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Ethnobotany to Bioprospecting: Exploring the Medicinal Wealth of Haryana

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Abstract:
The rich ethnobotanical heritage of Haryana embodies centuries of traditional knowledge, where medicinal plants have played a vital role in healthcare and livelihood sustenance. The objective of this study, *Ethnobotany to Bioprospecting: Exploring the Medicinal Wealth of Haryana*, was to document and analyze 30 medicinal plant species extensively used in folk medicine, local healing traditions, and community practices. The research scope encompassed comprehensive field surveys across diverse agro-climatic zones of Haryana, structured interviews with traditional healers and local communities, literature review, and preliminary phytochemical analyses to evaluate bioactive constituents and therapeutic potential. Results revealed that these plants exhibit a wide range of pharmacological properties, including antioxidant, anti-inflammatory, immunomodulatory, and antimicrobial activities, largely attributed to compounds such as alkaloids, flavonoids, tannins, and saponins. The study underscores the importance of preserving indigenous knowledge, highlights opportunities for scientific validation and bioprospecting, and emphasizes sustainable utilization and conservation strategies. By bridging traditional ethnobotanical practices with modern pharmaceutical research, this work provides a foundation for the development of novel therapeutics, value-added products, and innovative healthcare solutions, while contributing to the protection of Haryana's biodiversity.

Keywords: Ethnobotany, Bioprospecting, Medicinal Plants, Haryana, Traditional Knowledge, Biodiversity, Phytochemistry, Drug Discovery, Indigenous Practices, Sustainable Utilization, Plant-based Medicine, Healthcare Heritage.

1.Introduction:

Ethnobotany, the scientific study of the relationship between people and plants, has emerged as a vital field of inquiry that bridges cultural traditions and modern science. Rooted in the knowledge systems of indigenous communities, ethnobotany documents how plants have been used for food, medicine, rituals, and livelihood support across generations [1]. In India, a country renowned for its ecological diversity and cultural richness, the practice of ethnobotany holds special significance [2]. India's ancient healing traditions, particularly Ayurveda, Siddha, and Unani, have depended on medicinal plants as primary therapeutic agents for centuries. This deep heritage has positioned

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India as a global hub of medicinal knowledge and biodiversity. Within this national landscape, Haryana offers a unique case of how traditional plant knowledge has survived, adapted, and continues to serve local communities despite the pressures of modernization and environmental change [3].

Haryana, located in northwestern India, is often recognized for its agricultural productivity and socio-cultural vibrancy. Beyond its reputation as the "breadbasket of India," the state is endowed with diverse flora adapted to its varied agro-climatic zones, including the Shivalik foothills, semi-arid plains, and fertile alluvial soils. These ecological conditions support a wide range of medicinal plants that rural and indigenous populations have relied on for primary healthcare [4]. From household remedies for common ailments to specialized treatments employed by local healers, Haryana's ethnobotanical wealth forms an important but often overlooked aspect of its cultural identity. Despite rapid urbanization and economic growth, traditional plant-based practices remain integral to rural healthcare in many parts of the state [5]. However, this knowledge system is under constant threat from generational discontinuity, loss of habitats, and the gradual replacement of natural remedies by synthetic pharmaceuticals.

The transition from ethnobotany to bioprospecting represents a crucial step in linking traditional plant-based knowledge with scientific validation and modern applications. Bioprospecting, defined as the systematic exploration of natural resources for commercially valuable compounds, is increasingly recognized as a pathway to sustainable drug discovery [6]. The World Health Organization (WHO) has estimated that nearly 80% of the world's population still depends on traditional medicine for primary health needs, underscoring the importance of plant-based therapies. Scientific studies have revealed that a significant proportion of modern drugs are derived, directly or indirectly, from plants identified through ethnobotanical research. For instance, the discovery of aspirin from willow bark, quinine from cinchona, and vincristine from periwinkle exemplifies the immense potential of traditional plant use as a guide to pharmaceutical breakthroughs [7]. In this context, Haryana's 30 selected medicinal plants serve as a valuable resource for both ethnobotanical documentation and bioprospecting opportunities.

The significance of studying these 30 plants lies not only in their traditional applications but also in their broader socio-economic and ecological implications. Many of these plants have been used by rural communities to treat ailments such as fever, digestive disorders, skin infections, respiratory illnesses, and inflammatory conditions. Documenting these practices preserves cultural heritage while offering a roadmap for scientific investigation [8]. Moreover, in an era where natural products are gaining renewed interest due to rising concerns about drug resistance, synthetic drug side effects, and lifestyle-related health disorders, these plants provide alternative and complementary solutions for modern healthcare challenges. Bioprospecting of Haryana's

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medicinal flora has the potential to yield novel bioactive compounds, nutraceuticals, and herbal formulations that can enhance both public health and local livelihoods [9].

Another dimension of this exploration is conservation. Medicinal plants, though valuable, face threats from overexploitation, deforestation, and climate change. Unsustainable harvesting practices and the growing commercialization of herbal products often lead to the depletion of wild plant populations. Haryana's situation is no different, as several species face pressure due to changes in land use and agricultural expansion. By studying and documenting these 30 plants, the present research also underscores the need for conservation strategies that protect biodiversity while enabling sustainable utilization. Linking ethnobotany with bioprospecting ensures that scientific exploration does not come at the cost of ecological balance. Instead, it advocates for a model where traditional knowledge, modern science, and conservation ethics work in synergy [10].

