



**INTERNATIONAL JOURNAL OF
PHARMACEUTICAL SCIENCES**
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: <https://www.ijpsjournal.com>



Review Article

Pharmacological Potential and Characterization of Isolated Phytoconstituents from *Leptadenia Reticulata*: A Review

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ARTICLE INFO

Published: 19 Oct 2026

Keywords:

Leptadenia reticulata, Jivanti, Phytochemistry, Bioactive compounds, Isolation, Characterization, Pharmacological activity

DOI:

10.5281/zenodo.23466544

ABSTRACT

Leptadenia reticulata (Jivanti) is a valued Ayurvedic medicinal plant known for revitalizing and lactogenic properties. Contemporary phytochemical investigations have revealed that *L. reticulata* contains a broad range of bioactive secondary metabolites, including triterpenoids, phytosterols, flavonoids, phenolic acids, long-chain aliphatic compounds, and pregnane glycosides. Evidence from in vitro and in vivo studies suggests that major constituents such as rutin, quercetin, p-coumaric acid, luteolin, diosmetin, α -amyrin, β -amyrin, stigmasterol, β -sitosterol, lupeol, and the pregnane glycosides reticulatin, deniculatin, and leptaculatin contribute to anti-inflammatory, antioxidant, analgesic, hepatoprotective, immunomodulatory, anticancer, and reproductive benefits. Among the studied fractions, ethyl acetate-rich preparations consistently showed strong anti-inflammatory and analgesic effects in animal models, with HPLC-confirmed enrichment of p-coumaric acid, rutin, and quercetin. Overall, the evidence supports *L. reticulata* as a promising source of bioactive lead molecules, although many isolated compounds still need direct pharmacological validation and mechanistic work. Their isolation has largely relied on solvent extraction and chromatographic separation, whereas characterization has been accomplished through spectroscopic and hyphenated analytical techniques such as UV, IR, NMR, MS, GC-MS, HPTLC, HPLC, and more recently HR-LCMS/MS. However, the current evidence remains constrained by limited bioactivity-guided isolation, inadequate standardization, insufficient toxicological assessment, and minimal clinical validation. This review critically compiles the available evidence on the phytochemical isolation, structural characterization, and pharmacological evaluation of *L. reticulata*, and highlights key research gaps for its development as a standardized phytopharmaceutical candidate.

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Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.



INTRODUCTION

Because of its long history of traditional usage and its increasingly acknowledged phytochemical richness, *Leptadenia reticulata* holds a unique place among Ayurvedic medicinal plants [1,2,41–46]. Jivanti is the common name for this species, which has been regarded as a rejuvenating herb and has long been used in formulations to support lactation, boost reproductive health, increase vitality, and reduce overall weakness [1,2,19–21,41–46]. Its usage in cough, fever, diarrhoea, wound diseases, inflammatory illnesses, and times of dietary scarcity is also documented in ethnomedical and historical sources, highlighting its broader social and therapeutic relevance [1,2,43,47,48].

Over the past 20 years, there has been a significant increase in scientific interest in *L. reticulata* due to its

wide variety of biological activities and chemically diversified metabolite profile [1–4]. However, a large portion of the evidence that has been published still depends on crude extracts or partially purified fractions, and very few papers directly link isolated chemicals to confirmed pharmacological effects [1,3,5,6]. A targeted synthesis of the literature addressing isolation, characterisation, and pharmacological evaluation is clearly required in light of this gap. The present review therefore compiles current knowledge on the phytochemistry of *L. reticulata*, summarizes the principal analytical approaches used for compound identification, and evaluates the pharmacological evidence available for extracts, active fractions, and isolated constituents [1–4].

