



ANTIBACTERIAL EXTRACT OF BANDOTAN (*AGERATUM CONYZOIDES L.*) SYTEMATIS REVIEW

Debora Paramita Naibaho*, Fitranto Arjadi

Department of Medicine, Faculty of Biomedical Sciences, Universitas Jendral Soedirman, Jl. Profesor DR. HR Boeniyamin No.708, Dukuhbandong, Grendeng, Purwokerto Utara, Banyumas, Central Java 53122 Indonesia

*debora.naibaho@mhs.unsoed.ac.id

ABSTRACT

Antibacterial extract leaf Bandotan (*Ageratum conyzoides L.*) shows that effectiveness antimicrobial plant This is results synergy compound bioactives , such as flavonoids, tannins, saponins, and terpenoids, which are successful extracted optimally use solvent organic . Use solvent methanol and ethanol proven increase acquisition compounds said , which then contribute to mechanism Work antimicrobial through effect antioxidants and damage membrane cell bacteria . Innovative approaches such as green nanoparticle synthesis have also been shown to have the potential to improve the stability of the extract, thus supporting the development of alternative therapeutic applications to overcome antibiotic resistance. Objective: this study was to evaluate the antibacterial activity of methanol extract of Bandotan leaves against *S. aureus* and identify bioactive compounds, as well as highlight the integration of traditional knowledge with research innovations in the treatment of skin infections. This systematic review was conducted using the PRISMA method. The literature search process was carried out through Google Scholar, PubMed, and Science Direct databases, focusing on studies published between 2020 and 2024. Articles that met the inclusion criteria were observational studies that tested the antibacterial activity of Bandotan leaf extract. Of the 1086 articles initially identified, based on the PICO method, the systematic review's study selection. Initially, 1086 records were identified from databases like Google Scholar and PubMed. After removing 61 duplicates, 1025 records underwent screening. Exclusions included 249 systematic reviews, 270 irrelevant Bandotan studies, 112 with inadequate methods, 200 lacking exclude full text unavailable, and 189 outside the research scope. Finally 5 studies include criteria . Results: the study showed that Bandotan leaf extract, both extracted with ethanol and methanol, effectively inhibited the growth of various pathogenic bacteria, such as *Staphylococcus aureus*, *Streptococcus pyogenes*, Methicillin-Resistant *Staphylococcus aureus* (MRSA), and *Propionibacterium acnes*. In vitro tests conducted for 24 hours using the agar diffusion method revealed a dose-response correlation, where increasing extract concentrations resulted in wider inhibition zones. In addition, the integration of the extract into product formulations, such as anti-acne sheet masks, suggests that this extract also has potential for skin care applications. Conclusion: these findings support further development of the use of Bandotan leaf extract as an alternative source of natural active ingredients in infection therapy and as a basis for the development of antibacterial cosmetic products.

Keywords: *ageratum conyzoides*; antibacterial activity; bandotan extract

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INTRODUCTION

Methanol extract from Bandotan (*Ageratum conyzoides L.*) leaves has gained attention as a potential antibacterial agent for the treatment of skin infections due to *Staphylococcus aureus* (*S. aureus*). The advantage of methanol extract lies in its ability to solubilize polyphenolic compounds, such as flavonoids, tannins, and phenolic compounds, which are known to have inhibitory activity against the growth of Gram-positive bacteria, present through disruption of cell wall synthesis as well as enzymatic inhibition mechanisms. *S. aureus* is one of the main pathogens that cause skin infections and is often faced with the problem of resistance to modern antibiotics (Maulidya et al., 2020; Bamba et al., 2023). Although Bandotan is often considered a botanical weed, it has a strong ethnobotanical basis in local communities, where the presence of bioactive compounds underlies its traditional properties that have been applied to treat skin infections through various natural medicine methods (Yadav et al., 2019; Hariono

et al., 2021). Various supporting studies showed that the methanol extract of Bandotan leaves exhibited significant antibacterial activity; only the ethanol extract was active against *S. aureus*. The agar diffusion test method showed zones of inhibition supporting claims of the effectiveness of such extracts as therapeutic alternatives Bamba et al. (2023).

