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Phytochemical analysis and anti-bacterial activity of *Steganotaenia araliacea* stem bark for management of diarrhea

by

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Research dissertation submitted to the department of chemistry in partial fulfillment of the requirements for the award of the degree of Bachelor of Science Education of Busitema University.

May, 2024

DECLARATION

I Chemusto Dan declare that this research dissertation is my original work and it has not been submitted for award of a degree or professional qualification in any other institution of higher learning. Where other people's work was used, this has been acknowledged and cited according to the university policy.

Signature.....**Date**.....13th/May/2024.....

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APPROVAL

This research dissertation has been submitted for examination with my approval as his university supervisor.

Signature..... **Date** ....13/5/2024.....

DR OWOR RICHARD ORIKO

i

DEDICATION

I dedicate this research dissertation to my father Mr. Mashong Moses.

AKNOWLEGMENT

I give my warmest thanks to my supervisor Dr Owor Richard Oriko who made this work easy and possible. His guidance and advice and support carried me through all the stages of writing my project. He has been one of my top mentors always and motivated me towards doing further education in natural products.

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Table of Contents

ABSTRACT

Diarrhea remain a major concern in developing countries of Africa leading to high rates of death especially among children below the age of 5 and it is attributed to bacteria such as *Escherichia coli* and *Salmonella typhi*. Due to increased resistance of the prescribed drugs by diarrhea causing bacteria, alternatives medications derived from medicinal plants are being considered especially in the developing countries. *Steganotaenia araliacea* commonly known as the African parsley tree is traditionally used in Africa to manage various diseases including diarrhea. The main goal of this study was to analyze the phytochemical composition of the methanolic extract of the plant and evaluate its antibacterial activity. Alcoholic extracts *of S. araliacea* bark were subjected to various phytochemical analysis to identify the phytochemical components present in the plant. These phytochemicals (alkaloids, flavonoids, phenols and tannins) were then quantified using different standards whose calibration curves were used to determine the total amount of each phytochemical. Antibacterial assay of the Crude extract of *Steganotaenia araliacea* was carried out to investigate its effectiveness on *E. coli* bacteria. The results of the phytochemical analysis confirmed the presence of various phytochemical compounds including alkaloids, flavonoids, terpenoids, saponins, tannins and phenolic compounds. Quantification results showed that the extract had a high concentration of alkaloids (125.05.mg/g), moderate concentration of phenols and tannins (78.27 and 64.45 respectively) with low concentration of flavonoids (40.37). Antibacterial activity of the stem bark extracts of the plant material showed no inhibition on *E. coli*. Further investigation should be carried out against other bacterial strains like *Salmonella typhi* to fully explore the antibacterial potential of *steganotaenia araliacea.*

List of tables

LIST OF ABBREVIATION AND ACCRONYMS

S.A: Steganotaenia araliacea

E.C: *Escherichia Coli*

TT: Total tannins

TA: Total Alkaloids

TP: Total phenols

TF: Total Flavonoids

WHO: World Health Organization

DF: Dilution factor

PHC: Primary health care

H_2SO_4: Sulphuric acid

AE: Apigenin equivalent

APE: Atropine equivalent

PGA: Propyl gallate equivalent

UV-VIS: Ultraviolet visible spectrometer

LIST OF FIGURES

CHAPTER 1 INTRODUCTION

1.1 Background

Diarrhea is the passage of loose or watery stools occurring three or more times in 24 hours period Diarrhea may be of three types, acute, persistent and dysentery bacteria(WHO, 2017). Where diarrhea lasts for less than 14 days, it is regarded as acute diarrhea. Acute watery diarrhea causes dehydration, contributes to malnutrition and may lead to death of a child. When diarrhea lasts 14 days or more, it is called persistent diarrhea(Pawlowski et al., 2009).

Up to 20% of episodes of diarrhea become persistent. These often cause nutritional problems, creating the risk of malnutrition, serious non-intestinal infection and dehydration. Diarrhea with a blood in a stool with or without mucus is called dysentery diarrhea and it poses a serious health problem because of the ability to lead to anorexia and damage to the intestinal mucosa(Sagaro et al., 1995).

Diarrhea may be caused by many ways including a bacterial infection, a virus, food allergy, parasites that enter the body through food(Bari & Sasbina, 2018). The most frequently identified causing bacteria are *Escherichia coli*, *shigella*, *salmonella typhi*, *campylobacter*, *yersinia*, and *Clostridium spp* (Ali & Kumar, n.d.). Diarrhea is a common cause of death in third world countries especially among children worldwide(Bari & Sabina, 2018).

Statistics show that about 2 to 3 million diarrhea deaths occur annually in the developing countries throughout the world. is estimated to kill about 250000 children per day making it to be the second leading cause of death among children under the age of 5(Lanata et al., 2013).

World health organization together with the national drug authority have prescribed several drugs like Loperamide, Bismuth subsalicylate, Rifaximin and many more that may be too expensive and inaccessible(Swiss Academy of Medical Sciences, 2018). However, they have side effects like drowsiness, stomach ache, loss of weight, and dizziness. So, these calls for an alternative way for management of diarrhea(Riddle et al., 2017).