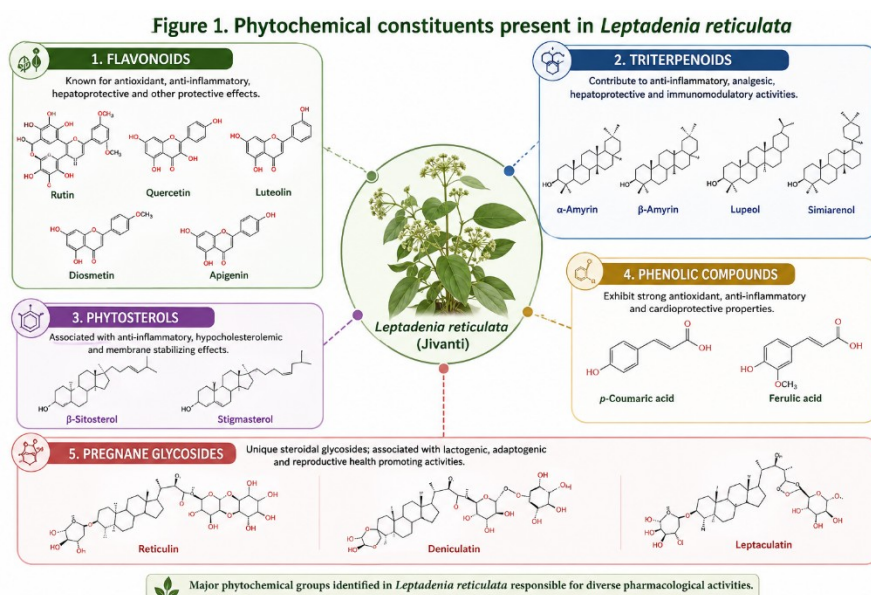


Figure 1: Phytochemical Constituents Present *Leptadenia reticulata*

2. Methods of Literature Collection

The present review was prepared using published literature from peer-reviewed journals, review articles, pharmacological studies, phytochemical reports, and analytical investigations dealing with *Leptadenia reticulata*. Particular emphasis was placed on studies addressing phytochemical composition, solvent extraction, chromatographic isolation, spectroscopic and hyphenated characterization, and pharmacological evaluation in experimental models.

Priority was given to studies reporting isolated compounds, bioactivity-guided fractionation, metabolomic profiling, or experimentally supported biological activity. Older pharmacological, botanical, and Ayurvedic references were also incorporated where they contributed to the historical understanding of the species, its traditional indications, or its early phytochemical documentation.

3. Botanical Profile and Ethnomedicinal Significance

Leptadenia reticulata (Retz.) Wight & Arn. belongs to the family Apocynaceae and is widely accepted as the authentic botanical source of Jivanti in Ayurveda [1,41–46]. The plant is a perennial twining shrub or climber, and several reports have highlighted concerns regarding overexploitation, restricted natural availability, and substitution in commercial trade [1,38–40]. These concerns have made authentication, conservation, and

standardization particularly important for both research and medicinal use [1,33–40].

Ethnomedicinally, the roots, stems, leaves, and whole plant have been used in respiratory complaints, weakness, reproductive disorders, wounds, gastrointestinal disturbances, and inflammatory conditions [1,2,19–21,41–46]. Galactagogue use remains one of the plant's most historically important applications, supported by classical Ayurvedic descriptions as well as older experimental and veterinary studies [20,21,50]. Historical famine-food reports also suggest that the plant held supplementary nutritional value in certain contexts, reflecting the broader ethnobotanical relevance of the species [47,48].

4. Phytochemical Profile of *Leptadenia reticulata*

The best-studied isolated constituents of *L. reticulata* include flavonoids, triterpenoids, sterols, phenolic acids, and pregnane glycosides. Reported compounds include α -amyrin, β -amyrin, ferulic acid, luteolin, diosmetin, rutin, β -sitosterol, stigmasterol, hentriacontanol, simiarenol, apigenin, reticulatin, deniculatin, and leptaculatin. A detailed review also reports lupeol, p-coumaric acid, quercetin, isoquercetin, α -tocopherol, and other metabolites across different plant parts [51]. The phytochemical profile varies with plant part, extraction method, and geography, which may explain why some fractions show stronger biological effects than others [22,26,28].

