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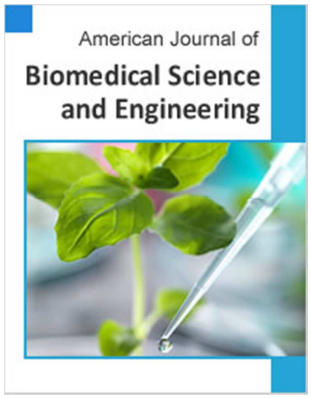

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Evaluation of the Medicinal Properties of *Solanum aethiopica*

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Abstract
The medicinal properties of different parts of *Solanum aethiopica* was studied. Phytochemical analysis was carried out on the various parts of the plant using a standard method. Result revealed the presence of alkaloids, saponins, flavonoids, tannins, resins and glycosides. Isolation and tentative identification of active principles was attempted using thin layer chromatography; alkaloids identified are cephaeline and emetine; saponins is β-hederin; flavonoids are hyperoside, chlorogenic acid, kaempferol arabinoside. Atomic absorption spectrophotometric method was used to identify the mineral elements present in the various plant parts and showed the presence of sodium, calcium, magnesium, potassium and phosphorus. All plant parts had a pH 7.

1. Introduction

Solanum aethiopica belongs to the family Solananceae and genus Solanum. It is known as "Wild garden egg" in English, "Añara-ohia" or "Afufa-ohia" in Igbo, "Egba or Ikan" in Yoruba, "Gautan kaji" in Hausa, "Suhwer kiben" in Kuteb and "Pwel cohot" in Berom [1]. The plant is an annual perennial shrub with broad and separate leaves; it bears smaller thorns on the leaves and the trunk. It grows to a height of 60 – 150cm, producing a bright blue flower with yellow centre which blooms most of the year and bears fruit between July and August. The plant is deciduous in nature and thrives well in temperate and tropical regions [1].

Solanum species are widely used as folk medicine in the treatment of hepatics in Taiwan [2]. The root of *Solanum aethiopica* and *Solanum incanum* are chewed to relieve tooth ache, the leaves are boiled and used in the treatment of mental disorder [3]. A report also said that farmers in Nigeria use *Solanum tuberosum, Solanum incanum* and *Solanum aethiopica* for food and for the management of diseases affecting their poultry [4].

2. Methodology

2.1. Preparation of Plant Extract

Different parts of *Solanum aethiopica* plant (leaves, fruit, stem and root) were freshly collected from the premises of Federal college of Forestry Jos, separately cut into parts and packed into polythene bags after having been identified in the Herbarium unit of the Federal College of Forestry, Jos. The plant parts were dried in a hot air oven at 50°C, pulverized, sieved into fine powder and separately stored in air tight containers.

2.2. Phytochemical Screening of Powdered Plant Parts of *Solanum aethiopica*

Phytochemicals such as Alkaloid, Tannin, Glycoside, Resin, Flavonoid and Saponin were analysed for based on standard acceptable scientific method [5].

2.2.1. Test for Alkaloids

0.5g of the dried pulverized *Solanum aethiopica* was dissolved 5mls of 1% aqueous HCl on a steam bath. This was filtered and 1ml of the filtrate treated with a few drops of Draggendorffs reagent and 1ml of a second portion of the filtrate treated with Wagner's reagent; the formation of precipitates indicated the presence of alkaloid.

2.2.2. Test for Tannins

0.5g of the dried pulverized *Solanum aethiopica* was dissolved in 10ml of distilled water. This was filtered and 2ml of 5% $FeCl_3$ added to the filtrate. A deep green colouration showed the presence of tannins. A second portion of the filtrate was treated with a few millilitres of iodine solution. A faint bluish colouration confirmed the presence of tannins.

2.2.3. Test for Saponins

0.5g of the dried pulverized *Solanum aethiopica* was measured, placed into a test tube, 5mls of distilled water added and shaken thoroughly. The formation of froth which persists on warming indicated the presence of saponins.

