CHARACTERIZATION OF THE ETHANOL ISOLATES OF *Ficus capensis* STEM EXTRACTS

BY

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BENIN CITY

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A PROJECT SUBMITTED TO THE DEPARTMENT OF CHEMISTRY, UNIVERSITY OF BENIN, BENIN CITY, NIGERIA, IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF SCIENCE DEGREE (B.Sc)

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CERTIFICATION

This is to certify that this project work was carried out by OGIZIEN VICTORY EGHONGHON with the Matriculation of PSC2010405 of the Department of chemistry, University of benin, Benin city, Nigeria.

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(HEAD OF DEPARTMENT) _____

DEDICATION

I dedicate this project to God Almighty for His guidance and protection.

To my loving parents, MR and MRS OGIZIEN, thank you for your unwavering support. I will make you proud. God bless you.

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I am deeply thankful to God almighty who has kept me going despite my shortcoming, down and trying time during my undergraduate years.

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ABSTRACT

Ficus capensis, a wild fig tree remains the most readily available remedy to many of human problems. The free oxygen we breathe in comes from plants and many more nutritional and health benefits which are yet to be discovered. This is why the proximate analysis, phytochemical screening, mineral content and the ethanol isolate of *Ficus capensis* stem bark extracts were investigated. The proximate analysis, phytochemical screening and mineral content analysis were carried using standard methods and the Ethanolic extracts were obtained by maceration technique. The proximate analysis of the stem bark extracts revealed; 60.12%, 20.35% and 8.37% for carbohydrate, crude fibre and moisture content respectively. The presence of active phytochemical constituents such as alkaloids, glycosides, flavonoids, saponins, terpenoids, phenolics and eugenols were detected in the stem bark. Among the minerals present in the stem bark was potassium which gave the highest concentration of 17.7ppm respectively. Others were Na (12.60ppm), Ca (5.62ppm), Mg (1.63ppm), Fe (5.30 ppm) and Cr (0.05 ppm). This study suggests that the plant samples have useful phytochemicals and minerals which can have useful pharmacological effects and also serve as nutritional supplement. The results of the ultraviolet-visible, gas chromatography spectral and infra-red analysis reveals the presence of carboxylic acid and nitro functional group in the UV-VIS, for GC-MS spectra the compound detected were benzoic acid, 2-nitroso, acetic acid e.t.c and for IR analysis reveals the presence of Amines, alkyl group and alcohol functional group.

CHAPTER ONE

INTRODUCTION AND LITERATURE REVIEW

INTRODUCTION

The practice of healing with medicinal plants is as ancient as humanity itself. The relationship between humans and their quest for natural remedies extends back to ancient times, with ample evidence found in various forms, including ancient texts, historical monuments, and even original herbal remedies. The awareness of how to utilize medicinal plants has emerged over many years of battling illnesses, leading people to seek out healing properties in different plant parts such as barks, seeds, and fruits. Modern science has recognized the efficacy of these plants and has integrated numerous plant-based medicines into current pharmacotherapy, many of which were known to ancient civilizations and have been utilized for thousands of years. The evolution of knowledge surrounding medicinal plant usage and its historical context has enhanced the capability of pharmacists and doctors to meet the challenges posed by the ongoing advancement of professional healthcare services aimed at improving human life (Bilijana Bauer and petrovska, 2012). Approximately one billion people, primarily in develeloping countries, rely on wild plants for their nutrition, according to report from the food and Agricultural Organization (Bharucha and Pretty, 2010). They are said to be vital components of the human diet since they provide the body with nutrients like Vitamins, Minerals and certain hormones, precursor's in addition to energy and proteins (Akubugwo *et al*., 2007). According to Khan *et al*., (2016), The fact that wild edible plants are excellent sources of Proteins, Minerals, Vitamins, dietary fiber, Carbohydrates, Essential fatty acids, antioxidants, phenolic compounds, and Secondary metabolites has led to rise in interest in these plants among people worldwide in recent years. For centuries, Medicinal plants are sources of raw materials for pharmaceutical

drug formulation [World Health Organization (WHO), 2014]. Medicinal plants contain numerous biologically active compounds such as phytochemicals which have physiological actions on the human body and important active components used for treating various ailments (Okigbo R.N *et al*., 2008). *Ficus capensis* can also serve as vegetables being one of the most affordable and readily accessible sources of Proteins, Vitamins and Minerals. Thus, they pose great help in providing medicinal Benefits (Thompson and Kelly, 1990). Herbs and vegetables also have plenty of Phytonutrients which are extremely valuable for our body and good health. *Ficus capensis* commonly called bush fig tree is one of the numerous plants used in ancient medicine. it is locally called in Nigeria Opoto (Yoruba), Akokoro (Igbo), Rima Bichechi (Fulani), Obada (Edo) and Uwaraya (Hausa). It belongs to the family *Moraceae*, the leaves of the plants are used for numerous medicinal purposes. In Nigeria, the decoction is used in treating diarrhoea, dysentery, oedema, epilepsy and rickets in infants. It is used to treat cold, sore throats, wounds and to stimulate lactation. The fruits and seeds are eaten raw as supplements by local population of Africa. Research has shown that it can help boost blood levels, prevent sickling in red blood cells, fight bacterial infections, support the immune system, prevent miscarriage, and relieve diarrhea, among other benefits. With the interest in Medicinal plants and the quest of getting a replacement for high cost of synthetic drugs in order to sustain individual's well-being and health as well as the bio prospecting of new derived drugs (Ani *et al*., 2024). Many plants native to Nigeria have long been recognized for their medicinal and pest-control properties (Ayensu, 1978; Okwule, 1992, 1998). However unfortunately, only a small number of these plants have been thoroughly researched to identify their active compounds (Takeda & Fatope, 1988; Okwute, 1989). Phytochemicals are chemical compounds that occur naturally in plants (phyto means "plants" in Greeks), some are responsible for colour and others for organoleptic properties, such as the deep purple of blue berries and the smell of garlic. Phytochemical composition or plants varies in their leaves, stem, roots, bark and seed (Mgbemena N.M.*et al*.,

2020). According to James (2000), examples of these compounds include flavonoids, tannins, saponins, terpenes, and other similar compounds. Phytochemical screening is very crucial in the determination of the important and active bio ingredients in the plants. There are many phytochemicals and each works differently. Some of the possible actions are via antioxidants, hormonal action, and stimulation of enzymes, interference with DNA replication, antibacterial effect and physical action (Papp, *et al.*, 2007).

1.1 BACKGROUND OF STUDY

Ficus capensis plant, commonly known as the Bush Fig has long been valued in Nigerian traditional medicine, where its roots, stems, and leaves are used for various therapeutic purposes. This study seeks to explore the phytochemical composition, mineral content, proximate analysis, Isolation and Extraction of the different compounds of *Ficus capensis* stem extract and biological activity of the plant, particularly its potential in combating typhoid fever and other microbial infections. Given the rising concerns over antibiotic resistance caused by the rapid and unpredictable genetic mutations of micro-organisms, there is a growing need for alternative treatments derived from natural sources of *Ficus capensis*. In recent years, there has been increasing interest in alternative therapies and the medicinal applications of natural products. This has driven the ongoing search for bioactive compounds derived from plants that could serve both nutritional and therapeutic purposes (Oktay *et al.*, 2003; Wangensteen *et al.*, 2004). It is well established that plants contain essential oils and various extracts that can be used as alternative treatments for infectious diseases. Due to their lower cost and reduced side effects, medicinal plants are often preferred over synthetic drugs (Kumar *et al*., 2012). Given the complications and potential harmful effects associated with chemical drugs, natural and herbal medicines have gained significant attention, leading to a notable increase in their use in recent years (Firenzuol*i et al*., 2007). The search for plant-based antimicrobial compounds is

particularly relevant in the face of rising antibiotic resistance, which has become a global public health concern, especially in relation to foodborne illnesses and infections (Mora *et al.*, 2005; Navon-Venezia *et al.*, 2005). Naturally occurring antimicrobials are being explored as alternatives to synthetic preservatives, such as parabens (ethyl, methyl, butyl, and propyl parabens), butylated hydroxytoluene (BHT), and butylated hydroxyanisole (BHA), which have been scrutinized for their potential carcinogenic effects (Wangensteen *et al*., 2004; Bergfeld *et al*., 2005). Plants synthesize numerous organic compounds with anti-inflammatory and antimicrobial properties, making them valuable sources for therapeutic agents. The investigation of the phytochemical profile, mineral composition, proximate analysis, and biological activity of *Ficus capensis* is particularly intriguing, as it integrates elements of botany, chemistry, and pharmacology. Commonly known as the Bush fig, *Ficus capensis* is a significant species within the *Ficus genus*, recognized globally for its medicinal properties in traditional medicine. Analyzing its phytochemical constituents provides insight into its potential therapeutic applications. Research has aimed to identify the bioactive compounds responsible for its healing effects. Phytochemical screening of *Ficus capensis* has revealed the presence of tannins, terpenoids, alkaloids, flavonoids, cardiac glycosides, and reducing sugars, whereas steroids and anthraquinones were absent in the water extracts of its leaves and bark. Saponins were found in the bark but not in the leaves. The ethanol extracts of the leaves and bark contained terpenoids, flavonoids, steroids, cardiac glycosides, and reducing sugars, but anthraquinones were absent. Alkaloids were detected in the ethanol extract of the bark but were absent in the leaves. Adebayo and Adeniyi, (2006) reported the presence of tannins in the bark, with the highest levels of saponins found in the leaves, followed by the stem and the least in the bark. Alkaloids and phenolics were most abundant in the bark, while their levels were lowest in the leaves, and terpenoids and flavonoids were found in the highest concentrations in leaf samples. Similarly, Owolabi *et al*., (2011) reported the presence of saponins, cardiac glycosides, tannins, and

flavonoids, along with traces of alkaloids and anthracene derivatives in the stem bark. Examining the mineral composition of *Ficus capensis* provides further understanding of its elemental content, highlighting its nutritional value and potential health benefits. The isolation and extraction of compounds from the stem of *Ficus capensis* have contributed to the study of traditional medicine, which has long utilized plant-based remedies for various health conditions, including pregnancy-related complications. Ficus capensis (wild fig tree) is a medicinal plant widely recognized for its healing properties (Omokhelin Owolabi *et al*., 2008). Ethanol extracts from its stem bark have been reported to exhibit anti-inflammatory, diuretic, and tocolytic effects. Minerals play essential roles in human physiology, and studying the mineral composition of Ficus capensis could help clarify its nutritional benefits and potential as a dietary supplement or functional food. Additionally, exploring its biological activities such as antioxidant, antibacterial, anti-inflammatory, and anticancer properties offer promising insights into its healing potential and broadens the scope of natural treatment options in medicinal botany. This interdisciplinary study of *Ficus capensis* highlights its significance in both traditional and modern medicine, reinforcing its relevance as an important subject of scientific research.

