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Comprehensive research on floristic diversity in the Chitrakoot region of Satna district, Madhya Pradesh

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Abstract
Chitrakoot (Satna district, M.P.), part of the Bundelkhand–Vindhyan transition, hosts a mosaic of dry deciduous hill forests, sacred groves (notably Kamadgiri), riparian corridors, and human-modified landscapes. Existing studies report rich medicinal and ethnobotanical resources, with multiple surveys documenting several hundred plant taxa and numerous rare/endangered medicinal species. This paper synthesizes published records, presents a standardized field protocol for a complete floristic inventory, summarizes observed taxonomic/functional patterns and threats, estimates diversity patterns, and outlines conservation and research priorities for the region. Key recommendations include systematic baseline surveys using stratified sampling, community-based conservation of sacred groves, ex-situ conservation of threatened medicinal taxa, and integration with state biodiversity planning.

Keywords: Chitrakoot, satna, floristic diversity, medicinal plants, Kamadgiri, sacred groves, biodiversity conservation, Madhy a Pradesh

Introduction

The Chitrakoot region, located in the Satna district of Madhya Pradesh, is a recognized biodiversity hotspot in central India, situated between 80°44′–80°54′ E longitude and 25°12′–25°19′ N latitude. This prehistorically and mythologically significant area covers approximately 18,919.80 ha of forest within the Vindhyan range and is dominated by tropical dry deciduous mixed forests (Singh *et al.*, 2013) [9]. The Chitrakoot region occupies forested hills and rocky outcrops of the Vindhyan system adjoining Bundelkhand granites. Historically and culturally significant (sacred groves such as Kamadgiri), the area supports diverse vegetation types and a long tradition of ethnomedicinal plant use. Recent botanical surveys and ethnobotanical studies document a rich assemblage of herbaceous; shrub and arboreal species used locally for medicine, fuelwood and rituals. Several authors report dozens to hundreds of taxa in targeted studies (ethnomedicinal lists, shrub dynamics and sacred-grove floras). This accumulated literature provides a foundation but lacks a single integrated, standardized floristic inventory for the Satna–Chitrakoot block and up-to-date conservation assessments. Over the past two decades, floristic diversity has undergone a marked decline, with documented species richness falling from 343 species in 1990 to 263 species in 2015—a 23.32% loss—due to anthropogenic pressures and habitat degradation (Singh *et al.*, 2018) [11].

Objectives

1. Synthesize published floristic and ethnobotanical information for Chitrakoot (Satna district).
2. Propose and describe a standardized field protocol for a comprehensive floristic inventory.
3. Summarize major taxonomic patterns, important medicinal/rare taxa, and conservation threats from published sources.
4. Provide management and research recommendations to support biodiversity conservation and sustainable use.

Methodology and Data Sources

Floristic assessments in the Chitrakoot region have employed systematic quadrat-based vegetation sampling, complemented by ethnobotanical interviews with local and tribal communities (Singh *et al.*, 2013; Mishra, 2023) [3, 4, 5, 9]. Data for temporal biodiversity change were drawn from comparative studies conducted from 2022 to 2024 (Singh *et al.*, 2018) [11].

1. Sampling design

Stratified random sampling across major habitat strata: (A) sacred groves (Kamadgiri), (B) undisturbed hill forest, (C) disturbed secondary forest/edges, (D) riparian corridors, and (E) agroforestry/plantation mosaics.
Within each stratum, establish transects (e.g., 500–1000 m long) and nested quadrats for different life forms:

Trees: 20 m × 20 m quadrats along transect (n per stratum depending on area; aim ≥30 tree quadrats total per stratum).

Shrubs: 5 m × 5 m quadrats nested in tree plots.

Herbs/seedlings: 1 m × 1 m sub-quadrats (4 per shrub plot).
GPS and GIS mapping of all plots; record aspect, slope, elevation, soil type, canopy cover (densiometer), and disturbance indicators.

2. Taxonomic identification & voucher specimens

Collect representative specimens (permit from Forest Department, Chitrakoot) with flowers/fruits where possible; deposit duplicates at a recognized herbarium (e.g., Department of Botany, Government Girls Postgraduate College, Rewa, and BSI regional herbarium Prayagraj). Use regional floras and online resources (eFloras, POWO) for IDs.

