Qualitative and Quantitative Phytochemical Studies of *Solanum Macrocarpum L.* and *Solanum Aethiopicum L.* Fruits

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Abstract: **The indigenous eggplants in Nigeria are cultivated for their leaves, fruits, or both, eaten as vegetables or used as traditional medicine. However, *solanum aethiopicum L.* and *solanum macrocarpon L.* is the most cultivated and most utilized in Nigeria. The phytochemical constituents, quantitative composition and chromatographic analysis of the two species of garden eggs fruits were studied. The samples obtained were oven-dried at 40°C and the dried matter were successfully soaked in 80% methanol while the resulting crude fraction of *S. aethiopicum* (13.40 %) and *S. macrocarpon* (13.00 %) were partitioned with petroleum ether (6.50 %) and ethyl acetate (4.00 %) respectively. The findings from qualitative phytochemical screening showed the presence of alkaloids, steroids, tannins, phenolics, terpenoids, flavanoids, saponins, and glycosides while alkaloid, saponin, and flavonoid were quantified in both species of garden eggs. The results revealed *solanum aethiopicum L.* contained higher levels of beneficial agents than *solanum macrocarpon L.* The thin layer chromatographic analysis showed a higher retention factor in *S. macrocarpon L.* (0.90, 0.98, 0.99, and 0.5) than in *S. aethiopicum L.* (0.70, 0.40, 0.55, and 0.75) at various ratios of n-hexane and chloroform. The two indigenous eggplants are not only nutritionally and therapeutically valuable but also have the potential of providing precursors for the synthesis of useful drugs.**

Keywords**: solanum aethipicum, solanum macrocarpum, phytochemical, chromatography, qualitative and quantitative.**

I. INTRODUCTION

Solanum species (eggplants) belong to the family of Solanaceae and the plant genus Solanum with over 1,000 species worldwide. It is represented in Nigeria by about 25 species including those domesticated; with their leaves, fruits, or both eaten as vegetables or used in traditional medicine (1). They are known as garden eggs in Nigeria and are called gauta in Hausa, afufa or anara in Igbo, or igbagba in Yoruba. They are highly valued constituents of the Nigerian foods and indigenous medicines that are either eaten raw or cooked, very popular in mixed and rich dishes such as stews and soups (2), especially in the southern and western parts of Nigeria, although, they are highly cultivated in the north (3). Eggplants come in different species and varieties. They also vary in fruit color, shape, and size (3,4). Solanum melongena is small and white, having two varieties that are round or oval; yellow and red, when they are ripe and overripe respectively. They are either eaten raw as a dessert or cooked and used for the preparation of stews, soups, and sauces eaten with yam or plantain. Eggplants have indigenous medicinal uses, which range from weight reduction to treatment of several ailments including asthma, skin infections, and constipation. Various plant parts are used in decoction for curing ailments such as diabetes, leprosy, gonorrhea, cholera, bronchitis, dysuria, dysentery, asthenia, and hemorrhoids. (5,6). Nutritional and phytochemical information on some Nigerian Solanum species are scanty and it is difficult to assess the values of these species in this regard.

II. MATERIALS

A. Apparatus/Equipments

Spatula, rotary shaker, rotary evaporator, filter paper No.1, weighing balance, separatory funnel, glass rod, tubes tube rack, conical flasks, bama bottle, beaker, measuring cylinder, funnel, oven, reagent bottles, and other necessary laboratory apparatus.

B. Collection and identification of samples

The fresh garden eggs fruits were collected from Bauchi local government in Bauchi state Nigeria the plant was identified by a professional botanist in the department of biological sciences, Faculty of science, Abubakar Tafawa Balewa University, Bauchi.

III. METHODS

A. Grinding and Extraction

The garden egg fruits were washed thoroughly thrice with distilled water and oven-dried at 40^0C. The fine powder was obtained from the garden eggs using laboratory mortar and pestle. About 100 g of the garden eggs dry powder were extracted with 400 ml of 80 % methanol solvent using a rotary shaker. After completion of the extraction, the prepared extracts were then filtered and concentrated using a rotary evaporator and dry in an oven at 40 ^{0}C to obtain crude methanol fractions (CF). The extraction yield was determined (13.00 % and 13.40 %). Partition of the CF was performed further by the method of (7) with slight modification as described by (8). The dried CF was then dissolved in 100 ml water and was then portioned sequentially with 50 ml each of petroleum ether and ethylacetate respectively 3 times each. The fraction of each solvent was then collected and concentrated using a rotary evaporator to remove the solvents.

