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Ethnomedicinal insights: Medicinal plants for jaundice treatment in India

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Abstract
Background: A fundamental review was conducted to assess the utilization of medicinal plants in treating jaundice across different regions of India.
Methodology: We collected data from peer-reviewed scientific research, including journals, thesis papers, and books. Our study focused on documenting the plant species traditionally used by tribal cultures. Relevant literature was sourced using keywords such as “medicinal plants”, “medicinal use”, “tribal”, “ethnobotany”, “ethnomedicine”, “Indigenous”, and “ethnic”, We searched databases like Google Scholar, Science Direct, Scopus, and explored various web links.
Results: We identified 65 plant species employed for jaundice treatment. Euphorbiaceae, Fabaceae, and Cucurbitaceae were the major plant families represented. Euphorbiaceae had the highest species diversity (9 species), followed by Fabaceae (8 species), Cucurbitaceae (5 species), and Asteraceae (3 species). Leaves were the most commonly used plant part, followed by fruits, bark, roots, flowers, stems, whole plants, and tubers.
Conclusion: While no single medication universally addresses severe liver diseases, our findings underscore the importance of ethnomedicinal research. The existence of a rich repository of medicinal plants for jaundice treatment reflects the enduring transmission of traditional knowledge across generations.

Keywords: India, Ethnomedicinal study, medicinal plants, jaundice, disease

Introduction
Medical plants had a significant part in human health care before to the birth of modern medicine and are now maintained as a solid foundation of traditional knowledge about herbal medicines. The Rig-Veda and Ayurveda, dating back to 4500-1600 BC and 250-600 BC respectively, hold precious knowledge about ethno-medicinal plants [1, 2]. These texts serve as foundational sources for herbal medicine. Indigenous communities worldwide have preserved traditional knowledge about medicinal plants, passing it down through generations and contributing to diverse healing practices. According to the World Health Organization (WHO), a medicinal plant contains compounds in its organs that can be harnessed for treatment or as precursors for effective pharmaceuticals [3]. These natural compounds hold immense therapeutic potential. Across different countries, traditional medical systems rely on over 80,000 plant species to address a wide spectrum of health conditions [4]. Despite Earth’s rich biodiversity, only about 10% of it has undergone thorough evaluation for therapeutic properties. Much remains untapped. Natural goods, including derivatives from higher plants, contribute significantly to the medications we use today [5] reported that approximately 10% of global biodiversity has undergone evaluation for therapeutic properties, while more than 50% of current medications are derived from natural sources, with higher plants contributing around 25% of these compounds [6].
India’s rich biodiversity encompasses a wide range of medicinal plants, distributed across diverse geographies and ecological contexts [7]. Rural and tribal communities in India heavily rely on these pharmacological plants for healthcare. Ethnobotanical research plays a crucial role in documenting indigenous knowledge and preserving biological assets [8]. Remarkably, approximately 43% of the world’s flowering plants are found in India, many of which hold medicinal significance [9].

Among the 15,000 higher plant species in India, around 1,500 are believed to possess therapeutic properties [10]. The Indo-Aryans, pioneers in Indian history, were familiar with over 1,200 plant-based medicines and their specialized uses. Despite historical limitations, ongoing ethnobotanical investigations across India continue to shed light on these valuable resources [7]. India's tribal communities, comprising 277 distinct ethnic groups, constitute approximately 7% of the population and hold a rich legacy of traditional knowledge related to medicinal plants [11]. Folk medicine, deeply rooted in ethnomedicine, serves as the foundation for various indigenous healing systems. Among these tribes, the Katkari community stands out for their belief in witchcraft and black magic, relying on plants for treating illnesses or seeking guidance from the knowledgeable village priest, Bhagat [12]. Similarly, the Lotha tribe, residing in remote hilltop villages, relies solely on local medicine men for their expertise in medicinal herbs [13]. While some Chenchu tribes continue to practice traditional herbal medicine [14], the Bhil people adapt their forest travels to daily needs [15]. In Meghalaya, the Garo, Khasi, and Jaintia tribes possess extensive plant knowledge, particularly in the context of medicine [16]. Elderly Bhotia individuals retain herbal knowledge, gathering plants from the jungle opportunistically. The Gond and Munda tribes rely heavily on medicinal plants, reflecting their diverse traditional applications [17]. However, widespread adoption of traditional practices has declined [18]. Plant-derived drugs continue to play a role in treating various ailments, including mental health conditions, skin disorders, diabetes, jaundice, and tuberculosis [19]. The most prevalent ailment affecting people in both developed and developing countries is jaundice [20]. Jaundice, characterized by yellowing of the skin, sclera, and mucous membranes, results from a discrepancy between bilirubin production and elimination [21]. Bilirubin, an orange pigment found in bile, accumulates when levels exceed 34.2 mol/L or 2 mg/dL, potentially leading to serious complications. Hyperbilirubinemia, associated with various fatal diseases, affects adults, while fetal jaundice remains a common neonatal morbidity [22]. Symptoms include anemia, satiety, diarrhea, gastrointestinal bleeding, edema, and weight loss, with severe cases leading to psychosis, lethargy, convulsions, coma, or death [23]. Ethnomedicinal research highlights the promise of plant-based treatments for jaundice. Despite advances in allopathic medicine, herbs continue to play a significant role in liver care. Notably, hepato-protective properties of various plant compounds have been explored [24]. This review aims to explore historical and current ethno-medicinal practices across different regions of India. Despite the dominance of allopathic medicine, traditional knowledge about medicinal plants remains invaluable. As these practices face the risk of extinction, it is crucial to document and preserve them. Focusing specifically on jaundice treatment through ethno-medicine, this review seeks to uncover diverse approaches within India's multi-religious, multilingual communities, leveraging the rich repository of potent ethno-medicinal plant uses and values.

