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COMPARATIVE ETHNOBOTANICAL STUDY OF MEDICINAL FLORA IN SHEKHAWATI AND ADJACENT ARID ZONES OF RAJASTHAN

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Abstract:
The arid and semi-arid landscapes of Rajasthan sustain a rich yet ecologically fragile repository of medicinal plant diversity that supports traditional healthcare systems among rural communities. The present study undertakes a comparative ethnobotanical analysis of medicinal flora in the Shekhawati region and adjacent arid zones of Rajasthan, including parts of the Thar Desert belt. The research aims to document species diversity, evaluate patterns of plant usage, and analyze variations in traditional knowledge systems across ecological gradients. Field surveys were conducted using semi-structured interviews, participant observation, and botanical specimen verification. A total of over 180 medicinal plant species were recorded across both regions, belonging predominantly to families such as Fabaceae, Meliaceae, Apocynaceae, and Euphorbiaceae. Comparative analysis revealed both shared and region-specific species, reflecting adaptation to climatic variability and socio-cultural practices. Gastrointestinal, dermatological, and respiratory ailments constituted the most frequently treated categories across zones, with high informant consensus values indicating reliability of therapeutic claims. However, species distribution and harvesting intensity differed due to ecological factors such as rainfall variability, soil composition, and grazing pressure. The study highlights the influence of environmental conditions on plant selection and preparation methods while underscoring the erosion of indigenous knowledge due to modernization and habitat degradation. By integrating taxonomic documentation with cross-regional comparison, the research contributes to understanding biodiversity conservation priorities and the resilience of traditional medical systems in arid ecosystems.

Keywords: Ethnobotany; Medicinal Flora; Arid Rajasthan; Shekhawati Region; Traditional Knowledge; Biodiversity Conservation.

1. INTRODUCTION

Traditional medicinal systems form an integral component of healthcare practices across arid and semi-arid regions of India, where ecological constraints and limited accessibility to modern medical facilities reinforce dependence on plant-based remedies. Globally, the World Health Organization (WHO, 2013) estimates that nearly 80% of populations in developing countries rely on traditional medicine for primary healthcare needs. India, recognized as one of the world's biodiversity-rich nations, hosts extensive ethnobotanical traditions shaped by regional climatic diversity and cultural heritage (Jain, 1991). Within Rajasthan, the arid and semi-arid landscapes provide a unique ecological context in which medicinal plant knowledge has evolved in close association with environmental adaptability and community resilience.

The Shekhawati region, situated in northeastern Rajasthan, and the adjacent arid zones forming part of the Thar Desert represent ecologically transitional belts characterized by sparse rainfall, sandy soils, extreme temperature fluctuations, and drought-resistant vegetation. These regions have historically sustained rural communities who depend upon locally available flora for treating common ailments such as digestive disorders, respiratory infections, skin diseases, fever, and musculoskeletal conditions. Ethnobotany,

defined as the scientific study of the relationships between people and plants, provides the methodological and conceptual framework for documenting such traditional knowledge systems (Cotton, 1996; Martin, 2004).

Comparative ethnobotanical studies are particularly valuable in understanding how ecological gradients influence plant selection, usage patterns, and preparation techniques. Differences in rainfall distribution, soil salinity, grazing intensity, and land-use practices may result in variations in species availability and therapeutic applications. For example, while Shekhawati exhibits semi-arid scrubland vegetation interspersed with agricultural fields, the deeper arid zones of western Rajasthan demonstrate desert grasslands and dune ecosystems dominated by hardy xerophytes (Bhandari, 1990). Such ecological diversity inevitably shapes medicinal plant inventories and associated knowledge systems.

Previous research in Rajasthan has documented medicinal plant use among tribal and desert communities; however, limited studies have undertaken systematic comparative analyses between semi-arid and arid belts (Sharma et al., 2012). Without comparative frameworks, understanding the adaptive strategies of rural healthcare systems across climatic gradients remains incomplete. Moreover, rapid socio-economic transformation, commercialization of herbal products, and climate variability threaten both plant biodiversity and knowledge transmission (Hamilton, 2004). Younger generations increasingly gravitate toward allopathic medicine, leading to erosion of orally transmitted ethnomedicinal traditions (Gadgil et al., 1993).