B. Stock solution

The extracts (200 mg) each were weighed and dissolved in a beaker containing a small amount of water and then quantitatively transferred into a 100 ml volumetric flask and made up to volume with distilled water. The resulting solution has a concentration of 2 mg/ml.

C. Serial Dilution of Extracts

The stock solutions (1 ml) each were measured and transferred quantitatively into a 100 ml volumetric flask and made up to volume with distilled water. The resulting solutions each have a concentration of 0.02 mg/ml (20 µg/ml).

IV. PHYTOCHEMICAL SCREENING

The preliminary phytochemical analysis of the extracts was performed using standard procedures (9). To detect the presence of bioactive components in the solanum species (eggplants).

A. Test for Phenolic compounds

Ferric chloride test: The extracts were dissolved in about 10 cm^3 of distilled water. To 2 cm^3 of each extracts few drops of 2 % ferric chloride solution were added. The formation of a dark green color was an indication of the presence of phenolic compounds.

B. Test for Tannins

To 2 cm^3 of each extracts 1cm^3 of distilled water and 3 drops of 10 % ferric chloride solution were added. The formation of blue or green-black color was an indication of the presence of tannins.

C. Test for Flavonoids

Lead acetate test: To 1 cm^3 of each of the extracts few drops of 10 % lead acetate solution were added. The formation of yellow precipitate was an indication of flavonoids.

D. Test for Terpenoids

Salkowski's test: To 1 cm^3 of each of the extracts, 3 cm^3 of chloroform was added. The resultant solutions were carefully mixed with 2 cm^3cconcentrated sulphuric acids. The formation of a reddish-brown color at the interface was an indication of the presence of terpenoids.

E. Test for Glycosides

To 5 cm^3 of the extracts, 2 cm^3 of glacial acetic acid containing one drop of ferric chloride solution were added. This was underlaid with 1 cm^3 of concentrated H_2SO_4. The formation of a brown ring of the interface was an indication of the presence of deoxy sugar of cardenolides.

F. Test for Alkaloids

To 1 cm^3 of the extracts, few drops of concentrated Hydrochloric acid and Dragendorf's reagent were added. The formation of white precipitate indicated the presence of alkaloids.

To 2 cm^3 of the extracts, 2 cm^3 of dilute hydrochloric acid was added. The resultant solutions were treated with few drops of Mayer's reagent. The formation of a yellow color precipitate was an indication of the presence of alkaloids.

G. Test for Saponins

Foam test: A 2 cm^3 of extracts were shaken in the test tube for 30 seconds. The formation of foam which persisted for 10 minutes was an indication of the presence of saponins.

H. Test for Steroids

To 1 cm^3 of each of the extracts, 2 cm^3 of each chloroform, and a few drops of concentrated sulphuric acid were added sidewise. A red color produced in the lower chloroform layer indicated the presence of steroids.

V. QUANTITATIVE ANALYSIS

A. Determination of Total Alkaloid

5 g of the sample was weighed into a 250 ml beaker and 200 ml of 10% acetic acid in ethanol was added and covered and allowed to stand for 4 h. This was filtered and the extract was concentrated on a water bath to one-quarter of the original volume. Concentrated ammonium hydroxide was added dropwise to the extract until the precipitation was complete. The whole solution was allowed to settle and the precipitated was collected and washed with dilute ammonium hydroxide and then filtered. The residue is the alkaloid, which was dried and weighed (10).

B. Determination of Total Saponins

The samples were ground and 5 g of each was put into a conical flask and 100 cm3 of 20% aqueous ethanol was added. The samples were heated over a hot water bath for 4 h with continuous stirring at about 55°C. The mixture was filtered and the residue re-extracted with another 200 ml 20% ethanol. The combined extracts were reduced to 40 ml over a water bath at about 90°C. The concentrate was transferred into a 250 ml separator funnel and 20 ml of diethyl ether was added and shaken vigorously. The aqueous layer was recovered while the ether layer was discarded. The purification process was repeated. 60 ml of n-butanol was added. The combined n-butanol extracts were washed twice with 10 ml of 5% aqueous sodium chloride. The remaining solution was heated in a water bath. After evaporation the samples were dried in the oven to constant weight; the saponin content was calculated (11).

