International Journal of Botany Studies
www.botanyjournals.com
ISSN: 2455-541X
Received: 02-06-2026, Accepted: 02-07-2026, Published: 17-07-2026
Volume 11, Issue 3, 2026, Page No. 102-107

Phytochemical profiling and evaluation of anti-inflammatory and antibacterial potential of selected tribal medicinal plants

Shashi Shekhar[1], Dr. Arpana Sharma[2]
[1] Research Scholar, Department of Botany, School of Science, YBN University Ranchi, Jharkhand, India
[2] Associate Professor, Department of Botany, School of Science, YBN University Ranchi, Jharkhand, India

Abstract
Medicinal plants have been an important component of traditional healthcare systems, particularly among tribal communities that utilize plant resources for managing inflammation, microbial infections, wounds, and other disorders. The present study was conducted to evaluate the phytochemical profile, antibacterial activity, and anti-inflammatory potential of five traditionally used tribal medicinal plants, namely *Mimosa pudica* L., *Azadirachta indica* A. Juss., *Tinospora cordifolia* (Willd.) Hook. f. & Thomson, *Aerva lanata* (L.) Juss. ex Schult., and *Calotropis procera* (Aiton) Dryand. Plant materials were collected, authenticated, shade dried, and extracted using suitable solvents. Qualitative phytochemical screening confirmed the presence of alkaloids, flavonoids, phenolics, tannins, saponins, and terpenoids in all selected plants. Quantitative estimation revealed significant variation in bioactive constituents. The highest total phenolic content was recorded in *Azadirachta indica* (86.42 ± 1.84 mg GAE/g extract), followed by *Tinospora cordifolia* (78.36 ± 2.15 mg GAE/g extract). The maximum total flavonoid content was observed in *Mimosa pudica* (74.36 ± 1.62 mg QE/g extract), followed by *Aerva lanata* (68.52 ± 1.48 mg QE/g extract). The antibacterial activity was evaluated against *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Klebsiella pneumoniae* using the agar well diffusion method. Among the tested extracts, *Azadirachta indica* showed the highest antibacterial activity with inhibition zones of 18.6 ± 0.7 mm against *S. aureus*, 16.8 ± 0.6 mm against *E. coli*, 15.5 ± 0.5 mm against *P. aeruginosa*, and 17.2 ± 0.6 mm against *K. pneumoniae*. The observed biological activities may be attributed to the presence of phenolics, flavonoids, alkaloids, and terpenoids. The study provides scientific validation of tribal medicinal knowledge and highlights the potential of selected plants as promising sources of natural antibacterial and anti-inflammatory agents.

Keywords: Tribal medicinal plants, phytochemicals, phenolics, flavonoids, antibacterial activity, anti-inflammatory activity, herbal therapeutics

Introduction

Tribal Medicinal Plants and Traditional Healthcare

Medicinal plants have been an important component of traditional healthcare systems, especially among tribal communities that depend on locally available plant resources for the treatment of various diseases. Indigenous knowledge related to plant identification, preparation, and therapeutic applications has been passed through generations and serves as a valuable source for the discovery of new bioactive compounds. Scientific validation of traditional medicinal practices helps in understanding the pharmacological potential of these plants and supports the development of plant-based therapeutic agents (Fabricant & Farnsworth, 2001; WHO, 2013) [8].

Tribal communities commonly utilize different plant parts such as leaves, roots, stems, and bark for managing inflammation, wounds, infections, and other health disorders. The therapeutic properties of medicinal plants are mainly attributed to secondary metabolites such as flavonoids, phenolics, alkaloids, tannins, and terpenoids, which exhibit antimicrobial, antioxidant, and anti-inflammatory activities (Kala, 2005) [10].

Mimosa pudica L. (Fabaceae), traditionally known as Lajalu, is used by tribal populations for wound healing, skin infections, inflammation, and microbial disorders. The presence of flavonoids, tannins, alkaloids, and phenolic compounds contributes to its reported antimicrobial and anti-inflammatory properties (Ahmad *et al*., 2012) [1].