An in-depth understanding of the mechanism of action of these active compounds may open up opportunities for the development of innovative topical therapies, potentially reducing reliance on synthetic antibiotics that often have resistance-related problems (Nastic et al., 2024). The integration of traditional knowledge and modern research approaches allows for a more systematic isolation and characterization of bioactive compounds, thereby increasing the effectiveness and stability of pharmaceutical products based on natural extracts from Bandotan leaves (Mitsunari et al., 2021). Research conducted by Hasyim showed that the ethanol extract of Bandotan leaves was effective in inhibiting the growth of *S. aureus* that causes boils, thus strengthening the therapeutic potential of the active compounds in this plant (Hasyim, 2020). Although there are findings stating the success of ethanol extracts, data on methanol extracts still require further research for optimal utilization. Thus, the utilization of methanol extracts of Bandotan leaves not only broadens scientific insights regarding the efficacy of medicinal plants, but also emphasizes the importance of synergy between local medicinal traditions and modern research innovations as an alternative solution in the treatment of skin infections caused by *S. aureus*. The entire study aimed to explore the antibacterial activity of methanol extracts against *S. aureus*, identify and isolate bioactive compounds that contribute to the antimicrobial activity, and highlight the importance of integrating traditional knowledge with modern innovations for more effective and environmentally friendly health solutions. In addition, this study also sought to determine the optimal dose of the extract for application in skincare products, so as to make a meaningful contribution to public health in addressing the challenges of increasing antibiotic resistance.

METHOD

Literature Search and Filtering

A systematic review of the antibacterial potential of Bandotan leaves (*Ageratum conyzoides* L.) as an alternative therapy for skin infections has been carried out by following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Jungjunan, 2023). The literature search was conducted electronically on three major databases, namely PubMed, Google Scholar, and ResearchGate. In this search process, keywords were compiled using the PICO framework and adjusted to the term Medical Subject Relevant Headings (MeSH), such as “*Ageratum conyzoides*”, “Antibacterial Activity”, “Bandotan extract”. The use of Boolean operators AND and OR was applied to refine the search strategy to produce a comprehensive and relevant collection of studies (Jungjunan, 2023). The search was limited to the years 2020 to 2025 to ensure that the literature review included the latest and up-to-date research on the antibacterial activity of Bandotan leaves against skin infections often caused by *S. aureus*. From the initial search, a number of articles were identified and then filtered through several stages starting from removing duplicates, reviewing titles and abstracts, to evaluating full texts based on predetermined inclusion criteria. The inclusion criteria focused on original studies evaluating the effectiveness of Bandotan leaf extract in inhibiting bacterial growth, especially *S. aureus*, with relevant test methods, such as agar diffusion tests (Jungjunan, 2023). In addition, the quality of the included studies was assessed using a risk of bias assessment tool to ensure the validity and reliability of the findings presented.

The screening process was carried out systematically, where each article that met the inclusion criteria was analyzed in depth to identify data related to the mechanism of action of

active compounds in Bandotan leaves, such as flavonoids, tannins, and phenolic compounds which are known to have a role in inhibiting the growth of Gram-positive bacteria. From the results of the screening, the remaining articles showed consistency that Bandotan leaf extract has significant antibacterial potential, thus supporting its use in the treatment of traditional skin infections (Jungjunan, 2023). This reaffirms the value of integrating traditional knowledge with modern research as a basis for developing safer and more effective therapeutic alternatives to overcome the increasing problem of antibiotic resistance.

Overall, this systematic review study not only provides a comprehensive overview of the effectiveness of Bandotan leaf extract against *S. aureus*, but also highlights the importance of a systematic methodological approach to evaluate the therapeutic potential of medicinal plants. The integration of findings from various studies provides a strong scientific basis for the development of pharmaceutical and cosmetic products based on natural bioactive compounds from Bandotan, which can be used as an alternative in treating skin infections in the era of increasingly worrying antibiotic resistance (Jungjunan, 2023).