Table 1: Isolated Compounds from *L. reticulata* and Their Main Reported Activity

Sr. No.	Isolated compound	Main reported activity
	Rutin	Anti-inflammatory, antioxidant, analgesic relevance [51].
	Quercetin	Anti-inflammatory, antioxidant, analgesic relevance [51].
	p-Coumaric acid	Antioxidant, anti-inflammatory [51].
	Luteolin	Anti-inflammatory, antioxidant [52].
	Diosmetin	Anti-inflammatory, antioxidant [53].
	α -Amyrin, β -Amyrin	Anti-inflammatory, wound-healing, antioxidant potential[54].
	β -Sitosterol, stigmasterol	Anti-inflammatory and membrane-modulating potential[55].
	Lupeol	Anti-inflammatory and cytoprotective potential [56].

Chemical composition varies with plant part, extraction solvent, geographical source, and growth conditions

[1,4,29]. A comparative GC-MS investigation of leaf, stem, root, and callus extracts reported 77



phytochemicals, including γ -sitosterol, campesterol, fatty acids, alcohols, and terpenoid-related compounds, demonstrating marked tissue-specific and solvent-dependent variation [4]. More recent HR-LCMS/MS-based metabolomic profiling identified 113 compounds in the methanolic extract and linked them to inflammatory-disease-related targets through network pharmacology and docking studies [3]. Taken together, these observations support the conclusion that the therapeutic profile of *L. reticulata* is likely the result of multiple interacting constituents rather than a single dominant active principle [1,3,4].

5. Isolation of Bioactive Phytochemicals

5.1 Extraction Strategies

Isolation of phytoconstituents from *L. reticulata* generally begins with drying, pulverization, and extraction using solvents of increasing polarity, including petroleum ether, chloroform, ethyl acetate, methanol, ethanol, and water [1,4,5]. Non-polar solvents are more suitable for triterpenoids, sterols, and aliphatic compounds, while polar and semi-polar solvents preferentially extract flavonoids, phenolic acids, and glycosidic constituents [1,4,22–29]. Sequential extraction remains particularly useful because it enables fractionation of metabolites according to polarity and supports

subsequent biological screening of chemically enriched fractions [1].

5.2 Chromatographic Isolation

After extraction, silica gel column chromatography is the most commonly reported method for separation and purification of compounds from *L. reticulata* [1,5]. Fractions are generally monitored using TLC or HPTLC and eluted with solvent systems of gradually increasing polarity [1,27,28]. One of the best documented examples is the isolation of lupeol from the chloroform extract of the roots. Rajanna and colleagues further evaluated the isolated lupeol for antimicrobial activity, thereby providing an example of direct linkage between compound isolation and pharmacological testing [5].

5.3 Bioactivity-Guided Fractionation

Bioactivity-guided fractionation has been explored in the context of antidiabetic investigation. An active fraction isolated from the leaf extract significantly improved serum glucose and lipid parameters in diabetic rats, highlighting the value of targeted fractionation compared with extract-level screening alone [6]. Although this direction is promising, the overall literature still contains relatively few rigorous bioactivity-guided isolation studies, indicating considerable scope for further work [1,3,6].

