ANTIMICROBIAL ASSESSMENT OF METHANOLIC EXTRACT OF *Tradescantia spathacea* ROOTS ON *Salmonella* spp AND *Escherichia coli*

By

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A PROJECT SUBMITTED TO THE DEPARTMENT OF MICROBIOLOGY, COLLEGE OF BASIC AND APPLIED SCIENCES, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE IN MICROBIOLOGY

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DECLARATION

I hereby declare that this project has been written by me and is a record of my own research work. It has not been presented in any previous application for a higher degree of this or any other University. All citations and sources of information are clearly acknowledged by means of reference.

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Date

CERTIFICATION

This is to certify that the content of this project entitled **ANTIMICROBIAL ASSESSMENT OF METHANOLIC EXTRACT OF *Tradescantia spathacea* ROOTS ON *Salmonella* spp AND *Escherichia coli,*** was prepared and submitted by Amosun, Olajumoke Ayinke with matriculation number 18010101029, in partial fulfilment of the requirements for the degree of Bachelor of Science in Microbiology,Department of Biological Sciences of the Mountain Top University, Ogun State, Nigeria**.** The original research work was carried out by her under my supervision and is hereby accepted.

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Head of Department

DEDICATION

This project is dedicated to God Almighty, the giver of wisdom and understanding, for this love and strength. To my nephew Akinkunle, Akinfolawe David and Late Mr OladehindeAmosun.

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LIST OF ABBREVIATED WORDS

ABBREVIATION	MEANING
AMR	Antimicrobial Resistance
HGT	Horizontal Gene Transfer
CELR	Cellular Level Resistance
COLR	Community Level Resistance
WHO	World Health Organization
TB	Tuberculosis
MIC	Minimum Inhibitory Concentration
LPS	Lipopolysaccharides
VISA	Vancomycin Intermediate *Staphylococcus aureus*
PBP	Penicillin Binding Protein
VRE	Vancomycin Resistance Enterococci
MRSA	Methylene Resistance *Staphylococcus aureus*

ABSTRACT

Antimicrobial resistance is a very serious occurrence that has a negative impact on Humans. Over the years, micro-organisms have developed resistance to the majority of the antibiotics that we have now. This is the reason why scientists are looking for new, and more improved antibiotics, especially those that are not of chemical origin. Plants have phytochemical constituents that have been used in the olden days as herbs to treat various diseases and infections. The phytochemicals of plants are of biological origin and as such antibiotics gotten from plants do not have chemical side effects. *Tradescantia spathacea*is a decorative plant that has some antimicrobial properties and has been used in ancient times to treat some diseases and infections. Although the leaves of this plant has been exploited, the root has not been studied, to determine its antimicrobial activity. This research was conducted to determine the antimicrobial activity of *Tradescantia spathacea*roots. In this study, Minimum Inhibitory Concentration was used to determine the antimicrobial activity of the plant extract. This study showed that, *E. coli* had no zone of inhibition, therefore, it was resistant to the plant extract. However, *Salmonella* spp had a zone of inhibition at 100% (800µl), at 75% (600µl) 50% (400µl) strong zone of inhibition and at 25% (200µl). The plant extract showed that it is effective against *Salmonella* species, and it could be a potential antimicrobial therapy for treating *Salmonella* related illnesses.

Keywords

Tradescantia spathacea, Antibiotics, Antimicrobial resistance, Phytochemicals, Micro-organisms.

CHAPTER ONE

INTRODUCTION

As the name suggests, antimicrobial resistance (AMR) refers to bacteria and fungi acquiring resistance to antimicrobial (antibacterial or antifungal) therapies aimed to prevent them from spreading. Through horizontal gene transfer (HGT), bacteria acquire AMR genes (ARGs) from other microbes through innate (e.g., lack of drug target site) and acquirable (e.g., enzymatic drug degradation) processes (transformation, transduction, and conjugation) (Schwarz *et al*., 2016).

Antimicrobial resistance (AMR) is currently one of the world's most critical health problems. Problems are compounded by factors such as climate change and globalization (increasing globalization), worldwide travel and food import/export as well as population changes (Miranda *et a*l., 2013). Antimicrobial therapy is jeopardized by these organisms (superbugs), resulting in untreatable and fatal infections. On a global scale, AMR has a huge and dreadful economic and health impact (Huttner *et al*., 2013).

Medicinal plants have been used as a source of medicine in practically all societies since time immemorial (Ang-Lee *et al.,* 2001; Goldman, 2001). Many of these traditional medicines have been rediscovered as cost-effective sources of complex bioactive chemicals in modern countries (Phillipson, 1994). Single synthetic compounds with significant clinical action are often encountered in oral dose forms in modern medications. On the other hand, natural chemicals derived from higher plants are still used in medicinal formulations (Gogtay*et al*.,2002). There are many ways to produce therapeutic medications, but natural goods are still one of the finest places to find new structural sorts (Hostettmann, 1999). As a result, in the never-ending quest to improve the efficacy and ethics of modern medicine, researchers are increasingly looking to folk medicine as a source of new medications (Wayne, 1998; Hoareau and Dasilva, 1999).

A succulent aesthetic and therapeutic plant, *Tradescantia spathacea* is grown for bedding, rock gardens, and tropical effects; however, the Global Compendium of Weeds classifies it as an environmental weed and an invasive plant. This species has escaped into natural regions after being planted as an ornamental in gardens and yards. Antimicrobial, insecticidal, anti-inflammatory, and anti-cancer activities are thought to exist in this plant. Several illnesses such as fever, cough, and bronchitis are treated with *Tradescantia spathacea* in Thailand.

Amenorrhea, headaches, sprains, and rheumatism are among the conditions for which this herb is utilized.

The leaves of *Tradescantia spathacea* have been used in the past and have shown antimicrobial activity against certain, but information in literature is scarce on the potential antimicrobial properties of the roots.

1.1 Statement of the Problem

Antimicrobial resistance is a global problem, and as such, scientists are searching for several ways to reduce the resistance to current antimicrobials. Some medicinal plants can be very effective in treating certain ailments but they are under-exploited.

1.2 Aim and Objectives of the Study

The aim of this research is to investigate the antimicrobial activity and genotoxic effect of the methanolic extract of the roots of Tradescantia*spathacea*.

The objective of this research is thus:

i. To extract both polar and non-polar bioactive compound from harvested roots of *T. spathacea*usingmethanol as solvent

ii. To determine the antimicrobial activity of the roots *Tradescantia spathacea*

iii. To determine the genotoxic effect of the plant extract using *Allium cepa* assay

CHAPTER TWO

LITERATURE REVIEW

2.1 Medicinal Plants

Pharmaceutical, non-pharmacopoeial, and synthetic drugs can all be made from medicinal plants. They have also influenced the evolution of human cultures around the planet. In addition to being a critical source of medication, plants also play a vital part in world health and wellbeing. It has long been understood that medicinal plants and herbs can be used as a vital source of medicine. Around the world, medicinal plants have become an important part of health care systems. In addition to treating ailments, medicinal plants can also be used to preserve good health and living circumstances. Two-thirds of the world's population rely on herbal medicine for healthcare. Its cultural acceptance, compatibility, and adaptability to the human body, as well as their reduced harmful consequences, are the reasons for this. In addition to aspirin, atropine and artimesinin, other drugs produced from plants include ephedrine, morphine, quinine, quinidine, and reserpine, taxol, tubocurarine and vincristine. (Sandberg and Corrigan 2001).

It has been said that infectious illnesses pose the greatest threat to global health on numerous times. 61,7% of the world's population was affected by infectious diseases in 2013, according to the World Health Organization (WHO). There are 5.9 million. Medicine has relied on plants with healing powers since the dawn of mankind. Evidence-based studies on medicinal plants have been undertaken all over the world, and some of these fragments of evidence have provided insight into the synthesis of plant-based compounds with therapeutic qualities (Dhama*et al*., 2014).

Nature's most abundant and diverse primary source of active drugs, plants are notably useful in the ethnomedical treatment of a wide range disorders. Phytochemicals abound in medicinal plants, and some of these substances are what give them their therapeutic properties. (Olasehinde*et al*., 2012).

Chemically manufactured medications may operate rapidly, but they have side effects that have a negative impact on the human body in the long term, whereas medicinal plants perform in a complementary or probiotic manner with little or no negative effects on the body (Idu 2009).

The usage of medicinal plants has had magical-religious significance in the formation of human society, as well as varied points of view on the conceptions of health and sickness that existed within each civilization.It has been more than 3000 years since plants were employed in Chinese, Indian and African Traditional Medicine, with most showing therapeutic properties according to Western criteria (Joshi *et al*., 2011).

