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Evaluation of nutrient and phytochemical constituents of four eggplant cultivars

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ABSTRACT

The nutrient and phytochemical constituents of four eggplant cultivars (*Solanum. marcrocarpon* (round), *Solanum aetheopicum, Solanum Marcrocapon* (oval), *Solanum gilo*) were evaluated by standard procedures. The moisture content in the cultivars was high ranging from 88.31±0.023–91.94±0.11% while the protein, ash, energy and fat content were low. There were significant differences ($P<0.05$) in the moisture, fiber and ash contents among the cultivars. The K^+ content of all the cultivars was higher than other elements analyzed ranging from 821.00±13.10 to 764.00±10.00mg/100g. Na^+, Ca^{2+} and Cu^{2+} were higher in *S. gilo* while *S. aetheopicum* had the lowest concentrations in all the elements analyzed except Na^+ and Ca^{2+}. The concentrations of alkaloids, tannins and saponins were very high. *S. marcrocarpon* (round) cultivar had the least values for both alkaloids and tannins while *S. Macrocarpon* (oval) and *S. gilo* had the highest concentrations of both phytochemicals. *S. marcrocarpon* (round) eggplant had the highest concentration of flavonoid (16.88±0.08mg/100g), *S. aetheopicum* (12.53±0.03mg/100g), *S. gilo* 12.87±0.06mg/100g and *S. marcrocarpon* (oval) (16.22±0.06 mg/100g). The results revealed that eggplants have rich mineral content and various important of phytochemicals which may account for their medicinal properties acclaimed. Thus, they could be valuable raw material for health and pharmaceutical industries.

Introduction

Eggplant is scientifically referred to as *Solanum melongena* and it belongs to the family of *Solanaceae,* the plant genus *Solanum* and sub genus *Leptostemonum* [1]. It has over a thousand species all over the world. In Nigeria, about 25 different species have been recorded including those domesticated for food and local medicine [2]. In northern Nigeria, the Hausas' call it 'gauta' or 'yalo', it is called 'yengi' in Nupe, 'afufa' or 'anara' in igbo and igba in Yoruba. They are highly valued constituents of the Nigerian foods and folklore medicines. Although, they are mostly grow in the northern part of Nigeria [3], they are either eaten raw or cooked, used in making stew or soups [4] in the southern and western parts of Nigeria.

Eggplants possess various nutritional and medicinal values that make them valuable addition to diets. This is basically because they have appreciable reserve of nutrients and loads of phytochemical compounds such as saponins, phenols, flavonoids, tannins among others. Eggplant fruit is helpful in preventing and treatment of several diseased conditions as it is effective in the reduction of blood cholesterol levels, in regulating high blood pressure, in weight reduction and it possess anti-haemorrhoidal and anti-glaucoma effects. Other medicinal applications include the use of the roots and fruits as carminative and sedatives, and to treat coelic problems [5], leaf juice as a sedative to treat uterine complaints, an alcoholic extract of leaves as a sedative, anti-emetic and to treat tetanus after abortion [6]. The proximate, mineral and phytochemical constituents of four eggplant cultivars (*S. marcrocarpon* (round), *Solanum aetheopicum, Solanum Marcrocapon* (oval), *Solanum gilo*) were evaluated in this study.

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Materials and Methods

Fresh samples of the eggplant cultivars (*S. marcrocarpon* (round), *solanum aetheopicum, solanum macrocarpon* (oval) and *solanum gilo*) were purchased from a farm in Kudenda, Kaduna State, Nigeria. The cultivars were identified at the department of biological science, Federal University of Technology, Minna, Nigeria. The samples were washed with water and divided into two portions; the first portion was instantly used for proximate analysis while the other was sliced into pieces, dried at room temperature for three weeks, ground into powder and stored in an air tight container for mineral and phytochemical analysis.

Proximate analysis of the fresh eggplant cultivars was done in triplicates according to standard procedures [7]. The energy value was determined using the Atwater factors 4, 4, and 9 for protein, carbohydrate and fat respectively [8]. The eggplants were screened for saponins, alkaloids, flavonoinds, phenols, tannins, anthroquinones, phlobatannins, steroids and terpenoids using the methods described by [9, 10, and 11].

