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# A COMPREHENSIVE REVIEW ON THE ANTIOXIDANT, ANTI-INFLAMMATORY AND ANTIMICROBIAL ACTIVITIES OF *BACCAUREA RAMIFLORA* LEAVES

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**ABSTRACT**

*Baccaurea ramiflora* (commonly known as Latkan or Burmese grape) is a tropical species which is found extensively throughout Southeast Asia and valued for its nutritional and medicinal property. Traditional knowledge highlights the therapeutic importance of its leaves, which are utilized to mitigate inflammation, pain, wounds, fever, and skin infections. Recent scientific research conducted between 2015 and 2025 has authenticated those ethnomedicinal uses and identify a diverse phytochemical composition in *B. ramiflora* leaves, which includes flavonoids, phenolics, tannins, glycosides, terpenoids, rosmarinic acid, and β-sitosterol. These compounds are contributed to significant antioxidant, anti-inflammatory, antimicrobial, analgesic, and wound-repairing effects. Studies on antioxidant properties indicate productive scavenging of free radicals which is determined by DPPH, ABTS, and FRAP assays, whereas anti-inflammatory inspection reveal marked decline in paw swelling and decreased levels of inflammatory cytokines. Antimicrobial tests show that the plant displays inhibitory effects against various bacterial and fungal pathogens. Toxicity tests indicate a broad safety margin, with acute $LD_{50}$ values exceeding 5000 mg/kg and no remarkable adverse effects monitored in sub-acute and sub-chronic studies. The therapeutic capabilities of *B. ramiflora* leaves approves their use in current herbal formulations, particularly within hydrogel-based wound-care systems that integrate silver nanoparticles. Future directions include clinical trials, studies focusing on underlying mechanisms, standardization of extraction processes, and exploration within pharmaceutical, cosmetic, and biomedical applications. In summary, *B. ramiflora* leaves arise as a promising natural resource for the innovation of safe and effective plant-derived therapeutic products.

**KEYWORDS:** Silver Nanoparticles, Anti-inflammatory, Anti-oxidant, Anti-microbial, Free radical scavenging, Biomedical applications.

## INTRODUCTION

*Baccaurea ramiflora* is also known as Latkan or Burmese grape, is a tropical fruit tree which is commonly found in India, Bangladesh, Myanmar, Thailand, and other Southeast Asian countries. Traditionally grown in rural areas, this plant has recently gained scientific importance because of its nutritional value and medicinal benefits.[1] For many years, local inhabitants have used the leaves of *Baccaurea ramiflora* to treat health related problems such as inflammation, pain, rheumatism, wounds, fever, and skin infections. These traditional uses inspired researchers to study the plant more profoundly.[2] Scientific studies have shown that *Baccaurea ramiflora* contains many advantageous natural compounds, including vitamin C, flavonoids, phenolics, sterols, and triterpenoids. These compounds helps the plant to strong antioxidant, anti-inflammatory, pain-relieving, and antimicrobial effects. Because antioxidants guard the body from harmful free radicals, the plant helps to prevent diseases initiated by oxidative stress. *Baccaurea ramiflora* is identified not just as a fruit tree but as a valuable medicinal benefits. Its leaves are considered a powerful source of natural healing compounds,helps in developing herbal formulations and plant-based therapeutic products.[3]

**Classification:**[4]

| **Kingdom** | **Plantae** |
|---|---|
| Sub-kingdom | Viridiplantae (Green plants) |
| Super-division | Embryophyta (Land plants) |
| Division | Tracheophyta (Vascular plants)` |
| Class | Magnoliopsida (Dicotyledons) |
| Sub-class | Rosidae |
| Order | Malpighiales |
| Family | Phyllanthaceae |
| Genus | Baccaurea |
| Species | *Baccaurea ramiflora* |


