Phytochemical Profiling and Functional Analysis of *Aegiceras corniculatum* Propagules Using TLC, FTIR, and Secondary Metabolite Screening

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Abstract: This study investigates the phytochemical profile and potential functional properties of propagules from *Aegiceras corniculatum*. Ethanol extracts were analyzed using thin-layer chromatography (TLC) and Fourier-transform infrared spectroscopy (FTIR) to characterize their chemical composition. TLC revealed one prominent spot with an Rf value of 0.89, indicative of highly non-polar terpenoids, lipophilic compounds, and non-polar alkaloids. FTIR spectra identified key functional groups, including O–H stretching at 3340 cm^{-1} (alcohols and phenolics), C–H stretching at 2920 and 2850 cm^{-1} (alkanes), and C=O stretching at 1740 cm^{-1} (esters or ketones). Secondary metabolite screening confirmed the presence of phenols, flavonoids, glycosides, terpenoids, and saponins. These results highlight the potential of Aegiceras corniculatum propagules for pharmaceutical and nutraceutical applications, emphasizing their rich phytochemical composition and functional diversity.

Key Words: Propagules, Thin layer chromatography, FTIR spectroscopy, Functional groups, Bioactive compounds

1. INTRODUCTION

Mangroves, unique ecosystems found in saline and coastal environments, are well known for their ecological significance and potential as sources of bioactive compounds. Among these, *Aegiceras corniculatum* has drawn significant attention due to its rich phytochemical profile, which includes secondary metabolites like phenolics, flavonoids, and terpenoids. These compounds are associated with a range of biological activities, such as antioxidant, antimicrobial, and anti-inflammatory properties, making them valuable for pharmaceutical and nutraceutical applications.

The unique saline environment of mangroves contributes to the biosynthesis of specialized compounds with distinct chemical structures and enhanced bioactivity. Ethanol is widely recognized as an efficient solvent for extracting both polar and non-polar phytochemicals, facilitating comprehensive analysis. Techniques such as thin-layer chromatography (TLC) and Fourier-transform infrared spectroscopy (FTIR) have proven instrumental in profiling these bioactive compounds. TLC serves as a rapid and cost-effective method for the preliminary separation and identification of compounds, while FTIR provides detailed insights into functional groups, enabling a deeper understanding of chemical composition.

Previous studies, including those by Bandaranayake (1998) and Mossa *et al.* (1994), have documented the diverse therapeutic potential of mangrove-derived compounds. Furthermore, research by Wagner and Bladt (1996) emphasizes the utility of TLC in phytochemical screening, while Tiwari *et al.* (2011) highlight the role of FTIR in identifying functional groups critical for bioactivity. Despite these advancements, limited studies have focused on the phytochemical profiling of *Aegiceras corniculatum* propagules, particularly using a combination of TLC and FTIR methods.

This study aims to bridge this gap by analyzing the chemical composition of ethanol extracts from *Aegiceras corniculatum* propagules through TLC and FTIR, correlating these findings with secondary metabolite screening. By doing so, it seeks to contribute to the growing understanding of mangrove-derived bioactive compounds and their potential applications in pharmaceutical and industrial contexts.

2. MATERIALS AND METHODS

2.1 Study area and sample collection:

Propagules were harvested from mangrove areas in and around Ratnagiri, Maharashtra, India (16.9954° N, 73.3120° E). After collection, propagules were washed with water, air-dried, and transported to the

laboratory at Gogate Jogalekar College for further processing.

2.2. Preparation of plant extracts:

The plant parts were examined for any foreign matter or mold and cleaned with distilled water. They were then cut into small pieces and air-dried in the shade at the laboratory. Once dried, the propagules were ground into a fine powder using a grinder. The resulting powdered material was packaged in 250-gram portions and stored in clean, airtight polythene bags. The plant material powder (50 gm each) was extracted with 300 ml of ethanol using Soxhlet apparatus for 24 Hours. The extracts were stored at 4° C and were used for the further analysis of secondary metabolites.

2.3. Phytochemical Screening: the propagules were screened for phytochemicals following the standard conventional protocols as described by Harborne (1984) and Trease and Evans (1989). Thin-Layer Chromatography (TLC) was performed to analyze the ethanol extract. Ready to use silica gel plates served as the stationary phase. The solvent system included Chloroform: Methanol: Water (5:4:1). Fourier-Transform Infrared Spectroscopy (FTIR) analysis was conducted on the powdered propagules sample to identify functional groups. The spectrum was recorded in the range of 4000-500 cm^{-1}, and transmittance values at various wavenumbers were documented and interpretations were made using LibreTexts Chemistry 2023.

