



## Antioxidant, Anti-Inflammatory, and Antibacterial Activities and Phytochemical Content of White Champaca (*Michelia alba*) Flower Extract

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**Abstract:** *Michelia alba* is a member of the Magnoliaceae family known to be rich in secondary metabolites with various biological activities. Multiple studies on related plants have shown that the flowers contain flavonoids, terpenoids, and phenolics that have potential as anti-inflammatory and antibacterial agents. The objectives of this study were to evaluate the phytochemical content of *Michelia alba* flower extracts and to determine their anti-inflammatory and antibacterial activities through an in vitro approach. Extraction was performed using the ethanol maceration method, followed by qualitative and quantitative phytochemical tests; quantitative phytochemical testing was performed using a UV-Vis spectrophotometer. Anti-inflammatory activity was tested using a UV-Vis spectrophotometer at a wavelength of 560 nm based on the membrane stabilization method, while antibacterial activity against *Staphylococcus aureus* was assessed using the disk diffusion method. The results showed that the extract contained flavonoids, phenolics, tannins, and saponins qualitatively, with a total phenolic content of 80.53 mg GAE/g, total tannin content of 122.32 mg TAE/g, and a total flavonoid content of 84.14 mg QE/g. Antioxidant test showed a content of 54.64 ppm (strong), anti-inflammatory test showed a potential with an average 98.90% (very strong), and antimicrobial potential in vitro with an inhibitory power of <15 mm with a variation of 5 mm - 10.25 mm. There was no difference in various concentrations (55%, 70%, 85%, and 100%) of white *Michelia alba* flower extract in inhibiting the growth of *S. aureus*, with a sig value = 0.095. The complex metabolite profile allows for synergistic effects between compounds, so that even though the inhibition zones are moderate, the biological activity remains pharmacologically relevant. Overall, this study shows that *Michelia alba* flower extract has significant potential as a candidate natural anti-inflammatory and antibacterial ingredient for the development of phytochemical-based products.

**Keywords:** Antibacterial activity; anti-inflammatory activity; *Michelia alba*; phytochemical analysis.

### INTRODUCTION

Medicinal plants continue to attract attention as a significant source of secondary metabolites with important therapeutic potential, such as antioxidant, anti-inflammatory, and antibacterial activities. Phenolic compounds, flavonoids, and terpenoids, which are commonly found in plants, play a role in neutralizing free radicals, reducing oxidative stress, and decreasing cell damage caused by chronic inflammatory reactions (Yang & Ma, 2024). As cases of diseases triggered by oxidative stress and inflammation increase, the use of natural ingredients as therapeutic agents is becoming increasingly relevant. In addition, the emergence of antibiotic resistance further emphasizes the need to expand research on new plant-

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based antibacterial sources to support more effective infection therapy (Yingjie Liu et al., 2025).

The increasing prevalence of infections by pathogenic bacteria such as *Staphylococcus aureus*, including strains resistant to first-line antibiotics, has created an urgent need for the search for safe and accessible alternative antimicrobial agents (Yingjie Liu et al., 2025). Antibacterial compounds from natural sources have the advantage of structural diversity and complex mechanisms of action, thereby potentially reducing the risk of resistance. Essential oil-producing plants, particularly those from the Magnoliaceae family, have been found to contain terpenoid compounds that inhibit the growth of pathogenic bacteria through membrane damage and disruption of cellular metabolic processes (Yang & Ma, 2024).

One species with high pharmacological potential is *Michelia alba*, a member of the Magnoliaceae family that has traditionally been used as herbal medicine. The bioactive components in this plant, especially in the flowers, are thought to contribute to a wide range of biological activities, including antioxidant and antibacterial properties. A recent investigation by Yahaya et al. (2024) reported that *Michelia alba* extract has a relatively high phenolic and flavonoid content and exhibits vigorous antioxidant potential when assessed using the DPPH assay. These findings indicate that *Michelia alba* flowers are a source of secondary metabolites with the potential to be developed as phytochemical-based products (Yahaya et al., 2024). Furthermore, a comprehensive study on the botany and essential oil of *Michelia alba* confirms that it contains various volatile compounds such as monoterpenes and sesquiterpenes that underlie important biological activities, including antimicrobial and antioxidant activities (Silalahi, 2023).

