



Qualitative Analysis of the Phytochemical Contents of Different Anatomical Parts of Ripe *Solanum aethiopicum* Linneaus Fruits

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Authors' contributions

This work was carried out in collaboration among all authors. Author DAT designed the study, wrote the protocol and managed the analyses. Author OAA read and approved the final manuscript. Author TEA managed the literature search and draft the first manuscript. Author SFO proofread and edited the initial manuscripts.

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ABSTRACT

Aims: To determine qualitatively the amount of alkaloids, saponin, tannin, volatile oil, phenol and flavonoids in the different anatomical parts of ripe *Solanum aethiopicum* Linn fruits.

Methodology: *Solanum aethiopicum* Linn fruits were purchased from Sabo market, Ogbomoso, Nigeria. The fruits were separated with a razor into four (4) anatomical parts (the epicarp, mesocarp, endocarp, and seed) after washing with distilled water. 1gram of each anatomical parts of the fruit were soaked in 20mls of distilled water, 1% volume per volume (v/v), 2% v/v, 3%v/v, 4%v/v and 5%v/v of ethanol, ethylacetate and methanol separately. The mixtures were left for 24 hours after which they were sieved to obtain the extracts. The presence of alkaloid, tannin,

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saponin, volatile oil, phenol and flavonoid were determined qualitatively in the extracts at selected concentrations.

Results: The results obtained showed that alkaloids are more concentrated in the mesocarp of *Solanum aethiopicum* Linn; volatile (essential) oil is more pronounced in the mesocarp and endocarp of *Solanum aethiopicum* Linn; saponin is confirmed in all anatomical parts of the fruit at reasonable quality except in the seed; tannin is found to be moderately present only in the aqueous extract of mesocarp of *Solanum aethiopicum* Linn fruit while the presence of phenol and flavonoids were confirmed in trace amount at few tested concentrations of the extracts.

Conclusion: Taken together, the presence of a variety of phytochemicals in the different anatomical parts of *Solanum aethiopicum* Linn fruit indicate that the fruit might be pharmacologically active against a number of diseases. However, this should be subjected to subsequent researches.

Keywords: *Solanum aethiopicum* Linn; garden egg; phytochemical content; epicarp; mesocarp; endocarp; seed.

1. INTRODUCTION

Solanum aethiopicum Linn. popularly known as garden egg or African eggplants are highly consumed for dietary and medicinal purposes in most African countries. It is known as dauta, afufa or añara, and igbagba in Hausa, Igbo and Yoruba Languages respectively which are the major languages in Nigeria [1].

1.1 Scientific Classification

Kingdom: Plantae
Order: Solanales
Family: Solanaceae
Genus: *Solanum*
Species: *S. aethiopicum*
Authority: Linneaus
Botanical name: *Solanum aethiopicum* Linn

1.2 Botanical Description

Different species of the plant have been shown to demonstrate a level of variation in certain features which includes diameter of petal, petiole length, leaf blade width, plant branching, fruit shape and colour [1]. Garden egg fruit is round in shape with flattened out top and bottom and grooved portions which are averagely 5-6cm long and 6-7cm wide. It usually has a tiny seed and straight or arc stalk [2].

Garden egg fruit can be categorized anatomically into three distinct layers namely the epicarp (also known as exocarp), which is the outermost layer; the mesocarp, which is the middle layer; and the endocarp (inner layer surrounding the seeds).

1.3 Traditional and Pharmacological Activities

Traditionally, *Solanum aethiopicum* Linn fruits are used in the treatment of a number of diseases which include catarrh, asthma, allergic rhinitis, skin infections, gastro-esophageal reflux disease, constipation, obesity, dyspepsia, rheumatic disease and swollen joint pains, amidst others [3,4]. Its pharmacological activities include antidiabetic activity, anti-hypertensive activity [5], anti-inflammatory activity, antiulcer activity [6], antioxidant [7] and anti-obesity effect [8]. Other reported pharmacological activities are analgesic, anti-asthmatic, anti-glaucoma, hypoglycemic, hypolipidemic and weight reduction effects on animals and human [9,10]. The pharmacological activities of *Solanum aethiopicum* Linn are said to be connected to its phytochemical constituents [11].