1.1.1 STATEMENT OF PROBLEM

The research on "phytochemical screening, mineral analysis, proximate analysis, biological activities and studying the ethanol isolate of different components of *Ficus capensis* extract aims to comprehensively explore the chemical composition and potential health benefits of this plant species. Despite its traditional medicinal use and widespread distribution, little is known about the specific phytochemicals, minerals, proximate analysis and different extracted components and biological activities of *Ficus capensis.* This lack of knowledge hinders its full potential in modern healthcare and nutrition. With the rising interest in natural therapies and alternative healthcare options, it is crucial to bridge this gap. Understanding the phytochemicals, minerals,

and biological activities of *Ficus capensis* could unlock its therapeutic and nutritional potential, leading to evidence-based medicines and supplements. The study is designed to address this gap by meticulously analyzing the phytochemical, mineral, proximate analysis, biological activities and studying the ethanol isolate of different compounds of *Ficus capensis* extract paving the way for future research and potential applications in healthcare and nutrition.

1.1.2 JUSTIFICATION /RELEVANCE OF STUDY

Almost all the parts of *Ficus capensis* plant have been found useful. Some parts are used to treat pregnancy-related ailments most especially cases of threatened abortion. The bark decoction is used in Senegal in baths for the new-born, children with rickets and feverish children. The bark pulped up with Xylopia fruit is given in enemas for oedema. The latex is used for treating wounds, toothache, eye problems, general body pain, lung and throat problems, gonorrhea and an anti- emetic. Root preparations of *Ficus capensis* are used for the treatment of cough, sore throat, diarrhoea, stomach pain in babies, chest pain, infertility, uterine pain, gonorrhoea and oedema. Bark decoctions or infusions are used against pain, rheumatism, diarrhoea, stomach problems, oedema in children, infertility and as a galactagogue; bark macerations are drunk for treatment of fever and cough, and the powdered bark is applied on skin rashes and mouth sore (Esievo *et al*., 2018). In Nigeria, *Ficus capensis* has been used by the Igede people Benue state as a treatment for dysentery and in wound dressing. Gil, (2020) reported the use of the plant leaves in treating dysentery, oedema, epilepsy and rickets in infants among some tribes in Edo-Delta areas. *Ficus capensis* is believed by the Igala people of Kogi State to possess immune - boosting property hence, forming part of most of their traditional remedies for several ailments (Samuel Onuche Antony *et al*., 2018). It is also used to treat circumcision wounds, leprosy and epilepsy, rickets, infertility, gonorrhea, edema and respiratory disorders (Olowokudejo *et al*., 2008) and abortion (Owolabi *et al*., 2009). Apart from its traditional uses, scientific

investigations have reported its; blood-boosting effect (Otitoju *et al*., 2014; Njoku-oji *et al*., 2016), anti-sickling (Umeokoli *et al*., 2013; Mpiana *et al*., 2008), antibacterial (Oyeleke *et al*.,2008), anti-abortifacient (Owolabi *et al*., 2009), immune-stimulatory (Daikwo *et al*., 2012), antidiarrhoea (Owolabi, 2013), antioxidant (Ramde Tiendrebeogo *et al*., 2012), anti-Cancer and anti-paracitic (Haq Nawaz *et al*., 2019) and pro-fertility in treating azoospermia (Gelfand *et al*.,1985; Akomolafe *et al*., 2016). Previous work relating to *Ficus carpensis* showed antispasmodic and antiplasmodial activities from aqueous and leaves (Sanon *et al*., 2003; Ayinde *et al*., 2003). Hence there is need to evaluate extensively the phytochemical, minerals present, proximate analysis, antibacterial, anti-inflammatory, anti-sickling and Extraction of different components of *Ficus capensis* stem and bark extract.

1.1.3 SCOPE OF STUDY

The scope of this work majors on conducting a comprehensive analysis of *Ficus capensis*, encompassing phytochemical screening, mineral content evaluation, proximate analysis, nutritional assessment, environmental considerations, as well as the ethanol isolate and extraction of various bioactive compounds of *Ficus capensis* stem extracts.

1.1.4 AIM

This study aims to investigate the medicinal properties of *Ficus capensis*, specifically the bush fig tree, by examining its pharmacological effects, isolating and extracting its bioactive compounds of Ficus capensis stem extract using ethanol, analyzing its traditional medicinal uses and phytochemical composition. The research will also involve assessing the mineral content, proximate analysis and nutritional properties of the stem extract of *Ficus capensis* using various solvents. The findings of this study will provide valuable insights into the development of new natural health products.

1.1.5 SPECIFIC OBJECTI VES

To achieve this goal, we have set the following objectives:

1. Identify and quantify the key phytochemicals present in *Ficus capensis*, including alkaloids, flavonoids, and tannins. etc.

2. Determine the proximate composition of *Ficus capensis* including moisture content, crude protein, crude fiber, lipids, carbohydrates, and ash content.

3. Examine the mineral profile of *Ficus capensis*, with emphasis on key minerals like calcium, iron, and sodium, potassium etc.

4. Isolation and extraction of various compounds from the *Ficus capensis* stem extract using ethanol.

1.2 LITERATURE REVIEW

1.2.1 TAXONOMY/CLASSIFICATION OF *FICUS CAPENSIS*

KINGDOM *Plantae*

PHYLUM *Spermatophyta*

CLASS *Magnoliopsida*

SUBCLASS *Dilleniidea*

ORDER *Urticales*

FAMILY *Moraceae*

GENUS *Ficus*

SPECIES *Ficus carpensis*

Common Names; Wax-leaved fig,Cape fig, broom cluster or bush fig (Cronquist *et al*., 1835) .

1.2.2 MORPHOLOGY OF *FICUS CAPENSIS*

Ficus capensis is a tree species belonging to the *Moraceae* family. *Ficus capensis* commonly called "bush fig tree", it can also be named *Ficus riparia, Ficus ituriensis, Ficus guineensis and Ficus thonningiana* while its common names are cape fig and broom cluster fig (Berg, 1991). *Ficus* is a genus of above 850 species of woody trees, shrubs, vine-epiphytes and hemiepiphytes in the family *Moraceae*. The plant is a fast - growing, deciduous or ever green tree and usually grows to about 5 -12 metres (16 -39ft) in height but may attain a height of 35 - 40 metres (115 -

131ft). The tree has a spreading canopy with glossy, waxy leaves, the leaves are alternate simple and leathery, with a shiny surface. They are elliptic to obovate in shape and have prominent veins. The fig fruits produced by *Ficus Capensis* are small, rounded and turn from green to purple or black when ripe. The fruit are enclosed within a fleshy structure known as Syconium, which is characteristic of Figs. The fig fruits of *Ficus capensis* are enjoyed by various animals, including birds, monkey, and bats which help disperse the seeds and contribute to the tree's reproductive success. In some regions, the fig fruits are collected and consumed by local communities for their nutritional value, Additionally, the tree provides shade and can be used for land scaping purpose in garden and parks (Esievo *et al*., 2018). Fruits are borne on short, rounded peduncles approximately 3cm long, which may develop from the surface roots, the trunk, or more commonly from the lower primary branches (Hankey, 2003). These fruits are edible and are consumed fresh or dried by indigenous populations across many parts of the globe. The fruits are typically rough and come in colors such as gray, pink, or red, with a white latex. This species is part of the genus *Ficus*, which is the largest genus within the *Moraceae* family, containing over 1500 species (Amde-Tiendrebeog *et al*., 2012). *Ficus* species are found in tropical and subtropical areas worldwide, exhibiting a wide range of morphological traits (Arbonnier, 2000). In Nigeria, this tree is cultivated throughout the country but is particularly plentiful in the North-Central region, known as the Middle Belt. It is referred to as ogbaikolo by the Igala people, Opoto by the Yoruba, Akokora in the Nsukka region of Enugu State, Uwaraya in Hausa, Rimabichechi by the Fulani, and Obada in Edo State.

Plate 1: ***Ficus capensis*** **Young leave (A), Fruits (B), Matured leaves (C), Stem with fruits (D).**

Plate 2: A mature specimen of *Ficus capensis*.

1.2.3 ETHNOMEDICINAL USES OF *FICUS CAPENSIS*.

Ficus carpensis leaves, stems, bark, fruits have been discovered to be helpful in curing various diseases. Some parts are used to treat pregnancy-related ailments most especially cases of threatened abortion (Owolabi *et al*., 2009). The bark decoction is used in Senegal in baths for the new-born, children with rickets and feverish children. The bark pulped up with Xylopia fruit is given in enemas for oederna (Burkill 1997; Fadimu *et al*., 2014). The latex is used for treating wounds, toothache, eye problems, general body pain, lung and throat problems, gonorrhoea and as an anti-emetic. Root preparations of *Ficus capensis* are used for the treatment of cough, sore throat, diarrhoea, stomach pain in babies, chest pain, infertility, uterine pain, gonorrhoea, oedema, and as a menstrual stimulant and emetic. The decoctions or infusions are used against pain, rheumatism, diarrhoea, stomach problems, oedema in children, infertility and as a galactagogue; bark macerations are drunk for treatment of fever and cough, and the powdered bark is applied on skin rashes and mouth sore (Ruffo *et al*., 2002). The leaves are chewed as a remedy for peptic ulcer, leaf maceration is drunk against chest problems, leaf infusions are drunk to treat tonsillitis and stomach pain. Sap squeezed from leaves is applied on wounds; leaf decoctions are used as a disinfectant wash and in the treatment of ophthalmia, the sap of young shoots is taken against gonorrhoea, preparations are used to treat infertility, tuberculosis, abscesses, sores, and as a lactogenic, purgative and aphrodisiac. The plant has been used extensively for the management of leprosy, epilepsy, rickets, infertility, gonorrhoea, oedema, respiratory disorders and as emollient (Olowokudejo *et al*., 2008). In Nigeria, *Ficus capensis* has been used by the Igede people in Benue state as a treatment for dysentery and in wound dressing (Igoli *et al*., 2005). Gill LS, (1992) reported the use of the plant leaves in treating dysentery, oedema, epilepsy and