Beyond research on *Michelia alba* specifically, various studies within the Magnoliaceae family support the claims of this plant's biological activity. Research by Yang & Ma (2024) on the essential oils of five Magnoliaceae species found that dominant terpenoid compounds, such as linalool and eugenol, have significant antioxidant and antibacterial properties. Meanwhile, another study conducted by Hernandez-Rocha & Vasquez-Morales (2023) confirmed that Magnolia species have great potential in the development of bioactive compounds that can be used for health applications and biological control. The consistency of this data shows that plants in the Magnoliaceae family, including *Michelia alba*, have strong prospects as a source of new bioactive agents.

Although there have been several studies related to the phytochemical content and biological activity of *Michelia alba* and other members of Magnoliaceae, comprehensive studies that simultaneously assess the phytochemical content (qualitative and quantitative), antioxidant, anti-inflammatory, and antibacterial activities of *Michelia alba* flower extracts are still very limited. Most previous studies have focused only on essential oils or on a single type of biological activity. In addition, quantitative data on the levels of phenols, flavonoids, and tannins in *Michelia alba* flowers are still rarely published, thus not providing a holistic understanding of the contribution of each compound to its biological activity (Yahaya et al., 2024).

In light of these identified research gaps, the present study was designed to identify and quantify the phytochemical content of *Michelia alba* flower extract and evaluate its antioxidant, anti-inflammatory, and antibacterial activities. This research is expected to contribute to the availability of data on the bioactive content and pharmacological potential of *Michelia alba* flowers, as well as provide a stronger scientific basis for the use of this plant as a source of natural ingredients with applications in health and phytochemical-based therapy.

## **MATERIALS AND METHODS**

### **Research design**

This research employed an approach using a true-experimental framework with a posttest-only control group design. This design allows for the administration of interventions to the treatment group while controlling for external factors that could potentially influence the results of the experiment. Biological activity testing was carried out on the treatment group with various concentrations of extract, as well as the positive control group and negative control group.

### **Research Location**

The research was conducted in several laboratories according to the type of test performed. Qualitative and quantitative phytochemical analysis and antioxidant activity testing were carried out at the Laboratory of the Faculty of Agriculture, Warmadewa University. Anti-inflammatory activity testing was carried out at the Integrated Chemistry Laboratory of the Denpasar Ministry of Health Polytechnic. Antibacterial testing was performed at the Microbiology Laboratory, Faculty of Medicine, Warmadewa University. The preparation of simplisia and white champaca flower extract was carried out at the Laboratory of the Technical Implementation Unit for Testing and Development of Traditional Medicine, Bali Provincial Health Office.

### **Materials and Equipment**

The primary material was 3 kg of fresh *Michelia alba* flowers obtained from a single location in Sibag Gede Village. The solvent used was 96% pro-analysis ethanol (MERCK). Supporting materials included standard phytochemical reagents, DPPH (2,2-diphenyl-1-picrylhydrazyl) reagent, buffer solution for anti-inflammatory testing, Mueller–Hinton agar medium, and 5 µg of ciprofloxacin antibiotic discs as a positive control (“CIP 5” code on the label). The leading equipment included a drying Memmert UN 30 oven, EBERBACH E8100 700G blender, RE2000VN rotary evaporator, 200-1000nm, 2n UV/VIS UV-Vis spectrophotometer, laminar air flow uk. 120 x 80 x 120 cm Vertical, bacterial incubator WPL30BE, autoclave HVE-50, and micropipette 100-1000ul.

### **Simplisia Preparation and Extraction**

The *Michelia alba* flowers were washed, aired, and dried in a Memmert UN 30 oven at 40°C for 10 hours. The dried samples were ground to form a homogeneous powder. Extraction was performed using the maceration method. The simplisia powder was macerated in 96% ethanol for six days at room temperature with occasional stirring. The filtrate was then filtered and evaporated using a RE2000VN rotary evaporator to obtain a thick gel-like extract. The resulting extract was stored at 4°C until used for testing.

### **Phytochemical Analysis and Antioxidant Test**

Phytochemical testing was performed qualitatively to detect the presence of phenolic compounds, flavonoids, saponins, tannins, and terpenoids. Total phenols and total flavonoids were determined quantitatively using a UV-Vis spectrophotometer. Antioxidant activity was tested using the UV-Vis spectrophotometry method with DPPH reagent at a wavelength of 517 nm to assess the extract's ability to capture free radicals.

