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MEDICINAL PLANTS OF THE ARAVALLI HILLS: AN AYURVEDIC PHARMACO-ECOLOGICAL REVIEW IN THE CONTEXT OF EMERGING CONSERVATION CHALLENGES

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ABSTRACT

Background: Ayurveda recognizes that the therapeutic attributes of medicinal plants are shaped by geographical and ecological context (*Desha*), influencing the expression of *Rasa*, *Guna*, *Virya*, and *Vipaka*. While Himalayan and Western Ghats ecosystems have been extensively interpreted through Ayurvedic and biomedical frameworks, the Aravalli Hills—one of the oldest mountain systems in the world—remain underrepresented in integrative Ayurvedic literature. The medicinal plants of this region are predominantly associated with dry deciduous forests, scrublands, rocky slopes, and lower hill ecosystems that are ecologically sensitive. **Objective:** This review aims to synthesize medicinal plants reported from the Aravalli Hills in indexed literature, interpret their therapeutic relevance using Ayurvedic principles, and examine their vulnerability in the context of recent ecological and regulatory developments. **Methods:** A narrative review was conducted using ethnobotanical, ethnopharmacological, and pharmacological studies indexed in PubMed, Scopus, ScienceDirect (Elsevier), and PMC. Medicinal plants reported from the Aravalli Hills were consolidated and mapped to Ayurvedic identity using classical texts. Contemporary judicial and policy discussions related to hill delineation and land-use regulation were reviewed to assess potential implications for medicinal plant conservation. **Results:** More than 250 medicinal plant species are reported from the Aravalli Hills, of which a representative set of 70 Ayurvedically relevant taxa was analyzed in detail. These plants

predominantly exhibit *Tikta* and *Kashaya Rasa*, *Laghu–Ruksha Guna*, *Ushna Virya*, and *Katu Vipaka*, reflecting adaptation to arid and semi-arid ecological stress. Recent judicial discussions before the Supreme Court of India regarding the definition of the Aravalli Hills, including adoption of a relief-based 100-metre criterion for regulatory purposes, have highlighted concerns that lower-elevation habitats may fall outside strict protection regimes. Such areas coincide with the natural habitats of several key Ayurvedic plants, including slow-growing resin-yielding species such as *Guggulu* and *Shallaki*. **Conclusions:** The Aravalli Hills represent a distinct Ayurvedic pharmaco-ecological zone shaped by ancient geology, arid climate, and traditional knowledge systems. From an Ayurvedic perspective, large-scale alteration of lower hill and scrubland ecosystems risks not only species depletion but also disruption of ecological conditions that govern *Rasa, Guna, Virya,* and *Vipaka*. Integrating Ayurvedic pharmaco-ecological understanding into regional planning is therefore essential for sustainable utilization and conservation.

KEYWORDS: Aravalli Hills; Ayurveda; pharmaco-ecology; medicinal plant conservation; traditional knowledge.

INTRODUCTION

Medicinal plants constitute the foundation of Ayurvedic therapeutics, where drug action is determined not only by botanical identity but also by ecological context. Classical Ayurvedic texts emphasize that *Desha* (geographical region), *Kala* (time and season), and environmental conditions influence the manifestation of *Rasa, Guna*, *Virya,* and *Vipaka,* thereby shaping therapeutic outcomes.[1-4] India's diverse physiography has thus given rise to region-specific medicinal plant assemblages with distinct pharmacodynamic profiles.[5-7]

The Aravalli Hills, extending across Rajasthan, Gujarat, Haryana, and the National Capital Region, represent one of the most ancient geological formations on Earth. The region is characterized by dry deciduous forests, scrublands, rocky slopes, and fragmented lower hill ecosystems that support a rich assemblage of medicinal plants adapted to arid and semi-arid stress[9] These vegetation types correspond to the dry deciduous and thorn forest categories described in classical forest-type classifications of India.[24] Numerous ethnobotanical studies have documented traditional medicinal plant use among indigenous communities such as the Bhil and Meena[8]; however, these accounts are largely descriptive and rarely interpreted through a comprehensive Ayurvedic pharmaco-ecological lens.

Recent judicial deliberations before the Supreme Court of India concerning the delineation of the Aravalli Hills, including the adoption of relief-based criteria for regulatory interpretation, have renewed attention on land-use governance in the region. Although such definitions are administrative rather than ecological, they may indirectly influence mining, construction, and infrastructure development in habitats that overlap with the natural distribution of several Ayurvedic medicinal plants.