Azadirachta indica A. Juss. (Meliaceae), commonly known as Neem, is a well-known medicinal plant traditionally used for treating skin infections, wounds, and inflammatory conditions. Bioactive compounds such as flavonoids, terpenoids, and limonoids are responsible for its antibacterial and anti-inflammatory activities (Biswas *et al*., 2002; Alzohairy, 2016) [2, 5].

Tinospora cordifolia (Willd.) Hook. f. & Thomson (Menispermaceae), commonly called Gurich, is widely used in traditional medicine for inflammation, fever, and immune enhancement. Its phytoconstituents, including alkaloids, glycosides, diterpenoids, and phenolics, contribute to its immunomodulatory and anti-inflammatory effects (Saha & Ghosh, 2012) [15].

Aerva lanata (L.) Juss. ex Schult. (Amaranthaceae) is traditionally used by tribal communities for urinary disorders, inflammation, and microbial infections. The presence of flavonoids, tannins, alkaloids, and terpenoids supports its reported pharmacological activities (Kumar *et al*., 2011) [11].

Calotropis procera (Aiton) Dryand. (Apocynaceae) is an ethnomedicinal plant traditionally used for treating wounds, swelling, skin disorders, and inflammation. Various secondary metabolites present in this plant contribute to its antibacterial and anti-inflammatory potential (Choedon *et al*., 2006) [7].

Thus, the traditional utilization of these medicinal plants highlights the importance of tribal knowledge in identifying valuable therapeutic resources. The present study aims to

scientifically evaluate the phytochemical constituents and antibacterial and anti-inflammatory activities of selected tribal medicinal plants.

Phytochemicals Responsible for Biological Activity

Medicinal plants contain a wide range of secondary metabolites that contribute to their therapeutic properties. These phytochemicals play important roles in protecting plants against pathogens and environmental stress, while also exhibiting significant pharmacological activities in humans. Among these, flavonoids, phenolic compounds, alkaloids, terpenoids, and tannins are considered important bioactive constituents responsible for antimicrobial, antioxidant, and anti-inflammatory effects (Harborne, 1998; Kumar & Pandey, 2013) [12].

Flavonoids are one of the major groups of plant polyphenols known for their anti-inflammatory and antioxidant properties. Plants such as *Mimosa pudica* L. and *Tinospora cordifolia* (Willd.) Hook. f. & Thomson are rich in flavonoids, which help in reducing inflammatory responses by modulating inflammatory mediators and oxidative stress pathways (Panche *et al*., 2016) [14].

Phenolic compounds are widely distributed phytochemicals associated with antioxidant and antibacterial activities. *Azadirachta indica* A. Juss. contains abundant phenolic constituents that contribute to free radical scavenging activity and inhibition of microbial growth through disruption of bacterial cellular functions (Biswas *et al*., 2002; Alzohairy, 2016) [2, 5].

Alkaloids represent another important class of bioactive compounds with significant antimicrobial properties. *Aerva lanata* (L.) Juss. ex Schult. contains alkaloid compounds that have been reported to contribute to its traditional use against infections and other health disorders (Kumar *et al*., 2011) [11].

Terpenoids are structurally diverse compounds known for anti-inflammatory, antimicrobial, and antioxidant activities. *Calotropis procera* (Aiton) Dryand. contains several terpenoid constituents that contribute to its traditional applications in inflammatory conditions and wound management (Choedon *et al*., 2006) [7].

Tannins are polyphenolic compounds present in almost all selected medicinal plants, including *Mimosa pudica*, *Azadirachta indica*, *Tinospora cordifolia*, *Aerva lanata*, and *Calotropis procera*. They exhibit antibacterial activity by causing protein precipitation, enzyme inhibition, and alteration of microbial cell membranes (Scalbert, 1991) [17].