**Fig: Baccaurea ramiflora leaves.**

**Other species:**[5]

| **Species** | **Distribution** |
|---|---|
| *Baccaurea motleyana* | Malaysia, Indonesia, Thailand |
| *Baccaurea angulata* | Borneo, Malaysia |
| *Baccaurea macrocarpa* | Malaysia, Indonesia |
| *Baccaurea courtallensis* | India (Western Ghats) |

| | |
|---|---|
| *Baccaurea lanceolata* | Southeast Asia |
| *Baccaurea polyneura* | Southeast Asia |
| *Baccaurea racemosa* | Malaysia, Indonesia |
| *Baccaurea sapida* | India, Myanmar |
| *Baccaurea siamensis* | Thailand, Laos |

**Phytochemical present in whole plant**[6,30]

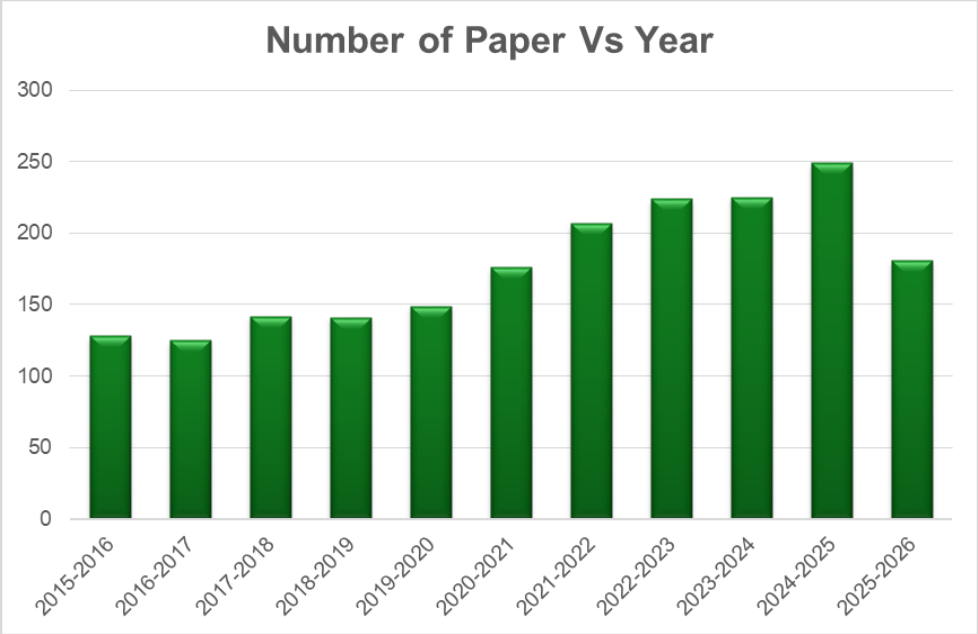
| Parts | Phytochemical name |
|---|---|
| Leaves | Rosmarinic acid, 6′-O-vanilloylisotachioside, 6′-O-vanilloyltachioside, Epicatechin, Icariside B5, β-Sitosterol. |
| Bark | Friedelin, Epifriedelanol, Beta-sitosterol, Methyl betulinate. |
| Fruit | Glycerol, Inositol, Mannitol, D-Glucose, D-Fructose. |
| Seed | Sapidolide A |

**Therapeutic effect in whole plant**[7]

| Parts | Therapeutic use |
|---|---|
| Leaves | Anti-inflammatory, antioxidant, Antimicrobial Activity |
| Bark | Constipation, Diuretics |
| Fruit | Antiviral agents |
| Whole plant | Central nervous system disease, Diuretics |
| Whole Plant excluding root | Cardiovascular system |

**Graphical representation of the paper from 2015 to 2026**

| Years | Number of Papers |
|---|---|
| 2015-2016 | 128 |
| 2016-2017 | 125 |
| 2017-2018 | 142 |
| 2018-2019 | 141 |
| 2019-2020 | 149 |
| 2020-2021 | 176 |
| 2021-2022 | 207 |
| 2022-2023 | 224 |
| 2023-2024 | 225 |
| 2024-2025 | 249 |
| 2025-2026 | 181 |