Study area

India, the seventh-largest country globally, spans 32, 87, 263 square km and comprises 28 states. Geographically located north of the equator, India experiences diverse climatic conditions, ranging from tropical monsoons to alpine regions. Its rich biodiversity encompasses over 5% of the world's species. Approximately 7, 43, 534 square km of India's land area is covered by forests, including tropical deciduous and scrub forests. Specific regions, such as the west coast, northeast, and Andaman-Nicobar Islands, host tropical rainforests. Arid zones in Rajasthan contrast with the Himalayas, Nilgiris, and other hilly areas, exhibiting subtropical, temperate, and alpine vegetation. Over 20,000 plant species thrive here, with more than 2,500 species utilized in indigenous medical systems. Rural communities, especially ethnic groups, continue to rely on plant resources for sustenance and healthcare. In the context of jaundice treatment, this review explores India's diverse ethno-medicinal practices, aiming to document and preserve this valuable traditional knowledge [25, 23].

Data collection

For this review on medicinal plants used by tribal cultures in India to cure jaundice, the data collection method involves a comprehensive search across peer-reviewed scientific literature, thesis papers, and books. Relevant information is extracted from reputable sources, including journals, using targeted keywords such as "medicinal plants," "medicinal use," "tribal," "ethnobotany," "ethnomedicine," "Indigenous," and "ethnic." Additionally, online databases like Google Scholar, Science Direct, and Scopus are explored. Weblinks from platforms such as HealthTime, NHP (National Health Portal), Dr. Goyal Gastro, TeachMeSurgery, PharmEasy, BYJU'S, Redcliffe Labs, and Mediconic are also considered. By synthesizing insights from these diverse sources, the review aims to compile a comprehensive understanding of traditional medicinal practices related to jaundice treatment within India's tribal communities.

Analysis

The analytical methodology for the review on the treatment of jaundice through traditional knowledge in India consists of different processes. For data compilation and preprocessing, we meticulously compiled information from various sources, including ethnobotanical studies, traditional healers, and scientific literature. This involved extracting details on plant species, their usage, and associated regions. MS Excel (Version 2019) was used for organizing and structuring the data, creating tables, and preparing it for subsequent analyses. We visualized the importance of different plant families in terms of species richness for treatment of jaundice as depicted in the literature using a stacked bar chart in Excel. This allowed us to compare the relative contributions of each plant family. To explore hierarchical relationships among plant species and their family, we created a sunburst chart in Excel. This chart visually represents the breakdown of plant species within each family and also suggested their relative importance. Excel's tree map feature was utilized to display the distribution of plant parts across different species. Each section of the tree map corresponds to a specific plant part, providing an organized overview. For geographical visualization, we used Quantum Geographic Information System (QGIS). This open-source software [26] (QGIS Development Team 2019) allowed us to create maps showing the distribution of studies on jaundice treatment using traditional knowledge across India. We performed cluster analysis using the PAST software (Paleontological Statistics). The Paired Group algorithm (UPGMA) and the Bray-Curtis similarity index were applied to group plant parts based on their traditional usage for jaundice treatment in different zones of India. PAST allowed [27] us to generate a dendrogram, revealing distinct clusters of plant parts usage with similar zonal distribution.

