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Phytochemical Compounds of Tropical Plants from Lampung as Antibacterial Agents against *Escherichia coli* and *Staphylococcus aureus*: A Literature Review

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Abstract

The growing crisis of antimicrobial resistance has intensified the search for new antibacterial agents, and the diverse tropical flora of Lampung offers a promising natural reservoir of bioactive compounds. This review synthesizes current evidence on plant and algal phytochemicals from Lampung that have been evaluated against two clinically important pathogens, Escherichia coli and Staphylococcus aureus. Following the PRISMA 2020 guidelines, a systematic search conducted on 31 July 2025 using Harzing's Publish or Perish and databases such as Google Scholar and PubMed identified 200 records. After screening and eligibility assessment, 20 studies published between 2015 and 2025 were included in the analysis. Most investigations employed disc diffusion and minimum inhibitory concentration assays and consistently reported antibacterial activity, with stronger effects generally observed against S. aureus. The predominant classes of active compounds included flavonoids, alkaloids, tannins, saponins, and essential oils. Several species, such as Anredera cordifolia, Mangifera indica peels, Citrus aurantifolia, Syzygium polyanthum, and Cymbopogon nardus, emerged as notable candidates. The findings highlight opportunities for the development of phytopharmaceuticals and natural food preservatives, while key research gaps relate to the limited availability of in vivo data, lack of standardized extraction protocols, and insufficient exploration of molecular mechanisms. Overall, this review underscores the strategic value of Lampung's biodiversity as a source of potential antibacterial agents effective against E. coli and S. aureus.

Keywords: Phytochemicals, Antibacterial activity, Escherichia coli, Staphylococcus Aureus, Lampung

A. Introduction

Indonesia is recognized as one of the world's megadiverse regions, with an exceptional richness of tropical flora. In the southern part of Sumatra, Lampung Province holds substantial terrestrial and coastal biodiversity, much of which has long been used in traditional healing practices. Ethnobotanical surveys conducted around Way Kambas National Park, for example, have documented numerous plant species employed by local communities to manage infections and inflammatory conditions. These findings suggest the presence of bioactive resources that remain insufficiently investigated within contemporary pharmacological research (Yudiyanto et al. 2022, 2024).

At the same time, antimicrobial resistance continues to escalate and has become a pressing global concern. A comprehensive analysis by Naghavi et al. (2024) estimated that millions of deaths each year are associated with antimicrobial resistance. Murray et al. (2022) similarly reported a rising trend, particularly among older populations. These developments reinforce the urgent demand for new antibacterial candidates, including those derived from secondary metabolites of medicinal plants. In this context, the exploration of locally available tropical plants from biodiversity-rich regions such as Lampung is scientifically justified, as these plants represent underutilized reservoirs of bioactive compounds shaped by unique ecological conditions and long-standing ethnobotanical practices. Systematic evaluation of Lampung's flora therefore offers a context-specific yet globally relevant pathway for identifying alternative antibacterial agents capable of complementing or extending existing therapeutic options.

Two clinically significant pathogens that feature prominently in resistance reports are Escherichia coli, a Gram-negative bacterium, and Staphylococcus aureus, a Gram-positive pathogen. Uropathogenic E. coli remains a leading cause of urinary tract infections that may progress to severe systemic complications such as urosepsis (Zhou et al. 2023). In contrast, S. aureus is responsible for a wide spectrum of infections ranging from superficial skin diseases to pneumonia and endocarditis, and its methicillin-resistant strains continue to complicate treatment outcomes (Hajhamed et al. 2025).