rickets in infants among some tribes in Edo-Delta areas. *Ficus capensis* is believed by the Igala people of Kogi State to possess immune - boosting property hence, forming part of most of their traditional remedies for several ailments (Daikwo et al., 2012). The leaf extract of *Ficus capensis* is used in some part of Nigeria as blood booster. Traditionally, different parts of the plant have been used in the treatment of ulcers, psoriasis, anemia, piles jaundice, vitiligo, hemorrhage, diabetes, convulsion, hepatitis, dysentery, biliousness, and as lactagogue and purgative (Sikiru Abiola Ojokuku *et al., 2010*). *Ficus capensis* leaf, stem, root and seed contained good amounts of minerals, phytochemicals, proximate and also showed good efficiency for antibacterial inhibition. It is therefore recommended and encouraged for consumption (Mohammed Ali and Nisha Chaudhary, 2011). In Sudan and Nigeria, its leaves and roots are used for treatment of leukoderma, leprosy, wounds, edema, respiratory disorders, diarrhea, sexually transmitted diseases, tuberculosis, anemia, epilepsy, rickets, dysentery, male infertility and gonorrhea. Ethnobotanical studies also showed *Ficus capensis* is used to treat swellings and edema, ln South Africa and other countries it is traditionally used in kidney problems and as a diuretic. In Ethiopia, the pounded fresh leaves of *Ficus capensis*, mixed with water are given orally as a traditional medication for urine retention thereby to alleviate the problem via increasing urine output.

1.2.4 PHARMOLOGICAL ACTIVITIES OF *FICUS CAPENSIS*

Ficus capensis has been scientifically proven to be biologically useful as drug/medicine because of its antimicrobial, antibacterial, antifungal, antioxidant and anti-sickling activities.

I. MICROBIAL INHIBITORY ACTIVITIES

Several studies have proven the microbial inhibitory activity of *F. capensis*. Microbial inhibitory activities of the stem, root and leaf of *F. capensis* against test disease-causing microorganisms

were reported (Adebayo - Tayo *et al*., 2012). The bark extracts had the highest inhibitions on *Pseudomonas aeruginosa, Candida albicans* and *Staphylococcus aureus*. While *Streptococcus faecalis* and *Proteus mirabilis* were resistant to many antibiotics (87.5%), they were effectively inhibited by all concentration of ethanolic extract of *F. capensis* extract. (Oyeleke *et al*., 2008) reported the inhibitory effect of the leaves and stem bark of *F. capensis* against *Esherichia coli* and *Shigella* species but no activity against *Salmonella typhi.* Solomon-Wisdom *et al*., (2011) reported the crude extract inhibited *S. aureus*, *Escherichia coli, Bacillus subtilis* and *Candida pseudotropicalis* at 2mg/ml but *P. aeruginosa* and *Salmonella typhimorium* were not inhibited at the same concentration. Ogundare *et al*., (2013) also reported antimicrobial activities of the methanol extract of *Ficus capensis* leaf against some clinical pathogenic bacteria namely: *Escherichia coli, Klebsiella pneumoniae, Proteus mirabilis, Staphylococcus aureus, Serratia marcescens, Pseudomonas aeruginosa, Micrococcus roseus* and *Bacillus cereus*. The leaf extract had inhibitory effect on all the test organisms except *Pseudomonas aeruginosa.*

II. ANTI-ULCER ACTIVITY

The anti-ulcer effects of the aqueous extract of the leaves of *Ficus capensis* were evaluated in rats using diclofenac sodium-induced ulcer model. The extract showed significant ($P<0.05$) dose-dependent anti-ulcer activity. The percentage ulcer inhibition of the extract at 100, 150 and 200 mg/kg were 25, 41.7 and 43.3% respectively, while that of ranitidine (150 mg/kg) was 66.7% (Eluka *et al*., 2015).

III. ANTI-SICKLING ACTIVITY

Ficus capensis was reported to have shown significant anti- sickling activity because of the anthocyanins and terpenoids present in the plant. It was said to have reversal anti-sickling activity (Mpiana *et al*., 2008). The anti-sickling test showed inhibition of sickling at 32.81% and

36.9% respectively on sickled red blood cell samples from patients using concentration of 50g/L and 100g/L. Significantly, high and anti-sickling properties of the plant have been reported (Umeokoli *et al*., 2015).

IV. ANTI - ABORTIFACIENT ACTIVITY

The ethanolic extract obtained by maceration technique was subjected to pharmacological testing on a piece of isolated rat uterus previously pretreated with stilbestrol, suspended in De Jalon at 37^0C. Concentrations used were 40 mg/mL and 80 mg/mL. The higher concentration (80 mg/mL) significantly ($p< 0.05$) exerted smooth muscle relaxant activity on the uterus (a reduction of oxytocin, ergometrin and acetylcholine induced contractions as well as an increase of the EC50 was observed for all the agonists tested in the presence of the extract). Evaluation of the data also indicated that the effect of the 40 mg/mL concentration was statistically insignificant, although a lowering of the dose response curve was observed for oxytocin, acetylcholine and ergometrin. Its relaxant activity at 80 mg/mL was 40 and 50% of the inhibitory effects produced by salbutamol (0.002 µg/mL) and atropine (0.02 µg/mL) on oxytocin and acetylcholine induced contractions, respectively. The results indicate the presence of active principles in the bark extract of *Ficus capensis* which may be responsible for some of the applications in traditional medicines as an anti-abortifacient and as a remedy against threatened abortion (Omonkhelin owolabi *et al*., 2009).

V. ANTIDIARRHEAL ACTIVITY

The leaf aqueous extract of the plant produced a significant dose-dependent increase in percentage inhibition of the movement of charcoal meal in the small intestine of the mice ($P < 0.05$). The extract showed a percentage inhibition of 23.52% 31.41% and 48.95% at a dose of 100 mg/kg, 200 mg/kg and 400 mg/kg. This is comparable to atropine at a dose of 0.1 mg/kg

which showed a percentage inhibition of 44.02%. The aqueous extract also exhibited a dose-dependent increase in the average onset of stooling in the animal using castor oil model. The onset of stooling in atropine treated animals was 19 + 0 min. The leaf extract exhibited a significant dose dependent decrease in the number and weight of stool produced by the mice (Ayinde *et al*., 2013).

VI. ANTI - INFLAMMATORY ACTIVITY

The methanolic stem bark extract of *Ficus capensis* was investigated for anti-inflammatory and anti-nociceptive activity. The anti-inflammatory effects were investigated using rat paw edema model, while the analgesic effects were studied using acetic acid induced writhing in mice. The results obtained revealed that the methanolic stem bark extract of *Ficus Capensis* in doses of 50 and 100 mg/kg possess significant ($P< 0.05$) dose dependent anti-inflammatory effect and inhibit abdominal contractions caused by acetic acid in mice. The intraperitoneal LD50 in mice was found to be 470 mg/kg. The preliminary phytochemical screening revealed the presence of glycosides, flavonoids, tannins, alkaloids and saponins.The results of this study indicated the presence of biologically active substances which may be beneficial in the treatment of pain and inflammation (Lawan et al., 2008).

VII. TOXICITY OF *FICUS CAPENSIS*

The acute toxicity test of the aqueous leaf extract showed no death or obvious signs of toxicity up to 5000 mg/kg body weight. Oral administration of aqueous extract of *F. capensis* up to 5 g/kg caused no death in mice. Also, no signs of obvious behavioural and physical adverse effects were observed (Eluka *et al*., 2015).

VIII. LEUKOCYTES MOBILIZATION

Daikwo *et al*., (2012) observed the plant extract increased leukocyte mobilization in all the treated groups in a study. Evaluation of data obtained from their study indicated a significant ($p<0.05$) dose-dependent increase in leukocyte mobilization, with doses 150 and 250 mg/kg respectively, the most mobilized being neutrophils at a dose of 250 mg/kg.

IX. IMMUNE-BOOSTING ACTIVITY

The immune system is subject to modification by substances to either enhance or suppress its ability to resist invasion by pathogens. Justification of the folkloric use of the plant as an immune boosting agent has been reported (Daikwo *et al*., 2012).

1.3 MINERALOGY/MINERAL ANALYSIS

Mineral analysis involves examining materials to determine the mineral composition and mineral structure. The analysis can be used to identify mineral species and understand their characteristics and properties. Atomic absorption spectrophotometer (AAS) and Flame photometer can be used to determine the minerals present. *Ficus capensis* leaves were found to have high quantities of calcium, magnesium and phosphorus. Iron, zinc, copper and manganese were present but not in very high concentration, sodium and potassium were absent, Manganese was absent in *Ficus Capensis* bark while calcium were present in high concentration. (Uzoekwe *et al*., 2015).

1.3.1 DIFFERENT MINERALS AND THEIR HEALTH BENEFITS

1.3.1.1 Calcium (Ca)

Calcium is a nutrient that all living organisms need, including humans. Dietary sources of calcium include dairy products, green leafy vegetables, nuts, seeds, and fortified products. Calcium is the most abundant mineral in the body. Humans need calcium to build and maintain strong bones, and 99% Trusted Source of the body's calcium is in the bones and teeth. It is also necessary for maintaining healthy communication between the brain and other parts of the body. It plays a role in muscle movement and cardiovascular function. Calcium occurs naturally in many foods, and food manufacturers add it to certain products. Supplements are also available. Alongside calcium, people also need vitamin D, as this vitamin helps the body absorb calcium. Vitamin D comes from fish oil, fortified dairy products, and exposure to sunlight.

Health Advantages: Calcium plays various roles in the body. These include the following; Bone health: Around 99% of the calcium in the human body is in the bones and teeth. Calcium is essential for the development, growth, and maintenance of bone. As children grow, calcium contributes to the development of their bones. After a person stops growing, calcium continues to help maintain the bones and slow down bone density loss, which is a natural part of the aging process. Females who have already experienced menopause can lose bone density at a higher rate than males or younger people. They have a higher risk of developing osteoporosis, and a doctor may recommend calcium supplements.