Therefore, the presence of diverse phytoconstituents in selected tribal medicinal plants provides a scientific basis for their traditional applications and supports their potential as sources of natural antibacterial and anti-inflammatory agents.

Materials and Methods

1. Collection and Authentication of Plant Materials

Five medicinal plants traditionally used by tribal communities were selected for the present study based on their ethnomedicinal importance and reported therapeutic properties. The plant materials were collected from tribal regions and carefully identified based on their morphological characteristics. The collected specimens were authenticated by a qualified botanist, and voucher specimens were preserved for future reference. Different plant parts were selected according to their traditional medicinal applications and used for further phytochemical and biological investigations.

Plant Name	Family	Part Used	Collection Area
Mimosa pudica L.	Fabaceae	Leaves	Mahuadanr
Azadirachta indica A. Juss.	Meliaceae	Leaves	Mahuadanr
Tinospora cordifolia (Willd.) Hook. f. & Thomson	Menispermaceae	Stem	Mahuadanr
Aerva lanata (L.) Juss. ex Schult.	Amaranthaceae	Roots	Mahuadanr
Calotropis procera (Aiton) Dryand.	Apocynaceae	Leaves	Mahuadanr

2. Preparation of Plant Extracts

The collected plant materials were thoroughly washed with distilled water to remove dust and unwanted materials, followed by shade drying at room temperature to preserve heat-sensitive bioactive compounds. The dried plant materials were finely powdered using a mechanical grinder and stored in airtight containers until further analysis.

Plant extracts were prepared using different solvents based on their polarity to obtain maximum extraction of phytoconstituents. Extraction was carried out by Soxhlet extraction/maceration method using ethanol solvent. The obtained extracts were filtered, concentrated under reduced pressure, and stored at 4^0C until phytochemical screening and biological activity evaluation.

The prepared extracts were further subjected to qualitative phytochemical analysis, quantitative estimation of phenolic and flavonoid contents, antibacterial assay, and *In Vitro* anti-inflammatory evaluation.

3. Phytochemical Screening

Qualitative phytochemical screening of the selected medicinal plant extracts was performed to detect the presence of major bioactive secondary metabolites responsible for their pharmacological activities. The extracts were subjected to standard phytochemical tests for the identification of alkaloids, flavonoids, phenolic compounds, tannins, saponins, and terpenoids using previously described methods (Harborne, 1998; Trease & Evans, 2002) [9, 19]. The presence or absence of different phytoconstituents was determined based on characteristic colour changes, precipitate formation, or foam production. These phytochemical investigations provide preliminary information regarding the chemical composition of plant extracts and their potential biological activities.

4. Quantitative Phytochemical Estimation

Quantitative estimation of phytochemical constituents was performed to determine the amount of phenolic and flavonoid compounds present in the selected medicinal plant extracts. The extracts of selected tribal medicinal plants, including *Calotropis procera* (Aiton) and were subjected to spectrophotometric analysis for estimation of total phenolic content (TPC) and total flavonoid content (TFC). These phytoconstituents are considered important contributors to antioxidant, antibacterial, and anti-inflammatory activities.

4.1 Total Phenolic Content (TPC)

The total phenolic content of *Calotropis procera* leaf extract was determined using the Folin–Ciocalteu colorimetric method as described by Singleton *et al*., (1999) [13]. Briefly, an appropriate amount of plant extract was mixed with Folin–Ciocalteu reagent and sodium carbonate solution. The reaction mixture was incubated under dark conditions, and

the absorbance was recorded using a UV–Visible spectrophotometer. Gallic acid was used as a standard reference compound, and the total phenolic content was calculated from the standard calibration curve. The results were expressed as milligrams of gallic acid equivalent per gram of extract (mg GAE/g extract).