Table 1: A list of plant species that are used to treat jaundice

Sl. no	Family Name	Botanical name	Common Name	Part used	Locality	Reference
1	Euphorbiaceae	*Phyllanthus niruri* L.	Bhuiamla	Whole plant	Raipur Chhattisgarh, District Durg	[39, 41]
2	Euphorbiaceae	*Phyllanthus urinaria* L.	Bhuiamla	Whole plant	District Durg	[41]
3	Fabaceae	*Tamarindus indica* Lim.	Imali	Leaves	District Durg, Chhattisgarh	[41, 42]
4	Poaceae	*Saccharum officinarum* L.	Ikha, Ganna	Leaves	District Durg	[41]
5	Lamiaceae	*Leucas cephalotes* (Roth) Spreng.	Gubbha	Root	District Durg, Chhattisgarh	[41, 42]
6	Lythraceae	*Lawsonia inermis* Linn.	Mehndi, Henna	Root	District Durg, Raigarh Area	[41, 43]
7	Menispermiaceae	*Tinospora cordifolia* (Willd.) Miers	Giloye, Gudich, Gurach	Stem	District Durg, Mizoram	[41, 47]
8	Asteraceae	*Eclipta prostrata* (L.) L.	Bhringraj	Leaf	District Durg, Chhattisgarh	[41, 42]
9	Cucurbitaceae	*Momordica charantia* L.	Karela	Tree	District Durg	[41]
10	Euphorbiaceae	*Baliospermum montanum* Muell Arg.	Wild castor, Dandi	Shrub	District Durg	[41]
11	Euphorbiaceae	*Mallotus phillipensis* Muell Arg.	Rohini	Fruit	District Durg	[41]
12	Berberidaceae	*Berberis asiatica* Roxb. ex-DC.	Rasanjana, Daruhaldi, Kilmora	Root	Kumaun Himalaya	[44]
13	Euphorbiaceae	*Ricinus communis* L.	Arand	Leaves, seeds, oil	Kumaun Himalaya	[44]
14	Fabaceae	*Acacia nilotica* (L.) Delile	Babool	Whole plant, flower	Raigarh Area	[43]
15	Papaveraceae	*Argemone mexicana* L.	Pilikatere	Yellow milk	Durg District, Raigarh Area, Chhattisgarh	[40, 43, 45]
16	Acanthaceae	*Andrographis paniculata* (Burm.f.) Nees	Bhuineem	Whole plant	Raigarh Area, Raipur, Chhattisgarh	[43, 46]
17	Lythraceae	*Punica granatum* L.	Anaar	Fruit, Leaf, whole plant	Raigarh Area	[43]
18	Moraceae	*Ficus religiosa* L.	Peepal	Whole plant, Latex	Raigarh Area	[43]
19	Sapotaceae	*Achras sapota* Linn.	Pilaghanti	Leaf, flower	Raipur Chhattisgarh	[39]
20	Crassulaceae	*Bryophyllum pinnatum* (Lam.) Oken	Patharchata	leaf	Raipur Chhattisgarh	[39]
21	Lamiaceae	*Mentha arvensis* L.	Pudina	Whole plant	Raipur Chhattisgarh	[39]
22	Brassicaceae	*Raphanus sativus* L.	Muli	Leaf, root	Raipur Chhattisgarh, Chhattisgarh	[39, 45]
23	Anacardiaceae	*Spondias Mangifera* Willd.	Amra	Bark	Burdwan District	[48]
24	Solanaceae	*Solanum indicum Roxb.*	Brihati	Fruit	Burdwan District	[48]
25	Euphorbiaceae	*Emblica officinalis* Gaertn.	Amla	Fruit	Durg District, Raipur Chhattisgarh	[40, 46]
26	Cucurbitaceae	*Coccinia grandis* (L.) Voigt	Kunuru	Leaves	Chhattisgarh	[45]
27	Euphorbiaceae	*Phyllanthus amarus* Schumach. & Thonn.	Jipa, Bhui korma	Leaf	Chhattisgarh	[45]
28	Asteraceae	*Sphaeranthus indicus* Linn.	Molalphaji	Whole plant	Chhattisgarh	[45]
29	Fabaceae	*Cajanus cajan* Linn.	Arhar	Leaf	Paschim Medinipur, Alipurduar District, Murshidabad, Durg District	[62,63, 64, 40]
30	Poaceae	*Triticum aestivum* L.	Ganhu	Leaves, seed	Durg District	[40]
31	Malvaceae	*Abutilon indicum* (L.) Sweet	Thuthi	Leaves	Vellore District	[49]