Importantly, many key Aravalli medicinal plants—such as *Guggulu* (Commiphora wightii Arn.) and *Shallaki* (Boswellia serrata Roxb.)[10-12]—are slow-growing, resin-yielding species associated with scrublands and lower hill slopes rather than steep hill cores. From an Ayurvedic pharmaco-ecological perspective, large-scale alteration of these habitats risks not only loss of plant populations but also disruption of the environmental conditions that shape *Rasa*, *Guna*, *Virya*, and *Vipaka*. This contemporary context underscores the need to reinterpret the Aravalli Hills as a distinct Ayurvedic pharmaco-ecological zone and to integrate traditional medicinal plant conservation into broader environmental planning. **(Fig 1 & Fig 2)**

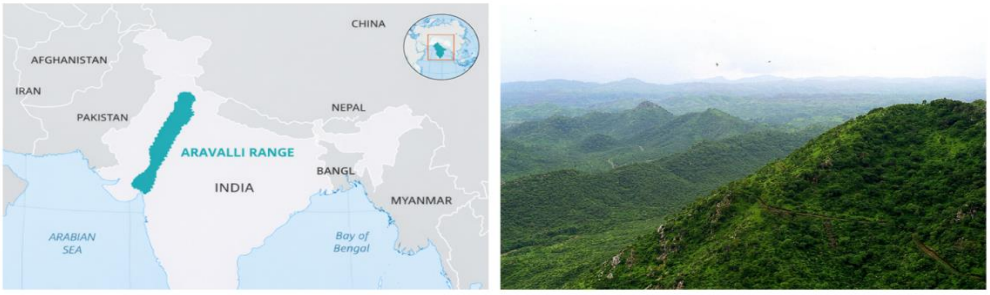

Fig 1: Spread of Aravalli Range.

Fig 2: New definition of Arravali Hill By Supreme Court and Environmental Concern.

MATERIALS AND METHODS

Study design

The present work is a **narrative integrative review** aimed at synthesizing published evidence on medicinal plants of the Aravalli Hills and interpreting their therapeutic relevance through Ayurvedic pharmaco-ecological principles. No primary field surveys, human participants, animal experimentation, or laboratory analyses were undertaken as part of this study.

Literature search strategy

The review followed a narrative synthesis approach rather than a systematic review framework. A comprehensive literature search was conducted using the following electronic databases: PubMed**,** Scopus**,** ScienceDirect (Elsevier)**,** PubMed Central (PMC). The search covered articles published up to the most recent available year at the time of manuscript preparation. Combinations of keywords were used, including: "Aravalli Hills", "medicinal plants", "ethnobotany", "ethnomedicine", "Ayurveda", "traditional knowledge", "pharmacology", "conservation", and "mining". Only peer-reviewed articles, review papers, and authoritative reports relevant to medicinal plants of the Aravalli region were considered.

Eligibility criteria

Inclusion criteria

- Studies reporting medicinal or ethnomedicinal plants from the Aravalli Hills or adjoining Aravalli landscapes
- Articles indexed in PubMed, Scopus, or Elsevier journals
- Publications providing botanical identification, traditional use, or pharmacological data
- Studies relevant to Ayurveda or compatible with Ayurvedic interpretation

Exclusion criteria

- Non-peer-reviewed sources, unpublished theses, or anecdotal reports
- Studies lacking clear botanical identification
- Purely floristic surveys without medicinal relevance
- Articles unrelated to the Aravalli ecological region

Data extraction and consolidation

From eligible publications, the following information was extracted.

- Botanical name and family

- Reported traditional or ethnomedicinal uses
- Pharmacological or phytochemical findings

Phytochemical identity and quality parameters were further corroborated using standardized monographs published by the Indian Council of Medical Research.[22]

Ayurvedic mapping and pharmaco-ecological interpretation

Each plant species was mapped to its corresponding Ayurvedic identity using classical Ayurvedic literature, including *Charaka Samhita*, *Sushruta Samhita*, and *Bhavaprakasha Nighantu*. Ayurvedic attributes—*Rasa*, *Guna*, *Virya*, and *Vipaka*[7]—along with major *Karma* (therapeutic actions) were assigned based on classical descriptions and standard Ayurvedic Materia medica. Classical drug identity, nomenclature, and quality standards were cross-verified using official pharmacopoeia sources of the Government of India.[21] Interpretation emphasized the relationship between ecological conditions of the Aravalli Hills and the dominant Ayurvedic pharmacodynamic patterns, in line with the Ayurvedic concept of *Desha*.[6]

Selection of representative plant species

Although more than 250 medicinal plant species have been reported from the Aravalli Hills in published literature, a **representative subset of 70 Ayurvedically relevant plants** was selected for detailed analysis and tabulation. Selection was based on.

- Frequency of citation in indexed literature
- Clear Ayurvedic identity and classical references
- Therapeutic importance and contemporary relevance
- Availability of phytochemical or pharmacological evidence

Data presentation

Data are presented descriptively using tables and thematic synthesis. A comprehensive table summarizes key Ayurvedic medicinal plants of the Aravalli Hills, including botanical identity, Ayurvedic attributes, traditional uses, phytochemicals, and recent research findings.