C. Determination of Total Flavanoids

The samples were ground and 5 g of each was put into a conical flask and 100 cm3 of 20% aqueous ethanol was added. The samples were heated over a hot water bath for 4 h with continuous stirring at about 55°C. The mixture was filtered and the residue re-extracted with another 200 ml 20% ethanol. The combined extracts were reduced to 40 ml over a water bath at about 90°C. The concentrate was transferred into a 250 ml separator funnel and 20 ml of diethyl ether was added and

shaken vigorously. The aqueous layer was recovered while the ether layer was discarded. The purification process was repeated. 60 ml of n-butanol was added. The combined n-butanol extracts were washed twice with 10 ml of 5% aqueous sodium chloride. The remaining solution was heated in a water bath. After evaporation the samples were dried in the oven to constant weight; the saponin content was calculated (10).

VI. TLC SPOTTING

For TLC, extracts were dissolved with few drops of methanol. The mobile phase used was 8 ml of hexane and 2 ml of chloroform for a start and then the ratios were varied to obtain the best and highest number of constituents. The solution was poured into a Bama bottle and sealed. A TLC plate coated with silica gel was marked up and down to get the origin and terminating point. After drying it was sprayed with a solution of 90% ethanol and 10% concentrated sulphuric acid and was placed on a hot plate to view the separation on the TLC plate.

After which the retention factor (rf) was calculated using the following equation:

VII. RESULTS

A. Phytochemical Screening:

Phytochemical screening was carried out on the crude extracts of the garden eggs *solanum aethiopetum L. and solanum macrocarpon L.* for qualitative determination of various secondary metabolites and the results obtained were tabulated in table 1 and table 2 below:

Table 1: Phytochemical screening of the solvent extracts of *Solanum Aethiopitum L.*

SM	PE	PE	EAE
Alkaloids	(+)	-	(+)
Phenolics	(+)	-	(+)
Tannins	+	-	+
Flavanoids	+	-	(+)
Saponins	(+)	(+)	(+)
Terpenes	(+)	(+)	-
Glycosides	(+)	(+)	(+)
Steriods	(+)	(+)	-

KEY: (+) = Presence, + = Slightly present, -- = Absence ME = Methanol extract, PE = Petroleum ether extract, EAE = Ethyl acetate extract

Table 2: Phytochemical screening of the solvent extracts of *Solanum macrocarpon L.*

SM	PE	PE	EAE
Alkaloids	(+)	-	(+)
Phenolics	(+)	-	(+)
Tannins	+	-	+
Flavanoids	(+)	-	(+)
Saponins	(+)	(+)	(+)
Terpenes	+	+	-
Glycosides	(+)	(+)	(+)
Steriods	+	+	-

KEY: (+) = Presence, + = Slightly present, -- = Absence ME = Methanol extract, PE = Petroleum ether extract, EAE = Ethyl acetate extract, SM = Secondary metabolite

B. *Quantitative Composition:* quantitative composition of selected secondary metabolites of *solanum macrocarpon L.* and *solanum aethiopicum L* were shown in table 3 and table 4 below.

Table 3: Quantitative composition of *solanum macrocarpon L.* (%)

SM	ME	EAE
Alkaloids	10.8 %	11.6 %
Flavanoids	6.1 %	6.4 %
Saponins	4.0 %	4.1 %

KEY: ME = Methanol Extract, EAE = Ethyl acetate extract, SM = Secondary metabolite

Table 4: Quantitative composition of *solanum aethiopicum L.* (%)

SM	ME	EAE
Alkaloids	11.2 %	13.6 %
Flavanoids	7.2 %	7.0 %
Saponins	4.2 %	4.4 %

KEY: ME = Methanol Extract, EAE = Ethyl acetate extract, SM = Secondary metabolite

Thin Layer Chromatography Spotting: The retention factor of both *solanum macrocarpon L. and solanum aethiopicum L.* are shown below.