Choice

The selection process involves the application of pre-defined inclusion and exclusion criteria to ensure the relevance of the research. Articles were filtered based on criteria following :

I. Criteria Inclusion

1. Original studies (primary research articles) that present primary data about activity antibacterial or application therapeutic leaf The Bandit .
2. Experimental studies both in vitro and in vivo evaluating effectiveness extract leaf Bandotan (for example , extract methanol or ethanol) against growth bacteria , especially *Staphylococcus aureus*, or in the application healing wound .
3. Articles published in English or Indonesian.
4. Studies published between 2019 and 2024 to ensure data up-to-dateness and relevance to the latest research developments.
5. Studies with clear and structured methodology, including the use of extraction methods, phytochemical analysis, and antibacterial activity tests (e.g., agar diffusion method, minimum inhibitory concentration/MIC, etc.).

II. Criteria Exclusion

1. Studies in the form of review articles, meta-analyses, conference abstracts, or short reports without complete primary data.
2. Studies that do not focus on Bandotan leaves or the active compounds in them, or that use pathogen targets outside the context of antibacterials against *Staphylococcus aureus* or skin infections.
3. Articles with inadequate research methods, lacking detail, or not including experimental validation that allows for replication.
4. Studies that are not available in full-text form make it difficult to evaluate the methodology and results in depth.
5. Publications published outside the 2020 to 2024 timeframe, so that the results included reflect the most current information.

Data Extraction

1. Identification Details Morphology and Samples
2. Extraction Method and Process Parameters
 - The duration, temperature and concentration of the extract specified in the extraction protocol, which affect the comparison of the results of antibacterial analysis and phytochemical profiles.

3. Activity Test Parameters Antibacterial
 - Quantitative parameters collected , including size of inhibition zone , Minimum Inhibitory Concentration (MIC) value , and dose extract used .
4. Applications and Formulations Product Derivative
 - Information about development product based on extract leaf Bandotan , for example anti-acne sheet mask formulation developed by Ginting, in which the extract used For against Propionibacterium acnes (Hasyim, 2020).
 - Product formulation parameters such as consistency, pH, and stability are assessed in derivative products, as well as evaluation of the performance of the product in the context of cosmetic applications and topical therapy.
5. Analysis Phytochemistry and Profile Compound Bioactive
 - Quantitative parameters other related identification compound through technique chromatography or spectrophotometry , which allows comparison composition active between the resulting extract with different solvents

