How illness categories shape medicinal plant selection in the Zagros Mountains of western iran: A biocultural perspective on traditional ecological knowledge and ethno-pharmacological evidence

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Research

Abstract

Background: Medicinal plant use in the Zagros Mountains of western Iran is closely linked to local understandings of illness, healing, and the environment. Although Ilam Province has been extensively documented floristically, limited attention has been paid to the cultural concepts and ecological knowledge that guide medicinal plant selection and therapeutic decision-making. This study investigated the relationships among emic illness categories, traditional ecological knowledge (TEK), and medicinal plant use in Ilam Province, Iran.

Methods: Between January 2024 and May 2026, ethnobotanical fieldwork was conducted in rural and peri-urban communities across Ilam Province using semi-structured interviews and focus group discussions with 78 knowledgeable informants, including traditional healers and experienced herbal practitioners. A total of 912 use-reports were documented. Emic illness terms were recorded in Lori and Kurdish and analyzed as the primary framework for interpreting therapeutic practices. Eighteen culturally salient medicinal species were selected for detailed phytochemical and pharmacological assessment. To contextualize field observations, a structured literature review guided by PRISMA 2020 principles was undertaken, resulting in the inclusion of 79 relevant publications.

Results: Medicinal plant use was organized around locally recognized illness categories rather than biomedical disease classifications. Gastrointestinal disorders constituted the most important therapeutic domain, with Soozesh-e Mede (stomach burning) accounting for 37.5% of all recorded use-reports. Strong agreement among informants was observed for several illness categories, particularly those associated with digestive, respiratory, wound-healing, and nervous system conditions. Evaluation of the 18 culturally salient species revealed broad agreement between traditional therapeutic applications and published pharmacological evidence. Patterns of medicinal plant selection were further influenced by floristic distribution, habitat availability, and locally transmitted ecological knowledge related to plant collection, preparation, and use.

Conclusions: The findings show that medicinal plant use in Ilam Province is shaped by culturally defined illness concepts and practical ecological knowledge accumulated through experience. The observed agreement between local therapeutic applications and published pharmacological evidence indicates that many commonly used remedies warrant further investigation. At the same time, the continued erosion of traditional knowledge highlights the need to document and preserve local medical traditions in the Zagros region.

Keywords: Cultural salience; Knowledge transmission; Medicinal flora; Pharmacological validation; Traditional healing.

Background

In the rural communities of the Zagros Mountains, plant-based medicine functions as a primary healthcare system grounded in culturally specific understandings of the body, illness, and environment (Mirzaei Mossiavand *et al.* 2025). Ilam Province, situated at the intersection of the Irano-Turanian and Gulf-Omani floristic regions, represents a biocultural hotspot where ecological heterogeneity shaped by altitude, climate, and topography has supported both high medicinal plant diversity and long-standing traditions of healing (Zargari 2013; Mozaffarian,2017).

What defines this system is not the breadth of remedies but the cultural logic that organizes them (Etkin 1998; Gonzalez *et al.* 2022). Therapeutic choices follow emic illness categories that integrate bodily experience, seasonal cues, and shared social interpretation, rather than biomedical diagnoses. Conditions such as *Soozesh-e Mede* (stomach burning) or *Sarma Khordan* (catching a cold) operate as culturally constituted symptom complexes that guide treatment in ways biomedical classifications cannot fully capture (Ghasemi Pirbalouti *et al.* 2013; Heinrich *et al.* 2018; Leonti & Casu 2023).

Despite considerable progress in documenting medicinal plant uses across Iran, ethnobotanical studies have predominantly focused on descriptive inventories, with comparatively less attention devoted to the epistemological frameworks that shape local understandings of health, illness, and plant use (Heinrich *et al.* 2009; Harvey *et al.* 2015; Ludwig & El-Hani 2023). Recent scholarship warns that privileging biomedical categories over emic concepts obscures the internal logic of traditional medical systems (Heinrich *et al.* 2018; Leonti & Casu 2023). Parallel developments in ethnobiology highlight Traditional Ecological Knowledge (TEK) as a dynamic, adaptive system shaped by long-term engagement with environmental variability (Berkes *et al.* 2000; Cunningham, 2020). In Ilam, steep ecological gradients, from cold montane zones to semi-arid lowlands, inform local perceptions of plant potency, quality, and optimal harvest timing, reflecting a refined ecological awareness embedded in everyday practice (Ladio & Lozada 2004; Reyes-García *et al.* 2019).

This biocultural system is increasingly strained by climatic shifts, socio-economic change, rural out-migration, and expanding access to formal healthcare, all of which disrupt intergenerational knowledge transmission (Ghorbani *et al.* 2014; Savo *et al.* 2014; Molina *et al.* 2021; Agatha *et al.* 2024; Hanazaki 2024). Rising market demand further intensifies harvesting pressure on wild species, often without effective governance or benefit-sharing mechanisms (Manohar 2012; Rao *et al.* 2025).

These dynamics underscore a central gap: documenting which plants are used is insufficient. Understanding how and why plants are selected requires an integrative approach that situates medicinal plant use within a dynamic socio-ecological and cultural system. This study adopts such an approach by combining primary ethnobotanical fieldwork with a structured synthesis of phytochemical, pharmacological, and ecological evidence. Medicinal plants are treated not as isolated remedies but as nodes within a broader system linking cultural meaning, ecological processes, and adaptive knowledge (Figure 1)

The study was guided by three propositions: (1) plant selection in Ilam is structured primarily by emic illness categories; (2) a small set of culturally salient species accounts for most use-reports and exhibits strong consensus within specific symptom complexes; and (3) local ecological knowledge, particularly perceptions of seasonal cues, phenology, and micro-climatic variation, shapes harvesting decisions and perceived plant potency (Berkes *et al.* 2000; Cunningham 2020; Leonti & Casu 2023).

Materials and Methods

This study employed a two-component design integrating (1) an ethnobotanical field survey documenting local knowledge and cultural salience, and (2) a structured narrative synthesis of phytochemical, pharmacological, and ecological evidence. Insights from both components were combined through narrative synthesis to evaluate the correspondence between traditional uses, experimentally reported bioactivities, and ecological vulnerabilities.

Ethnobotanical fieldwork was conducted between 2023 and 2025 (Section 2.2). The literature synthesis followed PRISMA 2020 principles to ensure transparent identification and screening of sources (Page *et al.* 2021), but it was not a formal systematic review or meta-analysis. Instead, it provided a structured, multidisciplinary context for interpreting field data. No quantitative synthesis or risk-of-bias scoring was undertaken due to the heterogeneity of available studies.

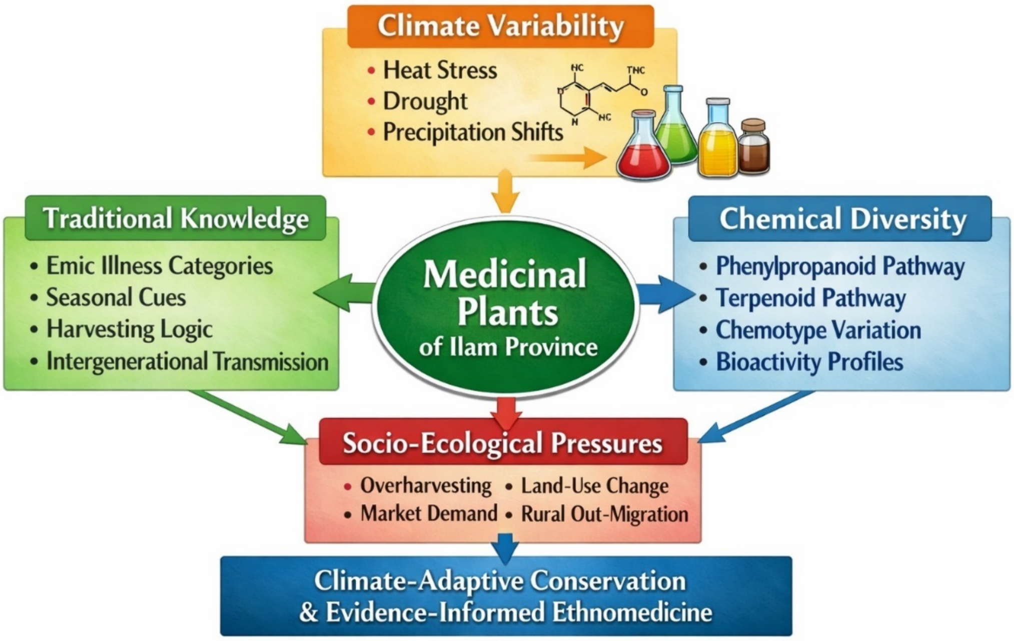

Figure 1. Conceptual framework of the biocultural system of medicinal plant uses in Ilam Province. The diagram illustrates the interactions between Traditional Ecological Knowledge (TEK), emic illness categories, ecological gradients, and phytochemical diversity. It highlights how climatic variability and socio-ecological drivers influence plant selection, therapeutic applications, and conservation strategies.