2.2.4. Test for Flavonoids

0.5g of the dried pulverized *Solanum aethiopica* was measured, placed in a test tube and dissolved in 2mls of dilute NaOH solution. A few drops of concentrated H_2SO_4 was then added. The appearance of a colourless solution, indicated the presence of flavonoids.

2.2.5. Test for Resins

0.5g of the dried pulverized *Solanum aethiopica* was measured and placed in a test tube and 5mls of boiling ethanol added. The solution was then filtered using a Whatman's No. 1 filter paper and the filtrate diluted with 4mls of 1% aqueous HCl. The formation of a heavy resinous precipitate indicated the presence of resins.

2.2.6. Test for Glycosides

0.5g of the dried pulverized *Solanum aethiopica* was dissolved in 10mls of distilled water. The solution was filtered and 2mls of the filtrate hydrolysed with a few drops of concentrated HCl. The mixture was then alkanized with a few drops Ammonia solution. Five (5) drops of this solution was added to 2mls of Benedict's qualitative reagent and boiled. A reddish brown precipitate showed the presence of glycosides.

2.3. Chromatographic Screening of Phytochemicals in Powdered Plant Parts of *Solanum aethiopica*

The phytochemicals that were found present qualitatively were extracted and assayed chromatographically. The solvent system used was ethylacetate-methanol-water in the ratio of 100:13.5:10 [6].

2.3.1. Preparation of Chromatoplates for Thin Layer Chromatographic Analysis

Five (5) chromatoplates were thoroughly washed with water and allowed to dry. The plates were further cleaned with acetone and set on the plate holder. 50g of silica gel powder was dissolved in 110mls of deionized water, the mixture corked and fixed on an Action Wrist Shaker, balanced with 50mls of water and shaken for 30 minutes. The mixture was then applied on the plates and drawn from one to the other with a spreader at a thickness of 0.25mm and allowed to dry for 30 minutes.

2.3.2. Extraction of Active Principles from Dried Pulverized Parts of *Solanum aethiopica*

The phytochemicals identified were extracted and prepared for chromatographic Screening using a standard acceptable scientific method [6].

I. Alkaloids

1g of the dried pulverized *Solanum aethiopica* was mixed thoroughly with 1ml of 10% ammonia solution and extracted by shaking for 5 minutes with 5mls of methanol at 60°C on a water bath, filtered and the filtrate used for the chromatography.

II. Saponins

1g of the dried pulverized *Solanum aethiopica* was shaken for 15 minutes with 20mls of chloroform and filtered. The filtrate was then evaporated to dryness and residue dissolved 2mls of chloroform/methanol (1:1). The mixture was then used for the chromatography.

III. Flavonoids

1g of the dried pulverized *Solanum aethiopica* was extracted with 10mls of methanol for 5 minutes on a water bath at 60°C and filtered. The filtrate was used for the chromatographic screening.

IV. Bitter Principles

1g of the dried pulverized *Solanum aethiopica* was extracted for 10 minutes with methanol at 60°C on a water bath. The mixture is filtered and the filtrate evaporated to 2ml volume which was used for the chromatographic screening.

2.3.3. Activation of Chromatoplates

The chromatoplates were set in the hot air oven and activated at 110°C for 30 minutes, removed and was allowed to cool.

2.3.4. Application of the Extracts on the Chromatoplates

Each of the extracts were spotted on the chromatoplates on a line from the lower edge (origin) of the plates with a spacing of 2-3cm in-between.

2.3.5. Saturation of the Chromatographic Tank

The chromatographic tank was saturated for 1 hour with the developing solvent chroloform/ methanol (85:15) for alkaloids; chloroform/methanol/water (64:50:10) for saponins; n-butanol/glacia-acetic acid/water (40:10:50) for flavonoids and chloroform/methanol (95:5) for the bitter principle, respectively. The spotted plate is then placed in the chromatographic tank containing the solvent, petroleum jelly (Vaseline) applied on the edges, covered with the lid and allowed to stand. When the solvents reached the score line or solvent front, the plate was removed and reactivated in an oven at a temperature of 110°C for 10 minutes.