2.1.1 Phytochemical Constituents of Medicinal Plants

Screening medicinal plants for antimicrobial activity is a common strategy for detecting antimicrobial activity against a wide variety of bacteria. A growing number of bacteria are becoming resistant to antimicrobial therapy. This has prompted continuing research to identify new and safer treatment agents (Kpadonou*et al*., 2019). Organic products contain phytochemicals, a class of bioactive organic chemical compounds present in cereals and other plant products such as vegetables, fruits, and grains Many of these phytochemicals operate as a barrier against both metabolic disease and infectious disease in the host (Esposito*et al*., 2016).

Lipids and carbohydrates are common primary metabolites found in all plants, whereas secondary metabolites only occur in a small number of plants and have specific functions. They are macromolecules that plants produce in their environment for a variety of purposes, such as drought tolerance, pollination, and predator defence, but they are not needed for the immediate survival of the plants in the environment. A medicinal or aromatic plant's roots, stems, bark, leaves and flowers can all contain active components (Kennedy and Wightman 2011). A range of bioactive compounds were found in therapeutic plants, including saponins, tannins, and alkaloids (Ezike *et al*., 2016).

In the pharmaceutical industry, extraction entails separation utilizing plant and microorganism tissue components according to standard, selected buffer solution or solvents standard operating procedures (Udochukwu *et al*., 2015). The most important variables that can have an impact components used as indicators of the quality of a plant extract a sample (leaf, bark, or root), as well as the solvent and concentration of the solvent employed for extraction, as well as the method of extraction, while the effect depending on the chemical elements extracted from the extract depending on the type of plant material, where it came from, and how much of it was used processing, moisture content, and particle size are all factors to consider. An extract's secondary metabolite composition can be affected by factors

such as extraction method, solvent type and concentration, processing temperature, and analyte polarity among others (Oramadike and Ogunbanwo 2017).

2.1.2 Characteristics of Medicinal Plants

When utilized as a treatment, medicinal plants have several qualities, including:

i. Synergic medicine- is when the compounds in plants interact at the same time, complementing or harming others, or neutralizing their potential negative impacts.

ii. Support for official medicine- Plant components have been shown to be particularly effective in the treatment of complicated instances such as cancer disorders.

iii. Preventive medicine- It has been established that the components of plants have the power to prevent the onset of certain diseases. This will assist to limit the use of chemical medicines when the disease is already manifest, as well as the adverse effects of synthetic treatments (Hassan, 2012).

2.1.3 Classification of Medicinal Plants

Medicinal plant classification is done in a variety of methods, depending on the criteria utilized. In general, medicinal plant phytochemicals are reserved in their storage organs, such as roots, leaves, flowers, seeds, and other sections of the plant, according to their active ingredients. These are beneficial to mankind in terms of disease treatment.

Utilization-Based Classification

i. Medicinal herbs, culinary herbs, aromatic herbs, and ornamental plants are the four categories of herbs. Medicinal herbs, such as marigold, lemon balm, lavender, johnny-jump-up, feverfew, and others, have medicinal capabilities and are utilized in the manufacture of medicines due to their therapeutic capabilities.

ii. Culinary herbs, such as oregano, parsley, sweet basil, horseradish, and thyme, are arguably the most utilized as culinary herbs due to their strong flavours.

iii. Aromatic herbs are used for a variety of purposes due to their pleasant-smelling blossoms or foliage. Perfumes, toilet water, and a variety of smells can all be made from oils derived from aromatic herbs. Mint, rosemary, basil, and other herbs are examples.

iv. Lavender, chives, bee balm, lemongrass, and other ornamental herbs with vividly coloured flowers and foliage are used for décor (Krishnaiah *et al.*, 2011).

2.1.4 Medicinal Plants in Nigeria with Antimicrobial Activities

Although antibiotic research has been successful, infectious diseases continue to be the world's second-leading cause of death, notwithstanding the success of antibiotic research (Pavithra *et al*., 2010). In the search for new compounds with therapeutic promise for infectious diseases for which there is no recognized treatment, such as Lassa fever and others, plants are the best source of pharmacological molecules. Because antimicrobial resistance is one of the most serious challenges of our time, we must continue to look for innovative, effective, and safe treatment options (Chikezie *et al*., 2015).

1. Antibacterial Activity

A potentially lethal infection produced by various Mycobacterium species, tuberculosis is one of the leading causes of death in developing countries (Okwuosa*et al*., 2012). Globally, 8.6 million people contracted tuberculosis (TB) in 2013, with 1.3 million deaths and an estimated 450,000 new cases of multidrug-resistant TB being found, according to the World Health Organization. Globally, chronic cough is most widespread in Europe (12.7%), Oceania (18.1%) Asia (4.4%), the United States (11.0%), and Africa (4%) (2.3 percent). (Aiyeloja and Bello 2006).

Diarrhoea is a deadly disease; according to WHO observatory data from 2015, diarrhoeal disease causes between 9 and 34%of childhood mortality in underdeveloped countries. *Helicobacter pylori*, *Vibrio cholerae*,*Campylobacter jejuni*, *Salmonella typhi or paratyphi*, *Clostridium difficile*, *Shigella flexneri*, and Shiga toxin-producing *Escherichia coli* are only a few of the enteric bacterial pathogens that cause diarrhoea. Root and leaf extracts of Terminalia glaucescens have antibacterial activity against *E. coli* and *S. typhi*, according to the study findings (Ogbonnia *et al.*, 2008).

The methanol extracts of three Nigerian medicinal plants were found to be antibacterial against five clinical bacterial isolates, including two Gram-positive bacteria (*Staphylococcus aureus and Bacillus subtilis*) and three Gram-negative bacteria (*E. coli*, *Klebsiella pneumonia*, and *Pseudomonas aeruginosa* (Chikezie *et al*., 2015).

Using concentrations of 25–400 mg/ml, acetone, and ethanol extracts of *Azadirachta indica* (A. Juss.) bark demonstrated considerable antibacterial action against all 14 multidrug-resistant *Salmonella typhi* strains with zone diameters of 18–31 mm (Okpe *et al*., 2016). An investigation of the action of aqueous and ethanolic extracts of *Zingiber officinale* and *Allium sativum* on selected foodborne bacteria discovered multidrug

resistance (*S. aureus*, *E. coli*, *Bacillus cereus*, and *Salmonella 7*) (Ola-Fadunsin and Ademola, 2014). Ethanol extracts inhibited S. aureus and Salmonella, while only aqueous extracts affected E. coli. There was antibacterial activity identified in alcoholic extracts from the leaves of two different Diospyros species (D. barteri and D. monbuttensis), but two different fungal species (Aspergillus niger and Candida albicans) were resistant to both Diospyros species under investigation (Suleiman et al., 2008).

The Senna alata flower extracts were tested in methanol, chloroform, water, and petroleum ether at final concentrations of 500 g/mL and showed antibacterial activity against clinical isolates of *Candida albicans, S. aureus, Proteus vulgaris, E. coli,* and *B subtilis, Proteus aeruginosa.* (Omotoyinbo and Sanni 2015). In vitro vibriocidal activities of three medicinal plants (traditional Ogi-tutu, *Psidium guajava*, and *Vernonia amygdalina*) were studied, and early results showed that *Vernonia amygdalina* had the most beneficial effects in preventing and curing V.-choleraem infection (Barbieri *et al*., 2017).

Using the agar diffusion method, researchers found that *T. vulgaris* has antibacterial activity against a variety of antibiotic-resistant *Vibrio fluvialis* and *Vibrio parahaemolyticus*, both of which were obtained from shrimps It was shown that aerial and root extracts of *Argemone mexicana* L. were antibacterial against *B. subtilis* and *K. pneumoniae,* but not against *P. aeruginosa* or *S. aureus* (Suleyman and Alangaden 2016).

2. Antimalarial Activity

Malaria is a huge hazard to global health and are responsible for the deaths of millions of people, especially in Sub-Saharan There has been an increase in the number of multidrug-resistant malaria parasites, which has spurred efforts to produce mixed formulations (such as sulfadoxine-pyrimethamine and artemether-lumefantine) and continued *Morinda lucida* "Oruwo,", *Momordica charantia* ("Ejirin"), and *Diospyros monbuttensis* ("Egun eja") and were tested in vitro for *Plasmodium falciparum* sensitivity. *M. lucida* had the lowest antiplasmodial activity (IC50 25 nM), whereas *D. monbuttensis* had the highest. When Oladele tested crude n-hexane and ethanolic extracts of *M. oleifera* seeds for antiplasmodial activity, she discovered that the ethanolic extract was most effective (Oladele., 2018).

