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Evaluation of In Vitro Anti-Microbial Activity of *Mukia maderaspatana*

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ABSTRACT:

The rapid rise in antimicrobial resistance has increased the need for alternative therapeutic agents from natural sources. This study evaluates the *in vitro* antimicrobial activity of the hydroalcoholic extract of *Mukia maderaspatana*, a medicinal plant known for its traditional therapeutic uses. The plant material was collected, dried, and extracted using Soxhlet extraction. Phytochemical screening revealed the presence of key bioactive compounds such as phenolics, flavonoids, tannins, and alkaloids.The antimicrobial activity was assessed against Gram-positive (*Staphylococcus aureus*) and Gram-negative (*Escherichia coli*) bacteria using the agar well diffusion method. The extract exhibited significant antibacterial activity with a concentration-dependent increase in the zone of inhibition. Higher activity was observed against *Staphylococcus aureus* compared to *Escherichia coli*. Although the extract showed lower efficacy than the standard drug ciprofloxacin, it demonstrated promising antimicrobial potential.These findings support the traditional use of *Mukia maderaspatana* and highlight its potential as a natural antimicrobial agent. Further studies are required to isolate active compounds and evaluate their clinical applicability.

Keywords: *Mukia maderaspatana*, antimicrobial activity, hydroalcoholic extract, phytochemical screening, agar well diffusion, medicinal plants, antibiotic resistance

INTRODUCTION

The field dedicated to the prevention and treatment of diseases caused by micro-organisms is referred to as medical microbiology. This discipline encompasses several subfields, including virology (the study of viruses), bacteriology (the study of bacteria), mycology (the study of fungi), phycology (the study of algae), and protozoology (the study of protozoa).

In the treatment of diseases, inhibitory chemicals that are utilized to eliminate micro-organisms or inhibit their growth are known as antimicrobial agents. These agents are categorized based on their application and spectrum of activity. Germicides are agents that kill micro-organisms, while micro biostatic agents inhibit the growth of pathogens, allowing the leucocytes and other defence mechanisms of the host to manage static invaders. Germicides may demonstrate selective toxicity, which is contingent upon their spectrum of activity. They can function as viricides (agents that kill viruses), bacteriocides (agents that kill bacteria), algicides (agents that kill algae), or fungicides (agents that kill fungi)[1].

Infection is a significant contributor to morbidity and mortality among hospitalized burn patients.Despite substantial advancements in medical science and targeted treatments for burns, infection remains the most critical threat to burn patients, with approximately 73% of all fatalities occurring within the first five days post-burn being directly or indirectly attributable to septic processes [2].

The incidence of nosocomial infections is elevated in burn patients due to several factors, including the nature of the burn injury, the patient's immunocompromised state, age, the extent of the injury, and the depth of the burn, along with microbial factors such as the type and quantity of organisms, enzyme and toxin production, colonization of the burn wound site, and systemic spread of the colonizing organisms[3].Moreover, cross-infection can occur among different burn patients due to overcrowding in burn units. The burn wound serves as a vulnerable site for opportunistic colonization by both endogenous and exogenous organisms, as thermal injury compromises the skin barrier that typically prevents microbial invasion. This vulnerability renders the burn wound the most common source of sepsis in these patients. Currently, the prevalent pathogens identified in burn patients include Pseudomonas aeruginosa, Staphylococcus aureus, Klebsiella spp and various coliform bacilli Multidrug-resistant bacteria have frequently been reported as the cause of nosocomial outbreaks of infection in burn units or as wound colonizers in burn patients [4].

In recent years, the rapid emergence of antimicrobial resistance has become a major global health concern, reducing the effectiveness of conventional antibiotics and increasing the risk of infectious diseases. This growing challenge has prompted the scientific community to explore alternative therapeutic agents, particularly those derived from natural sources. Medicinal plants have been used for centuries in traditional systems of medicine and continue to play a significant role in modern drug discovery due to their diverse bioactive compounds and relatively lower incidence of adverse effects.

Among various medicinal plants, *Mukia maderaspatana* (L.) M. Roem, belonging to the family Cucurbitaceae, has been traditionally used in herbal medicine for its therapeutic properties. It is commonly known for its anti-inflammatory, antidiabetic, and antimicrobial potential. The plant contains a variety of phytoconstituents such as alkaloids, flavonoids, tannins, and glycosides, which are believed to contribute to its pharmacological activities.