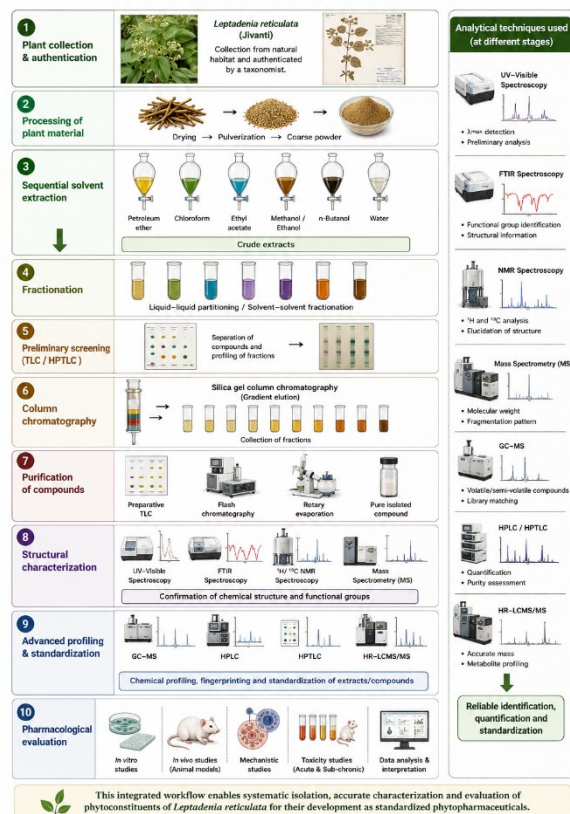
Figure 2. Isolation, Characterization and Pharmacological Evaluation Workflow of Phytoconstituents from *Leptadenia reticulata*

Figure 2: Isolation and Characterization Flowchart

6. Characterization of Isolated Compounds

6.1 Spectroscopic Characterization

Structural elucidation of isolated compounds from *L. reticulata* has primarily relied on UV-visible spectroscopy, infrared spectroscopy, ¹H NMR, ¹³C NMR, and mass spectrometry [1,5,25]. Lupeol isolated from the roots represents one of the clearest compound-level examples in this species and was characterized using UV, IR, ¹H NMR, ¹³C NMR, and FAB-MS [5]. Earlier phytochemical investigations also documented crystalline principles and characteristic triterpenoid or sterol constituents using classical natural product chemistry approaches [22–26].

6.2 GC-MS Profiling

GC-MS has been widely used for characterization of volatile and semi-volatile compounds, including terpenoids, sterols, fatty acids, and long-chain aliphatics [4,29,32]. Comparative GC-MS studies across plant tissues have highlighted major chemical differences between leaf, stem, root, and callus extracts,

underscoring the importance of analytical profiling in authentication and standardization [4,29].

6.3 HPTLC, HPLC, and Advanced Profiling

Marker-based standardization using HPTLC and HPLC has been reported for compounds such as rutin, stigmasterol, tocopherol acetate, β-sitosterol, lupeol, quercetin, and related phytochemical markers [27,28,30]. These methods are critical because *L. reticulata* is commercially important and susceptible to substitution and compositional variability [1,27,28]. More recently, HR-LC/MS/MS, metabolomics, and network pharmacology have expanded the chemical understanding of the species beyond conventional profiling and have provided a systems-level framework for linking multiple metabolites with predicted biological targets and pathways [3].

7. Pharmacological Evaluation

7.1 Antioxidant Activity

Antioxidant activity is among the most frequently reported pharmacological properties of *L. reticulata*. Ethanolic leaf extract has been shown to produce antioxidant effects in rodent models, and the activity is generally attributed to flavonoids and phenolic constituents present in the plant [7,10]. Such antioxidant potential may contribute significantly to its traditional reputation as a rejuvenative and restorative herb [1,2,7].

7.2 Anti-inflammatory and Analgesic Activity

A substantial body of evidence supports the anti-inflammatory and analgesic potential of *L. reticulata*. Experimental studies have demonstrated anti-inflammatory, analgesic, and anti-lipoxygenase activities, while recent metabolomic and docking work also supports anti-inflammatory effects mediated through multiple targets and pathways [3,9]. The plant's triterpenoids, phytosterols, and polyphenolic constituents likely contribute collectively to these actions [1,3,9].

7.3 Immunomodulatory Activity

Immunomodulatory activity is another important pharmacological property of *L. reticulata*. Ethanolic leaf extract has been reported to modulate both humoral and cell-mediated immune responses in rodents [7]. In another study, the plant alleviated chromate-induced immunosuppression and oxidative stress, supporting its immunorestorative potential [8]. These observations align closely with its traditional rasayana-like use [1,7,8].