Study Area

Fieldwork took place across Ilam Province (33.6°N, 46.4°E), a region marked by pronounced ecological heterogeneity along the Zagros Mountain system. The province spans high-elevation montane zones in the north and central areas and transitions to semi-arid and arid lowlands in the south and southwest. These steep topographical and climatic gradients shape species composition, distribution, and secondary metabolite profiles (Moher *et al.* 2009). Sampling locations across both montane and lowland habitats are shown in Figure 2**.**

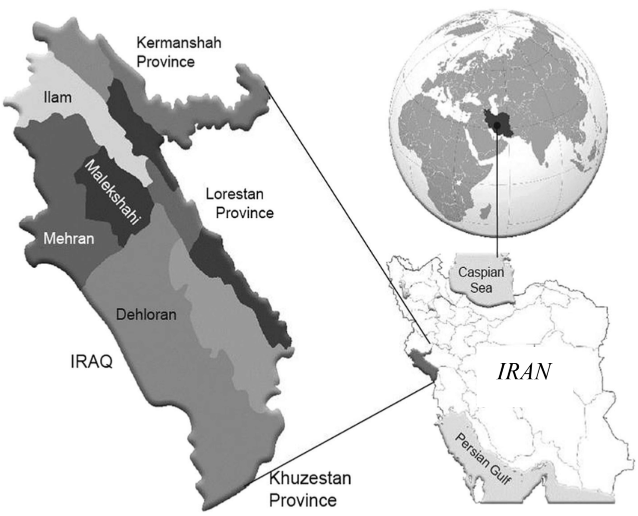

Figure 2. Geographic location and topography of the study area. Map of Ilam Province, western Iran, indicating the sampling locations across the montane Irano-Turanian (north/central) and semi-arid Gulf-Omani (south/southwest) floristic regions.

Ethnobotanical Data Collection

Ethnobotanical fieldwork was conducted between January 2024 - May 2026 across rural and peri-urban communities in Ilam Province. Traditional knowledge was documented through semi-structured interviews and focus group discussions with 78 key informants, including traditional healers, herbal practitioners, and senior knowledge holders. Informants were selected through purposive sampling, followed by snowball recruitment to capture additional locally recognized experts. This combined strategy ensured the inclusion of knowledge-rich individuals and broad coverage of expertise. Data collection continued until thematic saturation, defined as the point at which no substantially new information or use-reports emerged.

Interviews recorded vernacular plant names, plant parts used, preparation methods (e.g., decoction, infusion, topical application), routes of administration, therapeutic indications, dosage practices, and perceived contraindications. All interviews were conducted in Lori and Kurdish and later translated into Persian and English. Field notes were systematically coded and cross-validated to maintain internal consistency.

Socio-demographic Profile of Informants

The 78 informants included 51 men (65.4%) and 27 women (34.6%), ranging in age from 32 to 91 years (mean 58.7 ± 14.3). Most participants (79.5%) had no formal schooling or only primary education. Informants were distributed across 14 villages and two small towns spanning elevations from 350 m in the southern lowlands to over 1800 m in the Zagros highlands. Primary occupations included livestock herding or dry farming (55.1%), household-based agricultural work (28.2%), and traditional healing or herbal practice (16.7%). Knowledge transmission was predominantly vertical: 87.2% learned from parents or grandparents, while the remainder cited apprenticeship with local healers or personal experimentation.

Ethical Considerations

The study involved non-invasive interviews with adults aged ≥30 years and did not include the collection of biological or genetic material. In accordance with institutional and national regulations, the protocol received formal exemption from full ethics review by the Ilam University IRB (Exemption No. ILAM-ETH-2025-001). All procedures adhered to the ethical guidelines of the International Society of Ethnobiology (ISE, 2008) and internationally recognized principles for research involving human participants.

Given limited literacy among many participants, written consent was considered inappropriate; verbal informed consent was obtained after explaining study objectives, procedures, voluntary participation, and the right to withdraw in local languages. Confidentiality was ensured through anonymized coding. The study followed prior informed consent (PIC) principles and aligned with the Declaration of Helsinki and the Nagoya Protocol on Access and Benefit-Sharing (Nagoya Protocol 2011). Full methodological details, including extended protocol description and data extraction structure, are provided at the end of the article text.

Analysis of Use-Reports and Local Therapeutic Consensus

Ethnobotanical data were analyzed using absolute use-report frequencies rather than composite indices. A use-report was defined as a single mention of a plant species for a specific therapeutic purpose; multiple uses of the same species by the same informant were counted separately.

Therapeutic indications were first documented verbatim in Lori and Kurdish to preserve emic terminology. These expressions (e.g., abdominal pain, bloating, cold-related respiratory complaints, wound infections) were later grouped into broader analytical categories for comparative purposes, but consensus calculations were based solely on the original emic reports.
For each species, four descriptive parameters were calculated: (1) percentage of informants citing the species; (2) total use-reports; (3) distribution of use-reports across emic categories; and (4) number of species used within each category. Local therapeutic consensus was assessed by examining the concentration of use-reports within categories relative to the number of species used, following established cultural consensus approaches (Martin, 1995; Romney *et al.* 1986; Caulkins & Hyatt, 1999). Categories with many independent use-reports but few species were interpreted as reflecting stronger agreement.

To preserve the granularity of emic knowledge, this study prioritized absolute use-report frequencies over composite indices (e.g., UV, RFC), which can obscure fine-scale cultural distinctions (WHO 2003; Lenoti 2022).

Plant Collection and Identification

Plant specimens were collected in triplicate during flowering or fruiting seasons to ensure accurate identification. Specimens were identified morphologically in the field and verified using *Flora Iranica*, regional floristic references for Ilam Province, and authenticated herbarium material.

Table 1. List of culturally salient wild medicinal plant species documented in Ilam Province. Data include scientific names, local names (Lori/Kurdish), botanical families, herbarium voucher codes, and corresponding floristic regions.

Local Name	Scientific Name	Family	Herbarium Code	Floristic Region
Kalkom	*Capparis spinosa* L.	*Capparaceae*	ILAM-H-001	Gulf-Omani
Kahoorak	*Prosopis farcta* (Banks & Sol.) J.F.Macbr.	*Fabaceae*	ILAM-H-002	Gulf-Omani
Kerf	*Vitex agnus-castus* L.	*Lamiaceae*	ILAM-H-003	Gulf-Omani
Kahoor-e Irani	*Prosopis cineraria* (L.) Druce	*Fabaceae*	ILAM-H-004	Gulf-Omani
Konar	*Ziziphus spina-christi* (L.) Desf.	*Rhamnaceae*	ILAM-H-005	Gulf-Omani
Avishan	*Thymus daenensis* Celak.	*Lamiaceae*	ILAM-H-006	Irano-Turanian
Zofa	*Hyssopus officinalis* L.	*Lamiaceae*	ILAM-H-007	Irano-Turanian
Avishan-e-Khuzestani	*Satureja khuzistanica* Jamzad	*Lamiaceae*	ILAM-H-008	Irano-Turanian
Kolkena	*Stachys lavandulifolia* Vahl.	*Lamiaceae*	ILAM-H-009	Irano-Turanian
Zafero	*Crocus sativus* L.	*Iridaceae*	ILAM-H-010	Irano-Turanian
Teshna-Dari	*Scrophularia striata* Boiss.	*Scrophulariaceae*	ILAM-H-011	Irano-Turanian
Balut-e Irani	*Quercus brantii* Lindl.	*Fagaceae*	ILAM-H-012	Irano-Turanian
Baneh, Koleng	*Pistacia atlantica* Desf.	*Anacardiaceae*	ILAM-H-013	Irano-Turanian
Toei	*Celtis tournefortii* Lam.	*Cannabaceae*	ILAM-H-014	Irano-Turanian
Sumac	*Rhus coriaria* L.	Anacardiaceae	ILAM-H-015	Irano-Turanian
Gol hiroo	*Althaea officinalis* L.	*Malvaceae*	ILAM-H-016	Irano-Turanian
Malim	*Glycyrrhiza glabra* L.	*Fabaceae*	ILAM-H-017	Irano-Turanian
Berenjas	*Achillea millefolium* L.	*Asteraceae*	ILAM-H-018	Irano-Turanian