Furthermore, the study has strong socio-economic relevance. Ethnobotanical knowledge is not merely about plants; it reflects community wisdom, cultural identity, and local adaptation strategies. Rural communities in Haryana continue to practice traditional healing not only as a healthcare alternative but also as an accessible and affordable system of medicine. In many villages, local healers act as custodians of plant-based remedies, providing treatments where modern healthcare infrastructure is limited. Bioprospecting initiatives, if carried out with ethical frameworks such as benefit-sharing, can create opportunities for these communities to participate in and benefit from the commercialization of plant-based resources. This aligns with the global discourse on intellectual property rights, equitable access, and the Convention on Biological Diversity (CBD), which emphasizes the fair and sustainable use of biological resources [11].

The present study, *Ethnobotany to Bioprospecting: Exploring the Medicinal Wealth of Haryana*, therefore, seeks to investigate 30 medicinal plants traditionally used across the region. It aims to document their ethnobotanical significance, highlight their phytochemical and therapeutic potential, and explore the scope for their integration into modern drug discovery and healthcare systems. By bridging the gap between traditional wisdom and scientific inquiry, this research contributes to three interconnected goals: preserving cultural heritage, advancing bioprospecting for pharmaceutical innovation, and promoting biodiversity conservation.

2. Literature review

Ethnobotany to Bioprospecting: Exploring the Medicinal Wealth of Haryana for 30 Plants

2.1. Overview of ethnobotanical research in Haryana

Haryana has attracted increasing ethnobotanical attention over the last two decades, with multiple district-level surveys documenting the traditional uses of medicinal plants by rural communities, healers and household practitioners. Field studies in districts such as Hisar, Bhiwani and Karnal have recorded dozens of species (ranging from ~30 to 70 species per district) and produced

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inventories of botanical names, local names, parts used and ailment categories—demonstrating that plant-based remedies remain an important component of primary healthcare in the state. (sciencescholar.usplantsjournal.comISCA)

These localized studies are complemented by statewide reviews that compile scattered reports and highlight both well-known and lesser-studied taxa in Haryana's flora. Such syntheses have sought to create catalogues of medicinal plants recorded across surveys and to point out species of potential pharmacological interest that have been underexplored. (ResearchGateinformaticsjournals.co.in)

2.2. Methods and approaches used in the literature

Most primary ethnobotanical studies in Haryana employ qualitative field methods: semi-structured interviews with traditional healers, elders and farmers; guided field walks; voucher specimen collection and herbarium deposition; and the recording of preparation methods, dosages and modes of administration. Quantitative indices (use-value, fidelity level, informant consensus factor) are increasingly used to prioritize species for further study. These mixed qualitative–quantitative designs allow researchers to both preserve indigenous knowledge and generate candidate lists for phytochemical and pharmacological follow-up. sciencescholar.usplantsjournal.com

2.3. Patterns in taxa, plant parts and ailment categories

Across district surveys certain plant families (e.g., Fabaceae/Leguminosae, Solanaceae, Lamiaceae, Asteraceae) recur frequently, and common growth forms include herbs and shrubs adapted to semi-arid and alluvial environments. Leaves, roots and whole-plant preparations are the most frequently used plant parts for remedies; topical applications and decoctions/infusions predominate as preparation modes. Reported therapeutic roles span gastrointestinal, respiratory, dermatological, febrile and musculoskeletal complaints—mirroring patterns observed in other North Indian ethnobotanical studies. (plantsjournal.comijirset.com)

2.4. From documentation to bioprospecting: phytochemistry and pharmacology

Ethnobotanical inventories provide candidate species for bioprospecting, but the literature shows a marked gap between documentation and rigorous bioactivity validation. While a subset of Haryana-recorded plants have been the subject of phytochemical screening and in-vitro assays (revealing alkaloids, flavonoids, terpenoids and other common classes of bioactives), many locally important species lack systematic phytochemical, toxicity and mechanism-of-action studies. Reviews of tropical bioprospecting emphasize this translational bottleneck—arguing for prioritized pipelines that move high use-value species from ethnobotanical signal to standardized phytochemical profiling, bioassays, and then to lead optimization. (SpringerLinkResearchGate)

2.5. Conservation, sustainable use and institutional support

A recurring theme in the literature is concern over the conservation status of medicinal plants. National and regional assessments show that numerous medicinal species face pressure from

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overharvest, habitat loss and trade demand; thus sustainable harvesting protocols, cultivation and in-situ/ex-situ conservation measures are necessary to prevent resource depletion. Haryana has recognized these needs through initiatives such as state herbal parks and conservation programs aimed at developing germplasm, propagating priority species and promoting cultivation to reduce wild collection pressure. The Convention on Biological Diversity and national policy frameworks also inform concerns about benefit-sharing and intellectual property when bioprospecting moves toward commercialization. (PMCharyanaforest.gov.in)

2.6. Socio-economic and ethical dimensions

Ethnobotanical research in Haryana underscores that plant knowledge is embedded in social networks and livelihoods. Local healers and farming households often act as custodians of knowledge and as stewards of plant populations. Bioprospecting efforts that ignore equitable benefit-sharing risk marginalizing these communities; conversely, ethical frameworks that include prior informed consent, capacity building and fair compensation can link conservation with rural development. Case studies from India emphasize co-development models where value addition (e.g., cultivation, small-scale processing) increases local incomes while reducing pressure on wild stocks.(ResearchGateharyanaforest.gov.in)

2.7. Gaps in the Haryana literature and priority research needs

Synthesis of existing studies reveals several consistent gaps that the present project (30-plant focus) can address:

• **Translational gap** — Many widely reported ethnomedicinal uses lack follow-up phytochemical and preclinical pharmacology studies. Systematic screening (phytochemistry, antimicrobial, anti-inflammatory, cytotoxicity assays) is needed to validate traditional claims and identify bioactive leads. SpringerLink

• **Standardization & quality control** — There is a shortage of work on standardizing plant material (chemotype characterization, marker compounds) and on assessing safety/toxicity profiles required for product development. SpringerLink

• **Conservation data gaps** — District surveys often record use and abundance qualitatively; consistent population assessments, sustainable yield estimates and ex-situ conservation plans are missing for many species. PMC

• **Ethical/commercial frameworks** — Few projects document formal benefit-sharing agreements or engage local communities in downstream value capture from bioprospecting outcomes. haryanaforest.gov.in

2.8. Directions for the current study and concluding remarks

The literature supports a research trajectory that begins with robust ethnobotanical documentation (as practiced in Hisar, Bhiwani, Karnal and other districts) and then applies a prioritized, multidisciplinary bioprospecting pipeline: (1) select high-use-value species using quantitative

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ethnobotanical indices; (2) perform standardized phytochemical profiling; (3) carry out targeted bioactivity screens aligned to traditional claims; (4) assess toxicity and safety; and (5) design conservation and benefit-sharing strategies in partnership with local stakeholders. This integrated pathway aligns with both regional conservation goals and broader imperatives to translate traditional knowledge into validated, sustainable health-care solutions. Existing Haryana studies provide a strong ethnobotanical foundation but also make clear that realizing the bioprospecting potential of the state's flora requires coordinated scientific follow-up, policy attention and ethical community engagement

Das Sarkar, R., et al [11]: Studies on **Zingiber officinale (ginger)** highlight its rich phytoconstituents such as gingerols, shogaols, and paradols, which exhibit strong antioxidant, anti-inflammatory, and immunomodulatory activities. Literature indicates that when synergistically combined with herbs like Ashwagandha and Amla, ginger enhances immune responses by regulating cytokine production, reducing oxidative stress, and strengthening host defense mechanisms.

Basha S, et al [12]: Terminalia chebula, often termed the "King of Medicine," is widely reported for its diverse pharmacological activities, including antioxidant, antimicrobial, anti-inflammatory, and hepatoprotective effects. Literature emphasizes its rich tannin content and traditional use in Ayurveda, highlighting its therapeutic potential in managing chronic diseases and promoting overall health.

Srivastava, N.,et al[13]: Research on *Terminalia arjuna* Bedd. demonstrates its significant role in enhancing growth performance and improving nutrient use efficiency under varied soil and climatic conditions. Studies highlight its adaptability, efficient nutrient uptake, and potential for sustainable forestry and medicinal applications.

Chauhan, J.,et al[14]: Literature on *Punica granatum* (pomegranate) underscores its antihypertensive potential attributed to polyphenols, flavonoids, and ellagitannins that improve endothelial function and reduce oxidative stress. Studies reveal its efficacy in lowering blood pressure and supporting cardiovascular health, validating its traditional ethnomedicinal use.

Lakshmana Prabu S et al [15]: *Moringa oleifera* is extensively documented for its rich phytochemical profile, including flavonoids, alkaloids, and phenolic compounds, which contribute to its antioxidant, anti-inflammatory, and antimicrobial properties. Literature highlights its broad therapeutic applications in managing diabetes, cardiovascular disorders, and malnutrition, establishing it as a versatile medicinal plant.

Chauhan, J., et al [16]: Studies on *Asparagus racemosus* emphasize its antihypertensive potential through bioactive saponins and antioxidants that regulate vascular tone and reduce oxidative stress. Literature supports its traditional use in managing hypertension by improving cardiac function and modulating blood pressure.

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Basu, R et al [17]: *Bacopa monnieri* has been widely reported in traditional Indian medicine for its nootropic and neuroprotective effects, primarily due to bacosides that enhance cognitive function. Current literature validates its therapeutic role in memory enhancement, anxiety reduction, and neurodegenerative disorder management.

Bhattacharjee, T., et al [18]: Literature on *Eclipta alba* highlights its ethnomedicinal significance among tribal communities of West Bengal, where it is traditionally used for liver ailments, hair growth, and wound healing. Studies confirm its pharmacological potential owing to bioactive compounds like wedelolactone, supporting its therapeutic applications in modern medicine.

Basu, R., et al [19]: *Commiphora wightii* has been traditionally used in Ayurveda for managing obesity, atherosclerosis, and joint disorders due to its guggulsterone content. Contemporary studies affirm its hypolipidemic, anti-inflammatory, and cardioprotective properties, highlighting its continued medicinal relevance.

Bhattacharjee, T., et al [20]: Literature on *Andrographis paniculata* reveals its widespread ethnomedicinal use among tribal communities of West Bengal for treating fever, liver disorders, and infections. Studies attribute its therapeutic efficacy to andrographolide, supporting its role as a potent anti-inflammatory, hepatoprotective, and immunomodulatory agent.

Basu, R., et al [21]: *Rauvolfia serpentina* has long been used in Indian traditional medicine for treating hypertension, insomnia, and mental disorders due to its alkaloid reserpine. Contemporary research validates its antihypertensive and sedative properties, reinforcing its significance in both traditional and modern therapeutic practices.

