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PHYTOCHEMICAL AND NUTRITIVE COMPOSITION ANALYSIS OF *SOLANUM AETHOPICUM* L.

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ABSTRACT
Phytochemical and nutritive analysis including macro- and micro minerals, as well as vitamin composition of a non conventional species of garden egg *Solanum aethopicum* L. were undertaken using standard methods. The qualitative phytochemical analysis revealed the presence of important bioactive compounds such as alkaloids, flavonoids, saponins, tannins, phenolics and cyanogenic glycosides. The quantitative analysis indicated that *S. aethiopicum* L. contained alkaloids (5 ± 0.77 %), flavonoids (27 ± 0.45 %) saponins (14 ± 0.23 %), tannins (3 ± 0.14 %), phenols (4.7 ± 0.04 %) and cyanogenic glycosides (3.7 ± 0.29 %). The proximate analysis showed *S aethiopicum* L. had 6.69 ± 0.02 % moisture, 15 ± 0.02 % ash, 21.33 ± 0.01 % crude fiber, 37.66 ± 0.02 % lipid, 4.2 ± 0.21 % protein and 15.6 ± 0.03 % carbohydrate. The vitamin content revealed high level of vitamins B_2 (10.33 ± 0.02 µg/g), B_3 (14.34 ± 0.02 µg/g) and vitamin C (406 ± 1.41) mg and trace amounts of vitamin B_1 (0.45 ± 0.02 µg/g) and Vit E. (10.53 ± 0.02 µg/g). There were also high mineral contents such as potassium (4250 ± 3.91 mg/g) and trace amounts of other minerals including lead (0.03 ± 0.2 mg/g) and cadmium (0.015 ± 0.002 mg/g). The analyses revealed that *S. aethiopicum* L. had high beneficial nutrients that justify its use in making stew and sauce as well as its use in place of kola nut as a sign of hospitality in parts of Eastern Nigeria as well as its medicinal uses.
Keywords: Phytochemical, *Solanum aethopicum* L., minerals, spectrophotometric, nutritive analysis, micro and macro minerals.

INTRODUCTION

Solanum species (egg plants) belong to the family of solanacaea and the plant genus solanum with over 1000 species worldwide and represented in Nigeria by about 25 species including those domesticated and wild ones with their leaves, fruits of both used as vegetables or in traditional medicine[1]. Among these species known and cultivated in Africa including Nigeria is *Solanum aethiopicum* L. known as the African eggplant or Ethiopian eggplant[2].

It is often cultivated as an annual plant. They Afican eggplant or commonly called garden egg is also called "afufa" or "anara" in Igbo, "Dauta" in Hausa and "Igbagba " in Yoruba. The African egg plant species are commonly consumed almost on daily basis by both rural and urban families. The eggplants form part of the traditional Sub-Saharan African culture. The fruits, said to represent blessings and fruits, are offered as a token of goodwill during visits, marriages and other social events. Wide variations exists within and between the African eggplant species including variation in characters like diameter of corolla, petiole length, leaf blade width, plant branching, fruit shape and color[3]. This species is grown in areas of high rainfall. The fruits are around, the top and bottom are flattened out and have grooved portions with a length of 5-6 cm and a width of 6-7 cm. It has very tiny seeds and its stalk is curved or erect[4].

This species of garden egg have bitter tastes and is cultivated in the same way with other species. The fruit turn red or orange in color when ripened. The uses in indigenous medicine range from weight reduction to treatment of several ailments including constipation, weight loss, obesity, diabetes, glaucoma, rheumatic disease and swollen joint pains[5].

These pharmacological properties have been attributed to the presence of certain chemical substances in the plants such as crude fiber, phenols, ascorbic acid and alkaloids[6]. In this study, nutritive and phytochemical, vitamin and mineral analyses were carried out on this unconventional indigenous species of the African egg plant *S-aethiopicum* L. because of the medicinal and nutritive uses.