Despite its traditional usage, there is limited scientific evidence supporting the antimicrobial efficacy of *Mukia maderaspatana*, particularly in the form of hydroalcoholic extracts. Therefore, the present study aims to evaluate the antimicrobial activity of the hydroalcoholic extract of *Mukia maderaspatana* against selected microbial strains. This research seeks to provide scientific validation for its traditional use and explore its potential as a natural alternative to synthetic antimicrobial agents.

MATERIALS AND METHODS

Collection of Samples

The plant *Mukia maderaspatana* were collected near sulur and authenticated in TNAU.

Preparation of Extracts

The whole plants of *Mukia madraspatana* were shade dried for 2 weeks. Then the plant was powdered in a crusher. The plants were extracted with hydroalcoholic solvent based on the polarity using Soxhlet extraction. The extraction was performed for 12 hrs[5,6,7].

Phytochemical analysis

The hydroalcoholic plant Extract were subjected to phytochemical analysis for the presence of alkaloids, tannins, saponins, flavonoids and phenols by simple qualitative and quantitative methods[8].

Antimicrobial activities

The strains of human pathogenic microorganisms examined in this study included gram-negative bacteria, namely *Escherichia coli* as well as gram-positive bacteria, which are *Staphylococcus aureus*[9,10,11].

Antimicrobial testing

The antimicrobial properties of the hydroalcoholic extract derived from *Mukia maderaspatana* were assessed using the agar well diffusion technique. Prior to application, bacterial strains were cultivated overnight at 37°C in nutrient broth[12].

Agar well diffusion method

The antimicrobial spectrum of the extracts was qualitatively assessed for the bacterial species by measuring the sizes of the zones of inhibition surrounding wells created in Mueller Hinton agar plates. The agar was sterilized and poured into sterile Petri dishes, then allowed to solidify. Once solidified, the microorganism cultures were swabbed onto the agar surface under aseptic conditions. All experiments were conducted in duplicates. The plates were incubated at 37 degrees Celsius for 24 hours. The strains were classified as sensitive or resistant, and the zones were measured at the conclusion of the incubation period. A zone of inhibition measuring 10mm or more was deemed to indicate significant antibacterial activity[13,14].

RESULTS

Phytochemical screening

The phytochemical screening of the hydroalcoholic extract of *Mukia maderaspatana* revealed the presence of important bioactive constituents such as phenolic compounds, tannins, flavonoids, and alkaloids. These secondary metabolites are well known for their significant pharmacological properties, particularly antimicrobial, antioxidant, and anti-inflammatory activities.

Phenolic compounds and flavonoids contribute to antioxidant potential by neutralizing free radicals, while tannins exhibit antimicrobial activity through protein precipitation and inhibition of microbial enzymes. Alkaloids are also known for their broad-spectrum antimicrobial effects by interfering with microbial metabolism. The presence of these phytoconstituents supports the therapeutic potential of the plant and justifies its traditional medicinal use.

Table 1 Phytochemical analysis.

TESTS	RESULTS
Ferric Chloride Test	Presence of phenolic compounds.
Lead Acetate Test	Presence of tannins.
Dragendorff's Test	Presence of alkaloids.
Salkowski Test	Absence of terpenoids.
Alkaline reagent test	Presence of Flavonoids.