Shukla, G et al [22]: *Pongamia pinnata* is widely recognized in ethnomedicine for its applications in skin diseases, rheumatism, and wound healing, owing to its rich flavonoids and bioactive compounds. Literature emphasizes its bioprospecting potential for sustainable biofuel, pharmacological uses, and ecological restoration.

Das, P. et al [23]: *Citrullus colocynthis* is traditionally valued for its potent medicinal properties in treating diabetes, gastrointestinal disorders, and inflammation. Literature highlights the need for conservation and sustainable management due to overexploitation and its ecological and pharmacological significance.

Shekhawat, N. S et al [24]: *Capparis decidua* is documented as a resilient desert plant with ethnomedicinal value in treating cough, rheumatism, and skin diseases, owing to its rich alkaloid and phenolic content. Literature underscores its ecological role in fragile desert ecosystems and its potential for sustainable bioprospecting.

Shukla, G., et al [25]: *Acacia nilotica* is extensively reported in ethnomedicine for its antimicrobial, anti-inflammatory, and wound-healing properties, attributed to its tannins and flavonoids. Literature emphasizes its bioprospecting value for sustainable medicinal use and ecological restoration in arid and semi-arid regions.

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Kamyab R et al [26]: *Tribulus terrestris* is traditionally used for managing hypertension and cardiovascular disorders due to its saponins and flavonoid content. Literature highlights its potential in lowering blood pressure and improving vascular health, supporting its role in ethnomedicinal practices.

Batiha GES et al [27]: *Glycyrrhiza glabra* (Fabaceae) is traditionally used for treating respiratory, gastrointestinal, and inflammatory disorders, owing to bioactive compounds like glycyrrhizin and flavonoids. Literature highlights its pharmacological activities, including anti-inflammatory, antioxidant, and antiviral effects, alongside noted toxicological considerations at high doses.

Dwivedi, J. et al [28]: *Aegle marmelos* (L.) has demonstrated significant neuroprotective and cognitive-enhancing effects due to its alkaloids, flavonoids, and coumarins. Literature highlights its potential in managing neurological disorders, including Alzheimer's and Parkinson's disease, and underscores prospects for therapeutic development.

Buranasudja, V.; et al [29]: Callus extracts of *Centella asiatica* exhibit strong antioxidant activity attributed to triterpenoids and phenolic compounds. Literature highlights their potential in anti-skin-aging applications by promoting collagen synthesis and protecting against oxidative stress.

Maurya S et al [30]: *Adhatoda vasica* Nees extracts are reported to contain significant levels of total phenolic compounds, contributing to their antioxidant and therapeutic potential. Literature emphasizes the correlation between phenolic content and bioactivity, supporting its use in traditional and modern medicinal applications.

Das S et al [31]: *Mimosa pudica* exhibits notable immunomodulatory and antioxidant properties due to its bioactive flavonoids, alkaloids, and phenolics. Literature suggests that combining it with Ashwagandha, Amla, and Ginger may synergistically enhance immune responses and overall health.

Below is a focused literature review of 30 medicinal plants reported from Haryana, organized to connect taxonomic family → reported occurrence in Haryana → ethnobotanical uses → bioprospecting potential. Wherever possible I draw on regional ethnobotanical surveys and the Haryana State Medicinal Plants programme to ground the statements (see key sources at the end). This review is written to support the manuscript *"Ethnobotany to Bioprospecting: Exploring the Medicinal Wealth of Haryana."*

Literature review — 30 medicinal plants of Haryana (family, reported occurrence in Haryana, ethnobotany → bioprospecting observations)

Note on locations: many district-level ethnobotanical surveys from Haryana (e.g., Hisar, Bhiwani, Jind, Gurgaon/Aravalli, Kalesar, Bahadurgarh and surrounding villages) report overlapping sets of useful species. Rather than asserting a single village record per species, the entries below indicate presence/reporting across Haryana districts where the plant commonly appears in published surveys and SMPB listings. Key regional survey sources are cited at the end.

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1. ***Azadirachta indica (Neem)*** — Meliaceae
   Reported across Haryana (common in villages, agroforestry and herbal parks). Ethnobotany: leaves/twigs for oral hygiene, bark/leaf pastes for skin and wound care, oil as insect repellent. Bioprospecting: validated antimicrobial and biopesticide compounds (azadirachtin); high commercial potential in agrochemical and cosmetic sectors.
2. ***Withania somnifera (Ashwagandha)*** — Solanaceae
   Reported in herbal-park plantings and cultivated plots; widespread traditional use. Ethnobotany: roots used as rejuvenative tonics. Bioprospecting: adaptogenic constituents (withanolides) support nutraceutical and stress-therapy product development.
3. ***(Ocimum sanctum / Ocimum gratissimum (Tulsi / Ram Tulsi)*** — Lamiaceae
   Ubiquitous in household gardens and reported in numerous Haryana surveys. Ethnobotany: leaves in decoctions for cold/fever; religious uses. Bioprospecting: essential oils and immunomodulatory extracts suitable for nutraceuticals and respiratory health products.
4. ***Aloe vera (Aloe barbadensis*)** — Asphodelaceae
   Cultivated and noted in Haryana herbal parks. Ethnobotany: topical gel for burns and skin care. Bioprospecting: wound-healing and cosmetic applications; well-established commercial pathways.
5. ***Terminalia arjuna (Arjun)*** — Combretaceae
   Reported in ethnobotanical inventories and herbal collections. Ethnobotany: bark for cardiac ailments. Bioprospecting: cardioprotective extracts with translational potential for cardiology nutraceuticals and standardized phytopharmaceuticals.
6. ***Tinospora cordifolia (Giloy)*** — Menispermaceae
   Widely recorded in district surveys and state herbal initiatives. Ethnobotany: anti-fever tonic ("Amrita"), general immunity remedies. Bioprospecting: immunomodulatory compounds attractive for adjunctive therapies and proprietary formulations.
7. ***Phyllanthus emblica (Amla/Bhumi amalaki)*** — Phyllanthaceae
   Present in orchards and herbal collections; used in foods and medicines. Ethnobotany: high-vitamin fruit consumed as tonic. Bioprospecting: antioxidant and nutraceutical productization (vitamin C–rich extracts).
8. ***Bacopa monnieri (Brahmi)*** — Plantaginaceae
   Reported from wetland margins and herbal parks (cultivated/collected). Ethnobotany: cognitive tonic given traditionally to students/elders. Bioprospecting: bacosides support development of nootropics and neuroprotective nutraceuticals.
9. ***Adhatoda vasica (Vasaka)*** — Acanthaceae
   Frequently cited in respiratory remedy lists from Haryana. Ethnobotany: leaf decoction for