Ethical considerations

As this study is based entirely on published literature and does not involve human participants, animals, or biological samples, formal ethical approval was not required.

RESULTS

3.1 Overview of medicinal plant diversity in the Aravalli Hills

Synthesis of indexed ethnobotanical, ethnopharmacological, and pharmacological literature indicates that the Aravalli Hills harbour a rich assemblage of medicinal plants adapted to arid and semi-arid ecological conditions. Across the reviewed literature, more than **250 medicinal plant species** are reported from the Aravalli landscape, spanning trees, shrubs, herbs, climbers, grasses, and parasitic taxa.[23] Species occurrence and medicinal relevance were cross-verified using authoritative national compendia of Indian medicinal plants.[23]

From this pool, **70 Ayurvedically relevant plant species** with clear classical identity and contemporary research relevance were selected for detailed analysis **(Table 1 & Fig 3).**

3.2 Taxonomic distribution

The selected 70 species belong to more than **40 botanical families**, with dominant representation from Fabaceae, Combretaceae, Apocynaceae, Euphorbiaceae, Lamiaceae, Menispermaceae, Rutaceae, and Poaceae. Trees and shrubs constituted a major proportion of the flora, reflecting the dry deciduous and scrub forest structure of the Aravalli Hills, while herbs and climbers formed an important secondary component.

This taxonomic distribution highlights the ecological heterogeneity of the Aravalli region and its capacity to support both woody perennials and short-lived seasonal taxa with medicinal value.

3.3 Dominant Ayurvedic pharmaco-ecological profile

Analysis of Ayurvedic attributes revealed a consistent pharmaco-ecological pattern among the Aravalli medicinal plants

- **Rasa:** Predominance of *Tikta* and *Kashaya Rasa* was observed across the majority of species, with secondary contribution from *Katu* and *Madhura Rasa*.
- **Guna:** *Laghu* and *Ruksha Guna* were most frequently represented, consistent with plants growing under water-limited and nutrient-stressed conditions.
- **Virya:** *Ushna Virya* predominated, while *Sheeta Virya* was comparatively less common and largely restricted to specific taxa.
- **Vipaka:** *Katu Vipaka* was the most frequently reported post-digestive effect, followed by *Madhura Vipaka*.

This collective profile reflects ecological adaptation to arid environments and supports the Ayurvedic concept that regional ecology influences drug potency through *Desha*.

Table 1: A. Ayurvedic medicinal HERBS reported from the Aravalli Hills.

S. No.	Botanical name & Family	Ayurvedic name	Rasa–Guna–Virya–Vipaka	Main Karma	Traditional uses	Major phytochemicals
1	*Andrographis paniculata* (Burm.f.) Nees — Acanthaceae	*Kalmegha*	Tikta; Laghu–Ruksha; Ushna; Katu	*Jvaraghna, Yakrituttejaka*	Fever, liver disorders	Andrographolide
2	*Boerhavia diffusa* L. — Nyctaginaceae	*Punarnava*	Tikta–Kashaya; Laghu–Ruksha; Ushna; Madhura	*Mutrala, Shothahara*	Edema, renal disorders	Boeravinones
3	*Boerhavia erecta* L. — Nyctaginaceae	*Punarnava bheda*	Tikta–Kashaya; Laghu–Ruksha; Ushna; Madhura	*Shothahara*	Swelling	Rotenoids
4	*Centella asiatica* (L.) Urb. — Apiaceae	*Mandukaparni*	Tikta–Kashaya; Laghu; Sheeta; Madhura	*Medhya, Rasayana*	Memory, wound healing	Triterpenoids, Hydrocotyline
5	*Eclipta alba* (L.) Hassk. — Asteraceae	*Bhringaraja*	Tikta–Kashaya; Laghu; Ushna; Katu	*Yakrituttejaka*	Liver disorders, hair care	Wedelolactone
6	*Cassia tora* L. — Fabaceae	*Chakramarda*	Tikta–Kashaya; Laghu–Ruksha; Ushna; Katu	*Kusthaghna*	Fungal skin diseases	Anthraquinones
7	*Mimosa pudica* L. — Fabaceae	*Lajjalu*	Kashaya; Laghu–Ruksha; Sheeta; Katu	*Raktastambhaka*	Diarrhea, piles	Alkaloids
8	*Aloe vera* (L.) Burm.f. — Asphodelaceae	*Ghritkumari*	Tikta–Madhura; Guru–Snigdha; Sheeta; Madhura	*Virechaka*	Burns, constipation	Aloin
9	*Tridax procumbens* L. — Asteraceae	*Jayanti*	Tikta–Kashaya; Laghu–Ruksha; Ushna; Katu	*Vrana ropana*	Cuts, wounds	Flavonoids
10	*Cleome viscosa* L. — Cleomaceae	*Peeta Hulhul*	Katu–Tikta; Laghu–Ruksha; Ushna; Katu	*Dipana*	Flatulence	Glucosinolates
11	*Achyranthes aspera* L. — Amaranthaceae	*Apamarga*	Tikta–Kashaya; Laghu–Ruksha; Ushna; Katu	*Lekhana*	Piles, obesity	Saponins
12	*Argemone mexicana* L. — Papaveraceae	*Svarnakshiri*	Tikta–Katu; Laghu–Ruksha; Ushna; Katu	*Bhedana*	Constipation	Isoquinoline alkaloids
13	*Cannabis sativa* L. — Cannabaceae	*Vijaya*	Tikta–Katu; Laghu–Ruksha; Ushna; Katu	*Vedanasthapana*	Pain, insomnia	Cannabinoids
14	*Ricinus communis* L. —	*Eranda*	Madhura; Guru–Snigdha; Ushna;	*Vatahara*	Arthritis	Ricinoleic acid

