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Antifungal Activity of Ethanol Extract of Stem Bark And Fruit Flesh of Baccaurea Lanceolata Against Fungi Causing Skin Infections

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Abstract: Indonesia has a diversity of medicinal plants that are used by the community to treat various diseases. Indonesian people often experience skin problems caused by fungi. The high number of cases of fungal diseases is due to the high air humidity in the tropics, thus supporting the growth of fungi that cause skin infections. This study examines the phytochemical content and antifungal activity of *Baccaurea lanceolata* (lempaung) plants. The parts of lempaung used as samples are the stem bark and fruit flesh. Samples were taken in Bioa Sengok Village, Rimbo Pengadang District, Lebong Regency. Antifungal testing was conducted at the Chemistry Education Laboratory and Microbiology Laboratory of Bengkulu University (UNIB) from January to June 2022. Antifungal activity testing uses the disc diffusion method by immersing the disc into the ethanol extract of lempaung. The test fungi used were *C. albicans, M. furfur, and T. mentagrophytes*. The results of phytochemical tests showed that the stem bark and fruit flesh samples of lempaung contained alkaloids, flavonoids, tannins, saponins, steroids, and terpenoids. The antifungal activity test results showed that the samples had inhibition against *C. albicans, M. furfur, and T. mentagrophytes*.

Keywords: Antifungal; *Baccaurea lanceolata*; Disk diffusion; Lempaung

Introduction

Indonesia has a biodiversity of medicinal plants used by the community to treat various diseases. Fungal skin infections are one of the most common health problems in Indonesia, as the tropics have high levels of humidity (Prakoeswa et al., 2022; Wahyuningsih et al., 2021). These infections are generally caused by groups of dermatophyte fungi such as Trichophyton, Microsporum, and Epidermophyton, as well as non-dermatophyte fungi such as *Candida spp*. and *Malassezia spp* (Almada et al., 2025; Chanyachailert et al., 2023; Kruithoff et al., 2023). The widespread use of synthetic antifungal drugs has helped overcome these infections. Still, it is often accompanied by various obstacles, such as side effects, toxicity, and the emergence of pathogen resistance to drugs.

Along with the increasing awareness of the importance of using natural ingredients as an alternative treatment, research on medicinal plants continues to grow. One local plant with potential as a source of bioactive compounds is *Baccaurea lanceolata*, or locally known as lempaung. This plant is widely distributed in Southeast Asia, such as Malaysia, Thailand, and Indonesia (Henri et al., 2022; Syamsuardi, 2024). Local communities have long utilized lempaung fruit for culinary purposes and traditional medicine (Bakar et al., 2014), although scientific data on its pharmacological properties are still limited.

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Several previous studies have reported that certain parts of clay plants contain active compounds such as flavonoids, tannins, saponins, and alkaloids that are known to have antimicrobial activity (Ulpah et al., 2024). However, there is minimal information on antifungal potential, especially against fungi that cause skin infections. Therefore, it is necessary to test the antifungal activity of ethanol extracts of lempaung stem bark and flesh to determine the extent of its ability to inhibit the growth of fungi that cause skin infections.

This study aims to test the antifungal activity of ethanol extracts of lempaung stem bark and flesh against skin pathogenic fungal species. The results of this study are expected to provide a scientific basis for the development of natural ingredient-based antifungal preparations that are safe, effective, and potentially serve as an alternative treatment for skin fungal infections.

Method

This study used stem bark and fruit flesh samples from *Baccaurea lanceolata* (Lempaung) plants obtained in Bioa Sengok Village, Rimbo Pengadang District, Lebong Regency. After the samples were collected, they were cleaned using running water. The samples were then thinly sliced and dried by drying in the sun, but not exposed to direct sunlight, so that the active compounds contained in them were not damaged (Al-Hamdani et al., 2022; Caputo et al., 2022; Thamkaew et al., 2021). After drying, the sample is weighed, and the shrinkage (SM) period is calculated using formula 1.

$$\% \text{ SM} = \frac{\text{initial sample mass (g)} - \text{dry sample mass (g)}}{\text{initial sample mass (g)}} \text{ x } 100\% \quad (1)$$

After the shrinkage period is determined, phytochemical testing of secondary metabolite compounds in the sample includes alkaloid, flavonoid, saponin, tannin, steroid, and terpenoid tests. The results of phytochemical test data are marked positive (+) if the sample shows the presence of secondary metabolite compounds and negative (-) if it does not show the presence of secondary metabolite compounds.