The study focused on 18 frequently cited and culturally salient wild medicinal species that form the core of Ilam's traditional pharmacopoeia. Selection was based on citation frequency, therapeutic breadth, and ecological prominence, with cultivated taxa excluded to maintain emphasis on wild flora. These species show the highest levels of informant consensus and provide a strong basis for integrating ethnobotanical, ecological, and phytochemical evidence. Voucher specimens were authenticated and deposited at the Herbarium of the Faculty of Agriculture, Ilam University (ILAM H 001-018). Rather than representing isolated targets, the examined taxa reflect the dominant medicinal flora naturally distributed across the major vegetation zones of the Central Zagros, particularly the Irano-Turanian region, allowing the analysis to capture the ecological and ethnomedicinal structure of the regional landscape

Systematic Literature Review Protocol

A structured narrative review, guided by PRISMA 2020 principles, was conducted to synthesize multidisciplinary evidence relevant to the medicinal species documented in Ilam Province. Searches were performed across major international databases (Web of Science, Scopus, PubMed/MEDLINE, Google Scholar) and Persian-language repositories (SID, Magiran, IranDoc) to ensure comprehensive coverage of both global and regional literature. The search period spanned from January 2024 to May 2026. Boolean search strings combined geographic identifiers ("Ilam Province," "western Iran," "Zagros"), taxonomic names (including synonyms), and thematic keywords related to phytochemistry, pharmacology, ethnomedicine, ecology, and conservation. Reference lists of eligible studies were manually screened to identify additional sources.

The search strategy, protocol, and eligibility criteria are detailed at the end of the article text (with Appendix A). Inclusion criteria required studies to be peer-reviewed and to report original data on phytochemical composition, experimental pharmacological or biological activities, ethnomedicinal applications, ecological characteristics, distribution, phenology, or conservation status for species verified as occurring in Ilam Province or the wider Zagros region. Studies lacking methodological transparency, addressing non-local species, or focusing solely on economic analyses were excluded.

Given the heterogeneity of study designs, no quantitative synthesis or risk-of-bias scoring was performed. Instead, pharmacological findings were interpreted qualitatively in relation to documented ethnomedicinal uses, with attention to congruence, divergence, and methodological robustness. The adherence to reporting standards is summarized at the end of the article text (PRISMA Checklist).

Study Selection Process

The study selection process followed a structured workflow to ensure transparency. The initial search yielded 420 records; after removing 110 duplicates, 310 unique records remained for title and abstract screening. 95 full text articles were assessed for eligibility, of which 79 met all inclusion criteria and were incorporated into the final synthesis. 16 studies were excluded due to insufficient methodological detail, lack of relevance to Ilam's flora, or because they were reviews/editorials. The full selection process is summarized in Figure 3.

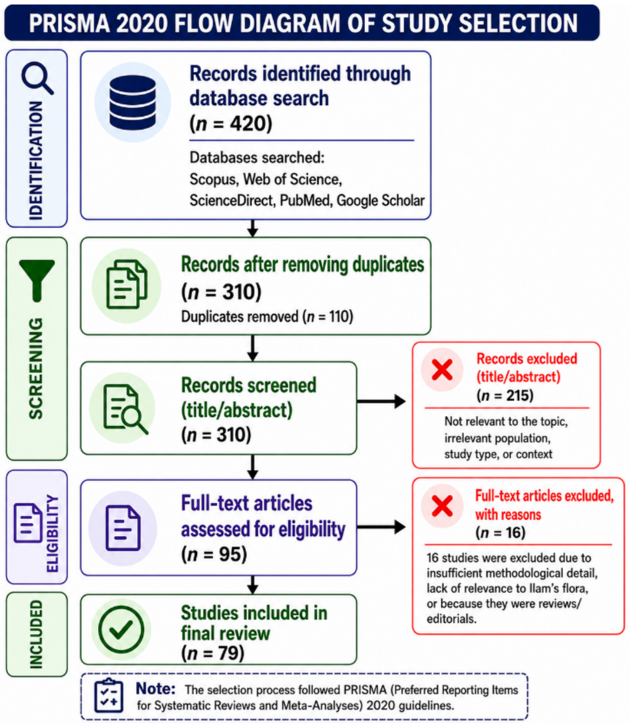

Figure 3. PRISMA 2020 flow diagram illustrating the study selection process. A total of 420 records were identified, 110 duplicates were removed, 310 records were screened, 95 full-text articles were assessed for eligibility, and 79 studies were included in the final synthesis.

Analysis of Correspondence

A qualitative cross-comparison was conducted between the therapeutic uses reported in the ethnobotanical fieldwork and experimentally demonstrated bioactivities in the literature. Correspondence was evaluated by examining the degree to which emic indications aligned with pharmacological evidence across published studies.

Interpretive Synthesis of Climate-Phytochemistry Relationships

Environmental drivers were examined in relation to documented patterns of secondary metabolite production, with particular attention to stress-responsive phenylpropanoid and terpenoid pathways. Evidence linking drought and thermal stress to elevated levels of thymol, carvacrol, and rosmarinic acid (Heinrich *et al.* 1998; Jangpangi *et al.* 2025) was synthesized to clarify ecological influences on phytochemical variability. Interview data further revealed that local harvesters possess a refined seasonal awareness, timing the collection of aerial parts to specific micro-climatic cues, such as post-rain intervals or characteristic wind patterns, to maximize perceived potency.

Conservation Vulnerability Assessment

Species were qualitatively assessed for vulnerability based on ecological niche sensitivity, geographic distribution, harvesting intensity, and reported habitat instability. This evaluation aimed to identify taxa most at risk under ongoing climatic and anthropogenic pressures.

Research Gap Identification

Species lacking robust pharmacological corroboration, chemotype characterization, or standardized cultivation protocols were identified as priorities for future research. Recommended directions include targeted experimental validation and the development of chemotype-specific cultivation strategies.

Given the heterogeneity of available data, quantitative meta-analysis was not feasible. Instead, narrative synthesis enabled an integrated interpretation of ecological variability, convergence between indigenous knowledge and experimental findings, and implications for conservation and sustainable management of Ilam's medicinal flora.

Emic Disease Categorization

To preserve the cultural specificity of medicinal plant use, ailments were first recorded verbatim in Lori and Kurdish during interviews. Informants described symptoms, local illness terms, and perceived causes, producing emic categories such as *Soozesh-e Mede* (stomach burning), *Del Dard* (heartburn), *Nafkh* (bloating), *Sarma Khordan* (catching a cold), and *Qotta* (coughing). These terms were later grouped into broader biomedical categories solely for comparative purposes. Quantitative analyses, however, relied on the original emic reports to ensure that consensus patterns reflected culturally grounded perceptions of efficacy rather than imposed biomedical classifications.

Assessing How Well Evidence Matches

To see if the traditional uses recorded in the field match scientific studies, a simple framework was created. Each important plant was put into one of three categories based on how well published research supports what local people said it does.

C1 (Strong Match) means multiple studies show the plant does exactly what locals use it for, and we know which compounds make it work.
C2 (Partial Match) means the evidence is indirect or incomplete. Maybe studies show it helps with related issues, but not the specific use documented in the field.
C3 (Limited Evidence) means there isn't enough research, the results are conflicting, or we can't really say if the traditional use works based on current science.

This system is just a general way to compare local knowledge with scientific literature, not a strict ranking. These categories are listed in Table 3 to help compare local healing ideas with proven biological activities.

Results and Discussion

Informant Profile and Knowledge Transmission

Sociodemographic characteristics of the 78 informants (Section 2.2.1) provide essential context for interpreting the results. Informants represented diverse ecological settings across Ilam Province, and their knowledge of medicinal plants was shaped primarily through long-term, family-based learning. Most participants described acquiring expertise by observing and assisting parents or grandparents during plant gathering and preparation, while others attributed their knowledge to apprenticeship with local healers or to decades of personal experimentation. This pattern of experiential, kin-based transmission aligns with ethnobiological findings that identify the household as the central locus of knowledge continuity and adaptive practice (Heinrich *et al.* 1998; Hamilton 2004), a trend widely documented across traditional societies (Bennett & Prance 2000; Gaoue 2017).