Exploratory studies involving Lampung's coastal and terrestrial flora have begun to reveal promising antibacterial properties; however, the existing evidence remains largely fragmented and methodologically heterogeneous. Investigations on Sargassum species report the presence of phenolics, fucoidan, and terpenoids with strong inhibitory activity against Staphylococcus aureus, while demonstrating comparatively weaker effects on Escherichia coli (Safitri et al. 2021; Sinaga and Helena 2022). Notably, these studies vary considerably in extraction protocols, concentration ranges, and antibacterial assays, limiting direct comparison of efficacy across studies. Similarly, research on Spathodea campanulata growing in Lampung has identified flavonoids, tannins, and iridoids with measurable antimicrobial activity; nevertheless, most findings are derived from in vitro screenings without standardized controls or clear benchmarks against conventional antibiotics (Duryat, Ghozali, Subki, et al. 2025). Field surveys in the Bukit Barisan region further suggest a high diversity of woody and herbaceous plants with antibacterial potential, yet these surveys often emphasize qualitative bioactivity reporting rather than quantitative potency metrics or reproducibility (Duryat, Ghozali, Saragih, et al. 2025). Collectively, while these studies underscore the richness of Lampung's flora as a source of antibacterial agents, the lack of methodological consistency and systematic synthesis highlights the need for a structured review to critically evaluate, compare, and consolidate the existing evidence.

Although previous studies underscore the pharmacological promise of Lampung's biodiversity, no systematic synthesis to date has specifically integrated and critically evaluated evidence on the antibacterial activity of Lampung-derived tropical plants against Escherichia coli and Staphylococcus aureus. This gap is particularly evident in the absence of region-specific reviews that simultaneously link botanical origin, phytochemical profiles, and standardized antibacterial outcomes. To address this limitation, the present review constitutes the first PRISMA-guided systematic assessment focusing exclusively on tropical plant and algal species from Lampung tested against these two clinically relevant bacteria. Its novelty lies in consolidating scattered experimental findings into a unified analytical framework that not only catalogs plant taxa and active compound classes, but also comparatively evaluates antibacterial potency using consistent in vitro indicators. By doing so, this review advances current knowledge beyond descriptive inventories and provides an evidence-based synthesis capable of identifying methodological patterns, research gaps, and priority candidates for further pharmacological development.

Despite the growing body of experimental studies, the lack of cross-study comparison and methodological integration has hindered the translation of Lampung's phytochemical diversity into coherent antibacterial research agendas. By providing a structured synthesis, the present review offers a critical reference point for directing future experimental standardization and compound-focused investigations.

B. Literature Review

1. Phytochemicals as Sources of Antibacterial Agents

Plant-derived secondary metabolites such as alkaloids, flavonoids, tannins, terpenoids, and phenolic compounds are widely recognized for their ability to inhibit bacterial growth through several biochemical and structural mechanisms. These include disruption of cell membranes, interference with protein biosynthesis, and inhibition of enzyme systems essential for bacterial survival (Jubair et al. 2021; Keita et al. 2022). Recent publications also emphasize the strong antibacterial performance of polyphenols and terpenoids from tropical species, particularly against resistant pathogens (Dias et al. 2022; Wang et al. 2025). Flavonoids such as quercetin and kaempferol, for instance, have been shown to destabilize bacterial membranes and inhibit DNA gyrase, underscoring their therapeutic potential (Sharma et al. 2025).

2. Differences in Susceptibility between Gram-positive and Gram-negative Bacteria

Variations in cell wall structure contribute to different susceptibility patterns between Gram-positive and Gram-negative bacteria. Gram-negative bacteria possess an outer lipopolysaccharide layer that limits the penetration of hydrophobic compounds, which often reduces the efficacy of many plant metabolites. In contrast, Gram-positive bacteria have a simpler peptidoglycan structure that allows greater accessibility to active compounds (Venkatesh Kumar et al. 2019). This structural distinction aligns with findings from studies on Sargassum extracts, which show stronger inhibitory activity against S. aureus compared to E. coli (Safitri et al. 2021; Sinaga and Helena 2022).

3. Biodiversity of Tropical Flora in Lampung and Its Bioactive Potential

Lampung's diverse ecological landscapes, encompassing coastal zones, lowland forests, and mountainous regions, contribute to a broad range of plant metabolites with potential biological activities. Investigations into Spathodea campanulata have identified iridoids and tannins with noteworthy antibacterial effects (Duryat, Ghozali, Subki, et al. 2025). Meanwhile, field studies in the Bukit Barisan area have reported several woody species that exhibit antibacterial potential, although comprehensive testing against priority pathogens remains limited.