3. Ethnobotanical data

Semi-structured interviews with local healers, elders and herbal vendors, with prior informed consent and documentation of local names, uses, preparation methods, and harvesting pressure.

4. Data & analyses

Diversity indices: Species richness (S), Shannon–Wiener (H'), Simpson (D), Pielou's evenness (J'). Compute per stratum and overall.

Community analyses: NMDS ordination of Bray–Curtis distances, cluster analysis to detect floristic groupings, and indicator species analysis to identify species linked to sacred groves or disturbed habitats.

Population structure: DBH class distributions for dominant trees; regeneration indices.

Statistical tests: ANOVA or Kruskal–Wallis to compare diversity across strata; regression to relate disturbance metrics to diversity/regeneration.

Study area

1. **Geography & geology:** Chitrakoot hills lie in the eastern part of Satna district (Madhya Pradesh) and adjacent parts of Chitrakoot district (Uttar Pradesh). Topography is undulating to hilly (elevations ~350–800 m locally), with Vindhyan sedimentary rocks and exposed Bundelkhand granites locally. The climate is tropical sub-humid with monsoonal rainfall concentrated June–September.

2. **Vegetation types:** Predominantly dry deciduous and scrub forests, rocky outcrops with sparse tree cover, riparian corridors, and sacred groves (e.g., Kamadgiri) that retain relatively more intact vegetation due to cultural protection. Dominant species groups reported include Boswellia serrata, Acacia/Anogeissus/Hardwickia complexes, bamboo clumps in some patches, and a diverse herbaceous understory.

Floristic Composition and Taxonomic Diversity

Multiple targeted studies report differing scopes: sacred-grove and ethnomedicinal surveys recorded ~100–150 taxa in single studies (e.g., 130 species reported in some Kamadgiri surveys), while broader assessments and compilations suggest several hundred taxa across the wider Chitrakoot region. One review cited ~343 plant species in the study area over two decades. These discrepancies reflect differences in sampling extent, taxonomic scope (vascular plants only vs. medicinal species), and survey methods. Recent surveys documented 263 plant species from 78 families, compared with 343 species recorded in 1990 (Singh *et al.*, 2018) [11].

1. **Dominant families & life forms:** Reports commonly list Asteraceae, Fabaceae, Lamiaceae, Rosaceae and Poaceae among the most represented families in various sub-studies; herbs and shrubs dominate ethnobotanical uses, while trees form the structural canopy (*Boswellia, Butea, Terminalia* spp., etc.). Growth form proportions reported in an ethnobotanical study showed herbs as the most used group (~70–80% of uses in one survey).

2. **Medicinal & threatened taxa:** Several high-value medicinal plants are reported from Chitrakoot: *Tinospora cordifolia, Gymnema sylvestre, Achyranthes aspera, Urginea indica, Curculigo orchioides, Dioscorea bulbifera, Butea monosperma, Gloriosa superba, Abrus precatorius, Asparagus racemosus* and others. Some surveys emphasize rare and endangered medicinal plants present in local trade and markets.

3. **Shrub dynamics & invasive species:** Recent shrub surveys show dominance by species such as *Lantana camara* and *Carissa opaca* in some compartments, indicating invasive expansion and secondary succession in disturbed patches.

Key findings include

Non-graminaceous forage species: 52 species from 39 genera and 8 families (Singh *et al.*, 2013).

Shrub diversity: 29 species with a total of 16,209 individuals; dominant species include *Lantana camara*, *Carissa opaca*, and *Solanum nigrum* (Mishra, 2023) [3, 4, 5].

4. **Medicinal plants:** 84 species from 39 families with documented ethnomedicinal uses (Mishra, 2023) [3, 4, 5].

The dominant families are Fabaceae (6.70% of total species), Poaceae (6.41%), and Euphorbiaceae (5.24%) (Singh *et al.*, 2018) [11]. The Chitrakoot area hosts (a) rich ethnomedicinal flora including multiple rare species; (b) sacred-grove Kamadgiri with distinctive assemblages; (c) shrub/invasive species dynamics affecting regeneration.

Vegetation Types

The vegetation structure comprises:

1. **Tropical dry deciduous forests:** predominant formation.
2. **Mixed deciduous forests:** growing on sandstone and shale substrates.
3. **Open forests:** planted/disturbed, covering 4,582.37 ha.
4. **Dense forests:** 8,746.62 ha (Mishra *et al.*, 2023) [3, 4, 5].

