INTRODUCTION

Solanum species (egg plants) belong to the family of solanaceae 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 medicine1. Among these species known and cultivated in Africa including Nigeria is Solanum aethiopicum L. known as the African eggplant or Ethiopian eggplant2. It is often cultivated as an annual plant. They African eggplant or commonly called garden egg is also called “afufo” or “anara” in Igbo, “Dauta” in Hausa and “Igbaqua “ 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 color3. 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 erect4. 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 pains5. These pharmacological properties have been attributed to the presence of certain chemical substances in the plants such as crude fiber, phenols, ascorbic acid and alkaloids6. 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°C, pulverized to obtain a fine dry powder. The pulverized sample was stored in an air-tight container at room temperature.

Phytochemical Screening

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 Harbone7 as reported by osagie8. 2 g of the powdered sample was added into 10 ml of distilled water. The mixture was shaken for 30 minutes and the filtrate used as aqueous
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°C for 24 hours. The resulting ash was cooled in a desiccator 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 B2 (riboflavin) was carried out using spectrophotometric method as described by Okwu[7]. Determination of vitamin B3, 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[3]. 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[12]. 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 vaccines[16].

Tannins were found to be slightly present in the egg plant studied. The astringency from tannin is known to cause the dry and puckering feeling in the mouth following the consumption of unripe fruits[17]. Foods rich in tannin can be used in treatment of hemorrhoidosis[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 foods 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>
<thead>
<tr>
<th>Phytochemical</th>
<th>S. aethiopicum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaloid</td>
<td>-</td>
</tr>
<tr>
<td>Flavonoid</td>
<td>(+)</td>
</tr>
<tr>
<td>Saponin</td>
<td>-</td>
</tr>
<tr>
<td>Tannin</td>
<td>(+)</td>
</tr>
<tr>
<td>Phenol</td>
<td>-</td>
</tr>
<tr>
<td>Cyanogenic glycoside</td>
<td>(+)</td>
</tr>
</tbody>
</table>

+ Present; (+) Slightly present

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

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[71].

Test for Saponin

The presence of saponins in the test sample was done using the Harbone[2], as reported by Osagie[1]. 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. Amyl 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 cm³ conical flasks. A dry drip of alkaline picrate paper (prepared by soaking in equal volumes of 10 % Na₂CO₃ 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[72] as modified by Okwu[7].

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 (FeCl₃) was added to the mixture. The formation of a very dark precipitate indicated the presence of tannin.
Quantitative Phytochemical Analysis

Table 2 shows qualitative analysis of the phytochemical present in *S. aethiopicum* 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 Jæger and Hepper13. This is a moderate value for consumption, of the fruit. Flavonoids generally possess anti-bacterial and antifungal activities14. They are potential sources of natural preservatives and also known to have anti-inflammatory and anti-oxidants activities15. 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 al23. 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 production16. From the result *S. aethiopicum* 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 Xurt et al5 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 25 % value reported by lambert and yang20. This signifies that this species is not a good source of tannins. Phenols are beneficial as they are versatile precursors to a large collection of drugs e.g. Aspirin and many pharmaceutical drugs21 known to be corrosive to the eyes, skin and respiratory tract on prolonged exposure. *S. aethiopicum* contained (4.7 ± 0.04) which is higher than 3.6 % reported by Vinson et al28, *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. aethiopicum* (5 ± 0.29) compared very well with 6 % as reported by Clark29. 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 3: Proximate Composition of *S. aethiopicum*

<table>
<thead>
<tr>
<th>Parameters (%)</th>
<th><em>S. aethiopicum</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>6.69 ± 0.02</td>
</tr>
<tr>
<td>Ash</td>
<td>15 ± 0.02</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>21.33 ± 0.01</td>
</tr>
<tr>
<td>Lipid</td>
<td>37.66 ± 0.02</td>
</tr>
<tr>
<td>Protein</td>
<td>4.2 ± 0.021</td>
</tr>
<tr>
<td>Cyanogenic glycoside</td>
<td>15.6 ± 0.03</td>
</tr>
</tbody>
</table>

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 fruits5. 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 researchers30 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 fruit19. *S. aethiopicum* having an ash content of (15 ± 0.02) which is14 but higher than that reported by Eze and Ogbuefi for fruits and leaves of Nucelia latifolia33. 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 Norman24. 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 al31 that reported by Ekpeyong36. 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 reactions37.

*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 Gruben and Denton34 as well as by Gbile and Adesina35. Carbohydrates are important due to their nutritional and metabolic functions; they are natural sweeteners, raw material for various products35. *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 al31.

Table 3: Proximate Composition of *S. aethiopicum*
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.17.

Table 4: Vitamin Content of S. aethiopicum

<table>
<thead>
<tr>
<th>Parameter (µg/g)</th>
<th>S. aethiopicum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiamine (B1)</td>
<td>0.45 ± 0.02</td>
</tr>
<tr>
<td>Riboflavin (B2)</td>
<td>10.33 ± 0.02</td>
</tr>
<tr>
<td>Nicotinamide (B3)</td>
<td>14.34 ± 0.02</td>
</tr>
<tr>
<td>Ascorbic Acid (mg)</td>
<td>406 ± 1.41</td>
</tr>
<tr>
<td>α-Tocopherol (E)</td>
<td>0.33 ± 0.02</td>
</tr>
</tbody>
</table>

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 Pb, 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 NAFDAC18 standard of trace minerals found in food including Pb 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. aethiopicum

<table>
<thead>
<tr>
<th>Parameters (mg/g)</th>
<th>S. aethiopicum</th>
<th>NAFDAC STANDARD (mg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pb</td>
<td>0.03 ± 0.02</td>
<td>0.30</td>
</tr>
<tr>
<td>Zn</td>
<td>0.15 ± 0.01</td>
<td>5.0</td>
</tr>
<tr>
<td>Fe</td>
<td>0.03 ± 0.03</td>
<td>5.0</td>
</tr>
<tr>
<td>Cu</td>
<td>0.3 ± 0.02</td>
<td>5.0</td>
</tr>
<tr>
<td>Cd</td>
<td>0.015 ± 0.002</td>
<td>0.01</td>
</tr>
<tr>
<td>Se</td>
<td>0.015 ± 0.002</td>
<td>0.01</td>
</tr>
</tbody>
</table>

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 health19 e.g. Ca, Mg, P30 also energy production, nerve and muscle function16 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 NAFDAC40 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

<table>
<thead>
<tr>
<th>Parameters (mg/g)</th>
<th>S. aethiopicum</th>
<th>NAFDAC STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca</td>
<td>0.12 ± 0.02</td>
<td>30.0</td>
</tr>
<tr>
<td>K</td>
<td>4250 ± 3.91</td>
<td>25.0</td>
</tr>
<tr>
<td>P</td>
<td>1.14 ± 0.03</td>
<td>25.0</td>
</tr>
<tr>
<td>Mg</td>
<td>0.56 ± 0.02</td>
<td>20.0</td>
</tr>
<tr>
<td>Na</td>
<td>0.63 ± 0.03</td>
<td>30.0</td>
</tr>
</tbody>
</table>

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.

REFERENCES

References:


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