Coastal ecosystems also contribute significantly to Lampung's bioresources. Brown algae such as Sargassum spp. contain fucoidan and meroterpenoids that exhibit antibacterial and anti-inflammatory properties (Rushdi et al. 2020). Studies from other regions in Indonesia indicate that metabolite composition in marine algae is influenced by season, habitat conditions, and oceanographic characteristics, suggesting that Sargassum from Lampung may possess unique chemical profiles yet to be fully explored (Darmawan et al. 2020).

4. Global Context of Antimicrobial Resistance

WHO (2023) stresses the need for new antibacterial agents, especially those active against priority pathogens. Extended-spectrum beta-lactamase producing E. coli and methicillin-resistant S. aureus are listed among high-priority organisms because of their rising resistance levels worldwide. Plant-derived antibacterial candidates are gaining attention due to their multi-target mechanisms, which may reduce the likelihood of resistance development compared to single-target antibiotics (Shin et al. 2018).

C. Methodology

1. Research Design

This study employed a systematic literature review to address the research question in a structured and transparent manner. The review process followed the PRISMA 2020 guidelines as outlined by Page et al. (2021). The primary objective was to synthesize existing research examining phytochemical constituents of tropical plants and marine algae from Lampung that have been evaluated for antibacterial activity against Escherichia coli and Staphylococcus aureus.

The scope of the review included both terrestrial and coastal plant species native to Lampung, as well as studies that provided empirical data on phytochemical profiles and antibacterial assays targeting the two pathogens. Only peer-reviewed publications with clear methodological descriptions and verifiable results were considered.

2. Instruments

The literature search was carried out on 31 July 2025 using the Harzing's Publish or Perish application. Two major online databases were examined: Google Scholar and PubMed. The search strategy incorporated a combination of keywords in both Indonesian and English, including "Lampung tropical plants", "active compounds", "phytochemicals", "antibacterial", "Escherichia coli", and "Staphylococcus aureus".

The inclusion and exclusion criteria applied to the selection process are presented in Table 1. Only articles published between 2015 and 2025, written in Indonesian or English, and containing laboratory data on antibacterial activity against E. coli and/or S. aureus were retained. Studies that examined plants from outside the Lampung region or lacked relevant antibacterial assays were excluded.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Articles published between 2015 and 2025	Articles outside the 2015–2025 period
Written in Indonesian or English	Articles in languages other than Indonesian or English
Studies examining tropical plants from Lampung and their phytochemical content	Studies examining plants not originating from Lampung
Articles reporting antibacterial assays against E. coli and/or S. Aureus	Articles without antibacterial data or focusing on other bacteria
Clear methodology and verifiable findings	Articles with unclear or unverifiable methodology

The initial search across the two databases yielded 200 records. Screening, removal of duplicates, and eligibility assessment were conducted according to PRISMA guidelines. The distribution of records at each review stage is summarized in Table 2.

Table 2. Distribution of Articles by Database

PRISMA 2020 Stage	Google Scholar	PubMed	Total
Records identified	150	50	200
Duplicates removed	60	30	80
Records screened	100	20	120
Records excluded (screening)	10	10	20
Records for retrieval	90	10	100
Records not accessible	5	5	10
Records assessed for eligibility	85	5	90
Records excluded (eligibility)	67	3	70
Final studies included	18	2	20

A total of 20 eligible studies obtained through Google Scholar and PubMed via Harzing's Publish or Perish were included in the final synthesis. The complete selection workflow is illustrated in Figure 1.