Quantitative determination of saponins, phenols, alkaloids, flavonoids, phytate, oxalates and cyanides were investigated using the methods described by [12, 13, 48, 49, 14, 15 and 16]. The mineral content was analyzed using the standard procedure as described by [17]. Atomic absorption spectrophotometer (Model Accusy 211 Bulk Scientific USA) was used to determine Ca, Mg, Fe, P and Zn, while flame photometer (Model FP6410 Harris Medical Essex, England) was used for the determination of Na and K.

Results

The proximate analysis of the eggplant cultivars is shown in table 1 and revealed very high moisture content which ranged between 88.31±0.23% and 91.94±0.11%. The moisture content of all the eggplant cultivars were significantly different ($P<0.05$). The content of fat, ash and protein were low in all the cultivars although there were significant difference ($P<0.05$) in their concentrations among the cultivars except the protein content that showed no significant difference ($P<0.05$) between *S. marcrocarpon* (round) and *S. marcrocarpon* (oval) cultivars. The crude fiber and carbohydrate contents of the cultivars were within the range of 2.21±0.017% to 3.07±0.03% and 4.06±0.19% to 6.03±0.19%% respectively. Both nutrients were significantly different ($P<0.05$) in all the eggplant cultivars. *S. aetheopicum* and *S. macrocarpon* (oval) had the highest and lowest values for energy values; 34.02±0.95kcal/100g and 22.90±0.46kcal/100g respectively.

The mineral values is shown in Table 2 and revealed that *S. gilo* had the highest levels Na, Ca and Cu (590.00±6.30, 30.00±1.10 and 5.20±0.30 mg/100g) respectively while *S. atheopicum* had the least concentrations for P, Mn, Fe, Cu and K (97.50±9.90, 0.90±0.10, 11.90±0.40, 0.60±0.10 and 764.00±10.00 mg/100g) respectively. There was no significant difference ($P<0.05$) in P and Na concentrations among all the cultivars. *S. Marcrocarpon* (oval) had the highest concentrations of Potassium and phosphorus (821.00±13.10 and 122.90±11.40 mg/100g) respectively. There was no significant difference ($P<0.05$) in K^+ concentration between *S. marcrocarpon* (round) and the other cultivars. *S. marcrocarpon* (round) had the highest value of Fe and Mn (29.80±0.10 and 1.20±0.10 mg/100g) but lowest concentration of Na and Ca (30.00±1.10 and 15.00±0.20mg/100g) respectively.

The bioactive constituents; alkaloids, saponins, flavonoids, tannins, phenols, anthraquinones, were present in all the *S. melongena* cultivars (Table 3). However, alkaloid and saponin were more in *S. Macrocarpon* (oval) and *S. gilo*, phenol was slightly present in all the cultivars while terpenoids, phlobatannins and steroids were absent in *S. Gilo, S. macrocarpon* (oval) and *S. marcrocarpon* (round) cultivars respectively. The concentrations of saponins, alkaloids and tannins were high. Saponin concentration ranged from 436.00±12.49mg/100g to 1272.0±36.17mg/100g, alkaloid (143.33±5.06mg/100g to 482.93±14.97mg/100g) and tannins (598.67±4.06 mg/100g to 984.67±8.11mg/100g). *S. marcrocarpon* (round) and *S. gilo* cultivars had the least and highest values for saponin respectively. Sweet white cultivar had the least values for both alkaloids and tannins while *S. macrocarpon* and *S. gilo* had the highest concentrations of both phytochemicals respectively. The alkaloid and tannin concentrations varied significantly ($P<0.05$) among the analyzed cultivars. Sweet white eggplant had the highest concentration of flavonoid (16.88±0.08mg/100g), *S. aetheopicum* (12.53±0.03mg/100g), *S. gilo* 12.87±0.06mg/100g and *S. Marcrocarpon* (oval) (16.22±0.06 mg/100g). Oxalate and phytate concentrations were higher in *S. aetheopicum* and *S. macrocarpon* (oval) (68.13±1.25 mg/100g and 28.73±0.80mg/ 100g) respectively. Cyanide concentrations were low in all the cultivars with *S. macrocarpon* (oval) having the least value 13.33±0.39µg/100g while *S. gilo* had the highest value (20.67±0.17 µg/100g). There was significant difference ($P<0.05$) in the cyanide concentrations among all the eggplant cultivars.