In recent years, the interest in plant-based medicine has increased worldwide(van Wyk & Prinsloo, 2020). A number of traditional medicinal plants have been recommended for ant-

diarrheal use and one of such is *S. araliacea* that has also got many medicinal uses in the practice of traditional medicine(Liheluka et al., 2023). *Steganotaenia araliacea* plant is used in eastern Uganda for the treatment of diarrhea and wound infections because it contains bioactive compounds that are believed to have medicinal properties(Masters, 2023). Bioactive compounds in *S. araliacea* present include, flavonoids, alkaloids, saponins, tannins, terpenoids, phenolic compounds and steroids(Deepa & Nalini, 2013). Therefore, this research investigated the phytochemicals present in *Steganotaenia araliacea* and their relevance in the management of diarrhea.

1.2 Problem statement.

Diarrhea is the passage of watery stools occurring three or more times in 24 hours period. A large number of people especially young children under the age of 5 die as a result these health condition. These has affected their normal body functioning, reduction in their weight and to others it goes to an extent of claiming their lives. Diarrhea is commonly caused by a bacterial infection, a virus, food intolerance, food allergy, parasites that enter the body through food.

Statistics shows that about 2 to 3 million diarrhea deaths occur annually in the developing countries throughout the world. is estimated to kill about 250000 children per day making it to be the second leading cause of death among children under the age of 5.

The ministry of health together with the national drug authority have recommended some conventional medications for instance the use of anti-depressants and anti-diarrheal activity. However, these have some side effects like drowsiness, stomach ache, loss of weight, and dizziness. Therefore, these call for an alternative way for management of diarrhea.

Several traditional modifications have been the option to replace the drugs because of fear of their consequences. PHC investigates that local herbs are still in use in most trans-Saharan areas to treat diarrhea. *S. araliacea* is one of the local plants used to curb this condition. These findings aim at formulation of an herbal syrup from *S. araliacea* stem bark to management of diarrhea.

1.3 RESEARCH OBJECTIVES

1.3.1 General research objective.

To develop an herbal syrup from *S. araliacea* stem bark that can be used as an alternative treatment for diarrhea.

1.3.2 Specific objectives

1. To quantify the phytochemical composition of *S. araliacea stem bark* using specific techniques.

2. To evaluate the efficacy of *S. araliacea* on Escherichia coli.

3. To formulate an herbal syrup from S. araliacea stem bark for manage to curb diarrhea.

1.4 Justification

Medicinal plants have been a rich source of therapeutic compounds, leading to the development of effective drugs. For example, Quinine is derived from the bark of the cinchona tree for treatment of malaria, vincristine from the Madagascar periwinkle plant is used to treat childhood leukemia. Similarly, *S. araliacea*, with its diverse phytochemical composition, including alkaloids, tannins, phenols and flavonoids, is likely to possess therapeutic properties, making it a promising resource for developing new drugs to treat diseases like diarrhea, Cancer, Skin ailments and other bacterial infections infections(Tabuti et al., 2023).

1.5 Scope

This study was purely experimental investigation that explored the bioactive compounds present *Steganotaenia araliacea* stem bark. The primary focus was on conducting comparative analysis of the antibacterial properties of the extract from *S.A* stem bark specifically around Tororo region.

CHAPTER 2 LITERATURE REVIEW

Nature has been a source of medicinal plants for centuries(Petrovska, 2012). Plants have been used to treat various ailments, and the active compounds found in these plants have been the basis for many modern medicines. 50% of all modern drugs are derived from natural products, with plants being the most significant source(Veeresham, 2012). Living cells can generate free radicals, which are highly reactive molecules that contain unpaired electrons and other reactive oxygen species bi-products as a result of physiological and biochemical processes(Phaniendra et al., 2015).

Free radicals can cause oxidative damage to DNA, proteins, lipid peroxidation, inflammation, Aging and many others. However, free radicals generated by living cells can cause significant damage to cellular components and contribute to the development of various diseases like cardiovascular disease, diabetes, cancer, Alzheimer's disease and many others(Lobo et al., 2010).

Plants are often endowed with free radical scavenging molecules such as vitamins, terpenoids, flavonoids, quinones, coumarins, alkaloids, ammines, betanin's, steroids and other metabolites, which are rich in antioxidant activity(Arulkumar et al., 2020). Studies have shown that many of these antioxidant compounds possess anti-inflammatory, antiatherosclerosis, antitumor, ant mutagenic, and antibacterial and antiviral activities on and inside the body(Kalyani et al., 2011).

The species *steganotaenia araliacea*, also known as the African parsley tree is a plant species native to certain regions of Africa, including Ghana, Nigeria, and Cameroon(Odukoya et al., 2022). It belongs to the Apiaceae family, which includes other well-known plants like carrots, parsley, celery, fennel, coriander and cumin(Oskolski et al., 2010). *S. araliacea* stem-bark has been employed in diverse situations in man and animal. The extract has found use as rodent poison, insect repellant and as a diuretic agent in man(Agunu et al., 2005).