Endemism and Conservation Status

The conservation assessment reveals:

- Critically endangered species: 20 (7.60%).
- Endangered species: 14 (5.32%).
- Extinct species: 18 (6.84%) (Singh *et al.*, 2018) [11].

Priority conservation targets include *Dichanthium annulatum*, *Phaseolus trilobus*, *Paspalidium* spp., *Adiantum* spp., *Grewia hirsuta*, and *Zizyphus oeroplia* (Singh *et al.*, 2017) [10].

Ethnobotanical Significance

Ethnobotanical surveys report that 100% of non-graminaceous forage species have medicinal applications, and 40% also serve as food plants (Singh *et al.*, 2013). These plants are used to treat 109 human diseases and 5 livestock diseases, with leaves being the most frequently used plant part (62%), followed by roots, bark, and fruits; aerial roots and cladodes are least used (2%). Rare medicinal species of high conservation concern include *Abrus precatorius*, *Andrographis paniculata*, *Asparagus racemosus*, and *Terminalia chebula* (Singh *et al.*, 2022) [12].

8. Ecological Characteristics

The region has a semi-arid climate, annual rainfall of 800 mm, average temperature of 26°C (peaking at 35–45°C in summer), and average annual humidity of 56.29% (Mishra *et al.*, 2023) [3, 4, 5]. Soils range from sandy to sandy-loam, fine to coarse-grained, with red lateritic types

predominating. Elevation spans 500–2,354 ft, supporting varied microhabitats (Mishra *et al.*, 2023) [3, 4, 5].

Discussion: patterns, drivers, and conservation implications

1. Cultural protection and biodiversity

Sacred groves (Kamadgiri) act as cultural keystones that conserve patchily-distributed species and older trees, often harboring medicinal taxa that are scarce in the surrounding matrix. Protection through cultural taboo reduces extraction in some patches and maintains structural complexity.

2. Anthropogenic pressures

Fuelwood collection, grazing, small-scale agriculture expansion, and indiscriminate harvesting for herbal trade are major local threats. Secondary succession and proliferation of invasive shrubs (e.g., *Lantana camara*) limit tree regeneration in disturbed compartments documented by shrub dynamics studies.

3. Knowledge gaps

No single, georeferenced, up-to-date checklist exists that covers the entire Satna–Chitrakoot landscape with herbarium vouchers. Population viability assessments for reported rare medicinal plants are lacking. Quantitative data on harvesting intensity and trade networks are fragmentary. Evidence quality is strengthened by consistency across independent studies documenting biodiversity decline (Singh *et al.*, 2018) [11].

Conservation and Management Implications

Comprehensive baseline inventory. Implement the stratified sampling protocol above, produce a georeferenced checklist with herbarium vouchers and digitize results in state biodiversity databases.

Sacred-grove conservation program. Partner with local temple authorities and communities to formalize protection, control trampling and grazing on pilgrimage routes, and restore degraded patches with native species.

Community-based sustainable use. Establish community herb gardens, rotational harvesting rules, and value-addition training to reduce wild plant pressure; promote cultivation of high-demand medicinal species (e.g., *Asparagus racemosus*, *Tinospora cordifolia*).

Ex situ conservation. Seed banking and live collections for prioritized rare/endangered taxa; coordinate with Madhya Pradesh State Biodiversity Board programs.

Control of invasives. Integrate manual removal and assisted regeneration plans for *Lantana*-dominated patches, combined with active planting of native shrubs/trees to prevent reinvasion.

Research & monitoring. Long-term permanent plots to monitor trends, plus socioecological studies of harvesting, market chains, and cultural values.

Biodiversity indices such as the Margalef Index (2.88) and Shannon Index (1.60) for shrub communities provide quantitative baselines for ecosystem health monitoring and adaptive management (Mishra *et al.*, 2023) [3, 4, 5].

Conclusion

Chitrakoot (Satna district) is floristically rich, culturally significant and contains numerous medicinal and potentially threatened taxa. Existing studies provide important site-level snapshots (sacred groves, shrub dynamics, ethnobotany), but a coordinated, standardized inventory and monitoring program is required to produce a definitive checklist, quantify population status of priority taxa, and design effective conservation interventions. Integrating local communities, state biodiversity institutions and academic partners will maximize conservation and sustainable-use outcomes.

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