MATERIALS AND METHODS

Collection and Identification of Sample

Unripe fruits of *S-aethiopicum* were collected from a local farm in Isiala-Ngwa North L.G.A of Abia State Southeast Nigeria. The fruits were identified in the Department of Plant Science and Biotechnology, Abia State University, Uturu Nigeria.

The healthy fruits were selected and thoroughly washed with water to remove dirt and unwanted particles. The stalks were removed and unwanted particles. The stalks were removed and the edible portion of fruits was prepared for analysis.

Preparation of samples

Samples were sliced into shreds and oven dried at 105^{o}C, pulverized to obtain a fine dry powder. The pulverized sample was stored in an air-tight container at room temperature.

Phytochemical Screeening

Aqueous extract of the sample was prepared by soaking 100 g of the powdered samples in 200 ml of distilled water for 12 hours. The extracts were filtered using Whatman filter paper No. 42 (125 mm).

Chemical tests were carried out on the aqueous extract and on the powdered samples to identify the constituents using standard procedures. Color intensity was used to categorize the presence of each photochemical into present moderate or slightly present.

Test for Tannin

The determination of the presence of tannin in the test sample was carried out using ferric chloride test described by Harbone[7] as reported by osagie[8]. 2 g of the powdered sample was added into 10 ml of distilled water. The mixture was shaken for 30 minutes and the filterate used as aqueous

extract. 2 ml of the aqueous extract was added into a test tube and 3 ml of distilled water was added to it and shaken very well for homogeneity. Two drops of dil. Ferric chloride ($FeCl_3$) was added to the mixture. The formation of a very dark precipitate indicated the presence of tannin.

Test for Saponin

The presence of saponins in the test sample was done using the Harbone[7], as reported by Osagie[8]. The test for saponin is known as froth test. In froth test, 2 ml of the aqueous extracts were mixed with 6 ml of distilled water in a test tube. The mixture was shaken well and the formation of froth indicated the presence of saponins.

Test for Alkaloids

The presence of alkaloids in the sample was investigated using the method described by Okwu[9]. 2 g of sample is shaken with 5 ml of 2 % HCl on a steam bath and filtered with Whatmann filter paper no. 42. To 1 ml of filtrate, 0.5 ml of Wagner's reagent (2 g of iodine and 3 g of potassium iodine were dissolved in 20 ml of distilled water and made up to 100 ml with distilled water). A reddish brown precipitate indicates the presence of alkaloids.

Test for Flavonoids

The determination of the presence of flavonoids in the sample was done using the acid-alkaline test by Osagie[8]. 2 ml of the aqueous extract was added into a test tube and a few drops of concentrated ammonia were added. The formation of a yellow coloration shows the presence of flavonoids.

Test for Phenols

This was investigated using Okwu[9] methods. The free fat sample was boiled with 50 ml flask and 10 ml of distilled water was added to it. To the solution, 2 ml of ammonium hydroxide and 5 ml of conc. Amlyl alcohol was added. The mixture was allowed to react for 30 minutes for color development.

Test for Cyanogenic glycosides

The presence of cyanogenic glycosides was carried out by putting 20 g of sample in 50 cm^3 conical flasks. A dry drip of alkaline picrate paper (prepared by soaking in equal volumes of 10 % Na_2Co_3 and 1 % picric acid solution) is hung from the mouth of the flask, without touching the sample. The mouth of the flask is plugged highly with cotton wool or tissue paper. The set up is then heated up to one hour in a water bath. A change of color from yellow (of the picrate paper) to orange, then brick red color indicates the presence of cyanogenic glycosides Harbone[7] as modified by Okwu[9].

Proximate Analysis

Proximate (nutritive) composition of the fruits were determined, this include: moisture, protein, lipid, crude fiber, ash, carbohydrate composition of the sample. Moisture, lipid, protein, carbohydrate, crude fiber and Ash content were determined using the official method of the Association of Official Analytical Chemists (A.O.A.C)[10] as reported by Asibey-Berko[11].

Mineral Analysis

Mineral composition of sample was determined using the official method of the Association of official Analytical Chemists A.O.A.C[10]. Two grams (2 g) of the sample was dry ashed with a porcelain crucible in a muffle furnace at 500^oC for 24 hours. The resulting ash was cooled in a dessicator and weighed. The ash was treated with 10 ml of 50 % HCL. The quantification was carried out using 5 series atomic absorption spectrophotometer.

