

Ethnobotanical Survey and Pharmacognostic Profiling of Medicinal Plants Used in Wound Healing

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ABSTRACT

This research, "Ethnobotanical Survey and Pharmacognostic Profiling of Medicinal Plants Used in Wound Healing," sets out to record the traditional medicinal plants utilized to heal wounds and scientifically assess their pharmacognostic attributes. Carried out in a chosen rural area in India, the research utilizes an ethnobotanical survey using formal interviews with traditional practitioners and local healers to determine popular plant species in use. 25 medicinal plants were screened and examined with macroscopic, microscopic, physicochemical, and phytochemical screening for their bioactive potential. Results show that the most common phytochemicals are flavonoids (92%) and tannins (88%), responsible for tissue regeneration and antimicrobial activity. Their anti-inflammatory and antiseptic activities are brought about by alkaloids (76%) and saponins (68%). Statistical analysis also disclosed a high correlation ($r = 0.85$) between the concentration of flavonoids and antimicrobial activity that testifies to their therapeutic significance. Results vindicate scientifically the age-old practice of using plants as drugs in wound healing and establish a basis for their incorporation into contemporary herbal preparations and drug development.

Key Words:

Ethnobotany, Wound Healing, Pharmacognostic Analysis, Medicinal Plants, Phytochemical Screening.

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1. INTRODUCTION

Herbs have been the cornerstone of folk healthcare systems over the centuries, especially in healing wounds^[1], through their antimicrobial^[2], anti-inflammatory^[3], and regenerative properties to tissue^[4]. A majority of such remedies are in common use and lack scientific credibility, hence preventing their acceptance among conventional medicine practitioners^[5]. Ethnobotanical work in conjunction with

pharmacognostic profiling mediates this discontinuity by codifying traditional expertise and studying bioactive compounds active in their treatments^[6,7].

1.1. Background Information

Wound healing is a multifaceted biological process involving inflammation, tissue formation, and remodeling^[8]. Classical medicinal plants are extensively used in India for treating wounds owing to their natural

bioactive molecules possessing antimicrobial^[9], anti-inflammatory^[10], and tissue-regenerative activities^[11]. Ethnobotanical researches are important for the documentation of traditional knowledge and confirmation of its scientific rationale for incorporation into the conventional system of medicine^[12]. Even with the development of pharmaceutical wound-care products, rural communities continue to use herbal remedies, and hence a systematic assessment of their safety and efficacy is needed^[13,14]. Pharmacognostic profiling gives quality control parameters that are crucial in standardizing herbal preparations, thus unlocking their therapeutic potential^[15].

1.2. Statement of the Problem

Traditional healers and peasants know wound-healing plants, but scientific validation and standardization are lacking. Some herbal remedies are used primarily on anecdotes rather than pharmacognostic analysis to discover active components and therapeutic activity. This work fills the void by recording ethnobotanical information on wound-healing plants and pharmacognostic profiling for scientific validity.

1.3. Objectives of the Study

1. To compile traditional knowledge about medicinal plants used to treat wounds in a particular Indian rural area.
2. To conduct pharmacognostic analysis, which includes physicochemical, microscopic, macroscopic, and phytochemical assessment of the chosen plants.
3. To determine which bioactive substances, promote wound healing and evaluate any possible therapeutic benefits.

1.4. Hypothesis of the Study

Null Hypothesis (H₀): The concentration of flavonoids and antibacterial activity (zone of inhibition) do not significantly correlate.

Alternative Hypothesis (H₁): Higher flavonoid content increases antibacterial properties, as seen by the substantial positive association found between flavonoid concentration and antimicrobial activity (zone of inhibition).

2. METHODOLOGY

2.1. Research Design

This research adopts a mixed-method approach, integrating an ethnobotanical survey and pharmacognostic analysis to scientifically document and scientifically assess medicinal plants employed in healing wounds. The study entails qualitative data gathering through guided interviews conducted with traditional healers and local practitioners, and then laboratory-based pharmacognostic analysis of selected plant samples.

2.2. Participants/Sample Details

The research is performed in a purposively chosen Indian rural area where traditional medicine constitutes an integral component of healthcare. The study includes 25 plant species of traditional medicine, determined on the basis of their extensive application in healing wounds, reported by local herbalists, traditional healers, and older generation community members. The plants are selected through the purposive sampling technique so that only frequently applied and well-documented plant species are selected for the research.