**Medical uses**

*Baccaurea ramiflora* is an appealing tropical plant acknowledged not only for its visual entreaty but also for its various medicinal properties. It has been traditionally characterized as bitter, pungent, astringent, cephalic, antiseptic, alterant, thermogenic, and invigorating. Different parts of the plant provide uniquely to its medicinal applications.[8] The roots illustrate anti-inflammatory, antioxidant, analgesic, antipyretic, antispasmodic, and antimicrobial effects, which provide a solid foundation for its ancient use in tackling infections and pain-related issues.[9] The flowers, which exhibit a purple hue and have a natural cooling effect, showcase febrifuge, vermifuge, astringent, hepatoprotective, and digestive attributes, which is beneficial in the treatment of heart conditions.Out of all the plant components, the leaves are particularly remarkable for their pharmacological significance.[10] They retain strong anti-inflammatory properties, relaxation of bronchial smooth muscles, anti-arthritic effects, anthelmintic characteristics, and a pleasant fragrance. These property make the leaves appropriate for managing inflammation, infections, and oxidative stress. Additionally, the entire plant shows a wide range of effects, including anti-convulsant, anti-gonorrhoea, anti-rheumatic, CNS depressant, diuretic, and expectorant actions, highlighting its comprehensive role in traditional medicine.[11]

**Antioxidant**

The recent research features that leaves of *Baccaurea ramiflora* due to rich of bioactive compounds including phenolics, flavonoids, tannins, proanthocyanidins, and glycosides. These compounds function as natural antioxidants, capable of counteracting destructive free radicals in the body, thereby sheltering cells from oxidative stress.[12]

Oxidative stress is affiliated with aging, inflammation, chronic diseases, and tissue damage, making natural antioxidants crucial for health. Research papers covering from 2015 to 2025 has indicated that methanolic and hydroalcoholic extracts of *B. ramiflora* leaves can efficiently scavenge free radicals.[13] Standard laboratory analysis, such as DPPH, ABTS, ferric-reducing antioxidant power (FRAP), and hydrogen peroxide scavenging assays, were engaged to analyze this activity.[14] The total phenolic content of leaf extracts calculate approximately 79 mg GAE/g, with flavonoid levels around 28 mg QE/g, both of which were linked very strongly to antioxidant activity. These discovering indicates that the leaves may be a feasible natural source of antioxidants.[15] The antioxidant properties of *B. ramiflora* leaves not be prominent out independently but also tender to practical uses. For example, in recent formulations such as hydrogels incorporating silver nanoparticles, the leaf extracts can execute several roles. They can assist as both reducing and stabilizing agents during the synthesis of nanoparticles, while also providing antioxidant protection that may aid in wound healing and minimize inflammation. Although many reseachers have performed in vitro (in laboratory settings), these findings underlining the therapeutic promise of leaf extracts. The leaves of *B. ramiflora* offers a promising natural source of antioxidants that could be employed in pharmaceutical, cosmetic, and therapeutic sectors.[16]

**Anti-inflammatory Activity**

Several recent inspections provides clear evidence data that the leaf extracts of *B. ramiflora* exhibit anti-inflammatory properties in vivo. For example, the methanolic extract of *B. ramiflora* leaves (BME), which includes substantial levels of polyphenols (79.06 ± 0.03 mg GAE/g), flavonoids (28.80 ± 0.01 mg QE/g), proanthocyanidins (29.42 ± 0.01 µg catechin equivalent/g), and the polyphenol Rosmarinic acid, decreases edema by over 63% at a dosage of 200 mg/kg in a rat model of carrageenan-induced paw edema, in a dose-dependent manner.[5] In vitro, the same extract illustrate free radical scavenging (DPPH) and nitric oxide scavenging activities, indicating that a combination of antioxidant and anti-