Muscle contraction: Calcium helps regulate muscle contraction. When a nerve stimulates a muscle, the body releases calcium. The calcium helps the proteins in muscle carry out the work of contraction. When the body pumps the calcium out of the muscle, the muscle will relax. Cardiovascular system: Calcium plays a key role in blood clotting. The process of clotting is

complex and has a number of steps. These involve a range of chemicals, including calcium. Calcium's role in muscle function includes trusted Source maintaining the action of the heart muscle. Calcium relaxes the smooth muscle that surrounds blood vessels. Various studies have indicated a possible link between high consumption of calcium and lower blood Pressure. Vitamin D is also essential for bone health, and it helps the body absorb calcium. Calcium is a co-factor for many enzymes. Without calcium, some key enzymes cannot work efficiently. Studies have also suggested that consuming enough calcium can result in a lower risk of developing conditions involving high blood pressure during pregnancy, lower blood pressure in young people, lower blood pressure in those whose mothers who consumed enough calcium during pregnancy, improved cholesterol values and a lower risk of colorectal adenomas, a type of non-cancerous tumor (Peter morales - Brown, 2023).

Sources: People can obtain calcium from a range of foods and drinks like yogurt, milk, fortified dairy alternatives, such as soy milk, sardines and salmon, cheese, tofu, green leafy vegetables, such as broccoli, turnip leaves, watercress, and kale, many fortified breakfast cereals, fortified fruit juices, nuts and seeds, especially almonds, sesame, and chia, legumes and grains, cornmeal and corn tortillas. Some dark green vegetables, such as spinach, contain calcium.

Insufficient Calcium: Insufficient calcium can weaken bones and cause osteoporosis, a condition marked by brittle bones and a higher chance of falling (Institute of Medicine, 2011). While vitamin D insufficiency is most frequently the cause of these problems, calcium shortage can also result in rickets in children and other bone disorders in adults. The rickety development cartilage in children might cause irreparable abnormalities to the skeletal structure because it does not mineralize normally (Institute of Medicine, 2011). Osteomalacia, or abnormal bone mineralization and softening, is another consequence of long-term calcium insufficiency that can affect both adults and children (Institute of Medicine, 2011).

1.3.1.2 Zinc (Zn)

Zinc is an essential nutrient found in a variety of plant and animal foods, along with supplements. It plays a key role in skin health, immune function, and cell growth and may protect against acne, inflammation, and other conditions. Zinc is a nutrient that plays many vital roles in your body. Because your body doesn't naturally produce zinc, you must obtain it through food or supplements. Zinc is considered an essential nutrient, meaning that your body can't produce or store it. For this reason, you must get a constant supply through your diet. Zinc is required for numerous processes in your body, including: gene expression, enzymatic reactions, immune function, protein synthesis, DNA synthesis, wound healing, growth and development. Zinc is naturally found in a wide variety of both plant and animal foods. Foods that don't naturally contain this mineral, such as breakfast cereals and snack bars, are often fortified with synthetic forms of zinc. For all living organisms, zinc is a trace element that is necessary. It was only lately that the importance of zinc for human nutrition and public health was realised. Many specialists have acknowledged that inadequate zinc intake is a serious public health concern, particularly in poorer nations. The frequency of zinc deficiency and its clinical effects on growth retardation, diarrhoea, pneumonia, altered cognitive function, and anomalies in foetal development. Because zinc is so important to human health, even a slight deficit can have disastrous consequences. Supplementing with zinc is an effective therapeutic strategy for treating a wide range of diseases (Hambidge, 2000).

Health Advantages: Zinc is a trace mineral that is necessary for the metabolism of 300 different enzymes in the body. It is also thought to be important for cell division and the creation of DNA and protein. Protein, carbohydrate, fat, and alcohol metabolism are all impacted by these enzymes. According to Debjit Bhowmik *et al*., (2010). In addition, it's critical for the development and function of immune cells, this mineral is also fundamental to skin health, body

growth and development relies on zinc because of its role in cell growth and division. Zinc is also needed for your senses of taste and smell, because one of the enzymes crucial for proper taste and smell is dependent on this nutrient, a zinc deficiency can reduce your ability to taste or smell. Zinc is commonly used in hospitals as a treatment for burns, certain ulcers, and other skin injuries, Because this mineral plays critical roles in collagen synthesis, immune function, and inflammatory response, it is necessary for proper healing (Jillian kubala *et al*., 2022).

Sources: Zinc is abundant in Shellfish: oysters, crab, mussels, lobster, and clams. Meat: beef, pork, lamb, and bison. Poultry: turkey and chicken, Fish: flounder, sardines, salmon, and sole Legumes: chickpeas, lentils, black beans, kidney beans, etc. Nut and seeds: pumpkin seeds, cashews, hemp seeds, etc. Dairy products: milk, yogurt, and cheese, Eggs, Whole grains: oats, quinoa, brown rice, etc. Certain vegetables: mushrooms, kale, peas, asparagus, and beet greens.

1.3.1.3 Copper (Cu)

One of the d-block elements or transition metals is copper. Life requires copper, which is the body's third most prevalent trace element after iron and zinc. Copper is a mineral found throughout your body. It’s a nutrient that your body needs in small amounts to function properly, Additional research is needed to explain the potential benefits of copper supplements for different health conditions. However, an adult's body can become poisonous when it absorbs more than 80,000 µg to 100,000 µg of copper from the environment. A surplus of copper damages antioxidant enzyme performance, oxidatively modifies DNA and proteins, oxidises lipids, activates redox-sensitive genes, inhibits the body's consumption of zinc, and interferes with iron homeostasis to cause anaemia (Wikipedia, 2025).

Health Advantages: Copper has an important role in a number of functions, including the; production of red blood cells, regulation of heart rate and blood pressure, absorption of iron,

prevention of prostatitis, or inflammation of the prostate development and maintenance of bone, connective tissue, and organs like the brain and heart, activation of the immune system. Copper is a vital component for your body, but you need just the right amount. Copper supplements may improve some health conditions, though these are usually associated with a copper deficiency (Susan York Morris and Erika Klein, 2023).

Sources: One easy way to make sure you are getting enough copper is to eat foods that contain it. You can find copper in shellfish and organ meats, like liver. You can also get a good amount of copper by eating vegetables, grains, and seeds, like: potatoes, peas, beans, green vegetables whole grains, sunflower seeds, Peanut butter and dark chocolate also contain copper.

1.3.1.4 Manganese (Mg)

Manganese is an essential trace element that is naturally present in many foods and available as a dietary supplement. Manganese is a cofactor for many enzymes, including manganese superoxide dismutase, arginase, and pyruvate carboxylase. (A. Catherine *et al*., 2014 and John W. Erdman *et al.*, 2012). Through the action of these enzymes, manganese is involved in amino acid, cholesterol, glucose, and carbohydrate metabolism, reactive oxygen species scavenging, bone formation, reproduction, and immune response. Manganese also plays a role in blood clotting and hemostasis in conjunction with vitamin K (Asher JL, 2005). Manganese is absorbed in the small intestine through an active transport system and possibly through diffusion when intakes are high (John W.Erdman *et al.*, 2012). After absorption, some manganese remains free, but most is bound to transferring, albumin, and plasma alpha-2-macroglobulin. Manganese is taken by the liver and other tissues, but the mechanism of this process is not well understood. The human body contains about 10 to 20 mg manganese, of which 25% to 40% is in bone. The liver, pancreas, kidney, and brain also contain manganese. The body maintains stable tissue manganese concentrations through regulatory control of manganese absorption and excretion

(Ascher JL, 2005). More than 90% of absorbed manganese is excreted via bile into the faeces, and a small amount is reabsorbed, very little is excreted in urine. Manganese status is difficult to assess and not routinely measured in clinical practice. Normal whole blood concentrations of manganese range from 4 to 15 mcg/L, but they are highly variable and their utility as a status indicator is unclear. According to (Institute of Medicine, 2001). Some studies that measured serum or plasma manganese concentrations in apparently healthy adults have shown mean serum concentrations of 1.04 mcg/L and mean plasma concentrations of 1.28 mcg/L. Large variations in manganese intakes appear to affect these concentrations somewhat (Greger *et al*., 1992). However, these concentrations often do not correlate well with typical manganese intakes, so whether they are useful indicators of manganese status is not clear. Although urinary manganese concentrations decrease with severe deficiency, it is not clear whether they are useful indicators of manganese status when intakes are within the normal range (Institute of Medicine, 2001).

Sources of Manganese in food: Manganese is present in a wide variety of foods, including whole grains, clams, oysters, mussels, nuts, soybeans and other legumes, rice, leafy vegetables, coffee, tea, and many spices such as black pepper. Drinking water also contains small amounts of manganese at concentrations of 1 to 100 mcg/L. The top sources of manganese in the diets of U.S adults are grain products, tea, and vegetables.

1.3.1.5 Potassium (K)

One significant mineral that is thought to be necessary for human survival is potassium. It is among the most crucial minerals required for the heart, kidneys, and other major body organs to operate properly. One of the seven important macrominerals, along with calcium, sodium, phosphorus, sulphur, and chloride, is potassium (Institute of Medicine, 2005). The human body needs at least 100 milligrammes of potassium each day to support vital physiological processes.

Excessive potassium consumption can assist lower blood pressure, stroke, muscle loss, kidney stone production, and bone mineral density preservation (Weaver, 2013). In the human body, potassium's main job is to maintain fluid balance and manage electrical activity in the heart and other muscles (Guyton and Hall, 2016). In essence, potassium is an electrolyte that balances the body's acid-base levels while opposing the effects of sodium.

Sources: The most significant sources of potassium are citrus fruits, cereals, and vegetables. Additionally, whole milk, almonds, fresh fruit juices, poultry, and salmon can all provide significant levels of potassium. Potassium is also found in potatoes, chicken, legumes, and nuts. Nonetheless, bananas, avocados, and coconut water are the most important dietary sources of potassium (United states department of Agriculture, 2020).

Benefits to Health: Potassium is essential for the normal operation of the brain, the body's regulation of sugar levels, the contraction of muscles, the prevention of low blood pressure and cardiovascular diseases, and the promotion of an alkaline environment. potassium salts are essential for the body to build muscle and protein, reduce cramping in the muscles, increase muscle strength, keep cells free of excess waste, enhance bone health, prevent osteoporosis, build lean muscle mass, maintain muscle health over an extended period of time, enhance cell function, and help people manage stress (Institute of Medicine, 2005).