Figure 1: Growth behavior of steganotaenia araliacea

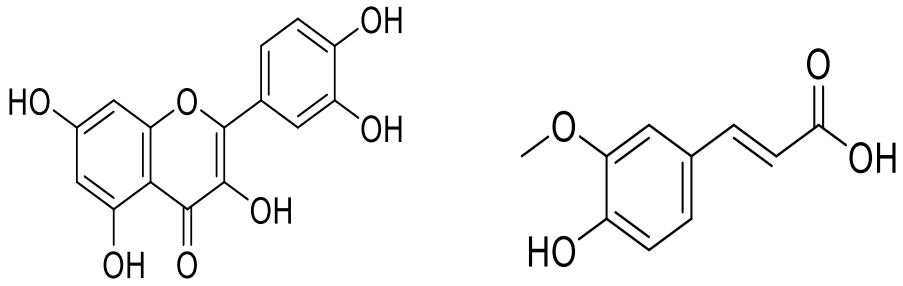
The roots of *S. araliacea* plant are fibrous and contribute to the plant stability and nutrient uptake(p Christensen, 2011). In traditional medicine, its roots are used are used to treat ailments such as stomachaches, and root extracts may contain anti-inflammatory and antioxidant properties(Masters, 2023).

S. araliacea has compound pinnate leaves with Lanceolate leaflets arranged in an umbrella like fashion and have been traditionally used in some regions for medicinal purposes which include the treatment of diarrhea(Esser & Jebb, 2009). The leaves and the stem bark of *S. araliacea* may contain compounds with potential anti-diarrheal properties(Agunu et al., 2005).

The stem of *S. araliacea* is typically smooth and green serving as a primary support structure for the plant. *S. araliacea* produces small-round berry-like fruits that are initially green and turn to a purplish black color when ripe. The fruits are about 1-2 centimeters in diameter and contain a single seed. They are edible and have a sweet, slightly tangible flavor. *S. araliacea* is native to almost all parts of Africa and their fruits are used in traditional medicine and as food in some regions(Oskolski et al., 2010).

In Africa, *steganotaenia araliacea* is commonly referred to as the pepper bark tree due to the peppery taste of its bark and leaves, however in different countries of Africa for example it is called Mutumbi in Zambia, Mukena in Zimbabwe, and Mugabe in Uganda(Picos & Mora, 2019).

Figure 2: Some isolated structures present in *Steganotaenia araliacea* plant



2.1 Phytochemistry of *steganotaenia araliacea.*

Phytochemistry is the branch of chemistry that deals with the study of plant-based chemicals including their isolation, identification and characterization(Odukayo, 2018). It focusses on the chemical composition of plants and the investigation of their bioactive compounds such as Flavonoids, alkaloids, essential oils, terpenoids, phenolic compounds, steroids and alkaloids(Jonathan et al., 2018)

Phytochemical screening of *S. araliacea* was conducted to determine and analyze the presence of phytochemical compounds(Deepa & Nalini, 2013). The phytochemical screening of *S. araliacea* involved the extraction of the plant using the appropriate solvents followed by qualitative analysis of the extracted components(Deepa & Nalini, 2013). Common phytochemical tests such as alkaloid tests, flavonoid tests, tannins tests, phenolic tests, glycoside tests and steroid tests were conducted to determine the specific phytochemicals in the *S. araliacea* (Theanphong et al., 2023). The results of the phytochemical analysis of *S. araliacea* confirmed the presence of various phytochemical compounds including alkaloids, flavonoids, terpenoids, saponins, tannins and phenolic compounds (Olila & Apak, 2006). These compounds are known for their potential health benefits and contribute to the medicinal properties of the plant like anti-inflammatory, anti-cancer, anti-aging, cardio protective, neuroprotective, immunomodulatory, antidiabetic, and anti-bacterial, anti-parasitic and anti-viral properties(Farmaceutische & Wetenschappen, 2015). Therefore, phytochemical analysis of the *S. araliacea* stem bark provided valuable information about the chemicals of the plant and its potential pharmacological activities.

2.2 Anti-diarrheal activity of S. araliacea.

Basing on the anti-diarrheal activity demonstrated using a modification of the method originally described by which was widely used for the antibacterial and anti-diarrheal susceptibility testing. There is an evidenced loopful bacterial which was then taken from the stock culture and the resultant constituents dissolved in 0.1ml saline(DeLong & Manning, 1994).

Agar cup diffusion method was used to determine the activity of the extracts on the following typed organisms *Escherichia coli*.

Briefly, a 0.1mL of a 10-2 dilution of an overnight broth culture of each organism (containing an inoculum size 106 – 107 cells/mL) seeded into molten but cooled 20mL nutrient agar (pH 7.4 Oxoid) was used. The extracts were prepared (using methanol-water) as 10 and 20mg/mL of hexane, dichloromethane and aqueous were dropped into the 3mm diameter wells bored in the agar(Njateng et al., 2017).