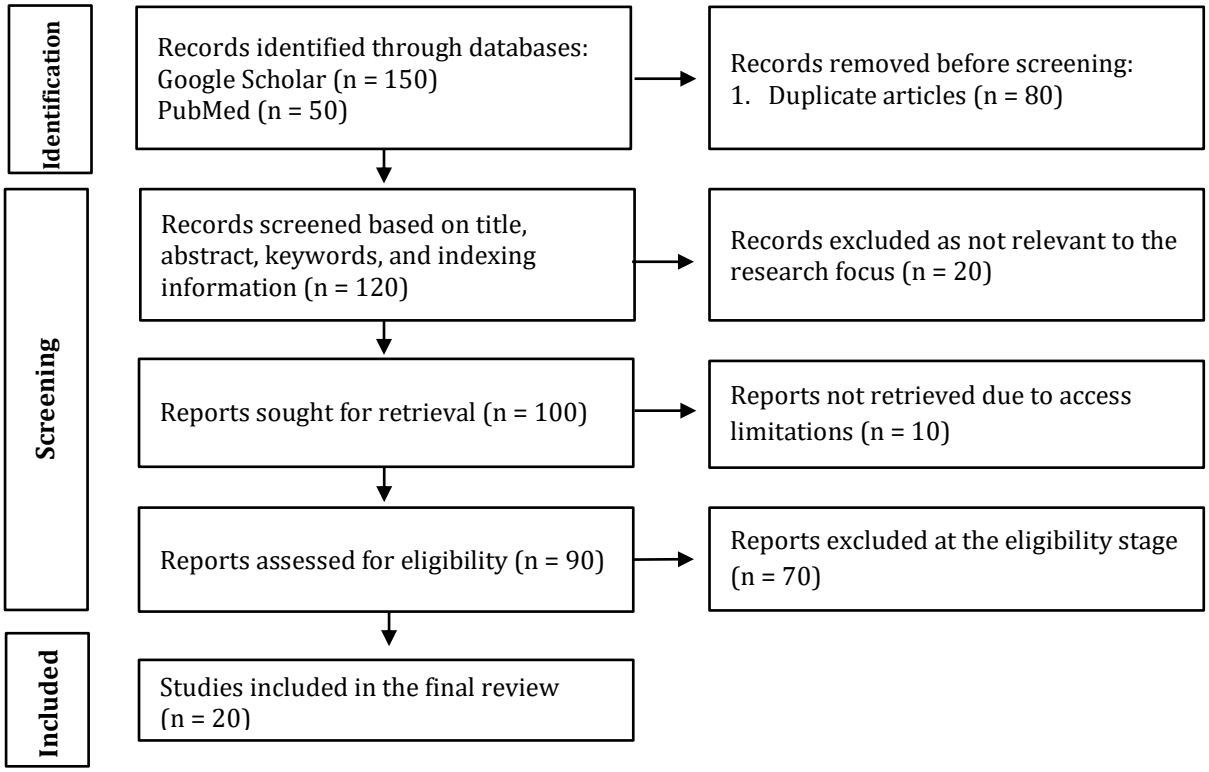

Figure 1. PRISMA 2020 Flow Diagram for Study Selection

3. Technique of Data Analysis

The studies meeting the inclusion criteria were examined through descriptive analysis. Extracted data included the plant or algal species investigated, identified classes of phytochemical constituents, assay techniques used, and antibacterial activity against E. coli and S. aureus.

Differences in antibacterial activity between Gram-positive and Gram-negative bacteria were examined using a qualitative comparative–narrative approach, whereby trends in inhibition zones, minimum inhibitory concentrations, and reported efficacy levels were systematically contrasted across studies. In parallel, dominant metabolite groups were analyzed through cross-study pattern mapping to identify recurring phytochemical classes associated with stronger antibacterial effects. Methodological variations, including extraction solvents, concentration ranges, and assay types, were assessed narratively to reveal common practices and sources of heterogeneity. Through this integrative synthesis, the analysis moves beyond isolated findings to elucidate overarching tendencies, research variability, and persistent gaps, particularly in relation to assay standardization, compound isolation strategies, and the limited exploration of antibacterial mechanisms.

D. Findings and Discussion

1. Findings

The literature search identified a total of two hundred articles from two major databases, namely Google Scholar and PubMed. After the removal of duplicate records, eighty items were excluded and one hundred and twenty articles remained for the screening stage. Screening based on titles, abstracts, keywords, and indexing led to the exclusion of twenty studies that did not align with the research focus. Full texts of one hundred articles were further examined and eighty were removed because of insufficient methodological clarity, incomplete data, or limited relevance to the topic. As a result, twenty articles met all inclusion criteria and were selected for detailed analysis.