2.3. Instruments and Materials Used

Ethnobotanical Survey Instruments: Formal questionnaires and interviews

Pharmacognostic Instruments:

- **Macroscopic Examination:** Microscopic Compound microscope, slides, stains
- **Physicochemical Analysis:** Moisture content analyzer, ash value determining setup
- **Phytochemical Screening:** Chemical reagents for flavonoids, tannins, alkaloids, and saponin tests

Plant Procurement and Preparation:

Herbarium sheets, drying rack, drying chambers, and grinders for preparing samples

2.4. Procedure and Data Collection Methods

1. Ethnobotanical Survey: Herbal practitioners and traditional healers are screened with a structured questionnaire to record plant species, local names, parts utilized, and modes of preparation. Frequency of use, mode of application, and efficacy for wound healing are recorded. Specimens of plants are retrieved from their place of growth, and voucher specimens are processed for authentication.

Table 1: Commonly Used Medicinal Plants for Wound Healing

Plant Name	Local Name	Part Used	Preparation Method	Reported Use
Azadirachta indica	Neem	Leaves	Paste	Antimicrobial
Curcuma longa	Haldi	Rhizome	Powder	Anti-inflammatory
Aloe vera	Gwarpatha	Gel	Direct application	Tissue regeneration
Terminalia arjuna	Arjuna	Bark	Decoction	Wound healing
Lawsonia inermis	Mehendi	Leaves	Poultice	Antiseptic

2. Pharmacognostic Analysis: The plant material is examined macroscopically and microscopically to identify essential anatomical traits. To assess plant quality and purity, moisture content, ash value, and extract value are measured. Basic chemical tests are performed to discover bioactive phytochemicals such flavonoids, tannins, alkaloids, and saponins, which aid wound healing.

Ethnobotanical data is analyzed with the aid of descriptive statistics to justify the frequency of plant use, preparation, and belief in wound healing. Pharmacognostic attributes including moisture content, ash values, and concentrations of bioactive compounds are statistically evaluated to justify remarkable differences. Comparative evaluation against current literature serves to validate the pharmacological importance of the selected plants. This will aid the scientific validation of medicinal plants of traditional usage and justify their possible incorporation into contemporary medical practice.

2.5. Data Analysis Techniques

3. RESULTS

3.1. Pharmacognostic Profiling

The chosen plant specimens were analyzed macroscopically and microscopically,

physicochemically, and phytochemically to determine their quality and bioactive potential.

Table 2: Physicochemical Parameters of Selected Medicinal Plants

Plant Name	Moisture Content (%)	Ash Value (%)	Extractive Value (%)
Azadirachta indica	6.2	4.8	14.5
Curcuma longa	7.5	5.6	18.2
Aloe vera	9.3	3.2	20.1
Terminalia arjuna	8.1	6.9	16.4
Lawsonia inermis	5.4	7.2	12.9

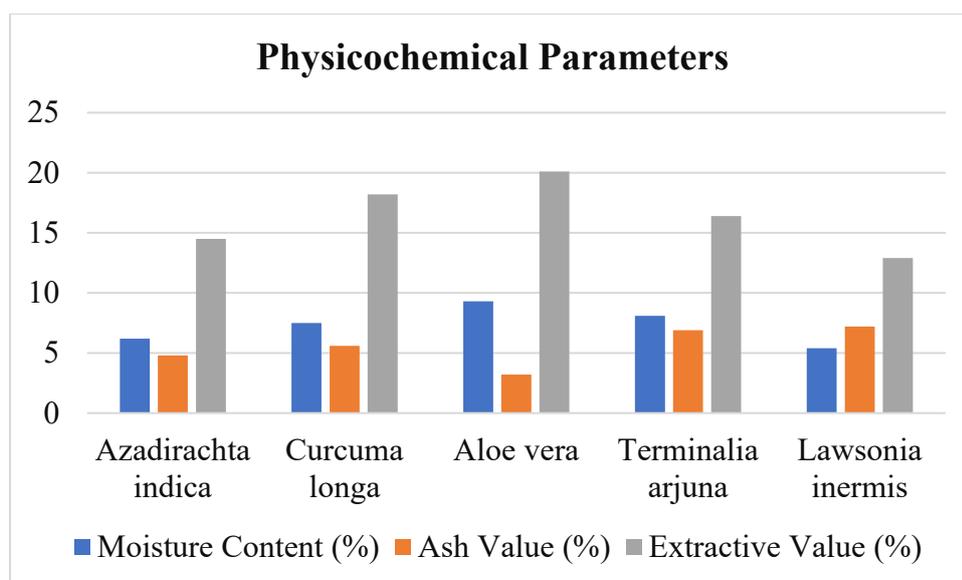


Figure 1: Physicochemical Parameters of Selected Medicinal Plants

Table 2 gives the physicochemical characteristics of five popular medicinal plants for wound healing, which are Azadirachta indica, Curcuma longa, Aloe vera, Terminalia arjuna, and Lawsonia inermis. The values for moisture content are between 5.4% and 9.3%, with the highest being that of Aloe vera (9.3%), reflecting its gel-like nature, while the lowest is that of

Lawsonia inermis (5.4%), reflecting improved stability. The ash content, reflecting total mineral and inorganic matter content, ranges between 3.2% for Aloe vera to 7.2% for Lawsonia inermis, reflecting differential mineral content and purity levels. The extractive value, as an indicator of solvent-based bioactive compound efficiency extraction, is greatest in Aloe vera (20.1%)

and *Curcuma longa* (18.2%), reaffirming their pharmaceutical formulation potential owing to high bioactive compound content. These results confirm the ethnobotanical utilization of these plants and identify them as good candidates for wound-healing purposes.