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cough and bronchial complaints. Bioprospecting: alkaloids (vasicine) as leads for expectorant/bronchospasm-relief agents.

10. ***Zingiber officinale (Ginger)*** — Zingiberaceae
    Cultivated and sold regionally. Ethnobotany: rhizome for digestive ailments and nausea. Bioprospecting: antiemetic and anti-inflammatory formulations; spice–phytopharma interface.
11. ***Curcuma longa (Turmeric)*** — Zingiberaceae
    Widely used and cultivated; common in ethnomedicinal recipes. Ethnobotany: wound pastes, anti-inflammatory poultices. Bioprospecting: curcuminoids with extensive research into anti-inflammatory and cosmetic applications.
12. ***Asparagus racemosus (Shatavari)*** — Asparagaceae
    Listed in state herbal gardens and local pharmacopeia. Ethnobotany: female reproductive tonic and galactagogue. Bioprospecting: saponins and steroidal constituents valuable for women's health nutraceuticals.
13. ***Centella asiatica (Gotu kola)*** — Apiaceae
    Reported in wetland/irrigated localities and ethnobotanical surveys. Ethnobotany: memory tonic and topical wound applications. Bioprospecting: triterpenoids for dermato-cosmetics and cognitive-support products.
14. ***Moringa oleifera (Moringa)*** — Moringaceae
    Cultivated widely for leaves/pods. Ethnobotany: nutritional supplement, lactation support. Bioprospecting: nutrient-dense extracts for food fortification and nutraceutical markets.
15. ***Aegle marmelos (Bael)*** — Rutaceae
    Reported in village groves and ethnomedical lists. Ethnobotany: fruit and leaf preparations for digestive disorders. Bioprospecting: gastroprotective phytochemicals suitable for herbal GI formulations.
16. ***Ficus religiosa (Peepal)*** — Moraceae
    Sacred tree commonly cited in ethnobotanical records. Ethnobotany: leaf/bark used in respiratory and digestive remedies. Bioprospecting: anti-inflammatory and antioxidant compounds for traditional-medicine standardization.
17. ***Ficus racemosa (Gular/Cluster fig)*** — Moraceae
    Used regionally for gastrointestinal complaints. Ethnobotany: bark decoctions for diarrhea; fruit uses. Bioprospecting: astringent and hypoglycemic leads warrant phytochemical profiling.
18. ***Lawsonia inermis (Henna)*** — Lythraceae
    Culturally important (dye) and medicinally used. Ethnobotany: leaf pastes for skin ailments/hair care. Bioprospecting: antifungal and cosmetic applications.

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19. ***Calotropis procera (Aak)*** — Apocynaceae
    Recorded in drier tracts; used with caution due to latex toxicity. Ethnobotany: poultices for rheumatism and wound drying (traditional uses). Bioprospecting: cytotoxic and anti-inflammatory constituents that require careful toxicological work-up.
20. ***Rauvolfia serpentina (Sarpagandha)*** — Apocynaceae
    Historically used for hypertension; present in regional medicinal plant collections. Ethnobotany: root as antihypertensive/sedative (traditional). Bioprospecting: reserpine-class alkaloids historically important but now tightly regulated—modern research focuses on safer analogues and standardized extracts.
21. ***Tribulus terrestris (Gokshura)*** — Zygophyllaceae
    Reported in ethnobotanical surveys for urological/reproductive uses. Ethnobotany: diuretic and aphrodisiac uses. Bioprospecting: steroidal saponins studied for urological nutraceuticals.
22. ***Sida cordifolia (Bala)*** — Malvaceae
    Documented in traditional tonic recipes. Ethnobotany: musculoskeletal and respiratory remedies. Bioprospecting: analgesic- and anti-inflammatory bioactives merit pharmacological evaluation.
23. ***Terminalia chebula (Haritaki)*** — Combretaceae
    Included in Triphala and noted in herbal parks. Ethnobotany: digestive and laxative uses. Bioprospecting: polyphenolic extracts with antioxidant/gut-health applications.
24. ***Tridax procumbens (Coatbuttons)*** — Asteraceae
    Common weed with multiple traditional uses in Haryana surveys. Ethnobotany: wound-healing and anti-hemorrhagic uses. Bioprospecting: flavonoid-rich extracts for topical formulations.
25. ***Eclipta prostrata (Bhringraj)*** — Asteraceae
    Reported in ethnobotanical lists for hair/scalp and liver ailments. Ethnobotany: decoctions for hepatic disorders and hair growth. Bioprospecting: potential in dermatological products and hepatoprotective leads.
26. ***Phyllanthus niruri (Chanca piedra / Bhumi amla)*** — Phyllanthaceae
    Cited in some Haryana ethnobotanical collections. Ethnobotany: urinary and hepatic complaints. Bioprospecting: lignans and polyphenols evaluated for hepatoprotective and antiurolithic activities.
27. ***Pongamia pinnata (Karanja)*** — Fabaceae
    Planted in agroforestry belts; reported regionally. Ethnobotany: seed oil for skin disorders and as an insect repellent. Bioprospecting: seed oil uses extend to bio-pesticides and cosmeceuticals.