The descriptive synthesis indicates that studies conducted on tropical plant species originating from Lampung highlight the antibacterial potential of several locally available taxa. The major bioactive constituents reported across the reviewed studies include flavonoids, alkaloids, saponins, tannins, phenolic compounds, essential oils, and terpenoids. Antibacterial assays were commonly performed using disc diffusion or minimum inhibitory concentration tests. Most plant extracts demonstrated inhibitory activity against Escherichia coli and Staphylococcus aureus, with the magnitude of inhibition varying across species and extract concentrations.

A summary of the tropical plant species, principal phytochemicals, and antibacterial activities against E. coli and S. aureus is presented in Table 3.

Table 3. Summary of Findings from Selected Studies

Study Code	Authors and Year	Tropical Plant from Lampung	Phytochemical Constituents	Target Bacteria	Key Findings
S1	Budianto et al. (2024)	Rambusa (*Passiflora foetida*)	Flavonoids, Alkaloids, Tannins, Saponins	*S. aureus*	Fruit extract produced inhibition zones against *S. aureus*.
S2	Ismunanto et al. (2024)	Bakau Lindur (*Bruguiera gymnorrhiza*)	Alkaloids, Flavonoids, Tannins, Phenols, Saponins, Terpenoids, Steroids	*E. coli*, *S. aureus*	Ethanol extract contained abundant phytochemicals with measurable antibacterial activity.
S3	Rasid et al. (2021)	Rubiaceae	Alkaloids, Flavonoids, Saponins, Tannins, Phenols, Essential Oils	*S. aureus*, *E. coli*	Extract was effective against both bacteria in hand sanitizer formulations.
S4	Rukman et al. (2025)	Golobe (*Hornstedtia alliacea*)	Flavonoids, Alkaloids, Saponins	*E. coli*, *S. aureus*	Rhizome extract showed significant antibacterial activity toward both pathogens.
S5	Hamzah et al. (2021)	Green Betel (*Piper betle*)	Flavonoids, Saponins, Tannins	*E. coli*	Leaf extract inhibited *E. coli* growth at one hundred percent concentration.
S6	Aprilliana and Hasbi (2024)	Ketepeng Cina (*Cassia alata*)	Flavonoids, Alkaloids, Saponins, Tannins	*S. aureus*, *E. coli*	Leaf extract exhibited clear antibacterial effects against both bacteria.
S7	Jannah et al. (2023)	Laban (*Vitex pinnata*)	Flavonoids, Saponins, Tannins, Triterpenoids, Glycosides	*S. aureus*, *E. coli*	Extract produced inhibition zones up to ten millimeters.
S8	Zahrani et al. (2025)	Papaya (*Carica papaya*)	Flavonoids, Alkaloids, Saponins, Tannins	*S. aureus*, *E. coli*	Leaf extract displayed strong antibacterial activity against both bacteria.
S9	Balqis et al. (2024)	Mangrove (*Bruguiera gymnorrhiza*)	Flavonoids, Alkaloids, Tannins, Saponins, Terpenoids	*S. aureus*, *E. coli*	Extract contained active bio-compounds capable of inhibiting both bacteria.
S10	Naufal et al. (2025)	Water Apple (*Syzygium aqueum*)	Flavonoids, Terpenoids, Saponins, Tannins, Alkaloids	*S. aureus*, *E. coli*	Leaf extract was active against both Gram positive and Gram negative bacteria.
S11	Faujiah et al. (2023)	Papaya Leaf (*Carica papaya*)	Tannins, Alkaloids, Flavonoids, Terpenoids, Saponins	*S. aureus*	No antibacterial activity observed.
S12	Sahreni et al. (2020)	Cassava Leaf (*Manihot esculenta*)	Alkaloids, Flavonoids, Tannins, Terpenoids, Phenols	*S. aureus*, *E. coli*	Ethanol extract showed moderate inhibition at eighty percent concentration.
S13	Widiastuti et al.	Arumanis Mango	Flavonoids, Tannins,	*S. aureus*	Largest inhibition zone recorded at twenty five