Landolphiaowariensis P., a member of the Apocynaceae family, is also used in southeast Nigeria to treat malaria. This is due to the alkaloids, flavonoids, saponins and tannins that

are present in the leaf methanol fraction, which has shown to be the most effective against Plasmodium berghei in albino mice with early, established, and persistent infections (Butler and Buss., 2006).

Cajanus cajan (L.) is a member of the family Fabaceae. Additionally, the compound has antimalarial characteristics. Researchers tested *C.elegans*' crude methanolic extract. With the multiresistant*P. falciparum* (K1) strain and several chromatographic procedures, the cajanchalcone (2′,6′-dihydroxy-4-methoxychalcone) was found as one of physiologically active chemicals in the ethyl acetate fraction of cajan leaves (Subramaniyan *et al*., 2016). Most commonly grown in Africa, *Azadirachthyte indica* (A. juss.) is a herb of the Meliaceae family with pharmacological activities, including antiplasmodial activity (Okoye *et al*., 2012

Because of this, the antimalarial activity of *A. indica* must be further investigated. However, in a computer simulation, margolonone, nimbinone, and nimbione were found to be the most useful compounds for influencing the activity of P. falciparum heat shock protein 90 (Ncube *et al.,* 2008). All portions of *A. africanus* were found to be rich in flavonoids, saponins, tannins, and carbohydrates, and these compounds were found to diminish parasitemia in mice following intraperitoneal delivery of *P. berghei* (NK-65) erythrocytes (Oladosu *et al*., 2013). Four novel chemical constituents of *A. africanus* have been discovered, including hanocokinoside, allotaraxerolide, alloeudesmenol, and alloaminoacetaldehyde. (Daniyan and Ojo 2019).

Justicia flava VAHL had three lignans in it: (+) isolariciresinol, helioxanthin, and justicinol. Another two novel 1-aryl-2, 3-naphthalide lignans were discovered in J. root flava: 8-demethylorosunol and orosunol. As a result, further study and optimization of these special compounds may help create and produce a new class of antimicrobial drugs that are both effective and safe (Bongomin*et al*., 2019).

3. Antifungal Activity

Fungal infections, often known as mycoses, are caused by fungi. In recent years, fungal infections have been recognized as a serious health risk and a life-threatening illness, especially in immunocompromised patients (Ogbole*et al*., 2018). Other medical conditions, such as HIV, asthma, cancer, organ transplantation, and corticosteroid medication, can lead to serious fungal infections (Okigbo*et al*., 2009). In Nigeria, HIV/AIDS patients and newborns in intensive care units have been related to fungal

infections (cryptococcal antigenemia, subclinical histoplasmosis) (Nishan and Subramanian, 2014). A major public health concern is the re-emergence of previously treated fungal infections due to the use of newer drugs for autoimmune and cancer-related illnesses (Lockhart and Guarner 2019).

Traditional medicine has employed the Asclepiadaceous flowering plant *Calotropis procera* in a number of different ways. In addition to treating eczema and skin infections, this medication is used to prevent leprosy, treat syphilis, and treat malaria as well.

An investigation into the antifungal properties of *C. niger* was conducted. Microsporum and Trichophyton species were fully suppressed after ten days of inoculation with varying dosages of water extract (Olaniyi 1982). Crude methanolic extracts of *Spondiasmombin* (bark and leaves) with diameters of 11.000.47 mm and 15.000.47mm, respectively, were found to have anti candida effects. Terpenoids, alkaloids, glycosides, saponins, and flavonoids are only a few examples of the phytochemicals found in extracts (Agbaje and Onabanjo 1994). *Candida albicans* isolates from caries patients respond favorably to extracts of *Psidium guajava*, according to the research(Adeniyi *et al*., 2015). Leaf extracts of *Alchornealaxiflora*contain antibacterial and antifungal activities in the form of flavonoids, alkaloids, saponins, tannins, and reducing sugars (Aiyegoro and Okoh., 2009).

4. Antiviral Activity

In Nigeria, scientists studied antivirals. The antiviral activity of 27 medicinal plant extracts from 26 different plant species against the echovirus 7, 13, and 19 serotypes (E7, E13, and E19, respectively) revealed that the methanolic extract of *Macaranga barteri* leaves had the highest antiviral activity on E7 and E9, followed by *Ageratum conyzoides* leaves extract on E7 and E19, and *Mondia white*i leaves extract on E7 and E19, respectively (Taiwo and Igbeneghu., 2014).

Rheum palmatum and *Rheum officinale* extracts, as well as anthraquinone derivatives of their principal single isolated constituents, suppressed HIV-1 reverse transcriptase-associated DNA polymerase (RDDP) and ribonuclease H activity in China (Nayak *et al*., 2011). Antiretroviral activity was discovered in several plants. MichellamineA and B were made by *Ancistrocladuskorupensis* and *Ancistrocladuscongolensis*, respectively (Boyd *et al*., 2016). Numerous antibacterial plants have been discovered in Nigeria, as shown in Table 2.1.

Table 2.1: Summary of selected antimicrobial medicinal plants in Nigeria

SN	Botanical name of the medicinal plant	Major therapeutic action
1	*Citrullus colocynthis, Argenomemexicana, Ficus exasperate, Persia americana, Annoma senegalensis, Alchornealaxiflora, Crinum jagus, Adansonia digitate,, Cola nitida, Dorstenia prorepens, Echinacea purpurea, Spondiasmombin, Vernonia amygdalina, Thymus vulgaris*	Antibacterial
2	*Enantiachlorantha, Azadirachta indica, Justica flava, Landolphiaowariensis, Cassytha filiformis, Morinda lucida, Allamanda cathartica, Allpphylus africanus, Clerodendrum capitatum, Bixa Orellana, Senna alata*	Antibacterial, antiparasitic, antifungal
3	*Amaranthus spinosus, Mangifera indica, Myristica fragrans, Cjanuscajan, Gossypium arboretum, Heeria insignis, Diospyros monbuttensis, Morinda lucida Calotropis procera, Momordica charantia*	Antiparasitic
4	*Macrangabarteri, Ageratum conyzoides, Mondia whitei*	Antiviral

Source- Ugboko*et al*., 2020.

2.1.5 Mechanisms of Action of Medicinal Plants

Infectious illnesses are uncommon in wild plants, which is a strong indicator of the presence of effective defence mechanisms. Phytochemicals can decrease enzyme and toxin activity, damage the bacterial membrane, reduce virulence factors, produce biofilms, impede protein synthesis, and quorum quenching, among other methods of action (Meskin 2002**).** Tannins' mechanism of action is mostly based on their capacity to bind proteins and hence suppress cell protein synthesis. Quorum sensing has three levels of intervention: signal generation, signal sequestration, and signal reception (Maitera*et al*., 2018).

Antibiotics and antimicrobial medicinal plants work in tandem.

It has been shown that antibiotics are beneficial for combating a wide range of infectious diseases. However, antibiotic resistance has led to an increase in the number of new and re-emerging infectious diseases. Three factors have led scientists to believe that microbes are developing resistance to antibiotics:

i. Direct destruction or alteration of the antibiotic by organism-produced enzymes;

ii. Changes to the target antibiotic that reduce the binding efficacy of antibiotic efflux from the cell; and

iii. Drug efflux from the cell (Sasidharan *et al*., 2011).

Using polyherbal formulations or combination active pharmaceuticals to counteract resistance mechanisms is one strategy (Oladosu *et al*., 2015). The use of natural materials in conjunction with medications to increase therapeutic efficacy is a novel method to combating antibiotic resistance (Kutama*et al*., 2015). However, when medicinal plants' several bioactive compounds are mixed with common pharmaceuticals, the efficacy of the treatment is often increased while toxicity and overdose issues are raised (Khan *et al*., 2009).

A 60 percent synergistic impact was seen when *Helichrysum pedunculatum* leaf extracts and wound infection-related bacteria-treating medicines were combined (Hemaiswarya*et al* 2008). He studied the antiplasmodial activity of *Murrayakoenigii* leaf, *Artocarpus altilis* stem bark, *Nauclea latifolia* root, and *Enantiachlorantha* stem bark in combination with conventional medicines. They discovered that when *N. latifolia* was coadministered with conventional medications, its protective, chemo suppressive, and curative effects were significantly reduced. Furthermore, combining *N. latifolia* or *M. koenigii* with additional

plants generated a synergistic effect, as opposed to employing each plant separately. In addition, *E. chlamydia* together with *A. N. altilis* or *N. altilis latifolia* boosted their respective preventive or curative effects, making them viable combinations for malaria treatment (Singh*et a*l., 2013). The administration of plants like *Carica papaya* and *Vernonia amygdalina* can help you feel better. Plasmodium infection has synergistic effects in mice. Within three months, there was a considerable reduction in parasite burden days of clinical therapy (Adebiyi and Abatan., 2013).

