^e \pm 0.22$
Crude Fat (%)	$2.36^a \pm 0.06$	$2.22^a \pm 0.10$
Crude Fibre (%)	$12.73^{bc} \pm 0.18$	$13.66^{bc} \pm 0.20$
Ash Content (%)	$16.45^e \pm 0.15$	$14.77^{bc} \pm 0.19$
Crude Protein (%)	$17.06^e \pm 0.06$	$14.54^c \pm 0.12$

Carbohydrate content (%)	$51.40^{d}\pm0.21$	$54.81^{d}\pm0.21$
Energy Value (Kcal/100g)	$297.24^{f}\pm0.93$	$297.38^{f}\pm0.89$

NOTE: Within each row, mean values followed by the same superscript are not significantly different at P<0.05 level according to Duncan's New Multiple Range Test (DMRT); Values represent means of triplicate determination ±standard deviation

The proximate composition and energy value of red soko and green soko is represented in Table 1. Proximate composition is essential to assess the nutritional significance of plants, especially leafy vegetables [34]. The moisture content of red soko and green soko were 10.26±0.29% and 10.86±0.33% respectively and these values were not significantly different (P<0.05). The moisture content of food materials are very important parameters because it is an index of water activity of water soluble enzymes that takes place in metabolic activities of plants [35]. The low moisture content of red and green soko provides for lesser activity of water soluble. High content of moisture content increases the rapid growth of micro-organism and also leads to chemical degradation of plant [36]. The moisture content of the two samples was dried to acceptable level of less than 12% recommended for most food substances. The moisture content of the food is an indication of the keeping quality during storage. Crude protein values of red soko was 17.06±0.06% and green soko was 14.54±0.12% and there was no significant difference ($p < 0.05$) in the protein values of both vegetables. The protein content was higher than 11.32% reported for *A. cruentus* [37]. The crude protein values of most leafy vegetables ranged from 1 to 7% of fresh weight or 8 to 30% of dry weight [38] which shows they are still within the range. The high composition of protein in vegetables indicated that it can be used as food supplements especially for malnourished children [21]. The value of crude fibre depicted in red soko and green soko were 12.73±0.18% and 13.66±0.20% respectively and there was no significantly difference ($p < 0.05$) between the two vegetables species. The values still fall within the range reported by Isong and Idiong, 1997 for some Nigerian leafy vegetable , it shows that red soko and green soko have good dietary fibre which will helps to prevent constipation, bowel problems and piles .The percentage lipid content of red soko was 2.36 ±0.06% and green soko was 2.22±0.10 %. The values were low when compared with values reported in some other leafy vegetables [15, 39]. There was no significant different ($p < 0.05$) in lipid value of red soko and green soko. Red soko had 16.45±0.15% of ash content and that of green soko was 14.77±0.19%. There was no significant difference ($p < 0.05$) in the ash content of both vegetables. Plant that has high ash value shows richness in mineral elements [34]. The total carbohydrate content of red soko and green soko were 51.40±0.21% and 54.81± 0.21% respectively. There was no significant difference ($p < 0.05$) in their carbohydrate values. The red soko and green soko had dry matter of 89.74±0.24% and 89.14±0.22% respectively and there was no significant difference between the dry matters of the two vegetable. The energy value (kilocalories per 100g) were 297.24±0.93 and 297.38±0.89 for red soko and green soko respectively. These values were not significantly different ($p < 0.05$). The energy values for both vegetables were less than 337.57-360.67 kcal/100 g reported for some cowpea seeds found in Nigeria [40].

Table-2. Mineral composition of red soko and green soko

Samples	**Red Soko (mg/Kg)**	**Green Soko (mg/Kg)**
Ca	$160.11^{e}\pm0.89$	$180.16^{e}\pm1.00$
Na	$63.78^{d}\pm0.33$	$73.44^{d}\pm0.00$
K	$415.73^{f}\pm0.49$	$694.14^{f}\pm0.96$
Mg	$25.16^{c}\pm0.22$	$20.31^{e}\pm0.08$
Fe	$2.86^{b}\pm0.05$	$0.07^{a}\pm0.00$
Zn	$0.10^{a}\pm0.02$	$0.05^{a}\pm0.01$
Mn	$0.56^{a}\pm0.08$	$0.01^{a}\pm0.00$
Pb	$0.15^{a}\pm0.03$	$0.23^{a}\pm0.00$
Cu	$0.20^{a}\pm0.01$	$0.09^{a}\pm0.00$
Se	$0.05^{a}\pm0.00$	$0.20^{a}\pm0.03$

NOTE: Within each row, mean values followed by the same superscript are not significantly different at P<0.05 level according to Duncan's New Multiple Range Test (DMRT); Values represent means of triplicate determination ±standard deviation.