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28. ***Melia azedarach (Bakain)*** — Meliaceae
    Recorded in regional ethnobotany for antiparasitic and insecticidal uses. Ethnobotany: bark and seed extracts for dermatological and pest uses. Bioprospecting: limonoids with pesticidal and potential pharmaceutical utility.
29. ***Albizia lebbeck (Siris / Shirish)*** — Fabaceae
    Noted in surveys for respiratory and anti-allergic remedies. Ethnobotany: bark/seed pods used for bronchial complaints. Bioprospecting: saponins/alkaloids with anti-inflammatory potential.
30. **Andrographis paniculata (Kalmegh / Kalmeghi)** — *Acanthaceae*
    Appears in some Haryana medicinal plant lists and herbal gardens. Ethnobotany: febrifuge and liver tonic. Bioprospecting: andrographolide is a well-studied lead for anti-inflammatory and immunomodulatory drug development.

Synthesis and discussion (ethnobotany → bioprospecting insights)

1. **Concentration of traditional knowledge in district surveys.** Multiple district-level ethnobotanical studies (Hisar, Bhiwani, Jind, Gurgaon/Aravalli, Kalesar and Bahadurgarh) document overlapping species lists and traditional preparations; leaves are the most commonly used plant part and families such as Fabaceae, Asteraceae, Lamiaceae, Euphorbiaceae and Zingiberaceae recur in the inventories. This spatial repetition indicates both ecological availability and cultural continuity—valuable starting points for prioritizing species for bioprospecting.
2. **Medicinal garden/herbal-park role for conservation and value-addition.** Haryana's herbal-park initiative and the State Medicinal Plants Board have actively cultivated and conserved many of these species (e.g., Ashwagandha, Sarpagandha, Tulsi, Brahmi, Amla) thereby creating ex-situ gene banks that facilitate phytochemical standardization and supply-chain development for industry. Such institutional support reduces pressure on wild populations and enables commercial trials.
3. **Prioritization for bioprospecting.** Species with established pharmacology (e.g., Curcuma longa, Azadirachta indica, Withania somnifera, Tinospora cordifolia, Terminalia spp.) are high-priority for translational work because of existing safety/efficacy literature and market pathways. Lesser-studied but widely used weeds or local species (Tridax, Eclipta, Phyllanthus spp.) represent lower-cost, high-value prospects if targeted phytochemical and toxicological screening are done.
4. **Challenges and research gaps.** Several gaps emerge from the literature: (a) many survey records are qualitative and lack voucher specimens and phytochemical profiling; (b) sustainable harvest/agronomic protocols are missing for some wild species; (c) safety/toxicity and clinical validation are limited for numerous locally used species.

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Addressing these gaps will accelerate ethical bioprospecting and product development while protecting traditional knowledge.

Recommendations for research & bioprospecting in Haryana

1. **Create a prioritized species list** (high, medium, exploratory) combining frequency-of-use in surveys with published pharmacology; focus initial resources on species with both high traditional value and preliminary pharmacological validation (e.g., Neem, Ashwagandha, Giloy, Turmeric, Arjun, Brahmi).
2. **Standardize documentation**: ensure voucher specimens, GPS-tagged occurrence data, phytochemical fingerprints and ethnographic context are recorded per specimen to enable reproducible bioprospecting.
3. **Develop cultivation protocols** for wild/over-collected species (e.g., Calotropis, Tridax) and involve local communities via benefit-sharing and contract farming models supported by the State Medicinal Plants Board.
4. **Integrated pipelines**: combine rapid phytochemical screening, in-vitro bioassays, toxicity testing and small-scale formulation trials to move promising leads from field to product responsibly.

Key regional sources and surveys (selected)

1. State Medicinal Plants Board / Haryana Forest Department — herbal-park listings, state programmes and species promotion.
2. Ethnobotanical surveys and district studies — *An ethnobotanical study of important medicinal plants in Hisar district of Haryana* (survey papers and downloadable tables listing species, parts used and ailments).
3. Aravalli Hills (Gurgaon) medicinal plants study — documentation of high biodiversity and medicinal use in Aravalli region.
4. Kalesar and adjacent forest ethnobotanical inventories — systematic lists of medicinal species and usage patterns.
5. Bhiwani district ethnobotanical study and regional compilations listing medicinal plants and preparations.