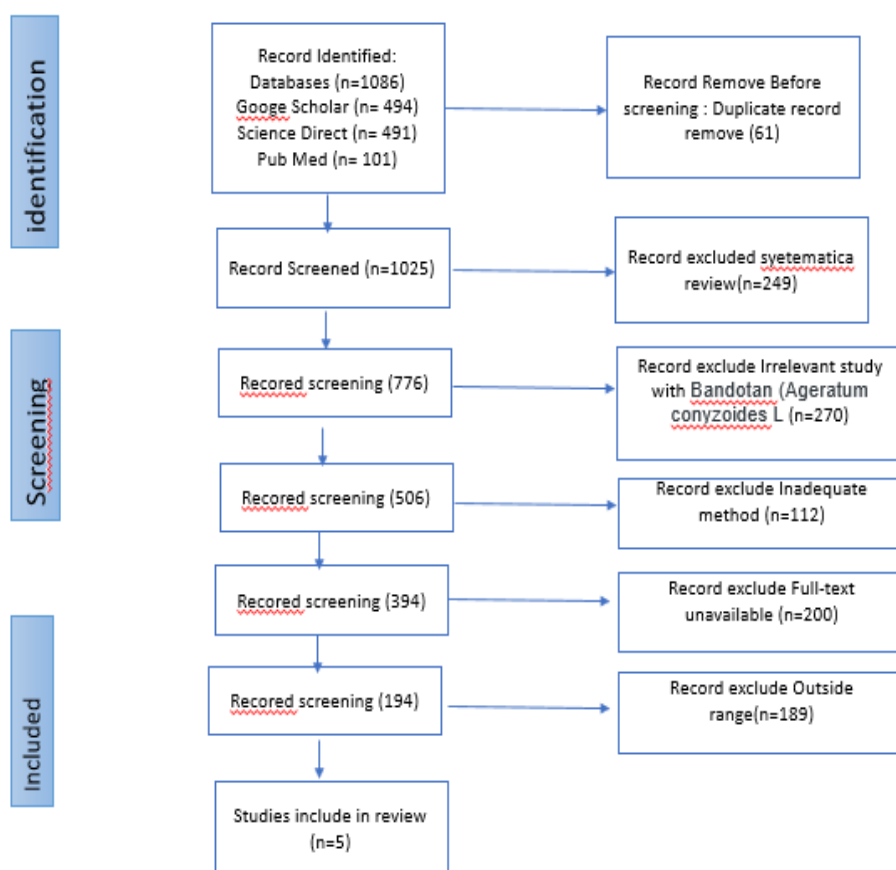


Figure 1. PRISMA flow diagram

RESULT

Table 1.
Summary of Studies on Antibacterial Extract of Bandotan (*Ageratum conyzoides* L.

Author	Dose	Duration	Findings
The Last Supper (2020)	extract dose expressed through the number of colonies (10 ⁴ , 10 ⁷ , and 10 ⁹ CFU/ mL)	Real time	The difference in the number of colonies (expressed in CFU/ mL) and bacterial morphology shows that Bandotan leaf extract has the potential as an antibacterial agent that can be applied to water quality testing.
Maulidya et al. (2020)	1 gram of extract per liter	24 hours	the effectiveness of ethanol extract against MRSA, which is important considering the increasing antibiotic resistance that is a clinical challenge.
Ginting et al. (2021)	2% w/v	24 hours	showcases skincare product innovation by integrating Bandotan extract into sheet formulations mask , which not only inhibits acne-causing bacteria but also meets the quality standards of cosmetic formulations
Anggrainy et al. (2022)	10%, 20%, and 30%	24 hours incubation	underlining the influence of methanol extract concentration on its antibacterial effectiveness, which supports the potential role of Bandotan leaves as a therapeutic alternative in the treatment of skin infections
Princess & Fhatonah (2021)	15%, 25%, and 35% (w/v)	24 hours incubation	reaffirmed that the ethanol extract of Bandotan has significant antibacterial activity against <i>Streptococcus pyogenes</i> , thus providing a scientific basis for the development of topical therapies based on medicinal plants

DISCUSSION

Studies that have been conducted on the antibacterial potential of Bandotan (*Ageratum conyzoides* L.) leaf extracts show very promising results. These extracts, both obtained using methanol and ethanol solvents, were shown to have significant antibacterial activity against various pathogens, including Methicillin-Resistant *Staphylococcus aureus* (MRSA), *Streptococcus pyogenes*, *Propionibacterium acnes*, and *Staphylococcus aureus* (Maulidya et al., 2020; Bamba et al., 2023). This antibacterial activity is ascribed to the bioactive compounds contained in the extracts, suggesting that Bandotan could serve as a potential raw material in the development of natural ingredient-based therapeutic and cosmetic products (Bamba et al., 2023). One notable study by Adeko and Hidayat (2024) revealed the use of Bandotan leaf extract in water quality testing, where colony concentration measurements (CFU/mL) were used as an indicator of antibacterial effectiveness. Gram staining of the samples identified a variety of bacterial morphologies, including bacillus and cocci forms, indicating the presence of antimicrobial activity. Although this approach provides a quick snapshot of the extract's potential in controlling microbial contamination, further studies are needed to understand the long-term effectiveness of this extract (Wardhani et al., 2023). This research is also in line with findings that show the ability of extracts in dealing with water quality issues in the environment (Yuliani & Rahayu, 2021).