1.4 Phytochemical Profile

Phytochemicals are naturally occurring plant's bio-active constituents which provide health benefits for mankind [12]. Plants produce these chemicals primarily to protect themselves and secondarily humans against diseases [13]. They also contribute to the plant's features such as colour, aroma and taste [14]. Phytochemicals can be found in different parts of the plants, such as the leaves, flowers, roots, stems, seeds and fruits however their concentration varies from plant to plant depending on variety, growth conditions, season and so on [13]. Phytoconstituents reported to be present in *Solanum aethiopicum* Linn include alkaloids, flavonoids, phytosterols, saponins, ascorbic acid,



Fig. 1. *Solanum aethiopicum Linn* fruit

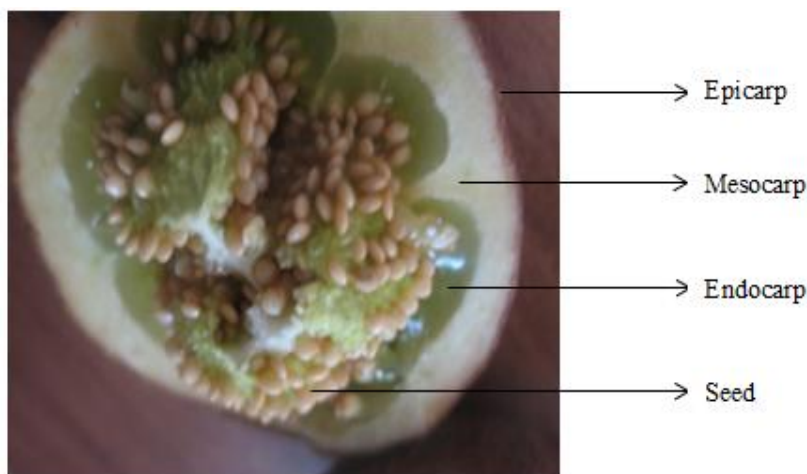


Fig. 2. Anatomical parts of *Solanum aethiopicum Linn* fruit

cardiac glycosides, tanins and terpenols amidst others [15,16].

Up to date, there is limited information as regards the phytochemical contents of the different anatomical parts of *Solanum aethiopicum Linn* fruit hence the need for this research

2. MATERIALS AND METHODS

2.1 Chemical and Reagents

Mercury chloride, potassium iodide, sodium hydroxide, hydrochloric acid (dilute and concentrated), iron (iii) chloride, ethanol, ethylacetate, methanol.

2.2 Plant Material and Extraction

Solanum aethiopicum Linn fruits were purchased from Sabo market, Ogbomoso, along Ilorin Express road, Oyo state, Nigeria. The fruits were selected and thoroughly washed with water to remove unwanted particles after which it was separated with a razor into four (4) anatomical parts (epicarp, mesocarp, endocarp and seed) which were used for the experiment. 1 gram of each anatomical parts of the fruit were soaked in 20 mls of distilled water, 1% volume per volume (v/v), 2%v/v, 3%v/v, 4%v/v and 5%v/v of ethanol, ethylacetate and methanol separately. The mixture was left for 24 hours after which they were sieved to obtain the extracts.

2.3 Methodology

2.3.1 Test for alkaloid

Two drops of Mayer's reagent together with two drops of 2% v/v of Hydrochloric (HCl) acid was added to 1 ml of plant extracts. The cream colouration of the mixture indicates the presence of Alkaloid [17].

2.3.2 Test for volatile oil

0.2 mls of 1% v/v of sodium hydroxide was added to 1 ml of plant extracts. Formation of white precipitate indicates the presence of Volatile oil [18].

2.3.3 Test for saponin

1 ml of distilled water was added to 1mls of plant extracts. Foaming after vigorous shaking for about 20 minutes indicates the presence of Saponin [19].

2.3.4 Test for phenol and tannin

Two drops of FeCl_3 was added to a mixture of 1ml of distilled and 1ml of plant extracts. The formation of a green precipitate indicates the presence of tannin and bluish green or dark green indicates the presence of phenol [20].

2.3.5 Test for flavonoid

3 drops of 20% NaOH was added to the mixture of 1 ml of distilled and 1 ml of plant extracts. The intense yellow colouration of the mixture indicates the presence of Flavonoid. The disappearance of the yellow colour after the addition of 1 mls of dilute HCl acid validates the presence of Flavonoid [21].

3. RESULTS AND DISCUSSION

The phytochemical screening of *Solanum aethiopicum Linn* (seed) as shown in Table 1 shows that volatile oil, phenol, tannin and flavonoid were absent at all tested concentrations of the extracts (i.e. aqueous, ethanol, ethyl acetate, methanol extracts). Alkaloid was present only in 2% methanol extracts of *Solanum aethiopicum Linn* (seed). Saponin was present in 2% ethanol, 3% ethyl acetate and 3% methanol extracts.

According to Table 2, alkaloid was present in 5% ethanol extract, 3% ethylacetate extract and 5% methanol extract; moderately present in aqueous extract, 1% ethanol extract, 2%, 4% and 5% ethylacetate extracts, 1% methanol extract and highly present in 4% ethanol extract of *Solanum aethiopicum Linn* (mesocarp). Volatile oil was found to be present only in 2% ethanol extract and moderately present in aqueous and 1% ethanol extracts of *Solanum aethiopicum Linn* (mesocarp). Phenol was absent at all tested concentrations of the extracts. Saponin was present in 2% and 5% ethanol extracts, 3% and 4% ethylacetate extracts and moderately present in aqueous and 3% ethanol extracts. Tannin was moderately present in aqueous extract while flavonoid was only present in 2% ethylacetate extract.