4.2 Total Flavonoid Content (TFC)

The total flavonoid content of *Calotropis procera* leaf extract was estimated using the aluminium chloride ($AlCl_3$) colorimetric method described by Chang *et al*., (2002) [6]. Plant extracts were treated with aluminium chloride reagent, and the formation of a flavonoid–aluminium complex was measured spectrophotometrically. Quercetin was used as a standard compound, and the flavonoid content was expressed as milligrams of quercetin equivalent per gram of extract (mg QE/g extract).

5. Antibacterial Activity

The antibacterial potential of selected tribal medicinal plant extracts was evaluated against pathogenic bacterial strains using the agar well diffusion assay. The test organisms selected for the present study included both Gram-positive and Gram-negative bacteria, namely *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Klebsiella pneumoniae*. These bacterial strains are commonly associated with human infections and are frequently used for evaluating the antimicrobial potential of plant-derived compounds.

5.1 Agar Well Diffusion Assay

The antibacterial activity of plant extracts was determined by the agar well diffusion method. Briefly, bacterial cultures were grown in nutrient broth and adjusted to the required turbidity. The standardized bacterial suspension was uniformly spread on sterile Mueller–Hinton agar plates. Wells were prepared in the agar medium using a sterile cork borer, and different concentrations of plant extracts were added into the wells. The plates were incubated at 37^0C for 24 hours. After incubation, the antibacterial activity was evaluated by measuring the zone of inhibition (mm) around the wells. The antibacterial efficiency of the extracts was compared based on the diameter of inhibition zones produced against different bacterial strains. The presence of phenolic compounds, flavonoids, tannins, alkaloids, and terpenoids in plant extracts may contribute to antibacterial activity through mechanisms such as disruption of bacterial cell membranes, inhibition of enzymes, and interference with microbial metabolic pathways.

Results and Discussion

1. Phytochemical Profile

The phytochemical screening of selected tribal medicinal plants (*Mimosa pudica*, *Azadirachta indica*, *Tinospora cordifolia*, *Aerva lanata*, and *Calotropis procera*) revealed the presence of important secondary metabolites including flavonoids, phenolics, alkaloids, tannins, saponins, and terpenoids. The presence of flavonoids and phenolic compounds indicates the therapeutic potential of these plants due to their antioxidant, antibacterial, and anti-inflammatory properties.

Among the detected phytoconstituents, phenolic compounds contribute to antimicrobial activity, while flavonoids play an important role in reducing inflammatory responses. The higher activity observed in ethanolic extracts may be attributed to the efficient extraction of bioactive compounds such as phenolics and flavonoids compared with other solvents.

The phytochemical diversity observed in these medicinal plants supports their traditional use by tribal communities and highlights their potential as sources of natural antibacterial and anti-inflammatory agents.

Table 1: Qualitative Phytochemical Screening of Selected Tribal Medicinal Plants

Plant Extract	Alkaloids	Flavonoids	Phenolics	Tannins	Saponins	Terpenoids
Mimosa pudica	+	+	+	+	+	+
Azadirachta indica	+	+	+	+	+	+
Tinospora cordifolia	+	+	+	+	+	+
Aerva lanata	+	+	+	+	+	+
Calotropis procera	+	+	+	+	+	+

Note: (+) Presence of phytoconstituent; (–) Absence of phytoconstituent

2. Quantitative Phytochemical Estimation

The quantitative analysis of phytochemical constituents revealed significant variation in the total phenolic content (TPC) and total flavonoid content (TFC) among the selected tribal medicinal plant extracts.

The total phenolic content (Table 2) showed that *Azadirachta indica* exhibited the highest phenolic concentration (86.42 ± 1.84 mg GAE/g extract), followed by *Tinospora cordifolia* (78.36 ± 2.15 mg GAE/g) and *Mimosa pudica* (72.58 ± 1.96 mg GAE/g). The lowest phenolic content was observed in *Calotropis procera* (64.28 ± 1.73 mg GAE/g). The higher phenolic content of *A. indica* suggests its strong antioxidant potential and possible contribution to antibacterial and anti-inflammatory activities.

