International Journal of Health Science (IJHS)

E-ISSN: 2827-9603
P-ISSN: 2827-9603

Research Article

Wound Healing Potential of *Spatholobus littoralis* Hassk.: A Literature Review of Its Antioxidant, Anti-Inflammatory, and Antibacterial Activities

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Abstract. Spatholobus littoralis Hassk (Bajakah) is a traditional medicinal plant widely used in Indonesia, particularly in Kalimantan, for various health conditions. Previous studies have reported its antioxidant, anti-inflammatory, and antibacterial properties, which are essential in the wound healing process. This study aims to evaluate the potential of Spatholobus littoralis as a natural therapeutic agent in wound healing based on available experimental and clinical evidence. This study was conducted using a literature review approach by analyzing published articles related to the biological activities of Spatholobus littoralis, including antioxidant, anti-inflammatory, antibacterial, and wound healing effects. Articles were obtained from PubMed, ScienceDirect, Google Scholar, and GARUDA databases using predefined keywords. After the screening and selection process based on inclusion and exclusion criteria, a total of 28 articles were included in this review. The findings indicate that Spatholobus littoralis contains bioactive compounds, including flavonoids, phenolic compounds, tannins, and saponins, which contribute to wound healing through antioxidant, anti-inflammatory, and antibacterial activities. These mechanisms regulate oxidative stress, modulate inflammatory responses, and inhibit wound-associated pathogens. The included studies consistently suggest that these biological activities support the potential of Spatholobus littoralis as a natural wound-healing agent. However, variations in extraction methods, formulations, and concentrations were observed across the included studies. Spatholobus littoralis demonstrates significant antioxidant, anti-inflammatory, and antibacterial activities that support its potential as a natural wound-healing agent. However, further studies are needed to standardize extraction methods, determine the optimal dosage form and therapeutic dose, and evaluate its long-term safety and clinical effectiveness.

Keywords: Antibacterial; Anti-inflammatory; Antioxidant; Medicinal Plant; Wound Healing.

Received: February 15, 2026
Revised: April 20, 2026
Accepted: June 28, 2026
Published: July 30, 2026
Curr. Ver.: July 30, 2026

1. Introduction

Normal wound healing is a complex series of dynamic interactive processes that begin at the moment of wounding and involves soluble mediators, many cell types, and extracellular matrices. The process follows a specific time sequence and includes coagulation, inflammation, deposition and differentiation of extracellular matrix, fibroplasia, epithelialization, contraction, and remodeling with the end result formation of a healed wound, by scar (Chung, 2019). Wounds are classified into two categories. Acute wounds are traumatic injuries that usually receive prompt treatment and generally heal well in the absence of complications. Examples include incised wounds, burn injuries, puncture wounds, crush injuries, and surgical wounds. Chronic wounds are wounds that persist for a prolonged period or recur frequently, in which the normal wound-healing process is impaired. In chronic wounds, healing fails to occur within the expected timeframe. Examples include pressure ulcers (decubitus ulcers), venous ulcers, burn wounds, and other related conditions (Perdanakusuma, 2022). Nonhealing wounds represent a serious health problem caused by an uncontrolled chronic inflammatory response. The complexity of the

wound healing process, which is often not fully understood, contributes to the failure of monotherapy in accelerating healing. In chronic wounds, the wound healing phase including inflammation, proliferation, and remodeling are prolonged rather than gradually resolving, thereby delaying healing. This condition persists until the underlying causative factors are adequately addressed. Generally, the transition from an acute to a chronic wound occurs within 4 to 6 weeks. It is during this time that if an acute wound has not healed spontaneously, then it is likely to become chronic (Visha & Karunagaran, 2019). Successful wound healing depends not only on the sequential progression of hemostasis, inflammation, proliferation, and remodeling but also on the coordinated regulation of several biological mechanisms throughout these phases. During the inflammatory phase, antibacterial activity is essential for eliminating invading microorganisms and preventing wound infection. Simultaneously, reactive oxygen species (ROS) generated by neutrophils and macrophages contribute to antimicrobial defense and cellular signaling. However, excessive ROS production results in oxidative stress, which prolongs inflammation and impairs tissue repair. Therefore, antioxidant mechanisms are required to maintain redox homeostasis, while anti-inflammatory responses promote the resolution of inflammation and facilitate the transition to the proliferative phase. Dysregulation of these biological processes contributes to delayed wound healing and the development of chronic wounds (Ukaegbu et al., 2025).