	Euphorbiaceae		Madhura			
15	*Solanum nigrum* L. — Solanaceae	*Kakamachi*	Tikta; Laghu–Ruksha; Ushna; Katu	*Yakrit hara*	Liver disorders	Glycoalkaloids
16	*Physalis minima* L. — Solanaceae	*Chirpotika (Tankari)*	Tikta; Laghu–Ruksha; Ushna; Katu	*Jvaraghna*	Fever	Withanolides
17	*Tribulus terrestris* L. — Zygophyllaceae	*Gokshura*	Madhura; Guru–Snigdha; Sheeta; Madhura	*Mutrala*	Urinary disorders	Saponins
18	*Cynodon dactylon* (L.) Pers. — Poaceae	*Durva*	Kashaya–Madhura; Laghu; Sheeta; Madhura	*Raktastambhaka*	Bleeding disorders	Flavonoids
19	*Desmostachya bipinnata* (L.) Stapf — Poaceae	*Darbha*	Kashaya–Madhura; Laghu; Sheeta; Madhura	*Mutrala*	Urinary disorders	Phenolics
20	*Imperata cylindrica* (L.) P. Beauv. — Poaceae	*Kusha*	Kashaya–Madhura; Laghu; Sheeta; Madhura	*Raktastambhaka*	Hemorrhage	Saponins

Table 1 B: Ayurvedic medicinal SHRUBS reported from the Aravalli Hills.

S. No.	Botanical name & Family	Ayurvedic name	Rasa–Guna–Virya–Vipaka	Main Karma	Traditional uses	Major phytochemicals
21	*Withania somnifera* (L.) Dunal — Solanaceae	Ashwagandha	Tikta–Kashaya–Madhura; Laghu–Snigdha; Ushna; Madhura	Balya, Rasayana	Debility, stress	Withanolides
22	*Vitex negundo* L. — Lamiaceae	Nirgundi	Tikta–Kashaya; Laghu–Ruksha; Ushna; Katu	Vedanasthapana	Pain, inflammation	Flavonoids
23	*Calotropis procera* (Aiton) Dryand. — Apocynaceae	Arka	Katu–Tikta; Laghu–Ruksha; Ushna; Katu	Shothahara	Swelling	Cardiac glycosides
24	*Justicia adhatoda* L. — Acanthaceae	Vasa	Tikta–Kashaya; Laghu; Ushna; Katu	Kaphaghna	Cough, asthma	Vasicine
25	*Plumbago zeylanica* L. — Plumbaginaceae	Chitraka	Katu; Laghu–Ruksha; Ushna; Katu	Dipana	Indigestion	Plumbagin
26	*Sida cordifolia* L. — Malvaceae	Bala	Madhura; Snigdha; Sheeta; Madhura	Balya	Weakness	Alkaloids
27	*Solanum xanthocarpum* Schrad. & H.Wendl. — Solanaceae	Kantakari	Tikta–Katu; Laghu–Ruksha; Ushna; Katu	Kaphaghna	Asthma	Steroidal alkaloids
28	*Solanum indicum* L. — Solanaceae	Brihati	Tikta–Katu; Laghu–Ruksha; Ushna; Katu	Kaphaghna	Cough	Alkaloids
29	*Pergularia daemia*	Uttamarani	Tikta–Katu; Laghu–	Shothahara	Wounds	Glycosides

	(Forssk.) Chiov. — Apocynaceae		Ruksha; Ushna; Katu			
30	*Euphorbia neriifolia* L. — Euphorbiaceae	Snuhi	Katu–Tikta; Laghu–Snigdha; Ushna; Katu	Bhedana	Piles	Diterpenes

Table 1C: Ayurvedic medicinal TREES reported from the Aravalli Hills.