On the other hand, research by Maulidya et al. (2020) confirmed that ethanol extract from Bandotan leaves can effectively fight MRSA. In this study, the dose used was 1 g/L with a testing time of 24 hours, which resulted in a significant zone of inhibition. These findings indicate the potential of Bandotan as an alternative or adjunctive therapy in the treatment of infections caused by resistant bacteria, which is a major challenge in healthcare, particularly in the context of hospital infections (Bamba et al., 2023). In addition, Ginting et al. (2021)

innovated their product by formulating an anti-acne sheet mask based on Bandotan leaf extract. The use of the extract in a concentration of about 2% (w/v) showed effectiveness in inhibiting *Propionibacterium acnes*, providing supporting evidence for the development of skin care products that are not only effective, but also consider aspects of product stability and safety (Bamba et al., 2023).

Research by Anggrainy et al. (2022) explored the antibacterial activity of methanol extract at varying concentrations (10%, 20%, up to 30% w/v) against *Staphylococcus aureus*. The results showed that the zone of inhibition increased in proportion to the increase in concentration, which indicates a clear dose-response relationship and becomes important to consider the optimal dose in clinical applications. In addition, research conducted by Putri & Fhatonah (2021) found that increasing the concentration of ethanol extract resulted in a greater zone of inhibition against *Streptococcus pyogenes*, confirming the effectiveness of this extract in controlling Gram-positive pathogens (Maulidya et al., 2020). The success of these various studies is supported by the phytochemical analysis conducted by Bamba et al. (2023), who reported the content of flavonoids, terpenoids, and phenolic compounds in Bandotan leaf extracts, which are known to have antimicrobial properties. Further research into the effects of various extraction methods showed that maceration using ethanol yielded better results than water, providing important implications in the selection of the optimal extraction method (Wardhani et al., 2023).

Overall, the results of this study clearly suggest that Bandotan leaf extract has great potential as an antibacterial agent. Various studies have shown that the effectiveness of extracts depends not only on the characteristics of the plant itself, but also by variations in the extraction method as well as the concentration applied in each experiment. This suggests that extraction techniques and dosage settings are crucial aspects that must be considered in the research and clinical application of this extract to maximize its antibacterial potential. Furthermore, continued development of Bandotan leaf extract is highly expected for applications in environmental care, such as water quality management and prevention of microbial contamination, as well as in the formulation of innovative skincare products. Given the increasing awareness of health problems associated with the use of synthetic antibiotics and antibiotic resistance, the need for natural ingredient-based alternatives is becoming more urgent. In this regard, Bandotan leaves can provide a sustainable and safe solution for a wide range of applications, from topical remedies to cosmetic products intended for the skin.

CONCLUSION

Based on the results of a review of several studies on the antibacterial activity of Bandotan leaves (*Ageratum conyzoides* L.), it can be concluded that Bandotan leaf extract has significant potential in inhibiting the growth of various pathogenic bacteria. Extraction using ethanol and methanol solvents produces bioactive compounds such as flavonoids, tannins, and phenolic compounds that show effectiveness in suppressing the growth of bacteria such as *Staphylococcus aureus*, *Streptococcus pyogenes*, Methicillin-Resistant *Staphylococcus aureus*, and *Propionibacterium acnes*. The study showed that higher doses and optimal extract concentrations, with 24-hour incubation, produced larger inhibition zones, indicating that the extract was more effective in carrying out antibacterial activity. In addition, innovations involving the application of Bandotan leaf extract in formulated products, such as anti-acne sheet masks, prove that the use of this extract is not only therapeutically beneficial but also has the potential to be developed as an effective skin care product. Overall, these results support further development of the use of Bandotan leaves as an alternative natural active ingredient in treating infections and making antibacterial cosmetic products, which can be an effective solution in overcoming the challenge of antibiotic resistance and meeting the need

for safe and efficient modern therapy.

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