Naveen Shodh Sansar (An International Refereed / Peer Review Multidisciplinary Research Journal)
RNI No.- MPHIN/2013/60638, ISSN 2320-8767, E- ISSN 2394-3793, Scientific Journal Impact Factor (SJIF)- 8.054,
January to March 2026, E-Journal, Vol. I, Issue LIII (53), ISO 9001:2015 - E2024049304 (QMS)

Relevance of Bioactive Phytochemicals in Traditional Medicinal Plants: An Ethnobotanical Study of Tribal Communities of Madhya Pradesh, India

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Abstract : The present study aims to document ethnomedicinal plants used by tribal communities of Madhya Pradesh for treating skin disorders and to relate their traditional uses with their phytochemical properties. Commonly used plant species were analyzed and presented with details such as botanical name, family, local name, plant parts used, medicinal uses, and associated phytochemicals.The healing ability of these plants is mainly due to bioactive compounds like flavonoids, phenolics, tannins, alkaloids, and terpenoids, which help in reducing inflammation, fighting infections, protecting the skin, and promoting wound healing.

The study clearly shows a strong link between traditional knowledge and scientific evidence. It highlights that these plants have great potential for developing safe and effective herbal skin treatments. At the same time, it also stresses the need for further research and the conservation of this valuable indigenous knowledge.

Keywords: Ethnomedicinal plants, Tribes of Madhya Pradesh, Skin disorder,Phytoconstituents.

Introduction - Ethnobotanical research has played a crucial role in understanding the relationship between humans and plant resources, particularly in the domain of traditional medicine. India possesses a rich and ancient heritage of indigenous healthcare systems that are primarily based on medicinal plants and herbal formulations (Balick, 1996; Jain, 1991). This knowledge, transmitted orally across generations, continues to serve as a vital component of primary healthcare, especially in rural and tribal regions where access to modern medical facilities remains limited (World Health Organization, 2022).

Central India, particularly Madhya Pradesh, is recognized for its extensive forest cover and rich biodiversity, making it a significant repository of medicinal plant wealth (Jain, 2010)The state is inhabited by diverse tribal communities such as Gond, Bhil, Baiga, Kol, Korku, and Sahariya, who maintain a close relationship with their natural environment. These communities rely heavily on locally available plant resources for treating a wide range of ailments, with particular emphasis on skin-related disorders such as wounds, burns, eczema, infections, and fungal diseases (Singh et al., 2022; Verma & Verma, 2010). Their traditional practices show a strong practical knowledge of how plants are used for healing.

Ethnodermatology, a specialized branch of ethnomedicine, focuses on the use of plants for skin care, protection, and treatment of dermatological conditions. Various plant parts including leaves, roots, bark, seeds, latex, and fruits are utilized in the form of pastes, decoctions, extracts, and oils (Begum & Nath, 2000; Mishra & Patil, 2014). These remedies are widely accepted due to their affordability, accessibility, cultural acceptance, and relatively fewer side effects. However, the therapeutic potential of these ethnomedicinal plants is largely attributed to the presence of diverse bioactive phytoconstituents such as flavonoids, phenolic compounds, alkaloids, tannins, terpenoids, and glycosides. These compounds exhibit significant biological activities including antioxidant, antimicrobial, anti-inflammatory, and wound healing properties, which are essential for the management of skin disorders (Kumar & Pandey, 2013; Dai & Mumper, 2010). Previous ethnobotanical studies conducted in different regions of Madhya Pradesh have documented numerous plant species used traditionally for the treatment of skin ailments (Jain et al., 2010). However, systematic analysis of plant usage patterns, phytochemical basis, and their relevance in dermatological applications remains limited.

Aim: The present study aims to document the commonly used plants by tribal communities of Madhya Pradesh for treating skin disorders and to analyze specific plant parts . It also attempts to link their traditional uses with known phytochemicals. Hence, this study may help in preserving traditional knowledge and support the development of safe, plant-based medicines for skin diseases.

Methodology: To achieve this objective, the present study was conducted as a systematic review based on secondary data. Information was collected from published scientific literature, including research articles, review papers, ethnobotanical surveys, books, and government reports such as the Census of India (2011). Online academic databases including Google Scholar, ResearchGate, and PubMed were used to ensure the inclusion of authentic and peer-reviewed sources.

Ethnomedicinal Data related to major tribal communities of Madhya Pradesh, namely Gond, Bhil, Baiga, Kol, Korku, and Sahariya, were compiled from previously documented ethnobotanical studies (Verma, P. ,2023;Singh et al., 2022; Samar et al., (2015).Information regarding traditional plant use for treating skin-related ailments such as wounds, burns, eczema, infections, and fungal diseases was carefully extracted and compared across different sources to ensure reliability. Only those Plant species were included which were consistently reported in multiple ethnobotanical studies, had documented use in treating skin disorders, and possessed reported phytochemical constituents. Species with insufficient ethnomedicinal evidence or lacking phytochemical information were excluded. The selected plant species were systematically arranged in tabular form, including details such as botanical name, family, local name, plant part used, medicinal application, and reported phytochemicals.