Such transmission pathways also enhance the internal reliability of ethnobotanical data. High levels of agreement among informants reflect cumulative, community-validated experience rather than isolated individual knowledge, consistent with cultural consensus theory (Mozaffarian 2012; Hawkins 2017; Rechinger 1963-2015). In many ethnomedicinal systems, strong consensus is interpreted as evidence of culturally salient and functionally effective remedies that have undergone long-term empirical validation (Nasir 1970-2005; Turner *et al.* 2000; Mehrnia *et al.* 2021). These patterns support models suggesting that medicinal plant knowledge is structured around a relatively small set of culturally validated "core species" that anchor local healthcare systems and are preferentially retained across generations.

Use-Report Distribution and Cultural Salience

The 912 use-reports recorded in this study show a markedly skewed distribution in which a small number of species account for most therapeutic applications (Table 2). This non-random pattern reflects the cultural salience of certain taxa and aligns with the "cultural keystone species" framework, wherein a subset of plants becomes deeply embedded in everyday healthcare practices through repeated validation (Parmesan 2006; Reyes-García *et al.* 2019).

The disproportionate concentration of citations around T. *daenensis*, C. *spinosa* and S. *lavandulifolia* indicates their role as culturally salient taxa within the local therapeutic repertoire. Also, Irano-Turanian species like *Althaea officinalis*, *Glycyrrhiza glabra*, and *Achillea millefolium* stood out. People often use them for stomach, inflammation, breathing, and female health issues, which shows they are widely accepted in local ethnomedicine (Buso *et al.* 2020).

High citation frequency should therefore be interpreted as a marker of culturally reinforced effectiveness, shaped by collective memory, repeated therapeutic success, and intergenerational transmission (Turner *et al.* 2000; Walther *et al.* 2002; Gershenzon, 2007). Similar concentration patterns have been documented globally, where culturally important species dominate use distributions regardless of overall floristic richness (Root *et al.* 2003; IPCC, 2021). This selective retention process functions as a form of long-term community-level experimentation, in which ineffective remedies are gradually abandoned while effective ones persist, resulting in a refined and functionally optimized pharmacopoeia (Thuiller *et al.* 2005; Yessoufou *et al.* 2025).

Table 2. Quantitative analysis of use-reports and cultural consensus for the 18 most salient medicinal plant species. The table presents informant citation counts, percentages, total use-reports, the number of emic use categories, and the dominant therapeutic category for each species.

Scientific Name	Local Name	Informants citing species (n)	Informants (%)	Total use-reports (n)	No. of emic use categories	Dominant emic category (n)
Achillea millefolium L.	Berenjas	45	57.7	58	5	Gynecological / Hemostatic (18)
Althaea officinalis L.	Gol hiroo	48	61.5	62	4	Respiratory (28)
Capparis spinosa L.	Kalkom	65	83.3	85	5	Gastrointestinal (38)
Celtis tournefortii Lam.	Toei	30	38.5	38	3	Gastrointestinal (20)
Crocus sativus L.	Zafero	40	51.3	52	3	Metabolic disorders (24)
Glycyrrhiza glabra L.	Malim	52	66.7	75	5	Musculoskeletal / Trauma (25)
Hyssopus officinalis L.	Zofa	55	70.5	68	4	Respiratory (32)
Pistacia atlantica Desf.	Baneh / Koleng	50	64.1	65	4	Oral health / Wound (29)
Prosopis cineraria (L.) Druce	Kahoor -e Irani	35	44.9	44	4	Gastrointestinal (21)
Prosopis farcta (Banks & Sol.) J.F.Macbr.	Kahoorak	42	53.8	56	4	Wound healing (22)
Quercus brantii Lindl.	Balut-e Irani	60	76.9	88	6	Gastrointestinal (48)
Rhus coriaria L.	Sumac	54	69.2	71	5	Gastrointestinal (35)
Satureja khuzistanica Jamzad	Avishan-e Khuzestani	48	61.5	61	5	Gastrointestinal (28)
Scrophularia striata Boiss.	Teshna-Dari	45	57.7	59	5	Dermatological / Trauma (25)
Stachys lavandulifolia Vahl.	Kolkena	62	79.5	95	6	Nervous system (40)
Thymus daenensis Celak.	Avishan	72	92.3	112	7	Respiratory (45)
Vitex agnus-castus L.	Kerf	38	48.7	49	6	Gynecological (18)
Ziziphus spina-christi (L.) Desf.	Konar	58	74.4	78	5	Gastrointestinal (42)

The concentration of use-reports around a small subset of taxa aligns with the concept of “cultural keystone species,” in which a limited number of plants function as structural pillars of local healthcare systems and disproportionately shape therapeutic knowledge and practice.

Emic Illness Categories: Structure, Logic, and Therapeutic Implications

Verbatim documentation of illness terminology in Lori and Kurdish revealed a set of culturally specific diagnostic categories that structured the distribution of use-reports across species and preparation methods (Table 3). These emic categories are not linguistic variants of biomedical diagnoses but represent integrated symptom complexes shaped by local understandings of the body, environment, and experiential knowledge. Reducing them to biomedical equivalents risks obscuring the cultural logic that organizes therapeutic decision-making (Heinrich*et al.* 2018; Leonti & Casu 2023).

Medicinal plant use is therefore organized primarily through emic illness categories, which function as the core diagnostic and therapeutic framework. Within the gastrointestinal domain, informants consistently differentiated among Soozesh-e Mede (stomach burning linked to internal heat and dietary imbalance), Del Dard (epigastric pain), Nafkh (bloating/flatulence), Eslah-e Hazm (digestive improvement), and Is-hal (diarrhea) (Miraldi *et al.* 2001; Zeidali *et al.* 2021). Each category directed the selection of distinct species and preparations (Table 3). *Soozesh-e Mede* was the most frequently cited term, understood not as a discrete clinical entity but as a constellation of experiential triggers. Its treatment centered on plants perceived as cooling and moistening, particularly *Capparis spinosa* (22 reports) and *Quercus brantii* (30 reports). As one herbalist explained: “It is not just about the pain; it is about the fire inside… we give plants like *Capparis* or *Quercus* to bring the moisture back and cool the body, just as the rain cools the earth.” Such statements illustrate an emic logic in which plant properties are interpreted through ecological analogies of bodily states, a pattern widely recognized in traditional medical systems (García-Hernández *et al.* 2021). The use of oak in the Zagros region is not limited to the oak itself. Local communities also widely use the thin woody covering of the fruit, called Jaft, which is prepared as a tea, infusion, decoction, and topical formulation. Informed individuals have often reported its use for the management of gastrointestinal complaints, especially diarrhea, as well as respiratory problems such as colds, coughs, and fever. One of the most commonly mentioned traditional medicines was Bali-mas, a medicine obtained by mixing powdered dried oak with yogurt and administered in cases of severe diarrhea. The widespread use of this medicine among local populations may be related to the high content of biologically active compounds in oak tissues. Previous studies have identified triterpenoids, phenolic acids, and flavonoids as the main components of oak, compounds known for their antimicrobial, anti-inflammatory, antioxidant, and gastrointestinal protective activities (Taib *et al.* 2020). These findings provide a plausible pharmacological basis for several of the therapeutic uses reported by participants in the present study.

This coherence indicates that plant selection is guided by culturally encoded therapeutic reasoning rather than random choice or simple availability. In the respiratory domain, *Sarma Khordan* (catching a cold) and *Qotta* (coughing) were dominant categories. *Thymus daenensis* received 28 and 17 reports for these conditions, respectively, the highest species-level concentration in any emic category. Its selection as a warming remedy aligns with its aromatic profile and high thymol/carvacrol content, which exhibit antimicrobial and expectorant activity in preclinical studies (Balick 1996; Rates 2001; Pan *et al.* 2013). *Hyssopus officinalis* was primarily cited for *Sinusit* (32 reports), consistent with its spasmolytic and anti-inflammatory properties (Atazhanova *et al.* 2024).

Within the nervous system domain, *Stachys lavandulifolia* dominated reports for *Asabaniat* (anxiety, 24 reports) and *Bi-khoei* (insomnia, 16 reports), reflecting strong community consensus around a single species. Preclinical evidence of anxiolytic and sedative effects supports this pattern. *Crocus sativus* was associated with mood-related and metabolic categories such as *Khososhi* (low mood, 10 reports) and *Garmi-e Badan* (metabolic warmth, 8 reports), showing partial convergence with clinical findings on its neuroprotective and antidepressant properties (Cunningham 1996; Lopresti & Drummond 2014).