32	Amaranthaceae	*Aerva lanata* (L.) Juss.	Kati-Bui	Root	Shekhawati region Rajasthan	[50]
33	Rutaceae	*Aegle marmelos* (L.) Correa	Bel	Leaves	Nasik District	[51]
34	Liliaceae	*Allium tuberosum* Rottler ex Spreng.	Ban lahsun	seed	Nasik District	[51]
35	Acanthaceae	*Andrographis ovata* (T.Anderson ex Bedd.)		Leaves	Dindigal District	[52]
36	Liliaceae	*Asparagus officinalis* L.		Leaves	Nasik District	[51]
37	Asparagaceae	*Asparagus racemosus* Willd.	Kurito	Tuberous roots	Eastern Sikkim Himalayan region	[53]
38	Nyctaginaceae	*Boerhavia diffusa* L.	Punara	Root	Madhya Pradesh	[54]
39	Asclepiadaceae	*Calotropis procera* (Aiton) Drynd.	Akanda	Root bark	Madhya Pradesh	[54]
40	Fabaceae	*Cassia fistula* L.	Sonaru	Fruit	Dibrusaikhowa Biosphere reserve	[55]
41	Apiaceae	*Centella asiatica* (L.) Urb.	Thankuni	Leaves	West Midnapore District	[56]
42	Fabaceae	*Cicer arietinum* Linn.	Chana	seed	Madhya Pradesh	[57]
43	Cucurbitaceae	*Coccinia indica* Wight & Arn.	kunuru	Leaves	Tamil Nadu	[58]
44	Zinziberaceae	*Costus speciosus* (J.Koenig) Sm.	Jhomlakuti	Root	Coimbatore District	[59]
45	Hypoxidaceae	*Curculigo orchioides* Gaertn.	Kalimusli	Tubers	Dibrusaikhowa Biosphere reserve	[55]
46	Convolvulaceae	*Cuscuta reflexa* Roxb.	Aarbel	Whole plant	Churu District	[60]
47	Fabaceae	*Dalbergia volubilis* (L.) Urb.	Kamla	Leaves	Madhya Pradesh	[54]
48	Cucurbitaceae	Benincasa hispida Cogn.	Torbot, Ash gourd	Fruits	Manipur	[61]
49	Cucurbitaceae	*Melothria perpusilla* (Blume) Cogn.	Lamthabi	Whole parts of plant	Manipur	[61]
50	Urticaceae	*Dendrocnide sinuata* (Blume) Chew	Thakpui	Root	Mizoram	[47]
51	Dilleniaceae	*Dillenia indica* L.	Kawrthindeng	Fruit & bark	Mizoram	[47]
52	Asteraceae	*Inula cappa* (Buch.-Ham. ex D.Don) DC.	Buarthau	Leaf	Mizoram	[47]
53	Lythraceae	*Lagerstroemia speciosa* (Linn.) Pers.	Chawnpui/Thlado	Root, Bark	Mizoram	[47]
54	Euphorbiaceae	*Mallotus roxburghianus* Müll.Arg.	Zawngtenawhlung	Twigs	Mizoram	[47]
55	Euphorbiaceae	*Phyllanthus fraternusniru*Webster.	Mitthisunhlu/ Bhuiamla	Whole plant/ Leaves	Mizoram, Chhattisgarh	[47, 42]
56	Scrophulariaceae	*Scoparia dulcis Medic*.	Perhpawng-chaw/ Hlothlum	Whole plant	Mizoram	[47]
57	Amaranthaceae	*Achyranthes aspera* L.	Apang tree	fruit	Paschim Medinipur, Alipurduar, Murshidabad District	[62, 63, 64]
58	Asclepiadaceae	*Hemidesmus indicus* (L.) R.Br.	Anantamul	Root	Paschim Medinipur	[62]
59	Meliaceae	*Azadirachta indica* A.Juss	Neem	Leaves	Paschim Medinipur	[62]
60	Poaceae	*Cynodon dactylon* (L.) Pers.	DurbaGhas	Leaves	Paschim Medinipur	[62]
61	Fabaceae	*Abrus precatorius* L.	Gunja	Root	Chhattisgarh	[42]
62	Fabaceae	*Cassia angustifolia* Vahl	Markandik a, CharotaBhaj	Whole plant	Chhattisgarh	[42]
63	Boraginaceae	*Heliotropium curasavicum* L.	Banhatisur	leaves	Sunderbans	[65]
64	Bignoniaceae	*Oroxylum indicum* (L.)	Banahata, Surimal	Bark	Alipurduar district	[63]
65	Malvaceae	*Thespesia lampas* (Cav.) Dalzell & A.	Amagong	Root	Chhattisgarh	[42]