7.4 Antimicrobial and Antifungal Activity

Antimicrobial activity has been demonstrated for both crude extracts and isolated compounds of *L. reticulata*. Lupeol isolated from the root extract exhibited activity against bacterial and fungal strains [5]. Additional reports have documented antibacterial or antifungal properties of extracts and phytochemical fractions, lending support to the traditional use of the plant in infection-associated conditions and wound management [16,17,30].

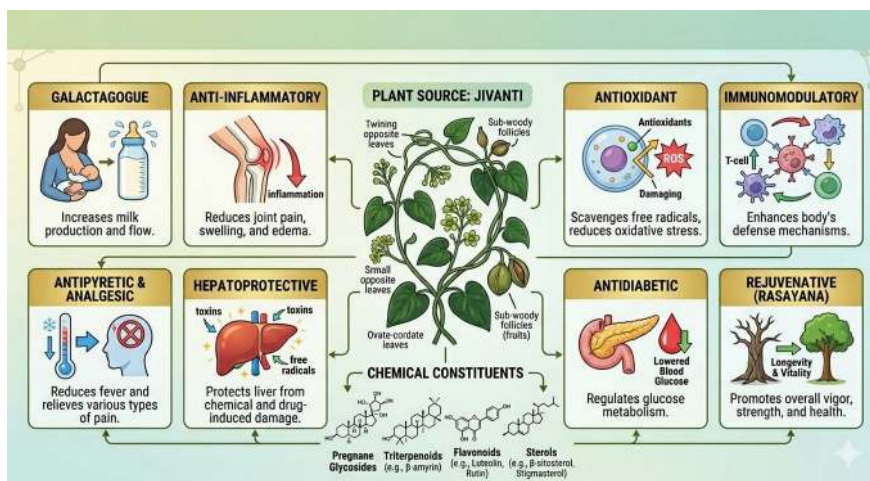


Figure 3: Various Pharmacological Activities of *Leptadenia reticulata*

7.5 Wound-Healing Activity

Wound-healing activity has been reported for aqueous extract formulations of *L. reticulata* in excision and burn wound models. Improvement in wound contraction and tissue repair is pharmacologically plausible in view of the combined antioxidant, anti-inflammatory, and antimicrobial properties of the plant [11].

7.6 Antidiabetic and Hypolipidemic Activity

Antidiabetic studies on *L. reticulata* have yielded promising results. An active leaf fraction significantly lowered serum glucose and improved lipid profiles in normal and diabetic rats. This suggests that the plant contains constituents capable of modulating carbohydrate and lipid metabolism, although further

purification and mechanism-oriented work remain necessary. Experimental studies on *Leptadenia reticulata* have demonstrated both antidiabetic and hypolipidemic potential. In streptozotocin-induced diabetic rats, the ethanol extract of the leaves reduced fasting blood glucose, while the isolated active fraction Lr-1 significantly decreased glucose, cholesterol, and triglyceride levels and improved HDL, indicating a dual metabolic benefit. Reviews of the plant's pharmacological profile also list antidiabetic activity among its documented effects, supporting its traditional use in metabolic disorders [6]. Venkatesan & Arul Gnana Dhas, 2014 tested Petroleum ether, ethyl acetate, and ethanol leaf extracts on normal and diabetic rats models. The ethanol extract was most active, and the purified fraction **Lr-1** had stronger glucose- and lipid-lowering effects than the crude extract [57].

7.7 Antiulcer and Hepatoprotective Activity

The literature also attributes antiulcer activity to *L. reticulata*, with extract-level studies reporting reductions in ulcer index and improvement in gastric parameters in experimental models. Hepatoprotective potential has also been suggested in paracetamol-induced hepatotoxicity models, indicating that the plant may possess additional protective effects in oxidative and inflammatory injury states. Bodhanapu et al., 2011 perform ethanol, indomethacin, and pylorus ligation induced ulcer models in rats. The aqueous leaf extract reduced ulcer index, acidity, and acid volume, and increased gastric pH [12-13].