Gentamicin 25mg/mL was used as a positive control, and 50% methanol as negative control. The plates were incubated at 37^{o}C for 24 hours and the diameter of the zone of inhibition was measured to determine the antibacterial activity. The tests were performed in duplicates and average values were recorded and mass spectrometry analysis was used to identify and quantify the compounds present in the sample. This may involve comparing mass spectrometer to standards for peak identification deconvolution and quantification(Yunana et al., 2018).

CHAPTER 3 MATERIALS AND METHODS

3.1 Plant material

The stem bark of *S. araliacea* plant was collected from mature trees from their natural habitat in west Budama county in Nagongera and a voucher specimen was deposited in the department of chemistry Busitema university Nagongera there in for further study and analysis. The stem bark was air dried for a period of two weeks under a shade and the dried sample pulverized.

3.2 Extraction

3.2.1 Aqueous extraction

This was achieved using a decoction technique. Approximately 25g of air dried and pulverized sample of *S. araliacea* stem bark was boiled in (200ml) of distilled water for 2 hours and then cooled. The mixture was then be filtered using a sieve to dispose of the suspended particles. The filtrate was then concentrated to obtain a paste.

3.2.2 Organic extraction

This extract was obtained through adding 10g of *S. araliacea* stem powder to 100ml of 80% methanol in a conical flask and the mixture was shaken occasionally for about 12 hours using an electric shaking machine.

The mixture was then filtered through 110 mm Whatman filter paper and then evaporated to yield a crude extract.

3.3 PHYTOCHEMICAL TESTS

The aqueous and organic extracts of the stem bark of *S. araliacea* was subjected to various phytochemical tests to identify the various active components in *S. araliacea* as stated in the literature. The tests were as follows:(Njateng et al., 2017)

3.3.1 Test for Flavonoids.

Lead-acetate test: 2 ml of the plant extract was mixed with few drops of basic lead acetate solution. Formation of reddish-brown precipitate indicated the presence of flavonoids.

Ferric chloride test: 3 drops of neutral ferric chloride solution was added to 1 ml of an alcoholic solution of the crude extract of *S. araliacea* in a test tube. Formation of a dark red color indicated the presence of flavonoids.

3.3.2 Test for Alkaloids.

Wagner's test

1 cm3 of HCl was added to 3 cm3 of each extract in a test tube. The mixture was heated for 20 minutes, cooled and filtered. 2 drops of Wagner's reagent were added to 1 cm3 of the filtrate and observed for reddish brown precipitate.

3.3.3 Test for glycosides.

1mL of glacial acetic acid was added 1mL of aqueous solution of S. araliacea extract (dissolve a little part of *S. araliacea* prototype in 1mL of distilled water and filter). After cooling, few drops of ferric chloride solution were added to it. The content was transferred to a test tube containing 2mL of concentrated sulphuric acid. Formation of a reddish-brown ring at the junction of two layers indicated the presence of glycosides.

3.3.4 Test for phenolic compounds:

2 ml of the extract of *S. araliacea* solution was mixed with ferric chloride solution. Formation of dark blue color showed the presence of phenolic compounds.

3.3.5 Test for Tannins.

Ferric chloride test: 2 ml of the extract of *S. araliacea* was added few drops of $FeCl_3$ solution. Formation of black precipitate indicated the presence of tannins.

3.3.6 Test for saponins.

5 ml of the extract of *S. araliacea* was placed in a test tube and shaken vigorously for 5-10 minutes to obtain a stable froth and warmed. If the froth persisted, saponins was confirmed present.

3.3.7 Test for steroids.

Salkowski's test. 5 drops of concentrated H_2SO_4 were added to 1cm3 of each extract and observed. A red colouration indicated the presence of steroids.

3.4 QUANTITY OF THE PHYTOCHEMICALS PRESENT

3.4.1 Total flavonoid content

The total flavonoids content in *steganotaenia araliacea* crude extract was determined using aluminum chloride spectrophotometric method. Apigenin was used as a standard and flavonoid content determined as apigenin equivalent. From the standard apigenin solution, the concentrations (0.45, 0.225, 0.1125 & 0.05625 mg/ml) were prepared in methanol. 100 µl of each of the apigenin dilution was mixed with 1500 µl of distilled water followed by 100 µl of 5% sodium nitrate solution and allowed to stand for 6 minutes. Then 150 µl of 10% aluminum chloride solution was added then allowed to stand for 5 minutes after which 200 µl of solution of 1M sodium hydroxide solution was added. The absorbance of this reaction mixture was measured at λmax 416 nm using single beam UV-VIS spectrophotometer. The same procedure was repeated for methanolic extract solution of *steganotaenia araliacea.* All measurements were performed in triplicate for each analysis. The total flavonoids content was determined from the linear equation of a standard curve prepared with apigenin and expressed as mg/g Apigenin equivalent (AE) of the dry extract of *S. araliacea*.