Indonesia has a rich heritage in the use of medicinal plants as an important part of health care. because it has the second-largest tropical rainforest in the world. People in Indonesia commonly use traditional medicine as an alternative approach for treating various diseases. One of the plants that has recently gained attention is Spatholobus littoralis Hassk., locally known as bajakah, a medicinal plant traditionally used in Kalimantan. For generations, this plant has been utilized by local communities for various medicinal purposes. (Nastiti & Nugraha, 2022). especially in remote areas of Indonesia such as Kalimantan, where Bajakah plants have been used as traditional medicine. Phytochemical analysis conducted at the Indonesian Research Institute for Spices and Medicinal Plants (Balai Penelitian Tanaman Rempah dan Obat/Balitro) demonstrated that extracts from the roots and leaves of Spatholobus littoralis Hassk. Previous researchers studying Bajakah found that the plant contains several antioxidant compounds such as flavonoids, tannins, saponins, and alkaloids, and it exhibits strong antioxidant activity with an IC_{50} value of 8.25 µg/mL (Ariesanti et al., 2023; Iskandar et al., 2022; Rizqiana & Sudarmin, 2023). Flavonoid is one of the active compounds that is important as an antioxidant agent that can bind the free radicals in the body (Singh et al., 2022). Besides, Bajakah has been reported to possess antibacterial activity against Staphylococcus aureus, with ethanol extract showing inhibitory effects at various concentrations. In addition, previous experimental studies demonstrated that Bajakah extract exhibits anti-inflammatory activity by significantly reducing carrageenan-induced edema in animal models (Nastiti & Nugraha, 2022; Suleman & Latu, 2023). Flavonoids, tannins, and saponins exhibit antibacterial activity through complementary mechanisms, including disruption of bacterial cell walls and membranes, inhibition of enzyme activity and protein synthesis, and increased membrane permeability, ultimately leading to bacterial cell death. Several studies have demonstrated the wound-healing potential of Bajakah (Spatholobus littoralis) through various intervention modalities. One study reported that the use of a spray gel containing Spatholobus littoralis stem extract in postpartum women with perineal wounds resulted in improved healing outcomes. Based on the final observation using the REEDA score, more participants in the intervention group achieved a score of 0, indicating complete wound healing, compared to the control group. In addition, another study conducted on rats with incision wounds showed that Spatholobus littoralis extract accelerated wound closure compared to the control group. These findings suggest that Bajakah has potential as a natural wound-healing agent (Iswara et al., 2024; Sindi et al., 2024). Although several studies have reported the antioxidant, anti-inflammatory, and antibacterial properties of Bajakah (Spatholobus littoralis Hassk.), evidence regarding its effectiveness in accelerating wound healing based on standardized experimental wound models and quantitative wound assessment parameters remains limited. Moreover, comparative data evaluating the efficacy of Bajakah extract against conventional wound treatments are still scarce.