As shown in Table 3, alkaloid, volatile oil, phenol and tannin were absent at all concentrations of the selected extracts of *Solanum aethiopicum Linn* (Epicarp). Flavonoid is found to be present only in 2% methanol extract. Saponin was present in 1% and 3% ethanol extracts, 2%, 3% and 5% ethylacetate extracts, 2% and 3% methanol extracts and moderately present in 1% and 4% ethylacetate extracts.

Table 4. Shows that alkaloid was present in 1% ethanol extract, 1% ethyl acetate extract and 3% methanol extract while tannin is only present in 5% ethyl acetate extract. Saponin was present in aqueous extract, 1% and 4% ethanol extracts, 2% and 5% ethyl acetate extracts and 4% methanol extract; moderately present in 2%, 3% and 5% ethanol extracts, 3% and 4% ethyl acetate extracts and 5% methanol extract; highly present in 1% ethyl acetate extract. Volatile oil was found to be present in 1% ethanol extract, 1% ethyl acetate extract, 3% methanol extract and moderately present in 3% ethanol while flavonoid was completely absent at all tested concentrations of the selected extracts of *Solanum aethiopicum Linn* (Endocarp).

Phytochemical screening is a means of determining qualitatively or quantitatively the amount of substance of therapeutic and nutritional benefit in plants. Plants that are rich in certain phyto-constituents have always been of pharmacological importance. In this study, the phytochemical contents of the different anatomical parts of *Solanum aethiopicum Linn* fruit were determined qualitatively to know which part is rich in the tested phytochemicals at selected extracts.

Table 1. Phytochemical test for *Solanum aethiopicum* Linn (seed)

Extracts	<i>Solanum aethiopicum</i> Linn (Seed)					
	Alkaloid	Volatile oil	Saponin	Phenol	Tanin	Flavonoid
Aqueous	-	-	-	-	-	-
1%Ethanol	-	-	-	-	-	-
2%Ethanol	-	-	+	-	-	-
3%Ethanol	-	-	-	-	-	-
4%Ethanol	-	-	-	-	-	-
5%Ethanol	-	-	-	-	-	-
1%Ethyl-acetate	-	-	-	-	-	-
2%Ethyl-acetate	-	-	-	-	-	-
3% Ethyl-acetate	-	-	+	-	-	-
4%Ethyl-acetate	-	-	-	-	-	-
5%Ethyl-acetate	-	-	-	-	-	-
1%Methanol	-	-	-	-	-	-
2%Methanol	+	-	-	-	-	-
3%Methanol	-	-	+	-	-	-
4%Methanol	-	-	-	-	-	-
5%Methanol	-	-	-	-	-	-

+ = Present in trace amount
 ++ = Present in moderate amount
 +++ = Present in high concentration
 - = Absent

Table 2. Phytochemical test for *Solanum aethiopicum* Linn (mesocarp)

Extracts	<i>Solanum aethiopicum</i> Linn (Mesocarp)					
	Alkaloid	Volatile oil	Saponin	Phenol	Tanin	Flavonoid
Aqueous	++	++	++	-	++	-
1%Ethanol	++	++	-	-	-	-
2%Ethanol	-	+	+	-	-	-
3%Ethanol	-	-	++	-	-	-
4%Ethanol	+++	-	-	-	-	-
5%Ethanol	+	-	+	-	-	-
1%Ethyl-acetate	-	-	-	-	-	-
2%Ethyl-acetate	++	-	-	-	-	+
3% Ethyl-acetate	+	-	+	-	-	-
4%Ethyl-acetate	++	-	+	-	-	-
5%Ethyl-acetate	++	-	-	-	-	-
1%Methanol	++	-	-	-	-	-
2%Methanol	-	-	-	-	-	-
3%Methanol	-	-	-	-	-	-
4%Methanol	-	-	-	-	-	-
5%Methanol	+	-	-	-	-	-

+ = Present in trace amount
 ++ = Present in moderate amount
 +++ = Present in high concentration
 - = Absent

The presence of alkaloids, volatile oil, saponin, phenol, flavonoid and tannin were confirmed in the different anatomical part of *Solanum aethiopicum* Linn fruit albeit at different

concentration. This observation is in line with the studies of various scientists who have confirmed the presence of the phytochemicals in the *Solanum aethiopicum* Linn fruit in previous times

although their analysis focused on the whole fruit [11,15,16,22,23].