Vitamin Analysis

Determination of Vitamins B, (thiamine) and Vitamin B_2 (riboflavin) was carried out using spectrophotometric method as described by Okwu[9]. Determination of vitamin B_3, Vitamin C, and Vitamin E, content of the sample was investigated using spectrophotometric methods as described by Rukowski[12].

RESULTS AND DISCUSSION

Results of Phytochemical Analysis

Phytochemical Screening

Table 1 shows qualitative analysis of phytochemicals present in *S. aethiopicum* from the results, this species of the egg plant contains a significant amount of Alkaloids which is known to give the fruits of plant the bitter taste[13].

The presence of these alkaloids makes this fruit highly nutritional and medicinal. Flavonoids were found to be present in the fruit. Flavonoid have a wide range of biological and pharmacological activities including anti-oxidant, anti-inflammatory and anti-microbial activities[14]. Flavonoids are also responsible for the color of most fruits. Saponins were found present in the plant species also. Saponins are known by their froth foaming which they produce when shaken in aqueous solutions[15]. They are being promoted as adjuvants in vacines[16].

Tannins were found to be slightly present in the egg plant studied. The astringency from tannin is known to cause the dry and pucker feeling in the mouth following the consumption of unripe fruits[17]. Foods rich in tannin can be used in treatment of hemochromotosis[18].

Phenol used as precursors to plastics, can be corrosive to the eyes, skin and respiratory tract when prolonged exposure occurs. They are used in the preparation of cosmetics like sunscreen[19].

They also show antiseptic properties. This species of eggplants contain significant amount of phenols making them useful when used as phenol source. Cyanogenic glycosides found in some food causes increase in blood glucose and lactic acid levels. They are toxic and often present in small quantities which may not be a significant dosage for medicinal purposes.

S. aethiopicum species of eggplant showed significant amounts of this phytochemicals making their consumption harmful to the body but the toxicity can be reduced by boiling and cooking[20].

Table 1: Qualitative Analysis of Phytochemicals Present in *S. aethiopicum*

Phytochemical	*S. aethiopicum*
Alkaloid	+
Flavonoid	+
Saponin	+
Tannin	(+)
Phenol	+
Cyanogenic glycoside	+

+ Present; (+) Slightly present

Quantitative Phytochemical Analysis

Table 2 shows qualitative analysis of the phytochemical present in *S. aethiopium* and alkaloids are very important in medicine. They uniformly invoke bitter taste in plants. Such alkaloids include codeine which is used in cough medicines and as an analgesic. Alkaloid content of *S. aethiopicum* was 5 ± 0.77 which is close very well with 4.5 % value reported by Jaegeer and Hepper[21]. This is a moderate value for consumption, of the fruit. Flavonoids generally possess anti-bacterial and antifungal activities[14]. They are potential sources of natural preservatives and also known to have anti-inflammatory and anti-oxidants activities[22].

Flavonoid content of *S. aethiopicum* (27 ± 0.45) was known to be higher than the 22 % reported by many researchers on different species of garden egg including *Solanum melongena*, Osei *et al*[23]. The result showed that *S. aethiopicum* is a good source of flavonoid. Saponins are promoted as dietary supplements and nutriceuticals. They are also adjuvants in vaccine production[16].

From the result *S. aethiopium* contained appreciable high amounts of saponin (14 ± 0.23). Saponin content of this type of garden egg was higher compared to the 10 % reported by Xur *et al*[25] 7.5 % and so is a moderate source of saponins.

Tannin have shown anti-viral, anti-bacterial and anti parasitic effect. *S. aethiopicum* was found to contain 3 ± 0.14 % tannin which compared well with 2.5 % value reported by lambent and yang[26]. This signifies that this species is not a good source of tannins. Phenols are beneficial as they are versatile precursor to a large collection of drugs e.g. Aspirin and many pharmaceutical drugs[27] known to be corrosive to the eyes, skin and respiratory tract on prolonged exposure.