S. No.	Botanical name & Family	Ayurvedic name	Rasa–Guna–Virya–Vipaka	Main Karma	Traditional uses	Major phytochemicals
31	*Commiphora wightii* (Arn.) Bhandari — Burseraceae	Guggulu	Tikta–Katu; Laghu; Ushna; Katu	Lekhana, Shothahara	Arthritis, obesity	Guggulsterones[16]
32	*Boswellia serrata* Roxb. ex Colebr. — Burseraceae	Shallaki	Tikta–Kashaya; Laghu–Ruksha; Ushna; Katu	Shothahara	Joint disorders	Boswellic acids
33	*Acacia catechu* (L.f.) Willd. — Fabaceae	Khadira	Kashaya; Laghu–Ruksha; Sheeta; Katu	Kusthaghna	Skin diseases	Catechins
34	*Azadirachta indica* A.Juss. — Meliaceae	Nimba	Tikta–Kashaya; Laghu–Ruksha; Sheeta; Katu	Krimighna	Skin infections	Limonoids
35	*Terminalia arjuna* (Roxb. ex DC.) Wight & Arn. — Combretaceae	Arjuna	Kashaya; Laghu–Ruksha; Sheeta; Katu	Hridya	Cardiac disorders	Triterpenoids
36	*Terminalia chebula* Retz. — Combretaceae	Haritaki	Pancharasa; Laghu–Ruksha; Ushna; Madhura	Anulomana	Constipation	Tannins
37	*Terminalia bellirica* (Gaertn.) Roxb. — Combretaceae	Bibhitaki	Kashaya; Laghu–Ruksha; Ushna; Madhura	Kaphahara	Respiratory disorders	Gallic acid
38	*Phyllanthus emblica* L. — Phyllanthaceae	Amalaki	Amla; Laghu–Ruksha; Sheeta; Madhura	Rasayana	Rejuvenation	Ascorbic acid
39	*Tecomella undulata* (Sm.) Seem. — Bignoniaceae	Rohitaka	Tikta–Kashaya; Laghu–Ruksha; Ushna; Katu	Yakrit-pliha hara	Liver disorders	Iridoids
40	*Madhuca longifolia* (J.Koenig ex L.) J.F.Macbr. — Sapotaceae	Mahua	Madhura; Guru–Snigdha; Sheeta; Madhura	Balya	Nutrition	Saponins
41	*Albizia lebbeck* (L.) Benth. — Fabaceae	Shirisha	Kashaya; Laghu–Ruksha; Sheeta; Katu	Vishaghna	Allergy	Flavonoids

42	*Ficus religiosa* L. — Moraceae	Ashvattha	Kashaya; Guru–Ruksha; Sheeta; Katu	Raktaprasadana	Bleeding disorders	Polyphenols
43	*Ficus bengalensis* L. — Moraceae	Vata	Kashaya; Guru–Ruksha; Sheeta; Katu	Sandhana	Wound healing	Triterpenes
44	*Syzygium cumini* (L.) Skeels — Myrtaceae	Jambu	Kashaya–Madhura; Laghu; Sheeta; Katu	Pramehaghna	Diabetes	Jamboline
45	*Pongamia pinnata* (L.) Pierre — Fabaceae	Karanja	Tikta–Katu; Laghu–Ruksha; Ushna; Katu	Krimighna	Skin diseases	Flavonoids
46	*Anogeissus latifolia* (Roxb. ex DC.) Wall. ex Guill. & Perr. — Combretaceae	Dhava	Kashaya; Laghu–Ruksha; Ushna; Katu	Raktastambhaka	Bleeding	Tannins
47	*Melia azedarach* L. — Meliaceae	Mahanimba	Tikta–Kashaya; Laghu–Ruksha; Sheeta; Katu	Krimighna	Worm infestation	Limonoids
48	*Aegle marmelos* (L.) Corrêa — Rutaceae	Bilva	Kashaya–Tikta; Laghu; Ushna; Madhura	Grahi	Diarrhea	Coumarins
49	*Salvadora persica* L. — Salvadoraceae	Pilu	Katu–Tikta; Laghu–Ruksha; Ushna; Katu	Dipana	Dental health	Alkaloids
50	*Moringa oleifera* Lam. — Moringaceae	Shigru	Katu–Tikta; Laghu–Ruksha; Ushna; Katu	Shothahara	Inflammation	Isothiocyanates

Table 1D: Ayurvedic medicinal CLIMBERS / PARASITIC PLANTS reported from the Aravalli Hills.

