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Phytochemical Analysis of Mangrove Leaf Extract *Lumnitzera racemosa* as a Potential Source of Bioactive Compounds

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Abstract

This study was conducted to identify the secondary metabolite profile in the leaf extract of *Lumnitzera racemosa*, which has potential as a natural antibacterial agent. Leaf samples were collected from the mangrove area of Pecinta Alam Bahari (PAB), Dumai City, and extracted with 96% ethanol using a maceration method. Phytochemical tests were conducted qualitatively on seven groups of compounds, namely alkaloids, flavonoids, phenolics, saponins, tannins, triterpenoids, and steroids. Analysis revealed the presence of flavonoids, phenolics, and triterpenoids, while alkaloids, saponins, tannins, and steroids were not detected. The identified compounds have different antibacterial mechanisms but are effective in disrupting the structure and function of bacterial cells. These findings suggest the potential of *L. racemosa* leaf extract as a source of bioactive compounds for health and aquaculture applications.

1. INTRODUCTION

Indonesia is known for its high coastal biodiversity, including mangrove ecosystems. Mangroves have great potential as a source of natural bioactive compounds that can be used in the health and fisheries sectors. One of the mangrove species with such potential is *Lumnitzera racemosa*. This plant contains various secondary metabolites, including flavonoids, phenolics, alkaloids, triterpenoids, and steroids (Dewi et al., 2023).

These secondary metabolites are reported to exhibit several biological activities, such as antibacterial, antioxidant, antifungal, and antiplasmodial (Poncowati et al., 2022). However, few studies have examined the phytochemical content of *L. racemosa*, especially in coastal regions of Sumatra. Therefore, it is essential to conduct research to determine the phytochemical profile of this plant as a basis for its further utilization. This research was conducted to identify groups of bioactive compounds in the ethanol extract of *L. racemosa* leaves from Dumai City. The results are expected to serve as a foundation for developing natural antibacterial agents to address the increasing issue of antibiotic resistance (Rahmitasari et al., 2020).

2. RESEARCH METHODS

Time and Place

This research was conducted from October 2024 to June 2025. *L. racemosa* leaf samples were collected from the Mangrove Forest of Pecinta Alam Bahari (PAB), Dumai City, Riau Province. The evaporation process and phytochemical tests were carried out at the Marine Chemistry Laboratory, Department of Marine Science, Faculty of Fisheries and Marine, Universitas Riau. The antibacterial activity tests were conducted at the Marine Microbiology Laboratory, Faculty of Fisheries and Marine, Universitas Riau.

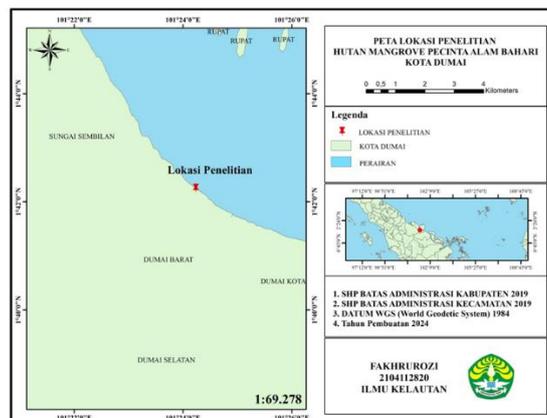


Figure 1. Research site map

Method

The phytochemical test covered alkaloids, flavonoids, saponins, tannins/phenolics, triterpenoids, and steroids. This test aimed to identify secondary metabolites in the leaf extract of *L. racemosa*. The test was performed by adding specific color reagents to the extract (Syawal *et al.*, 2021). The analysis method used in the phytochemical test was based on Harborne (1987).

Procedures

Sample Preparation and Extraction

L. racemosa leaves were randomly collected, washed thoroughly, air-dried, and ground into powder. A total of 1 kg of dried leaves was macerated with 5 L of 96% ethanol for 24 hours. The extract was filtered and concentrated using a rotary evaporator to yield a thick concentrate.

Saponin

A total of 0.5 mL of sample was placed in a test tube, followed by 1 mL of hot water. The mixture was shaken for 1–2 minutes and left for 10 minutes, then 1 mL of 2N HCl was added. The presence of saponins was indicated by foam formation lasting for 2–4 minutes.

Alkaloid

A total of 0.05 mL of the sample was placed in a test tube, followed by the addition of 4 drops of concentrated H_2SO_4 , and the mixture was shaken thoroughly. The mixture was divided into three parts and reacted with Meyer's, Wagner's, and Dragendorff's reagents. The presence of white, brown, or orange precipitate indicated a positive result for alkaloids.

Flavonoid

A total of 0.5 mL of extract was placed in a test tube, 2 mg of Mg powder was added, and 1 drop of 2N HCl was added, then shaken vigorously. The appearance of yellow, orange, dark red, reddish-orange, or magenta color indicated the presence of flavonoids.

Phenolic and Tannin

A total of 1 g of extract was added with 2 drops of 5% FeCl₃. The presence of a dark blue or brownish-green color indicated the presence of phenolic and tannin compounds.

