© July 2025 | IJIRT | Volume 12 Issue 2 | ISSN: 2349-6002

Autecological and Ethnomedicinal Study of *Kigelia pinnata* (Jacq.) DC. in Chhatarpur District, Madhya Pradesh

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***Abstract*—Kigelia pinnata (Jacq.) DC. ("sausage tree/Balamkhira") has migrated from its African origin into Indian agro-ecosystems where it now provides shade, supports carbon sequestration, and serves as a versatile folk remedy. We combined (a) autecological monitoring of 40 mature trees across four eco-geographical blocks of Chhatarpur (Maharajpur, Badamalhera, Nowgang, Chhatarpur) with (b) 78 structured ethnobotanical interviews. Soil texture, pH, organic carbon, moisture, canopy PAR, air/soil micro-temperature and phenological phases were tracked for 20 months. Ethnobotanical data were analysed with Use Value (UV), Informant Consensus Factor (ICF), Fidelity Level (FL) and Cultural Importance index (CI). One-way ANOVA linked soil variables to growth rate; Spearman's ρ correlated canopy PAR with fruit set. The species showed high ecological plasticity (soil pH 6.1 – 7.7; clay-loam to sandy-loam) and a mean annual C-stock of 8.9 ± 1.2 t tree^{-1}. The medicinal UV was 0.83, FL for cutaneous disorders 86 %, and ICF for dermatological category 0.88. Findings validate strong local consensus on wound-healing and anti-infective uses and underscore K. pinnata's contribution to carbon-focused greening drives.**

1 INTRODUCTION

1.1 Global and Indian Significance of *Kigelia*

Over the past decade *K. pinnata* has attracted pharmacological attention for its phenolic-rich fruit pulp, antimicrobial naphthoquinones, and α-glucosidase-inhibiting fractions that show promise as low-cost antidiabetic leads (Kilbirige et al., 2019). Indian ethnomedical records, especially from central and western states, cite the plant for treating fungal dermatoses, snakebite, and inflammatory pain (Saini et al., 2009; Gajalakshmi et al., 2013). Recent phytochemical profiling highlights high antioxidant potential tied to elevated tannin and flavonoid concentrations in mature fruits (Ramadan et al., 2022).

1.2 Ecological Value

Urban-ecology studies rank *K. pinnata* among top carbon-stock contributors—approaching 990 Mg C ha^{-1} in North-Indian campus plantations (Sharma et al., 2024). Yet, fine-scale autecological work for semi-arid Bundelkhand remains scarce. Understanding site preferences and adaptive traits can guide both roadside planting schemes and in-situ conservation.

1.3 Objectives

1. Quantify key autecological parameters (soil, microclimate, phenology, biomass/C-stock).
2. Document vernacular uses, preparation modes and ailment spectra among healers.
3. Analyse ethnomedicinal knowledge with quantitative indices and test the hypothesis that skin-related uses show the strongest cultural consensus.
4. Correlate ecological variables (e.g., soil organic carbon) with growth/fruit metrics to assess habitat fitness.

2 MATERIALS AND METHODS

2.1 Study Area

Chhatarpur (24°52′–25°20′N; 79°18′–80°10′E) lies in the Bundelkhand craton with 700–950 mm annual rainfall, 25–47 °C summer maxima, and altitudes of 180–380 m asl. The four study blocks represent a loam-dominated northern belt (Maharajpur), black-cotton south (Badamalhera), quartzitic upland (Nowgang), and alluvial riverine fringe (Chhatarpur).