2.1.6 Alternative Medicine

The term "alternative medicine" has become increasingly popular in western culture these days, and it refers to the practice of employing plants for therapeutic purposes. Many people, on the other hand, believe that capsules and pills are the only types of medications we can rely on. Nonetheless, the majority of the pills and capsules we take and utilize on a regular basis are made from plants. Medicinal plants are widely employed as raw materials for extracting active components that are then employed in the production of various medications. Plant-based compounds are found in laxatives, blood thinners, antibiotics, and antimalaria treatments, among other things. Taxol, vincristine, and morphine are active compounds extracted from foxglove, periwinkle, yew, and opium poppy, respectively (Rasool Hassan 2012).

2.1.7 The Importance of Medicinal Plants in the Future

Many therapeutic plants have yet to be discovered and studied for their phytochemical compositions, making the future of medicinal plants bright. Medicinal plants have made it feasible to comprehend the scaffold for synthetic drug design and development. Furthermore, as new illnesses and disorders emerge that necessitate the use of alternative or supplementary medicine, the future of medicinal plants will have an impact on medical practice (El-Ghani, 2016). Medical professionals are alarmed by the rising tide of microorganism antibiotic resistance, which has sparked an urgent need for the manufacture of natural compounds that are safe in the postgenomic era. The use of medicinal plants as nutraceuticals and functional foods is increasing to ensure preventative medicine and find a solution to the global problem of the emergence of drug-resistant microorganisms (Dhama*et al*., 2014).

A bright future awaits medicinal plants due to the fact that there are over 500,000 species worldwide, the majority of which have not yet had their medicinal properties studied. These untapped resources could prove invaluable in the treatment of patients in both current

and future studies. The development of human culture, including religion and other rites, has been aided by medicinal plants. Aspirin, for example, is derived indirectly from medicinal plants like ginseng. Garlic, for example, is a food crop with medicinal properties. The study of medicinal plants helps us understand plant toxicity and improves our ability to protect humans and animals from natural poisons. Secondary metabolites produced by plants are what give them their therapeutic properties. As a result, natural product chemistry research has seen a surge in popularity (Hosseinzadeh *et al*., 2015).

2.2 Antimicrobial Resistance

The medical healthcare sector believed that the struggle against infectious diseases had been won with the discovery of antibiotics. However, because so many bacteria have developed resistance to many antimicrobial drugs, the conflict appears to have shifted in favour of bacteria. An infectious disease has overtaken non-communicable diseases as the main cause of global morbidity and mortality. Antimicrobial resistance has had a major impact on the spread of infectious diseases, as well as the number of infections and the expense of healthcare. Despite the fact that we have a wide range of antimicrobial agents to choose from for possible infection therapy, antimicrobial resistance has been observed for all of them and resistance develops quickly once a new treatment is approved for use. An antimicrobial resistance global action plan was launched by the WHO in 2015 in response to these issues (WHO., 2015).

Antimicrobial agents are classified into classes depending on their antimicrobial action mechanism. Inhibitors of cell wall production, depolarizers of the cell membrane, inhibitors of protein synthesis, inhibitors of nucleic acid synthesis, and inhibitors of metabolic pathways in bacteria are the primary classes. With such a diverse set of processes, it would appear that we would have more control over the creatures. Unfortunately, poor antimicrobial stewardship has contributed to the massive resistance problem that we currently face. Two factors have contributed to the rising resistance problem: increased antimicrobial drug intake by humans and animals, and poor antimicrobial therapy prescriptions. Many common antimicrobial agents may be overused by physicians since the medicine of choice is based on a combination of low cost and low toxicity (Griffith *et al*., 2012).

The use of antibiotics by humans increases the risk of antibiotic-resistant bacteria emerging. Furthermore, earlier use of antimicrobial medications increases the chance of infection with a drug-resistant organism, and individuals who have had the most antimicrobial exposure are

more likely to be infected with resistant bacteria (Griffith *et al*., 2012). Antibiotics have long been used in animals to cure or prevent disease. A wide range of antibiotics, from those used in people to those used in animal feed, are routinely found in dosages ranging from those below therapeutic to those fully therapeutic. Antibiotics have been linked to the development of antibiotic-resistant bacteria, which can subsequently infect humans who ingest animals that have been injected with them (Landers *et al*., 2012). Antimicrobial resistance patterns found in animals reflect the types and doses of antibiotics given to them. Antimicrobial resistance can be passed from animals to humans via a variety of routes, the most common of which is direct oral transmission (includes eating meat plus ingestion of faces in contaminated food or water) (includes eating meat plus ingestion of faces in contaminated food or water people can also be harmed by animals if they have close encounters with them (Wegener 2012).

2.2.1 The Origin of Resistance

A given antimicrobial medicine may or may not be effective against all strains of a particular pathogen. Resistant strains might range widely even within the same bacterial family. MIC, or the minimal concentration of medicine required to suppress bacterial growth, is widely used to assess a sample's sensitivity or resistance to a particular treatment or drug. Susceptibility is a phrase used to describe the average minimum inhibitory concentration (MIC) of an antibiotic across a wide spectrum of microorganisms. Drug intrinsic resistance occurs when an organism's mean MIC falls into the drug's resistant range. Resistance genes can be acquired by bacteria from related organisms as well. As a result, the level of bacterial resistance varies based on the species and genes acquired (Coculescu 2009).

1. **Natural Resistance**

   Natural resistance can be either intrinsic (i.e., always present in the species) or induced (i.e., not always present in the species) (the genes are naturally occurring in the bacteria but are only expressed to resistance levels after exposure to an antibiotic). Intrinsic resistance is a feature that is found across a bacterial species, is independent of previous antibiotic exposure, and is unrelated to horizontal gene transfer. Reduced permeability of the outer membrane (most especially the lipopolysaccharide, LPS, in gram negative bacteria) and natural efflux pump activity are the most prevalent bacterial mechanisms implicated in intrinsic resistance. Induced resistance can also be caused by multidrug-efflux pumps (Cox and Wright., 2013).

2 Acquired Resistance

Bacteria can acquire resistance-inducing genetic material via all of the main routes for bacteria to acquire genetic material: transformation, transposition, and conjugation (all referred to as horizontal gene transfer—HGT); in addition, the bacteria may experience mutations to its own chromosomal DNA. It is possible that the purchase will be temporary or permanent. The most common way to get outside genetic material is by plasmid-mediated transmission of resistance genes; bacteriophage-mediated transfer is uncommon. Certain bacteria, such as Acinetobacter spp., are inherently competent, meaning they may obtain genetic material from the outside world.Internally, insertion sequences and integrins may move genetic material around, and stressors (starvation, UV radiation, chemicals, etc.) on the bacteria are common causes of genetic mutations (substitutions, deletions etc.). Bacteria have a mutation rate of 1 per 106 to 109 cell divisions, with the majority of these mutations being harmful to the cell (Davies and Davies., 2010).

Antimicrobial resistance mutations mainly only arise in a few categories of genes: those encoding drug targets, drug transporters, drug transporter regulators, and antibiotic-modifying enzymes (Martinez 2014). Furthermore, many antibiotic resistance mutations come at a cost to the organism. For example, when Staphylococcus aureus acquired methicillin resistance, the bacteria's growth rate is considerably reduced (Reygaert 2009). One of the most perplexing aspects of antimicrobial resistance is that using these medications increases resistance. Even the use of low or very low concentrations of antimicrobials (sub-inhibitory) can lead to the selection of high-level resistance in subsequent bacterial generations, increase the ability to acquire resistance to other antimicrobial agents, and promote the movement of mobile genetic elements (Blázquez *et al*., 2012).

2.2.2 Mechanisms of Resistance

Antimicrobial resistance mechanisms are divided into four categories:

(1) Drug uptake limitation.

(2) Drug target modification.

(3) Drug inactivation; and

(4) Active drug efflux.

Intrinsic resistance mechanisms include things like changing the drugs' targets or preventing them from working acquired resistance mechanisms include things like changing the drugs' targets or preventing them from working. Structural and other differences make gram-negative bacteria's mechanisms different from those of gram-positive bacteria. Gram-negative bacteria use all four major processes, whereas Gram-positive bacteria use lower drug uptake (because of the absence of an LPS outer membrane) and a number of additional mechanisms (Mahon *et al*., 2014).

1. **Limiting the drug uptake**

As previously said, bacteria differ in their ability to block the uptake of antimicrobial drugs due to innate differences. The LPS layer's structure and functions serve as a barrier to chemicals in gram-negative bacteria. As a result, some bacteria develop an innate resistance to some classes of powerful antibacterial medications (Blair *et al*., 2014). Hydrophobic drugs like rifampicin and fluoroquinolones, which have lipid-rich outer layers like mycobacteria, have better access to cells than hydrophilic ones like hydrophilic antibiotics like chloramphenicol (Kumar and Schweizer., 2005). Bacteria that lack a cell wall, such as Mycoplasma and related species, are naturally resistant to cell wall-targeting medication such as -lactams and glycopeptides (Bébéar and Pereyre., 2005).