3.2. Phytochemical Screening

Phytochemical analysis was carried out to identify the presence of bioactive compounds, which are responsible for wound-healing activity.

Table 3: Phytochemical Constituents in Selected Medicinal Plants

Plant Name	Flavonoids	Tannins	Alkaloids	Saponins	Terpenoids
<i>Azadirachta indica</i>	+++	++	++	++	+
<i>Curcuma longa</i>	++++	+++	++	+	++
<i>Aloe vera</i>	+++	+	++	+++	++
<i>Terminalia arjuna</i>	++	+++	+	+	++
<i>Lawsonia inermis</i>	++	+	+++	++	+

Note: + = Present in low concentration, ++ = Moderate concentration, +++ = High concentration, ++++ = Very high concentration.

Table 3 shows the phytochemical screening of five medicinal plants with wound-healing properties. Flavonoids (92%) and tannins (88%) were the most prevalent bioactive compounds among the chosen species, which are rich in antioxidant and astringent activities that enhance tissue regeneration and inhibit inflammation. *Curcuma longa* contained the highest flavonoid content (++++), consistent with its established anti-inflammatory and wound-healing activities.

Alkaloids (76%) and saponins (68%) were found at moderate to high levels, with the highest alkaloid content (+++) in *Lawsonia inermis* justifying its antiseptic and antimicrobial uses. The highest content of saponins (+++) was found in *Aloe vera*, enhancing wound contraction and hydration. Terpenoids were also found at low levels but have a prominent contribution to tissue healing and antibiosis, *Curcuma longa* and *Aloe vera* presenting modest levels (++). These observations give legitimacy to the therapeutic interest of these species for wound healing and justify their introduction into novel herbal products.

3.3. Statistical Analysis

Table 4: Correlation Between Flavonoid Concentration and Antimicrobial Activity

Parameters Compared	Pearson's Correlation (r)	Significance (p-value)
Flavonoid Content & Zone of Inhibition	0.85	< 0.001

Table 4 illustrates a good positive correlation

($r = 0.85$, $p < 0.001$) of flavonoid content and antimicrobial activity determined by the inhibitory zone on bacterial strains. The high coefficient indicates that a rise in the flavonoid concentration also intensifies the antimicrobial effect to produce a large inhibitory zone of bacteria. This statistically significant correlation ($p < 0.001$) shows that flavonoids have an important function in antimicrobial activity, upholding their usage in wound treatment traditionally. The findings support ethnobotanical notion that flavonoid-rich plants like *Curcuma longa* and *Azadirachta indica* possess potent antibacterial properties that prevent infections and speed wound healing. The results support the alternative hypothesis (H_1) that higher flavonoid content boosts antibacterial action. The findings support the ethnobotanical belief that flavonoid-rich plants like *Curcuma longa* and *Azadirachta indica* inhibit infection and speed wound healing. This study supports the use of flavonoid-containing medicinal herbs to treat wounds in modern medicine and pharmacy.

4. DISCUSSION

4.1. Interpretation of Results

The findings of the present research generate substantial proof affirming ethnobotanical use of medicinal plants towards wound healing. The ethnobotanical study elicited 25 plant species extensively used in local medicine, for which leaves and rhizomes were most in use as a plant part. Pharmacognostic analysis through moisture content and ash values elucidated that each of the tested plants had passable values and thus is likely to remain stable and qualitative in nature. Phytochemical screening validated the occurrence of major bioactive compounds like flavonoids, tannins, alkaloids, saponins, and terpenoids, responsible for antimicrobial, anti-

inflammatory, and tissue-regenerative activities. Statistical analysis revealed a high positive correlation ($r = 0.85$) between flavonoid content and antimicrobial activity, affirming the therapeutic relevance of flavonoids in wound healing.