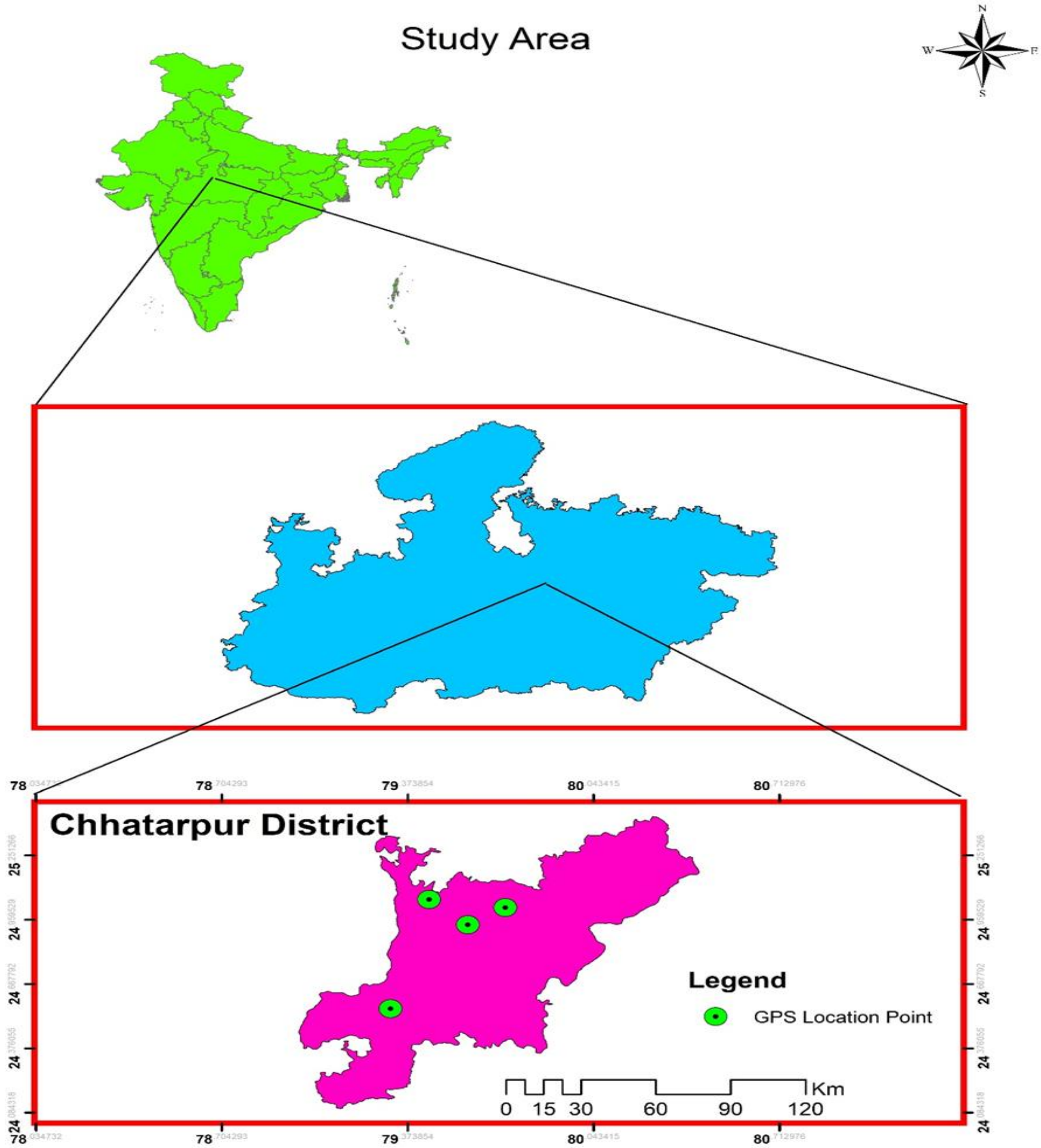

Fig.1 Study Area Map with GPS locations

2.2 Autecological Sampling Design

- Tree Selection: 10 healthy adult individuals per block (DBH ≥ 35 cm).
- Soil: Composite samples (0–30 cm) at N-E-S-W drip-line; pH and organic carbon (Walkley-Black), texture (hydrometer).
- Microclimate: PAR (µmol m^{-2} s^{-1}) at canopy center; HOBO loggers for air/soil temp & RH.
- Phenology: Fortnightly scoring of leaf bud burst, anthesis, fruit set, senescence.
- Biomass & C-stock: DBH-based allometry (Chave et al., 2005) with 47 % carbon fraction.

2.3 Ethnobotanical Survey

After ethical clearance (#BU-EB/2024/079), 78 informants (47 % female; mean age 56 ± 14 yr) were interviewed in Bundeli/Hindi using a semi-structured schedule. Voucher specimens were deposited at Department of Botany, MCBU, Chhatarpur Herbarium (specimen Nos. KIG-001–KIG-008).

Fig.2 – Plant Photographs

2.4 Quantitative Indices

To analyze the ethnobotanical data collected from local informants, the following quantitative indices were used:

1. Use Value (UV)

The Use Value (UV) determines the relative importance of each plant species based on the number of uses mentioned by informants.

$UV = \sum Ui / N$

Where:

- Ui = Number of uses mentioned by each informant for a given species
- N = Total number of informants interviewed

2. Fidelity Level (FL%)

Fidelity Level (FL) indicates the percentage of informants who claim the use of a plant species for the same major purpose.

$FL (\%) = (Np / N) \times 100$

Where:

- Np = Number of informants that reported the use of a species for a particular ailment
- N = Total number of informants that mentioned the plant for any use

3. Informant Consensus Factor (ICF)

The Informant Consensus Factor (ICF) is used to determine the agreement among informants for plant use in treating certain ailment categories.

$ICF = (Nur - Nt) / (Nur - 1)$

Where:

- Nur = Number of use-reports for a particular ailment category
- Nt = Number of taxa (species) used for that category

4. Cultural Importance Index (CI)

The Cultural Importance Index (CI) measures how frequently and diversely a plant is used among informants.