Employing an emic lens reveals that local classifications reflect complex systemic imbalances rather than isolated medical conditions. For instance, *Ziziphus spina-christi* and *Celtis tournefortii* are frequently prescribed for "Zardi" (jaundice), a local category denoting perceived toxicity and systemic instability. This culturally informed conceptualization finds scientific validation in the documented hepatoprotective properties of these species (Abdulrahman *et al.* 2022; Touhtouh *et al.* 2025). The reliance on specific species such as *Ziziphus* and Sumac for managing metabolic symptoms like sugar cravings aligns with broader national patterns where these plants are frequently cited for diabetes management across different ethnographic contexts (Labbafi *et al.* 2024).

Such examples demonstrate how biomedical mapping can fail to capture the full conceptual scope of emic categories and underscore the need to analyze indigenous classifications on their own terms. Plants like *Althaea officinalis*, *Glycyrrhiza glabra*, and *Achillea millefolium* stand out because they have so many different uses (Kazemi & Kafi 2025). *Glycyrrhiza glabra* is a key part of trauma care. Locals make a remedy called '*Kom*' by grinding dried licorice root into powder and mixing it with egg yolk. They put this paste on fractures and bad bruises, showing how they combine plant and animal resources. *Althaea officinalis* is not only good for stomach burning but also helps stop coughing. People often use washes made from its flowers and leaves on wounds to help them heal faster. Meanwhile, *Achillea millefolium* is very important for women's health and stopping bleeding. Healers use it as a sitz bath to strengthen the uterus and stop abnormal bleeding. They also apply it to the cervix or use it as an inhalation to help open it up during childbirth. It is also used to stop bleeding wounds. Additionally, cooked parts of the plant are used for bruises around the eyes, showing how useful it is for treating injuries. The widespread use of *Achillea millefolium* for gynecological and hemostatic purposes is supported by the rich phytochemical profile of the Asteraceae family in Iran, which validates its prominence in traditional healing protocols (Nadaf *et al.* 2025).

Local practices for treating skin and inflammation show how people combine plant properties with specific timing beliefs. In Ilam, *Scrophularia striata* (Teshna-Dari) is popular because it is great at reducing inflammation and healing wounds. People often use it as a poultice or wash for skin infections, burns, and joint pain, showing how useful it is for injuries. Also, timing is important for some treatments. For example, in Lori-speaking areas, healers believe that rubbing *Vitex agnus-castus* (Kerf) on warts exactly at sunset (for a week), is the key to making them disappear and dry up. This shows how important timing is when preparing and using herbal remedies in the region.

Table 3. Detailed emic use-reports and correspondence with biomedical categories. Data include verbatim local illness terminology (in Lori/Kurdish), translated symptom descriptions, mapped biomedical categories, and frequency of use-reports for each species.

Scientific Name	Local Name	Emic Term (Vernacular Concept)	Translated Meaning / Symptom Description	Mapped Biomedical Category		Use-Reports (n)
Capparis spinosa L.	Kalkom	*Soozesh-e Mede*	Stomach burning / Gastritis	Gastrointestinal	C1	22
		Del Dard	Heartburn / Epigastric pain	Gastrointestinal		12
		Gaz	Flatulence / Bloating	Gastrointestinal		4
		Dard-e Mafasel	Joint pain / Rheumatism	Inflammatory		2
		Other documented uses	(e.g., wound healing, anti-infective, liver tonic)	Various		45
		Total				85
Prosopis farcta (Banks & Sol.) J.F.Macbr.	Kahoorak	*Zakhm*	Wound (External)	Wound healing	C1	22
		Eslahe Hazm	Digestion improvement	Gastrointestinal		8
		Shekame	Stomach ache	Gastrointestinal		6
		Other documented uses	(e.g., anti-diabetic, anti-inflammatory)	Various		20
		Total				56
Vitex agnus-castus L.	Kerf	Zegil (kar)	Warts (Rubbed at sunset)	Dermatological	C2	12
		Eghteza-e Pakestani	Premenstrual syndrome cravings	Gynecological		18
		Dard-e Pestan	Breast pain / Mastodynia	Gynecological		10
		Bi-khoei	Insomnia	Nervous system		5
		Other documented uses	(e.g., hormonal balance)	Various		4
		Total				49
Prosopis cineraria (L.) Druce	Kahoor-e Irani	*Zakhm-e Jaryan*	Fresh wound / Bleeding	Wound healing	C1	15
		Is-hal	Diarrhea	Gastrointestinal		6

Scientific Name	Local Name	Emic Term (Vernacular Concept)	Translated Meaning / Symptom Description	Mapped Biomedical Category		Use-Reports (n)
		Other documented uses	(e.g., anti-diabetic, digestive, antimicrobial)	Various		23
		Total				44
Ziziphus spina-christi (L.) Desf.	Konar	*Zardi (Zardiak)*	Jaundice	Hepatic / Gastrointestinal	C2	15
		Zahar	General intoxication / Poisoning	Gastrointestinal		12
		Ehtiaj be Shirin	Craving for sweets (Diabetes symptom)	Metabolic		8
		Other documented uses	(e.g., wound healing, anti-inflammatory, sedative)	Various		43
		Total				78
Thymus daenensis Celak.	Avishan	*Sarma Khordan*	Catching a common cold	Respiratory	C1	28
		Qotta	Coughing	Respiratory		17
		Soorakh-e Zaban	Mouth ulcers / Thrush	Inflammatory		8
		Other documented uses	(e.g., digestive, antimicrobial, antispasmodic)	Various		59
		Total				112
Hyssopus officinalis L.	Zofa	*Sinusit*	Sinusitis / Facial pressure	Respiratory	C1	32
		Balgham	Phlegm congestion	Respiratory		10
		Asabianit	Nervousness	Nervous system		5
		Other documented uses	(e.g., digestive, sedative, antimicrobial)	Various		21
		Total				68
Satureja khuzistanica Jamzad	Azboa, Avishan-e Khuzestani	*Tun-e Mede*	Stomach ache / Cramps	Gastrointestinal	C1	28
		Gardan Dard	Neck pain	Inflammatory		5
		Other documented uses	(e.g., antimicrobial, respiratory, wound healing)	Various		28
		Total				61
Stachys lavandulifolia Vahl.	Kolkena	*Asabaniat*	Nervousness / Anxiety	Nervous system	C1	24
		Bi-khoei	Insomnia	Nervous system		16
		Sard-e Maghz	Brain cold / Headache	Nervous system		5
		Other documented uses	(e.g., sedative, anti-inflammatory, digestive)	Various		50
		Total				95
Crocus sativus L.	Zafero	*Zaban-e Sefid*	Oral thrush	Infectious	C1	12
		Khososhi	Low mood / Depression	Mental health		10
		Garmi-e Badan	Body heat (Metabolic booster)	Metabolic		8
		Other documented uses	(e.g., mood enhancement, neuroprotection, digestive)	Various		22
		Total				52
Scrophularia striata Boiss.	Teshna-Dari	Zakhm	Wound healing (Topical poultice/Decoction)	Wound healing	C1	20
		Suzakhtegi	Burns / Skin infections	Dermatological		15