Results

According to this study, many medicinal plants can be used to treat jaundice. People in India use the roots, leaves, or complete plants, either separately or in combination with other parts for the treatment of jaundice as revealed from pilot study of various literature. A comprehensive list of plants used in treatment of jaundice is provided in Table 1.

In the current study, many plant species utilized by people from various parts of India to treat jaundice are reported. These regions are shown in Figure 1.

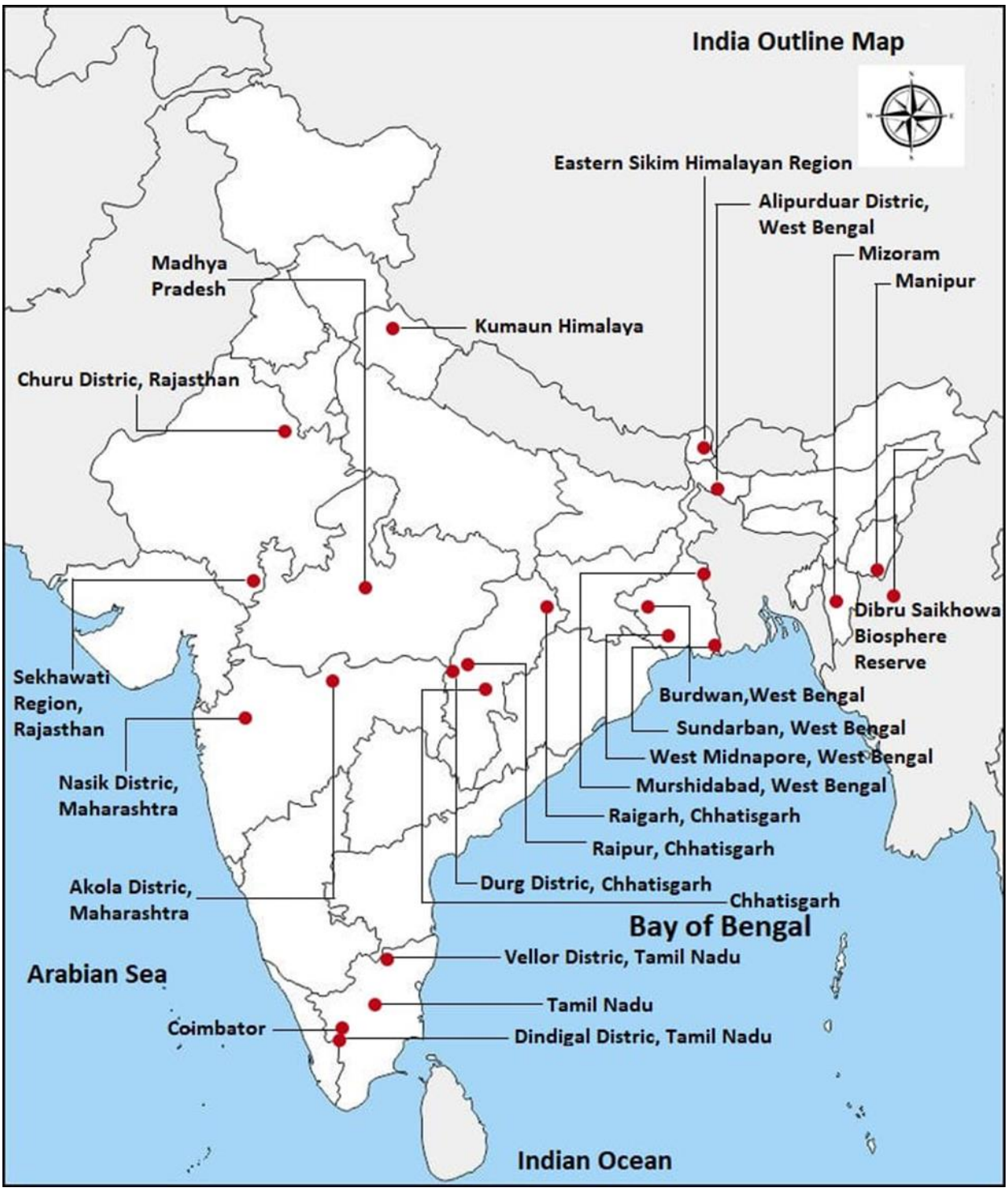

Fig 1: Map of India showing the study area

Extensive research across scientific literature, thesis papers, and books has revealed a rich repository of 65 plant species utilized for treating jaundice in India. These plants are deeply embedded in the traditional knowledge of various tribal cultures across the country. Notably, several prominent plant families play a pivotal role in jaundice therapy. Euphorbiaceae stands out as the dominant contributor, with nine distinct species recognized for their jaundice-healing properties. Following closely, Fabaceae boasts eight species known for their efficacy in treating jaundice. Cucurbitaceae and Asteraceae families are represented by five and three species, respectively, emphasizing their relevance in traditional medicine. Lythraceae and Poacea each contributes three species to the jaundice treatment repertoire. Acanthaceae, Lamiaceae, Amaranthaceae, Asclepiadaceae, Liliaceae, and Malvaceae families are associated with two species each, underscoring their significance. The remaining families, including Anacardiaceae, Apiaceae, Asparagaceae,

Bignoniaceae, Boraginaceae, Convolvulaceae, Crassulaceae, Dilleniaceae, Hypoxidaceae, Meliaceae, Moraceae, Nyctaginaceae, Papaveraceae, Papilionaceae, Rutaceae, Sapotaceae, Scrophulariaceae, Solanaceae, and Urticaceae, contribute one species each. These findings, visually represented through a stacked bar chart (Figure 2) for family level and a sunburst chart (Figure 3) for species level, underscore the diverse botanical heritage that informs jaundice treatment practices in India.