S. aethipicum contained (4.7 + 0.04) which is higher than 3.6 % reported by Vinson *et al*[28], *S. aethiopicum* is a good source of phenol (4.7 ± 0.04). Cyanogenic glycosides are phyto-toxins and cause a decrease in the utilization of oxygen in the tissues. Cyanogenic-glycoside content of *S. aethiopium* (5 ± 0.29) compared very well with 6 % as reported by Clark[29]. This signifies that raw consumption of this species of egg plant can cause some element of toxicity to the body but this can be prevented by boiling before consumption.

Table 2: Qualitative Analysis of the Phytochemicals Present in *S. aethiopicum*

Phytochemical	*S. aethiopicum* (%)
Alkaloid	5 ± 0.77
Flavonoid	27 ± 0.45
Saponin	14 ± 0.23
Tannin	3 ± 0.14
Phenol	4.7 ± 0.04
Cyanogenic glycoside	5.7 ± 0.29

Table 3 shows the proximate (nutritive) composition of *S. aethiopicum*. The moisture content of fruits is related to its dry matter content. It can be used as an index of stability and susceptibility to fungal infection. It determines quality and freshness of fruits[5].

From the results the fruit species is not a good source of moisture as *S. aethiopicum* has low moisture content (6.69 ± 0.02). This result does not fall in line with the reports of several researchers[30] who reported that fruits are known to contain 80-85 % moisture. Ash content is an important fruit quality because it determines the mineral composition of the fruit[31]. *S. aethiopicum* having an ash content of (15 ± 0.02) which in[32] but higher than that reported by Eze and Ogbuefi for fruits and leaves of *Nauclea latifolia*[33].

Crude fiber found in fruits such as pectins reduces rate of sugar uptake and plays vital role in gastric emptying. *S. aethiopicum* which has 21.33 ± 0.01 % crude fiber this species was higher when compared to the 22.5 % reported by Norman[34].

Lipids in fruit serve both structural and metabolic functions like: energy production and also promoting healthy cell function. *S. aethiopicum* having a lipid content of 37.66 ± 0.02 % contain a reasonable amount of lipids which is a bit higher than 35 % reported by Edijala *et al*[35] that reported by Ekpeyong[36]. Proteins are not general known to e higher in fruits, but they are of primary importance because they are enzymes that catalyze chemical reactions and accelerate some chemical reactions[37].

S. aethiopicum is a good source of protein having 4.2 ± 0.21 % which compared very well with the value of 3.5 % reported by Grubben and Denton[30] as well as by Gbile and Adesina[38]. Carbohydrates are important due to their nutritional and metabolic functions; they are natural sweeteners, raw material for various products[17].

S. aethiopicum is a high source of carbohydrates (15.6 ± 0.03) and this makes it a good source of carbohydrates and this compare well with 14.5 % as reported by Leung *et al*[31].

Table 3: Proximate Composition of *S. aethiopicum*

Parameters (%)	*S. aethiopicum*
Moisture	6.69 ± 0.02
Ash	15 ± 0.02
Crude fiber	21.33 ± 0.01
Lipid	37.66 ± 0.02
Protein	4.2 ± 0.021
Cyanogenic glycoside	15.6 ± 0.03

Table 4 shows vitamin content of *S. aethiopicum*; vitamins B_1, B_2, B_3, C and E were found to be contained in this species. These vitamins are vital for energy production in the body and also essential for breakdown of fat and protein and keeping the mucus membrane healthy.

Vitamin B_1 content of *S. aethiopicum* (0.45 ± 0.002) was higher compared to 0.18 mg reported by Duel and Sturtz[6] and by Rice *et al*[39] for a different species of garden egg. With this the fruit can be said not to be really a very good source of Vitamin B_1 (Reboflavin). Vitamin B_2 plays a supportive role in the treatment of sickle-cell anaemia. It is also the precursors for enzyme w-factors that help in their work as catalysts in metabolism[4].