Table 2 depicts the mineral composition (mg/kg) of red soko and green soko. The most abundant mineral in both red soko and green soko was potassium followed by calcium, sodium and magnesium but low concentration of zinc, manganese, lead, copper and selenium were found in the two *Celosia* species [23, 41]. This was in accordance with the report of Ayodele and Olajide [42] for *Celosia argentea* leaves. Due to low or trace amount of the micro minerals, and heavy metals in red soko and green soko, it will be safe for consumption. Generally, deficiencies in micro nutrients with severe malnutrition conditions leads to mental impairment [43]. Red soko and green soko exhibited no significant difference ($p < 0.05$) in all the minerals (Ca, Na, K, Mg, Zn, Mn, Pb, Cu and Se) except in iron (Fe) in which red soko was 2.86±0.05 mg/kg and green soko was 0.07±0.00 mg/kg. Red soko contained higher iron (Fe) content than green soko. This was in agreement with the report given by Lin, *et al.* [44]. There was significant difference ($p < 0.05$) in iron content of the two leafy vegetables. Iron is an essential trace element for haemoglobin formation and needed for proper immune functioning. The recommended dietary allowance (RDA) of iron in men and women are 10 milligrams and 15 milligrams respectively [45]. Iron plays an important role in the prevention of anaemia [46]. Green soko was richer in selenium (0.20±0.03 mg/kg) than red soko (0.05 ±0.00 mg/kg). Selenium is an important trace element because it aids antioxidant system. Its RDA is 55-70 micro grams [45, 47]. Green soko had the higher value of potassium (694.14±0.96 mg/kg) than red soko (415.73±0.49 mg/kg).

There was no significant difference ($p < 0.05$) in potassium content in both red soko and green soko. Potassium functions as a major ion of intracellular fluid and it aids nerve impulse.

Table-3. Antioxidant properties of red soko and green soko

Samples	Ferric reducing antioxidant power (FRAP) (%)	Fe^{2+} Chelating Activity (%)	DPPH Radical Scavenging Activity (%)	$ABTS^{+}$ Radical Scavenging Activity (%)
Red Soko	$0.29^{a}\pm0.01$	$2.77^{b}\pm0.26$	$9.40^{c}\pm0.08$	$8.14^{c}\pm0.37$
Green Soko	$0.36^{a}\pm0.04$	$4.46^{b}\pm0.09$	$11.75^{c}\pm0.74$	$10.18^{c}\pm0.44$

NOTE: Within each column, mean values followed by the same superscript are not significantly different at P<0.05 level according to Duncan's New Multiple Range Test (DMRT); Values represent means of triplicate determination ±standard deviation.

DPPH=2,2-Dpihenyl-1-picrylhydrazyl; $ABST^{+}$ = 2,2-Azino-bis (3-ethylbenzthiazoline -6 –sulphonic acid) cation.

Table 3 shows the antioxidant properties of red soko and green soko. Reducing property is a significant mechanism for antioxdation potential of a food item. It is also a bioactive compound which is associated with antioxidant activity and the higher the value of reducing power the higher the antioxidant activity [48]. The result indicated that red soko had lower reducing power (0.29±0.001%) and green soko had the highest reducing power (0.36±0.04%) and there was no significant difference (p<0.05) in ferric reducing antioxidant power (FRAP) of red soko and green soko. Ferrous (Fe^{2+}) chelating activity was low in red soko (2.77±0.26%) and high in green soko (4.46±0.09) and their values were not significant difference (p<0.05). 2, 2 Diphenyl-1-piclhydrazyl (DPPH) scavenging activity of red soko and green soko had 9.40±0.08% and 11.75±0.74%respectively. There was no significant difference (p<0.05) in DPPH scavenging activity of red soko and green soko. DPPH had been used extensively as a free radical to evaluate reducing substance and DPPH radical scavenging activity is commonly used to assess the antioxidant activity and the higher the value the higher the antioxidant activity. 2, 2- Azino-bis (3-ethylbenzthiazoline-6-sulphonic acid) ABTS cation radical scavenging activity of red soko was 8.14±0.37% and green soko was 10.18±0.44%. There was no significant difference (p<0.05). $ABTS^{+}$ also used to measure antioxidant activity and the higher the value the better is the antioxidant performance. Amic, *et al.* [49], reported the superiority of the $ABTS^{+}$ assay over DPPH because $ABTS^{+}$ can operate over a wide range of pH, inexpensive more rapid than that of the DPPH assay.

5. Conclusion

The chemical profile of red soko and green soko were not significantly different as much. Though red soko had relatively higher dry matter, crude lipid, ash content and crude protein than green soko while green soko contained relatively higher moisture content, crude fibre, carbohydrate and energy value than red soko. Both vegetables were very rich in calcium, sodium, potassium, magnesium and iron but extremely low in heavy metals (Se, Cu, Pb, Mn and Zn). Green soko had higher value of ferric reducing antioxidant power, Fe^{2+} Chelating Activity, DPPH radical scavenging activity and $ABTS^{+}$ Radical Scavenging Activity than red soko.

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