In the alkaloid test, 0.5 g of sample was put into a beaker, and then 10 ml of chloroform ($CHCl_3$) and 10 ml of ammonia (NH_3) were added. The mixture was filtered into another beaker using filter paper. The solution obtained was put into a separatory funnel, and 10 drops of 2N sulfuric acid (H_2SO_4) were added, shaken, and allowed to form 2 layers. The top layer is taken and tested with Mayer's reagent. The appearance of a white or creamy precipitate indicates the presence of alkaloids (Jha et al., 2012).

The saponin test is done by mixing 0.5g of the sample with 10 ml of boiling distilled water in a test tube and filtering using filter paper. The filtrate obtained was shaken for 3 minutes. The presence of stable foam as high as 2 cm indicates the presence of saponins (Umi Nurlila et al., 2024).

The flavonoid test was conducted by mixing 0.5g of the sample with 5 ml of 70% ethanol, then heating it for 5 minutes in a water bath. The hot filtrate was transferred to another test tube, and a few drops of concentrated HCl and 1 cm of magnesium tape were added. The appearance of red color indicates the presence of flavonoid compounds (Alves et al., 2017).

The tannin test was carried out by dissolving 0.5g of the sample in distilled water. Then, a few drops of 1% $FeCl_3$ solution were added. Blackish green color changes indicate the presence of tannin compounds (Abdelfatah et al., 2021).

Steroid and terpenoid tests were performed by mixing 0.5 g of the sample with 5 ml of 70% ethanol, left while occasionally shaken, and filtered until the filtrate was obtained. A few drops of Salkowski reagent were added. The formation of a red ring-like color indicates the presence of steroids, while if it is greenish gray or bluish green, it indicates the presence of terpenoid compounds (Alemu et al., 2024; Das et al., 2014).

After obtaining the results of phytochemical testing, this study carried out a series of systematic stages to test antifungal activity. The procedure starts from the extraction process, making media, and testing antifungal activity. The extraction process was carried out using the maceration method. Samples of stem bark and fruit flesh were soaked separately in 70% ethanol in a closed container stored in a place protected from light for three days (3x24 hours) (Santos & Santana, 2022; Tzanova et al., 2020). Every 1x24 hours, stirring was carried out so the active compounds could dissolve optimally with the solvent. After the soaking process, the maceration results are filtered using a flannel cloth to separate the coarse flesh, then filtered again using filter paper to obtain the filtrate. The filtrate is then separated from the extract and solvent by the evaporation method using a rotary evaporator until a thick extract is obtained, and the yield is calculated using equation 2.

$$\% \text{Yield} = \frac{\text{Extract Weight (g)}}{\text{Sample Weight (g)}} \text{ x } 100\% \quad (2)$$

The fungal growth media was prepared by dissolving 20 g of Potato Dextrose Agar (PDA) into 500 ml of distilled water in an Erlenmeyer flask. The solution was heated using a hot plate and stirred using a magnetic stirrer until homogeneous. Next, the media were sterilized by autoclaving at 121℃ for 15 minutes.

