

Ethnomedicinal Diversity and Conservation Perspectives of Selected Medicinal Plants Associated with the Menal Forest Region of Rajasthan

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Abstract:

The traditional usage of medicinal plants is a significant part of rural communities' healthcare systems and plays a significant role in the preservation of biocultural knowledge. With a focus on members of the Euphorbiaceae family, the current study details the ethnomedical significance and traditional use of a few medicinal plants connected to the Menal Forest region in southeast Rajasthan, India. From the existing ethnomedical data, a total of fifteen medicinal species, mostly from the Euphorbiaceae and Phyllanthaceae families, were assembled. Species of *Euphorbia*, *Jatropha*, *Acalypha*, *Croton*, *Ricinus*, and *Phyllanthus* were among the reported plants. Traditional medical methods have reportedly made use of a variety of plant components, including leaves, roots, stems, seeds, aerial parts, entire plants, and latex. The care of wounds, warts, skin infections, inflammation, gastrointestinal diseases, respiratory illnesses, urinary issues, liver disorders, and other common health concerns were among the reported applications. Fresh latex, plant paste, juice, powder, infusion, and decoction were among the traditional preparations. The wealth of traditional medical knowledge connected to the local flora is reflected in the variety of plant parts and preparation techniques. However, the sustainability of these plant resources may be threatened by invasive species, habitat degradation, infrastructural development, overexploitation, grazing pressure, and environmental changes. Therefore, maintaining medicinal plant diversity and related traditional knowledge requires integrated conservation approaches that include in situ and ex situ conservation, sustainable harvesting, community involvement, genetic resource preservation, and systematic ethnobotanical documentation.

Keywords: Ethnobotany; Ethnomedicine; Euphorbiaceae; Menal Forest; Rajasthan; Medicinal plants; Traditional knowledge; Conservation.

1. Introduction

Ethnobotanical knowledge is a result of people's long-term contact with the plants in their surroundings. Beneficial species identification, the selection of plant components, preparation procedures, application

techniques, and maintenance strategies are all covered. Medicinal plants play an important part in this knowledge, especially in rural and forest-dependent cultures where traditional remedies are still helpful for everyday healthcare (Fabricant and Farnsworth, 2001; Kala, 2005; Heinrich et al., 2009). Rajasthan has a particularly long history of using plant-based traditional medicine, and several investigations have revealed that a variety of ailments are treated with locally available species (Tripathi et al., 1996; Katewa et al., 2004; Sharma and Kumar, 2011). In the Mewar area of the Aravalli highlands, Katewa et al. (2004) discovered 61 medicinal plants from 38 families through fieldwork with local inhabitants and traditional practitioners. Numerous research carried out over Rajasthan have also emphasized the continued importance of medicinal plants in community healthcare (Upadhyay et al., 2010; Kapoor and Lakhera, 2013; Meena and Dudi, 2019).

Due to the large number of species with ecological, commercial, and therapeutic value, Euphorbiaceae is particularly significant within this traditional medicinal flora. Plants of this family have historically been used to treat a wide range of conditions, including skin conditions, wounds, digestive problems, inflammation, respiratory complaints, and infections (Schultes, 1962; Duke and Ayensu, 1985; Secco et al., 2012). Its significance in regional therapeutic practices is further demonstrated by its inclusion in ethnobotanical surveys from Rajasthan (Upadhyay et al., 2010; Sharma and Kumar, 2011). Similar patterns have been seen in other regions of India, where Euphorbiaceae plants are commonly mentioned in traditional remedy records for gastrointestinal, dermatological, inflammatory, and infectious illnesses (Ayyanar and Ignacimuthu, 2005; Ganesan et al., 2009; Ragupathy et al., 2008).

The Euphorbiaceae family's remarkable chemical diversity may be a contributing cause to the family's continued medicinal interest. Investigations of its members have shown phenolics, flavonoids, tannins, alkaloids, coumarins, saponins, steroids, diterpenoids, and triterpenoids. The genus *Euphorbia* is notable for its diverse terpenoid and flavonoid chemistry. About 80 distinct types of flavonoids have been found in the species, and research has been done on the antioxidant, anti-inflammatory, antibacterial, and associated biological activities of each individual component (An et al., 2021). Diterpenoids and triterpenoids, which have attracted a lot of medicinal interest, are also abundant in *Euphorbia* species (Al-Suwayyid et al., 2020; Salehi et al., 2022).