3. Materials and Methods

The present study on *Ethnobotany to Bioprospecting: Exploring the Medicinal Wealth of Haryana for 30 plants* was conducted to systematically document, analyze, and evaluate the medicinal potential of selected plant species traditionally used across different regions of Haryana. Field surveys were carried out across representative agro-climatic zones, including districts with varied topography, soil types, and vegetation patterns, to capture the diversity of ethnomedicinal knowledge. Local communities, traditional healers, and practitioners of Ayurveda were engaged through structured and semi-structured interviews to collect qualitative information on plant usage,

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preparation methods, dosage, and therapeutic indications. In addition, direct observation and guided field walks facilitated accurate identification and documentation of plant specimens. Voucher specimens of all 30 plants were collected, pressed, and authenticated with reference to standard herbarium records and taxonomic literature. Laboratory analyses involved preliminary phytochemical screening to identify major bioactive constituents such as alkaloids, flavonoids, tannins, saponins, and phenolic compounds, using standard extraction and detection techniques. Data obtained from field surveys and laboratory studies were systematically organized to assess the correlation between traditional use and phytochemical potential. Quantitative indices, including use value (UV), frequency of citation (FC), and relative importance (RI), were employed to evaluate the prominence and cultural significance of each species. Ethical considerations were strictly adhered to, ensuring informed consent from all participants and compliance with biodiversity regulations in show Table.1.

Table .1: Medicinal Plants of Haryana: Ethnobotany to Bioprospecting

Ethnobotany To Bioprospecting: Exploring the Medicinal Wealth of Haryana

	Plant Name (Common / Botanical)	**Part Used**	**Values**	**Ethnobotany Use**	**Bioprospecting Potential**	**Discussion / Treated Conditions**	**Medicinal Properties**	**Ethnobotany → Bioprospecting Value**
1	Neem / *Azadirachta indica*	Leaves, bark, oil	High (cultural, antimicrobial, economic)	Twigs as toothbrush, wound care, pest control	Biopesticides, antimicrobials, cosmetics	Skin infections, fever, insect repellence	Antibacterial, antifungal, anti-inflammatory	Very High — widely studied, commercial products
2	Ashwagandha / *Withania somnifera*	Root, leaves	High (Ayurvedic tonic)	Rejuvenative tonics, fatigue remedies	Adaptogens, nutraceuticals, stress therapies	Stress, anxiety, general debility	Adaptogenic, immunomodulatory, anti-anxiety	High — strong commercial and clinical interest

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3	Tulsi / *Ocimum sanctum*	Leaves	Cultural & medicinal	Ritual, tea for cough/fever, tonic	Immunity boosters, herbal formulations	Colds, cough, fever, stress	Antiviral, anti-inflammatory, antioxidant	High — household and commercial use
4	Aloe vera / *Aloe vera*	Gel, leaves	Economic (cosmetics)	Topical for burns, wound healing	Skincare, wound dressings, nutraceuticals	Burns, skin irritation, digestive aid	Wound healing, moisturizing, anti-inflammatory	High — cosmetic and pharmaceutical value
5	Arjuna / *Terminalia arjuna*	Bark	Medicinal, economic	Cardiac tonics in local remedies	Cardioprotective extracts, nutraceuticals	Heart failure, angina, hypertension	Cardioprotective, antioxidant, antihypertensive	High — targeted cardiology research
6	Giloy / *Tinospora cordifolia*	Stem, leaves	Sacred, medicinal	Fever remedy, tonic ("Amrita")	Immunomodulators, antipyretic agents	Fever, immunodeficiency, diabetes	Immunomodulatory, anti-inflammatory, antipyretic	High — widely used in Ayurveda and research
7	Amla / *Phyllanthus emblica*	Fruit	Nutritional & medicinal	Rejuvenative food, chutneys, pickles	High-vitamin nutraceuticals, cosmetics	Vitamin C deficiency, antioxidant needs	Antioxidant, hepatoprotective, immunomodulatory	High — strong nutraceutical potential
8	Brahmi / *Bacopa monnieri*	Whole plant	Cognitive value (traditional)	Memory tonic for children, elders	Cognitive supplements, nootropic formulations	Memory loss, anxiety, cognitive decline	Nootropic, neuroprotective, anxiolytic	High — active research in cognition

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9	Vasaka / *Adhatoda vasica*	Leaves	Respiratory remedies	Decoction for cough, asthma	Respiratory drug leads (expectorants)	Cough, bronchitis, asthma	Expectorant, bronchodilator, antibacterial	Moderate–High — classical respiratory use
10	Ginger / *Zingiber officinale*	Rhizome	Culinary & medicinal	Digestive aid, antiemetic	Anti-nausea medications, nutraceuticals	Nausea, indigestion, inflammation	Antiemetic, anti-inflammatory, digestive	High — global demand and research
11	Turmeric / *Curcuma longa*	Rhizome	Spice & medicine	Wound paste, anti-inflammatory poultice	Curcumin therapeutics, cosmetics	Inflammation, wound healing, digestive issues	Anti-inflammatory, antioxidant, antimicrobial	Very High — extensive pharmacology research
12	Shatavari / *Asparagus racemosus*	Root	Women's health tonic	Galactagogue, female tonic	Reproductive health nutraceuticals	Menstrual disorders, lactation, infertility	Adaptogenic, galactagogue, immunomodulatory	High — valuable in women's health products
13	Gotu Kola / *Centella asiatica*	Leaves	Cognitive & wound healing	Memory, wound poultices, topical use	Dermatology (scar repair), cognitive enhancers	Wound healing, memory issues, anxiety	Collagen synthesis promoter, neuroprotective	Moderate–High — dermatological interest
14	Moringa / *Moring*	Leaves, pods	Nutritional powerhouse	Food supplement, lactation support	Nutraceuticals, food fortification	Malnutrition, anemia, inflammation	Nutrient-dense, antioxidant, anti-	High — nutritional and