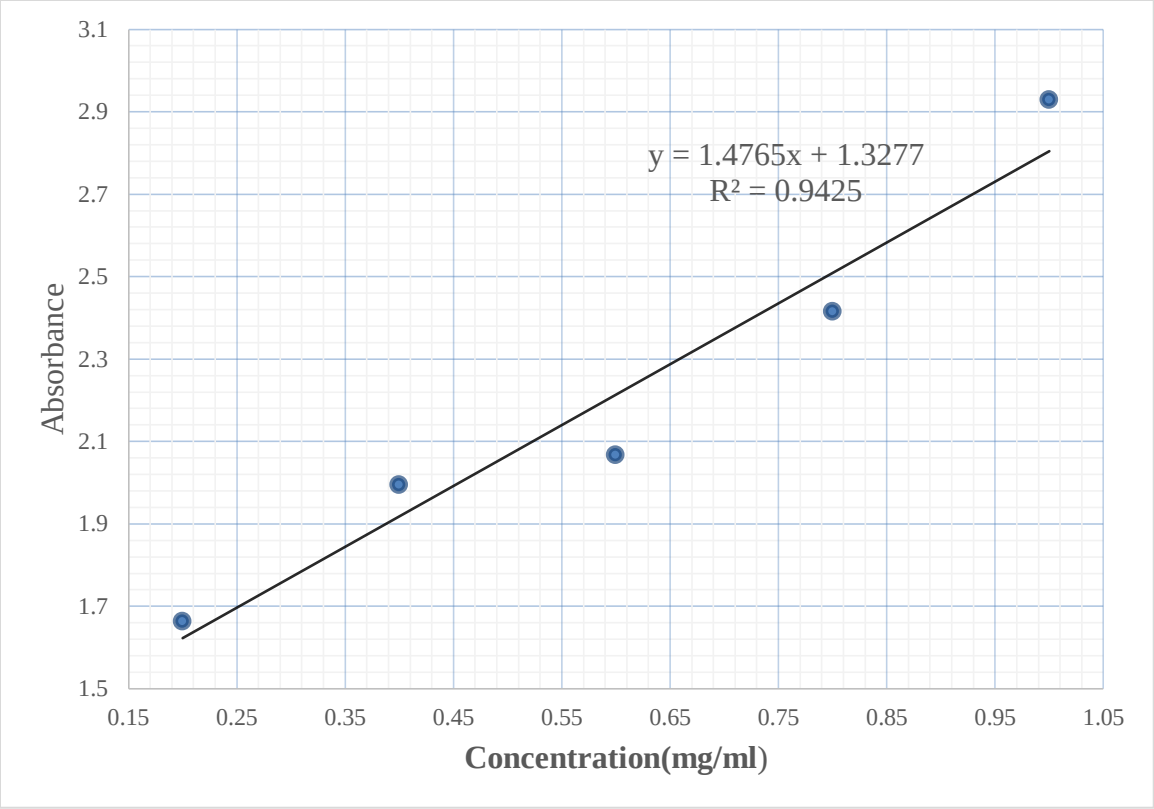


Figure 3: Calibration curve for determination of TF content

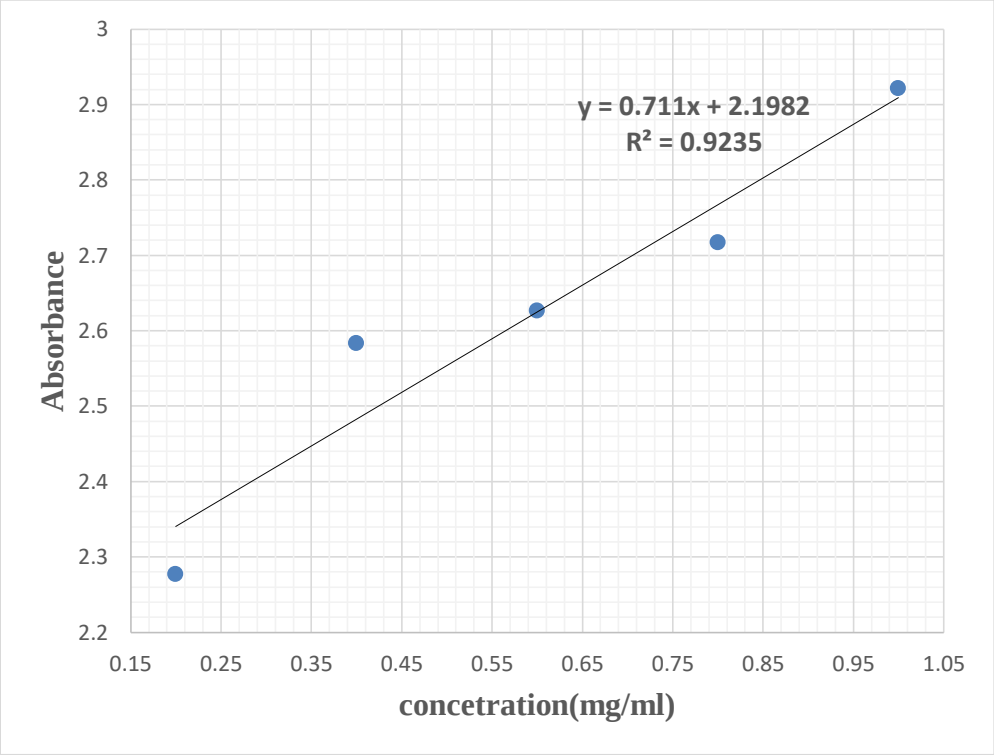
$$Total\ \ Flavonoids = \frac{x * DF * vol\ of\ 80\%\ methanol * volume\ added}{weight\ of\ the\ sample}$$

Where x = concentration of the extract in mg/ml obtained from the calibration curve.