2.3.6. Visualization and Identification of Separated Components

The chromatographic film was set in the ultra violet light machine and viewed under the short wave length. The individual components were identified by their characteristic colours and their R_f values. The R_f values obtained were compared with those of known standard in a standard atlas.

$$R_f = \frac{\text{Distant moved by the solute}}{\text{Distant moved by the solvent}}$$

2.4. Mineral Element Analysis

Some macro and micro elements were determined after ashing and digestion, using Atomic Absorption Spectrometer according to the method described by the Association of the Official Analytical Chemist [7].

2.4.1. Ashing and Digestion

2g of the dried pulverized *Solanum aethiopica* plant parts were weighed into a crucible and ashed in a murfle furnace preheated to 600°C for 4 hours. The crucible was then transferred directly to a desicator and allowed to cool. The various ash from different parts of the plant were then separated treated with a few millilitres of HCl and a few drops of concentrated HNO_3 and boiled. These were then cooled and filtered, and the filtrate made up to 10mls in a standard volumetric flask with deionized water. These solutions were used for the determination of cations.

2.4.2. Determination of Cations

Seven (7) cations; sodium, calcium, magnesium, potassium, phosphorus, selenium and lead were determined with the aid of Atomic Absorption Spectrometer. The results were converted from ppm to mg per 100g using the formular:

$$\text{mg}/100\text{g} = \frac{\text{conc. (ppm)}}{10} \times \frac{\text{Soln. Vol}}{wt.(g)^2} \times \frac{100}{1}$$

2.5. Test for pH of Solutions of Powdered Plant Parts of *Solanum aethiopica*

0.5g of powdered plant parts (leaves, fruit, stem and roots) of *Solanum aethiopica* were individually dissolved in 5ml of distilled water. The electrode of the pH meter was introduced into each of the solutions and their pH was read.

3. Result(s)

3.1. Phytochemicals Identified in *Solanum aethiopica*

Result from the phytochemical analysis of the different parts of *Solanum aethiopica* revealed the presence of alkaloids, saponins, flavonoids, and resins in all parts of the plant in varying concentrations while tannins is present in the leave and stem but absent in the fruit and root. Glycoside is present in the leaves and fruit but absent in the stem and root (Table 1).

Table 1. *Phytochemicals in Solanum aethiopica.*

Phytochemical	Leave	Fruit	Stem	Root
Alkaloids	++	++	+	+
Saponins	++	++	++	+
Resins	+	+	+	+
Flavonoids	++	++	+	+
Tannins	+	-	+	-
Glycosides	+	+	-	-

Key: ++ (highly present), + (present), - (not present)

3.2. Identified Active Principles from Parts of *Solanum aethiopica*

Result after the chromatographic screening of the parts of *Solanum aethiopica* showed Alkaloids, cephaeline and emetine with R_f values 0.18 and 0.4, respectively in the leaves and an unidentified compound with R_f value 0.13 in the fruit; Saponin, $_{\beta}$-hederin with R_f value 0.8 in the fruit; Flavonoids, hyperoside and chlorogenic acid with R_f values 0.61 and 0.85, respectively in the leaves, kaempferol arabinoside with R_f value 0.92 in the fruit and two unidentified compounds with R_f values 0.94 and 0.95 in the stem and root, respectively; Tannin, hydrolysable tannin with R_f value 0.20 in the leaves and stem. The chromatogram did not indicate any spot for Glycosides and Bitter principles (Table 2).