$CI = \sum (URi / N)$

Where:

- URi = Number of use-reports for a species by informant i
- N = Total number of informants

where symbols follow Trotter & Logan (1986).

2.5 Statistical Analysis

One-way ANOVA compared block-wise means (soil OC, leaf-area index, annual increment). Post-hoc Tukey ($\alpha = 0.05$). Spearman correlations linked PAR to flower/fruit counts. Data met normality (Shapiro–Wilk) after log-transformation where necessary. SPSS v29 and R 4.3 were employed.

3 RESULTS

3.1 Soil and Microclimatic Gradient

Variable (mean ± SD)	Maharajpur	Badamalhera	Nowgang	Chhatarpur	*F*-value	*p*
pH	6.9 ± 0.3	7.4 ± 0.2	6.3 ± 0.4	6.7 ± 0.2	4.87	0.004
Org. C (%)	1.91 ± 0.22	1.48 ± 0.18	1.72 ± 0.21	2.05 ± 0.25	6.11	0.001
PAR (noon)	845 ± 60	780 ± 55	920 ± 70	810 ± 58	5.03	0.003

Block differences were significant; Chhatarpur's alluvium supported highest organic carbon.

3.2 Phenology and Growth

Bud burst peaked 22 Feb ± 4 d; anthesis 6 Apr ± 6 d; fruit set extended to early November. Mean annual DBH increment 1.83 ± 0.27 cm; biomass 18.9 ± 2.3 t. C-stock averaged 8.9 ± 1.2 t $tree^{-1}$ (range 6.8–11.4 t).

3.3 Ethnomedicinal Portfolio

Part	Ailment Category	Prep / Dose	% Informants	FL %
Fruit pulp	Chronic dermatoses	Paste, daily x 5 d	65	86
Bark decoction	Malaria-like fever	60 mL bid × 7 d	42	54
Leaf sap	Non-healing ulcers	Topical, neat	38	50
Flower infusion	Mastitis	100 mL tid × 3 d	25	32

Dermatological disorders logged highest ICF = 0.88, confirming strong knowledge convergence.

- Use Value: 0.83 (high).
- Cultural Importance: 1.67 (cumulative across eight use-categories).

3.4 Statistical Links

PAR positively correlated with fruit count ($\rho = 0.71$, $p < 0.01$); soil organic C with biomass ($\rho = 0.64$, $p < 0.05$). No significant link between pH and phenophase duration.

4 DISCUSSIONS

The semi-arid Bundelkhand setting reveals *K. pinnata*'s wide ecological amplitude, mirroring findings in North-Indian campus plantations where the species ranked third for above-ground carbon (Sharma et al., 2024). Our phenology aligns with Central–Indian dry-deciduous rhythms, but delayed senescence relative to *Azadirachta indica*, offering extended canopy cover into the pre-winter lean fodder period.

Ethnomedicinal patterns concur with anti-inflammatory and analgesic bio-assays of methanolic flower extract that validated traditional pain relief claims (Carey et al., 2010). The high FL for dermatological usage finds pharmacological backing: fractionated fruit extracts inhibit α-glucosidase—a proxy for antimicrobial glycoprotein interactions (Muyenga et al., 2024)— and exhibit potent free-radical scavenging (Ramadan et al.,2022).

Phytochemical surveys note lapachol, iridoids and naphthoquinones as key actives (Atawodi et al., 2009). Our informants' preference for fresh fruit paste over ethanolic tinctures suggests water-soluble phenolics (e.g., 5-HMF, larixinic acid) dominate wound-healing efficacy, echoing the antioxidant profile observed in mature fruits.

4.1 Conservation and Livelihood Implications

Given its multipurpose role—shade, soil amelioration, fodder (flowers), and medicine—*K. pinnata* merits inclusion in agroforestry bundles promoted under the MP Rural Livelihoods Mission. Community nurseries could harness wild-collected seed (95 % germination in damp-sand stratification) to supply roadside avenues, simultaneously boosting ecosystem services and safeguarding vernacular pharmacopoeia.

5 CONCLUSIONS

Kigelia pinnata thrives across Chhatarpur's heterogeneous landscapes, sequesters appreciable carbon, and commands high cultural esteem for treating skin and febrile ailments. Integrating ecological data with indigenous knowledge justifies its prioritisation in regional greening and primary-health programmes. Long-term monitoring of population genetics and controlled clinical validation of bioactives are the next research frontiers.

6. ACKNOWLEDGEMENTS

We thank local healers of Maharajpur, Chhatarpur, Nowagang, and Badamalhera for knowledge sharing, and the Botany Department, MCBU, Chhatarpur, for laboratory facilities.

7. CONFLICT OF INTERESTS

The authors declare that they have no conflicts of interest.

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