Table 2: Total Phenolic Content (TPC) of Selected Tribal Medicinal Plant Extracts

Plant Extract	Total Phenolic Content (mg GAE/g extract)
Azadirachta indica	86.42 ± 1.84
Tinospora cordifolia	78.36 ± 2.15
Mimosa pudica	72.58 ± 1.96
Aerva lanata	69.74 ± 1.52
Calotropis procera	64.28 ± 1.73

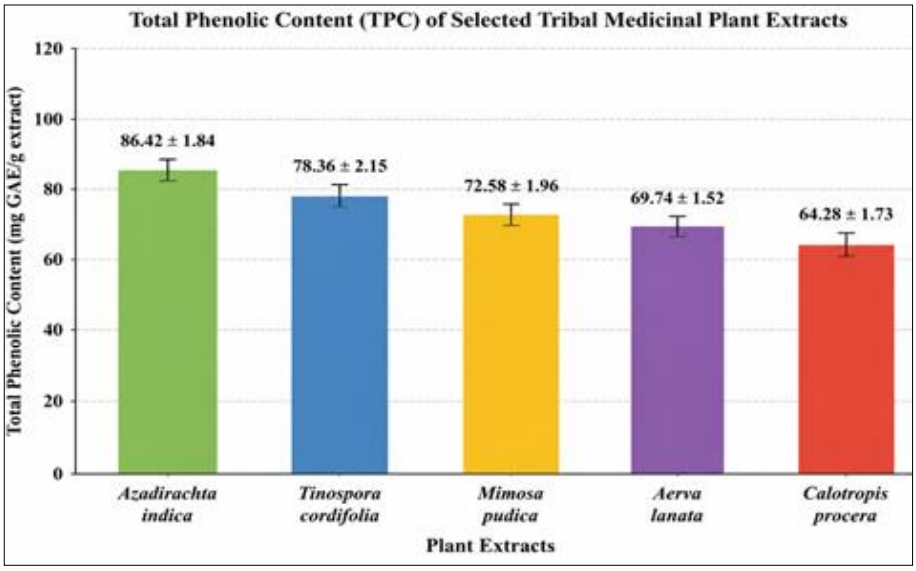

Fig 1: Total Phenolic Content (TPC) of Selected Tribal Medicinal Plant Extracts

Table 3: Total Flavonoid Content (TFC) of Selected Tribal Medicinal Plant Extracts

Plant Extract	Total Flavonoid Content (mg QE/g extract)
Mimosa pudica	74.36 ± 1.62
Aerva lanata	68.52 ± 1.48
Azadirachta indica	65.84 ± 1.75
Tinospora cordifolia	61.27 ± 1.39
Calotropis procera	58.46 ± 1.54