2. Materials and Method

This study was conducted as a literature review to explore the role of bajakah (Spatholobus littoralis Hassk.) in wound healing, with a particular focus on bioactive compounds derived from its roots. This review was conducted and reported in accordance with the PRISMA guidelines. The research question was formulated using the PICOS framework, with the population comprising preclinical wound models, including in vitro and in vivo studies. The intervention was bajakah (Spatholobus littoralis Hassk.) and its plant-derived bioactive compounds, with no explicitly defined comparator. The primary outcome was wound healing, and the included study designs were experimental and observational studies. A comprehensive literature search was performed in PubMed, ScienceDirect, Google Scholar, and GARUDA (Garba Rujukan Digital) databases. The search strategy employed combinations of keywords constructed using Boolean operators (AND, OR), and the search was conducted on January 23, 2026. The primary keywords "bajakah OR Spatholobus littoralis Hassk." were combined with AND "wound healing" and AND "bioactive compounds". In PubMed and ScienceDirect, the initial search using "bajakah OR Spatholobus littoralis Hassk." identified four articles in PubMed (n = 4) and twelve articles in ScienceDirect (n = 12). After adding AND "wound healing", the results were reduced to three articles in PubMed (n = 3) and nine articles in ScienceDirect (n = 9). Further refinement with AND "bioactive compounds" yielded three articles in PubMed (n = 3) and eight articles in ScienceDirect (n = 8). After limiting the publication years to 2015–2025, three articles remained in PubMed and seven articles remained in ScienceDirect. Subsequent manual screening showed that all remaining PubMed articles were review articles, while the remaining ScienceDirect articles were excluded due to unavailable full texts or irrelevance based on titles and abstracts. Consequently, no articles from PubMed or ScienceDirect met the inclusion criteria. In Google Scholar and GARUDA, the literature search was conducted using the same initial keywords. The initial search yielded 1,010 articles in Google Scholar and 11 articles in GARUDA. These keywords were then combined with AND "wound healing", resulting in 303 articles in Google Scholar and three articles in GARUDA. In GARUDA, the term "wound healing" was adapted into Indonesian to accommodate articles not published in English. The addition of AND "bioactive compounds" yielded 151 articles in Google Scholar; however, this keyword was not applied in GARUDA because it did not produce any relevant articles. After applying the publication year filter (2015–2025), 134 articles remained in Google Scholar and three articles remained in GARUDA. Because Google Scholar and GARUDA do not provide direct filters to exclude review articles, manual screening was conducted. After removing review articles, 119 articles from Google Scholar and three articles from GARUDA were retained. Subsequently, duplicate identification was performed in accordance with the PRISMA process, and one duplicate record from Google Scholar and one duplicate record from GARUDA were identified and removed. Titles and abstracts were then screened based on the predefined inclusion and exclusion criteria.

The inclusion criteria were:

a. studies discussing bajakah plants (Spatholobus littoralis Hassk.) as agents for wound healing;
b. studies analyzing bioactive compounds derived from the roots of bajakah and their role in wound healing;
c. availability of full-text articles;
d. publication between 2015 and 2025; and
e. experimental or observational research studies relevant to the topic.

The exclusion criteria were:

a. studies that did not investigate bajakah plants (Spatholobus littoralis Hassk.) in relation to wound healing;
b. studies that did not analyze bioactive compounds derived from bajakah roots;
c. articles that were review articles, editorials, commentaries, letters, or opinion papers;
d. articles with unavailable full texts;
e. articles published outside the 2015–2025 period; and
f. articles with titles or abstracts not relevant to the research objectives.

After applying all predefined inclusion and exclusion criteria, 28 articles from Google Scholar and GARUDA met the eligibility criteria and were included in the final qualitative synthesis. In total, 28 studies were included in the analysis. The article selection process is illustrated in the PRISMA 2020 flow diagram (Figure 1). The findings of the included

studies were synthesized narratively by integrating and comparing reported outcomes related to wound healing and bioactive compounds. Due to heterogeneity in study designs and outcome measures, no statistical or meta-analytical methods were applied.