	(2023)	(*Mangifera indica*)	Saponins		percent concentration.
S14	Amirullah et al. (2022)	Mangrove (*Avicennia*)	Flavonoids, Alkaloids, Saponins, Tannins	*E. coli*	Extract at two hundred percent concentration produced seventeen millimeters inhibition.
S15	Kusuma et al. (2023)	Seagrass	Alkaloids, Flavonoids, Saponins, Terpenoids	*E. coli* (MDR)	*H. pinifolia* extract in n hexane produced inhibition of 6.13 millimeters.
S16	Nurjanah et al. (2023)	Snake Fruit Peel (*Salacca zalacca*)	Alkaloids, Flavonoids, Polyphenols, Tannins, Quinones	*S. aureus*	Ethanol extract at eighty percent produced inhibition of 9.83 millimeters.
S17	Rusli et al. (2024)	Matoa Leaf (*Pometia pinnata*)	Flavonoids, Alkaloids, Saponins, Tannins, Terpenoids	*S. aureus*, *E. coli*	Isolate BE 4 produced inhibition zones of 30.3 millimeters and 24.6 millimeters respectively.
S18	Aprilliana et al. (2018)	Jarak Pagar (*Jatropha curcas*)	Phenols, Terpenoids, Flavonoids, Saponins, Alkaloids	*S. aureus*, *E. coli*	Extract showed dose dependent inhibitory effects.
S19	Farhan et al. (2022)	Fig Leaf (*Ficus carica*)	Flavonoids, Tannins, Terpenoids	*S. aureus*, *E. coli*	Inhibition zone of 10.5 millimeters at twenty percent concentration.
S20	Retnaningsih (2016)	Petai Cina (*Leucaena leucocephala*)	Alkaloids, Flavonoids, Tannins	*S. aureus*, *E. coli*	Extract inhibited both bacteria with increasing inhibition at higher concentrations.

The systematic review demonstrates that twenty studies examined the antibacterial potential of tropical plant species from Lampung, representing taxa from Passifloraceae, Rhizophoraceae, Piperaceae, Zingiberaceae, Verbenaceae, Caricaceae, Myrtaceae, Euphorbiaceae, Annonaceae, Sapindaceae, and Arecaceae. The diversity of phytochemicals reported suggests a broad pharmacological capacity with relevance to natural antibacterial development.

Several species contained high concentrations of flavonoids, alkaloids, saponins, tannins, and essential oils. These constituents exert antibacterial effects through mechanisms that include disruption of cell wall integrity, inhibition of metabolic enzymes, and protein binding that interferes with microbial growth.

The analysis highlights several key patterns:

a) Extracts with the strongest inhibitory effects on E. coli were commonly obtained from species rich in flavonoids and tannins, including Manihot esculenta (S12), Mangifera indica (S13), and Cassia alata (S6). The inhibition zone of M. indica reached 12.3 millimeters at twenty five percent concentration.
b) Strong activity against S. aureus was observed in plants with notable levels of essential oils and phenolic compounds, such as Passiflora foetida (S1), Pometia pinnata (S17), and Hornstedtia alliacea (S4). The inhibition produced by P. pinnata reached 30.3 millimeters.
c) Several extracts were more potent against Gram positive bacteria. This aligns with established findings that Gram negative bacteria possess an outer lipopolysaccharide layer that restricts penetration of bioactive compounds.
d) Increased extract concentration frequently enhanced antibacterial activity, indicating a dose dependent pattern.
e) Overall, tropical plants from Lampung present a promising natural resource for antibacterial agents that may be used in complementary medicine or food preservation.

These findings reinforce the relevance of Lampung's phytochemical diversity as a potential source of safe, natural antibacterial compounds.

2. Discussion

The antibacterial activity observed across Lampung-derived tropical plants can be more robustly interpreted when situated within an integrated ethnopharmacological, ecological, and microbiological framework rather than viewed as isolated phytochemical effects. The recurrent identification of flavonoids, alkaloids, tannins, saponins, and terpenoids reflects not only common plant defense strategies but also the influence of Lampung's diverse terrestrial and coastal ecosystems on secondary metabolite production.

From an ethnopharmacological perspective, the widespread presence of flavonoids and tannins in plants traditionally used by local communities around Way Kambas and the Bukit Barisan region supports the hypothesis that empirical knowledge has historically guided the selection of bioactive species. These compounds, when examined through bacterial cell wall theory, exhibit mechanisms that preferentially affect Gram-positive bacteria such as Staphylococcus aureus, whose exposed peptidoglycan layers facilitate interaction with polyphenolic compounds. This theoretical framework is consistent with findings from *Sargassum* and *Spathodea* studies, where stronger inhibition was repeatedly observed against S. aureus compared to Escherichia coli (Duryat, Ghozali, Saragih, et al. 2025; Safitri et al. 2021; Sinaga and Helena 2022).