Table 2. *Chromatogram of Active Principles in Solanum aethiopica.*

Phytochemical	Plant Part	R_f Value	Possible Identity
Alkaloid	Leave	0.18	Cephaeline
		0.4	Emetine
	Fruit	0.13	-
	Stem	-	-
	Root	-	-
Saponin	Leave	-	-
	Fruit	0.80	β-hederin
	Stem	-	-
	Root	-	-
Flavonoid	Leave	0.61	Hyperoside
		0.85	Chlorogenic acid
	Fruit	0.92	Kaempferol arabinoside
	Stem	0.94	
	Root	0.95	
Tannin	Leave	0.20	Hydrolysable tannin
	Stem	0.20	Hydrolysable tannin
Glycoside	Leave		
	Fruit		
	Stem		
	Root		

3.3. Mineral Elements Present in *Solanum aethiopica.*

Result showed mineral elements present in different parts of the plant. Phosphorus showed the highest concentration in the leaves with 2.85g with calcium having the least concentration in the leaves, 0.15g. Potassium showed the highest concentration in the fruit with 3.15g with the least being phosphorus with 0.15g. Phosphorus however showed the highest concentration of 0.56g in the stem with the least concentration being calcium with 0.08g. Potassium showed the highest concentration in the root with 1.13g with calcium showing the least concentration with 0.08g. Other mineral elements present in the plant parts include sodium and magnesium. Selenium and lead were absent (Table 3).

Table 3. *Minerals in Solanum aethiopica.*

	Concentration(g/100g)			
Elements	**Leaves**	**Fruit**	**Stem**	**Root**
Sodium	0.39	0.30	0.29	0.31
Potassium	2.62	3.15	0.48	1.13
Magnesium	0.14	0.16	0.14	0.13
Phosphorus	2.85	0.15	0.56	0.65
Calcium	0.15	0.23	0.08	0.08

3.4. pH Levels of Different Parts of *Solanum aethiopica*

Results of the pH values of leaves, fruit, stem and root of *Solanum aethiopica* showed a pH 7 indicating the neutral position (Table 4).

Table 4. *pH of Solanum aethiopica Parts.*

Plant Part	**pH**
Leaves	7
Fruit	7
Stem	7
Root	7

4. Discussion

The study of the medicinal properties of *Solanum aethiopica* will help us to know the bioactive chemicals present in the parts of the plant to use as medicine or drug and the parts with higher concentration of phytochemicals for preferred therapeutic or prophylactic purpose. Phytochemicals fight to protect health; they have complimentary and overlapping mechanisms of action in the body including antioxidant effects, modulation of detoxification enzymes, stimulation of the immune system, modulation of hormone metabolism and antiviral/ antibacterial effect. Phytochemical may help slow the aging process and reduce the risk of many disease [8].

The result revealed that the leave, fruit, stem and root of *Solanum aethiopica* contained various quantities of alkaloids, saponins, resins, flavonoids, tannins and glycosides; the fruit and root however do not contain tannins. Alkaloids, saponins, resins, flavonoids tannins, and glycosides have been recorded to have retrogressive effect on microorganisms [9]. Alkaloids represent the active principles of vegetable drugs. They are alkaline in reaction and richly combine with acid forming salts soluble in water. All contain Nitrogen. Some drugs may contain more than one alkaloid and the actions may be antagonistic. Alkaloid Yohimbine is a preterential presynaptic α- Adrenolytic agent. Yohimbin and its stereoisomers are used as tools for study of different adrenoceptor sites. It is antidepressant used clinically and shows hypertensive activity - causes vasopressin release and antidiuretic activity. It is also alleged to have aphrodisiac capabilities [10]. Tannins is used in styptic preparations — which produces contractions of the blood vessels; stopping bleeding; having the quality of retaining haemorrhages when applied to the bleeding part. It has been suggested that the consumption of tannin containing beverage especially teas and red wines can cure or prevent a variety of illness [11]. It has also been reported that human or animal physiological activities such as stimulation of phagocytic cells, mediated tumour activity and a wide range of anti-infective have been assigned to tannins [12]. Tannin-like polyphenols have been shown to have activities against bacteria, virus and fungi; thus displaying a mode of antimicrobial action that is same with Quinones [11]. This may be related to their ability to inactivate microbial adhesion, enzymes, cell envelope transport protein with the suggestion that low tannin concentration modified the morphology of germ tubes of *Crinipellis periniciosa*. Tannic acid because of its styptic and astringent properties have been used in the treatment of tonsillitis, pharyngitis, haemorrhoid and various skin eruption. Tannic acid have also been administered internally to check diarrhoea and intestinal bleeding and as antidote for metallic alkaloidal and glycosidal poisons with which it forms insoluble precipitates. The most significant function that has been assigned to the flavonoids is as regulators of seed germination and plant growth but has also been implicated in the protection of plants and animals against infections from microorganisms. Flavonoids have aroused considerable interest recently because of their potential beneficial effects on human health; they have been reported to have antiviral, anti-allergic, anti-inflammatory, anti-tumour and anti-oxidant activities [13]. Flavonoid compound exhibit inhibitory effects against multiple virus: numerous studies have documented the effectiveness of flavonoid such as sivertifracheside, glycyrrhizin and chrysin against HIV [13]. More than one study has suggested that flavones derivatives are inhibitory to respiratory syncytial virus. Flavonoid rutin have been shown to have antihaemorrhagic activity and also acts as a vasodilator. Chlorogenic acid is one of the most important flavonoid in the field of pharmacology- has been shown to have antibacterial, antimutagenic, antitumor, and antiviral activities, plus antioxidant and clastogenic activities. The transisomer acts as an insect oviposition stimulant, and it may also reduce larval growth [14]. Flavonoid hyperoside has shown that it can effectively protect $PC1_2$ cells against