The present study seeks to bridge this gap by conducting a comparative ethnobotanical investigation of medicinal flora in the Shekhawati region and adjacent arid zones of Rajasthan. The primary objectives are to (a) document and taxonomically verify medicinal plant species in both regions, (b) compare therapeutic categories and informant consensus patterns, (c) analyze ecological influences on plant diversity and usage, and (d) assess conservation challenges affecting sustainability. By integrating botanical documentation with socio-cultural interpretation, this study contributes to broader discourses on biodiversity conservation, climate adaptation, and preservation of indigenous knowledge systems in arid ecosystems.

2. STUDY AREA AND ECOLOGICAL–SOCIO-CULTURAL CONTEXT

The study encompasses two ecologically distinct yet contiguous regions of Rajasthan: the semi-arid Shekhawati belt (covering Jhunjhunu, Sikar, and parts of Churu districts) and the adjacent arid zones extending toward the Thar Desert region, including western Churu and parts of Nagaur and Bikaner districts. These regions collectively represent a gradient from semi-arid scrublands to true desert ecosystems, characterized by declining rainfall and increasing aridity from east to west.

Shekhawati experiences average annual rainfall between 300 and 500 mm, primarily during the southwest monsoon. The vegetation comprises thorny scrub forests, scattered trees, agricultural margins, and pasturelands. Dominant species include Acacia nilotica, Prosopis cineraria, Azadirachta indica, Calotropis procera, and Ziziphus mauritiana. These species exhibit xerophytic adaptations such as deep root systems and reduced leaf surfaces, enabling survival in moisture-deficient soils (Sharma & Khandelwal, 2014). The region's mixed agroforestry practices also support cultivated medicinal plants such as Aloe vera and Withania somnifera.

In contrast, the adjacent arid zones of western Rajasthan receive less than 250 mm of annual rainfall and are characterized by sand dunes, desert grasslands, and saline soils. Vegetation is dominated by hardy shrubs and grasses, including Capparis decidua, Calligonum polygonoides, Cenchrus ciliaris, and Haloxylon salicornicum (Bhandari, 1990). Plant diversity in these areas is comparatively lower in terms

of density but often includes species uniquely adapted to extreme desert conditions. Such ecological variation significantly influences medicinal plant availability and harvesting practices.
Socio-economically, communities in both regions are predominantly rural, relying on agriculture, animal husbandry, and small-scale trade. Healthcare accessibility remains uneven, particularly in remote desert villages where primary health centers may be located several kilometers away. Consequently, reliance on traditional medicinal plants remains a practical and culturally embedded healthcare strategy. Traditional healers, commonly referred to as vaidya or hakim, possess specialized knowledge of plant identification, seasonal collection, and preparation methods. Elderly community members and women managing household herbal gardens serve as additional custodians of ethnomedicinal knowledge.

Cultural and spiritual beliefs further shape medicinal plant conservation and use. Sacred groves (locally known as orans) historically functioned as protected ecological niches where plant extraction was restricted due to religious reverence (Gadgil & Vartak, 1976). Species such as Azadirachta indica (Neem) and Ocimum sanctum (Tulsi) hold both medicinal and ritual significance, reflecting the integration of spiritual and therapeutic practices. However, modernization, migration, and formal education systems have disrupted traditional transmission pathways, resulting in knowledge gaps among younger generations (Kala & Sajwan, 2007).

Comparative analysis across these regions provides insight into how ecological constraints influence plant selection and medicinal repertoire. In semi-arid Shekhawati, greater species density and agroforestry integration allow a broader range of therapeutic options, whereas in deeper arid zones, communities rely heavily on drought-resistant shrubs and multipurpose desert trees. Differences in soil composition and water availability also affect preparation techniques, with decoctions and dried powders more common in arid settings where fresh plant material is seasonally limited.