### **Inflammatory Activity Test**

The anti-inflammatory activity test was carried out using a UV-Vis spectrophotometer at a wavelength of 560 nm based on the cell membrane stabilization method and the calculation of the percentage formula for red blood cell membrane stability. Samples were tested at several concentrations, namely 25 ppm, 50 ppm, 100 ppm, 200 ppm, 400 ppm, and 800 ppm, using positive controls in the

form of 1 mL of Na diclofenac solution, 2 mL of hyposaline, 0.5 mL red blood cell suspension, and 1 mL of phosphate buffer pH 7.4 (0.15M) and negative controls in the form of 1 mL of isosaline solution replacing the sample solution, 0.5 mL of red blood cell suspension, 2 mL of hyposaline, and 1 mL of phosphate buffer pH 7.4 (0.15M). Preparation began with taking human blood cells, making isosaline solution, hyposaline solution, preparing *Michelia alba* flower extract concentration, making sodium diclofenac concentration, and making human blood cell suspension. All measurements were carried out three times to ensure data reliability.

### Antibacterial Activity Test

Antibacterial testing was carried out using *Staphylococcus aureus* ATCC 25923 as the test bacterium. The bacterial suspension concentration of 0.5 McFarland was diluted using Dimethyl sulfoxide. The method used was disc diffusion on Mueller–Hinton agar media. The extract was tested at concentrations of 55%, 70%, 85%, and 100%, each with six replications, so that the total test sample was 24.

Antibacterial testing was performed using *Staphylococcus aureus* ATCC 25923 as the test bacterium. The bacterial suspension was prepared with a turbidity equivalent to 0.5 McFarland using sterile saline solution. The method used was disc diffusion on Mueller–Hinton agar media. Extracts were tested at concentrations of 55%, 70%, 85%, and 100%, each with six replications, resulting in a total of 24 test samples, with dilution using dimethyl sulfoxide (DMSO) as the solvent. The positive control used a 5 µg ciprofloxacin disc (CIP 5), while the negative control was 96% sterile ethanol. After incubation at 37 °C for 24 hours, the diameter of the inhibition zone was measured using a digital caliper.

### Data Analysis

The antibacterial test results were analyzed statistically. Normality was tested using Kolmogorov–Smirnov. Since the data did not meet the assumption of normality, the analysis proceeded with the Kruskal–Wallis test to evaluate differences in antibacterial activity among the treatment groups at a 95% confidence level with an alpha value of 0.05.

## RESULTS AND DISCUSSION

The simplisia manufacturing process shows that *Michelia alba* flowers have a moisture content of 9%, thus meeting the criteria for stable dry simplisia suitable for extraction. Qualitative phytochemical screening results indicate the presence of phenolic compounds, tannins, flavonoids, and saponins (Table 1). Testing shows color changes and precipitation consistent with the positive characteristics of each group of compounds, indicating that *Michelia alba* flowers are rich in secondary metabolites that have the potential to provide biological activity. The phytochemical profile of *Michelia alba* flower extract, which shows the presence of phenols, flavonoids, tannins, and saponins, provides a strong scientific basis that this plant contains secondary metabolites with important biological potential. Polyphenolic compounds such as phenols and flavonoids are widely known to play a role in capturing free radicals and reducing oxidative stress. The findings of high polyphenol and flavonoid content in *Michelia alba* flower extract in this study are in line with previous studies reporting that *Magnolia* and *Michelia* species have a rich polyphenolic profile and significant biological activity (Cheng et al., 2022; Yahaya et al., 2024).

Quantitative analysis of phytochemical content (Table 2) showed that the extract contained 80.53 mg GAE per gram of total phenols, 122.32 mg TAE per gram of tannins, and 84.14 mg QE per gram of flavonoids. These contents illustrate that the

extract has a relatively high concentration of polyphenols, which in previous studies have been reported to contribute to various biopharmaceutical activities.