On the other hand, fungal culture rejuvenation was carried out using sterile PDA media in petri dishes. One ose of pure fungal culture was taken and inoculated on PDA media and incubated for 2 × 24 hours at 37°C (Gakuubi et al., 2022). The results of fungal rejuvenation were dissolved in 0.9% NaCl and compared with the turbidity of 0.5 McFarland solution (Keller et al., 2023). When both turbidity levels were the same, the fungal solution was mixed into sterile PDA and poured into ± 20 ml petri dish. Antifungal Agents from lempaung bark and flesh extracts were concentrated with each concentration variation %b/v: 2.5%, 5%, 10%, 20%, 40%, 50%, and 75%. DMSO was used as a negative control, and Ketoconazole 2% as a positive control.

Determination of Antifungal Activity used the diffusion method (Kirby-Bauer), namely 6 mm paper discs soaked in stem bark and fruit flesh extracts at various concentrations, then placed on media that had been inoculated with fungi and incubated for 1 × 24 hours at 37 °C (Aljuhani et al., 2024; Lysakova et al., 2024). Antifungal activity is characterized by forming a clear zone (zone of inhibition) around the disc. The diameter of the inhibition zone was measured using a digital caliper (Nawaz et al., 2025).

Data analysis techniques were carried out descriptively and analytically. Descriptive analysis was used to describe all measurement results presented in tabular form, which aims to determine the potential of Lempaung stem bark and flesh as an antifungal agent based on the inhibition zone strength. Interpretation of the strength of the inhibition zone was carried out based on the classification criteria shown in Table 1.

Table 1. Criteria Diameter (d) Zone of Inhibition of Antifungal Activity

Diameter (mm)	Criteria
1 ≥ d ≤ 5	Very Weak
6 ≥ d ≤ 10	Weak
11 ≥ d ≤ 20	Strong
≤ 21	Very strong

Result and Discussion

Antifungal activity tests were conducted on ethanol extracts of *Baccaurea lanceolata* (Lempaung) stem bark and flesh, collected from Bioa Sengok Village, at coordinates 3°19'30.3 "S 102°26'39.6 "E. This location is shown in Figure 1, which presents a map of the sampling points. This location was chosen because it is a natural habitat for the species with a high level of biodiversity.

The bark and flesh samples were dried naturally until a stable mass was obtained. The fruit flesh showed 91% shrinkage, much higher than the bark, which only experienced 20% shrinkage, indicating that the fruit flesh has a much higher water content. This shrinkage was mainly caused by the evaporation of water and volatile compounds due to drying.

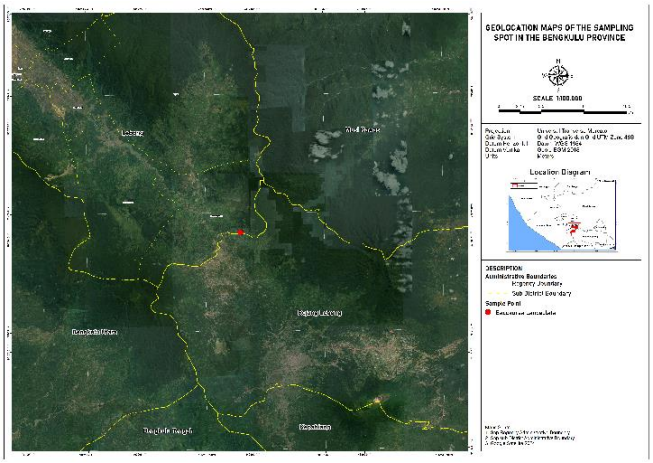


Figure 1. Map of *Baccaurea lanceolata* sampling locations

Table 2. Sample Period Percentage

Sample	Initial sample mass (g)	Sample mass after drying (g)	Shrinkage mass (%)
Stem Bark	500	400	20
Fruit flesh	2500	225	91

After the drying process, the samples were pulverized using a blender to expand the surface area and increase the contact efficiency between the solvent and the material during the extraction process (Alsaud & Farid, 2020; Horablaga et al., 2023). The resulting powder was then used for phytochemical tests to identify secondary metabolite compounds that have potential as antifungals.