Potassium Allergies and Side Effects: People who consume excessive amounts of potassium may experience major health problems. Hypokalemia is a potassium shortage in the blood that causes irregular heartbeats, an increase in blood levels and weak muscles. Hypokalemia, or having too much potassium in the blood, can cause hazardous or irregular cardiac beats (National institute of Health, 2020).

1.3.1.6 Sodium (Na)

Sodium plays crucial role in maintaining acid-base balance and osmotic regulation of the body fluids and as the primary caution in blood plasma and other extracellular body fluids, sodium is essential for various bodily functions, A deficiency in sodium can lead to stunted growth, dehydration, low osmotic pressure, reduction in egg production (Institute of Medicine, 2005).

Sources: According to The Centers for Disease Control and Prevention, (2020) the top 10 sources of sodium in our diets include: breads/rolls, pizza, sandwiches, cold cuts/cured meats, soups, burritos, tacos, savory snacks (chips, popcorn, pretzels, crackers), chicken, cheese, eggs and omelets.

Health Benefits: Sodium plays a key role in quite a few of your body's functions. It is crucial for fluid balance, active transport mechanism and proper regulation of the acid-base balance of the body. It participates in the transmission of nerve impulses as well as regulates the passage of fluids and nutrients into and out of cells. Sodium in the bones signifies a reserve for the body in the instance that requires modification of the pH level in the blood. Sodium, in conjunction with potassium, is accountable for balancing nerve stimulation and muscle contraction. An imbalance of fluid and electrolytes in the body can result from the deficiency of sodium. Signs or symptoms connected with the deficiency of sodium include anorexia, nausea, and vomiting. The abnormal serum sodium levels in extreme cases, can also affect action of the muscles, especially of the heart; this can result to coma or lethal consequences. Hypertension and other complications can result from excessive sodium intake, which is caused by an increase in water retention and blood pressure levels. These impediments involve the organs, arteries, and the heart, which in turn upset the health of the organism as a whole. Similarly, some of the symptoms caused by extreme doses of sodium include fever, vomiting, nausea, convulsions as well as impairment of the respiratory centers (Humanities Research Hospital, 1996).

1.4 SPECTROMETRY

Spectrometry is the measurement of the interactions between light and matter, and the reactions and measurements of radiation intensity and wavelength. In other words, spectrometry is a method of studying and measuring a specific spectrum, and it's widely used for the spectroscopic analysis of sample materials.

1.4.1 TYPES OF SPECTROMETRY

1.4.1.1 Atomic Absorption Spectrometry (AAS)

Atomic absorption spectrometry (AAS) is a spectroanalytical technique used for the quantitative determination of chemical elements by free atoms in the gaseous state (Skoog *et al*., 2014). The technique is based on the absorption of light by free metallic ions (Ingle & Crouch, 1988). In analytical chemistry, AAS is widely used for determining the concentration of a particular element (the analyte) in a sample (Christian, 2004). This technique can be used to determine over 70 different elements in solution or directly in solid samples via electrothermal vaporization (Perkin-Elmer, 1982).

Plate3: Atomic absorption spectrophotometer (Spectrophotometry and chromatography lab NCEE), Benin city.

It uses the principle that atoms (and ions) can absorb light at a specific, unique wavelength. When this specific wavelength of light is provided, the energy (light) is absorbed by the atom. Electrons in the atom move from the ground state to an excited state. The amount of light absorbed is measured and the concentration of the element in the sample can be calculated.

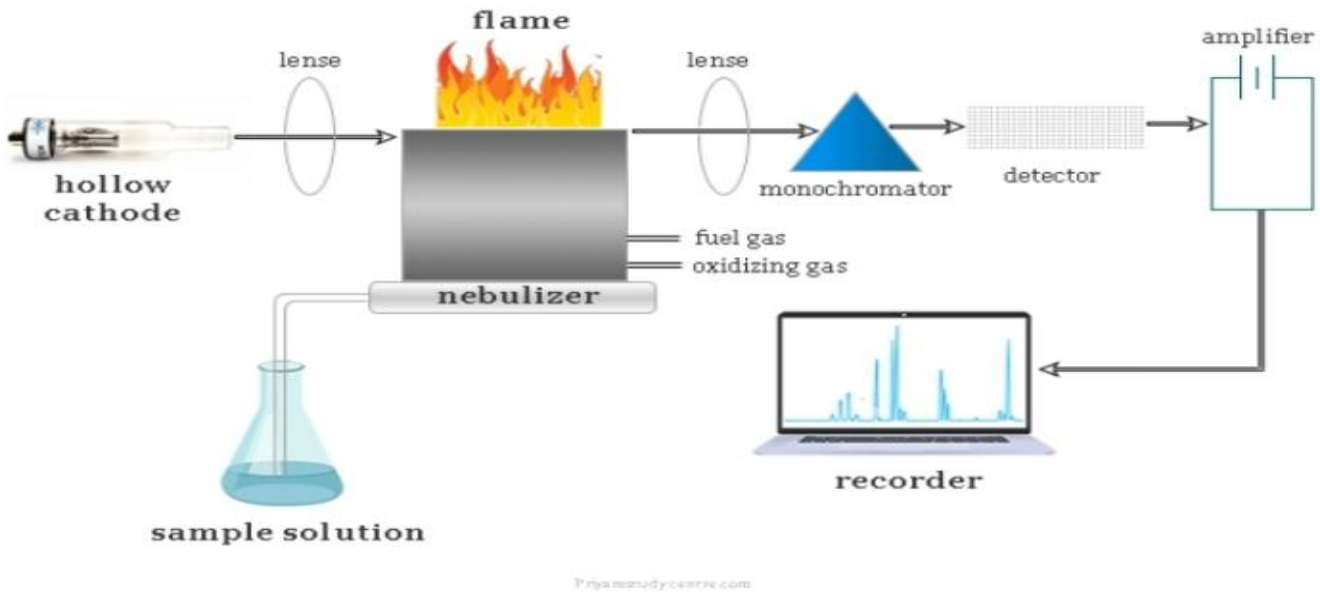

Plate 4: Working principles of AAS

1.4.1.2 Flame Emission Spectrometry (FES)

Flame emission spectrometry is a widely used analytical technique for detecting and quantifying metal ions in solution, particularly for Group I and Group II elements (Ingle & Crouch, 1988). The principle behind this technique is that when substances are heated, they emit energy in the form of light as electrons return to their ground state after being excited by heat energy (Skoog *et al*., 2014). In flame emission spectrometry, a sample is exposed to a high-temperature flame, causing the atoms to become excited and emit light at specific wavelengths (Christian, 2004). The intensity and wavelength of the emitted light are then measured to determine the concentration of the analyte.

- Desolvation: The metal particles in the flame are dehydrated by the flame and hence the solvent is evaporated

- **Vapourisation:** The metal particles in the sample are dehydrated. This also led to the evaporation of the solvent.

- **Atomization:** Reduction of metal ions in the solvent to metal atoms by the flame heat.

- **Excitation:** The electrostatic force of attraction between the electrons and nucleus of the atom helps them to absorb a particular amount of energy. The atoms then jump to the exited energy state.

- **Emission process:** Since the higher energy state is unstable the atoms jump back to the stable low energy state with the emission of energy in the form of radiation of characteristic wavelength, which is measured by the photo detector.

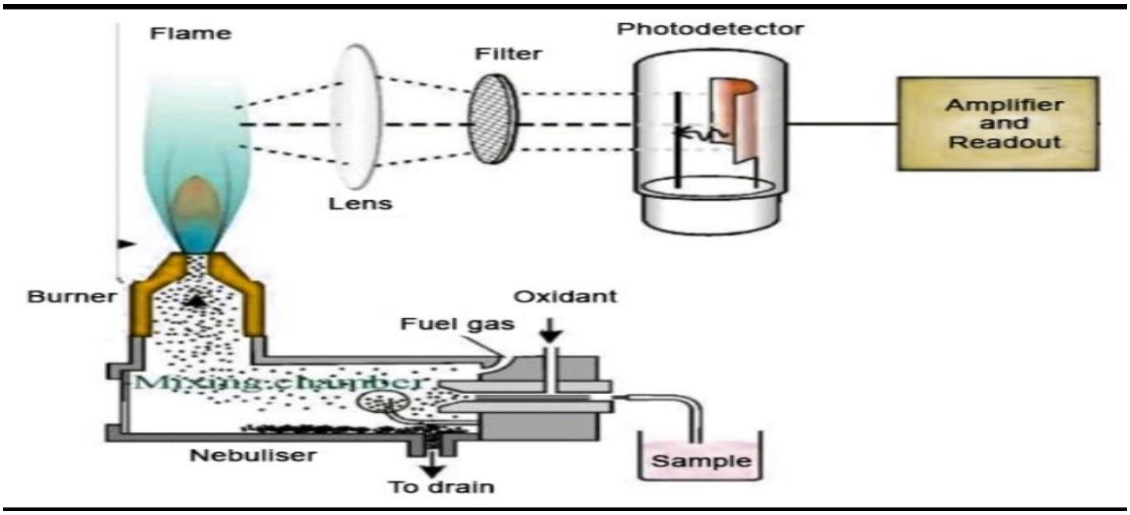

Plate 5: Schematic representation of flame emission spectrometer

1.5 PHYTOCHEMICAL SCREENING

A phytochemical screening is a procedure in which the chemicals from a plant are extracted and tested to determine if they are biologically active. It is one of the methods through which new medications can be identified. Phytochemicals are separated from plant matter using the techniques of analytical chemistry. They tend to partition in certain kinds of solvent more than others and this fact can be exploited to purify them. Phytochemicals are chemical compounds that occur naturally in plants (phyto means “plant” in Greek). Some are responsible for colour and other for organoleptic properties, such as the deep purple of blueberries and the smell of garlic (James, 2000). The stem of *Ficus capensis* contained saponin, tannin, flavonoid, glycoside, alkaloid, phenol and terpenoid etc. Phytochemical composition of plants varies in their leaves, stems, roots, bark, seed and twig (Mgbemena N.M. *et al*., 2020). Phytochemical Screening is very crucial in the determination of the important and active bio ingredients in the plants. There are many phytochemicals and each works differently, some of the possible actions are via antioxidants, hormonal action, and stimulation of enzymes, interference with DNA replication, antibacterial effect and physical action (Papp *et al*., 2007).