3.4.2 Total phenolic content

Folin-Ciocalteau method was used to estimate the total phenol content in a pulverized sample of *S. araliacea* stem bark. In this method, a methanolic solution of the extract (1000 µg/ml) was added to 2500 µg of 10% Folin-Ciocalteau reagent dissolved in water and 2500 µg of 7.5% sodium carbonate was added. A blank was similarly prepared containing 500 µg methanol, 2500 µg of 10% Folin-Ciocalteau reagent which was dissolved in water and 2500 µg of 7.5% sodium carbonate. The samples were incubated in a thermostat at 45^0C for 45 minutes and their absorbance determined using spectrophotometer at λmax 765nm using a single beam UV-VIS spectrophotometer. The same procedure was repeated for the standard solution of propyl gallate. The calibration curve was constructed using standard propyl gallate solution which was prepared at concentrations of 31.25, 62.50, 125.00, 250.00 and 500 µg/ml. The concentration of phenols was read (µg/ml) from the calibration curve. Thereafter total phenolic content in the plant was expressed in terms of propyl gallate equivalent (mg of PGA/mg of extract).

Figure 4: Calibration curve for determination of TP content

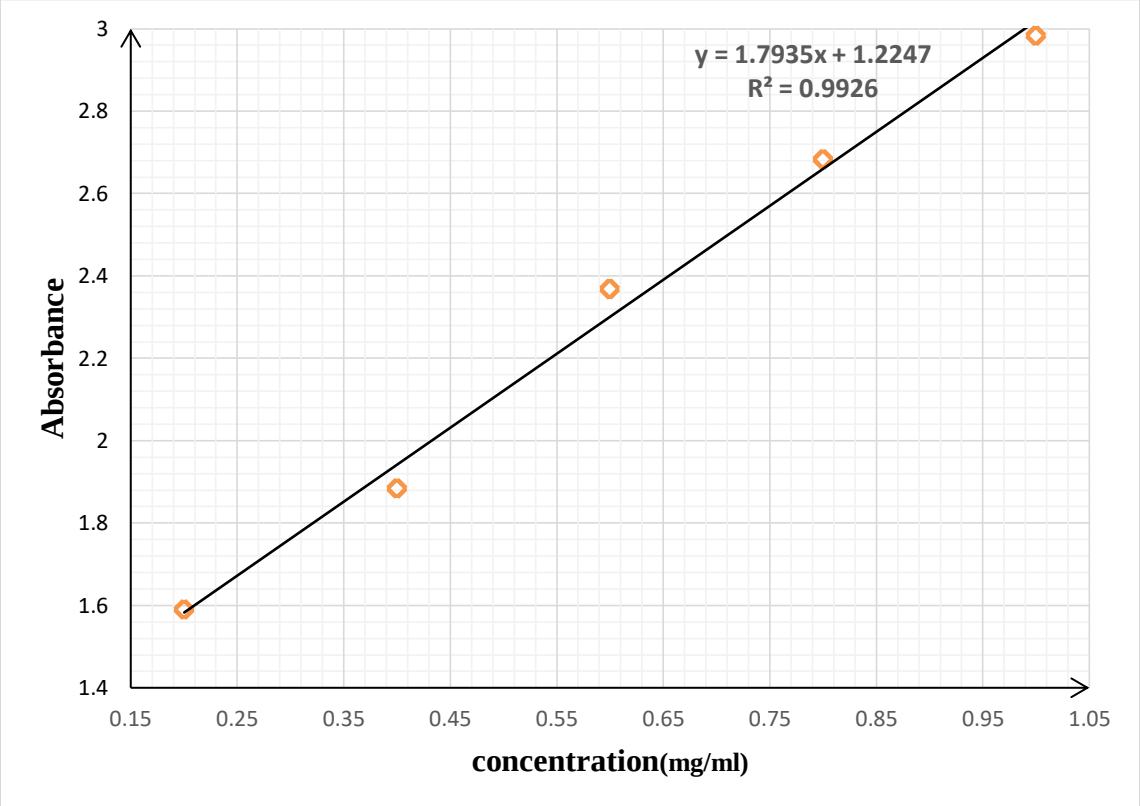


$$Total\ \ Phenols = \frac{x * DF * vol\ of\ 80\%\ methanol * volume\ added}{weight\ of\ the\ sample}$$

3.4.3 Total tannins.

100 µL of 10 mg/mL extract was added to a clean test tube containing 7.5mL distilled water. The Folin-Ciocalteau reagent (500 µL) was added to the mixture and vortexed thoroughly. 10mL of 35% solution of sodium carbonate ($NaCO_3$) was added to the mixture. The mixture in the test tube was transferred to 10 mL volumetric flask and the volume of the mixture was filled up to 10mL with distilled water. The mixture was shaken and kept at ambient temperature for 30 minutes in the dark. Tannic acid was used as a standard and reference standard solutions (31.3-500 mg/ml) were prepared. The absorbance of the solution was measured at 322nm against a blank reagent a single beam UV-VIS spectrophotometer. The calibration curve was constructed using standard tannic acid solution prepared at concentrations of (31.3, 62.5, 125.0, 250.0 and 500 mg/ml). The concentration of phenols was read (µg/ml) from the calibration curve.