Discussion

African eggplant fruits generally have high moisture content (about 75%) and low dry matter [18]. The moisture content of any food is an index of its water activity [19] and is used as a measure of stability and the susceptibility to microbial contamination. However, the fibrous nature of the skin of eggplants makes it a bit difficult for microorganism to access. This high moisture content also implies that dehydration would increase the relative concentrations of the other food nutrients and improve the shelf-life/preservation of the fruit. Protein content in two varieties of eggplant, round and oval as reported by [1] were 5.79±0.22 % and 4.58±0.40 % respectively and higher than the values obtained in this study. The eggplant cultivars may therefore not be an ideal plant for protein supplementation. [20] reported that vegetables contain very little fats. Dietary fats are essential for the make-up and biological functions and integrity of cells and also increase the tastiness of food by absorbing and retaining flavours [21]. A diet high in fat is said to be implicated in certain cardiovascular disorders such as atherosclerosis, cancer and aging [21]. Eggplants may therefore be ideal fruits for individuals with high serum lipid levels, high blood pressure and other ischemic heart diseases. The percentage carbohydrate obtained in this study was found to be lower than those reported for papaya, apple, water melon, guava, orange, prickly pear, apricot and paprika seeds which were in the range of (8.54 – 34.74 %) [22]. The low carbohydrate level of eggplant cultivars make them good for diabetic patients and individuals watching their weight [1, 23]. The ash level shows the degree of the inorganic matter. Values obtained from this study were higher than those in the work of [1] which was within the range of 1.81±0.86% - 1.78 ±0.13% but lower than that recorded by [24] which was 7.10± 0.38%. It therefore imply that the cultivars analysed have considerable concentration of mineral elements.

The high crude fiber, low fat and low dry matter of the eggplants may be helpful in preventing diseases such as constipation, carcinoma of the colon and rectum and atherosclerosis [25]. The low energy content of the eggplant cultivars may be very helpful in weight management. To lose weight, fewer calories must be taken than what is expended [26]. Water and fiber in foods increase volume of the food and thereby reduce its energy density. It has been shown that in their natural state, fruits and vegetables have high water and fiber content and are low in calories and energy density [27].

The mineral analysis of the eggplant cultivars showed high concentrations of potassium, sodium and phosphorus. The Na^+ and K^+ in these cultivars were higher than those determined for *S. Melongena*: 170 and 230 mg/100g respectively [28]. High potassium has been reported to have a protective effect against excessive sodium intake. [29], suggested that a ratio of sodium ion to potassium ion less than one ($Na^+/K^+ < 1$) would be suitable for reducing high blood pressure. It therefore suggests that all four eggplant cultivars would be suitable for this function. [30] reported that *S. melongena, S. atheopicum and S. macrocarpon* had Ca^{2+} concentration of 1.64±0.01mg/100g, 9.03±0.03 mg/100g and 3.31±0.05 mg/100g respectively. These values were lower than the values obtained in the present study. [31] reported that the Ca^{2+} level from different fruits and vegetables in the German food composition was within the range of 4-11 mg/100g which was still lower than those in the present study. Eggplants could therefore be a good source of calcium ion and may be used as supplements in diets low in calcium ion.

Copper and manganese which are known trace element were very low compared to other elements analyzed in all the cultivars. Copper is involved in the process of erythropoiesis, erythrocyte function and regulation of red blood cell survival. High doses of copper can lead to diarrhea, epigastric pain and discomfort, blood in the urine, liver damage, hypotension and vomiting [32]. The manganese concentration as reported by [33] for *M. whytii* (6.2±0.15mg/100g) was higher than values obtained for the eggplant cultivars in this study. Manganese is transported in the body by transferrin, macroglobulins and albumin.