Table 1. Phytochemical Compound Content of *Michelia alba* Flower Extract

Test	Results	Description
Phenol	Positive	Color change to green
Tannin	Positive	Color change to bluish green
Flavonoid	Positive	Green precipitate present
Saponin	Positive	Cloudy light green, foam persists for 10 minutes

Table 2. Quantitative Test of Phytochemical Compounds in *Michelia alba* Flower Extract

Parameter	Method	Results	Unit
Phenol	Spectrophotometry	80.53	Mg GAE/g
Tannin	Spectrophotometry	122.32	Mg TAE/g
Flavonoid	Spectrophotometry	84.14	Mg QE/g

In addition to polyphenols, the literature on the Magnoliaceae family indicates the presence of volatile compounds and terpenoids such as linalool,  $\alpha$ -terpineol,  $\beta$ -caryophyllene, and various other sesquiterpenes that are often dominant in the essential oils of flowers and leaves. This volatile composition has been associated with antimicrobial and antioxidant activities in several Magnoliaceae studies, suggesting that the presence of volatile components in crude extracts may provide an additional explanation for the observed biological activities (Yingjie Liu et al., 2025; Yang & Ma, 2024).

The presence of tannins in the extract has biological significance because tannins are known to interact with proteins through hydrogen bonding and the formation of stable complexes. This interaction can cause protein precipitation on the surface of microbial cells, disrupting membrane function and reducing enzymatic activity essential for cell survival. In addition, the astringent properties of tannins also play a role in reducing membrane permeability and inhibiting the growth of microorganisms. In the context of anti-inflammatory activity, tannins can inhibit inflammatory mediators by reducing oxidative stress and stabilizing cellular structures. Thus, tannins contribute through different but complementary mechanisms with polyphenols and terpenoids in supporting the antibacterial and anti-inflammatory activities of plant extracts (Pizzi, 2021; Sunani & Hendriani, 2023).

Flavonoids detected in *Michelia alba* flower extracts have high biological relevance because this group of compounds is known to have antibacterial activity through several complementary mechanisms. Based on a comprehensive review by Ying Liu et al. (2025), flavonoids work by inhibiting bacterial cell wall synthesis, disrupting cell membrane integrity, preventing biofilm formation, and inhibiting efflux pump activity, thus making the bacteria more vulnerable to antimicrobial agents. This mechanism is further substantiated by findings summarized in the review conducted by Hamid et al. (2024), which shows that flavonoids have the ability to damage membrane permeability and modulate physiological pathways that are important for the survival of both Gram-negative and Gram-positive bacteria. The broad antimicrobial effects of flavonoids reinforce the interpretation that the presence of flavonoids in the extract contributes to the observed biological activity, particularly in the context of inhibiting the growth of *S. aureus*, a Gram-positive bacterium with a cell wall structure that is sensitive to membrane disruption and inhibition of peptidoglycan

synthesis. These findings are consistent with the literature stating that flavonoids are strong candidates as natural antimicrobials capable of enhancing the antibacterial effects of other compounds in the extract through synergistic mechanisms, thereby supporting the therapeutic potential of *Michelia alba* flower extract (Hamid et al., 2024; Yingjie Liu et al., 2025; Mahyantika et al., 2025).

The saponins detected in the extract act as active compounds that can affect cell membrane integrity through pore formation and increased membrane permeability mechanisms. This surfactant effect allows the leakage of intracellular components and simultaneously strengthens the penetration of other active compounds in the extract, resulting in higher biological activity. This mechanism has been described in studies on the bioactive properties of saponins and their role as antimicrobial agents in various plants (Alina et al., 2023; Nguyen et al., 2020).

In addition to the groups mentioned above, several studies on *Michelia* and *Magnolia* have identified nonvolatile compounds such as steroids, aporphine-type alkaloids, and fatty acids. These nonvolatile compounds play a role in the stability of the extract matrix, affecting the solubility, adsorption, and release of active components when applied to in vitro test models. Therefore, their influence is indirect but still significant in the context of biopharmaceutical activity (Cheng et al., 2022; Mahyantika et al., 2025).

The phytochemical profile obtained in this study shows that *Michelia alba* flowers are a rich source of secondary metabolites and have the potential to provide various biological activities. The presence of multiple classes of bioactive constituents, including phenolics, flavonoids, terpenoids, tannins, and saponins, provides a strong scientific basis that this flower extract has significant pharmacological capabilities. These findings are in line with recent research reports that place *Michelia* and other species in the Magnoliaceae family as promising natural sources in the development of antioxidant, anti-inflammatory, and antimicrobial agents. The study confirms that the secondary metabolite content in this group of plants has the potential to be further developed as raw materials for phytopharmaceuticals or natural-based health products (Yahaya et al., 2024; Yang & Ma, 2024).