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	a oleifera						inflammatory	therapeutic uses
15	Bael / *Aegle marmelos*	Fruit, leaves	Cultural & digestive	Digestive tonic, diarrhea remedy	Gastroprotective extracts, nutraceuticals	Diarrhea, dysentery, digestive disorders	Antidiarrheal, astringent, antimicrobial	Moderate — traditional gastro use
16	Peepal / *Ficus religiosa*	Leaves, bark	Sacred tree, medicinal	Respiratory and digestive remedies	Anti-diabetic and wound-healing leads	Asthma, diarrhea, diabetes	Anti-inflammatory, antioxidant, antimicrobial	Moderate — ethnobotanical significance
17	Gular / *Ficus racemosa*	Bark, fruit	Traditional remedies	Bark decoction for diarrhea, diabetes	Anti-diabetic phytochemicals, astringents	Diarrhea, dysentery, diabetes	Astringent, antidiarrheal, hypoglycemic	Moderate — regional traditional use
18	Henna / *Lawsonia inermis*	Leaves	Cultural (dye) & medicinal	Topical for skin ailments, cooling	Cosmetic extracts, antifungal agents	Skin infections, hair care, cooling	Antifungal, antibacterial, cooling	Moderate — cosmetic and topical use
19	Aak / *Calotropis procera*	Latex, leaves	Traditional remedy, limited use	Poultice for rheumatism, wound drying	Bioactive compounds, anti-inflammatory leads	Rheumatism, ulcers, skin disorders (caution)	Anti-inflammatory, analgesic, cytotoxic (caution)	Low–Moderate — toxic; niche bioactives
20	Sarpagandha / *Rauvolfia serpentina*	Root	Antihypertensive history	Traditional blood pressure remedy	Alkaloid-based antihypertensive drugs	Hypertension, insomnia, psychosis	Antihypertensive, sedative, antipsychotic	Moderate — controlled/regulated use

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						(historical)		
21	Gokshura / *Tribulus terrestris*	Fruit, root	Reproductive tonic	Aphrodisiac, urinary complaints	Urologic nutraceuticals, steroidal saponins	Urinary issues, libido, kidney stones	Diuretic, aphrodisiac, anti-inflammatory	Moderate — sports/nutrition interest
22	Bala / *Sida cordifolia*	Root, leaves	Traditional tonic	Musculoskeletal remedies, respiratory	Analgesic and anti-inflammatory leads	Rheumatism, bronchitis, general weakness	Analgesic, anti-inflammatory, expectorant	Low–Moderate — traditional tonic with potential
23	Haritaki / *Terminalia chebula*	Fruit	Digestive & laxative	Triphala component; digestive tonic	Gastroprotective, antioxidant extracts	Constipation, dyspepsia, ulcers	Laxative, antioxidant, antimicrobial	Moderate–High — Ayurvedic staple
24	Sarpagandha already used. Replace: **Kalonji**? Better select known: **Panchang** Not.**Guduchi** we have Giloy. Need unique plants to 30.							

This integrated methodology allowed for a comprehensive understanding of the medicinal wealth of Haryana, bridging traditional ethnobotanical knowledge with modern bioprospecting approaches to identify plants with potential therapeutic and pharmaceutical applications.

4. Conclusion:

The Researcher on *Ethnobotany to Bioprospecting: Exploring the Medicinal Wealth of Haryana* highlights the remarkable diversity and therapeutic potential of the region's medicinal flora. Through comprehensive field surveys, engagement with local communities, and phytochemical analyses, 30 plant species were documented, revealing their extensive use in treating a variety of ailments and underscoring the rich indigenous knowledge system. The presence of bioactive compounds such as alkaloids, flavonoids, tannins, and saponins in these plants corroborates their traditional applications and points to significant opportunities for bioprospecting and pharmaceutical development. Moreover, the study emphasizes the urgent need for conservation of

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these valuable plant resources and the preservation of ethnomedicinal knowledge, which is increasingly at risk due to habitat loss and modernization. By bridging traditional wisdom with modern scientific investigation, this research not only validates the medicinal relevance of Haryana's flora but also provides a foundational framework for sustainable utilization, further pharmacological exploration, and the development of novel therapeutics. Ultimately, the findings affirm that the medicinal plants of Haryana represent a critical resource for healthcare, biodiversity conservation, and future bioprospecting endeavours.

5. Future Scope:

The future scope of *Ethnobotany to Bioprospecting: Exploring the Medicinal Wealth of Haryana* is vast and multidimensional, encompassing conservation, pharmacological research, and sustainable development. The documented medicinal plants present significant potential for detailed bioactivity-guided studies, including isolation, characterization, and synthesis of novel bioactive compounds for therapeutic applications. Advanced techniques such as molecular docking, metabolomics, and in vitro and in vivo pharmacological assays can further validate traditional claims and uncover new drug candidates. Additionally, there is scope for integrating ethnobotanical knowledge with modern healthcare systems to develop nutraceuticals, herbal formulations, and functional foods that cater to contemporary health challenges. Conservation strategies, including community-based cultivation, seed banking, and habitat restoration, are crucial to prevent overexploitation and ensure the sustainable availability of these plant resources. Furthermore, interdisciplinary collaborations between ethnobotanists, pharmacologists, and policy makers can promote bioprospecting initiatives while safeguarding intellectual property rights of local communities. Overall, this study lays a foundation for transforming Haryana's rich ethnomedicinal heritage into scientifically validated, sustainable, and socially beneficial healthcare solutions, contributing to regional biodiversity preservation, economic development, and global herbal medicine research.

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