Scientific Name	Local Name	Emic Term (Vernacular Concept)	Translated Meaning / Symptom Description	Mapped Biomedical Category		Use-Reports (n)
		Dard-e Mafasel	Joint pain / Rheumatism	Musculoskeletal / Inflammatory		15
		Etemad	Boils / Skin abscesses	Dermatological		5
		Other documented uses	(e.g., anti-inflammatory, analgesic)	Various		4
		Total				59
Quercus brantii Lindl.	Balut-e Irani / Bali / Baru	Bali-mas	Oak fruit powder mixed with yogurt (for diarrhea)	Gastrointestinal	C1	15
		Is-hal	Diarrhea (General)	Gastrointestinal		15
		Tal'khordegi	Intestinal worms	Gastrointestinal		12
		Sookhtegi	wound healing	Gastrointestinal		6
		Other documented uses	inflammatory)	Various		40
		Total				88
Pistacia atlantica Desf.	Baneh / Koleng	*Dard-e Dandan*	Toothache	Oral health	C1	15
		Zakhm	Wound healing	Wound healing		14
		Soozesh	Burning sensation / Inflammation	Inflammatory		8
		Other documented uses	(e.g., digestive, antimicrobial, metabolic)	Various		28
		Total				65
Celtis tournefortii Lam.	Toei	*Zardi*	Jaundice	Hepatic	C2	20
		Dard-e Shikam	Stomach ache	Gastrointestinal		8
		Other documented uses	(e.g., digestive, tonic, anti-inflammatory)	Various		10
		Total				38
Rhus coriaria L.	Sumac	*Is-hal*	Diarrhea	Gastrointestinal	C1	35
		Soozesh	Inflammation	Inflammatory		10
		Other documented uses	(e.g., digestive, antimicrobial, metabolic)	Various		26
		Total				71
Althaea officinalis L.	Gol hiroo	Soozesh-e Sine	Chest burning & Cough (Antitussive)	Respiratory	C1	25
		Zakhm	Wound healing (Flower/Leaf decoction)	Dermatological		15
		Soozesh-e Mede	Stomach burning	Gastrointestinal		12
		Other documented uses	(e.g., mucosal soothing)	Various		10
Glycyrrhiza glabra L.	Malim	Kom	A topical paste of powdered licorice root and egg yolk	Musculoskeletal / Trauma	C1	25
		Balgham	Phlegm / Respiratory congestion	Respiratory		30
		Zakhm-e Dakheli	Internal ulcer / Stomach ulcer	Gastrointestinal		15
		Other documented uses	(e.g., expectorant, laxative, liver tonic)	Various		5
		Total				75
Achillea millefolium L.	Berenjas	Tashil-e Zayman	Facilitating childbirth (Cervical dilation)	Gynecological / Obstetric	C1	18

Scientific Name	Local Name	Emic Term (Vernacular Concept)	Translated Meaning / Symptom Description	Mapped Biomedical Category	Use-Reports (n)
		Adam-e Khun / Zakhm-e Khunari	Bleeding control / Hemostatic wounds	Hematological / Wound healing	20
		Zakhm	Wound healing (Topical/Fomentation)	Dermatological	10
		Kabodi-e Cheshm	Bruising around the eye	Musculoskeletal / Trauma	5
		Other documented uses	(e.g., anti-inflammatory, sitz bath for uterus)	Various	5
		Total			58

This table reports all documented use-reports for each species. For species where only the most frequently cited emic applications were listed in the original version, the category "Other documented uses" has been added to account for the remaining use-reports. These additional applications represent culturally salient but less frequently cited therapeutic indications (e.g., anti-inflammatory, antimicrobial, digestive tonic, or metabolic uses) that were documented during interviews but did not fall within the primary emic categories shown individually. This approach maintains both the granularity of emic disease concepts and the integrity of the total use-report counts, providing a complete and transparent foundation for subsequent convergence analysis. Evidence Convergence Categories: C1 = strong agreement between ethnomedicinal use and experimentally documented pharmacological activity; C2 = partial agreement or indirect pharmacological support; C3 = limited pharmacological evidence currently available.

The evidence suggests that medicinal plant use in the region operates as a structured biocultural system in which illness perception and therapeutic choice are tightly interlinked, consistent with ethnobiological models that view traditional medical systems as coherent knowledge frameworks rather than assemblages of discrete remedies (Figure 4).

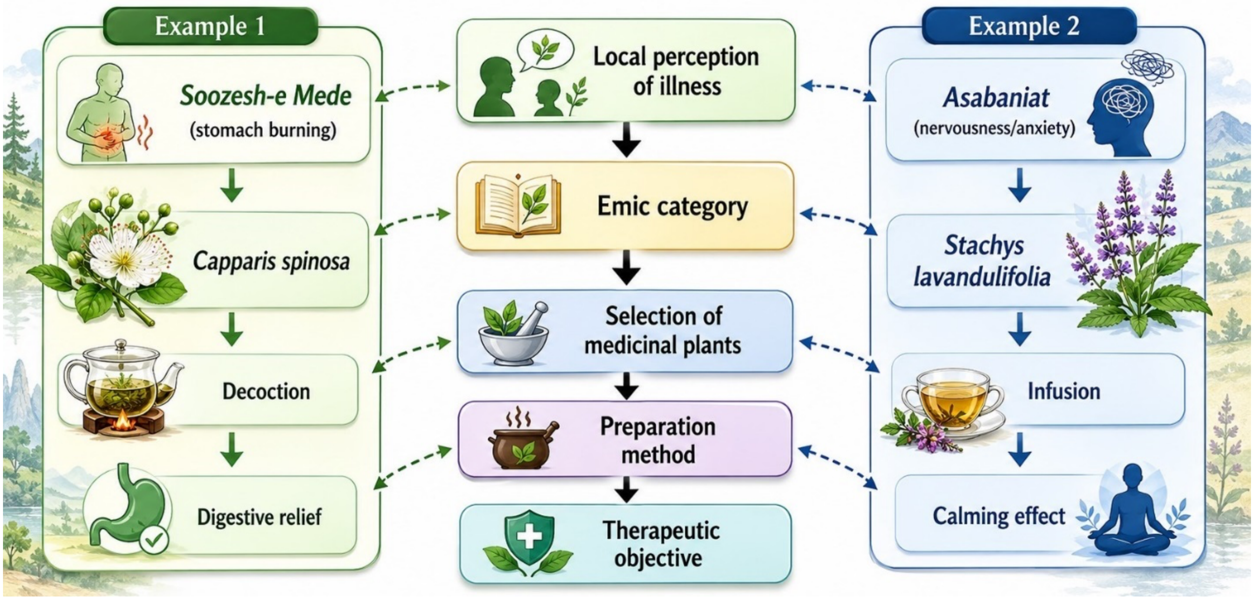

Figure 4. Conceptual pathway of emic therapeutic logic in Ilam ethnomedicine
The diagram illustrates the sequential process from local illness perception to therapeutic application. (1) Diagnosis: Local experiences of illness are first interpreted through specific emic categories. (2) Selection & Preparation: These categories subsequently guide the choice of medicinal plant species and the preparation method. (3) Application: Representative examples include Soozesh-e Mede (stomach burning), treated with a decoction of *Capparis spinosa* for digestive relief, and Asabaniat (nervousness/anxiety), treated with an infusion of *Stachys lavandulifolia* for calming effects.

This study prioritized emic illness categories over composite quantitative indices because reducing culturally complex symptom clusters to standardized biomedical metrics risks obscuring the specific cultural logic guiding therapeutic choices. Conventional statistical measures often fail to capture these nuanced, context-dependent health concepts, whereas absolute frequencies of use-reports more transparently reflect local consensus and the practical relevance of species within the indigenous medical system.

Floristic Regionalization and Ethnomedicinal Patterns

The distinction between Gulf-Omani and Irano-Turanian floristic elements reflects underlying ecological gradients that shape both phytochemistry and therapeutic application. Species adapted to arid and semi-arid lowlands, such as *Capparis spinosa* and *Prosopis* spp., often accumulate stress-induced secondary metabolites, including flavonoids, alkaloids, and phenolic compounds (Zohary, 1973; Evans, 2009; Selmar & Kleinwächter, 2013). These ecological adaptations correspond closely with their local therapeutic uses, as summarized in Table 4.

In contrast, montane Irano-Turanian species, particularly members of the *Lamiaceae*, frequently exhibit elevated concentrations of phenolics and essential oils under the environmental stress regimes characteristic of the Zagros Mountains (Wink, 2015; Newman, 2016; Yang *et al.* 2018). These phytochemical profiles are strongly associated with antimicrobial, antioxidant, and anti-inflammatory activities, which likely contribute to their widespread use in treating respiratory and gastrointestinal conditions (Table 4) (Martin, 1995; Ticktin, 2011; Newman, 2016).

Table 4. Phytochemical profiles, plant parts used, reported pharmacological activities, and biocultural valorization potential of culturally salient medicinal species in Ilam Province.