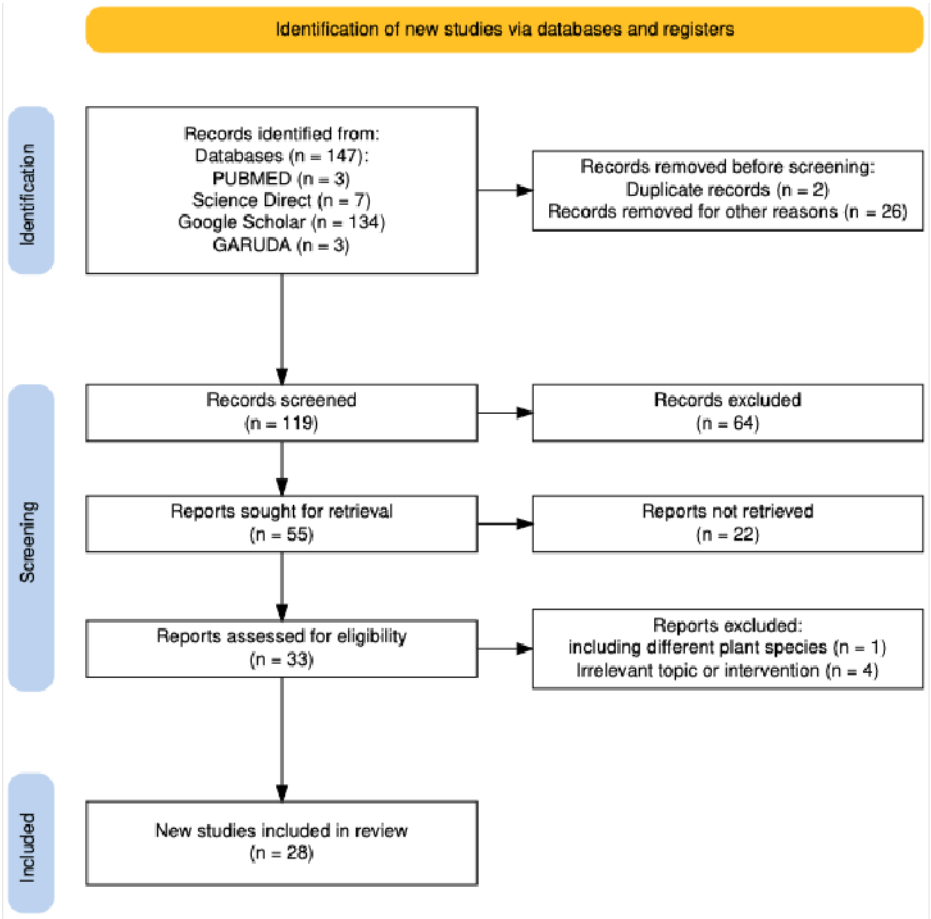

Figure 1. The process of screening and selecting articles to be reviewed.

3. Results and Discussion

The literature search using the keywords "bajakah OR Spatholobus littoralis Hassk.," "wound healing," and "bioactive compounds" identified a total of 1,037 records at the initial stage. After applying keyword refinement and publication year limitations (2015–2025), 147 records remained. A total of 119 records were then screened based on titles and abstracts. Subsequently, 64 records were excluded due to irrelevance to the research objectives. A total of 55 full-text articles were sought for retrieval. Of these, 22 articles were not retrieved due to unavailable full texts, leaving 33 articles assessed for eligibility. Subsequently, 5 articles were excluded due to reasons such as different plant species, inappropriate study focus, or mixed herbal formulations. After the selection process, 28 studies met the inclusion criteria and were included in the final qualitative synthesis. Despite a comprehensive search across multiple databases, only a limited number of studies met the eligibility criteria. This reflects the current scarcity of published research specifically investigating the wound healing properties of Spatholobus littorlalis Hassk. The study selection process is presented in the PRISMA 2020 flow diagram (Figure 1). Of the 28 included studies, the majority were experimental studies evaluating the biological activities of Spatholobus littoralis Hassk. in relation to wound healing. Most studies utilized in vivo wound models, while others employed in vitro assays and phytochemical analyses. Several studies also analyzed bioactive compounds derived from bajakah roots, including flavonoids, phenolic compounds, tannins, and saponins. The main findings of the included studies include are as follows. Bajakah extracts demonstrated antioxidant activity through DPPH assays and other methods, with IC_{50} values varying depending on extraction methods and plant parts. Anti-inflammatory activity was demonstrated through inhibition of protein denaturation, enzyme activity, and reduction of edema in in vivo models. Antibacterial activity was observed against both Gram-positive and Gram-negative bacteria,

including Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa, as well as activity against MRSA. Antifungal and antibiofilm activities against Candida albicans were also reported in several studies.