1.6 PROXIMATE ANALYSIS

Proximate analysis is defined by H. Bennett in the Concise Chemical and Technical Dictionary as the “determination of a group of closely related components together e.g. total protein, fat.” It conventionally includes determinations of the amount of water, protein, fat (ether extract), ash and fiber, with nitrogen-free extract (sometimes termed Nifext) being estimated by subtracting the sum of these five percentages from 100. In order to emphasize the group nature of the percentage of protein, fat and fiber, many chemists use the word “crude” before these three terms (Hart *et al*., 1971).

1.6.1 TYPES OF PROXIMATE ANALYSIS

1. Moisture content**:** This is determined by drying the sample at a specific temperature untill it reaches a constant weight.

2. Ash content: The ash content of a sample is determined by incinerating the sample at a high temperature untill all organic matter has been burned off.

3. Crude fibre content**:** This is determined by boiling the sample in acid and alkali solutions to remove the digestible components and then weighing the remaining fiber.

4. Crude protein content: The crude protein content of a sample is determined by measuring the amount of nitrogen in the sample and multiplying it by a conversion factor

5. Total carbohydrate**:** Total carbohydrates" refers to the overall amount of carbohydrate compounds present in a sample, calculated by subtracting the weight of other measured components like (protein, fat, moisture, ash, and fiber) from the total weight of the sample.

6. Lipid content: Lipid content is the total amount of fat extracted from a sample using a solvent like diethyl ether, essentially measuring the "crude fat" content.

Proximate analysis is used for estimation of the food and food substances including moisture and crude protein, total fat, crude fiber and total carbohydrate content (J Adv Pharma technol Res, 2020).

1.6.2 THIN LAYER CHROMATOGRAPHY

This method is used for analyzing mixtures by separating compounds in the mixture. It helps to determine the number of components present in a mixture, identify them, and the purity of the

compound. It consists of three steps spotting, development, and visualization. The Retention factor valve **(R_f)** is used to quantify the movement of the materials along the plate. **R_f** is equal to the distance traveled by the substance divided by the distance traveled by the solvent.

CHAPTER TWO

MATERIALS AND METHODS

Materials

Solvents and Reagent

Equipment

Others e.t.c.

2.1 SOLVENTS AND REAGENT

Ethanol

Distilled water

Deionized water

Concentrated HNO3

Concentrated HCL

Benedict solution

Dragendoff's Reagent

Gelatin solution

Silica gel

Concentrated H_2SO_4

n-hexane

Dilute H_2SO_4

Nacl solution

Chloroform

2.2 MATERIALS

Glassware

Beaker

Conical flask

Evaporating dish

Sinister glass funnel

Measuring cylinder

Stirrer

Test tube

Round bottom flask

Spatula

Sample collection bottles

Funnels

Volumetric flask

All glassware used were products of pyrex .

2.3 EQUIPMENT

Analytical balance

Mechanic grinder

Atomic absorption spectrometer (BULK SCIENTIFIC VGP 210)

Heating mantle

Rotary evaporator

Flame Emission spectrometer (SHERWOOD 7200)

2.4 OTHER MATERIALS

Filter paper

Masking tape

Tlc plate

2.5 METHODOLOGY

2.5.1 Sample collection and preparation of *Ficus capensis* stem

The fresh stem of *Ficus capensis* were collected from its tree at University of Benin, Ugbowo, Benin city. The plant sample was authenticated at the Plant biology and biotechnology PBB, University of Benin, Benin city, with herbarium voucher number (UBH-F331)**.** The samples were washed with distilled water to remove any foreign materials, air dried at room temperature for two weeks. The dried leaves were ground using a milling machine, it was then packaged for further studies.

2.6 EXTRACTION PROCESS

A maceration process was carried out on the ground stem bark of *Ficus capensis*. The ground stem was soaked in Ethanol for 3days and the ethanol was boiled off till all the ethanol have been evaporated and a jelly like stem extract sample was formed and collected and kept in a sample collection bottle. 10g of the stem sample was mixed with 10g of solid silica gel (the silica gel which is used in the extraction process is used to remove impurities in the stem sample), the mixed sample was placed inside the sinister glass funnel with a filter paper under and another filter paper was placed on top. 100ml of pure ethanol was poured into the vacuum liquid - chromatography using a vacuum pump. The 100ml ethanol was used to isolate the sample and the flow was a slow process due to ethanol been a very polar solvent, the process was re-run with the filtrate for the second time and the solution of the filtrate was darker than the first one given a golden yellow colouration.

2.7 PHYTOCHEMICAL SCREENING

Phytochemical tests (Sofowara, 1982).

Various tests were conducted to identify phytochemicals present in plant extracts. These tests included:

Test for flavonoids: A few drops of lead acetate solution were added to 2ml of plant extract. Observation was made for the formation of a yellow precipitate.

Test for Saponins: About 5ml of the filtrate was diluted with 20ml of water and shaken vigorously. A stable froth upon standing indicated the presence of saponins.

Test for Alkaloids: Dragendorff's test: A few mg of extracts sample was taken and dissolved in 5ml water. Then 2M hydrochloric acid was added until an acid reaction developed. In this mixture, 1ml of Dragendorff's reagent (potassium bismuth iodine solutions) was added. The formation of orange red precipitate indicated the presence of alkaloid.

Test for Tannins: Ferric chloride test. About 1g of powdered crude plant sample was boiled with 50ml of water, filtered and the filtrate was used for the following test:

Ferric chloride test: To 3ml of the filtrate, two drops of ferric chloride were added. The presence of green precipitate indicated the presence of tannins. However, tannins were absent in all extracts of leaves and stem back.

Test for phenolic compounds*:* About 3 drops of ferric chloride solution was added to 2 ml of the plant extract. The observation was made for the formation of a bluish-black coloured solution.

Test for Glycosides: About 1ml of the extract was mixed with 2ml of glacial acetic acid in a test tube, then 1 drop of 15% ferric chloride and 1ml of concentrated sulfuric acid were added to the mixture. The observation was made for the formation of a brown coloration at the interface.

Test for Reducing Sugar: About 1ml of the plant extract was added to a boiling mixture of 1ml

each of Fehling's solutions A and B in a test tube. A colour change from blue to green was observed.

Test for Steroids: 1ml of the extract in a test tube was mixed with 2ml of acetic acid and 2ml of concentrated sulphuric acid. The observation was made for a colour change from violet to blue-green.

Test for Terpenoids: This test was done using Salkwoski test. 1ml of extract in a test tube was mixed with 2ml of chloroform and 3ml of concentrated sulfuric acid. A reddish brown colouration at the interface confirmed the presence of terpenoids (Trease and Evans, 1989 and Harbone, 1993).

***Test for Anthraquinones*:** 1ml of extract in a test tube was mixed with 5ml of benzene and 2.5ml of dilute ammonia.The mixture was then shaken vigorously. A pink-red colour at the lower phase indicated the presence of anthraquinones (Trease and Evans, 1989 and Harbone, 1993).

2.8 MINERAL ANALYSIS

The process started with carefully collecting *Ficus capensis* stem, making sure they were clean and truly represented the plant. After that, the sample were dried to remove any moisture that could interfere with the analysis and to help preserve them. Once dried, they were ground into a fine powder to ensure consistency, which made the mineral analysis more reliable and the minerals were extracted from the powdered stem often using the aqua regia digestion method. The mineral content of the sample was determined through digestion using aqua regia, a powerful acid mixture composed of hydrochloric acid (HCl) and nitric acid (HNO_3) in a 3:1 ratio. To prepare the solution, 75 mL of HCl was combined with 25 mL of HNO_3 and left to react for 10 minutes. A brown color appeared, indicating the presence of nitrogen dioxide (NO_2). Next,

2.0 g of air-dried soil was carefully weighed and placed into a digestion flask. Then, 40 mL of the prepared aqua regia was added to the soil sample, and the digestion process began. As the temperature increased, agitation was observed, and evaporation caused the solution's volume to reduce from 40 mL to 10 mL, which helped in the removal of NO_2. The solution gradually turned colorless, signaling the completion of the digestion process. It was then filtered, rinsed with distilled deionized water, and transferred to a 100 mL volumetric flask, where it was diluted to the mark with deionized distilled water. The diluted solution was analyzed using an Atomic Absorption Spectrophotometer (BULK SCIENTIFIC VGP210) (AAS) for magnesium, calcium, iron, copper, zinc, manganese, lead, nickel, cadmium, and chromium. While sodium and potassium were analyzed using a Flame Photometer (SHERWOOD 7200) to determine the mineral composition of the soil (Abegunde SM *et al*., 2018).

2.9 PROXIMATE ANALYSIS

The analyses for the proximate contents of the dried powder of *Ficus capensis* stem bark was carried out using methods described by the Association of Official Analytical Chemists (AOAC, 1999). The samples were analysed for moisture content, carbohydrates, crude fibre, crude proteins, total ash content and crude fats (lipids).

2.10 THIN LAYER CHROMATOGRAPHY MEASUREMENTS

A pencil line of about 1cm was drawn carefully from the end of the plate on the powdered side of the silica gel plate. A very small spot was made on the plate to avoid spillage. The plate was then dipped into a very small amount of Ethanol (2ml). It was then left to develop for a while. The solvent must be below the line, After the solvent has almost gotten to the top of the plate, the plate is removed and dried. It is then visualized using a UV lamp and the distance and Retention factor valve is measured.