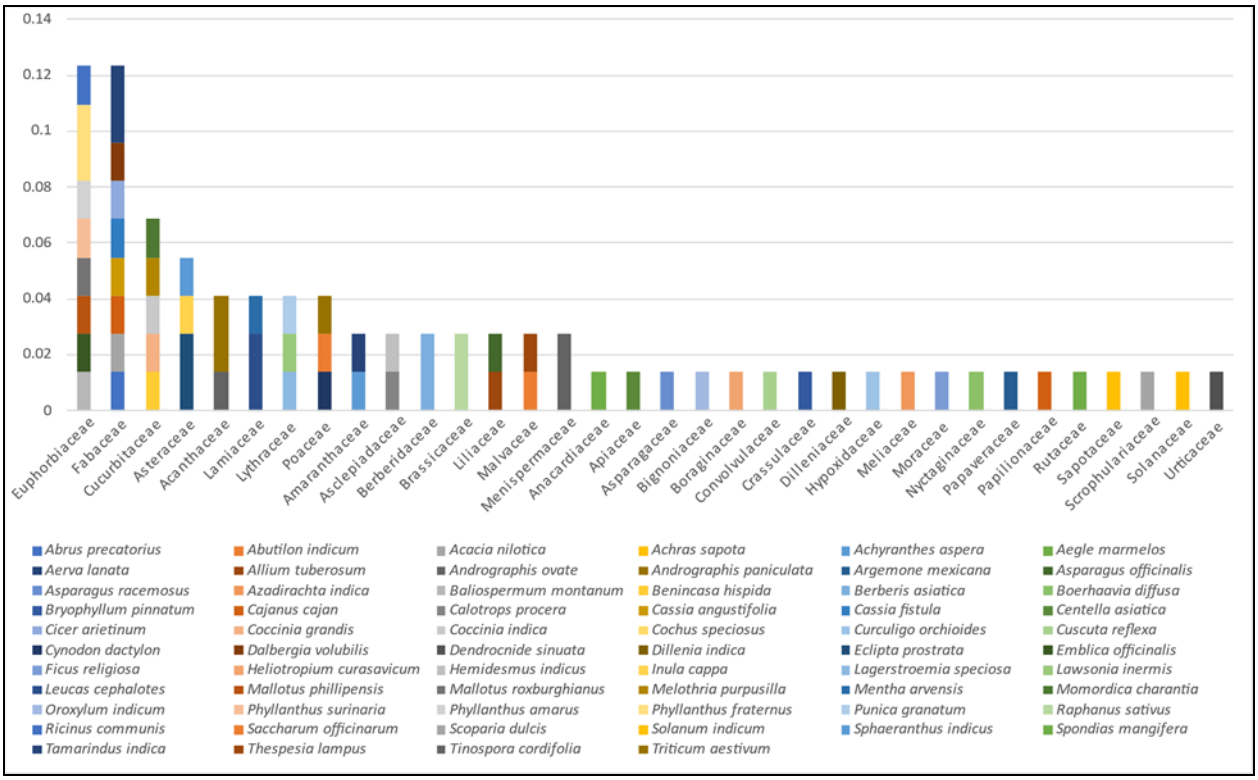

Fig 2: Importance of different plant families in terms of species richness for treatment of jaundice as depicted in the literature, the vertical axis shows the percentage of studies where the plant family is mentioned

Fig 3: Importance of different plant species in each of the eight diverse plant families for treatment of jaundice as depicted in the literature, number in percentage showed the percentage of studies where the species is mentioned

In the preparation of medicinal treatments, various plant parts are utilized by people across different regions of India. Notably, leaves emerge as the dominant plant parts employed, followed by fruits, bark, roots, flowers, stems, whole plants, and tubers. Among the studied plant species, *Cajanus cajan* Linn and *Argemone mexicana* L. stand out as the most commonly used, each cited four times in distinct studies. Additionally, *Achyranthes aspera* is noteworthy, having been studied three times (Figure 4). The locations reviewed for the use of plant parts are divided into six regions namely Eastern, North-Eastern, Central, Southern, Western and Northern region. The dendrogram (Figure 5) reveals distinct groupings of regions based on their usage of medicinal plant parts for jaundice treatment. Southern and Central Regions exhibit high similarity in their plant part preferences. They share common practices related to jaundice treatment, emphasizing the use of leaves. Similarly, the Northern and Western regions cluster together, indicating similar ethnomedicinal practices. Leaves remain prominent in both areas. Interestingly, North-Eastern and Eastern Regions show less similarity in their plant part usage. Their practices diverge, suggesting unique traditional knowledge related to jaundice treatment. The North-Eastern and Southern regions also exhibit dissimilarities, emphasizing their distinct approaches to managing jaundice. Across all regions, leaves emerge as the preferred plant part for jaundice treatment. This consistent preference underscores the significance of leaves in traditional medicine. The Eastern region stands out with a higher percentage of medicinal plant usage. This area shows a rich tradition of ethnomedicinal practices related to jaundice