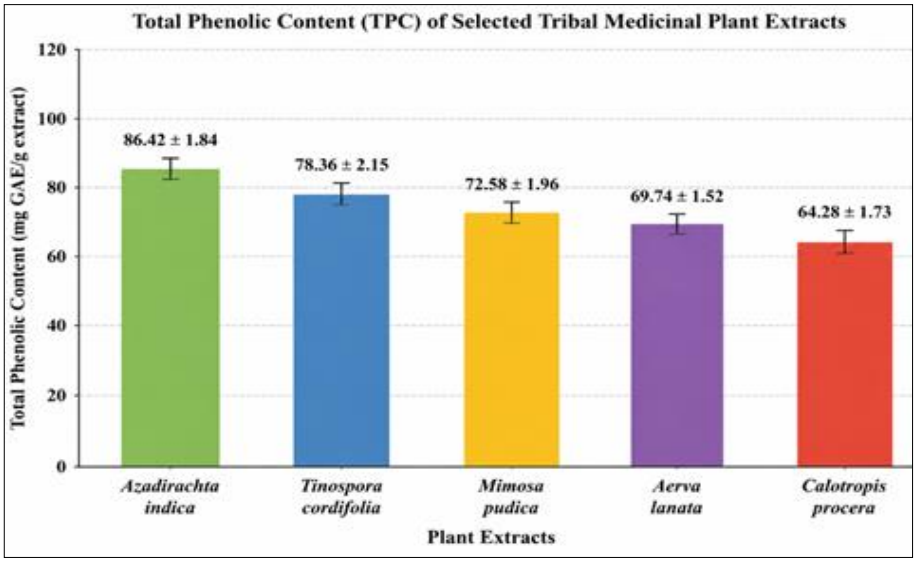

Fig 2: Total Flavonoid Content (TFC) of Selected Tribal Medicinal Plant Extracts

The highest flavonoid content was recorded in *Mimosa pudica* (74.36 ± 1.62 mg QE/g), followed by *Aerva lanata*. The presence of higher flavonoid concentration may be associated with enhanced anti-inflammatory activity due to their antioxidant and free radical scavenging properties.

Quantitative phytochemical estimation revealed considerable variation in phenolic and flavonoid contents among the selected tribal medicinal plants. *Azadirachta indica* exhibited the highest phenolic concentration, suggesting its strong antioxidant potential, whereas *Mimosa pudica* showed comparatively higher flavonoid content, which may contribute to its reported anti-inflammatory properties. Phenolic compounds are known to inhibit oxidative stress, while flavonoids regulate inflammatory pathways by reducing the production of inflammatory mediators. The presence of these bioactive compounds supports the traditional use of these plants for managing microbial infections and inflammatory disorders.

3. Antibacterial Activity

The antibacterial assay demonstrated that all selected plant extracts exhibited inhibitory effects against the tested bacterial pathogens. Among the evaluated plants, *Azadirachta indica* showed the highest antibacterial activity against *Staphylococcus aureus* (18.6 ± 0.7 mm), followed by *Calotropis procera* and *Tinospora cordifolia*. The activity may be attributed to the presence of phenolics, flavonoids, tannins, and other secondary metabolites capable of inhibiting bacterial growth.

Table 6: Antibacterial Activity of Selected Tribal Medicinal Plant Extracts (Zone of Inhibition in mm)

Plant Extract	*S. aureus*	*E. coli*	*P. aeruginosa*	*K. pneumoniae*
Mimosa pudica	15.4 ± 0.6	13.2 ± 0.5	12.8 ± 0.4	14.1 ± 0.5
Azadirachta indica	18.6 ± 0.7	16.8 ± 0.6	15.5 ± 0.5	17.2 ± 0.6
Tinospora cordifolia	16.9 ± 0.5	15.3 ± 0.4	14.7 ± 0.5	15.8 ± 0.6
Aerva lanata	14.8 ± 0.5	13.6 ± 0.4	12.5 ± 0.3	14.2 ± 0.4
Calotropis procera	17.2 ± 0.6	15.7 ± 0.5	14.9 ± 0.4	16.3 ± 0.5