Phytochemical test results showed that Lempaung stem bark and flesh contained alkaloids, flavonoids, tannins, saponins, and steroid compounds. Saponin compounds were detected most dominantly in both parts, as presented in Table 3. These compounds have antifungal agents. Therefore, extraction was carried out to take extracts from each sample and then tested for antifungal activity (Osuagwu & Eme, 2013; Youl et al., 2023; Zong et al., 2025).

Table 3. Phytochemical Test Results

Phytochemical test	Result	
	Stem Bark	Fruit flesh
Alkaloids	(++)	(+)
Saponins	(+++)	(+++)
Flavonoids	(+)	(+)
Tannins	(+)	(+)
Steroids	(-)	(+)
Terpenoids	(-)	(-)

Extraction was carried out by the maceration method using 70% ethanol for 3 × 24 hours and every 1 24 hour, stirring. Ethanol was chosen because it can

dissolve polar to non-polar compounds, is economical, and non-toxic (Ahmad et al., 2023; Atwi-Ghaddar et al., 2023; Haido et al., 2024). This process utilizes the principle of plasmolysis, which is the rupture of cell walls due to differences in osmosis pressure, so that active compounds come out and dissolve in the solvent (Fang et al., 2020).

The filtrate from maceration was concentrated using a rotary evaporator at 60 ℃, then continued with heating using a water bath at 100 ℃, to evaporate the solvent still in the extract. To ensure the solvent content in the extract, 0.1 g of extract was taken and oven at 100 ℃ for 15 minutes. The results show that there is still ±10.5% solvent, which is still within safe limits for testing.

Table 4. Yield of Ethanol Extract: Sample

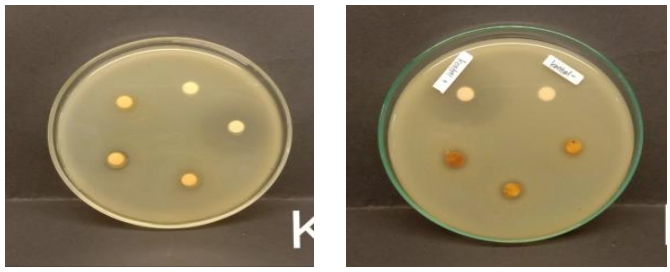
Sample	Sample Mass (g)	Extract Mass (g)	Yield %
Stem Bark	300	15.649	5.216
Fruit flesh	200	24.778	12.389

The extraction results showed that the stem bark produced a yield of 5.216% while the fruit flesh was 12.389% (Table 4). This difference in yield can be logically explained based on differences in tissue composition and density of bioactive compounds in each plant. Fruit flesh contains polar compounds such as phenolics, flavonoids, and anthocyanins that dissolve well in 70% ethanol solvent, resulting in higher extract yields. Instead, the stem bark has a denser lignocellulosic structure and tends to be challenging to degrade (Supriyadi et al., 2025), resulting in a lower release rate of active compounds in the solvent (Adeyi et al., 2023).

Previous research has also shown that the flesh of Lempaung fruit has a higher content of phytochemical compounds than the stem, including phenolics, anthocyanins, carotenoids, and steroids, all of which contribute to the increased weight of the extract obtained (Otero-Guzman & Andrade-Pizarro, 2025). In addition, the presence of polar compounds in the fruit facilitates solubilization during the maceration process, in contrast to the stem bark, which is semi-polar, mainly non-polar, and less soluble in aqueous ethanol (Kumar et al., 2023).

Antifungal Activity of Baccaurea lanceolata (Lempaung) Extract against Candida albicans

The antifungal activity test was carried out to determine the ability of ethanol extracts from the stem bark and pulp of lempaung fruit to inhibit Candida albicans (C. albicans) fungi growth. The results showed that both extracts had potential antifungal activity, as indicated by forming a clear zone (zone of inhibition) around the disc paper treated with extracts on the culture plate. As shown in Figure 1.