Figure 5: Calibration curve for determination of TT Content

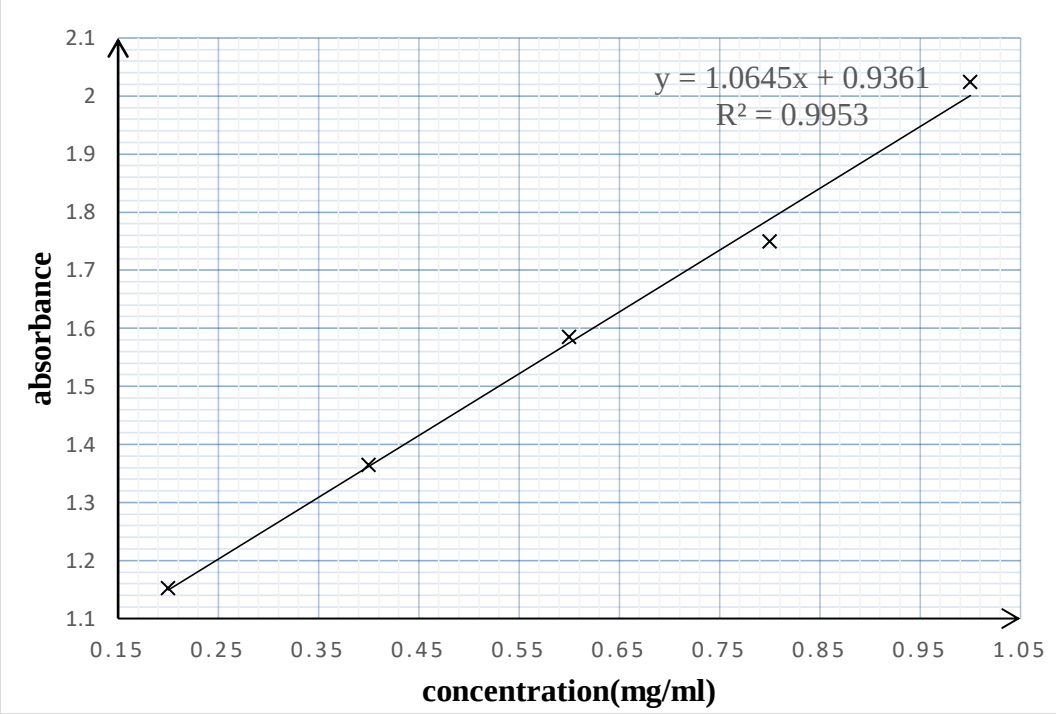


$$Total\ Tannins = \frac{x * DF * vol\ of\ 80\%\ methanol * volume\ added}{weight\ of\ the\ sample}$$

3.4.4 Total alkaloid content.

A solution of 1 mg/ml of plant extract was prepared using dimethyl sulfoxide (DMSO). 1 ml of 2 M HCl is added to 1 ml of DMSO dissolved extracts and the resulting mixture was filtered using filter paper. The filtrate was transferred to a 250 ml separating funnel and to this solution, 5 ml of 0.1% Bromocresol green (dissolved in methanol) was added followed by 5 mL of phosphate buffer (pH 6.6). Chloroform (1 ml) was added into the separating funnel and the mixture was vigorously shaken, after which the funnel was allowed to stand to allow the mixture to separate into different layers. The lower layer is collected in a 10 ml volumetric flask. The process was repeated with 2, 3, and 4 ml of chloroform. Atropine was used to construct a standard curve using a concentration range of 1.0–0.0625 mg/ml The absorbance of the sample and standard solutions was recorded at a wavelength of 470 nm against a reagent blank. The total alkaloid content was expressed as milligram atropine equivalent/ gram of extract (mg APE/g). All the measurements were evaluated in triplicates.