Table 1: The Proximate Composition of Four Eggplant Cultivars

		Cultivars		
Nutrient composition (%)	*S. marcrocarpon* (round)	*S. atheopicum*	*S. marcrocarpon* (oval)	*S. gilo*
Moisture	89.21 ± 0.22^{b}	88.31 ± 0.23^{a}	91.94 ± 0.11^{d}	90.01 ± 0.22^{c}
Protein	1.26 ± 0.07^{a}	2.36 ± 0.03^{c}	1.21 ± 0.02^{a}	2.10 ± 0.02^{b}
Fat	0.42 ± 0.02^{c}	0.35 ± 0.01^{b}	0.24 ± 0.01^{a}	0.31 ± 0.02^{b}
Fiber	2.63 ± 0.026^{c}	3.07 ± 0.03^{d}	2.21 ± 0.017^{a}	2.32 ± 0.02^{b}
Ash	0.45 ± 0.01^{b}	0.56 ± 0.02^{d}	0.42 ± 0.01^{a}	0.53 ± 0.01^{c}
Carbohydrate	6.03 ± 0.19^{c}	5.36 ± 0.20^{b}	4.06 ± 0.19^{a}	4.73 ± 0.21^{b}
*Metabolizable Energy(kcal/100)	33.03 ± 0.74^{c}	34.02 ± 0.95^{c}	22.90 ± 0.46^{a}	30.11 ± 0.87^{b}

Values are mean ± standard error of mean (SEM) of triplicate determinations. Mean ± SEM followed by different letter(s) on a row are significantly different (p<0.05).*= Calculated using Atwater facto

Table 2: Mineral composition of the four eggplant cultivars

		Cultivars		
Elements (mg/100g)	*S. marcrocarpon* (round)	*S. atheopicum*	*S. marcrocarpon* (oval)	*S. gilo*
K	790.00±5.30^{ab}	764.00±10.00^{a}	821.00±13.10^{b}	809.00±11.70^{b}
Na	370.70±6.60^{a}	423.00±9.00^{b}	492.00±11.50^{c}	590.00±6.30^{d}
Ca	15.00 ±0.20^{a}	18.00±0.30^{a}	25.00±1.30^{b}	30.00 ±1.10^{c}
Cu	0.80±0.04^{a}	0.60±0.10^{a}	0.90±0.02^{a}	5.20±0.30^{b}
Fe	29.80±0.30^{c}	11.90±0.40^{a}	14.40±0.70^{b}	13.40±0.20^{ab}
Mn	1.20±0.10^{a}	0.90±0.10^{a}	1.20±0.10^{a}	1.10±0.20^{a}
P	102.80±10.5^{b}	97.50±9.90^{a}	122.90±11.4^{d}	118.80±14.20^{c}

Values are mean ± standard error of mean (SEM) of duplicate determination. Mean ± SEM followed by different letter superscript on a row are significantly different (p<0.05).

Table 3: Phytochemical screening of eggplant cultivars

Parameters	*S. marcrocarpon* (round)	*S. atheopicum*	*S. marcrocarpon* (oval)	*S. gilo*
Alkaloids	++	++	+++	+++
Anthroquinones	+	++	+	++
Flavonoids	++	+	+	+
Phenols	+	+	+	+
Phlobatannins	-	+	-	+
Saponins	++	++	+++	+++
Steroids	-	++	++	++
Tannins	++	++	++	++
Terpenoids	+	+	+	-

Absent (-), slightly present (+), moderately present (++), highly present (+++)

Table 4: Quantitative phytochemical constituents of four cultivars of *S. melongena*

		Cultivars		
Phyto-constituents (mg/100g)	*S. marcrocarpon* (round)	*S. aetheopicum*	*S. macrocarpon* (oval)	*S. gilo*
Alkaloids	143.33±5.06^{a}	284.20±11.57^{b}	482.93±14.97^{c}	347.73±6.78^{d}
Flavonoids	16.88±0.08^{d}	12.53±0.03^{a}	16.22±0.06^{c}	12.87±0.06^{b}
Phenols	5.08±0.22^{bc}	4.17±0.34^{ab}	5.98±0.35^{c}	3.91±0.23^{a}
Saponins	436.00±12.49^{a}	650.00±8.72^{b}	1120.00±6.93^{c}	1272.0±36.17^{d}
Tannins	598.67±4.06^{a}	846.67±7.42^{c}	619.33±4.67^{b}	984.67±8.11^{d}
Cyanide*	15.63±0.32^{b}	20.00±0.46^{c}	13.33±0.39^{a}	20.67±0.17^{c}
Phytate	25.87±0.52^{b}	34.33±0.33^{c}	38.67±0.75^{d}	22.73±0.48^{a}
Oxalate	44.99±0.74^{c}	68.13±1.25^{d}	28.73±0.80^{a}	33.97±1.11^{b}