S. No.	Botanical name & Family	Ayurvedic name	Rasa–Guna–Virya–Vipaka	Main Karma	Traditional uses	Major phytochemicals
51	*Tinospora cordifolia* (Willd.) Hook.f. & Thomson — Menispermaceae	Guduchi	Tikta–Kashaya; Laghu–Snigdha; Ushna; Madhura	Rasayana, Jvaraghna	Fever, immunity	Diterpenoids
52	*Cissampelos pareira* L. — Menispermaceae	Patha	Tikta; Laghu–Ruksha; Ushna; Katu	Atisaraghna	Diarrhea	Alkaloids
53	*Cuscuta reflexa* Roxb. — Convolvulaceae	Amaravalli	Tikta–Kashaya; Laghu–Ruksha; Ushna; Katu	Rasayana	Jaundice	Flavonoids
54	*Dendrophthoe falcata* (L.f.)	Vrikshadani	Kashaya–Tikta; Laghu–Ruksha;	Sandhivatahara	Bone fractures	Polyphenols

	Ettingsh. — Loranthaceae		Ushna; Katu			
55	*Hemidesmus indicus* (L.) R.Br. ex Schult. — Apocynaceae	Sariva	Madhura; Guru–Snigdha; Sheeta; Madhura	Raktashodhaka	Skin disorders	Saponins
56	*Cocculus hirsutus* (L.) Diels — Menispermaceae	Patalagarudi	Tikta; Laghu–Ruksha; Ushna; Katu	Jvaraghna	Fever	Alkaloids
57	*Gloriosa superba* L. — Colchicaceae	Langali	Tikta–Katu; Laghu–Ruksha; Ushna; Katu	Bhedana	Constipation	Colchicine
58	*Ipomoea pes-tigridis* L. — Convolvulaceae	Vyaghrapadi	Tikta–Kashaya; Laghu–Ruksha; Ushna; Katu	Shothahara	Inflammation	Flavonoids
59	*Smilax zeylanica* L. — Smilacaceae	*Chopchini bheda*	Tikta–Kashaya; Laghu–Ruksha; Ushna; Katu	Raktashodhaka	Skin diseases	Saponins
60	*Leptadenia reticulata* (Retz.) Wight & Arn. — Apocynaceae	Jivanti	Madhura; Guru–Snigdha; Sheeta; Madhura	Rasayana	Lactation, debility	Saponins

Table 1E: Ayurvedic medicinal GRASSES / ALLIED TAXA of the Aravalli Hills.

No.	Botanical name & Family	Ayurvedic name	Rasa–Guna–Virya–Vipaka	Main Karma	Traditional uses	Major phytochemicals
61	*Bambusa arundinacea* (Retz.) Willd. — Poaceae	Vamsha	Kashaya–Madhura; Laghu; Sheeta; Madhura	Asthi-sandhana	Bone healing	Silica
62	*Saccharum spontaneum* L. — Poaceae	Kasha	Kashaya–Madhura; Laghu; Sheeta; Madhura	Mutrala	Urinary disorders	Polyphenols
63	*Vetiveria zizanioides* (L.) Nash — Poaceae	Ushira	Tikta–Madhura; Laghu; Sheeta; Madhura	Dahaprashamana	Burning sensation	Vetiverol
64	*Cyperus rotundus* L. — Cyperaceae	Musta	Tikta–Kashaya; Laghu–Ruksha; Ushna; Katu	Dipana	Digestive disorders	Sesquiterpenes
65	*Typha angustata* Bory & Chaub. — Typhaceae	*Gond pater*	Kashaya–Madhura; Laghu; Sheeta; Madhura	Vrana-ropana	Wounds	Phenolics
66	*Phragmites karka* (Retz.) Trin. ex Steud. — Poaceae	Nala	Kashaya–Madhura; Laghu; Sheeta; Madhura	Mutrala	Urinary disorders	Flavonoids
67	*Arundo donax* L. — Poaceae	Nala bheda	Kashaya–Madhura; Laghu; Sheeta; Madhura	Swedajanana	Respiratory support	Polyphenols

68	*Setaria verticillata* (L.) P.Beauv. — Poaceae	Chirchita	Katu; Laghu; Ushna; Katu	Kushthaghna		Phenolics
69	*Dactyloctenium aegyptium* (L.) Willd. — Poaceae	Makra	Katu; Laghu; Ushna; Katu	Krimighna		Flavonoids
70	*Eleusine indica* (L.) Gaertn. — Poaceae	*Nandimukhi*	Kashaya; Laghu; Sheeta; Madhura	Shwasnashak	Antidiabetic	Phenolics

Data compiled from classical Ayurvedic texts and published ethnobotanical and phytochemical literature.[1–18] **Phytochemical classification based on standard pharmacognosy texts.**[15]

Fig 3: Important Plants Covered In Aravalli Range.