Fig 4: Comparative usage of different plant parts of different species for treatment of jaundice as depicted in the literature, numbers indicate the number of studies where the part is mentioned

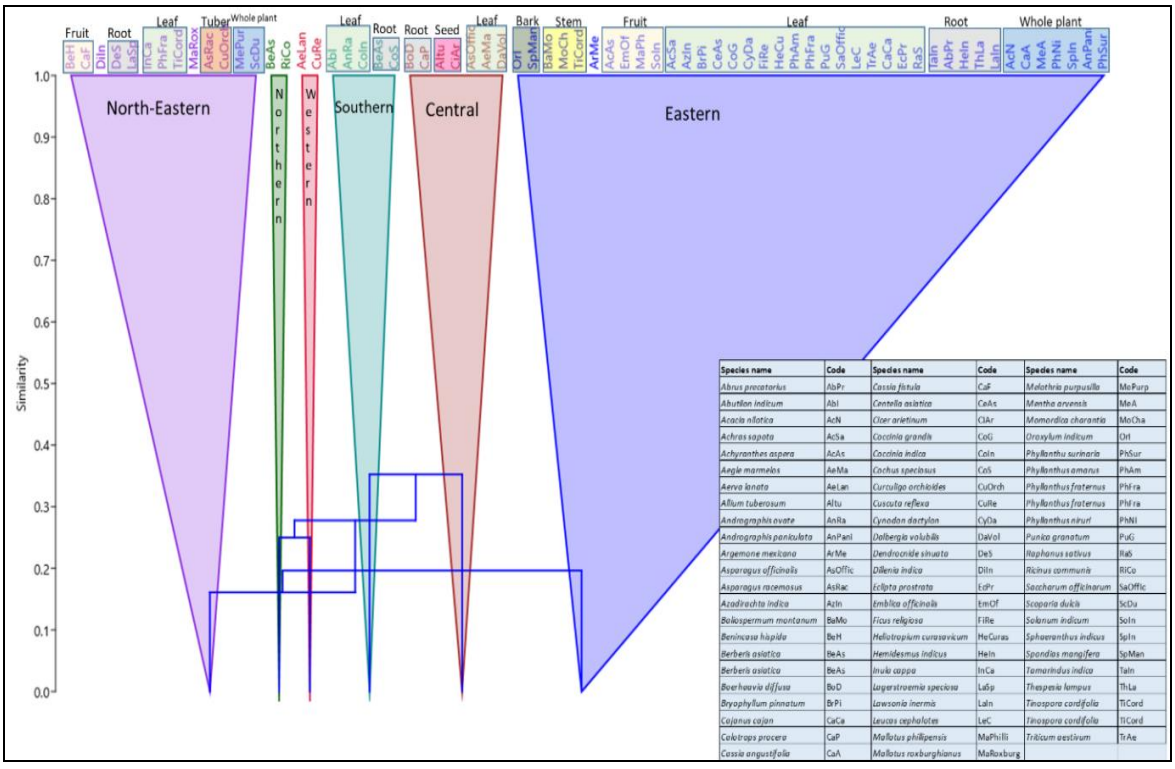

Fig 5: Clustering of plant species according to parts used in different regions of India, Classical cluster analysis using Paired Group algorithm (UPGMA) and Bray-Curti's similarity index with group constraints as regions