Studies that concentrate on specific species provide more evidence of this chemical diversity. Phytochemical investigations of *Euphorbia neriifolia* have identified a variety of secondary metabolites, including flavonoids, phenols, alkaloids, terpenoids, and saponins, as well as compounds like euphol, nerifoliol, taraxerol, β -amyrin, quercetin, and rutin (Ghosh et al., 2022). *Euphorbia hirta* has generated a range of phenolic and flavonoid chemicals, including quercetin, isorhamnetin, pinocembrin, kaempferol, luteolin, and gallic acid, in addition to triterpenoids, coumarins, lignans, and diterpenes (Wu et al., 2012; Li et al., 2015). Other members of the family that are used medicinally have shown similar variations. *Acalypha indica*, for example, has a wide range of phenolic compounds, including phenols, flavonoids, saponins, tannins, alkaloids, terpenoids, coumarins, anthraquinones, and anthocyanins, according to chromatographic analyzes (Pinto et al., 2017; Rajagopal et al., 2021). While *Croton* species are particularly well-known for their diverse diterpenoid profile, *Jatropha gossypifolia* has been discovered to include alkaloids, coumarins, flavonoids, lignoids, phenols, saponins, steroids, tannins, and terpenoids. When combined, these investigations show the significant chemical diversity seen in

Euphorbiaceae. However, phytochemical profiles can vary depending on the species, plant organ, place of origin, and extraction circumstances. Therefore, chemical data does not prove medicinal effectiveness on its own, but it does offer helpful background for understanding the historic significance of these plants.

An ideal location to investigate this connection between plant variety and traditional knowledge is the Menal Forest region of southeast Rajasthan. Rocky and rugged topography, dry deciduous flora, and significant seasonal variations in water availability define the environment. Diverse plant communities are supported by these environmental circumstances, which also make resources available locally for customary usage. Plant-based medicine and significant ethnobotanical variety have long been linked to the larger Aravalli area (Tripathi et al., 1996; Katewa et al., 2004; Sharma and Kumar, 2011). Previous records from Rajasthan include species of *Phyllanthus* with well-established traditional applications, as well as medicinal representatives of *Euphorbia*, *Jatropha*, *Acalypha*, *Croton*, and *Ricinus* (Upadhyay et al., 2010; Sharma and Kumar, 2011). However, the knowledge of specific communities cannot be accurately represented by data gathered at the regional level. Local environment, cultural customs, resource availability, and the experience gained within certain groups all influence ethnobotanical activities (Phillips and Gentry, 1993; Tardío and Pardo-de-Santayana, 2008).

The manner in which medicinal plants are collected and prepared provides another important dimension of ethnobotanical knowledge. Different organs, including leaves, roots, stems, seeds, fruits, latex, whole plants, and aerial portions, may be selected for different conditions. These materials can subsequently be used in forms such as pastes, juices, powders, infusions, or decoctions (Katewa et al., 2004; Ganesan et al., 2009; Meena and Dudi, 2019). Plant-part selection and preparation are not necessarily uniform and may depend on the ailment, local practice, accessibility of the material, and knowledge transmitted within the community (Phillips and Gentry, 1993; Trotter and Logan, 1986). Recording these details is therefore important because they provide information not only about medicinal use but also about the cultural relationship between communities and their plant resources (Heinrich et al., 2009; Tardío and Pardo-de-Santayana, 2008).