Note: Values represent mean ± standard deviation of triplicate experiments

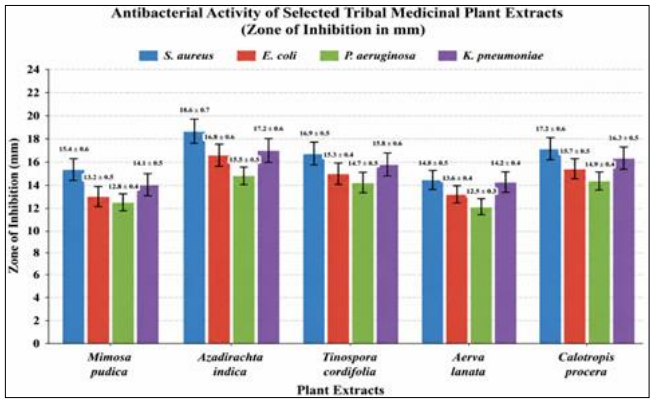

Fig 3: Antibacterial Activity of Selected Tribal Medicinal Plant Extracts

Discussion

The phytochemical screening of selected tribal medicinal plants revealed the presence of diverse secondary metabolites, including flavonoids, phenolic compounds, alkaloids, tannins, saponins, and terpenoids. These bioactive constituents are responsible for various pharmacological properties, including antioxidant, antibacterial, and anti-inflammatory activities. The presence of flavonoids and phenolic compounds in all selected plants indicates their therapeutic potential, as these compounds are known to reduce oxidative stress, inhibit microbial growth, and regulate inflammatory responses. Similar observations were reported by Kumar and Pandey (2013) [12], who highlighted the important biological roles of flavonoids in antioxidant and anti-inflammatory mechanisms.

Among the selected plants, *Azadirachta indica* exhibited a rich phytochemical profile and the highest total phenolic content (86.42 ± 1.84 mg GAE/g extract). The higher phenolic concentration suggests strong antioxidant potential and may contribute to its antibacterial and anti-inflammatory properties. Previous studies by Biswas *et al*., (2002) [5] and Alzohairy (2016) [2] reported that neem contains phenolic compounds, flavonoids, terpenoids, and limonoids responsible for its antimicrobial, antioxidant, and therapeutic activities.

The present study showed considerable phenolic content in *Tinospora cordifolia* (78.36 ± 2.15 mg GAE/g extract). These findings are in agreement with Saha and Ghosh (2012) [15], who reported that *T. cordifolia* possesses phenolics, alkaloids, glycosides, and diterpenoid compounds that contribute to its antioxidant, immunomodulatory, and anti-inflammatory effects.

The highest total flavonoid content was observed in *Mimosa pudica* (74.36 ± 1.62 mg QE/g extract), followed by *Aerva lanata* (68.52 ± 1.48 mg QE/g extract). The abundance of flavonoids in *M. pudica* may explain its traditional use in wound healing, inflammation, and microbial infections. Similar findings were reported by Ahmad *et al*., (2012) [1], who identified flavonoids, tannins, and phenolic compounds as important constituents contributing to the pharmacological activities of *M. pudica*.

The phytochemical composition and flavonoid content observed in *Aerva lanata* support previous reports by Kumar *et al*., (2011) [11], who demonstrated the presence of alkaloids, flavonoids, tannins, and terpenoids responsible for its antioxidant, antimicrobial, and protective activities. Similarly, *Calotropis procera* showed appreciable phenolic and flavonoid contents, which may contribute to its traditional applications in inflammation, wound healing, and skin disorders. Comparable findings were reported by Kumar and Roy (2010) [13], who suggested that secondary metabolites present in *C. procera* are responsible for its biological activities.

The quantitative phytochemical variation among the selected plants may be influenced by several factors, including plant species, geographical conditions, plant part used, and extraction solvent. Ethanolic extracts generally showed better phytochemical recovery because ethanol efficiently extracts polar and moderately polar compounds such as phenolics and flavonoids. Similar observations were reported by Sasidharan *et al*., (2011) [16], who emphasized the importance of solvent selection in obtaining bioactive plant constituents.

Overall, the findings demonstrate that selected tribal medicinal plants are rich sources of bioactive phytochemicals. The higher levels of phenolic and flavonoid compounds may contribute significantly to their antibacterial and anti-inflammatory activities, thereby providing scientific support for their traditional medicinal applications and highlighting their potential for development as natural therapeutic agents.