There is no external barrier to prevent Gram-positive bacteria from being affected by pharmacological restrictions. Enterococci exhibit intrinsic resistance to aminoglycosides because polar molecules penetrate the cell wall more slowly. Another vancomycin-resistant gram-positive bacterium is *Staphylococcus aureus.* A previously unidentified mechanism helps *S. aureus* resist vancomycin by causing the bacteria to build up a thicker cell wall, making it more difficult for vancomycin to enter the cell and providing intermediate resistance to the drug. The VISA strains are the scientific name for these bacteria (Miller *et al*., 2014).

Bacteria with thick outer membranes typically use porin channels to let substances in. Hydrophilic substances can be accessed by Gram-negative bacteria through porin channels (Blair *et al*., 2014). In both cases, medication absorption is affected by porin mutations that reduce the number of porins present or decrease the amount of porins present (Kumar and Schweizer., 2005).. Enterobacteriaceae bacteria grow more resistant to antibiotics as the number of porins in their cells diminishes (and sometimes stops production entirely of certain porins). As a carbapenem resistance mechanism, these bacteria diminish the number of porins

in the community (Chow and Shlaes., 1991). Ipenem and certain cephalosporin resistance have developed through alterations in the *E. aerogenes* porin channel, whereas *Neisseria gonorrhoeae* porin channel mutations have caused -lactam and tetracycline resistance (Thiolas*et al*., 2004).

Another well-known type of bacterial colonization is the formation of a biofilm by a colony These biofilms may be dominated by a single microorganism (such as *Pseudomonas aeruginosa* in the lungs) or by a broad community of species (as seen in the biofilm community of normal flora in the gut). The development of a biofilm shields dangerous microorganisms from the host immune system and antimicrobial treatments. Antimicrobial drugs find it difficult to reach the bacteria due to the biofilm matrix's thick, sticky structure, which comprises polysaccharides, proteins, and DNA from the resident bacteria.As a result, substantially larger medication concentrations are required to be effective. Antimicrobials that target growing, dividing microorganisms have little efficacy because of the sessile nature of the bacteria in a biofilm (low metabolic rate, sluggish cell division). The close proximity of bacterial cells in biofilms is expected to facilitate horizontal gene transfer, which is a significant discovery. These findings suggest that genes for antibiotic resistance may be spread more freely throughout bacterial populations (Van Acker *et al*., 2014).

2. **Modification of drug target**

Antimicrobial drugs can target a range of bacterial cell components, and bacteria can change those targets to permit resistance to those medications.One method of resistance to -lactam antibiotics, which are almost exclusively used by gram positive bacteria, is changes in the structure and/or number of PBPs (penicillin-binding proteins).PBPs are transpeptidases that aid in the formation of peptidoglycan in cells' walls.Changes in the quantity of PBPs have an impact on the amount of medication that can bind to that target (increase in PBPs with decreased drug binding ability or decrease in PBPs with normal drug binding capacity).A structural change (for example, in S. aureus, the acquisition of the mecA gene) can diminish or totally block drug binding (Beceiro*et al*., 2013).

Glycopeptides (such as vancomycin) inhibit cell wall production, whereas lipopeptides (such as daptomycin) depolarize the cell membrane. Because of the thick LPS coating, Gram negati ve bacteria are naturally resistant to these therapies (Randall *et al*., 2013). Vancomycin resista nce in enterococci (VRE—vancomycin-
resistant enterococci) and Staphylococcus aureus has become a major issue (MRSA).The acq

uisition of van genes causes changes in the structure of peptidoglycan precursors, reducing va ncomycin's ability to bind to them (Cox and Wright., 2013).The presence of calcium is requir ed for daptomycin binding. The charge of the cell membrane surface is shifted to positive by gene mutations (e.g., mprF), which prevents calcium binding and consequently daptomycin binding (Stefani *et al*., 2015).

Resistance to ribosomal subunit-
targeting drugs can be caused by ribosomal mutation (aminoglycosides, macrolides—
gram positive bacteria, oxazolidinones, streptogramins), ribosomal subunit methylation (amin oglycosides, macrolides—
gram positive bacteria, oxazolidinones, streptogramins) most commonly involving erm genes, or ribosome (tetracyclines). Because of these methods, the medicine has a tough time attachi ng to the ribosome. The level of medication interference varies greatly between routes (Kuma r *et al*., 2013).

A structural alteration (for example, the acquisition of the mecA gene in S. aureus) can reduc e or completely block drug binding (Beceiro *et al*., 2013). Glycopeptides (such as vancomycin) inhibit cell wall production, whereas lipopeptides (like daptomycin) depolarize the cell membrane. Because of the thick LPS coating, Gram negative bacteria are naturally resistant to these therapies (Randall *et al*., 2013). Changes in DNA gyrase (gram negative bacteria, for example, gyrA) or topoisomerase IV (gram positive bacteria, for example, gyrA) mediate resistance to medicines that target nucleic acid synthesis (fluoroquinolones) (gram positive bacteria, e.g., grlA). As a result of these structural alterations, the drug's capacity to bind to gyrase and topoisomerase is decreased or destroyed (Redgrave *et al*., 2014).

Mutations in enzymes involved in the folate biosynthesis route (DHPS—dihydropteroate synthase, DHFR—dihydrofolate reductase) and/or overproduction of resistant DHPS and DHFR enzymes (sulphonamides—DHPS, trimethoprim—DHFR) produce resistance to drugs that disrupt metabolic pathways.Vancomycin resistance has become a major issue in enterococci (VRE—vancomycin-resistant enterococci) and Staphylococcus aureus (MRSA).Sulphonamides and trimethoprim bind to their respective enzymes because they are structural analogs of natural substrates (sulphonamides—p-aminobenzoic acid, trimethoprim—dihydrofolate).These medications work by binding to the active sites of enzymes and competitively inhibiting them. The active sites of these enzymes are frequently

changed, and the ensuing structural modifications in the enzyme hinder drug binding while allowing natural substrate binding (Vedantam *et al*., 1998).

3. Inactivation of the drug

Bacteria inactivate pharmaceuticals in two ways: by degrading the drug or by attaching a chemical group to it. Beta-lactamases are a class of enzymes that degrade medications. Tetracycline is another medication that can be inactivated by hydrolysis via the tetX gene (Blair *et al*., 2015).

The transfer of acetyl, phosphoryl, and adenyl groups to the medication is the most common method of pharmacological inactivation via chemical group transfer. There have been a vast number of transferases discovered. Acetylation is the most often employed mechanism, with aminoglycosides, chloramphenicol, streptogramins, and fluoroquinolones all being known to use it. The aminoglycosides are known to be targeted by phosphorylation and adenylation (Blair *et al*., 2015).

4. Beta-lactamase

The most widely used antimicrobials are those classed as beta-lactams. All members of this pharmacological class have a four-sided -lactam ring as their basic structure. Antibiotic resistance to beta-lactams can be caused by three distinct mechanisms:

(1)Increasing the drug's ability to bind to the PBP target (through modifications to current PBPs or acquisition of other PBPs),

(2) the presence of efflux pumps capable of extruding Beta-lactam antibiotics.

(3) Drug hydrolysis by beta-lactamase (Bush and Bradford 2016).

Beta-lactamases (also known as penicillinases and cephalosporinases) inactivate Beta-lactam antibiotics by hydrolyzing a specific location in the ring structure of the Beta-lactam molecule, causing the ring to open. The open-ring drugs can't bind to the PBP proteins they're supposed to target. Beta-lactamases are a type of enzyme that can inactivate every Beta-lactam medication currently on the market. The most common gram-negative bacteria resistance mechanism against Beta-lactam drugs, as well as the most important resistance mechanism against penicillin and cephalosporin pharmaceuticals, is the creation of Beta-lactamases (Kumar *et al*., 2013).

These enzymes can be located on the bacterial chromosome naturally or acquired by plasmids.Beta-lactamase genes are found on the chromosomes of many gram-negative bacteria in the Enterobacteriaceae family.Gram-negative bacteria such as *Aeromonas* spp., *Acinetobacter* spp., and *Pseudomonas* spp. have them.plasmid-borne beta-lactamase genes are most commonly found in Enterobacteriaceae, although they can also be found in gram-positive bacteria including *Staphylococcus aureus*, *Enterococcus faecalis*, and En*terococcus faecium* (Schultsz and Geerlings., 2012).