(a) (b)

Figure 2. Inhibition zones on *C. albicans* fungal testing (a) Stem skin, (b) Fruit flesh

Measurement of the diameter of the inhibition zone showed that antifungal activity only appeared at a concentration of 50% b/v, with an inhibition zone of 3.733 mm on the stem bark and 4.833 mm on the fruit flesh. This value is classified as weak. While at 75% b/v concentration, the zone of inhibition increased significantly to 10.567 mm on the stem bark and 11.9 mm on the fruit flesh, which can be categorized as vigorous activity. These values are presented in Table 5.

Table 5. Inhibition Zone Diameter against *C. albicans*

Extract Concentration	*C. albicans* Zone of Inhibition Diameter (mm)	
	Stem Bark	Fruit Flesh
2,50%	0	0
5%	0	0
10%	0	0
20%	0	0
40%	0	0
50%	3.733	4.833
75%	10.567	11.9
Control (-)	0	0
Control (+) 2%	29.838	29.95

These results indicate that the extract's effectiveness against *C. albicans* is still moderate to low, especially at concentrations below 75% b/v. The absence of inhibition zones at low concentrations indicates that the active compound content is insufficient to cause a significant antifungal effect.

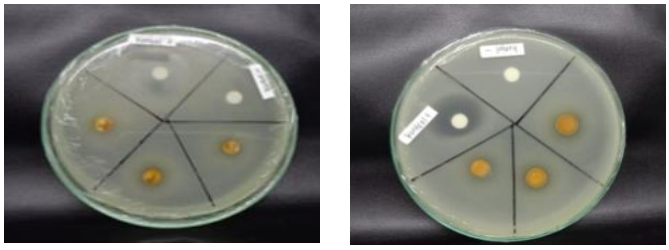
This low effectiveness is thought to be related to the complexity of the biological defense mechanisms of *C. albicans*. This fungus has a dimorphic morphology, adhesion ability to host tissues, and secretion of hydrolytic enzymes that increase its virulence by complicating the action of antifungal agents (Ramírez-Sotelo et al., 2025). In addition, *C. albicans* can also undergo phenotypic switching and form biofilms (Kaur & Nobile, 2023; Soll, 2024), which can reduce the activity of antifungal compounds from the outside.

Regarding phytochemistry, the extracts only contained low amounts of flavonoids (+), contributing to the limited inhibitory activity. Flavonoids have been reported as one of the compounds that have a mechanism of inhibiting fungal growth through cell

membrane damage, disruption of nutrient transport, and interference with intracellular enzyme activity (Rodríguez et al., 2023). The presence of saponins and alkaloids in the extracts also contains antifungal activity (Chen et al., 2023; Thawabteh et al., 2024). However, their effectiveness is highly dependent on the concentration and availability of these compounds around the fungal colonies.

Antifungal activity of Baccaurea lanceolata (Lempaung) extract against Malassezia furfur

Antifungal activity was tested against *M. furfur*, a lipophilic fungus commonly found as human skin flora, but can become an opportunistic pathogen under certain conditions. The test showed that ethanol extracts of lempaung stem bark and pulp had inhibitory activity against the growth of *M. furfur*, as shown by the formation of a clear zone of inhibition on the test media (Figure 2).



(a) (b)

Figure 3. Inhibition zones formed in *M. furfur* fungal testing: (a) Stem skin, (b) Fruit flesh

The zone of inhibition began to form at a concentration of 50% b/v, where the stem bark extract showed a diameter of 2.3 mm and the fruit pulp extract of 5.6 mm. This value is classified as a weak category. There was a significant increase at a concentration of 75% b/v, with an inhibition zone of 13.133 mm in the stem bark extract and 13.667 mm in the fruit pulp extract, which is in the strong category. These values are presented in Table 6.