Overall, the ecological–socio-cultural context of Shekhawati and adjacent arid zones demonstrates a dynamic interplay between environmental adaptation, cultural tradition, and healthcare necessity. Understanding this interplay is essential for developing region-specific conservation strategies and sustainable medicinal plant management practices. By situating ethnobotanical documentation within ecological gradients and social frameworks, the study offers a comprehensive perspective on the resilience and vulnerability of traditional medical systems in Rajasthan’s arid landscapes.

3. METHODOLOGY

The present study adopted a comparative ethnobotanical research design integrating qualitative field investigation with quantitative analytical tools to examine similarities and differences in medicinal plant usage between the Shekhawati region and adjacent arid zones of Rajasthan. Ethnobotanical research requires a multidisciplinary approach that combines botanical identification, cultural documentation, ecological observation, and statistical validation (Cotton, 1996; Martin, 2004). Given the orally transmitted nature of traditional medicinal knowledge in rural Rajasthan, qualitative methods formed the primary foundation of the research, supplemented by quantitative indices to strengthen analytical rigor.

Fieldwork was conducted over an 18-month period to account for seasonal variations in plant availability. The study area was divided into two comparative ecological zones: (a) semi-arid Shekhawati (Jhunjhunu, Sikar, eastern Churu) and (b) deeper arid zones extending toward western Churu, Nagaur, and Bikaner districts. Villages were selected using purposive sampling based on ecological diversity, active traditional medicinal practices, and the presence of knowledgeable informants. A stratified sampling strategy ensured representation across gender, age groups, and occupations.

Approximately 220 informants were interviewed across both regions, including traditional healers (*vaidya* and *hakim*), elderly community members (aged above 60 years), women managing household herbal gardens, farmers, shepherds, and local traders dealing in medicinal plants. Snowball sampling was employed to identify key knowledge holders recommended by initial participants. Prior informed consent was obtained, and ethical protocols respecting confidentiality and cultural sensitivity were strictly observed.

Data collection relied primarily on semi-structured interviews, participant observation, focus group discussions, and field-based botanical surveys. Semi-structured interviews enabled collection of detailed information regarding local plant names, plant parts used, methods of preparation, dosage forms, and ailments treated. Open-ended questions encouraged participants to elaborate on seasonal harvesting patterns, ritual dimensions, and perceived efficacy of remedies. Participant observation allowed the researcher to accompany healers during plant collection and preparation, thereby verifying reported practices through direct experience (Heinrich et al., 2009).

Botanical surveys were conducted across scrub forests, pasturelands, agricultural margins, sacred groves (*orans*), and desert dunes. Plant specimens were collected in limited quantities to avoid ecological damage. Voucher specimens were prepared and taxonomically identified using regional floras, including *Flora of the Indian Desert* (Bhandari, 1990). Scientific names were verified through herbarium comparison and cross-referenced with published botanical databases to ensure taxonomic accuracy.

Data analysis involved both qualitative thematic analysis and quantitative ethnobotanical indices. Therapeutic uses were categorized into major ailment groups such as gastrointestinal disorders, dermatological conditions, respiratory diseases, musculoskeletal ailments, febrile conditions, and reproductive health issues. Comparative patterns between semi-arid and arid zones were examined in terms of species richness, plant part utilization, and preparation techniques.

To assess cultural significance and reliability of medicinal claims, the Use Value (UV) and Informant Consensus Factor (ICF) were calculated following established ethnobotanical methodologies (Phillips & Gentry, 1993). Use Value was determined by dividing the total number of use-reports for a species by the number of informants, indicating relative importance. Informant Consensus Factor was calculated for each ailment category to measure agreement among respondents regarding plant selection. Higher ICF values reflected stronger consensus and potentially greater therapeutic reliability.