The first lactamase identified in *E. coli* was encoded by the ampC gene on the chromosome (so named for ampicillin resistance).By default, this gene is expressed at a low level, but mutations can lead it to become overexpressed.AmpC-lactamases are more vulnerable to penicillin and several first-generation cephalosporins.Several bla genes (Beta-lactamase genes) are carried by several plasmid-borne Beta-lactamases.ESBLs are Beta-lactamases that confer resistance to later-generation cephalosporins.They include members of the TEM, SHV, CTX-M, and OXA enzyme families (Bevan *et al*., 2017).

Beta-lactamases (carbapenemases) that target carbapenems have recently emerged, most notably in the Enterobacteriaceae family. Carbapenem-Resistant Enterobacteriaceae (CRE) enzymes and *Klebsiella pneumoniae*carbapenemases (KPCs) are two different forms of carbapenemases. KPCs were described by Friedman *et al*., (2016) as serine Class A (functional group 2f) -lactamases that are resistant to all -lactam antibiotics but susceptible to -lactamase inhibitors Friedman *et al*., 2016).

A key priority in the fight against CRE pathogens is the development of more efficient -lactamase inhibitor drug combinations.Ceftolozane/tazobactam is a novel Beta-lactamase/drug combination used to treat P. aeruginosa, although it has also shown promise against gram negative ESBL-producing infections.Other Beta-lactamase inhibitors that aren't Beta-lactam antibiotics have a different structure.The first of them, avibactam, has been approved for use in combination with ceftazidime against gram-negative bacteria.Avibactam is also being tested in combination with aztreonam against CREs (Docquier and Mangani., 2018).

5. Drug Efflux

Efflux pump genes are chromosomally encoded in bacteria. Others are triggered or overexpre ssed in response to certain environmental stimuli or the presence of an adequate substrate, an d others are expressed constitutively (high-

level resistance is usually achieved through a mutation that alters the transport channel). Alth ough efflux pumps are largely responsible for removing harmful molecules from the bacterial cell, several of them can transport a wide range of substances (multi-drug [MDR] efflux pumps). The carbon source available controls the resistance characteristic s of several of these pumps (Blair *et al*., 2015).

Efflux pumps in bacteria exist in a variety of shapes and sizes. The ATP-binding cassette (ABC) family, the multidrug and toxic compound extrusion (MATE) family, the small multidrug resistance (SMR) family, the major facilitator superfamily (MFS), and th e resistance-nodulation-cell division (RND) family are the five major families of efflux pumps found in bacteria. The majority of efflux pump families are one-component pumps that move substrates through the cytoplasmic membrane.The RND family of multi-component pumps (found almost exclusively in gram negative bacteria) efflux substrate over the entire cell envelope in collaboration with a periplasmic membrane fusion protein (MFP) a nd an outer membrane protein (OMP-porin) (Poole 2007).

When paired with additional biological components, members of the efflux family can functi on as multicomponent pumps in gram negative bacteria. MacB, an ABC family member, is a three-part pump that extrudes macrolide medicines (MacAB-TolC). EmrB, an MFS family member, functions in E as a tripartite pump (EmrAB-TolC) to extrude nalidixic acid (Jo *et al*., 2017).

2.3 Tradescantia spathacea

2.3.1 Nomenclature, Classification, and Taxonomy

Domain: Eukaryota

Kingdom: Plantae

Phylum: Spermatophyta

Subphylum: Angiospermae

Class: Monocotyledonae

Order: Commelinales

Family: Commelinaceae

Genus: Tradescantia

Species: *Tradescantia spathacea*

1. Description

The Commelinaceae family has 40 genera and 652 species that grow in both tropical and tem perate climates (Stevens, 2012). The leaves of this herb family are often delicate and meaty. The Commelinaceae is a plant family found in both the Old and New Worlds' tropics, with so me genera occurring in both (Faden, 1983; Evans *et al*., 2003). This plant family offers a dive rse set of morphological characteristics, particularly in terms of floral and inflorescence chara cteristics (.Evans *et al*, 2000; Faden, 2000).

It's a compact, strong upright plant that can grow up to 20 cm tall. It's an erect perennial sub s ucculent herb that's generally grouped and creates enormous colonies. Imbricate, crowded, lin ear-lanceolate to oblong-lanceolate, 20 - 35 cm long, mostly 3 -
5 cm wide, acuminate at apex, scarcely narrowed at base above sheath, dark green above, red dish-purple beneath, and imbricate, crowded, linear-lanceolate to oblong-lanceolate, 20 -
35 cm long, mostly 3 - 5 cm wide, acuminate - Peduncles 2 -
4.5 cm long, simple or branched; bracts profoundly boat-shaped, broadly ovate, 2 -
4.5 cm long, 2.5 - 5 cm broad; inflorescences axillary; peduncles 2 -
4.5 cm long, simple or branched; bracts profoundly boat-shaped, broadly ovate, 2 -
4.5 cm long, 2.5 - 5 cm broad; inflorescences.

Flowers are small, white, and arranged in a folded, boat-shaped bract (spathe) 3 -
4 cm long, short-
stalked from leaf axils; petals are three, white, and elliptical, and stamens are six with hairy fi laments. The seeds have an oblong-
ellipsoid form and a linear hilum. One seed per locule in a capsular fruit; oblong-
ellipsoid seeds with a linear hilum (Acevedo-
Rodrguez and Strong, 2005; Richard and Ramey, 2007).

It's a tough perennial herbaceous plant with a thick, unbranched stem that grows to be less tha n 0.5 meter tall. The lanceolate and acuminate leaves are 40–60 cm long, 4–
6 cm wide, and juicy, with a dark green upper surface and a purple lower surface. Each inflor escence features numerous fascicled, white flowers that are about 1 cm in diameter. Two larg e, imbricate, laterally compressed, distichous, 3 to 4 cm long violet bracts surround the blosso ms on an axillary, short, peduncled inflorescence.

1. Identification

Preferred Scientific Name

Tradescantia spathacea

Preferred Common Name

Boat lily

Other Scientific Names

i. Ephemerumbicolor Moench
ii. Rhoeodiscolor (L'Hér.) Hance
iii. Rhoeospathacea (Sw.) Stearn
iv. Rhoeospathacea f. concolor (Baker) Stehlé
v. Rhoeospathacea f. variegata (Hook.) Stehlé
vi. Tradescantia discolorL'Hér.
vii. Tradescantia discolor var. concolor Baker
viii. Tradescantia discolor var. variegata Hook.
ix. Tradescantia versicolor Salisb.

International Common Names

i. English: Moses-in-a-boat; Moses-in-the cradle; oyster plant
ii. Spanish: Barca de San Pedro; maguey morado
iii. French: moïse dans les jonc; plante huitre; rhoé
iv. Chinese: zi bei wan nianqing

1. Habitat

T. spathacea is a popular decorative plant that has become invasive in gardens and yards. It g rows and thrives in the understory of coastal forests, shrublands, pinelands, hammocks, secon dary forests, cultivated areas, and disturbed regions from sea level to low elevations. *T. spath acea* grows to make a dense ground cover (Richard and Ramey, 2007; Langeland and Burks,

2008, ISSG, 2012). The species grows on stone or coral walls, as well as steep cliffs, on Pacif ic islands (Smith, 1979; PIER, 2012).

Figure 2.1: *Tradescantia spathacea*

Source: https://www.bigbcart.com/product/tradescantia-spathacea-roheo-spathacea-rhoeo-bicolor-spiderwort-live-plant-with-pot/

2.3.2 Antimicrobial activity of Tradescantia spathacea

Leaves of *T. Spathacea* were used in traditional medicine to treat mycosal infections, venereal disorders, urinary tract infections, hemorrhoids, tuberculosis, and cough. Other traditional uses include anti-inflammatory, antitoxic supplementation, blood circulation improvement, anti-diarrhoea, expectorant, hypoglycemic agent, and snakebites. Antibacterial, anti-hyperuricemia, analgesic, and anti-inflammatory properties of distinct extracts of numerous Tradescantia species have been experimentally proven. *T. spathacea* has been shown to have cytotoxic and hepatoprotective properties (Mohamed, 2018).

1. Anti-Tuberculosis Activity

Radji (2015) investigated aqueous extracts of *T. spathacea* leaves obtained through maceration. For the Standard strain of Mycobacterium TB H37Rv and the isolated multidrug-resistant (MDR) strain, dried extracts were employed. Dimethyl sulfoxide was used to dissolve 2.5 grams of dry extract. Against *Mycobacterium tuberculosis* H37Rv strain, the proportion of inhibition in aqueous extract was 100%, 82.1 percent, 78.5 percent, 100 percent, and 100 percent, respectively, but against MDR strain, it was 93.7 percent, 50.0 percent, 50.0 percent, 100 percent, and 100 percent. An aqueous extract of the leaves had strong anti-mycobacterial properties.*T. spathacea* had a 100% inhibition rate against *M. tuberculosis* H37Rv and MDR strains using aqueous extract (2.5 mg/ml) (Radji *et al*., 2015).