CHAPTER THREE

RESULTS AND DISCUSSION

3.1 The results gotten from the phytochemical screening of *Ficus capensis* stem bark extract is shown below:

Table 1: The results of the phytochemical screening of *Ficus capensis* stem bark extracts

Key: ++ highly present **-** *Absent*

+ present

Table 1 shows that Alkaloid, steroids, terpenoids, cardiac glycosides, tannins, coumarins, Flavonoid, reducing sugar and phenolic compounds are present in 100% of ethanol but there is absence of Anthraquinones and saponins. The phytochemical analysis of the various extracts of *Ficus capensis* stem bark revealed the presence of alkaloids, steroids, coumarins, tannins, glycosides, terpenoids, Flavonoids and phenolic compounds. The results of the phytochemical screening study shows that glycosides were present in all extracts of the stem bark which contradicts the report of (Jocelyn *et al.,* 2018) who reported on the ethanolic extracts of *Ficus capensis* stem bark. It also corresponds with the report of (Haq *et al*., 2019). Glycosides play

Photochemicals present	***Ficus capensis* stem bark extracts (100% ethanol)**
Alkaloid	++
Steroids	+
Terpenoids	+
Cardiac Glycosides	+
Anthraquinones	-
Saponins	-
Tannins	+
Coumarins	+
Phenolic compounds	+
Flavonoid	++
Reducing sugar	+

numerous important roles in living organisms; many plants store important chemicals in the form of inactive glycosides. Whenever these chemicals are needed, the glycosides are brought in contact with water and an enzyme. The sugar part is broken off, making the chemical available for use. Many of such plant glycosides are used as medications. In animals (including humans), poisons are often bound to sugar molecules in order to remove them from the body (IUPAC, 2009). Saponins were present in all extracts of stem bark except ethylacetate and N- hexane. The reports of Solomon-Wisdom *et al*., (2011) shows that saponin were present in the Ethanol extracts of *Ficus capensis*. In a nutshell, saponins are bioactive compounds found in plants. Saponins have anti-inflammatory and anticancer qualities since they show cytotoxic effects and growth inhibition against a range of cells (Iniaghe *et al*., 2009). Phenolics were absent in all extracts of stem bark except ethylacetate and N-hexane while it was present in all extracts of leaves except water. Phenolics were also present in the Ethanolic extracts of *Ficus capensis* stem bark as reported by (Vincenzo *et al*., 2022). Phenolic compounds are potent water-soluble antioxidants and freeradical scavengers that prevent oxidative cell damage and have strong anti-cancer properties (Del-Rio *et al.,* 1997; Cowan, 1999; Okwu, 2004). Terpenoids was present in all extracts of stem bark and leaves except water and ethylacetate. This corresponds to the reports of (Amarvani *et al*., 2020). Eugenols was absent in all extracts of stem bark except methanol and water while it was present in all extracts of leaves except water and water/methanol extracts. Eugenol is a versatile naturally occurring molecule as phenolic monoterpenoid and frequently found in essential oils in a wide range of plant species. Eugenol bears huge industrial applications particularly in pharmaceutics, dentistry, flavoring of foods, agriculture, and cosmetics (Muhammad *et al.*, 2021). Steroids was absent in all extracts of stem bark while it was equally was absent in all extracts of leaves except ethanol and N-hexane. This is in accordance with (Jocelyn *et al.*, 2018) and contradicts (Bunawan *et al*., 2014). Plant steroids are phytoconstituents that have found therapeutic applications as arrow poisons or cardiac drugs

(Firn, 2010). Trace amounts of steroid content in the stem could be useful in promoting nitrogen retention in osteoporosis and in animals with wasting illness (Maurya *et al*., 2008; Madziga *et al*., 2010). Alkaloids were present in all extracts of stem bark and leaves, most plants extract contains alkaloids and this corresponds with (Jocelyn *et al*., 2018). Flavonoids was absent in all extracts of stem bark and leaves except ethylacetate. Flavonoids are powerful antioxidants and free radical scavengers. They also help to boost the immune system (Panche *et al*., 2016). Tannins were absent in all extracts of stem bark and leaves. This corresponds tom (Haq *et al*., 2019, Jocelyn *et al*., 2018 and Vincenzo *et al*., 2022). Reducing sugars was present in all extracts of stem bark except ethylacetate and N-hexane while it was present in all extracts of leaves.

3.2 The results gotten from the proximate analysis of the *Ficus capensis* stem bark are shown below:

Table 2: The results of the proximate analysis of *Ficus capensis* stem bark.

Test	**(%) In stem bark extracts**
Moisture content	8.37
Ash content	6.21
Crude fiber	20.35
Crude protein	3.78
Fats/Lipids	1.17
Carbohydrate	60.12

The results of the proximate analysis are presented in Tables 2, the proximate analysis of the stem bark revealed; was 60.12%, 20.35% and 8.37% for carbohydrate, crude fibre and moisture

content respectively. *Ficus capensis* leaves and stem back is very rich in carbohydrate which was higher compared to the values reported for the other contents. This corresponds to the report of (Mgbemena *et al*., 2020). This implies that *Ficus capensis* stem and leaves could serve as a good source of carbohydrates. Carbohydrates are easily digested and provide the necessary calories in the diets of humans. A high level of crude fiber content can lower the body cholesterol and therefore reduce the risks of cardiovascular diseases and diabetes. Plant with high amounts of fiber has been recommended for the treatment of obesity, diabetes, cancer, and gastrointestinal disorders to prevent coronary heart disease, hypertension, constipation, and diabetes (Iniaghe *et al*., 2009, Rishi *et al*., 2012). The amount of moisture in plant material determines its absorption and assimilation rate within an organism. Thus, the plant moisture content determines storability and plant quality since high moisture content is associated with lower storage stability.

3.3 The results gotten from the mineral analysis of the *Ficus capensis* stem bark extract are shown below:

Table 3: The results of mineral analysis of *Ficus capensis* stem bark extract

Element	**Concentration in ppm (stem bark)**
Pb	ND
Zn	1.40
Cd	ND
Ni	0.01
Cu	0.04

Cr	0.05
Mn	0.20
Fe	5.30
Mg	1.63
Ca	5.62
K	17.70
Na	12.60

Key: ND means not detected within the detection limit of Pb and CD of the AAS machine used.

Moisture contributes to slowing the growth and development of microorganisms and inhibiting hydrolysis of some components present in plant material, so that the material can be stockpiled for a long time with no risk of microbial attack (Egga *et al.*, 2014). Hence the leaves of *Ficus capensis* leaves cannot be stored fresh for a longer time because of its high moisture content, however it can be stored after it has been air-dried. However, the stem bark contains low moisture content which could be stored for a longer time compared to the leaves. The health benefits of proteins include the involvement of their essential and non-essential amino acids as building blocks for protein synthesis. Proteins are important in the body for the production of hormones, enzymes, and blood plasma (Mgbemena *et al.*, 2020). The habit of drinking the aqueous extracts of the leaf for blood building should be encouraged as a result of the high protein contents in the leaves as indicated in the result. According to Fagbohun *et al.*, (2012) ash

content in leafy vegetables reflects the percentage of mineral elements present in the vegetables. High ash content in a leafy vegetable is an indication of high mineral content and hence high nutritional quality. However, this may not always be the case according to (Ukam, 2008) who noted that it could be the reverse if it contained toxic metals which also contribute to the percentage ash content. The mineral analysis results reveal that the Ficus capensis stem bark contains Zn (1.40 ppm), Cu (0.04 ppm), Cr (0.05ppm), Mn (0.20ppm), Fe (5.30 ppm), Mg (1.63 ppm), Ca (5.62 ppm), K (17.70 ppm) and Na (12.60ppm). Cd and Pb where not detected within the detection limit for Cd and Pb of the AAS machine used. The mineral analysis results reveal that *Ficus capensis* stem bark is very rich in Potassium, which helps to maintain osmotic pressure and regulate acid-base equilibria. It plays an important role in nerve and muscle excitability and it is also involved in carbohydrate metabolism (McDonald *et al*., 2011). A high amount of potassium in the body was reported to increase iron utilization (Adebayo *et al*., 2017). It is also beneficial to people taking diuretics to control hypertension and suffer from excessive excretion of potassium, through body fluid (Mgbemena *et al*., 2020). Calcium and magnesium play a significant role in photosynthesis, carbohydrate metabolism, nucleic acids, and binding agents of cell walls (Russel, 1973). Calcium assists in teeth and bone development (Brody, 1994). However, its presence in high concentration may be a risk factor for hypertensive patients since it results in calcification of the arteriole walls. Magnesium is an essential mineral for enzyme activity. Like calcium and chloride, magnesium also plays role in regulating the acid-alkaline balance in the body. High magnesium levels in drinking water have been linked to resistance to heart disease (Fallon, 2001). Manganese is required for building the immune system, regulation of blood sugar levels, and production of energy. Copper is also required in the human body for

enzyme production and the biological transfer of electrons within the body. Zinc plays a vital role in gene expression, and regulation of cellular growth and acts as a coenzyme for carbohydrates, protein and nucleic acids metabolism. The mineral analysis of Ficus capensis leaves and stem as reported by (Jocelyn *et al*., 2018) also corroborates the findings of this work.