Information on phytoconstituents such as flavonoids, phenolics, alkaloids, tannins, terpenoids, glycosidesand bioactive molecules was collected from phytochemical and pharmacological studies. These compounds were then correlated with their known biological activities, particularly antimicrobial, anti-inflammatory, antioxidant, and wound healing properties, to scientifically justify their traditional use in skin disorders (Table 1).

Result:

Table 1 & 2 (See in last page)

Phytochemical Justification: The phenolics group, including flavonoids, phenolic acids, and tannins, represents the most dominant class of phytoconstituents identified in the documented ethnomedicinal plants. These compounds exhibit strong antioxidant, anti-inflammatory, and antimicrobial activities, which are essential in managing skin disorders. Flavonoids play a crucial role in reducing oxidative stress and enhancing wound healing, while also demonstrating antibacterial activity against skin pathogens such as Propionibacterium acnes through modulation of cellular signaling pathways like PI3K-Akt (Kumar & Pandey, 2013; Ruan et al., 2022).Tannins, another major component of this group, exhibit astringent and protective properties, facilitating wound contraction, reducing exudation, and forming a protective barrier over damaged tissues. Their antimicrobial and anti-inflammatory actions are particularly effective in conditions such as eczema and ulcers (Smeriglio et al., 2017; Salminen et al., 2011).Their presence provides scientific support for the traditional use of these plants in dermatological disorders (Dai & Mumper ,2010).

Alkaloids, nitrogen-containing bioactive compounds, are widely present in ethnomedicinal plants used for treating skin disorders. They exhibit antimicrobial, anti-inflammatory, and analgesic activities, helping to control infections, reduce inflammation, and promote wound healing. These compounds inhibit the growth of pathogenic bacteria and fungi responsible for skin infections, while also modulating inflammatory responses and reducing pain at the affected site (Cushnie et al., 2014). Their occurrence in plants such as Azadirachta indica and Rauvolfia serpentina further validates the ethnomedicinal practices of tribal communities of Madhya Pradesh and highlights their potential in plant-based skin therapies.

The terpenoid group, including terpenoids, resins, and iridoids, plays a vital role in skin protection and healing. These compounds exhibit anti-inflammatory, antimicrobial, and tissue-protective activities, which are crucial for wound management. Terpenoids and iridoids help regulate inflammatory mediators and reduce tissue damage, thereby accelerating the healing process (Viljoen et al., 2012).Resins, particularly from species such as Shorearobusta, contribute by forming a physical protective barrier over wounds, preventing microbial invasion and supporting tissue regeneration (Musa et al., 2023). This combination of biochemical and physical protective mechanisms highlights the importance of terpenoid-rich plants in traditional skin treatments.

Specialized phytoconstituents such as saponins, coumarins, and cardiac glycosides provide additional therapeutic support in managing skin disorders. Saponins exhibit antimicrobial and cleansing properties, helping in wound disinfection and maintaining skin integrity (Ekor, 2014). Coumarins contribute through their anti-inflammatory and antioxidant activities, making them effective in treating conditions like eczema and dermatitis (Venugopala et al., 2013).

Certain plants contain specific bioactive molecules that directly influence skin regeneration and healing processes. Vitamin C, found in Emblica officinalis, plays a critical role in collagen synthesis, accelerating tissue repair and protecting against oxidative damage (Pullar et al., 2017).Proteolytic enzymes such as papain in Carica papaya exhibit anti-inflammatory and immunomodulatory effects, promoting wound debridement and faster healing (Rakhimov, 2001). Similarly, anthraquinones such as aloin and emodin present in Aloe vera contribute to skin regeneration, antioxidant defense, and cytokine regulation, enhancing overall dermatological healing (Segal, 2022).

Conclusion: Traditional ethnomedicinal practices of tribal communities in Madhya Pradesh are based on effective plant species that have been used over generations for treating skin disorders. The present study shows that these communities possess valuable knowledge of medicinal

plants, and the repeated use of certain species across different studies suggests their reliability in treatment. The effectiveness of these plants is attributed to the presence of bioactive phytochemicals such as flavonoids, tannins, alkaloids, and specialized compounds (papain, aloin, vitamin C), which are known to exhibit antimicrobial, anti-inflammatory, antioxidant, and wound healing activities.

The findings establish a clear link between traditional ethnomedicinal practices and phytochemical evidence, highlighting the therapeutic potential of these plants in dermatological disorder. The study emphasizes the importance of conserving indigenous knowledge and suggests further research for clinical validationto establish the safety and efficacy of these plant-based remedies.