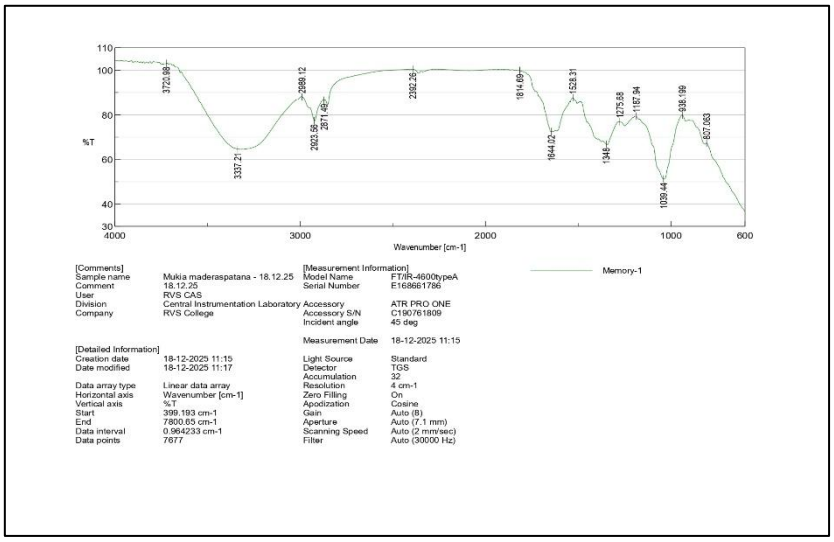

Fig.1 FTIR report

A distinct peak around **1600–1700 cm⁻¹** suggests the presence of **C=O (carbonyl group)**, which may be attributed to flavonoids and other phenolic compounds. The absorption bands in the region of **1500–1600 cm⁻¹** indicate **aromatic C=C stretching**, supporting the presence of aromatic rings in phenols and flavonoids.

Further peaks observed between **1000–1300 cm⁻¹** correspond to **C–O stretching vibrations**, confirming alcohols, ethers, and esters. The presence of these functional groups is consistent with phytochemicals such as phenolics, flavonoids, tannins, alkaloids, and terpenoids identified during preliminary screening.

Overall, the FTIR analysis supports the presence of bioactive compounds responsible for the pharmacological activities of the plant extract.

Antimicrobial activity

Plant extracts have been utilized for thousands of years as pharmaceuticals, alternative medicine, and natural therapies. It is essential to scientifically examine those plants that have been employed in traditional medicine to enhance the quality of healthcare. Extracts serve as potential sources of antimicrobial compounds, particularly against bacterial pathogens. Research has demonstrated that plant extracts can inhibit bacterial growth, although their effectiveness varies. The antimicrobial properties of numerous medicinal plant extracts have been previously assessed and categorized as strong, medium, or weak.

The anti microbial activity is determined by zone of inhibition and then its compared to ciprofloxacin (std). if its zone of inhibition above10mm considered good antimicrobial activity.

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Table 2 Zone of Inhibition

Organisms	Concentration of extract g/ml	Well 1	Well 2	Mean (cm)	Std Drug (ciprofloxacin)cm
S. aureus	100	1.6	1.7	1.65	2.7
	200	2.0	2.1	2.05	2.9
E. coli	100	1.4	1.5	1.45	2.5
	200	1.8	1.9	1.85	2.8

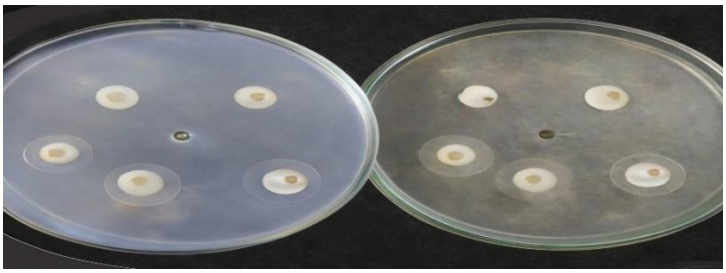

Fig. 2 Represents the comparison of Zone of Inhibition of extract and Std drug in *Staphylococcus aureus.*

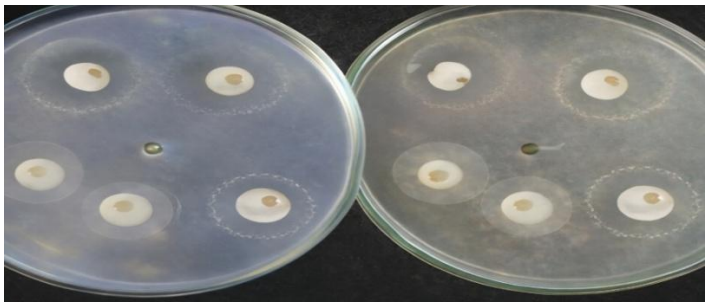

Fig.3 Represents the comparison of Zone of Inhibition of extract and Std drug in *Escherichia coli.*