The persistence of these medicinal plant resources is nevertheless challenged by changes in both natural habitats and patterns of resource use. Deforestation, fragmentation, conversion of land for agriculture, infrastructure development, excessive harvesting, livestock grazing, invasive species, and climatic fluctuations can alter plant populations and affect their regeneration (Kala, 2005; Hamilton, 2004; Chen et al., 2016). The problem extends beyond loss of plant populations because traditional knowledge itself may become vulnerable when its transmission between generations declines. Changes in livelihood patterns, modernization, and socioeconomic conditions can weaken the continuity of locally maintained knowledge concerning medicinal species and their use (Benz et al., 2000; Gómez-Baggethun et al., 2010). Systematic ethnobotanical documentation is consequently valuable for recording knowledge that may otherwise become difficult to recover and for identifying plant resources requiring conservation attention (Hamilton, 2004; Chen et al., 2016). Such information can also contribute to the development of priorities for sustainable harvesting and medicinal plant conservation (Kala, 2005; Schippmann et al., 2002).

Against this background, the present study focuses on the ethnomedicinal plants associated with the Menal Forest region. The study documents the medicinal taxa represented in the available traditional knowledge, their reported therapeutic applications, plant parts selected, and methods used for preparation. It also considers the major pressures affecting these resources and the possible approaches for their conservation and sustainable use. By bringing together information on medicinal diversity, traditional utilization, and conservation concerns, the study aims to provide a regional record of ethnobotanical knowledge and contribute to the broader understanding and conservation of medicinal plant resources in the Menal Forest landscape.

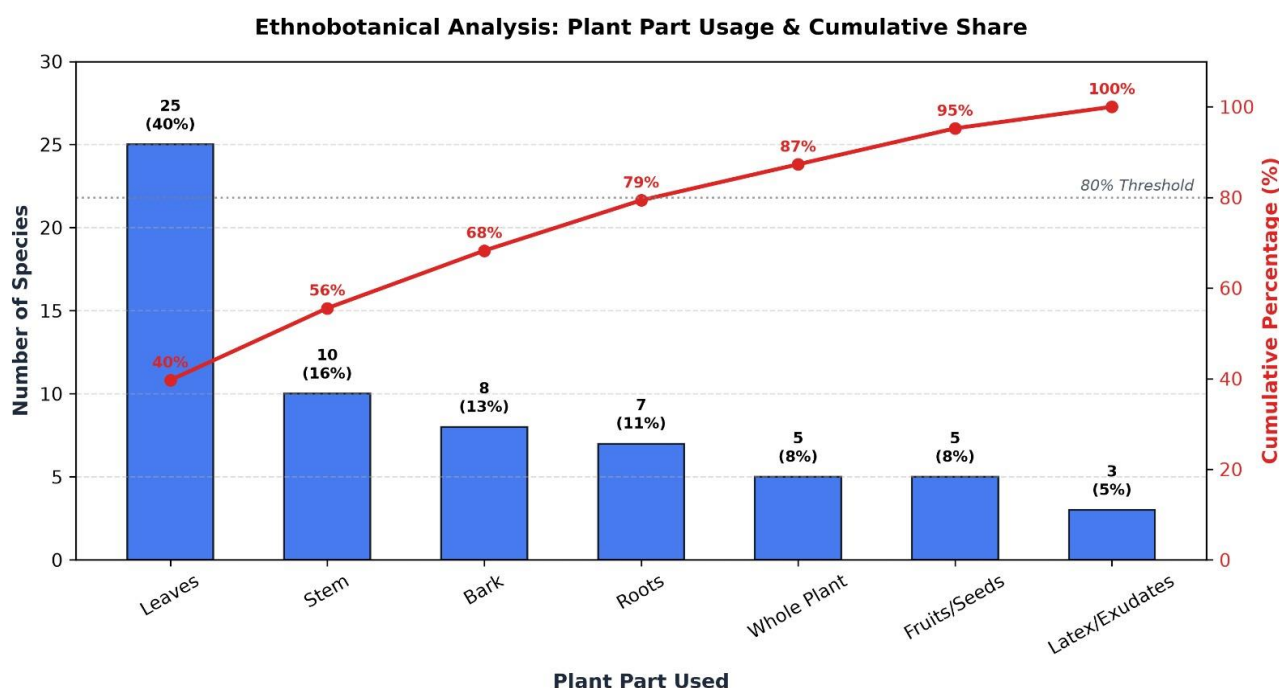


Figure 1 Number of plant parts of plant species used in medicines

Table 1 Number of Medicinal Plant Species by Plant Part Used (Southern Rajasthan)