Discussion

The rich diversity of plant species used by various tribal cultures in India reflects the intricate interplay between indigenous wisdom and natural resources. The prominence of Euphorbiaceae in jaundice therapy aligns with previous research. This plant family contains potent species known for their hepatoprotective properties. Contemporary studies should explore the bioactive compounds within Euphorbiaceae species to understand their mechanisms of action. Fabaceae (legume family) and Cucurbitaceae (gourd family) contribute significantly to jaundice treatment. Plant family Euphorbiaceae is most prevailling plant family found in other studies followed by Cucurbitaceae, Acanthaceae, Solanaceae, Rubiaceae, Convolvulaceae, Asteraceae, Anacardiaceae, Moraceae, Poaceae, and Nyctaginaceae [12, 28]. A few common medicinal plants are used by different tribals in india to cure jaundice are noted, Lotha-Naga tribes use *Adhatoda vasica* L, *Oroxylum indicum* L. and *Saccharum officinaram* L; Chenchu tribes are known to use *Achyranthes aspera* L, *Boerhavia diffusa* L, *Citrullus colocynthis* (L.) Schrad, *Cryptolepis buchananii* Roem. & Schult, *Cuscuta reflexa* Roxb, *Pergularia daemia* (Forssk.) Chiov, *Phyllanthus emblica* L, *Ricinus communis* L, *Tinospora cordifolia* (Willd.) Hook.f. & Thomson [14]. It is also found that the Bhil tribes used *Cassia glauca* Lamk, *Trichosanthes cucumerina* Linn and *Cicer arietinum* L. [29, 30]. Gond tribes used *Phyllanthus emblica* L, *Martynia diandra* L, *Ricinus communis* L, *Trigonella foenum-graecum* L, *Asparagus adscendens Roxb*, *Eclipta prostrata* (L.) L, *Phyllanthus niruri* L, *Solanum nigram* L, *Ailanthus excelsa* Roxb, *Echinops echinatus* Roxb. And Ficus religiosa L. [17, 31, 32]; *Aegle marmelos* (L.), *Senna tora* (L.) *Roxb*, *Clerodendrum indicum* (L.) Kuntze are used by Munda tribes [33]. A few medicinal plants were used by important West Bengali tribal communities, including the Santhals, Mundas, Lodhas, Bhumijis, and Oraon, to treat jaundice, such as *Achryanthes aspera* L, *Aloe vera* (L) Burm.f, *Andrographis paniculata* (Burm.f) Wal Ex. Nees, *Azadirachta indica* A.Juss, *Brassica nigra* (Linn.), *Centella asiatica* (L.), *Cynodon dactylon* (L.)Pers, *Eupatorium triplivere*, *Ocimum tenuiflorum* L, *Phyllanthus fraternus* G.L. Webster, *Mentha spicata* Linn. emend and *Tinospora cordifolia* (Thunb) [34]. These families have been historically revered for their medicinal properties. Comparative studies could investigate the efficacy of Fabaceae and Cucurbitaceae species across different regions. The specific species within these families, such as *Cajanus cajan* Linn, *Argemone mexicana* L, and *Achryanthes aspera* L, deserve further attention. It has been found that leaf of *Cajanus cajan* contain high amounts of bioactive compounds, especially flavonoids *viz*. Vitexin, Isovitexin, Orientin, Pinostrobin, Cajaninstilbene acid, Terpenes, Saponins, Tannins and also contains various chemical constituents having antioxidant activity which could be accounted for its higher utilization [35], most of the isolated compound for species *Argemone mexicana* L. is belong to the class of alkaloids, besides terpenoids, flavonoids, phenolics, long chain aliphatic compounds, and few aromatic compounds are found to be other constitutes of this plant [36]. Similar results were obtained in ethno-botanical studies for *Argemone mexicana* L.to cure jaundice. Its major chemical constituents are carbohydrates, protein, glycosides, alkaloids, tannins, saponins, flavonoids, lignin etc. [37]. The variation in plant part preferences across regions (leaves, fruits, bark, etc.) underscores the importance of local context. The cluster analysis provides insights into regional variations and similarities in the utilization of plant parts for jaundice treatment across India. These findings underscore the importance of preserving and documenting traditional knowledge associated with medicinal plants. Comparative studies can delve into cultural factors influencing these choices. The one-species contributions from various families highlight the need for conservation efforts. Contemporary studies should document indigenous knowledge, especially from tribal communities, to prevent loss of traditional practices. Collaborative research between traditional healers and modern scientists can bridge the gap and can validate traditional knowledge through rigorous scientific methods which is essential. In summary, these findings provide a foundation for evidence-based research, emphasizing the need for interdisciplinary approaches to preserve and harness India's rich ethnomedicinal heritage.

Conclusion

Despite enormous advancements in modern medicine, no effective medications exist that support the regeneration of hepatic cells or stimulate liver function [38]. On the other hand, as this study revealed, 65 species from various regions of India are recommended to be used in traditional Indian medicine for the treatment of jaundice. In conclusion, our exploration of traditional knowledge surrounding jaundice treatment in India reveals a fascinating interplay between indigenous wisdom and the abundant natural resources available. The dominance of the Euphorbiaceae family aligns with historical research, emphasizing its hepatoprotective properties. Contemporary studies should delve into the bioactive compounds within Euphorbiaceae species to unravel their mechanisms of action. Additionally, the Fabaceae and Cucurbitaceae families significantly contribute to jaundice therapy, warranting further investigation. As we celebrate the rich diversity of plant species used by various tribal communities, we recognize the need for interdisciplinary collaboration to validate and integrate traditional knowledge with modern medicine. The leaf of *Cajanus cajan* Linn. emerges as a standout, rich in bioactive compounds, while *Argemone mexicana* L. and *Achyranthes aspera* L. hold promise. As we navigate these regional variations in plant part preferences, we underscore the importance of context and cultural practices in shaping traditional medicine. Our findings serve as a valuable foundation for future research, conservation, and holistic healthcare approaches that honor both ancient wisdom and scientific rigor.

Declarations

Conflict of interest

Authors have no conflict of interest.

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