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Phytochemical, Proximate and Mineral Analyses of *Solanum incanum* Fruit

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Abstract

The present study was carried out to investigate the phytochemical, proximate, mineral and ascorbic acid composition of *Solanum incanum* fruit. These analyses were carried out using standard methods. The results indicated that *Solanum incanum* fruit contained alkaloids, steroids, cardiac glycosides, saponins, flavonoids, tannins, oxalates and cyanogenic glycosides while anthraquinones was absent. Proximate analysis of the fruit showed that the moisture content was the highest compared to other parameters with a value of 91.40%, while the crude fibre was the least (7.10%). Values for the other parameters were 21.20% ash, 12.50% crude lipid, 7.80% crude protein, 51.74% carbohydrate and 308.90 kcal of energy. Analysis of the mineral constituents showed that the fruit contained phosphorus (1082.50 mg/100g), magnesium (38.99 mg/100g), potassium (215.45 mg/100g), manganese (147.00 mg/100g), copper (256.05 mg/100g), sodium (147.00 mg/100g), iron (325.75 mg/100g) and calcium (15.00 mg/100g) as well as ascorbic acid (6.28 mg/100g). The constituents in *Solanum incanum* fruit may be responsible for its nutritional and pharmacological uses.

Keywords: *Solanum incanum*, phytochemicals, proximate constituents, mineral constituents, ascorbic acid

1. Introduction

Medicinal plants are used to maintain and promote healthy life, prevent disease and cure ailments [1]. Each medicinal plant species has its own nutrient composition besides having pharmacologically important secondary metabolites. These nutrients are essential for the physiological functions of human body [2]. Such nutrients include carbohydrates, proteins, fats, vitamins and minerals. Thus plant parts such as the fruit, leaf, stem, and seed are known to have high amount of essential nutrients such as carbohydrates, proteins, fats, vitamins, minerals and fiber which are required for normal growth and development of an organism. *Solanum incanum* which is also known as bitter garden egg belongs to the family *Solanaceae*. It is a perennial bushy herb or shrub up to 1.8 m of height with spines on the stem, leaves, stalks and calyces, and with velvet hairs on the leaves [3]. The fruit is botanically classified as a berry and contains numerous small, soft seeds which are edible but are bitter because they contain an insignificant amount of nicotinic alkaloids [4]. Also, the bitter taste of *Solanum incanum* which reduces palatability may be connected with the presence of cyanogenic glycosides [5]. The fruits of *Solanum incanum* are yellow at the beginning, later become black. It is used for sore-throat, angina, head ache, warts, and benign tumours [6, 7]. The leaves are alternate, flowers often borne in the leaf axilles, sometimes solitary or in few-flowered clusters [3]. It has been shown that herbs from *Solanum incanum* are used by several East African communities as a remedy

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for toothache, stomach-ache, fever, chest pains, snake bite and ear ache [8]. Other studies showed that extracts from the herb exhibited antimicrobial [9, 10, 11], antifungal [12], spasmolytic [13], anti-diabetic [14, 15], anti-schistosomal [16] and anticancer effects, an alkaloid solarmagine from the plant causes apoptosis in various tumor cell lines [17].

This study was carried out to determine the ascorbic acid content, proximate composition, mineral elements and phytochemical constituents of *Solanum incanum* fruit.

2. Materials and Methods

2.1. Plant Material and Reagents

The fruits of *Solanum incanum* were obtained from Farin-Gada market in Jos metropolis, Plateau State, Nigeria and were authenticated at the Herbarium of the Department of Plant Science and Technology, University of Jos, Nigeria, where a voucher specimen was deposited at the Herbarium of the Institute. All reagents and chemicals used were of analytical grades and prepared in glass apparatus using distilled water.

2.2. Fruit Processing and Phytochemical Screening

The fruits were washed, air dried and pulverized to powder using an electric blender. The pulverized fruits were subsequently used for phytochemical, proximate and mineral analysis. Phytochemical screening was done on the sample using methods as describe by Sofowora [18].

2.3. Proximate Analysis

The moisture content, crude protein, ether extract, crude fibre and ash contents of the *Solanum incanum* fruit were determined as described by Association of Analytical Chemistry (AOAC) [19] while the energy value (caloric value) was calculated using the Atwater factors by multiplying the value of the crude protein, lipid and carbohydrate by 4, 9 and 4, respectively and taking the sum of the product (Equation 1).

$$\textit{Energy value} = [\%\ \textit{crude protein} \times 4.0] + [\%\ \textit{crude fat} \times 9.0] + [\%\ \textit{carbohydrate} \times 4.0] \quad (1)$$

2.4. Minerals, Ascorbic Acid and Statistical Analyses

The determination of the levels of inorganic minerals of *Solanum incanum* fruit was carried out by acid digestion using nitric acid and perchloric acid mixture (HNO: HClO, 5:1 w/v). The total amounts of phosphorus, magnesium, potassium, manganese, copper, sodium and iron in the digested samples were determined by atomic absorption spectrophotometry (AA-7000F model) [20]. The Ascorbic acid content of the fruit was determined as described by AOAC [19]. The data were expressed as Mean ± Standard Error of Mean (SEM) using statistical package for social sciences (SPSS) version 20.0.