Table 5: Retention factor value of *solanum macrocarpon L.*

Solvent system	Ratio	Value
n-hexane: chloroform	8: 2	0.90
n-hexane	10 : 0	0.98
Chloroform	10 : 0	0.99
n-hexane:chloroform	7.5: 2.5	0.50

Table 6: Retention factor value of *solanum aethiopicum L.*

Solvent system	Ratio	Value
n-hexane: chloroform	8: 2	0.70
n-hexane	10 : 0	0.40
chloroform	10 : 0	0.55
n-hexane:chloroform	7.5: 2.5	0.75

VIII. DISCUSSION

Table 7 and Table 8 below the nature of each solvent fraction. Exhaustive extraction of 100 g samples of *solanum*

aethiopicum L. and solanum macrocarpon L. with 80 % methanol recovered 13.00 g of *S. aethiopicum* and 13.40 g of *S. macrocarpon* respectively. Which were partitioned with petroleum ether (23.00 % and 29 %) and ethyl acetate (27.50 % and 32.5 %) respectively.

The results of phytochemical screening in table 1 and table 2 revealed the presence of active entities that elicits a major pharmacological response. The results revealed the presence of alkaloids, flavanoids, phenolic compounds, tannins, saponins, terpenes, and glycosides. The presence of flavonoids and tannins in the methanol extracts is likely to be responsible for the free radical scavenging effects observed. Flavonoids and tannins are phenolics compounds and plant phenolics are the major group of compounds that acts as primary oxidants or free radicals scavengers. The presence of one secondary metabolite in one solvent extract and the absence in the other might be due to a difference in solvent polarity which agrees with the rule of thumb "like dissolved like" (12).

S. athiopicum general contained higher level phytochemicals than *S. macrocarpon.* The bitterness of eggplants is due to the presence of alkaloids, mainly glycoalkaloids, and the degree of bitterness determines to a great extent the edibility or otherwise. Poisoning by solanum species has been attributed to the presence of toxic glycoalkaloids which cause diarrhea or carcinogenic glycosides causing excessive deposition of calcium in tissues. Some researchers have insisted that caution should be applied in their uses and that they should be consumed in small quantities (13).

Saponins which are present in the samples are important dietary supplements and nutraceuticals. They possess antimicrobial activities and protect plants from microbial pathogens. Researchers have discovered that saponins present in traditional medicine preparation cause hydrolysis of glycosides from terpenoids which advert the toxicity associated with the intact molecule (14,15). The presence of saponins in the plants justifies their use in traditional medicine. Additionally, both *S. aethiopicum and S. macrocarpon* flavonoids are antioxidants and this potential is reflected in the antioxidants activities of the eggplant (16).

Table 3 and 4 depicts the quantitative composition of *S. aethiopicum L.* and *S. macrocarpon L.* fruits. with a considerable amount of alkaloids, flavonoids, and Saponins in methanol and ethyl acetate extracts present in *S. aethiopicum* than in *S. macrocarpon* respectively.

Table 5 and Table 6 the retention factor of *S. macrocarpon L. and S aethiopicum L.* using n-hexane and chloroform as the solvent of the system at various ratios. From above results showed that *S. macrocarpon* has a higher retention factor than *S. aethiopicum.*

IX. CONCLUSION

The results obtained from the studies showed *S. aethiopicum* contains higher beneficial constituents than *S. macrocarpon* while tin layer chromatographic analysis showed a higher retention factor in *S. macrocarpon* than in *S. aethiopicum*. However, the results proved the fruits of the two ingenious eggplants are nutritionally and therapeutically valuable and can be used for the synthesis of various useful drugs.

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REFERENCES

[1] Bonsu, K. O., Fontem, D. A., Nkansah, G. O., Iruome, R. N., Owusu, E. O., & Schippers, R. R. (2008). Diversity within the Gboma eggplant (*Solanum marcocarpon*), an indigenous vegetable from West Africa. Ghana Journal of Horticulture, 1:50-58.

[2] Edem, C. A., Dounmu, M. I. Bassey F. I., Wilson, C. and Umoren, P. (2009). A comparative Assessment of the proximate composition, Ascorbic Acid and Heavy metal content of two species of Garden egg (*Solanum gilo and Solanum aubergine*). Pakistan Journal of Nutrition, 8(5): 582-84.