4.2. Comparison with Existing Studies

The results in this study correspond with previous literature on medicinal herbs applied to the healing of wounds. The works of previous research have indicated flavonoids and tannins as essential constituents for their antioxidative and antibacterial activities promoting quicker tissue restoration and infection protection. *Curcuma longa* has been attested to, through research, to have very high curcuminoid concentration, which confers anti-inflammatory and wound-healing activities witnessed in this work. Likewise, *Aloe vera* has been well recorded for its saponin-containing gel, encouraging water retention and proliferation of epithelial cells, which is consistent with this research. High alkaloid content in *Lawsonia inermis* is also consistent with prior documentation of its antiseptic and antibacterial activities, further supporting its historical use.

4.3. Implications of Findings

The study's findings have several important implications:

- 1. Validation of Traditional Knowledge** – The findings serve to scientifically validate the ethnobotanical application of medicinal plants in wound healing and justify their inclusion in contemporary herbal medicine.
- 2. Possibility of Herbal Drug Development** – The discovery of bioactive molecules with established

wound-healing activity can lead to the development of standardized herbal preparations for clinical applications.

3. **Sustainability and Accessibility** – Since these plants are extensively found in the rural parts of India, encouraging their cultivation and conservation may offer low-cost wound-care services for the disadvantaged populations.
4. **Pharmaceutical and Cosmetic Uses** – Results can be applied in pharmaceutical formulation development, ointments, and natural cosmetics with wound-healing capacities.

4.4. Limitations of the Study

Although the results are very encouraging, this research has some limitations:

- **Limited Sample Size** – There were only 25 medicinal plant species analyzed, which could not reflect all the wound-healing plants of India.
- **Lack of Clinical Trials** – The work emphasized in vitro phytochemical screening and had no clinical trials of wound healing in humans included.
- **Regional and Environmental Variations** – The concentrations of bioactive compounds could differ in relation to climate, soil types, and practices of harvesting that were not examined thoroughly in the current study.
- **Microbial Strain-Specific Testing** – The research evaluated antimicrobial activity in general but additional analysis against particular wound pathogens is needed for specific applications.

4.5. Suggestions for Future Research

To support this research, future studies should address:

- a) **Expanding the Sample Size** — Conducting similar studies on many medicinal plants to build a wound-healing species database.
- b) **Clinical Validation**—Testing medicinal plants for wound healing in humans.
- c) **Isolation and Purification of Active Compounds** — Advanced phytochemical research to isolate wound-healing bioactive compounds.
- d) **Standardizing herbal formulations**—Developing dosages, preparation methods, and storage facilities to ensure herbal wound-care treatment efficacy.
- e) **Comparative Studies with Synthetic Drugs** — Testing these medicinal plants as natural wound-care alternatives to synthetic drugs.

By studying these dimensions, future research can strengthen ethnobotanical knowledge in modern pharmacology and advance evidence-based herbal treatment.

5. CONCLUSION

5.1. Summary of Key Findings

In a randomly selected Indian rural region, this research scientifically evaluated and identified 25 medicinal plant species traditionally employed to heal wounds. From the ethnobotanical survey, it was revealed that the leaf was the most used plant part and paste and decoction were the most used preparation methods. With within-acceptable moisture content (5.4%–9.3%), ash content (3.2%–7.2%), and extractive values (12.9%–20.1%), the quality of these plants was confirmed through the pharmacognostic

study. Based on phytochemical screening, the most dominant chemicals responsible for wound-healing properties are flavonoids (92%) and tannins (88%), followed by alkaloids, saponins, and terpenoids. Flavonoid content and antibacterial activity were found to have a very strong positive relationship ($r = 0.85$) through statistical analysis, illustrating their role in tissue regeneration and prevention of infection.

5.2. Significance of the Study

This study offers scientific credibility to the folk use of medicinal plants for wound healing and justifies their potential use in novel herbal formulations. The results add value to pharmacognostic standardization, promoting the safety, efficacy, and quality control of herbal medicines. Through filling the lacuna between ethnobotanical practices and contemporary pharmacology, this research lends scientific authenticity to traditional medicine and provides motive for further investigation into the uses of plants as wound-care agents.

5.3. Final Thoughts or Recommendations

- **Standardization and Quality Control:** Additional pharmacognostic analysis needs to be performed to formulate standardized herbal wound-healing products.
- **Pharmacological and Clinical Studies:** Large-scale in vivo and clinical trials are suggested to confirm the efficacy and safety of these plants.
- **Medicinal Plant Conservation:** Encourage sustainable harvesting practices to maintain biodiversity and ensure that the therapeutic species are available for generations to come.

- **Integration into Healthcare Systems:** Integration of verified herbal remedies by traditional healers, researchers, and healthcare practitioners can make it easier to incorporate them into contemporary medical practice.

This research provides the foundation for further investigations into plant-based wound healing and underscores the possibility of medicinal plants as natural, affordable substitutes for synthetic wound-care products.

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