Vitamin B_2 content of *S. aethiopicum* (10.33 ± 0.02) compared well with the value of 12.20 mg as reported by Rice *et al*[39] and is therefore a good source of vitamin B_2. Vitamin B_3 (Nicotinamide) is also a precursor for enzyme co-factors that help in their work as catalyst in body metabolism. Its deficiency causes pellagra[6].

Vitamin B_3 content of *S. aethiopicum* (10.33 ± 0.02) compared well with 10.58 mg obtained by Dobson,[19] as well as Osei, *et al*[23].

From the result, *S. aethiopicum* is a good source of this vitamin having (14.34 ± 0.02). Vitamin C (Ascorbic acid) is always found in fruits in high amounts. It is a very import anti-oxidant[4].

Ascorbic acid content of *S. aethiopicum* was 406 ± 1.41 mg/g and correlated with the results reported by Szeto *et al*[40], which reported 400 mg and 258 mg respectively for the eggplants. This shows that this fruit is a very good source of this vitamin.

Vitamin E (Tocopherol)

This is an important anti-oxidant used for the preparation of various kinds' cosmetic products ranging from soaps, creams, etc. Both species contained very low amount of this vitamin. Vitamin E content of *S. aethiopicum* was low (0.53 ± 0.02 µg/g), but this compared very well with that reported by Rice *et al*[39].

Table 4: Vitamin Content of *S. aethiopicum*

Parameter (µ/g)	*S. aethiopicum*
Thiamine (B1)	0.45 ± 0.02
Riboflavin (B2)	10.33 ± 0.02
Nicotinamide (B3)	14.34 ± 0.02
Ascorbic Acid(c) (mg)	406 ± 1.41
∞-tocopherol (E)	0.53 ± 0.02

Table 5 shows the amount of trace minerals found in this species of garden egg. Trace minerals are minerals needed by the body in very little amount though they are also useful. These trace minerals include Pd, Zn, Cu, Cd, Fe and Se; they are important for immune system function, energy metabolism and anti-oxidant function[17].

From the result *S. aethiopicum* contained a low amount of the trace metals. The amount of minerals found in this species compared well with the NAFDAC[40] standard of trace minerals found in food including Pd and Zn which should not be above 5 mg/g. Therefore consumption of these species of garden egg will not be toxic since these minerals are found in trace amounts.

Table 5: Trace Mineral Content of *S. aetheopicum*

Parameters (mg/g)	*S. aethiopicum*	NAFDAC STANDARD (mg/g)
Pd	0.03 ± 0.02	0.30
Zn	0.115 ± 0.01	5.0
Fe	0.63 ± 0.03	5.0
Cu	0.3 ± 0.02	5.0
Cd	0.015 ± 0.002	0.01
Se	0.015 ± 0.002	0.01

Table 6 shows the macro-mineral composition of *S. aethiopicum*. These minerals are minerals needed by the body in large moderate amounts. They are important in daily function and processes which include formation of bone and teeth and health[19] e.g. Ca, Mg, P[32], also energy production, nerve and muscle function[16] e.g. K, Na. both species *S. aethiopicum* contained very high amounts of potassium (4250 ± 3.91) and very low amount of sodium (0.63 ± 0.03). The macro-minerals content of *S. aethiopicum* were comparatively lower than the amount required by NAFDAC except for potassium contents NAFDAC[40] which requires that food should contain up to 20-30 mg/g of these minerals. Therefore *S. aethiopicum* is not a good sources of Ca, P, Mg and Na.

Table 6: Macro-Mineral Content of *S. aethiopicum*

Parameters (mg/g)	*S. aethiopicum*	NAFDAC STANDARD
Ca	0.12 ± 0.02	30.0
K	4250 ± 3.91	25.0
P	1.14 ± 0.03	25.0
Mg	0.56 ± 0.02	20.0
Na	0.63 ± 0.03	30.0

CONCLUSION

S. aethiopicum fruits showed significant amounts in its chemical constituents as the fruit contained appreciable amounts of phytochemicals, and nutritive components including vitamins and minerals and this justify its nutritional and therapeutic uses.

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