Figure 6: Calibration curve for the determination of TA content



$$Total\ \ Alkaloids = \frac{x * DF * vol\ of\ 80\%\ methanol * volume\ added}{weight\ of\ the\ sample}$$

CHAPTER 4 RESULTS AND DISCUSSION

4.1 Phytochemical screening.

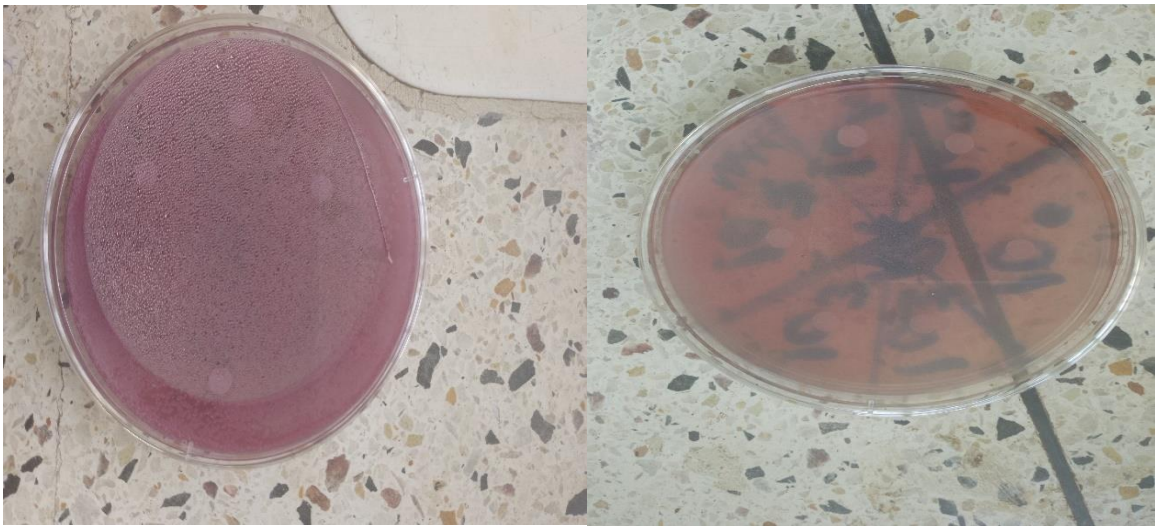
The phytochemical investigation of *S.A* stem bark extract revealed the presence of alkaloids, flavonoids, steroids, tannins, saponins phenolics and glycosides. Total quantification showed a high alkaloid content, moderate tannins and phenols, and low flavonoid Content as shown in table 1.

Table 1: Results of selected phytochemical of organic extract of *S. araliacea* stem bark

Phytochemical	**Test**	**Quantity present**	**Quantified amount (mg/g of crude extract)**
Alkaloids	Wagner's test	+++	125.05
Tannins	Ferric chloride test	+++	64.45
Flavonoids	Ferric chloride test	+	40.37
Saponins	Water & agitation test	+++	Nd
Steroids	Chloroform and sulphuric acid test	+	Nd
Terpenoids	-	-	-
Phenols	Ferric chloride test	++	78.27+
Glycosides	Sulphuric acid test	++	Nd

Key: strongly present +++, moderately present ++, weakly present +, absent -, Nd= not determined

Figure 7: antibacterial activity results



The antibacterial activity of the crude extract of the plant was done at different concentrations of 2mg/ml, 1mg/ml and 0.5mg/ml, however, these did not show a clear zone of inhibition on *E. coli* bacteria as evidenced in figure 7 above. This could suggest that the plant extract may not contain sufficient number of bioactive compounds with antibacterial properties effective on *E. coli.*

The extract may not contain sufficient bioactive compounds that are effective on *E. coli* bacteria and it could be that the bacteria inherently resistant to the bioactive compounds present in the extract and it could also be that the assay used to test the antibacterial activity was not suitable for detecting the effectiveness of the extract. Therefore, the plant extract may not exhibit a promising profile for management of diarrhea.

The high concentration of alkaloids could be attributed to its potential medicinal properties such as anti-inflammatory, antimicrobial and anti-oxidant effects. Additionally, the plant could have evolved to produce these compounds as a defense mechanism which could be harnessed for therapeutic applications.

The flavonoid content low in the plant did not significantly contribute to its antibacterial activity because they are primarily known for their anti-oxidant and inflammatory properties rather than antibacterial activity. Flavonoids play a crucial role in scavenging free radicals and protecting against oxidative stress.

Moderate concentration of phenols in the plant could indicate that the plant may possess a

moderate level of antibacterial and antioxidant activity contributing to its medicinal properties.

Moderate levels level of tannins suggests that the plant may have a moderate level of astringency and bitterness which could be a beneficial in medicinal applications such as treating digestive issues. Tannins can also contribute to the plant's antioxidant activity although their specific effects may vary depending on type and amount present.

CHAPTER 5 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The results of this research suggest that the plant contains phytochemicals particularly flavonoids, alkaloids, phenols, tannins, steroids, saponins and glycosides which validates its use in traditional medicine. High levels of alkaloids exhibited by the plant may signify antibacterial and inflammatory properties, moderate levels of tannins and phenols may enhance the antidiarrheal effects and low flavonoid content may not significantly contribute to antibacterial activity of the plant because they are known for their anti-oxidant and inflammatory properties.

Different concentrations of the crude extract of *S. araliacea* showed no inhibition on *E. coli* justifying that it may not exhibit a promising profile for management of diarrhea.

5.2 Recommendation

It is recommended, that; further investigation should be done against other bacterial strains like *salmonella typhi* to fully explore the antibacterial potential of *S.A.* Further research study should be done on the concentration that could be effective on *E. coli bacteria* because it is a highly resistant.

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