Table 6. Diameter of Inhibition Zone Against *M. furfur*

Extract Concentration	*M. furfur* Zone of Inhibition Diameter (mm)	
	Stem Bark	Fruit Flesh
2.50%	0	0
5%	0	0
10%	0	0
20%	0	0
40%	0	0
50%	2.3	5.6
75%	13.133	13.667
Control (-)	0	0
control (+) 2%	30.238	30.238

In general, the effectiveness of felt extracts against *M. furfur* was higher than that against *C. albicans* at the same concentration. This can be explained based on the biological characteristics of *M. furfur* as a lipophilic fungus with a high dependence on fatty or non-polar compounds for its growth. In this case, nonpolar compounds in the extract, such as saponins, terpenoids, and steroids, have the potential to interact directly with the structure of the fungal cell wall (Rhimi et al., 2020).

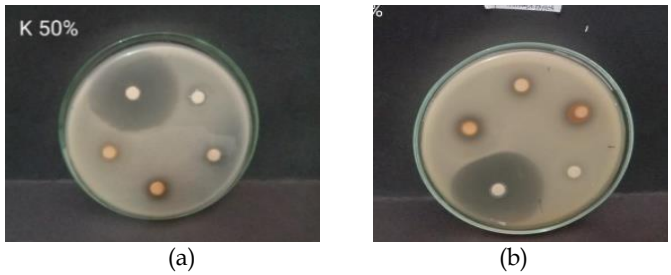
However, the antifungal effectiveness against *M. furfur* was still not comparable to the positive control (ketoconazole), which had a wider inhibition zone diameter. This may be due to the unique nature of *M. furfur,* which has a thick and complex cell wall structure and produces irregular, short hyphae-like elements. This structure can inhibit the penetration of active compounds into the fungal cells (Akpe et al., 2024; Saptarini et al., 2024; Sri Rahayu et al., 2024).

The high activity of the extract against *M. furfur* compared to *C. albicans* can also be caused by differences in membrane properties between lipophilic and non-lipophilic (Saptarini et al., 2024). The lipophilic nature of *M. furfur* allows non-polar compounds in the extract to more easily diffuse and interact with cell components, resulting in faster structural damage (Li et al., 2024). Meanwhile, non-lipophilic fungi such as *C. albicans* have cell wall structures and intracellular defense systems that are more complex and resistant to the penetration of compounds.

Thus, although the ethanol extract of lempaung did not provide as large a zone of inhibition as standard pharmaceutical agents, these results still suggest that the bark and pulp of this plant have potential as a source of natural antifungal compounds against lipophilic fungi such as *M. furfur*, especially at high concentrations.

Antifungal activity of Baccaurea lanceolata (Lempaung) Extract against Trichophyton mentagrophytes (T. mentagrophytes)

Ethanol extracts of Lempaung stem bark and pulp showed significant activity inhibiting the growth of *T. mentagrophytes*. This dermatophyte fungus causes superficial skin infections such as tinea pedis and tinea corporis. The antifungal activity was characterized by forming a clear and wide zone of inhibition around the disc containing the extract, as shown in Figure 3.



(a) (b)

Figure 4. Inhibition zones formed in the testing of *T. mentagrophytes* fungi; (a) Bark 50% b/v and (b) Flesh 75% b/v

The results showed that both extracts began to be effective at concentrations ≥10% b/v, with inhibition zones that continued to increase as the concentration increased. At a concentration of 10% b/v, the diameter of the inhibition zone for stem bark extract was 1.7 mm and fruit flesh was 2.8 mm, categorized as limp activity. At 20% b/v concentration, the diameter of the inhibition zone increased to 4.867 mm in the stem bark extract and 5.767 mm in the fruit flesh extract, both categorized as weak to moderate activity. At 40% b/v concentration, the zone of inhibition increased to 12.433 mm and 13.133 mm, respectively, which were classified as vigorous activity. While at concentrations of 50% and 75%, the zone of inhibition became wider and reached the powerful category, as presented in Table 7.