The comparative framework allowed examination of how ecological gradients influence medicinal plant diversity and healthcare strategies. Differences in rainfall, soil composition, grazing intensity, and vegetation types were correlated with variations in species distribution and usage patterns. This integrated methodology ensured a robust and systematic comparative ethnobotanical analysis grounded in both cultural narratives and botanical verification.

4. COMPARATIVE DOCUMENTATION AND TAXONOMIC ANALYSIS OF MEDICINAL FLORA

The comparative survey documented a total of 192 medicinal plant species across both ecological zones, belonging to 68 botanical families. The semi-arid Shekhawati region recorded 162 species, whereas the deeper arid zones documented 128 species, with approximately 98 species common to both regions. The higher species richness observed in Shekhawati reflects relatively greater rainfall, agroforestry integration, and vegetational heterogeneity compared to the more extreme desert ecosystems (Sharma & Khandelwal, 2014).

Fabaceae emerged as the most represented family in both regions, followed by Meliaceae, Apocynaceae, Solanaceae, and Euphorbiaceae. The dominance of Fabaceae aligns with its ecological adaptability to drought-prone conditions and nitrogen-fixing capacity, which supports survival in nutrient-poor soils (Bhandari, 1990). In semi-arid areas, tree and shrub species such as *Azadirachta indica*, *Prosopis cineraria*, *Acacia nilotica*, and *Ziziphus mauritiana* were frequently cited. In deeper arid zones, hardy shrubs such as *Capparis decidua*, *Calligonum polygonoides*, and *Haloxylon salicornicum* featured prominently.

In terms of growth forms, trees constituted approximately 36% of recorded species, shrubs 32%, herbs 24%, and climbers 8%. The relatively higher proportion of shrubs in arid zones reflects desert adaptation strategies, where low-stature woody plants dominate sand dune ecosystems. Leaves were the most commonly used plant part (41%), followed by roots (23%), bark (14%), fruits and seeds (12%), and latex or whole plant (10%). However, a notable difference emerged between regions: in arid zones, dried roots and bark were more frequently used due to seasonal scarcity of fresh foliage, whereas in Shekhawati, fresh leaf preparations were more common owing to relatively better moisture availability.

Therapeutically, gastrointestinal disorders represented the most frequently treated category in both regions, accounting for nearly 28% of total use-reports. High Informant Consensus Factor (ICF) values (0.81 in Shekhawati and 0.84 in arid zones) indicated strong agreement regarding plant efficacy for digestive ailments. Species such as *Aegle marmelos*, *Foeniculum vulgare*, and *Cassia fistula* were widely cited. Dermatological conditions ranked second, with species like *Aloe vera*, *Calotropis procera*, and *Azadirachta indica* commonly used for wound healing and skin infections.

Respiratory ailments, including cough and asthma, showed higher reliance on desert-adapted shrubs in arid zones, particularly *Capparis decidua* and *Leptadenia pyrotechnica*. Musculoskeletal treatments frequently involved root-based decoctions and oil infusions prepared from *Withania somnifera* and *Ricinus communis*. Febrile conditions and general weakness were commonly treated using neem-based decoctions and herbal tonics.

Quantitative analysis revealed that *Azadirachta indica* exhibited the highest Use Value (UV = 0.87) across both regions, underscoring its cultural and therapeutic prominence. *Withania somnifera* (UV = 0.79) and *Prosopis cineraria* (UV = 0.65) followed closely. In arid zones specifically, *Capparis decidua* displayed higher UV compared to semi-arid Shekhawati, reflecting ecological specificity in plant reliance.

Cultural practices surrounding plant use showed both similarities and variations. Sacred groves (*orans*) were more prevalent in semi-arid villages, functioning as biodiversity conservation zones protected by religious norms (Gadgil & Vartak, 1976). In deeper desert villages, where vegetation density is lower, community norms emphasize restrained harvesting and seasonal restrictions. Women in both regions played significant roles in household-level healthcare, though herbal garden maintenance was more common in semi-arid settings due to greater water availability.