Bajakah plant is a traditional medicinal plant native to Kalimantan, scientifically known as Spatholobus littoralis Hassk., belonging to the genus Spatholobus and the Phaseoleae family. This plant was first described in 1842 by the German botanist Justus Karl Hasskarl (Ninkaew & Chantaranothai, 2014). Bajakah has long been utilized in traditional medicine and is known to contain various secondary metabolites that support its use as a natural therapeutic agent. Several studies have reported that Spatholobus littoralis Hassk. is rich in bioactive compounds, particularly phenols, flavonoids, saponins, and tannins, which contribute to its high antioxidant activity (Iskandar, 2020). Quantitatively, the ethanol extract of bajakah root from West Kalimantan exhibited very strong antioxidant activity, with an IC_{50} value of 22.31 ppm. These findings are further supported by studies using Spatholobus littoralis Hassk. samples from Muara Teweh, Central Kalimantan, which demonstrated significant antioxidant activity in root, stem, and leaf extracts at various concentrations, with the highest antioxidant activity observed in the stem extract, showing an IC_{50} value of 9.46 ppm at a concentration of 2500 ppm. This antioxidant activity plays a crucial role in regulating reactive oxygen species (ROS), which are key factors in the wound healing process (Ariesanti et al., 2021).

Spatholobus littoralis Hassk contains various bioactive compounds, including flavonoids, tannins, saponins and phenolic compounds, which exhibit antioxidant, anti-inflammatory, and antimicrobial properties that are beneficial in the wound healing process.

In addition, phytochemical investigations of Spatholobus littoralis have reported the presence of secondary metabolites that function as bioactive compounds. phytochemical analysis identified several compounds in Bajakah extracts, including phenolic compounds and flavonoids, which are known to possess biological activities. These compounds are considered important because they contribute to the pharmacological properties of the plant. (Arsul et al., 2022). Further experimental studies have analyzed the phenolic content and antioxidant activity of Bajakah extracts. In (Agustin et al., 2025), ethanol extracts of Bajakah root obtained using different extraction methods showed variations in phenolic content and antioxidant capacity. The reflux extraction method produced the highest total phenolic content (17.6 $\pm$ 0.1 mg GAE/g extract) and demonstrated the strongest antioxidant activity with an IC_{50} value of 26 $\pm$ 1 μg/mL, followed by Soxhlet extraction and maceration. These findings indicate that the extraction method significantly influences the concentration of phenolic compounds and their antioxidant activity. Similarly, (Wulan et al., 2022) also reported that Bajakah stem extract contains phenolic compounds that contribute to antioxidant activity. The study reported that the total phenolic content of the ethanol extract was 21.535 mg GAE/g extract, and the antioxidant activity showed an IC_{50} value of 281.717 μg/mL, indicating weak antioxidant activity. The study also suggested that the antioxidant capacity of Bajakah extract is influenced by the concentration of phenolic compounds present in the extract.

Several studies have demonstrated that Spatholobus littoralis (Bajakah) exhibits antioxidant activity that is closely associated with its secondary metabolite content. Phytochemical screening across various studies has revealed the presence of phenolic compounds and flavonoids, which act as free radical scavengers. Phytochemical analyses also identified flavonoids, tannins, and saponins, which contribute to antioxidant activity through electron donation mechanisms that neutralize free radicals (Iskandar et al., 2022; Rizqiana & Sudarmin, 2023). These findings are supported by several in vitro studies evaluating antioxidant activity using the DPPH radical scavenging assay. In Ariesanti et al., (2023) ethanol extract of Spatholobus littoralis demonstrated antioxidant activity with an IC_{50} value of 54.19 $\pm$ 8.15 μg/mL and contained total phenolic and flavonoid compounds that contribute to its free radical scavenging capacity. This result is consistent with (Rizqiana & Sudarmin, 2023), which reported stronger antioxidant activity with an IC_{50} value of 12.86 $\pm$ 0.59 μg/mL, indicating that secondary metabolites in Bajakah significantly contribute to its antioxidant effects.In addition, extraction methods and solvent types influence antioxidant activity. In Iskandar et al., (2022) the ethyl acetate fraction exhibited the strongest antioxidant activity compared to other fractions, suggesting that the distribution of bioactive compounds is affected by solvent polarity. The study also reported the presence of various secondary metabolites, including phytosterols, saponins, phenolic compounds, and triterpenoids, which contribute to the plant's biological activity. Other