Table 7. Diameter of Inhibition Zone against *T. mentagrophytes*

Extract Concentration	*T. mentagrophytes* Zone of Inhibition Diameter (mm)	
	Stem Bark	Fruit Flesh
2.50%	0	0
5%	0	0
10%	1.7	2.867
20%	4.867	5.767
40%	12.433	13.133
50%	18.567	18.733
75%	20.767	21.667
Control (-)	0.443	0.475
control (+) 2%	49.54	50.657

The high effectiveness of the ethanol extract against *T. mentagrophytes* can be explained by several factors. First, active compounds in the extract, such as flavonoids, saponins, and alkaloids, are known to have a mechanism of action that can damage the structure of the cell wall and fungal membrane, disrupt protein and nucleic acid synthesis, and inhibit cellular respiration (Al Aboody & Mickymaray, 2020; Mendoza-León et al., 2022; Sari et al., 2024). This ability allows the compound to affect the growth and survival of dermatophyte fungi directly.

Secondly, the physiological structure of *T. mentagrophytes* allows non-polar and semipolar compounds in the extract to more easily penetrate the cell wall and reach intracellular targets compared to fungi such as *C. albicans,* which have more complex phenotypic protection (Al Aboody & Mickymaray, 2020; Kottferová & Čonková, 2023). This is why the Lempaung extract showed high activity against *T. mentagrophytes* compared to the other fungi tested in this study. Overall, these results reinforce the potential of Lempaung extract, especially the fruit pulp, as a natural antifungal agent against dermatophyte fungi. However, the effectiveness is still not equivalent to the positive control (ketoconazole), which showed more than double the diameter of the inhibition zone.

Effectiveness of Antifungal Agents of Baccaurea lanceolata Extracts

The test results showed that lempaung bark and pulp extracts could inhibit the growth of the three test fungi, with varying degrees of effectiveness depending on the concentration and type of fungus. In general, there was a directly proportional relationship between the increase in extract concentration and the area of inhibition zone formed, reflecting the increase in the content of soluble active secondary metabolite compounds, such as flavonoids, saponins, and alkaloids (Iqbal Hussain, 2011; Salhi et al., 2017).

In the test against *C. albicans* and *M. furfur*, the inhibition zone only began to form significantly at 50% b/v, indicating that the Minimum Inhibitory Concentration (MIC) against these fungi ranged from 41-50% b/v. In contrast to *T. mentagrophytes*, the inhibition zone was already visible at a concentration of 10 b/v, indicating that this fungus is more sensitive to the active compounds in the extract, with a relatively lower MIC.

The difference in antifungal response can be explained by the difference in cell wall structure and biochemical composition of the three fungi (Lima et al., 2019). As shown in Table 8, all three fungi have major components such as β-glucan, chitin, and protein. However, only *T. mentagrophytes* contained phospholipids, which, according to the literature, could potentially enhance interactions with saponins through disruption of membrane interactions. The saponin content in the lempaung extract was high (+++), which may explain the high effectiveness of the extract against this fungus (Ferreira et al., 2007; Li et al., 2023).

Table 8. Components that Make Up the Fungal Cell Wall

Component	*C. albicans*	*M. furfur*	*T. mentagrophytes*
β-1,6-glucan	√	√	√
β-1,3-glucan	√	√	√
Chitin	√	√	√
Chitosan	–	√	–
Lipids	√	√	√
Proteins	√	√	√
Phospholipids (POS)	–	–	√

The test results also showed that the negative control showed no antifungal activity. The results obtained in this study are also in line with the research conducted by Siregar et al. (2024). Dimethyl sulfoxide (DMSO) was used as a negative control to ensure that the antifungal activity observed on the discs came from the active compounds contained in the extract. Scientifically, DMSO does have the ability to penetrate membranes and is widely used in biological research as

a solvent (Rajakulasooriya et al., 2025). However, studies show that at low concentrations, DMSO is not toxic to the cells of microorganisms, including fungi (Hassanain et al., 2024). Therefore, in the context of disc diffusion, pure DMSO is not strong enough to inhibit fungal growth, especially in small volumes that evaporate quickly during incubation.