Comparing the tables above, it is observed that alkaloids are more concentrated in the mesocarp of *Solanum aethiopicum* Linn. Alkaloids are said to be pharmacologically active against certain diseases such as malaria, body pain, hypertension and cell metastasis amidst others [24,25]. Hence, this research suggests that the mesocarp of *Solanum aethiopicum* Linn fruit might be useful in the treatment of these diseases.

As shown in the tables above, the presence of volatile (essential) oil is more pronounced in the mesocarp and endocarp of *Solanum aethiopicum* Linn fruit compared to other anatomical parts, however at few tested concentrations. Since essential oils and their components possess antibacterial, antifungal, antiviral, insecticidal, and antioxidant properties [26,27], these parts of the plant might possess antimicrobial and free radical scavenging properties. Moreover, plant volatile oils have been said to possess other therapeutic activities which include antibiotic, analgesic, anti-inflammatory, antiseptic, astringent, diuretic, laxative, sedative, vasodilative and vasoconstrictive effects amidst others [28,29].

A comparison of the above tables shows the presence of saponin in all anatomical parts of *Solanum aethiopicum* Linn fruit at reasonable quality except in the seed were it is only observed in trace amount. It is more pronounced in the endocarp of *Solanum aethiopicum* Linn. The biological effect exerted by saponin includes antimicrobial, anti-tumour, anti-insect, hepatoprotective, haemolytic and anti-inflammatory activities. They cause a decrease in blood cholesterol level and may be used as an adjuvant in vaccines [30].

Tannin is found to be moderately present in the aqueous extract of mesocarp of *Solanum aethiopicum* Linn fruit. Research has shown that Japanese and Chinese uses tannin-containing plant extracts as diuretics against stomach and duodenal tumours [31], and as an anti-inflammatory, antiseptic and antioxidant [32]. Intake of tannins was affirmed by Serrano and colleagues to decreases the frequency of chronic disease [33]. Dietary consumption of tannin also helps in treating hemochromatosis [34].

The presence of phenol and flavonoids are only confirmed in trace amount at a few tested concentrations of the extracts.

Table 3. Phytochemical test for *Solanum aethiopicum* Linn (epicarp)

Extracts	<i>Solanum aethiopicum</i> Linn (Epicarp)					
	Alkaloid	Volatile oil	Saponin	Phenol	Tanin	Flavonoid
Aqueous	-	-	-	-	-	-
1%ethanol	-	-	+	-	-	-
2%ethanol	-	-	-	-	-	-
3%ethanol	-	-	+	-	-	-
4%ethanol	-	-	-	-	-	-
5%ethanol	-	-	-	-	-	-
1%ethyl-acetate	-	-	++	-	-	-
2%ethyl-acetate	-	-	+	-	-	-
3% ethyl-acetate	-	-	+	-	-	-
4%ethyl-acetate	-	-	++	-	-	-
5%ethyl-acetate	-	-	+	-	-	-
1%methanol	-	-	-	-	-	-
2%methanol	-	-	+	-	-	+
3%methanol	-	-	+	-	-	-
4%methanol	-	-	-	-	-	-
5%methanol	-	-	-	-	-	-

+ = Present in trace amount
 ++ = Present in moderate amount
 +++ = Present in high concentration
 - = Absent

Table 4. Phytochemical test for *Solanum aethiopicum* Linn (Endocarp)

Extracts	<i>Solanum aethiopicum</i> Linn (Endocarp)					
	Alkaloid	Volatile oil	Saponin	Phenol	Tanin	Flavonoid
Aqueous	-	-	+	+	-	-
1%Ethanol	+	+	+	-	-	-
2%Ethanol	-	-	++	-	-	-
3%Ethanol	-	++	++	-	-	-
4%Ethanol	-	-	+	-	-	-
5%Ethanol	-	-	++	-	-	-
1%Ethyl-acetate	+	+	+++	-	-	-
2%Ethyl-acetate	-	-	+	-	-	-
3% Ethyl-acetate	-	-	++	-	-	-
4%Ethyl-acetate	-	-	++	-	-	-
5%Ethyl-acetate	-	-	+	-	+	-
1%Methanol	-	-	-	-	-	-
2%Methanol	-	-	-	-	-	-
3%Methanol	+	+	-	+	-	-
4%Methanol	-	-	+	-	-	-
5%Methanol	-	-	++	-	-	-

+ = Present in trace amount

++ = Present in moderate amount

+++ = Present in high concentration

- = Absent

4. CONCLUSION

Taken together, the presence of a variety of phytochemicals in the different anatomical parts of *Solanum aethiopicum* fruit indicate that the fruit might be pharmacologically active against a number of diseases. However, this should be subjected to subsequent researches.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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