Comparative findings indicate that ecological conditions significantly influence species diversity, preparation methods, and harvesting intensity. While Shekhawati's semi-arid environment supports greater species richness and fresh plant use, the arid zones demonstrate adaptive reliance on drought-resistant shrubs and preserved plant materials. Despite ecological differences, strong informant consensus values across regions highlight the resilience and reliability of traditional medicinal systems.

However, both zones face similar conservation challenges, including habitat fragmentation, overgrazing, and knowledge erosion due to modernization (Hamilton, 2004). The comparative perspective underscores

the importance of region-specific conservation strategies that account for ecological constraints while preserving shared ethnomedicinal heritage.

5. CONSERVATION IMPLICATIONS AND SUSTAINABILITY CHALLENGES

The comparative ethnobotanical findings from Shekhawati and adjacent arid zones of Rajasthan reveal significant conservation implications shaped by ecological fragility, socio-economic transformation, and changing patterns of medicinal plant utilization. Although both regions demonstrate resilience in sustaining traditional healthcare systems under harsh climatic conditions, the sustainability of medicinal flora remains increasingly vulnerable. Semi-arid Shekhawati, characterized by relatively higher rainfall and agroforestry integration, supports greater plant species richness compared to the deeper arid zones. However, the ecological advantage does not exempt it from biodiversity loss resulting from agricultural expansion, urban development, and fragmentation of village commons. Similar ecological pressures are observed across arid landscapes of Rajasthan, where overexploitation and land-use change have reduced natural vegetation cover (Hamilton, 2004; Sharma et al., 2012).

In the semi-arid belt, traditional sacred groves (*orans*) historically functioned as informal conservation sites where extraction of plant resources was culturally regulated. These groves preserved multipurpose species such as *Azadirachta indica*, *Prosopis cineraria*, and *Acacia nilotica*, which hold both medicinal and ritual value. However, declining adherence to customary protection norms, coupled with privatization of common lands, has weakened the ecological function of these sacred landscapes (Gadgil & Vartak, 1976). In contrast, the deeper arid zones, though possessing lower species density, demonstrate heightened ecological vulnerability due to sparse vegetation and slower regeneration rates. Overharvesting of shrubs such as *Capparis decidua* and *Leptadenia pyrotechnica* for medicinal and fodder purposes directly impacts regeneration cycles in desert ecosystems.

Commercialization of herbal products further complicates conservation dynamics. While traditional harvesting practices were guided by empirical knowledge emphasizing seasonal collection and partial extraction, contemporary market demand often promotes bulk harvesting without ecological restraint. Root-based remedies, particularly those derived from *Withania somnifera* and *Ricinus communis*, pose greater sustainability risks because root extraction limits plant survival and regeneration (Kala & Sajwan, 2007). The shift from subsistence-level usage to market-oriented trade introduces pressures that exceed the carrying capacity of fragile arid ecosystems.

Climate variability intensifies these challenges. Erratic monsoon patterns, rising temperatures, and prolonged droughts reduce flowering and seed production in several medicinal species. Phenological shifts may alter the bioactive composition of plants, potentially affecting medicinal efficacy. Semi-arid Shekhawati experiences moderate climatic buffering through agroforestry and irrigation systems, whereas deeper desert regions face acute stress due to minimal rainfall and high evapotranspiration. The ecological gradient between these regions underscores the need for differentiated conservation strategies responsive to local environmental conditions.

Beyond ecological factors, the erosion of indigenous knowledge systems poses a parallel threat to sustainability. Comparative analysis indicates that elderly informants in both regions possess significantly greater knowledge of medicinal flora than younger respondents. Migration to urban centers, formal education systems privileging biomedical models, and reduced engagement with traditional healers contribute to declining knowledge transmission (Gadgil et al., 1993). In semi-arid villages, household herbal gardens maintained by women provide a degree of continuity; however, in arid zones where water scarcity limits cultivation, knowledge retention relies primarily on oral memory rather than active practice.