cytotoxicity induced by hydrogen peroxide because it has been reported that the crucial balance between reactive oxygen species generation and antioxidant defence is regarded as a force in a wide variety of chronic diseases [15]. Several medicinal activities have been ascribed to flavonoid Kaempferol arabinoside, chief among them is as an anti-cancer agent cutting across different cancerous conditions including breast, ovarian, gastric, bladder, prostrate, colorectal, and pancreatic and lung cancers. Other use includes in the management of leukaemia, diabetes, cardiovascular disorders, antibacterial, antiviral and antifungal activities [16]. Saponins have the property of causing haemolysis of cells even at low dilution, tend to be deposited on the surface of cells with which they come in contact and are not absorbed by the normal epithelium of the alimentary canal. Alkaloids represent the active principles of vegetable drugs. They are alkaline in reaction and richly combine with acid forming salts soluble in water. All contain nitrogen. Some drugs may contain more than one alkaloid and the actions of these may be antagonistic [17]. Triterpenoid saponins have the ability to lower surface tension and are soap-like. They form foams in aqueous solution and cause haemolysis of blood erythrocytes. Antifungal activity is also present [17]. Resins produced by most plants is composed mainly of terpenes and derivatives. Certain resins such as Gugulipid have been in use since 1987 for the management of atherosclerosis and hyper-lipidaemia [18]. Resins have been evaluated for a variety of medicinal purposes because of their anti-hypertensive, analgesic, and cardioactive properties as well as for the synthesis of anticancer compounds. Propolis, resin collected and mixed with wax by honeybees for use in their hives, has a long history of medical use for a wide spectrum of health benefits [18]. Other diseases claimed to be managed using resins include rheumatic diseases and ulcerative colitis as well as a well-documented anti-inflammatory and immune-modulatory activities. Furthermore, the extracts and essential oils of frankincense have been used as antiseptic agents in mouthwash, in the treatment of cough and asthma and as a fixative in perfumes, soaps, creams, lotions and detergents. In ancient Egypt the resin was used in mummification balms and unguents. Today frankincense is one of the most commonly used resins in aromatherapy [19]. Glycosides have a tendency to block the conduction of the electrical impulse that causes contraction as it passes from the atria to the ventricles of the heart. Cardiac glycosides also have a tendency to produce an abnormal cardiac rhythm by causing electrical impulses to be generated at points in the heart other than the normal pace marker region, the cells that rhythmically maintain the heartbeat. Glycosides have been shown to possess anti- tumour properties [20].

5. Conclusion

Solanum aethiopica plant has the potentials to be used in controlling numerous viral, bacterial, fungal and protozoan diseases.

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