Steroid and Triterpenoid

A total of 0.05 g of extract was placed in a test tube and added with 2 drops of glacial acetic acid, followed by 2 drops of concentrated H₂SO₄. A positive result was indicated by the appearance of a reddish-brown color that changed to blue, purple, or green. Blue indicates steroids, while red indicates triterpenoids.

3. RESULTS AND DISCUSSION

Phytochemical screening is a preliminary step used to detect the presence of active compounds in plants with potential as therapeutic agents against various diseases. In this study, phytochemical analysis was performed to identify bioactive compounds in the leaves of the mangrove *L. racemosa*, which exhibit a significant role in biological activities, particularly as antibacterial agents. Based on the test results, the ethanol extract of *L. racemosa* leaves contains several active compounds, as illustrated in Figure 2 and Table 1.

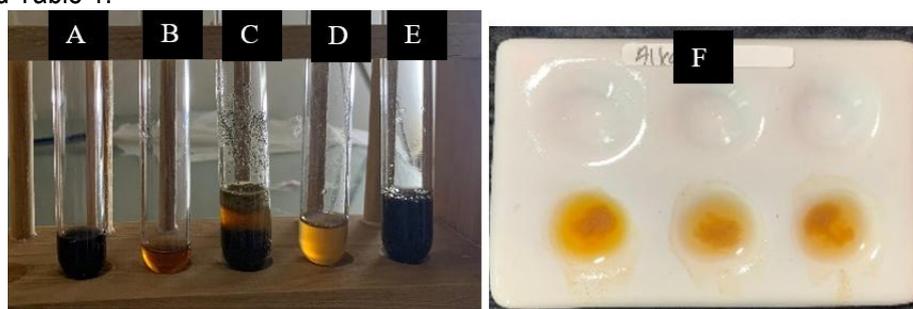


Figure 2. Phytochemical screening of *L. racemosa* leaves

Note: A : Phenolic; B : Triterpenoid & Steroid; C: Flavonoid; D : Saponin; E: Tannin; F: Alkaloid

Figure 2 illustrates the results of the phytochemical screening of *L. racemosa* leaf extract, indicating the presence of several bioactive compounds. Based on visual observations, the extract contains flavonoids, phenolics, and triterpenoids, as evidenced by characteristic color changes in each test tube. The presence of these compounds supports the potential of *L. racemosa* as a source of bioactive compounds for use in the pharmaceutical and aquaculture industries, particularly as a natural antibacterial agent.

Table 1. Phytochemical test results of *L. racemosa* leaf extracts

Parameter	Results	Remarks
Saponin	-	Negatives
Alkaloid	-	Negatives
Flavonoid	+	Positive
Tannin	-	Negatives
Phenolic	+	Positive
Steroid	-	Negatives
Triterpenoid	+	Positive

Based on the results presented in Table 1, the ethanol extract of *L. racemosa* leaves was found to contain only a few active compounds, namely flavonoids, phenolics, and triterpenoids. Meanwhile, saponins, alkaloids, tannins, and steroids were not detected in the extract. In the saponin test, the foam formed disappeared in less than two minutes. In the alkaloid test, Wagner's, Meyer's, and Dragendorff's reagents turned brown rather than forming the expected precipitates. In the tannin test, the extract was

expected to turn dark green, but instead appeared deep black. In the steroid test, the extract did not exhibit the characteristic blue color, confirming the absence of these compounds in the *L. racemosa* leaf extract.

Flavonoids, phenolics, and triterpenoids identified in the extract are well known for their antibacterial activity. Flavonoids can damage bacterial cell walls, form complexes with proteins and DNA, and induce cell lysis (Sadiah *et al.*, 2022). Phenolics act by increasing cell membrane permeability and causing cytoplasmic leakage (Siregar & Silitonga, 2021). Triterpenoids, being lipophilic, disrupt bacterial membrane porins, inhibit nutrient uptake, and ultimately lead to cell death (Wijaya *et al.*, 2022).

The absence of alkaloids, saponins, tannins, and steroids in the extract may be attributed to several factors, including the extraction method used, the particle size of the plant material, and environmental conditions in the plant's habitat (Syamsul *et al.*, 2020; Dewi *et al.*, 2023). Soxhlet extraction is reported to be more effective in isolating alkaloids and steroids compared to the maceration method (Poncowati *et al.*, 2022). These findings are consistent with those of Fitri (2021), who stated that the bioactive compound content in *L. racemosa* can vary depending on the plant's growing location and the extraction technique used. Therefore, further exploration using varied extraction methods and quantitative assays is highly recommended to optimize the potential of this plant.

4. CONCLUSIONS

The ethanol extract of *L. racemosa* leaves from Dumai City contains flavonoids, phenolics, and triterpenoids. These three compounds are known to possess strong antibacterial activity and have the potential to be developed as natural antibacterial agents. Alkaloids, saponins, tannins, and steroids were not detected in this test. These findings highlight the significant potential of *L. racemosa* as a phytochemical source and underscore the need for further research on the isolation of active compounds and specific bioactivity assays.

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