The conservation implications of these findings highlight the necessity of integrating indigenous ecological knowledge with scientific resource management. Community-based conservation models rooted in participatory biodiversity registers and revival of sacred groves can strengthen local stewardship. Agroforestry systems in Shekhawati present opportunities for ex situ cultivation of high-demand species, reducing pressure on wild populations. In arid zones, controlled harvesting protocols and community agreements regulating shrub extraction are critical for maintaining ecological balance. The integration of local governance institutions, Panchayati Raj bodies, and national medicinal plant boards can facilitate coordinated policy implementation.

Ultimately, sustainability in arid ethnobotanical systems requires recognizing that biodiversity and cultural heritage are mutually reinforcing. Medicinal plant conservation must be framed not only as ecological protection but also as preservation of community identity and healthcare autonomy. Comparative evidence from Shekhawati and adjacent arid zones underscores that while ecological conditions vary, the underlying conservation challenges are interconnected and demand collaborative, context-specific responses.

6. CONCLUSION AND FUTURE DIRECTIONS

The comparative ethnobotanical study of medicinal flora in Shekhawati and adjacent arid zones of Rajasthan demonstrates the adaptive resilience of traditional healthcare systems within ecologically challenging environments. Despite differences in rainfall patterns, vegetation density, and species richness, both regions exhibit strong informant consensus regarding plant-based treatments for gastrointestinal, dermatological, respiratory, and musculoskeletal ailments. Semi-arid Shekhawati supports greater overall species diversity due to comparatively favorable climatic conditions and agroforestry integration, whereas the deeper arid zones rely on a narrower yet ecologically specialized repertoire of desert-adapted shrubs and multipurpose trees.

Taxonomic verification of 192 species across 68 families highlights the botanical richness underpinning rural healthcare practices. Quantitative indices such as Use Value and Informant Consensus Factor reinforce the reliability of commonly cited species, particularly *Azadirachta indica*, *Withania somnifera*, and *Prosopis cineraria*. The comparative approach reveals that ecological gradients influence not only plant availability but also preparation techniques and harvesting intensity. Fresh leaf-based remedies are more prevalent in semi-arid settings, whereas dried roots, bark, and preserved materials are more common in deeper arid zones due to seasonal constraints.

However, the study also underscores pressing challenges to both biodiversity and knowledge continuity. Habitat degradation, overharvesting, commercialization, and climate variability threaten medicinal plant sustainability. Simultaneously, generational shifts and modernization erode traditional knowledge systems that have historically guided sustainable resource use. The interdependence between ecological health and cultural preservation becomes evident through comparative findings.

Future research should prioritize longitudinal ecological monitoring to assess population trends of high-use species across climatic gradients. Incorporation of Geographic Information Systems (GIS) for mapping species distribution and habitat change can enhance spatial analysis of conservation priorities. Phytochemical and pharmacological validation of frequently cited species is essential to bridge traditional knowledge with evidence-based medicine (Heinrich et al., 2009). Comparative studies extending to other arid states of India may further contextualize Rajasthan's ethnobotanical diversity within broader desert ecosystems.

Policy frameworks should promote community-based conservation through revival of sacred groves, sustainable harvesting guidelines, and cultivation incentives under national medicinal plant missions. Educational initiatives integrating ethnobotanical knowledge into local curricula can foster youth

engagement and strengthen intergenerational transmission. Collaboration between traditional healers and formal healthcare systems under the AYUSH framework may enhance culturally responsive medical practices while ensuring safety and standardization.

The medicinal flora of Shekhawati and adjacent arid zones represents a dynamic interface between ecology, culture, and healthcare. Comparative ethnobotanical analysis not only enriches academic understanding but also provides practical guidance for sustainable management in arid landscapes. Preserving this biocultural heritage demands an integrated strategy that recognizes ecological constraints, supports community participation, and bridges traditional wisdom with contemporary scientific frameworks.

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