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Table 1: CommonlyUsed Ethnomedicinal Plants with Plant Parts and Phytochemical Relevance (Source: secondary data-based systematic review)

Plant Species	Family	Local Name	Plant Part Used	Key Phytochemica-ls	Dominant Mechanism	Skin Disorder Use (Traditional)
Azadirachta indica	Meliaceae	Neem	Leaves	Nimbidin, azadirachtin, flavonoids	Antimicro-bial,anti-inflammatory	Eczema, boils, pimples
Aloe vera	Asphodelaceae	Gawarpata	Leaves (gel)	Aloin, emodin, polysaccharides	Wound healing, antioxidant	Burns, skin repair
Acacia catechu	Fabaceae	Khair	Bark	Catechin, tannins	Astringent, antimicrobial	Eczema, skin diseases
Cassia tora	Caesalpiniaceae	Chakoda	Leaves, seeds	Anthraquinones, flavonoids	Antifungal, antimicrobial	Ringworm, eczema
Cassia fistula	Caesalpiniaceae	Amaltas	Leaves, bark	Rhein, flavonoids	Antimicro-bial,anti-inflammatory	Leprosy, itching
Ocimum sanctum	Lamiaceae	Tulsi	Leaves	Eugenol, flavonoids	Antimicro-bial,anti-inflammatory	Ringworm
Tridax procumbens	Asteraceae	Lugharia	Leaves	Flavonoids, carotenoids	Wound healing, antioxidant	Cuts, wounds, eczema
Cynodondactyl on	Poaceae	Doob	Whole plant	Flavonoids, alkaloids	Antimicro-bial,tissue repair	Wound healing
Emblica officinalis	Phyllanthaceae	Amla	Fruits	Vitamin C, tannins	Antioxidant, collagen synthesis	Cuts, skin repair
Vitex negundo	Verbenaceae	Nirgundi	Leaves	Flavonoids, iridoids	Anti-inflammatory	Wounds
Calotropis gigantea	Apocynaceae	Madar	Leaves	Cardiac glycosides, flavonoids	Anti-inflammatory antimicrobial	Boils
Shorearobusta	Dipterocarpacea e	Sal	Stem (resin)	Resin, tannins	Protective barrier, wound healing	Wounds
Zizyphusmauri tiana	Rhamnaceae	Ber	Leaves	Saponins, flavonoids	Skin protection, antimicrobial	Skin eruptions
Carica papaya	Caricaceae	Papita	Latex, fruit	Papain enzyme, flavonoids	Anti-inflammatory, enzymatic healing	Ringworm, eczema
Ficus benghalensis	Moraceae	Bargad	Bark, latex	Tannins, flavonoids	Astringent, wound healing	Burns, wounds

Table 2: Phytochemical–Mechanism–Plant Relationship in Skin Disorder Treatment (Sources: secondary data-based systematic review)

Phytochemical Group	Specific Compounds	Biological Mechanism	Representative Plant Species	Therapeutic Relevance in Skin Disorders	Phytochemical Group
Phenolics Group	Flavonoids, Tannins, Phenolic compounds	Antioxidant, Antimicrobial Anti-inflammatory.	:Azadirachta indica, :Ocimum sanctum, :Cynodondactylon, :Acacia catechu, :Terminalia arjuna, :Shorearobusta, :Emblica officinalis, :Ficus religiosa, :Tridax procumbens	-Reduces oxidative stress, prevents infection, promotes wound healing and skin protection	Phenolics Group
Nitrogen Compounds	Alkaloids	Antimicrobial,Anti-inflammatory, Analgesic	:Rauwolfia serpentina, :Datura metel, :Azadirachta indica	Inhibits pathogenic microbes and reduces inflammation in skin infections	Nitrogen Compounds
Terpenoid Group	Terpenoids, Resins, Iridoids	Anti-inflammatory,Antimicrobial,Protective barrier formation	:Shorearobusta, :Calotropis gigantea, :Vitex negundo	Enhances tissue repair, prevents microbial invasion, supports wound healing	Terpenoid Group
Specialized Compounds	Saponins, Coumarins, Cardiac glycosides	Antimicrobial, Anti-inflammatory, Skin protection	:Zizyphusmauritiana, :Feronia limonia, :Calotropis gigantea	Cleanses wounds, reduces infection, improves skin integrity	Specialized Compounds
Bioactive Molecules	Vitamin C, Papain, Anthraquinones (Aloin, Emodin)	Collagen synthesis, Anti-inflammatory, Antioxidant, tissue regeneration	:Emblica officinalis, :Carica papaya, :Aloe vera	Accelerates wound healing, promotes skin regeneration, reduces inflammation	Bioactive Molecules
Phenolics Group	Flavonoids, Tannins, Phenolic compounds	Antioxidant, Antimicrobial, Anti-inflammatory	;Azadirachta indica, :Ocimum sanctum, :Cynodondactylon, :Acacia catechu, :Terminalia arjuna, :Shorearobusta, :Emblica officinalis, :Ficus religiosa, :Tridax procumbens	Reduces oxidative stress, prevents infection, promotes wound healing and skin protection	Phenolics Group

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