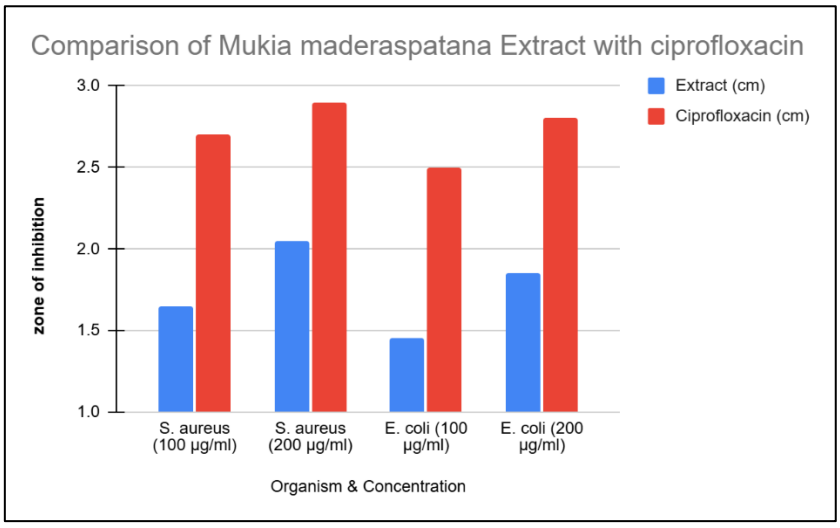

Fig 4 shows the comparison of *Mukia maderaspatana* extract and ciprofloxacin with gram positive and gram negative bacteria.

The extract demonstrated significant antibacterial activity against all organisms tested. The zone of inhibition expanded as the concentration of the extract increased, suggesting a response that is dependent on concentration. The hydroalcoholic extract showed maximum activity against *Staphylococcus aureus*. while comparatively lower activity was observed against *Escherichia coli*. Ciprofloxacin produced larger inhibition zones compared to the plant extract, as expected for a standard antibiotic.

DISCUSSION

The present study demonstrates that the hydroalcoholic extract of *Mukia maderaspatana* possesses significant antibacterial activity against both Gram-positive and Gram-negative bacteria.The extract showed stronger activity against gram positive Staphylococcus aureus compared to gram negative organisms.This difference may be attributed to structural variations in bacterial cell walls, Gram positive bacterial lack and outer lipopolysaccharide membrane allowing easier penetration of phytochemicals, whereas Gram negative bacteria possesses and additional outer membrane that act as a permeability barrier.

The concentration-dependent increase in inhibition zones suggests that the antimicrobial activity is directly related to the amount of bioactive phytoconstituents present in the extract. Hydroalcoholic extraction is known to enhance recovery of both polar and moderately non-polar compounds such as flavonoids, alkaloids, tannins, saponins, and phenolic compounds, which are reported to possess antimicrobial properties.

Although the plant extract showed lower activity compared to Ciprofloxacin, its broad-spectrum antibacterial activity indicates potential as a natural antimicrobial agent. Considering the global rise in antibiotic resistance, plant-based antimicrobials may serve as alternative or adjunct therapeutic agents. Overall, the results validate the traditional use of *Mukia maderaspatana* in treating infectious conditions. The findings of this study suggest that hydroalcoholic extract of *Mukia maderaspatana* leaves possesses promising antimicrobial activity and could serve as a potential candidate for development of novel herbal antimicrobial formulations.

CONCLUSION

In this context, the Plants are the basic source of knowledge of modern medicine. The relatively lower incidence of adverse reactions to plant preparations, compared to modern conventional pharmaceuticals, coupled with their reduced cost is encouraging both the consuming public and national health care institutions to consider plant medicines as alternatives to synthetic drugs. Nowadays herbal drugs are prescribed widely even when their biologically active compounds are unknown because of their effectiveness and minimal side effects in clinical experience. Large numbers of plants belonging to different families have been studied for their therapeutic properties.

The present study concludes that the hydroalcoholic extract of *Mukia maderaspatana* possesses significant antimicrobial activity against selected bacterial strains. The extract demonstrated prominent zones of inhibition particularly against *Staphylococcus aureus*, indicating strong activity against Gram-positive organisms. Moderate activity was observed against *Escherichia coli*.

The antimicrobial effect was found to be concentration-dependent, with higher concentrations (200µg/ml) producing larger zones of inhibition than lower concentrations (100 µg/ml). When compared with the standard antibiotic (Ciprofloxacin), the plant extract showed appreciable but relatively lower activity.

The observed antimicrobial potential may be attributed to the presence of bioactive phytoconstituents such as flavonoids, alkaloids, tannins, and phenolic compounds present in *Mukia maderaspatana*.

Overall, the study supports the traditional medicinal use of *Mukia maderaspatana* and suggests that it could serve as a potential natural source of antimicrobial agents. However, further studies including isolation of active compounds, toxicity evaluation, and in vivo investigations are recommended to establish its therapeutic efficacy and safety.

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