inflammatory mechanisms may assist to the observed effects.[18] More recently, an aqueous leaf extracts of *B. ramiflora* was assessed in a chronic inflammation model (induced by complete Freund's adjuvant) in rats: treatment at doses of 300–1000 mg/kg for 28 days between day 7 and 35 days significantly decreased paw edema, improved hematological and biochemical indicators (including ALT, AST, CRP), and suppressed the mRNA expression of critical pro-inflammatory mediators such as TNF-α, IL-1β, NF-κB, COX-2, prostaglandin synthase genes, and MMP1. These findings provide molecular-level evidence (gene expression) that *B. ramiflora* leaves consists of anti-inflammatory effects, likely through the modulation of cytokine and prostaglandin pathways. Overall, these studies suggest that both methanolic and aqueous extracts of *B. ramiflora* leaves exhibit strong anti-inflammatory potential, driven by phytochemicals particularly polyphenols like rosmarinic acid, which suppress inflammatory mediators and oxidative stress.[19]

**Antimicrobial Activity:** Research indicates that leaf extracts of *B. ramiflora* consist of antimicrobial properties. In a study conducted in 2024, the ethanolic extract of the leaves was analyzed against bacterial and fungal pathogens through agar well diffusion, yielding substantial inhibition zones for instance, it resulted in a 29 mm zone against Salmonella typhi at a concentration of 200 mg/ml and a 25 mm zone against Aspergillus fumigatus at the same dosage.[20] The phytochemical analysis of this extract determined the presence of alkaloids, glycosides, tannins, saponins, proteins, and flavonoids many of which are acknowledged for their antimicrobial effects. Furthermore, bioactivity tests on other plant parts (such as the stem bark) have exhibit antimicrobial activity, although data specific to the leaves is more relevant to research focus. Consequently, the leaves of *B. ramiflora* seems to be competent of inhibiting the growth of both bacterial and fungal pathogens in vitro thus confirming traditional applications for the treatment of infections, wounds, or skin ailments.[21]

**Traditional and Ethnobotanical Uses**

Ethnobotanical studies show that the leaves of *Baccaurea ramiflora* are commonly used for both food and medicinal benefits. In various inhabitants, young leaves are eaten as a vegetable in curries or applied as a seasoning, highlighting their cultural importance and safety as a food sources.[22] Medicinally, the leaves have been traditionally employed to mitigate inflammation, pain, wounds, skin ailments, and rheumatic issues, showcasing their role as effective anti-inflammatory and analgesic agents in traditional healthcare practices. Scientific exploration validate these traditional uses, illuminating that leaf extracts demonstrate potent antioxidant, anti-inflammatory, analgesic, and antimicrobial properties, which supports their dedication in treating wounds, infections, and inflammatory conditions.[23]

Phytochemical analysis identifies the presence of polyphenols, flavonoids, and other bioactive substances that assist to these health benefits, providing a scientific basis for ethnomedicinal declaration. Traditionally, fresh leaves are applied externally to improve wound healing and treating cuts, burns, ulcers, and trauma by facilitating tissue repair. They are also harnessed to manage skin infections like boils, abscesses, rashes, and fungal or bacterial issues due to their antimicrobial attributes. Additionally, leaf preparations are employed to reduce swelling and mitigate joint and muscle pain linked to rheumatism and arthritis, and they are occasionally used to reduce fever.[24]

**Toxicity and Safety Profile**

**Acute Toxicity**

Recent studies from 2015–2025 suggest that *Baccaurea ramiflora* leaf extracts indicating a high margin of safety in acute toxicity assessment. Experimental models report no mortality, no significant and behavioural or clinical

abnormalities, and no major signs of toxicity even at the highest tested doses. The extract possesses very low acute toxicity, with reported $LD_{50}$ values greater than 5000 mg/kg, suggesting that the leaf extracts is virtually non-toxic and safe for short-term application. Although acute toxic effects are negligible, evaluation of skin irritation and hypersensitivity remains essential for topical preparation development.[25,26,27]

**Sub-acute Toxicity**

Sub-acute toxicity studies involving repeated administration of *B. ramiflora* leaf extracts over 21–28 days report that the extract is well tolerated, with no significant modification in hematological, biochemical, or organ weight parameters at therapeutic dose levels. Moderate and temporary irritation has occasionally been noted at higher concentrations, but no systemic toxicity or structural damage to vital organs has been observed. These discovering emphasizes the importance of regular monitoring and histopathological evaluation, particularly when extracts are implied for dermal or wound-healing applications where skin integrity may be compromised.[28,29]