Meanwhile, the positive control (ketoconazole 2%) showed a wide zone of inhibition against *C. albicans* and *M. furfur* fungi (±30 mm), according to previous studies (Ivanov et al., 2022). However, the inhibition zone of ketoconazole against *T. mentagrophytes* reached ± 50 mm. Several factors can explain this difference. First, from differences in morphology and types of fungi, *C. albicans* and *M. furfur* are yeast or yeast-like fungi, which grow as round or oval cells, often forming dense colonies on the media (Gnat et al., 2020). Meanwhile, T. mentagrophytes is a thread fungus (dermatophyte) that grows as branched hyphae and spreads across the surface of the media. Thus, when an antifungal agent such as ketoconazole acts on dermatophyte fungi, the growth of radially spreading hyphae can be stopped more quickly, resulting in a wider zone of inhibition, not only because the compound is more effective, but also because the morphology of fungal growth is more diffuse. Hence, the zone of inhibition is physically larger.

Second, the level of sensitivity of the species to ketoconazole. *T. mentagrophytes* is known to be naturally more sensitive to azoles (Gupta et al., 2025), including ketoconazole, than *C. albicans* and *M. furfur*. Studies show that dermatophyte fungi do not have an enzymatic resistance system as strong as *C. albicans*. Thus, ketoconazole will more easily reach its target in *T. mentagrophytes* cells, such as inhibiting ergosterol biosynthesis, which causes damage to cell membrane structures and death (Gupta et al., 2025).

Third, the effect of local concentration and dispersion of the compound. Ketoconazole is lipophilic and has a high penetration ability in solid media such as PDA (Xu et al., 2021). In fungi with porous structures, such as *T. mentagrophytes,* the compound is likely to disperse more quickly and evenly, leading to the formation of a larger zone of inhibition (Maurya et al., 2019). However, when compared to ketoconazole, Lempaung extract required much higher concentrations to achieve similar effectiveness, especially against *C. albicans* and *M. furfur*, which suggests that the antifungal potential of this extract is more substantial against dermatophyte fungi than yeast fungi.

Based on the difference in inhibition zone between stem bark and fruit flesh, it was also detected that the fruit flesh generally showed a slightly larger inhibition diameter. This is most likely due to the fruit pulp's abundant and soluble phytochemical composition, such as flavonoids and steroids, as shown in the previous phytochemical test (Arunachalam et al., 2024). However, high concentrations of plant extracts also pose challenges in pharmacological aspects, such as potential side effects, formulation stability, and cost feasibility. According to Garg et al. (2020) Confirmed that the higher the concentration of an antimicrobial agent, the greater the potential for local irritation and toxicity. Therefore, these results suggest that the use of Lempaung extract in topical preparations would be promising for application against dermatophytic fungi, while its use against yeast fungi still needs further development, such as isolation of active fractions, formulation improvement, or combination with other antifungal compounds to increase its inhibitory power and potential application in the clinical or cosmetic dermatological field (Al-Suwaytee et al., 2024; Oikeh et al., 2016).

Conclusion

Based on the study's results, *Baccaurea lanceolata* bark and flesh extracts showed relatively high antifungal activity against *Trichophyton mentagrophytes*. However, they were less effective against *Candida albicans* and *Malassezia furfur*. Phytochemical tests revealed that the stem bark and fruit flesh contained alkaloids, flavonoids, tannins, saponins, and steroids. Disc diffusion tests showed that the effective concentration to inhibit fungal growth varied, depending on the type of fungus and the plant part used. The most vigorous activity against Trichophyton mentagrophytes was at concentrations ≥40% b/v.

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Author Contributions

Conceptualization, M.S., P.M., S.E.N., and W.S.; methodology, M.S., P.M., S.E.N., and W.S.; software, M.S.; formal analysis, M.S., P.M., S.E.N.; investigation, M.S.; resources, M.S.; data curation, M.S., P.M., S.E.N.; writing—original draft preparation, M.S.; writing—review and editing, M.S. and W.S.; visualization, M.S.; project administration, M.S.; funding acquisition, M.S. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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