Values are mean ± standard error of mean (SEM) of triplicate determinations. Mean ± SEM followed by a different letter superscript on a row are significantly different (p<0.05). * Measured in µg/100g of sample

It is involved in enhancing normal skeletal growth, functions with vitamin K in the formation of prothrombin. It is important for the utilization of glucose, metabolism of lipid, cholesterol metabolism, pancreatic function and enhancement of fertility [32].

The iron content of several fruits and vegetables which have been analyzed by different authors are within the range of 0.1-1.8 mg/100g [34]. The concentration of iron in this study could be compared with those obtained in the work of [35] who analyzed eight edible fruits (15.23±0.19 to 35.55±0.47mg/100g). Iron which is required for haemoglobin production [36] is necessary for oxygen transportation from the lungs through the blood stream to the tissues. Myoglobin, a protein in muscle, also contains iron which stores oxygen for use during muscle contraction. Variation of minerals among plants may be due to differences in geographical locations, soil type, and intensity of fertilization, plant species and seasons of cultivation.

The phytochemical analysis showed high concentrations of saponins, alkaloids and tannins in all four cultivars. Alkaloids and saponins are known to elicit antimicrobial abilities and defend plants against microbial and pathogenic attacks [37]. The presence of these phytochemical constituents showed that the *S. melongena* varieties have medicinal properties. [9] reported the roles of these phytochemicals as analgesic, anti-inflammatory, anti-hypertensive and anti-microbial. Tannin compounds have some antibacterial effects [38], antiviral and antiparasitic effect [39]. Phenolics or polyphenols have various physiological functions, including antioxidant, antimutagenic and antitumor activities. They have been reported to be effective in scarvenging free radicals, which are deleterious to the body and foods systems [40]. Several factors could be responsible for differences in total phenolic content of plants of similar origin. Some include variation in fruit cultivars, processing techniques, harvest and post harvest handling and storage conditions. [24] reported 39.60±0.02mg/100g as the flavonoid concentration of *S.incanum* (a cultivar of *S. melongena*). The flavonoid (nasunin) isolated from the peel of eggplant fruit, is a potent antioxidant and free radical scavenger and has been demonstrated to guard cell membranes from damage [41]. They also possess high lipid reducing effects; flavonoids extracted from the fruits of *S. melongena* showed significant hypolipidemic potentials in normal and cholesterol fed rats [42].

Very high cyanide concentrations have been detected in fresh samples of bitter apricot seed, bamboo shoot, cassava, and flaxseed at levels of 9.3 mg/kg to 330 mg/kg [43]. Excessive ingestion of cyanogenic glycosides can be lethal as it intercalates with cytochrome oxidase for aerobic function [44]. Although values obtained in this work were very low (13.33±0.39µg/100g -20.67±0.17µg/100g) and therefore safe for human consumption. Phytate and Oxalate are anti-nutritional factors which are present in various fruits and vegetables. High concentrations of antinutrients have been discovered to cause great effects on mineral bioavailability in foods [45] by forming complexes with them, as a result reducing their absorption and utilization by the body systems [46]. [47] also reported that a daily intake of 450mg of oxalic acid is able to disrupt various metabolic processes. The values obtained for phytate and oxalate in the cultivars studied are lower than the lethal dose, hence, may not elicit toxic effect when consumed.

Conclusion

The variations that occur in the eggplants cultivars do not end at the morphological level only but also in the composition of the various nutrients and bioactive substances present in them. Eggplants have appreciable contents of nutrients and phytochemicals which make them nutritionally and therapeutically beneficial.

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