Conclusion

The present study scientifically validates the traditional medicinal importance of selected tribal medicinal plants, namely *Mimosa pudica*, *Azadirachta indica*, *Tinospora cordifolia*, *Aerva lanata*, and *Calotropis procera*. Phytochemical analysis confirmed the presence of important bioactive constituents, including flavonoids, phenolics, alkaloids, tannins, saponins, and terpenoids, which are associated with significant antibacterial and anti-inflammatory properties. Quantitative estimation revealed considerable variation in total phenolic and flavonoid contents among the selected plants, indicating their potential therapeutic value. The findings support the traditional knowledge of tribal communities and suggest that these medicinal plants may serve as promising natural sources for the development of safe and effective herbal antibacterial and anti-inflammatory agents. Further studies involving isolation, characterization, and pharmacological evaluation of individual bioactive compounds are recommended to explore their clinical applications.

Refernces

1. Ahmad H, Sehgal S, Mishra A, Gupta R. *Mimosa pudica* L. (Fabaceae): An overview. Pharmacognosy Reviews,2012:6(12):115–124.
2. Alzohairy MA. Therapeutics role of *Azadirachta indica* (Neem) and their active constituents. Evidence-Based Complementary and Alternative Medicine, 2016, 2016.
3. Balouiri M, Sadiki M, Ibnsouda SK. Methods for *in vitro* evaluating antimicrobial activity: A review. Journal of Pharmaceutical Analysis,2016:6(2):71–79.
4. Bauer AW, Kirby WMM, Sherris JC, Turck M. Antibiotic susceptibility testing by a standardized single disk method. American Journal of Clinical Pathology,1966:45(4):493–496.
5. Biswas K, Chattopadhyay I, Banerjee RK, Bandyopadhyay U. Biological activities and medicinal properties of neem (*Azadirachta indica*). Current Science,2002:82(11):1336–1345.
6. Chang CC, Yang MH, Wen HM, Chern JC. Estimation of total flavonoid content in propolis by two complementary colorimetric methods. Journal of Food and Drug Analysis,2002:10(3):178–182.
7. Choedon T, Mathan G, Arya S, Kumar VL, Kumar V. Anticancer and biological properties of *Calotropis procera*. Pharmacologyonline,2006:1:215–226.
8. Fabricant DS, Farnsworth NR. The value of plants used in traditional medicine for drug discovery. Environmental Health Perspectives,2001:109(S1):69–75.
9. Harborne JB. Phytochemical methods: A guide to modern techniques of plant analysis. 3rd ed. Chapman & Hall,1998.
10. Kala CP. Current status of medicinal plants used by traditional healers in India. Ethnobotany Research and Applications,2005:3:267–278.
11. Kumar S, Malhotra R, Kumar D. *Aerva lanata*: A review on phytochemistry and pharmacological aspects. Pharmacognosy Reviews,2011:5(10):195–200.
12. Kumar S, Pandey AK. Chemistry and biological activities of flavonoids: An overview. The Scientific World Journal, 2013, 2013.
13. Kumar VL, Roy S. *Calotropis procera* latex extract in wound healing and inflammation. Inflammopharmacology,2010:18:115–120.
14. Panche AN, Diwan AD, Chandra SR. Flavonoids: An overview. Journal of Nutritional Science,2016:5:e47.
15. Saha S, Ghosh S. *Tinospora cordifolia*: One plant, many roles. Ancient Science of Life,2012:31(4):151–159.
16. Sasidharan S, Chen Y, Saravanan D, Sundram KM, Latha LY. Extraction, isolation and characterization of bioactive compounds from plant extracts. African Journal of Traditional, Complementary and Alternative Medicines,2011:8(1):1–10.
17. Scalbert A. Antimicrobial properties of tannins. Phytochemistry,1991:30(12):3875–3883.
18. Singleton VL, Orthofer R, Lamuela-Raventós RM. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin–Ciocalteu reagent. Methods in Enzymology,1999:299:152–178.
19. Trease GE, Evans WC. Pharmacognosy. 15th ed. Saunders Publishers, 2002.
20. World Health Organization. WHO traditional medicine strategy: 2014–2023. World Health Organization, 2013.