[3] Chinedu, SN., Olasumbo, A.C., Eboji O.K., Emiloju, O.C., Arinola O.K., and Dania D.I (2011). Proximate and Phytochemical Analyses of *Solanum aethiopicum L.and Solanum macrocarpon L.* Fruits, Res.J.Chem.Sci. 1(3): 24-35.

[4] Akanitapichat, P., Phraibung, K., Nuchklang, K. & Prompitakkul, S. (2010).

[5] Gil, L.S. (1992). Ethnomedical uses of plants in Nigeria. University of Benin Press. Benin, Nigeria. P.215.

[6] Bello, S.O., Muhammed, B.Y., Gammaniel, K.S., Abdu-Ayugel, K.S., Ahmed H., Njoku C. H., Pindiga U. H. & Salka A. M. (2005). Preliminary evaluation of the toxicity and some Pharmacological properties of Aqueous crude extract of *Solanum melongena* Research Journal of Agricultural and Biological Sciences.,1(1):1-9.

[7] Xu, R., Zhao W., Xu J., Shao., B and Qin, G. (1996). on bioactive saponins from Chinese medicinal plants, Exp. Med. Biol., 404: 371–382.

[8] Parasad, K.N., Hao, J., Chun, Y., Zhang D, Qiu, S., Jiang Y., Zhan M., and Chen, F. (2009). Antioxidant and anticancer activities of medicinal plants. Journal of Biomedicine and Biotechnology, 6(1):21.

[9] Santhi, K., sengottuvel, R. (2016). Qualitative and Quantitative Phytochemical Analysis of *Moringa concanensi*, International Journal of Current Microbiology and Applied Sciences,5(1):633-640.

[10] Harborne, J.B. (1973). Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis. Chapman A & Hall. London. Pp 279.

[11] Obdoni, B., and Ochuko, P. (2001) Phytochemical studies and comparative efficacy of the crude extracts of some homostatic plants in Edo and Delta States of Nigeria. Global J. Pure Appl. Sci. Pp. 8: 203–208.

[12] Adamu H.M., Yushau S., Yakubu, H. and Abubakar A. (2019). Phytochemical screening and antioxidant activity of the stem bark extracts of *Diospyros mespiliformis:* a medicinal plant in Bauchi International journal of chemical science, 4(3):37-42

[13] Bello, S. O., Muhammed, B. Y., Gammaniel, K. S., Abdu-Ayugel, K. S., Ahmed, H., Njoku C. H., Pindiga U. H., and Salka A. M. (2005). Preliminary evaluation of the toxicity and some Pharmacological properties of Aqueous crude extract of *Solanum melongena* Research Journal of Agricultural and Biological Sciences.,1(1):1-9.

[14] Asl, M.N., and Hossein H. (2008). Review of pharmacological effects of *Glycyrrhizasp* And its bioactive compounds, Phytotherapy Res., 22(6): 709–724

[15] Chinedu, S.N., Olasumbo A.C., Eboji O.K., Emiloju, O.C., Arinola O.K., and Dania, D.T. (2011). "Proximate and Phytochemical Analyses of *Solanum aethiopicum L. and Solanum macrocarpon L.* fruits". Research Journal of Chemical Sciences, 1(3): 63-71.

Table 7: Nature of recovery of crude extracts of *solanum aethiopicum L.*

Extracts	Texture	color	Wt. of sample (g)	Wt. of extracts (g)	% Recovery
Methanol	Oily, sticky paste	Dark brown	100	13.40	13.40
Petroleum ether	Oily and sticky liquid	Reddish brown	6.50	1.90	29.00
Ethyl acetate	solid	brown	4.00	1.30	32.50

Table 8: Nature of recovery of crude extracts of *solanum macrocarpon L.*

Extracts	Texture	color	Wt. of sample (g)	Wt. of extracts (g)	% Recovery
Methanol	Oily, sticky paste	Dark brown	100	13.00	13.40
Petroleum ether	Oily and sticky liquid	Reddish brown	6.50	1.50	23.00
Ethyl acetate	solid	brown	4.00	1.10	27.50