Plant Part Used	Number of Species	Percentage (%)
Leaves	25	40%
Stem	10	16%
Bark	8	13%
Roots	7	11%
Whole Plant	5	8%
Fruits/Seeds	5	8%
Latex/Exudates	3	5%
Total	63	100%

2. Materials and Methods

2.1 Study area and Floristic Survey

The study focuses on the Menal Forest region located in southeastern Rajasthan, India. The region is characterized by a dry deciduous vegetation system, undulating rocky landscapes, and seasonal water availability. These environmental conditions support a diverse assemblage of plant species adapted to semi-arid conditions. The region is also associated with traditional plant-based healthcare practices. The available documentation indicates the occurrence and utilization of several medicinally important plants, particularly members of Euphorbiaceae and Phyllanthaceae. A long-term floristic survey was conducted across different locations of the study area, with intensive sampling during the monsoon season to document maximum plant diversity. Additional observations were carried out from October to December to record seasonal flowering patterns, particularly among Euphorbiaceae members, and to assess aquatic vegetation exposed by declining water levels.

2.2 Plant Collection and Identification

Plant specimens were collected individually, transported in 18 × 12 inch polythene bags, and subsequently pressed using 12 × 18 inch plant presses. Specimens were preserved in Formalin–Acetic–Alcohol (FAA), dried using blotting-paper driers, and mounted on standard herbarium sheets (41.5 × 28.75 cm). Preliminary identification was performed using standard regional floras and taxonomic literature, including Duthie, Santapau, Hooker, Sharma and Tiagi, Bhandari, and Shetty and Singh. Identification was further confirmed by comparison with authenticated herbarium specimens at the Botanical Survey of India, Dehradun and Jodhpur, and RUBL Herbarium, Jaipur. Taxonomic arrangement primarily followed Bentham and Hooker, with selected families arranged according to Hutchinson. The compiled dataset included 15 taxa, namely *Euphorbia maculata*, *Euphorbia serpens*, *Euphorbia heterophylla*, *Euphorbia thymifolia*, *Jatropha curcas*, *Jatropha gossypifolia*, *Acalypha ciliata*, *Croton bonplandianus*, *Euphorbia hirta*, *Euphorbia prostrata*, *Ricinus communis*, *Euphorbia caducifolia*, *Euphorbia indica*, *Phyllanthus amarus*, and *Phyllanthus fraternus*.

2.4 Conservation Assessment

Potential conservation threats were assessed using available documentation and regional ethnobotanical literature. The major concerns included habitat loss, agricultural and infrastructural expansion, overharvesting, livestock grazing, invasive species, and climatic fluctuations. Conservation measures were considered under five broad approaches: in situ protection, ex situ preservation, sustainable utilization, community involvement, and institutional support.

3. Results

3.1 Diversity of Documented Medicinal Plants

The compiled dataset included 15 medicinal taxa, predominantly from Euphorbiaceae, with two species belonging to Phyllanthaceae. Euphorbiaceae was represented by *Euphorbia maculata*, *E. serpens*, *E. heterophylla*, *E. thymifolia*, *E. hirta*, *E. prostrata*, *E. caducifolia*, *E. indica*, *Jatropha curcas*, *J. gossypifolia*, *Acalypha ciliata*, *Croton bonplandianus*, and *Ricinus communis*, while Phyllanthaceae

included *Phyllanthus amarus* and *P. fraternus*. The taxonomic diversity reflects the range of medicinal plant resources documented in the region, with the predominance of Euphorbiaceae indicating its notable representation in local ethnomedicinal practices.

3.2 Plant Parts Used

A wide range of plant organs was used in the documented traditional remedies. Leaves, whole plants, and latex were most commonly recorded, while roots, stems, seeds, aerial parts, and seed oils were used for specific purposes. *Euphorbia maculata* involved the use of whole plants, leaves, and latex; *Jatropha curcas* utilized leaves, seeds, latex, roots, and whole plants; and *Ricinus communis* was represented by seeds, seed oil, leaves, and roots. This diversity of plant parts reflects the breadth of traditional knowledge in utilizing different plant-derived resources for medicinal purposes.