3.4 Therapeutic action (Karma) spectrum

The major *Karma* (therapeutic actions) represented among Aravalli medicinal plants include:

- *Shothahara* and *Vedanasthapana* (anti-inflammatory and analgesic actions)
- *Medohara* and *Pramehaghna* (metabolic regulation)
- *Kusthaghna* and *Raktashodhaka* (skin and blood-related disorders)
- *Dipana* and *Amapachaka* (digestive stimulation)
- *Rasayana* and *Balya* (rejuvenative and strengthening effects)

These actions align closely with the disease burden traditionally managed using Aravalli flora, particularly chronic inflammatory, metabolic, dermatological, and musculoskeletal conditions.

3.5 Correlation with traditional and tribal usage

Traditional medicinal practices documented among indigenous communities of the Aravalli region show strong correspondence with classical Ayurvedic indications.[11,31] Use of resin-yielding species such as *Guggulu* and *Shallaki* for joint disorders, woody taxa such as *Khadira* and *Nimba* for skin diseases, and herbs such as *Punarnava* and *Guduchi* for edema, fever, and metabolic disorders mirrors descriptions in classical Ayurvedic texts.

This convergence suggests that traditional knowledge systems in the Aravalli Hills represent region-specific applications of broader Ayurvedic principles shaped by local ecology.

3.6 Phytochemical[10-20] and pharmacological evidence[2,5,13]

A substantial proportion of the reviewed plants possess documented phytochemical and pharmacological profiles supporting their traditional and Ayurvedic use. Key phytochemical groups identified include.

- Terpenoids and resin acids (e.g., guggulsterones, boswellic acids)
- Polyphenols and tannins (e.g., catechins, gallic acid derivatives)
- Alkaloids, saponins, and flavonoids[14]

Recent experimental and clinical studies report anti-inflammatory, antioxidant, hypolipidemic, antidiabetic, hepatoprotective, and immunomodulatory activities for several key Aravalli species, reinforcing their therapeutic relevance.

3.7 Ecological distribution and habitat association[2,3,5]

The medicinal plants analysed are predominantly associated with **dry deciduous forests, scrublands, rocky slopes, and lower hill ecosystems** of the Aravalli range. Many slow-growing and resin-yielding species are specifically linked to ecotonal and lower-elevation habitats rather than steep hill cores.

This spatial association has direct implications for conservation, as such habitats are more susceptible to anthropogenic disturbance, including mining, construction, and infrastructure expansion.

3.8 Summary of findings

Collectively, the reviewed literature demonstrates that the Aravalli Hills support a diverse assemblage of Ayurvedic medicinal plants predominantly adapted to arid and semi-arid ecological conditions. Across the analyzed taxa, a consistent dominance of Tikta–Kashaya Rasa, Laghu–Ruksha Guna, Ushna Virya, and Katu Vipaka was observed. These findings highlight a coherent pharmaco-ecological pattern characteristic of the Aravalli landscape.

4. DISCUSSION

4.1 Aravalli Hills as a distinct Ayurvedic pharmaco-ecological zone

The present review demonstrates that the medicinal plant assemblage of the Aravalli Hills is not a random collection of ethnomedicinal species but represents a **coherent pharmaco-ecological unit** that can be meaningfully interpreted through Ayurvedic principles. Classical Ayurveda emphasizes that *Desha* (geographical region) significantly influences the expression of *Rasa*, *Guna*, *Virya*, and *Vipaka*. The dominance of *Tikta* and *Kashaya Rasa*, *Laghu–Ruksha Guna*, *Ushna Virya*, and *Katu Vipaka*[20] observed in Aravalli medicinal plants reflects long-term adaptation to arid and semi-arid ecological stress.

This pharmaco-ecological profile differs markedly from Himalayan flora, which is commonly associated with *Sheeta Virya* and nourishing properties, and from Western Ghats vegetation, characterized by *Snigdha* attributes linked to humid environments. The Aravalli Hills thus emerge as a **third, underrecognized Ayurvedic landscape**[5], shaped by ancient geology, low rainfall, high solar exposure, and nutrient-poor soils.

4.2 Ecological stress and Ayurvedic potency

Ecological stress is known to enhance the synthesis of secondary metabolites involved in plant defence and pharmacological activity.[30] Ayurveda recognizes that therapeutic potency is not merely species-dependent but is modulated by ecological conditions. Plants growing under water stress, rocky substrates, and high temperature gradients often accumulate secondary metabolites[13-16] associated with bitterness, astringency, and metabolic stimulation. The predominance of *Tikta* and *Kashaya Rasa* among Aravalli plants is consistent with this understanding and aligns with their traditional use in chronic inflammatory, metabolic, dermatological, and musculoskeletal disorders.