Table 3. Antioxidant Activity Test of *Michelia alba* Flower Extract

Parameter	Method	Unit	Result
Antioxidant activity	Spectrophotometry	ppm	54.64

Table 4. Anti-inflammatory Activity Test of *Michelia alba* Flower Extract

Sample Code	Concentration (ppm)	Anti-inflammatory Activity (%)
C25	25	99.06
C50	50	98.96
C100	100	99.04
C200	200	98.49
C400	400	98.88
C800	800	98.94
Positive Control	-	98.65
Negative Control	-	0.00

Antioxidant and anti-inflammatory activity testing using the membrane stabilization method demonstrated that *M. alba* extract exhibited a very high inhibitory capacity at all tested concentrations. The antioxidant assay showed an activity value of 54.64 ppm, indicating strong antioxidant potential (Table 3). The anti-inflammatory

activity at concentrations C25, C50, C100, C200, C400, and C800 ranged from 98.49% to 99.06%, with average value of 98.90%, which can be categorized as very strong. In comparison, the positive control showed an activity of 98.65%, while the negative control showed no activity (0%) (Table 4).

The antioxidant anti-inflammatory activity of *Michelia alba* flower extract in this study was demonstrated through its very high membrane stabilization ability at various extract concentrations. Maintained cell membrane stability indicates that the extract is capable of protecting erythrocytes from hemolysis due to hypotonic conditions, which is an early indicator of the ability of bioactive compounds to reduce the inflammatory process. The membrane stabilization model is widely used as an in vitro approach to assess the potential of a substance in preventing inflammation-related cell damage and has been recommended in various phytopharmaceutical studies (Triastuti et al., 2022). The finding that the extract was effective at all concentrations provides strong evidence that the active metabolites in *Michelia alba* flowers can interact with cell membrane structures, thereby reducing susceptibility to lysis, a mechanism also described in other medicinal plants rich in polyphenols and terpenoids (Gonfa et al., 2023; Nunes et al., 2020). The contribution of secondary metabolites to this activity is highly relevant, considering that *Michelia alba* flower extract contains flavonoids, polyphenols, terpenoids, and saponins. Flavonoids have been widely identified as a group of compounds capable of inhibiting inflammation through membrane stabilization mechanisms, inhibition of proinflammatory enzymes, and suppression of inflammatory mediators. The study conducted Al-khayri et al. (2022) indicates that flavonoids can reduce cyclooxygenase and lipoxygenase activity, thereby inhibiting the production of prostaglandins and leukotrienes. A similar study by Dias et al. (2021) also confirmed that flavonoids work through various molecular mechanisms, including inhibiting free radicals that trigger inflammation and increasing membrane resistance to oxidative damage. Additionally, research on other *Magnolia* species, such as *Magnolia champaca*, reports that flavonoids and terpenoids act as anti-inflammatory agents by inhibiting proinflammatory mediators and increasing cell membrane stability, supporting the assumption that secondary metabolites in *Michelia alba* have similar biological mechanisms of action (Hayatillah & Hapsari, 2024).

Apart from flavonoids, polyphenols act as powerful antioxidants that prevent membrane lipid peroxidation. Lipid peroxidation is one of the main processes that exacerbates cell damage during inflammation. Polyphenols are able to donate electrons or hydrogen atoms to stabilize free radicals, thereby reducing oxidative stress and maintaining cell membrane integrity. This is supported by evidence from Nunes et al. (2020), which emphasizes the important role of plant phytochemicals in modulating the inflammatory response through antioxidant activity. Terpenoids also make a significant contribution by interacting directly with the lipid layer of the membrane, increasing its structural stability, and reducing permeability that can trigger hemolysis and tissue damage.