7.8 Reproductive, Neuropharmacological, and Anticancer-Related Activity

Preliminary studies have examined anti-implantation, neuropharmacological, antiepileptic, and anticarcinogenic activity, although the evidence in these areas remains less extensive than for the anti-inflammatory or antioxidant effects [14,15,18,50]. These findings nevertheless expand the biological scope of the plant and indicate several avenues for future mechanistic investigation.

7.9 Lactogenic Activity

The galactagogue effect of *L. reticulata* remains one of its most historically important medicinal applications.

Older experimental and veterinary studies, along with subsequent review literature, support the view that the plant and related formulations may promote lactation [20,21,50]. However, stronger modern validation using standardized extracts and controlled clinical study designs is still needed [1,2].

DISCUSSION

The available evidence clearly establishes *Leptadenia reticulata* as a phytochemically rich medicinal plant with a broad spectrum of experimentally supported biological activities. One of the main strengths of the literature is the general consistency between traditional claims and modern pharmacological observations, especially in the areas of antioxidant, anti-inflammatory, immunomodulatory, antimicrobial, and metabolic activity. The plant's diverse chemical composition, particularly its triterpenoids, phytosterols, flavonoids, phenolic acids, and pregnane glycosides, provides a plausible mechanistic basis for these effects.

At the same time, the literature reveals significant limitations. Most studies remain extract-based rather than compound-based, and relatively few have employed rigorous bioactivity-guided isolation. Standardization remains inconsistent across plant parts, extraction solvents, and analytical methods. Toxicological assessment, pharmacokinetic profiling, and clinical evidence are sparse. These limitations restrict the translation of *L. reticulata* from a promising ethnomedicinal resource to an evidence-based phytopharmaceutical candidate.

Another important theme emerging from the literature is the need to connect phytochemistry with conservation. Since the plant is considered threatened or vulnerable in several regional contexts, sustainable sourcing, micropropagation, somatic embryogenesis, and in vitro conservation strategies are critical for ensuring future availability of authenticated material. Biotechnological interventions, including nodal culture, somatic embryogenesis, and cost-effective micropropagation systems, have already demonstrated value in the conservation and multiplication of the species.



9. Future Perspectives

Future research on *L. reticulata* should prioritize robust bioactivity-guided fractionation, isolation of active principles, and structure-confirmed compound-level pharmacology. Standardized analytical platforms such as HPTLC, HPLC, GC-MS, and HR-LCMS/MS should be routinely integrated into phytochemical and pharmacological studies. Particular attention should be directed toward anti-inflammatory, wound-healing, metabolic, and lactogenic applications, as these areas presently combine traditional relevance with promising experimental support.

There is also a clear need for better toxicological assessment, pharmacokinetic studies, and controlled clinical evaluation. In parallel, conservation-oriented cultivation, authenticated sourcing, and tissue culture-assisted propagation should be strengthened to ensure both scientific reproducibility and sustainable medicinal use.

CONCLUSION

Leptadenia reticulata is a therapeutically promising medicinal plant with strong traditional relevance and an expanding modern evidence base. Published studies show that it contains a wide spectrum of bioactive metabolites and exhibits antioxidant, anti-inflammatory, analgesic, immunomodulatory, antimicrobial, wound-healing, antidiabetic, hypolipidemic, antiulcer, hepatoprotective, neuropharmacological, and lactogenic activities. However, to achieve wider scientific and pharmaceutical acceptance, future work must move beyond crude extract pharmacology toward rigorous compound isolation, robust structural characterization, validated standardization, toxicological assessment, and clinical validation. In this regard, *L. reticulata* remains a valuable and underdeveloped source of bioactive phytochemicals with significant potential for phytopharmaceutical development.

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HOW TO CITE: Nupur Snehi, Dr. Arvind Kumar, Pharmacological Potential and Characterization of Isolated Phytoconstituents from *Leptadenia Reticulata*: A Review, *Int. J. of Pharm. Sci.*, 2026, Vol 4, Issue 10, 2877-2887. <https://doi.org/10.5281/zenodo.23466544>