Scientific Name & (Common)	Major Active Compounds	Used Plant Parts	Pharmacological Effects	Commercialization & Potential
Capparis spinosa (Kalkom)	Flavonoids, alkaloids, glucosinolates, saponins	Buds, roots, leaves	Anti-inflamm, antioxidant, hepatoprotective, wound healing	High potential: functional foods, GI products
Prosopis farcta (Syrian mesquite)	Fatty acids, flavonoids, lignans, anthraquinones	Fruits, leaves, roots	Anti-inflamm, antimicrob, wound healing	Moderate: wound-healing & antioxidant formulas
Vitex agnus-castus (Chaste tree)	Flavonoids, iridoid glycosides, diterpenes, oils	Fruits, leaves, bark	Hormonal modulator (PMS), antiviral, analgesic	Established: women's health market
Prosopis cineraria (Spunge tree)	Flavonoids, tannins, heneicosanoic acid	Leaves, pods, bark	Antioxidant, anti-inflamm, immune-stimulant	Moderate: phytopharmaceuticals
Ziziphus spina-christi (Konar)	Saponins, betulinic acid, ceanothic acid	Leaves, fruits, seeds	Hypoglycemic, anti-diabetic, antimicrob	Potential: metabolic health products
Thymus daenensis (Thyme)	Thymol, carvacrol, flavonoids	Leaves, stems, oil	Antimicrob, anti-inflamm, expectorant	High potential: essential oil, respiratory prep
Hyssopus officinalis (Hyssop)	Thymol, carvacrol, rosmarinic acid, pinene	Leaves, flowers	Antibacterial, antifungal, sedative	Potential: respiratory & aromatic products
Satureja khuzistanica (Azbooa)	Thymol, carvacrol, rosmarinic acid	Leaves, stems, oil	Antimicrob, cardioprotective, anti-inflamm	Very high: endemic & carvacrol-rich oil
Stachys lavandulifolia (Mountain tea)	Phenolic acids, monoterpenes, glycosides	Leaves, flowers	Anti-inflamm, anxiolytic, analgesic	High potential: calming teas, neuroprotective
Crocus sativus (Saffron)	Crocin, crocetin, safranal, picrocrocin	Stigmas, petals	Antioxidant, antidepressant, anticancer	High: established nutraceutical market
Scrophularia striata (Teshna-Dari)	Flavonoids, cinnamic acid, iridoids	Aerial parts, roots	Strong anti-inflamm, wound/burn healing, analgesic	Promising: topical dermatological products
Quercus brantii (Persian oak)	Triterpenoids, tannins, phenolic acids	Bark, fruits, Jaft	Gastroprotective, antitussive, antipyretic	Potential: tannin extracts, GI remedies
Pistacia atlantica (Wild pistachio)	Anacardic acids, polyphenols, fatty acids	Resin, fruits, kernels	Antimicrob, antitumor, antioxidant	High potential: resin-based medicinal/cosmetic

Scientific Name & (Common)	Major Active Compounds	Used Plant Parts	Pharmacological Effects	Commercialization & Potential
Celtis tournefortii (Toei)	Phenolics, alkaloids, terpenoids	Leaves, fruits, bark	Anti-inflamm, antibacterial, anticancer	Limited: needs validation
Rhus coriaria (Sumac)	Tannins, flavonoids, gallic acid	Fruits, leaves	Antioxidant, antibacterial, anticancer	Strong: functional foods, preservatives
Achillea millefolium (Yarrow)	Essential oils, flavonoids, coumarins	Leaves, flowers	Hemostatic, wound healing, antispasmodic	Established: gynecological & wound-care
Althaea officinalis (Marshmallow)	Mucilage, polysaccharides, coumarins	Roots, leaves, flowers	Demulcent, antitussive, immunomodulatory	Wide: respiratory & mucosal-protective
Glycyrrhiza glabra (Licorice)	Glycyrrhizin, flavonoids, coumarins	Roots, rhizomes	Anti-inflamm, expectorant, antiviral, spasmolytic	Major: extensive pharmaceutical applications

This table brings together information on the chemical makeup, plant parts used, medical effects, and sustainable uses of the main medicinal species found during the fieldwork. The last column points out species that have good potential for development, such as making medicines, supplements, essential oils, healthy foods, and traditional remedies. Instead of predicting exact profits, the focus is on ways to value these plants bioculturally. This approach aims to help local people make a living, protect nature, and ensure these traditional resources are used sustainably.

These findings highlight the importance of incorporating phytogeographic context into ethnobotanical interpretation. Patterns of medicinal plant use are not randomly distributed but reflect the interplay among ecological constraints, evolutionary adaptation, and culturally mediated selection processes (Takhtajan 1986; Duke 2002; Saslis-Lagoudakis *et al.* 2012). Similar patterns of plant selection driven by ecological constraints and local knowledge have been documented in other arid regions of Iran, such as Birjand, where specific taxa are retained for their adaptive properties (Mohammadi *et al.* 2023).

Traditional Ecological Knowledge and Harvesting Practices

Harvesting practices documented in this study reveal a highly refined system of ecological observation. Informants consistently identified post-rainfall periods as optimal for collecting aerial parts, associating these conditions with stronger aroma, greater potency, and improved therapeutic effect. As one healer explained: “We collect the plants after the spring rains, when their smell is stronger and their effect is better.” Such statements reflect an emic understanding of plant physiology grounded in sensory cues, environmental observation, and long-term experiential knowledge (Cunningham, 2020; Norkum *et al.* 2025).

Experimental evidence supports these perceptions: water availability, temperature fluctuations, and environmental stress influence the biosynthesis and accumulation of secondary metabolites, particularly in aromatic and medicinal species (Isah 2019; Fontana *et al.* 2022). The alignment between local knowledge and scientific findings reinforces the interpretation of TEK as a dynamic, adaptive, and empirically grounded knowledge system rather than a static set of inherited beliefs (Engler *et al.* 2009; Chaves *et al.* 2025).

Locals frequently reported a biocultural decline in resource availability, linking environmental shifts to knowledge erosion. Specifically, informants noted that dust storms have weakened Sumac trees, reducing their fertility and yield, while Thyme, Hyssop, *Stachys*, and *Satureja* have become scarce due to both unsustainable harvesting and regional warming. Community members expressed concern, stating, '*We used to harvest these plants abundantly, but now they are rarely found*,' indicating that environmental degradation is actively threatening the transmission of local ecological knowledge.

Climate Change, Knowledge Erosion, and Biocultural Vulnerability

Informants’ observations of shifting flowering times, declining plant abundance, and reduced perceived potency closely mirror regional climate projections for western Iran, which predict rising temperatures, reduced precipitation, and increased climatic variability (IPCC 2014; Khormizi *et al.* 2023). These ecological changes intersect with socio-economic transformations, including rural out-migration, healthcare modernization, and declining reliance on traditional practices, that contribute to the erosion of ethnobotanical knowledge (Adger 2006; Aitfella Lahlou *et al.* 2025). Simultaneously, growing commercial demand for medicinal plants intensifies harvesting pressure on wild populations, often without adequate conservation or regulatory frameworks (Smit & Wandel, 2006).

Patterns at the species level suggest that Irano-Turanian plants living in the mountains might be at higher risk. This is because they have smaller habitats and a harder time adapting to change, which matches studies showing that high-altitude species are very sensitive to environmental shifts (Moradi *et al.* 2025). This makes conservation even more urgent because many of these plants are important for local medicine, have proven medicinal uses, and offer great potential for biocultural development (Table 4).

Taken together, these findings underscore the need for conservation strategies that address both ecological sustainability and the preservation of biocultural knowledge systems. The long-term viability of medicinal plant resources in Ilam depends on maintaining the cultural frameworks that sustain their use and transmission.

Synthesis and Implications

Overall, the results indicate that medicinal plant use in Ilam functions as a structured and dynamic biocultural system shaped by ecological availability, phytochemical properties, and culturally embedded knowledge frameworks. Emic illness categories provide the primary structure for diagnosis and treatment, while traditional ecological knowledge mediates the relationship between environmental observation and plant selection (Berkes *et al.* 2000; Pieroni *et al.* 2015).

Medicinal plants thus operate not as isolated remedies but as components of a broader socio-ecological network in which knowledge, environment, and practice are mutually reinforcing (Petelka *et al.* 2022; Rahimi *et al.* 2025). This perspective moves beyond descriptive ethnobotany toward an integrative understanding of human-plant relationships that simultaneously considers cultural meaning, ecological context, and adaptive knowledge processes (de Albuquerque 2006; Quintana-Obregón 2026). Medicinal plants are part of local life not just for health, but also for business and industry. A good example is the bark and skin of the acorn, called 'jaft'. Beyond its health benefits from tannins and flavonoids, it is a key material for dyeing yarn, making crafts, and tanning animal hides (Fraga-Coral *et al.* 2021). The multifunctional use of *Quercus*-derived products illustrates the embeddedness of medicinal practices within broader livelihood systems, creating a system where nature supports both people's health and their income.

Such an approach is essential not only for advancing ethnobiological research but also for informing conservation planning, sustainable resource management, and the culturally grounded integration of traditional knowledge into broader health and environmental frameworks (Maffi 2005; Moleka 2026).