3. Results and Discussions

Table 1 shows the phytochemicals present in *Solanum incanum* fruit. Alkaloids, steroids, cardiac glycosides, saponins, flavonoids, tannins, oxalates and cyanogenic glycosides were detected. Anthraquinones was not detected. The results of proximate analysis of *Solanum incanum* fruit as shown on Table 2 revealed that it contains high content of moisture (91.40

Table 1. Qualitative Phytochemical Screening of *Solanum incanum* Fruit

Phytochemicals	***Solanum incanum* Fruit**
Alkaloids	+
Steroids	+
Anthraquinones	-
Cardiac glycosides	+
Saponins	+
Flavonoids	+
Tannins	+
Oxalates	+
Cyanogenic glycosides	+

Key: + present; - absent

±0.56%), ash (21.20±0.42%), carbohydrate (51.74±0.32%) and crude lipid (12.50±0.07%), while, crude protein (7.80±0.21%) and crude fiber (7.10±0.38%) are present in small amount compared to other parameters. The mineral analysis of *Solanum incanum* fruit (Table 3) showed that it contains mineral elements like phosphorus (1082.50±3.35 mg/100g),

magnesium (38.99±0.01 mg/100g), potassium (215.45±0.63 mg/100g), manganese (147.00±0.01 mg/100g), copper (256.05±1.23 mg/100g), sodium (147.00±0.42 mg/100g), iron (325.75±0.32 mg/100g) and calcium (15.00±0.03 mg/100g).

Table 2. Proximate Composition of *Solanum incanum* Fruit

Parameters	**Compositions**
Moisture content (%)	91.40±0.56
Ash (%)	21.20±0.42
Crude fat (%)	12.50±0.07
Crude protein (%)	7.80±0.21
Crude fibre (%)	7.10±0.38
Carbohydrate (%)	51.74±0.32
Estimated calorific value (kcal)	308.90

Values are expressed as Mean ± SEM (n = 3)

Table 3. Minerals and Ascorbic acid Content of *Solanum incanum* Fruit

Minerals /Vitamin	Composition (mg/100g)
Phosphorus	1082.50±3.35
Magnesium	38.99±0.01
Potassium	215.45±0.63
Manganese	147.00±0.01
Copper	256.05±1.23
Sodium	147.00±0.42
Iron	325.75±0.32
Calcium	15.00±0.03
Ascorbic acid	6.28±0.01

Values are expressed as Mean ± SEM (n = 3)

The plant possesses numerous biologically active compounds which could serve as potential source of vegetable drugs in herbal medicine [21]. It was reported that most of the plants of *solanaceae* contain alkaloids, tannins, steroids, saponins, as well as reducing sugars [22]. From this study, *Solanum incanum* fruit contains alkaloids, flavonoids, steroids, phenols, resins, tannins, saponins, cardiac glycosides and carbohydrates (Table 1). These phytochemicals are well known for their pharmacological activities. Alkaloids which are one of the largest groups of phytochemicals in plants have amazing effects on humans and this has led to the development of powerful pain killer medications [23]. Plants with tannins are used for healing wounds, varicose ulcers, hemorrhoids, frost-bite and burns [24, 25]. The biological functions of flavonoids include protection against allergies, inflammation, platelets aggregation, microbes, ulcer and tumour [26]. Steroids and Resins might be responsible for some pharmacological activities of the plant. Phenolic compounds have antimicrobial properties. Phenol and phenolic compounds have been extensively used in disinfections and remain the standards which other bacteriacides are compared [27]. Cardiac glycosides work by inhibiting the Na^+/K^+ pump. This causes an increase in the level of sodium ions in the myocytes, which then leads to a rise in the level of calcium ions. This inhibition increases the amount of Ca^{2+} ions available for contraction of the heart muscle, improves cardiac output and reduces distention of the heart [28]. Saponins possess both beneficial (cholesterol-lowering) and deleterious (cytotoxic permeabilization of the intestine) properties and also exhibit structure dependent biological activities [29]. Saponins have been found to be potentially useful for the treatment of hyperglycaemia [30, 31]. The presence of these phytochemicals in the fruit of *Solanum incanum* may be responsible for its medicinal properties.

Proximate analysis, also known as Weende analysis is a chemical method of assessing and expressing the nutritional value of a feed which reports the moisture, ash (minerals), crude fibre, crude fat and crude protein (total nitrogen) present in a food as a percentage of dry food weight. Carbohydrate (nitrogen free extract) is determined by difference. The proximate analysis gives the overall nutritional composition of the sample in question [32].