The anti-inflammatory effectiveness of *Michelia alba* flower extract can also be explained by the synergistic mechanism between these metabolite groups. The study by Hasnat et al. (2024) confirms that the pharmacological activities of flavonoids and polyphenols often show synergistic effects when present together in extracts, resulting in greater biological activity than individual compounds. This pattern is similar to the report by Rubiyanti et al. (2025), which states that plant extracts generally work through a combination of active compounds that affect several biological pathways simultaneously, including the inhibition of proinflammatory cytokines, decreased immune cell aggregation, and increased cell membrane stability.

From a functional perspective, the extract's ability to stabilize cell membranes indicates broad application potential, particularly in inflammatory conditions involving tissue damage or skin irritation. Rubiyanti et al. (2025) showed that plants with similar phytochemical profiles are widely developed as components in topical products and natural-based therapies to treat inflammation, skin irritation, and minor wounds. This provides a basis for the use of *Michelia alba* flower extract as an active ingredient in topical preparations such as ointments, gels, or face masks, as well as in oral preparations to treat mild to moderate systemic inflammation.

However, additional studies are required to elucidate the underlying molecular pathways involved in the anti-inflammatory activity of this extract. More in-depth analyses, such as assessment of pro-inflammatory cytokine expression, cyclooxygenase enzyme inhibition, modulation of the NF kappa B or MAPK inflammatory signaling pathways, and subsequent in vivo evaluations using animal models, are needed to strengthen the evidence obtained. Studies by Gonfa et al. (2023) and Al-khayri et al. (2022) also emphasize the importance of characterizing active compounds and assessing toxicity before the extract can be developed clinically. With a layered research approach, *M. alba* flower extract has excellent potential as a safe, effective, and suitable natural-based anti-inflammatory agent for the development of phytotherapy products and functional cosmetics.

Antibacterial activity against *S. aureus* was evaluated using the disk diffusion method. The positive control, ciprofloxacin, produced a mean inhibition zone of 16.67 mm (Table 5), whereas the negative control (96% ethanol) showed no inhibition zone. *Michelia alba* flower extract demonstrated inhibitory activity against *S. aureus* at all tested concentrations, with inhibition zones ranging from 5.00 mm to 10.25 mm. At a concentration of 55%, the inhibition zone was in the range of 5.00 to 7.50 mm. The 70% extract produced inhibition zones ranging from 6.00 to 8.50 mm. At 85%, the extract generated an inhibition zone ranging from 6.50 to 10.25 mm, while the 100% extract showed inhibition zones between 6.50 and 9.00 mm. The average and standard deviation are presented in Table 6.

Table 5. Inhibition Zone of *Michelia alba* Flower Extract against the Growth of *S. aureus* in Positive and Negative Controls

Replication	Inhibition Zone Diameter (mm)	
	Positive Control	Negative Control
I	17.25	0
II	16.50	0
III	17.00	0
IV	17.25	0
V	17.00	0
VI	15.00	0
Mean ± SD	16.67 ± 0.80	0

Statistical analysis indicated that the data were not normally distributed based on the Kolmogorov–Smirnov test with a significance value of 0.021. Therefore, the analysis was continued using the Kruskal–Wallis test, which gave a p-value of 0.095. This value indicates that there was no significant difference between the four extract concentrations in inhibiting the growth of *S. aureus*. Thus, increasing the extract concentration did not show a significant effect on antibacterial activity under these test conditions (Table 7).

Table 6. Growth Inhibition Zone of *S. aureus* in *Michelia alba* Flower Extract

Extract Concentration	Inhibition Zone Diameter (mm)
	Mean ± SD
55%	6.21 ± 0.96
70%	7.75 ± 1.05
85%	8.92 ± 1.31
100%	7.92 ± 1.03

Tabel 7. Statistical Analysis of Antibacterial Acitivity Data

Analysis test	Statistic	df	N	p-value	Interpretation
Kolmogorov Smirnov	0.1933	-	24	0.021	Data not normally distributed
Normality test					
Kruskal-Wallis test	$X^2=9.370$	5	24	0.095	No significant difference among extract concentrations

The antibacterial activity of *Michelia alba* flower extract against *S. aureus* showed a moderate inhibition zone, suggesting that the extract has the capacity to suppress the growth of Gram-positive bacteria, although not as strongly as standard antibiotics. This result aligns with the findings of Yingjie Liu et al. (2025), who reported that essential oils derived from the Magnolia genus exhibit activity against *S. aureus* through phenolic and terpenoid compounds. In the context of crude extracts, such as in this study, moderate activity is an expected result because the concentration of active compounds is still in a mixed form, but it still shows relevant antibacterial potential as a basis for further research.