3. RESULTS AND DISCUSSION

The results of secondary metabolite qualitative tests are reported in Table 1.

Table 1. Results of Qualitative Tests for Secondary Metabolites in *Aegiceras corniculatum* Propagules

Secondary Metabolite	Test Method	Result
Alkaloids	Hager's Test	Negative
Saponins	Froth Test	Positive (+++)
Phenols	Ferric Chloride Test	Positive (+)
Proteins	Xanthoproteic Test	Positive (+++)
Flavonoids	Alkaline Reagent Test	Positive (+)
Glycosides	Keller-Killiani Test	Positive (+++)
Terpenoids	Salkowski Test	Strongly Positive (++++)

Table 2: FTIR Peaks with Functional Group

Wavenumber (cm^{-1})	Functional Group	Interpretation
3340	O–H stretching	Alcohols or phenolics
2920, 2850	C–H stretching	Alkanes
1740	C=O stretching	Esters or ketones
1600–1500	C=C stretching	Aromatic rings
1450	C–H bending	Methyl groups
1260–1100	C–O stretching	Ethers, esters, or carboxylic acids
800–600	C–H bending	Aromatic out-of-plane bending vibrations

Figure 1. TLC Analysis of Propagules

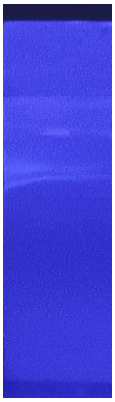
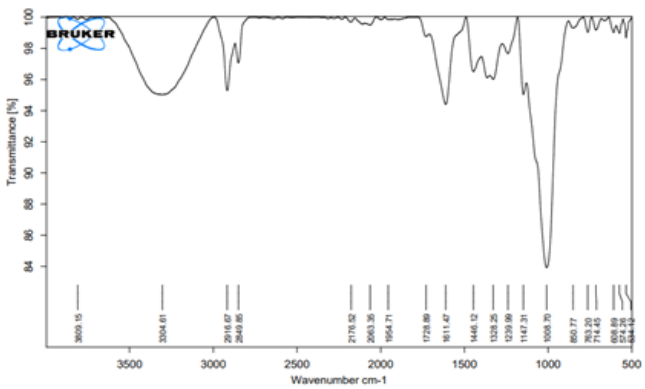


Figure 2. FTIR Analysis of Propagules



TLC analysis of the ethanol extract revealed 1 prominent spot at 10.0 cm corresponding to R_f values of 0.89. The Rf values, 0.89 suggest the presence of highly non-polar terpenoids, lipophilic compounds, non-polar alkaloids with high solubility in the solvent system employed. These results align with earlier studies conducted by Mossa *et al.* (1994) that reported similar R_f values for phenolic and flavonoid compounds in mangrove extracts.

The presence of functional groups such as alcohols, phenolics, and aromatic compounds in the FTIR spectrum suggests significant bioactive potential. Terpenoids, strongly positive in secondary metabolite tests, are known for their antioxidant and antimicrobial properties.

These findings corroborate previous studies on mangrove-derived compounds, which highlight the presence of phenolics, flavonoids, and other bioactive constituents. For example, Tiwari *et al.* (2011) emphasized the role of FTIR in identifying functional groups critical for bioactivity in plant extracts. Comparative analysis with earlier work reveals significant overlaps in the functional groups identified in mangrove extracts. Mossa *et al.* (1994) and Sofowora (1982) reported similar FTIR profiles for mangrove species, attributing the observed peaks to bioactive metabolites like flavonoids, tannins, and alkaloids. The slight variations in wavenumber intensities may be due to differences in sample preparation or environmental conditions influencing phytochemical composition. The fingerprint region was observed to span the wavenumber range between 600 cm^{-1} and 1500 cm^{-1}.

While this study highlights the phytochemical potential of *Aegiceras corniculatum* propagules, future work should focus on isolating individual compounds, evaluating their specific bioactivities, and exploring industrial and pharmacological applications.

4. LIMITATIONS OF THE STUDY

1. The study focused solely on preliminary phytochemical screening; advanced analytical techniques like HPLC or GC-MS were not employed for compound isolation.
2. Variations in phytochemical composition due to environmental factors were not assessed.

5. CONCLUSION

This study underscores the bioactive potential of Aegiceras corniculatum propagules, as revealed by TLC, FTIR, and secondary metabolite screening. The presence of phenolics, terpenoids, and flavonoids highlights their pharmaceutical significance. Further research is required to isolate and characterize individual compounds, evaluate their bioactivities, and assess their potential applications in nutraceutical and pharmaceutical industries.

6. ACKNOWLEDGEMENT

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