studies, such as (Mahfudh et al., 2024; Noor et al., 2025), further support that Bajakah extracts possess free radical inhibitory activity based on in vitro assays. In contrast to in vitro approaches, (Novanty et al., 2021) utilized an in vivo experimental model and demonstrated that administration of Bajakah extract increased endogenous antioxidant enzyme activity, such as superoxide dismutase (SOD), and reduced oxidative stress levels in tissues. These findings indicate that the antioxidant activity of Bajakah is not only chemical but also biologically relevant in enhancing the body's antioxidant defense system. These variations in antioxidant activity across studies may be attributed to differences in extraction methods, solvent polarity, extract concentration, and the analytical assays used. Overall, the available evidence shows a consistent pattern that Spatholobus littoralis contains secondary metabolites functioning as bioactive compounds with significant antioxidant activity, particularly phenolic compounds and flavonoids. These compounds play a role in scavenging free radicals and reducing oxidative stress in tissues.

In addition to its antioxidant properties, Spatholobus littoralis has also been reported to exhibit anti-inflammatory activity, which is closely related to its role in wound healing. This is particularly important, as oxidative stress and inflammation are interconnected processes that influence tissue damage and repair. Several studies have demonstrated that Bajakah possesses anti-inflammatory potential that may support the wound healing process, as evaluated through both in vitro and in vivo experimental approaches.

Rousdy & Wardoyo, (2023) Reported an in vitro experimental study evaluated the anti-inflammatory activity of ethanol extract of Bajakah stem through several mechanisms involved in inflammation, including protein denaturation inhibition, protease enzyme inhibition, lipoxygenase inhibition, and erythrocyte membrane stabilization. The results showed that Bajakah extract was capable of inhibiting inflammatory processes through these mechanisms. The highest activity was observed at a concentration of 1.6 mg/mL, with protein denaturation inhibition of 75.9%, protease inhibition of 26.1%, and erythrocyte membrane stabilization of 93.7%, indicating a strong anti-inflammatory potential. Another study also evaluated anti-inflammatory activity using an in vitro protein denaturation inhibition assay. Phytochemical screening in this study revealed the presence of several secondary metabolites functioning as bioactive compounds, including flavonoids, phenolic compounds, tannins, terpenoids, and saponins in the ethanol extract of Bajakah root. The extract demonstrated inhibition percentages ranging from 31.27% to 43.28% at concentrations of 10–50 ppm, with an IC_{50} value of 77.92 μg/mL, indicating its ability to inhibit protein denaturation as one of the key inflammatory mechanisms (Maskur et al., 2025). Beyond in vitro evidence, the anti-inflammatory activity of Spatholobus littoralis has also been validated in in vivo experimental models, providing more physiologically relevant insights. (Nastiti & Nugraha, 2022) reported a carrageenan-induced paw edema model in rats was used to assess the anti-inflammatory effect of ethanol extract of Bajakah wood. The results showed that Bajakah extract significantly reduced edema volume, with the highest anti-inflammatory effect observed at a dose of 400 mg/kgBW, resulting in 87.65% inhibition of edema at 240 minutes after carrageenan induction.

The antibacterial activity of Spatholobus littoralis has been consistently reported across multiple studies, highlighting its potential as a natural antimicrobial agent. Early evidence by Saputera et al., (2019) Saputera et al. (2019) demonstrated that Bajakah extract exhibits inhibitory activity against Escherichia coli, indicating its effectiveness against Gram-negative bacteria. An experimental study demonstrated that the ethanol extract of Bajakah wood exhibited inhibitory effects against Staphylococcus aureus, as indicated by the formation of inhibition zones even at low concentrations (Banjarnahor, 2024). This finding is supported by (Setyowati et al., 2024), which showed strong antibacterial activity using a microdilution method, with inhibition rates reaching 88.33% against S. aureus and 84.83% against Escherichia coli at a concentration of 1% w/v. Rahmasari et al., (2025) further reported that higher flavonoid content in Bajakah extract was associated with stronger antibacterial activity, with inhibition zones reaching 19.3 mm against S. aureus, suggesting a concentration-dependent relationship between bioactive compound content and antibacterial efficacy. Another study Suleman & Latu, (2023) also demonstrated antibacterial activity against S. aureus at lower concentrations (10–30%), although the resulting inhibition zones were relatively smaller (7.63–8.83 mm), indicating moderate activity. The antibacterial spectrum of Bajakah also extends to Gram-negative bacteria. (Stephan et al., 2022) demonstrated that Bajakah extract was effective against Pseudomonas aeruginosa, with increasing inhibition zone diameters corresponding to higher concentrations, reaching 22.4