3.3 Ethnomedicinal Applications

The documented species showed diverse traditional uses, with dermatological disorders forming a major category, including wounds, boils, warts, skin and fungal infections, eczema, and inflammatory conditions. Several *Euphorbia* species were traditionally used for wounds and skin ailments, commonly through topical application of latex, leaf pastes, or fresh extracts. Gastrointestinal complaints such as diarrhea and dysentery were also frequently reported. *Euphorbia hirta* had multiple traditional applications, including asthma, cough, diarrhea, dysentery, skin disorders, wounds, boils, and urinary problems. In contrast, *Phyllanthus* species were mainly associated with hepatic and urinary disorders. *Phyllanthus amarus* was traditionally used for liver disorders, jaundice, kidney stones, urinary infections, and digestive complaints, while *P. fraternus* was associated with liver and urinary ailments, jaundice, kidney stones, gastrointestinal disorders, and fever.

3.4 Traditional Preparation Methods

Traditional preparations included fresh latex, leaf paste, plant juice, powders, infusions, and decoctions. Latex was mainly applied externally for warts and other localized skin conditions, whereas fresh plant material was crushed with water to prepare pastes for wounds, boils, and skin infections. Powders were obtained by shade-drying and grinding aerial or whole plant material, while decoctions were prepared by boiling plant material in water and filtering the extract. Depending on the intended use, preparations were administered orally or applied topically.

3.5. Conservation strategy

The Menal Forest region of southeastern Rajasthan is characterized by dry deciduous vegetation, rocky terrain, and seasonal water availability, providing suitable habitats for medicinally important Euphorbiaceae members such as *Euphorbia hirta*, *E. neriifolia*, *Phyllanthus emblica*, *Jatropha curcas*, and *Ricinus communis*. These resources are increasingly affected by deforestation, agricultural expansion, infrastructure development, unsustainable medicinal plant collection, livestock grazing, invasive species, and climatic variability, which may reduce habitat quality and natural regeneration.

4. Discussion

The present compilation indicates the important role of medicinal plants in the traditional healthcare practices associated with the Menal Forest region and other parts of Rajasthan. Ethnobotanical surveys conducted in the Aravalli hills of Mewar have documented 61 medicinal species representing 38 families through interactions with traditional healers and tribal communities (Katewa et al., 2004). These earlier observations, together with the findings of the present study, demonstrate the considerable diversity of plant resources incorporated into traditional healthcare systems in southern Rajasthan.

Euphorbiaceae was one of the noteworthy families represented in the present dataset. Its importance in Rajasthan has also been reported by Upadhyay et al. (2010), who recorded 213 medicinal species belonging to 68 families in eastern Rajasthan, including 14 species of Euphorbiaceae. The medicinal relevance of this family is supported by its broad phytochemical diversity. Plants belonging to genera such as *Euphorbia*, *Jatropha*, *Acalypha*, and *Croton* have been reported to contain phenolics, flavonoids, tannins, alkaloids, coumarins, saponins, steroids, diterpenoids, and triterpenoids (Sabandar et al., 2013; An et al., 2021). *Euphorbia* species are particularly rich in flavonoids and terpenoid compounds, several of which have been investigated for antioxidant, antimicrobial, anti-inflammatory, and other biological properties (Al-Suwayyid et al., 2020; An et al., 2021). The frequent representation of Euphorbiaceae in the present ethnomedicinal records can therefore be discussed in relation to this established chemical diversity. However, traditional use or the presence of potentially bioactive compounds does not, by itself, demonstrate therapeutic effectiveness.

Considerable variation was observed in the plant parts selected for medicinal purposes. Leaves, whole plants, and latex were commonly used, whereas roots, seeds, and other specialized organs were associated with particular remedies. Such differences in plant-part selection have previously been observed in ethnobotanical studies from Rajasthan, where communities select specific plant organs according to the nature of the ailment and the traditional method of treatment (Katewa et al., 2004). This selection may also have chemical significance because secondary metabolites can vary considerably among different organs of the same plant. Phenolic compounds, flavonoids, diterpenoids, and triterpenoids, for example, have been reported from different tissues of Euphorbiaceae species (Sabandar et al., 2013; Ghosh et al., 2022). Therefore, the particular plant part used traditionally may influence the phytochemical composition and biological properties of the resulting preparation.