The detection of flavonoids, terpenoids, tannins, and saponins in the *Michelia alba* flower extract contributes significantly to its antibacterial activity. Flavonoids are recognized for their ability to compromise bacterial membrane permeability, leading to cytoplasmic leakage and disruption of intracellular functions, as explained by Mehta et al. (2023). Lipophilic terpenoid compounds also weaken the phospholipid structure of the membrane, increasing the susceptibility of bacteria to damage. A similar mechanism has also been reported in mangrove and Piper betle extracts, where the bioactive components cause membrane damage and inhibit metabolic pathways essential for bacterial survival (Ayu Rahmawati et al., 2023; Ngamsurach & Praipipat, 2022).

The absence of significant differences between extract concentrations in the disk diffusion test can be explained by the inherent limitations of the diffusion method when used to evaluate complex plant extracts. Compounds with large molecular weights, high polarity, or low solubility in water are often unable to diffuse optimally through the agar medium, so that an increase in extract concentration is not always directly proportional to the area of the inhibition zone formed. A similar phenomenon was also reported by Awadh & Ahmed (2025) and Mahyantika et al. (2025), who found that plant extracts with diverse metabolite compositions often exhibit disproportionate inhibition patterns in the disc diffusion method. The antibacterial activity of *Michelia alba* against Gram-positive bacteria is also supported by previous studies showing the ability of this flower extract to suppress the growth of *Corynebacterium diphtheriae*, confirming that its antibacterial ability can still be detected even though it is not

consistently reflected through concentration variations in the diffusion method (Putri et al., 2025).

Nevertheless, the antibacterial activity demonstrated by *Michelia alba* flower extract remains relevant as preliminary data for the development of plant-based antibacterial agents. Previous studies have shown that various local plants, such as betel leaf, legundi leaf, and ceremai leaf extract, have the ability to inhibit *S. aureus*, supporting the potential of tropical phytochemicals in the treatment of bacterial infections (Nafis et al., 2023; Suyasa et al., 2022). Such activity indicates that many plant species, including *Michelia alba*, may originate from similar mechanistic pathways in suppressing the growth of Gram-positive bacteria.

Further research steps should include fractionation of the extract to identify the main bioactive compounds, testing of individual antibacterial activities, and testing of synergistic effects between components. Studies on the synergy of pineapple peel extract with tetracycline, which enhances inhibition against *S. aureus* (Yuniati et al., 2024), and research on the formulation of a combined gel of kapok banana and bay leaves show that a combinatorial approach can produce stronger antimicrobial activity (Muniroh et al., 2025). Using a similar approach, *Michelia alba* flower extract has the potential to be developed as a candidate for topical antiseptic agents, natural antibacterial agents, and components of phytochemical-based health products.

Despite the promising results obtained in this study, several limitations should be considered. The present work only evaluated the phytochemical profile and the antioxidant, anti-inflammatory, and antibacterial activities of *Michelia alba* flower extract through in vitro assays. The specific bioactive compounds responsible for these activities were not isolated or identified. In addition, the antibacterial evaluation was limited to the disk diffusion method against *S. aureus*, without further quantitative analysis such as minimum inhibitory concentration (MIC) or minimum bactericidal concentration (MBC). Furthermore, the biological activities observed in vitro may not fully represent the effects in living systems. Therefore, additional studies involving compound isolation, mechanistic analysis, and in vivo evaluation are necessary to better understand the pharmacological potential of *Michelia alba* flower extract.

## CONCLUSION

The extract of *Michelia alba* (White Champaca) flower was to contain several phytochemical compounds both qualitatively and quantitatively, including phenolics (80.53 mg GAE/g), tannins (122.32 mg GAE/g), and flavonoids (84.14 mg QE/g). The extract also demonstrated potential biological activities, including antioxidant activity (54.64 ppm, classified as strong), anti-inflammatory activity with an average inhibition of 98.90% (very strong), and antibacterial activity in vitro against *S. aureus*, as indicated by inhibition zones of less than 15 mm.

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## CONFLICT OF INTEREST

The researcher has no conflict of interest in this research.

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