**Sub-chronic Toxicity (90-day exposure)**

Longer-term toxicity studies (2015–2025) illustrating the continuing exposure to *Baccaurea ramiflora* leaf extracts over a 90-day period is generally safe, with no major clinical toxicity or crucial tissue damage at controlled doses. However, some studies suggests that long use of high-dose administration may provoke mild oxidative or inflammatory responses, fortifying the need for attentive dose optimization. Sub-chronic data suggests monitoring toxicokinetic parameters and tissue morphology when extracts are deliberate for extended therapeutic or cosmetic usage.[25]

**Future Prospects**

*Baccaurea ramiflora* displays considerable potential for development in the biomedical sector owing to its extensive phytochemical composition and various pharmacological properties. The bioactive compounds present in the leaves including flavonoids, phenolics, tannins, and terpenoids worth further investigation for the innovation of new therapeutic agents, especially handling anti-inflammatory, antimicrobial, wound-healing, antioxidant, and analgesic treatments. Its remarkable antioxidant capabilities suggest prospects for applications in anti-aging, tissue regeneration, and safeguarding against disorders related to oxidative stress. The proven wound-healing and antimicrobial effects of *B. ramiflora* leaves extract present substantial opportunities for the development of topical formulations like hydrogels targeted at wound care, burn treatment, and skin-repair products, particularly within the enlarging market for herbal and biocompatible dermatological solutions. The integration of advanced drug-delivery systems such as polymer-based hydrogels, nano-encapsulation, and controlled-release technologies could upgrade its therapeutic productivity and clinical relevance. Future investigations should also emphasize an in-depth understanding of the mechanisms of action, pharmacokinetics, and clinical validation, which include extensive acute, sub-acute, and sub-chronic toxicity estimation to guarantee safety and facilitate regulatory approval. Clinical trials are critical for interpreting laboratory findings into standard clinical practice. Additionally, there is a need for the standardization of extraction techniques, compound isolation, and dosage optimization to assure consistent results for pharmaceutical purposes. The increase in global interest in plant-derived medicines, it is necessary to adopt sustainable cultivation practices and conservation efforts to prevent overharvesting and obtain long-lasting resource availability. With ongoing scientific validation and industrial partnerships, the leaves of *Baccaurea ramiflora* have substantial potential as a natural and effective therapeutic option, covering the way for innovative formulations and future drug development.

## CONCLUSION

This review suggests an in-depth analysis of the medicinal properties of *Baccaurea ramiflora* leaves, concentrating on their pharmacological characteristics, phytochemical profile, and future potential for therapeutic use. The leaves of *B. ramiflora* are profuse in biologically active substances, including flavonoids, phenolics, tannins, saponins, glycosides, and terpenoids, which are liable for a wide range of pharmacological effects such as anti-inflammatory, antimicrobial, antioxidant, analgesic, hepatoprotective, antipyretic, and wound-healing actions. Research papers suggests from the past decade provides vigorous support for its traditional applications in various medicinal systems for dealing inflammation, pain, rheumatic conditions, skin infections, wounds, and fever, confirming its historical significance in ethnomedicine. The proven antimicrobial and wound-healing capabilities of *B. ramiflora* leaf extracts underlining its potential as a significant candidate for topical drug delivery, especially in hydrogel formulations designed for wound care and dermatological uses. Toxicity evaluation reveals a considerable margin of safety, showing few adverse effects in acute, sub-acute, and sub-chronic studies, moreover supporting its appropriateness for the development of biomedical products. In summary, *Baccaurea ramiflora* leaves present a crucial prospects as a natural therapeutic resource, and ongoing scientific investigation, supported by inventive formulation technologies, may facilitate the production of novel and safe plant-based medical products for future healthcare uses.

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