2. Antibacterial Activity

This plant is defined by the World Health Organization (WHO) as one or more organs having chemicals that can be employed as therapies or as precursors for the production of effective medicines. *T. spathacea* Sw. is a member of the Commelinaceae family. Tradescantia is the common name for this plant, which is often grown in gardens. *Staphylococcus aureus*, *Staphylococcus citrus*, and *Bacillus subtilis* were investigated for resistance to the extract. *Salmonella typhi*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Serratia* sp., and *Proteus vulgaris* were among the Gram-negative bacteria studied. *Rhoeodiscolors* have the most potent antibacterial properties. Because *Rhoeodiscolors* exhibited the highest antibacterial activity in this investigation, it can be used to find bioactive natural compounds that may lead to the creation of novel pharmaceuticals to address unmet therapeutic needs (Parivuguna, 2008).

3. Antiviral activity

The most significant cytopathic inhibitory effect was seen on Vero cells, with cell viability of 92.6 percent, 91.5 percent, and 88.8 percent, respectively, according to Chan (2016), a study of the *T. spathacea*, Malaysian medicinal plant for anti-chikungunya virus activity, ethanol, methanol, and chloroforms leaf extracts of *T. Spathacea*. Hexane and chloroform extracts can be classified as nonpolar extracts, ethyl acetate extract as an intermediate polar extract, and ethanol, methanol, and water extract as polar extracts, due to the wide polarity range of solvents utilized in the extraction. In the cytotoxicity test, nonpolar and intermediate polar extracts were more hazardous to Vero cells than polar extracts.In the cytotoxicity test, nonpolar and intermediate polar extracts were often more harmful to Vero cells than polar extracts, preventing investigation of their prospective antiviral effects at greater doses. The extract was next tested for cytopathic effect regulatory properties at non-toxic concentrations (cell viability about 90%) (Cheng *et al*., 2016).

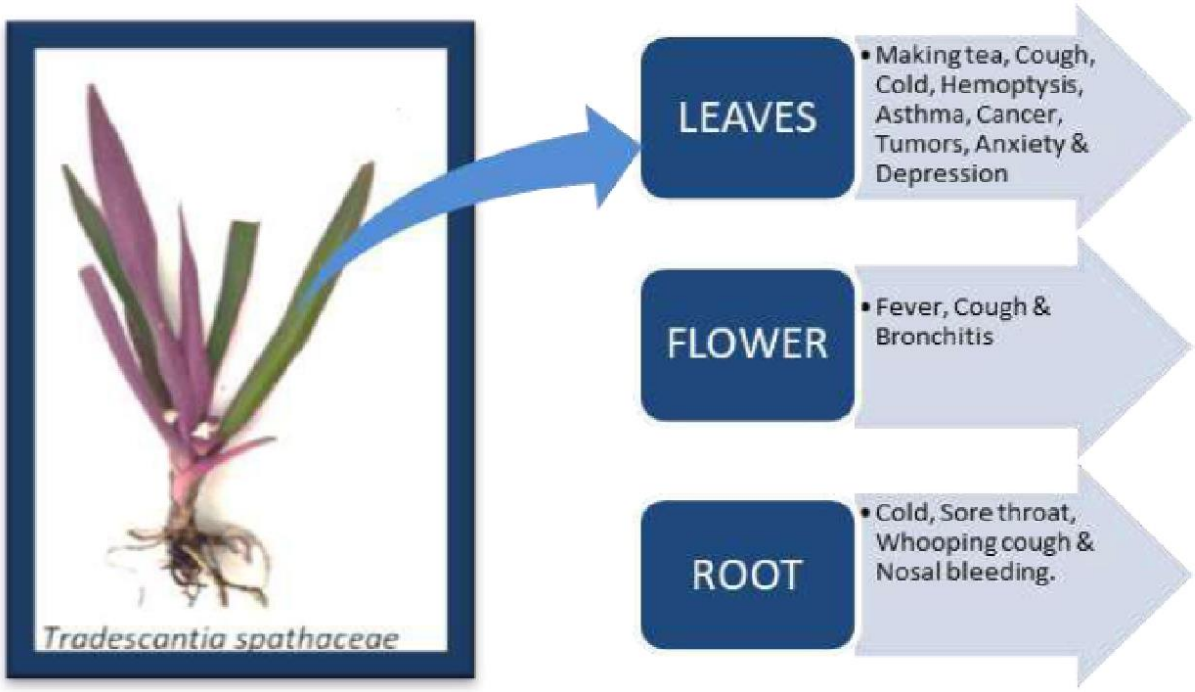

Figure 2.2: Pharmacological significance of *Tradescantia spathacea* as a whole plant

Source: Prajapat*et al*., 2020

2.4 Review of methods

2.4.1 Minimum Inhibitory concentration

The lowest concentration of an antibacterial agent necessary to totally suppress detectable growth of a test strain of an organism under well-controlled in vitro conditions, measured in milligrams per liter (g/mL) (Kowalska and Wicher, 2021).

MIC Methods of Determination

The following methods are employed:

1. Dilution procedures • in an agar media • in a liquid medium

2. Methods for determining antibiotic gradients • strips impregnated with an antibiotic concentration gradient Kowalska and Wicher, 2021) All quantitative approaches employ Mueller–Hinton (MH) medium in the form of agar (MHA) or broth to generate MIC values (MHB).

Antibiotics are tested to see if they have any inhibiting effects. The filter paper disc (Kirby-Bauer) method, agar and broth dilution method, and the dilution method are all methods used to test antibiotics. The dilution method is used to determine the Minimum Inhibitory Concentration (MIC), which is the lowest antimicrobial agent concentration required to prevent microbial growth, and the Minimum Bactericidal Concentration (MBC), which is the lowest antimicrobial agent concentration required to kill microorganisms. There are two types of dilution: microdilution and macrodilution.

The MIC and MBC have been determined using microdilution and macrodilution methods. MIC and MBC are usually determined by the Dilution Method (DM), which includes inoculating an indicator bacterium into various doses of an antibiotic, incubation for 18 to 24 hours, and then evaluating for bacterial viability by subculturing on antibiotic-free agar media. MIC and MBC determinations are usually performed using antibiotic-free agar mediums injected with samples from tubes that exhibit no turbidity or growth.

Agar media preparation necessitates additional time, tension, and the use of a Petri dish. As a result, a better new approach, the dilution tube, was developed. method (DTM), which is simpler and less expensive because it does not require agar media, although just broth medium is used in the use of tubes to determine MIC and MBC (Chikezie IhebuzoajuOwuama, 2017).

2.4.2 McFarland standard

Antibiotic Susceptibility Tests frequently employ the McFarland Standard to standardize the approximate number of bacteria in a liquid suspension or broth culture of bacterial cells by comparing the turbidity of the cultured test solution to the McFarland standard. 1% barium chloride (BaCl2) and 1% sulfuric acid (H2SO4) make up the solution, which reacts to generate a turbid solution due to the development of fine barium sulfate precipitate during the manufacturing process (BaSO4).

CHAPTER THREE

METHODOLOGY

3.1 Collection of plants

The plants were collected from The University of Ibadan. The clean pocket knife was used to collect the samples. The sample was kept in clean sterile Ziploc bags and taken to the laboratory. The plant was collected by Mr Ojah, Emmanuel Onah from the Department of Botany, University of Ibadan. The herbarium number is UIH- 23053.

3.2 Plant Preparation and Extraction

The plant's roots were air-dried at a temperature below 40 °C and pulverized into fine powder using a laboratory milling machine, following which 500 g of the ground powder were extracted in methanol, in that order. 5 L of the solvent (volume per volume [v/v]) were used in the maceration. A rotary evaporator was used to condense the extract, which was then dried in a vacuum desiccator. A laboratory mill was used to grind the dry extract into powder, which was then sieved with a 250-mesh sieve.

3.3 Test organisms

The antibacterial activity of the extracts was tested using agar well diffusion. The test organisms were obtained from the Department of Biotechnology, Mountain Top University, Ibafo, Ogun state, Nigeria. All the isolates were checked for purity and maintained in nutrient agar plates. The bacteria isolates used include *Salmonella* (SH1351), *Escherichia coli* (SH70E1).

3.3.1 Preparation of Agar

A weighing balance was used to weigh 7g of nutrient agar, which was then transferred to a conical flask. The conical flask containing the nutrient agar was filled with 250ml of distilled water. Before putting the mixture in the autoclave, it was given a final stir using a magnetic stirrer. After cooling in the autoclave, the media were put aseptically in sterile petri plates. After the media had cooled and formed, it was inverted and stored.