3.4 The Results gotten from UV, IR, GC-MS spectra of *Ficus capensis* stem bark extracts

VLC 4

3.4.1 UV analysis

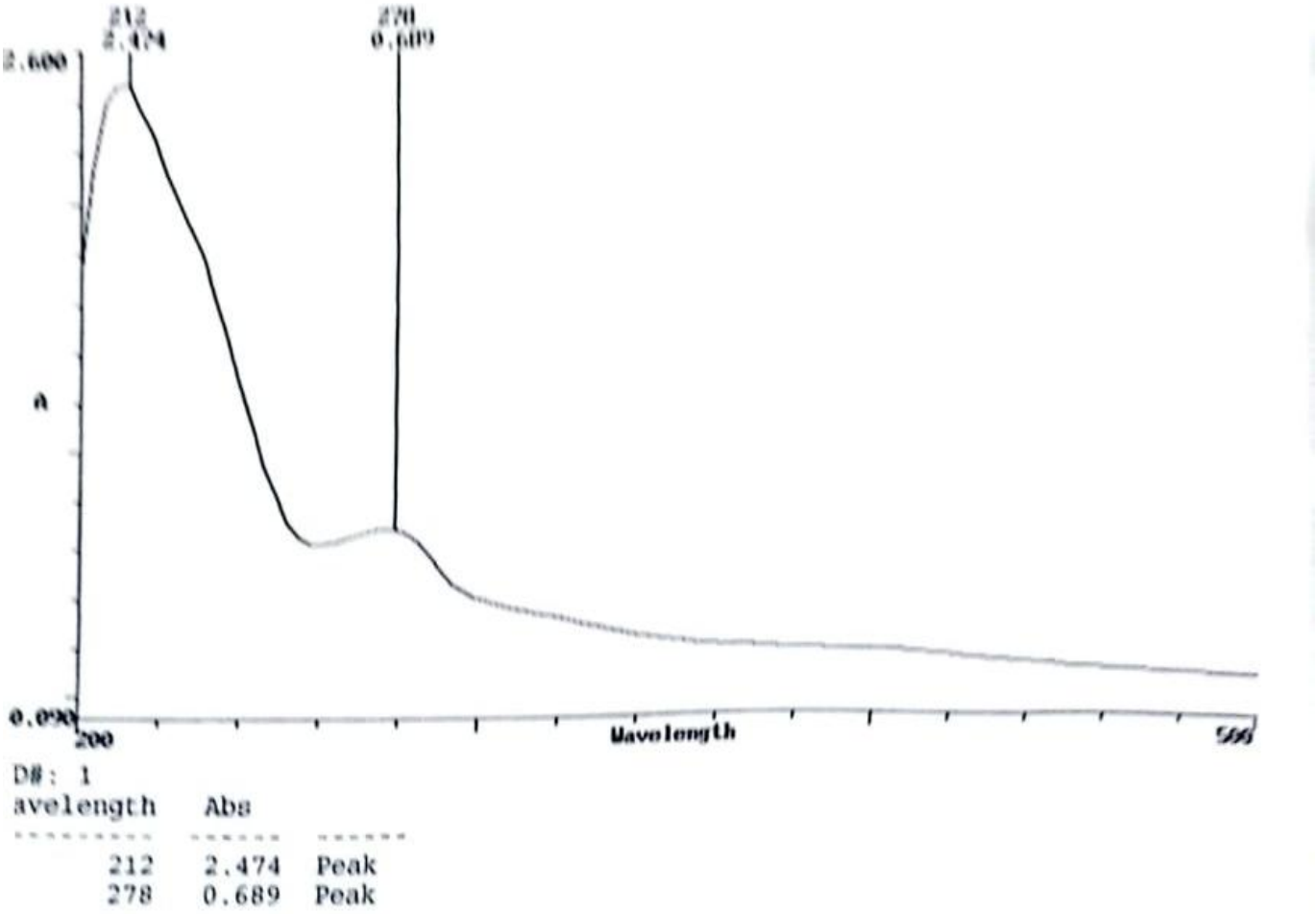

Plate 6: The UV analysis was recorded in a Philips 6405 UV/VIS scanning spectrometer.

Table 4: The results of UV absorption of VLC 4

Maximum wavelength (nm)	**E_{max}**	**Absorbance**	**Peak**	**Chromophore**
212	60	2.474	Sharp	-COOH
270	10	0.689	Bent	$-ONO_2$

The UV max in table 4 gave 212nm (E_{max}, 60) with a sharp peak indicating the chromophore (-COOH) while 270nm (E_{max}, 10) with a bent peak indicating ($-ONO_2$) as the chromophore.

3.4.2 IR Analysis

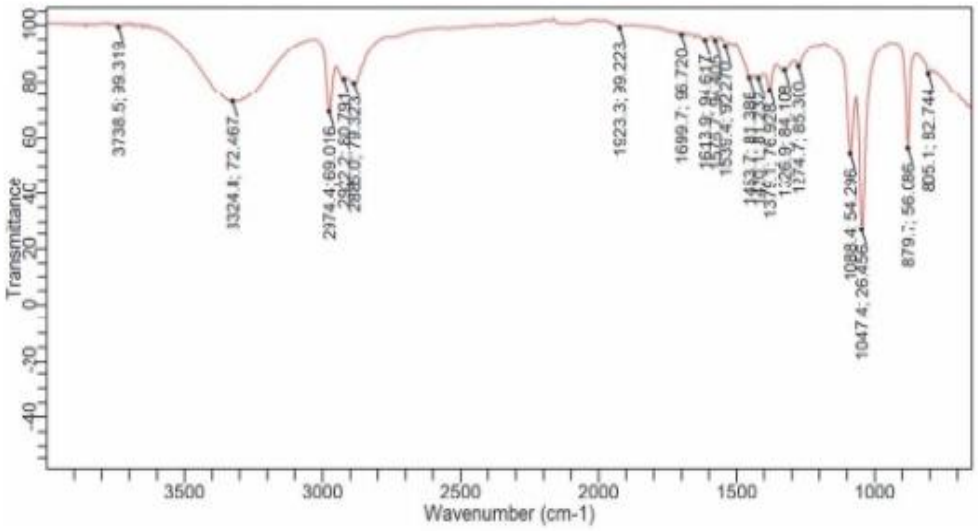

Plate 7: The IR analysis of VLC 4 was recorded on a bulk IR M500 spectrophotometer 4000 - 350cm^{-1}.

Table 5: The results of IR bands for VLC 4

S/N	Peak frequency(cm^{-1})	Bond	Functional group
1	3324.8	N-H stretch	Amines
2	2974.4	C-H stretch	Alkyl group (CH_3, CH_2, CH)
3	1379.1	C-H bend	Methyl (CH_2)
4	1088.4	C-O stretch	Secondary alcohol (R_2CH_2OH)
5	1047.4	C-O stretch	Primary alcohol (RCH_2OH)

6	879.7	C-H bend	Alkenes (CH_2=CH_2)

There were IR bands of medium strong intensities in table 5 at 3324.8cm^{-1} with a bond of N-H stretch indicating an amine group, 2974.4cm^{-1} with a C-H stretch indicating an alkyl group, 1379.1cm^{-1} with C-H bend indicating the presence of methyl, 1088.4cm^{-1} with a C-O stretch indicating the presence of a secondary alcohol, 1047.4cm^{-1} with a C-O stretch indicating the presence of a primary alcohol and 879.7cm^{-1} with a C-H bend indicating the presence of an alkene.

3.4.3 GC-MS Spectra Analysis

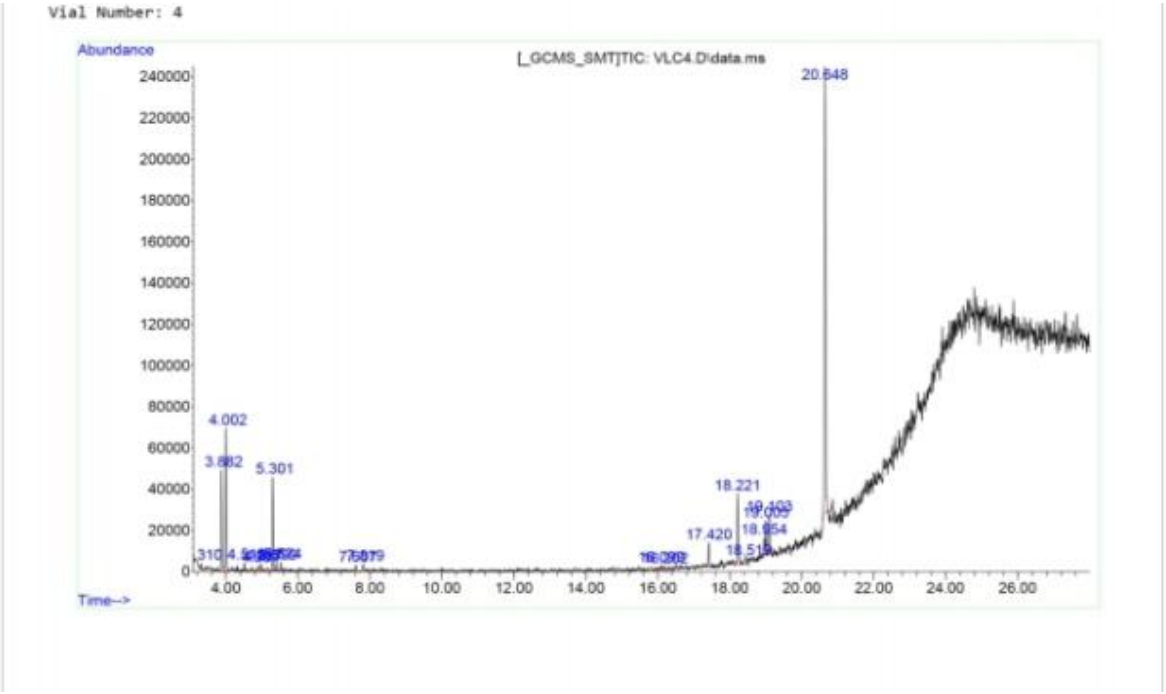

Plate 8: The GC-MS spectra analysis for VLC 4

Table 6: The result of GC-MS spectrum for VLC 4

S/N	RT (mins)	Compounds	Area percent
1	3.31	Benzoic acid	0.080
2	3.882	2-nitroso	0.126
3	4.002	Benzonitrile, benzoic acid	0.109
4	4.512	Acetic acid	0.057
5	4.901	Pterin-6-carboxylic acid	0.092
6	4.987	Benzaldehyde	0.069
7	5.301	5-(3-methylbutyl)-2pyridine carboxylic acid	0.074
8	5.399	Trans-4-{2-(5-nitro-2-furyl)-2quinolinamide	0.063
9	5.524	Carbamic acid	0.057
10	7.607	2-nitro,Thiocyanic acid	0.109
11	7.819	Benzoic acid	0.086
12	16.099	Propanoic acid	0.074
13	16.202	Benzaldehyde	0.086
14	17.42	Decanoic acid, Octadecanoic acid	0.080
15	18.221	Acetic acid, N-{2-(4-nitrophenyl) ethyl}	0.046
16	18.519	(5-amino-3H-Imidazol-4-yl) Acetonitrile	0.109
17	18.954	Acetic acid	0.046

18	19.005	9-Octadecenoic acid	0.052
19	19.103	Succinic acid	0.630
20	20.648	Carbamic acid	0.120

CONCLUSION

The findings from proximate analysis, phytochemical screening, mineral assessment, and ethanol extraction of *Ficus capensis* stem bark indicate that the plant is rich in essential minerals. The presence of terpenoids supports its anti-sickling properties, which aid in the production of healthy red blood cells. The strategic use of a solvent mixture has led to the identification of additional bioactive compounds, further enhancing its medicinal and pharmacological potential. These phytochemicals can be utilized for both medicinal and nutritional purposes. The presence of these beneficial components justifies the plant's use in alternative and traditional medicine, particularly for treating heart disease, sexually transmitted infections, hypertension, anemia, and diarrhea. Additionally, its high nutritional value, attributed to its impressive proximate composition and mineral content, makes *Ficus capensis* a valuable resource for both health and nutrition.

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