Dermatological conditions represented an important group of medicinal applications in the present compilation. Latex preparations of *Euphorbia* and *Jatropha*, together with externally applied leaves and whole-plant materials, were among the recorded practices. The reported phytochemistry of Euphorbiaceae provides a basis for further investigation of such applications. Phenolic and flavonoid compounds occurring in *Euphorbia* and *Acalypha* species have shown antioxidant and anti-inflammatory effects in experimental studies, while several Euphorbiaceae members are also characterized by abundant terpenoid constituents (Wu et al., 2012; Sabandar et al., 2013; Rajagopal et al., 2021). Nevertheless, these findings should be interpreted as supporting evidence for future investigation rather than as confirmation of the traditional therapeutic claims recorded in the present study. Biological activity demonstrated for an isolated compound or laboratory extract cannot necessarily be extrapolated to a traditionally prepared remedy.

The range of preparation methods recorded in the study further reflects the complexity of the traditional medicinal knowledge system. Latex was applied directly in some cases, whereas other remedies were prepared as pastes, juices, powders, infusions, or decoctions. The preparation procedure can influence the chemical profile of a plant-derived remedy because extraction conditions determine the extent to which different constituents are recovered. This is particularly relevant for Euphorbiaceae, whose species may contain chemically diverse phenolic, flavonoid, alkaloid, and terpenoid constituents. Consequently, pharmacological evaluation of traditional remedies should consider the identity of the plant, the organ used, preparation procedure, dose, and route of administration rather than relying solely on studies of crude extracts prepared under unrelated conditions.

The medicinal use of Euphorbiaceae also requires appropriate attention to safety. Although many species contain compounds of potential pharmacological interest, some members or plant parts may also possess irritant or toxic properties. Diterpenoids and diterpene esters occurring in several Euphorbiaceae taxa are particularly relevant because certain compounds within these groups have been associated with irritant or toxic effects (Al-Suwayyid et al., 2020; Ghosh et al., 2022). Thus, phytochemical richness should not automatically be considered synonymous with therapeutic value. Both efficacy and toxicity require species-specific investigation, particularly when latex or concentrated plant preparations are involved. Ethnobotanical information can identify promising species for scientific investigation, but therapeutic recommendations require supporting pharmacological and toxicological evidence.

The present observations also emphasize the conservation value of medicinal plant diversity. A considerable proportion of traditional medicinal resources is obtained from natural habitats, making their continued availability dependent on the ecological condition of these areas. Habitat degradation, excessive harvesting, grazing, and environmental changes can collectively affect the regeneration and abundance of medicinal species. Similar links between medicinal plant resources, natural ecosystems, and traditional knowledge have been reported in ethnobotanical studies of Rajasthan (Katewa et al., 2004; Upadhyay et al., 2010).

Conservation of medicinal plants should therefore be accompanied by efforts to preserve the traditional knowledge associated with their use. Habitat protection, controlled and sustainable harvesting, community participation, cultivation of important medicinal species, and systematic documentation can contribute to maintaining these resources. For the Menal Forest region, an integrated approach combining conservation biology with ethnobotanical documentation could help safeguard both medicinal plant diversity and the knowledge maintained by local communities. Further phytochemical, pharmacological, and toxicological investigations would provide an appropriate scientific basis for assessing the medicinal potential of the species documented in the present study.

5. Conclusion

The present study highlights that the family Euphorbiaceae constitutes a vital component of the Menal Forest ecosystem, contributing significantly to ecological stability and human well-being. However, increasing environmental stressors and human activities pose serious threats to its diversity and survival. A comprehensive conservation approach integrating in situ and ex situ strategies, sustainable utilization practices, community participation, and effective policy implementation is essential for ensuring the

long-term preservation of these species. Such integrated efforts will play a crucial role in maintaining biodiversity and ecological balance in the Menal Forest region.

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