From a modern perspective, these Ayurvedic attributes correlate with the presence of tannins, terpenoids, alkaloids, and polyphenols that exhibit anti-inflammatory, antioxidant,

hypolipidemic, and immunomodulatory actions. Thus, Ayurvedic pharmaco-ecology offers a conceptual bridge between environmental stress biology and pharmacological efficacy.

4.3 Convergence of classical Ayurveda and tribal knowledge

A key finding of this review is the strong concordance between classical Ayurvedic indications and traditional medicinal practices of indigenous communities inhabiting the Aravalli Hills. The use of *Guggulu* and *Shallaki* for joint and inflammatory disorders, *Khadira* and *Nimba* for skin diseases, and *Punarnava* and *Guduchi* for edema, fever, and metabolic disturbances mirrors descriptions found in *Charaka Samhita*, *Sushruta Samhita*, and *Bhavaprakasha Nighantu*.

This convergence suggests that tribal medicine in the Aravalli region represents a **localized expression of Ayurvedic principles**, shaped by regional ecology rather than an isolated folk system. Such alignment strengthens the validity of traditional knowledge as an empirical extension of classical Ayurveda.[12]

4.4 Contemporary conservation relevance and mining governance

Recent regulatory interpretations influencing land-use governance in the Aravalli Hills have renewed attention on mining, construction, and infrastructure activities within the region. Although such regulatory frameworks are administrative in nature and not based on ecological classification, they may indirectly affect dry deciduous forests, scrublands, rocky slopes, and lower-elevation habitats that support a substantial proportion of Ayurvedic medicinal plants.[25]

The present review indicates that many therapeutically important and slow-growing species, including resin-yielding taxa, are predominantly associated with these ecotonal and lower hill ecosystems rather than steep hill cores. Consequently, large-scale alteration of such landscapes may disproportionately influence medicinal plant availability and sustainability.[26-27] From an Ayurvedic pharmaco-ecological perspective, habitat modification risks not only species depletion but also disruption of the environmental conditions that govern Rasa, Guna, Virya, and Vipaka, thereby affecting therapeutic consistency.

4.5 Implications for sustainable Ayurveda and public health

Ayurveda increasingly contributes to integrative healthcare, preventive medicine, and wellness strategies. The Aravalli Hills represent a critical reservoir of medicinal plant

diversity supporting these applications. Unsustainable extraction, habitat fragmentation, and ecological degradation threaten the continuity of raw drug supply and may compromise therapeutic consistency. Medicinal plants of arid and semi-arid regions are particularly vulnerable to habitat disturbance, necessitating region-specific conservation strategies.[29]

Recognizing the Aravalli Hills as an Ayurvedic pharmaco-ecological zone provides a framework for.

- Prioritizing conservation of therapeutically important habitats
- Promoting sustainable harvesting and cultivation of threatened species
- Integrating traditional ecological knowledge with modern biodiversity planning

Such an approach aligns with both classical Ayurvedic wisdom and contemporary sustainability goals.

5. Limitations of the Review

This review is based exclusively on published literature and does not include primary field surveys or quantitative ecological assessments. While more than 250 medicinal plant species are reported from the Aravalli Hills, detailed analysis was restricted to a representative subset of 70 plants to maintain conceptual clarity and relevance. Variability in traditional usage across micro-regions and communities may not be fully captured.

6. Future Research Directions

Future studies should focus on.

- **Region-specific phytochemical and pharmacological profiling** of key Ayurvedic medicinal plants adapted to arid and semi-arid environments.
- **Comparative pharmaco-ecological studies** between Aravalli, Himalayan, and Western Ghats flora to elucidate regional influences on Ayurvedic attributes.
- **Population-level conservation assessments** of slow-growing and resin-yielding species vulnerable to habitat disturbance.
- **Development of sustainable cultivation and regeneration models** guided by Ayurvedic principles and local ecological conditions.

7. CONCLUSION

This review establishes the Aravalli Hills as a distinct Ayurvedic pharmaco-ecological zone characterized by arid environmental stress and a coherent medicinal plant profile dominated by Tikta–Kashaya Rasa, Laghu–Ruksha Guna, Ushna Virya, and Katu Vipaka. Strong

concordance between classical Ayurvedic texts and regional traditional practices underscores the therapeutic significance of this landscape. As many key medicinal plants are concentrated in dry deciduous and lower hill ecosystems, maintaining ecological integrity is essential for preserving both biodiversity and Ayurvedic drug potency. Integrating Ayurvedic pharmaco-ecological understanding into conservation and land-use planning offers a holistic pathway toward sustainable healthcare and environmental stewardship.

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Conflict of Interest

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