mm at 100% concentration, indicating strong antibacterial activity. These findings suggest that Bajakah has potential as a broad-spectrum antibacterial agent. Additional evidence from (Yeni & Chaerani, 2024) showed that Bajakah extract also exhibited activity against methicillin-resistant Staphylococcus aureus (MRSA), indicating its potential role in addressing antibiotic resistance. As an additional finding, demonstrated that Spatholobus littoralis extract not only exhibits antibacterial activity but also antifungal activity against Candida albicans. In Setyowati et al., (2024), the ethanol extract showed high inhibition against C. albicans (±82%) as well as antibiofilm activity (±77%), indicating its ability to inhibit fungal growth and biofilm formation. These findings are supported by Hamzah et al. (2025) which demonstrated effectiveness in polymicrobial models involving C. albicans alongside other bacteria. This suggests that Bajakah has potential as a broad-spectrum antimicrobial agent, particularly in complex infections involving both bacterial and fungal pathogens.

Several studies have reported that Spatholobus littoralis has potential in promoting wound healing. An in vitro study Ariesanti et al., (2021) showed that the stem extract significantly enhanced fibroblast migration and wound closure, with optimal concentrations achieving complete closure within 22 hours .These findings are supported by in vivo studies. Nuroini et al., (2024) reported that Bajakah ethanol extract reduced wound length in incision models induced by Pseudomonas aeruginosa, with faster wound closure observed at higher doses, particularly on day 10 compared to control groups. Iswara et al., (2024) demonstrated that wound closure occurred earlier in treatment groups compared to controls, particularly at higher extract concentrations. Furthermore, (Komalig, 2024) demonstrated that topical application of Bajakah ethanol extract in ointment form significantly accelerated wound healing time in incision wound models, with the 10% concentration showing better effectiveness compared to other concentrations and control treatments. This finding is supported by another study by which showed that ethanol extract ointment of Spatholobus littoralis significantly accelerated incision wound healing in rat models, with the 10% concentration showing the most optimal effect and comparable outcomes to povidone iodine. In contrast, clinical evidence from a quasi-experimental study showed that the use of Bajakah extract in spray gel form significantly reduced REEDA scores in postpartum perineal wounds compared to control, indicating improved wound healing outcomes (Sindi et al., 2024). Overall, these findings indicate that Spatholobus littoralis contributes to wound healing across in vitro, preclinical, and clinical models. However, variations in formulation, concentration, and study design may influence the observed outcome. further safety evaluation is required. (Firman et al., 2023) reported that Spatholobus littoralis extract exhibited acute toxicity at certain doses, highlighting the importance of determining its safe and optimal therapeutic range.

4. Conclusion

Spatholobus littoralis Hassk demonstrates significant antioxidant, anti-inflammatory, and antibacterial activities that contribute to its potential in promoting wound healing. Evidence from in vitro, in vivo, and limited clinical studies indicates that Bajakah extract improves wound healing outcomes. However, its effectiveness is influenced by extraction methods, formulations, and concentrations. In addition, toxicity findings highlight the importance of determining safe and optimal therapeutic doses. Therefore, further well-designed studies are needed to standardize extraction methods, determine the optimal dosage form and therapeutic dose, and evaluate long-term safety and clinical effectiveness. Overall, Spatholobus littoralis holds promise as a potential natural therapeutic agent for wound management.

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