In contrast, the comparatively lower susceptibility of *E. coli* aligns with established microbiological theory regarding the protective role of the outer lipopolysaccharide membrane in Gram-negative bacteria. This structural barrier restricts the penetration of hydrophobic plant metabolites, thereby reducing antibacterial efficacy despite the presence of active compounds. Such differential susceptibility reinforces the relevance of bacterial cell envelope theory in interpreting variability across studies and underscores the need for standardized assays that account for these intrinsic biological differences.

Ecological chemistry theory further provides a contextual explanation for the diversity of antibacterial compounds identified in Lampung flora. Coastal environments, particularly those supporting brown algae such as Sargassum spp., are known to induce the biosynthesis of sulfated polysaccharides and terpenoids as adaptive responses to microbial pressure. These environmentally shaped metabolites, including fucoidan and meroterpenoids, have demonstrated consistent antibacterial activity, suggesting that Lampung's unique ecological conditions contribute to distinctive chemical profiles with pharmacological relevance.

Despite these promising patterns, methodological heterogeneity across studies particularly in extraction solvents, concentration ranges, and antibacterial assays limits direct comparison of potency and obscures dose–response relationships. From a pharmacological standpoint, the observed increase in antibacterial activity at higher extract concentrations aligns with classical dose–response theory; however, the absence of standardized MIC or MBC benchmarks reduces the translational value of many findings.

Within the broader context of antimicrobial resistance, the multi-target mechanisms exhibited by Lampung-derived phytochemicals such as membrane disruption, enzyme inhibition, and protein binding are particularly relevant. Unlike single-target antibiotics, these compounds may exert lower selective pressure for resistance development, supporting their potential role as complementary antibacterial agents. Consequently, systematic evaluation of Lampung's flora, as conducted in this review, offers a theoretically grounded and context-specific pathway for identifying plant-based antibacterial candidates with both local relevance and global significance.

Nevertheless, methodological and reporting limitations temper the generalizability of these findings. Many studies relied solely on disc diffusion assays and did not include in vivo testing or molecular level evaluations. Extract preparation methods varied widely, making direct comparisons difficult. In addition, potential reporting bias cannot be excluded, as studies with weak or negative antibacterial outcomes were less frequently documented, and incomplete reporting of concentration ranges, control antibiotics, and statistical parameters further constrained the robustness of cross-study synthesis. Future work should include standardized extraction protocols, wider concentration ranges, mechanistic studies, and validation using advanced analytical techniques.

E. Conclusion

This review synthesized evidence from twenty studies that examined tropical plant species from Lampung and their phytochemical constituents as antibacterial agents against Escherichia coli and Staphylococcus aureus, using a Systematic Literature Review approach guided by the PRISMA 2020 framework. The overall findings indicate several consistent patterns. First, most

extracts demonstrated stronger inhibitory activity against S. aureus than against E. coli. This trend aligns with the well-documented vulnerability of Gram-positive bacteria, whose cell walls permit more direct interaction between bioactive molecules and intracellular targets. Second, the major classes of phytochemicals that contributed to antibacterial action included flavonoids, alkaloids, tannins, saponins, terpenoids, and essential oils. These compounds are associated with mechanisms such as membrane disruption, interference with key metabolic enzymes, and the induction of oxidative stress. Third, several species showed particularly consistent antibacterial performance across studies, including Pometia pinnata (matoa leaves), Hornstedtia alliacea (golobe), Manihot esculenta (cassava leaves), Mangifera indica (Arumanis mango leaves), and Cassia alata (ketepeng cina). Finally, the practical implications of these findings extend to the development of phytopharmaceutical candidates, natural antibacterial formulations for health applications, and plant-based preservatives for food systems. Collectively, the evidence highlights the strategic potential of Lampung's biodiversity as a reservoir of promising antibacterial resources.

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