3.3.2 Preparation of MacFarland Standard

To generate a 1 percent barium chloride (BaCl2) solution, 1 gram of anhydrous barium chloride (BaCl2) was combined with 100 mL of distilled water.To generate a 1 percent sulfuric acid (H2SO4) solution, 1 mL concentrated H2SO4 was combined with 99 mL distilled water.A 0.5 percent McFarland standard was created in a sterile test tube by

combining 0.05ml or 50l of 1 percent (BaCl2) in 9.95ml or 9950l of 1 percent H2SO4.The solution was vigorously mixed using a vortex, resulting in a turbid suspension.The test tube was sealed with an aluminum foil top to prevent evaporation.

3.4 Antibacterial activity and Minimum Inhibitory Concentration

100µl of the test organism were dispersed into test tubes containing BHI and was incubated for 24 hours at 37°C. This was done to activate the test organisms. 10mg of the plant extract was diluted four times with 1000µl of sterile distilled water into four sterile sample bottles labelled 800µl, 600µl, 400µl and 200µl. The set plate was labelled properly for each strain of the test organisms with the appropriate concentration.

The antibacterial activity of the extracts against the selected strains was determined using the agar well diffusion method. Each sterile Petri plate was filled with nutrient agar and let to set. The bacteria test cultures were equally distributed throughout the appropriate substrate with a sterile swab stick, which was standardized with 0.5 percent McFarland standard. A 2mm holes was then created in the medium using a sterile cork borer (Bhargav *et al*. 2016). Sample solutions were concentrated, then diluted to a final concentration of 20 mg/mL.

Incubation took place at 35°C for 24 hours with different concentrations. After the incubation period, the Zis could be viewed and measured with a transparent ruler. Each test was conducted three times to be sure it could be repeated again. There were three replicate studies, and SEM was utilized to compute zone inhibition diameter from those results. A tiny sensitivity disc was made by perforating sterile filter paper with a clean, sterile perforator. The perforated filter paper was incubated in 1.5ml Eppendorf tubes for 30 minutes with varying concentrations of extract. Sterile forceps were used to remove the perforated filter paper from the tubes and place it in a sterile Petri dish, which was then incubated at 37°C for 24 hours. After decanting 50 litres of test organisms into the dish, a hockey stick was used to spread the organisms over the dish. Filter paper was placed over the agar dish and incubated at 37°C for 24 hours.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 RESULTS

Using the following concentrations, these are the results that were gotten. 800µl consisting of 10mg of the extract and 800µl of sterile distilled water, 600µl 10mg of the extract and 600µl of sterile distilled water, 400µl 10mg of the extract and 400µl of sterile distilled water, and 200 µl10mg of the extract and 200µl of sterile distilled water. After incubating for 24 hours at 37°C, *E. coli* had no zone of inhibition, therefore it was resistant to the extract.

However, Salmonella was sensitive to the extract. There was a visible zone of inhibition which was both weak and strong. The plate with 800µl of the extract had a weak zone of inhibition, the diameter was 14cm, the plate with 600µl of the extract had a weak zone of inhibition, the diameter was 13cm. The plate with 400µl of the extract had a strong zone of inhibition, the diameter was 12cm. The plate with 200µl of the extract had a strong zone of inhibition, the diameter was 12cm. The effect of the extract was stronger at 200µl and weaker at 800µl.

To ensure reproducibility, each test was done three times. However, the second time the test was conducted, there was no zone of inhibition for all the plates. Both *Salmonella* and *E. coli* were resistant to the extract. The second time the test was conducted, a plate containing the extract with the concentration, with the 2 test organisms *Salmonella* and *E. coli*, had no zone of inhibition. There was no zone of inhibition on all the plates. Both test organisms became resistant to the plant extract.

Table showing the Minimum Inhibition Concentration of *Tradescantia spathacea* on *Salmonella* spp and *E. coli*

Test Organisms	Extract concentration (mg/µL)	Minimum Inhibition Concentration		
		Test 1	Test 2	Test 3
Salmonella spp	200	Strong	No inhibition	No inhibition
	400	Strong	No inhibition	No inhibition
	600	Weak	No inhibition	No inhibition
	800	Weak	No inhibition	No inhibition
Escherichia coli	200	No inhibition	No inhibition	No inhibition
	400	No inhibition	No inhibition	No inhibition
	600	No inhibition	No inhibition	No inhibition
	800	No inhibition	No inhibition	No inhibition

Table 4.1: Minimum Inhibition Concentration

4.2 DISCUSSION

Plants have been used as potential medication sources in biomedical research to prevent and treat human ailments. Antimicrobial resistance has been identified by the World Health Organization as a global health security problem that requires action from all levels of government and society (Duin and Doi., 2017). It is self-evident that the increasing prevalence of resistant microorganisms alleviates socioeconomic crises and deteriorates public health around the world. These resistant bacteria jeopardize the effectiveness of several currently available and affordable antimicrobials, particularly in developing nations.

The hunt for novel antimicrobials from medicinal plants to address the growing threat of pathogenic microorganisms, resistant bacteria, is being driven by these factors. This was proved by the extracts from the medicinal plant employed in this investigation, which revealed the possibility of novel medication discoveries to treat and control diseases caused by resistant pathogenic bacteria. These findings support prior research showing that plant-derived medicinal compounds are employed as a substitute, alternative, or supplemental treatment for infectious illnesses (Bakal *et al*., 2017).

Methanolic extracts from *Tradescantia spathacea* plants were found to have antibacterial activity against *Salmonella* in the current investigation. *Salmonella*, on the other hand, developed resistance to the plant extract. This could be due to the plant extract losing its initial effectiveness due to repeated freezing and thawing.

Also, the rate of drug diffusion through agar and the thickness of the agar medium can affect the zone of inhibition. According to Sagar Aryal (2018), Muller Hinton agar is the best agar for antibiotic sensitivity test. This is because it's made out of starch. Starch has been shown to absorb toxins generated by bacteria, preventing them from interfering with antibiotics. It also slows the pace at which antibiotics diffuse through the agar. In comparison to most other plates, this provides for better antibiotic diffusion. A truer zone of inhibition results from better diffusion. Sulphonamide, trimethoprim, and tetracycline inhibitors are in short supply (i.e., concentration of inhibitors thymidine and thymine is low in MHA). When the amount of para-aminobenzoic acid (PABA) and thymine/thymidine in Mueller Hinton Agar is decreased to a minimum, the inactivation of sulphonamides and trimethoprim is significantly reduced. When Mueller Hinton Agar is used to assess the susceptibility of bacterial isolates to these antimicrobics, both the para-aminobenzoic acid (PABA) and thymine/thymidine content is

lowered to a minimum, significantly lowering the inactivation of sulphonamides and trimethoprim. This criterion is missing in Nutrient Agar.

Storing of plant extracts in a freezer can affect the phytochemical constituents of the extract. After the extract was obtained, it was stored in a freezer. This could have made the extract lose its effectiveness, especially if the extract was stored in the freezer for a long time. Also, the concentration of the might is not enough for the zone of inhibition to appear. The size of the well, created by the cork borer could have been too small, if a bigger diameter was used, a zone of inhibition could have been observed.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

As a new emerging alternative to antimicrobial medications, medicinal plants must be used to cure diseases, resulting in non-toxic and eco-friendly disease management. Due to the rapid development of chemotherapeutic agent resistance (mainly to antibiotics), it is becoming increasingly important to investigate alternate and effective treatments such as herbs. This study has the potential to aid in the creation of medicinal plants as antibacterial agents that are effective against both resistant and susceptible bacteria, therefore increasing the use of plant extracts in the treatment of bacterial illnesses. Researchers will be able to find new antibiotics with improved activity and efficacy by using these active extracts. According to this study, more research on plant extracts that display significant antimicrobial responses against resistant pathogenic bacteria in people, in terms of low toxicity, safety tests, and affordability studies, is needed to make solid conclusions. Further testing on the extract's antibacterial properties has been made possible thanks to these most recent findings.

5.2 RECOMMDATIONS

Despite the fact that pharmaceutical corporations have recently created a huge number of antibiotics, emerging bacterial resistance is a big concern for the medical industry. The plants and their products, according to research, are a good source of physiologically active antibacterial agents. This activity could be boosted if more research is done to discover the antimicrobial activity of the plant extract, which could lead to the creation of new antimicrobial medicinal drugs.

Also, new, and effective techniques should be used to preserve the active components of the extract, to prevent it from losing its effectiveness. This would encourage the use of *Tradescantia spathacea* as a novel antibiotic.

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