Moisture content of *Solanum incanum* fruit from this analysis was 91.40 % which is higher than the moisture content reported for *Averrhoa carambola* (85.1%) [33], and lower than the value reported for *Solanum gilo* (94.8%) and for *Solanum aubergine* fruits (94.6%) [34]. The moisture content of any food is an index of its water activity [35] and is used as a measure of the stability and susceptibility to microbial contamination [36]. This indicates that *Solanum incanum* fruits may have a short shelf-life due to its high moisture content.

The crude fat content of *Solanum incanum* fruit (12.50%) in this study is higher than 8.90% earlier reported for the same fruit [37], it is also higher than 11.7% crude fat content reported for *Averrhoa carambola* fruits [33], 7.0% for *S. agilo* and 4.0% for *S. aubergine* fruit [34]. This indicates that *Solanum incanum* fruit contains a high level of crude fat. They are stored forms of energy in living organism and major structural elements of biological membranes as phospholipids and sterols [38].

The ash content of the *Solanum incanum* fruit obtained in this study was 21.20%. This value (23.78%) is lower than the value earlier reported for the same fruit [37]. Also, this value is higher than the value reported for *A. carambola* fruit [33] and 10.0% reported for both *S. gilo* and *S. aubergine* fruits [34]. This shows that *Solanum incanum* may be a very good source of mineral elements. Minerals are essential for the proper functioning of tissues and act as second messengers in some biochemical cascade mechanisms [39].

The protein content of *Solanum incanum* fruit obtained from the analysis was 7.80% which is same as earlier reported for the same fruit [37]. The value is also lower than 14.87% and 15.75 % reported for *S.gilo* and *S. aubergine*, respectively but higher than 4.0% reported for *A. carambola* fruits [33]. This result shows that *Solanum incanum* fruit is very low in its protein content. Plant foods that provide more than 12% of its caloric value from protein are considered to be good source of protein. *Solanum incanum* does not provide this requirement and is therefore considered not to be a good source of protein [40]. This value can be improved by the dehydration of the fruits [41].

The crude fibre content of *Solanum incanum* fruit (6.22%) obtained from this analysis is lower than the value reported for the same fruit [37]. Moreover, this value is lower than 8.60%, 16.0% and 11.75% reported for *A. carambola* [33], *S. gilo* and *S. aubergine* fruits, respectively [34]. The crude fibre content of *Solanum incanum* fruits can be increased by the dehydration of the fruits, as the consumption of fruits with high crude fibre content may contribute to a reduction in the incidence of certain diseases like colon cancer, coronary heart diseases diabetes, high blood pressure, obesity and other digestive disorders [41, 42, 43, 44, 45]. Increased crude fibre consumption also increase fecal bulk and rate of intestinal transit and have prebiotic effects [41].

The carbohydrate content (51.74%) obtained for *Solanum incanum* fruit is lower than the value earlier reported for the same fruit [37]. This value is lower than 72.20% reported for *A. carambola* fruits [33], 52.13% and 58.5% reported for *S. gilo* and *S. aubergine* fruits, respectively [34]. Hence, *Solanum incanum* may be a good source of carbohydrates. Carbohydrates provide readily accessible energy for physical performance and regulate nerve tissue [46].

The total metabolisable energy for *Solanum incanum* fruit was observed to be 308.9 kcal. This was lower than the value of 448.83 kcal reported for *Gnetum africanum* seeds [47], 403.54 kcal reported for *Solanum nigrum* seeds [34] and 384.33 kcal reported for *B. coricea* seeds [48]. This result shows that *Solanum incanum* fruit is a good source of energy that can be utilized as human nutrition.

The ascorbic acid content of *Solanum incanum* fruit is 6.28%, which is higher than 4.60% reported for *A. carambola* fruit [33], but lower than 53.5% reported for *Tetracarpidum conophorum* seeds [49], 93.7% and 75.9% reported for *S. gilo* and *S. aubergine* fruits, respectively [34]. The high level of ascorbic acid in this fruit shows that the fruit could be used to promote healthy living such as protection against scurvy and other ascorbic acid deficiency related ailments [50].

Major elements and minor elements are vital elements required for the normal growth and maintenance of the body. The mineral analysis of *Solanum incanum* fruit shows the presence of phosphorus, magnesium, potassium, manganese, copper, sodium and iron. The significance of these elements cannot be over emphasized. For instance, phosphorus is an essential mineral element that form part of DNA and RNA as well as helps in the formation of strong bones and teeth; magnesium is involve in enzymatic reactions of carbohydrate catabolism e.g. glycolysis; potassium plays an important role of electrolyte and acid-base balance in the body system; manganese is involve in enzymatic reactions such as cholesterol metabolism; copper is use for the synthesis of cytochrome oxidase; sodium helps in the transmission of nerve impulses and brings about osmotic balance of the cells in living tissues; iron is very vital in the formation of haemoglobin in red blood cells. Therefore, the fruit could also be a good source of the mineral elements listed above.

4. Conclusion

It can be concluded that *Solanum incanum* fruit is a rich source of both nutrients (carbohydrates, proteins, fats, vitamin, minerals and fibre) and pharmacologically important phytochemicals which justifies its uses as both a vegetable and medicinal plant.

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