Cross-cultural convergence and divergence in Zagros ethnomedicine

The predominance of gastrointestinal disorders in Ilam is consistent with ethnomedicinal patterns reported throughout the Zagros region, including Kermanshah, Lorestan, and Khuzestan, where digestive ailments constitute the principal focus of medicinal plant use (Ghasemi Pirbalouti 2013). Similar patterns have been documented in eastern Turkey, northern Iraq, and other parts of the eastern Mediterranean, suggesting a broader West Asian tradition of treating gastrointestinal complaints with plant-based remedies (Cakilcioglu 2011). Comparison with ethnobotanical studies from neighboring Zagros regions, Turkish Kurdistan, northern Iraq, and adjacent Iranian provinces revealed substantial overlap in therapeutic practices, supporting the “Medicinal Flora Synthesis” hypothesis for Western Asia (Mehrnia *et al.* 2021).

The use of *Quercus brantii* acorns for gastrointestinal disorders, particularly “Soozesh-e Mede” (stomach burning), closely resembles practices reported from southern Anatolia and the Hawraman region along the Iran-Iraq border, where oak-derived remedies remain important treatments for digestive ailments. Likewise, the use of *Thymus daenensis* and *Satureja khuzistanica* for respiratory and infectious diseases corresponds with reports from Kermanshah and Lorestan, reflecting a shared regional pharmacopoeia associated with the widespread occurrence of these Irano-Turanian species and their thymol- and carvacrol-rich phytochemical composition.

At the same time, several species exhibit region-specific uses that underscore the distinctiveness of Ilam’s TEK. In Ilam, *Capparis spinosa* is primarily used for gastric cooling, whereas studies from central Iran more frequently report dermatological and anti-rheumatic applications. Similarly, *Ziziphus spina-christi* shows unusually high cultural importance for treating “Zardi” (jaundice/intoxication), while northern Zagros communities often rely on alternative hepatic remedies such as *Cichorium intybus*. These differences indicate that medicinal plant use is shaped not only by species availability and phytochemical properties but also by local ecological conditions and culturally defined illness categories.

The continued use of oak-based remedies further distinguishes Ilam from parts of southeastern Turkey, where such practices have declined following rapid land-use change (Cakilcioglu 2011). This persistence suggests that Ilam remains an important reservoir of biocultural knowledge, maintaining therapeutic traditions that have been modified or lost in other parts of the region.

Conclusion

This study shows that medicinal plant use in Ilam Province functions as a coherent biocultural system structured around emic illness concepts and experience-based ecological knowledge. The 912 use-reports demonstrate that categories such as *Soozesh-e Mede*, *Sarma Khordan*, and *Zardi* operate as primary diagnostic frameworks that actively guide therapeutic choice, frameworks that cannot be meaningfully captured through biomedical classification alone.

Floristic differentiation between Gulf-Omani and Irano-Turanian taxa further shapes the pharmacopoeia, linking ecological distribution, phytochemical profiles, and therapeutic domains in ways largely overlooked in previous regional surveys. The strong correspondence between TEK-guided harvesting practices and experimentally documented post-rainfall shifts in secondary metabolite production underscores the functional ecological insight embedded in local knowledge.

Yet this system faces growing biocultural vulnerability. Climate-driven habitat change, declining plant abundance, and rapid erosion of intergenerational knowledge collectively threaten both medicinal resources and the cultural frameworks that sustain their use.

Future priorities include clinical evaluation of high-consensus species, chemotype characterization of key endemics such as *Satureja khuzistanica*, and longitudinal studies of knowledge transmission among younger generations. The integrative framework developed here, linking emic illness categories, TEK dynamics, and floristic context, offers a transferable model for investigating biocultural systems across the Zagros region and other ecologically diverse landscapes.

The findings show a move away from just studying specific plants. Instead, they focus on the knowledge itself and how people understand healing. This approach looks at how treatments work based on cultural illness categories that are part of the local society and environment.

Declarations

List of abbreviations: TEK: Traditional Ecological Knowledge, ISE: International Society of Ethnobiology, IRB: Institutional, Review Board, PIC: Prior Informed Consent,PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses, UV: Use Value, RFC: Relative Frequency of Citation, CI: Cultural Importance Index.

Ethics approval and consent to participate: The research protocol was reviewed and formally exempted from full ethics committee oversight by the Institutional Review Board of Ilam University (Ethics Exemption Registration No.: ILAM-ETH-2025-001).

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Ethics Exemption

Date: 26 February 2025

Ethics Exemption Registration No.: ILAM-ETH-2025-001

To Whom It May Concern,

Subject: Formal Approval of Ethical Exemption for Non-Invasive Ethnobotanical Research

This letter certifies that the research project entitled " How Illness Categories Shape Medicinal Plant Selection in the Zagros Mountains of Western Iran: A Biocultural Perspective on Traditional Ecological Knowledge and Ethnopharmacological Evidence", conducted by Dr. Ehsan Zeidali, botanist and faculty member of the Department of Agronomy and Plant Breeding, Faculty of Agriculture, Ilam University, has been reviewed by the departmental ethics review committee and has been formally exempted from the requirement for full ethical approval.

Study Details:

Principal Investigator: Dr. Ehsan Zeidali
Study Period: January 2024 - May 2026
Study Type: Non-invasive ethnobotanical documentation
Participants: 78 adult participants (≥30 years old) from local communities in Ilam Province

Basis for Exemption:

The study involved only:

1. Semi-structured interviews and focus group discussions with adult participants
2. Documentation of traditional medicinal plant knowledge
3. No collection of biological samples, personal identifiers, or sensitive human data
4. Voluntary participation with informed verbal consent (due to literacy limitations in target communities, consisting predominantly of Lor and Kurdish populations)
5. Full anonymization through coded data recording

According to national and institutional guidelines in Iran, research of this nature, limited to non-invasive ethnobotanical interviews without human biological sampling, does not fall under the category requiring mandatory institutional review board (IRB) approval.

Ethical Standards Maintained:

This research was conducted in accordance with:

The ethical principles of the Declaration of Helsinki for studies involving human participants
Prior Informed Consent (PIC) procedures, with participants informed of study objectives, voluntary participation, and right to withdraw
Principles of the Nagoya Protocol on Access to Genetic Resources and Benefit-Sharing, with commitment to sharing findings with local communities
No commercial use or bioprospecting of genetic resources was involved in this study

Retrospective Coverage:

This exemption applies retrospectively to all ethnobotanical fieldwork conducted between March 2023 and February 2025, as the study design was reviewed and determined to meet criteria for exemption prior to data collection.

This waiver is registered and hereby approved for academic and publication purposes. The department is available to provide further clarification if required.

Sincerely,

Dr. Yaser Alizadeh

Head of Department of Agronomy and Plant Breeding
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Appendix A: Search Strategy and Protocol Date of Search: January 2024 - May 2026

Databases Searched: Web of Science, Scopus, PubMed, and Google Scholar, Magiran, SID.

Search Strings: *(Boolean combinations of geographic identifiers ["Ilam Province," "western Iran," "Zagros"], taxonomic names, and thematic keywords related to phytochemistry, pharmacology, ethnomedicine, ecology, and conservation).*

Inclusion Criteria:

1. Peer-reviewed studies reporting original data (clinical, experimental, or observational).
2. Studies focusing on medicinal plants, specifically investigating:
   - Phytochemical composition (secondary metabolites, essential oils).
   - Experimental pharmacological or biological activities.
   - Ethnomedicinal applications and traditional use.
   - Ecological characteristics, distribution, or phenology.
   - Conservation status or vulnerability assessments.
3. Species verified as occurring in Ilam Province or the wider Zagros region.
4. Studies published in English or Persian.

Exclusion Criteria:

1. Studies lacking methodological transparency.
2. Studies addressing non-local species.
3. Studies focusing solely on economic analyses without biological data.

PRISMA 2020 Checklist ***(Adapted for an Integrative Review)***

How Illness Categories Shape Medicinal Plant Selection in the Zagros Mountains of Western Iran: A Biocultural Perspective on Traditional Ecological Knowledge and Ethnopharmacological Evidence

Section	Item #	Checklist item	Location where item is reported
TITLE	1	Identify the report as a review	Title
ABSTRACT	2	Structured summary	Abstract
INTRODUCTION	3	Rationale	Introduction, paragraphs 1-4
	4	Objectives	Introduction, final paragraph
METHODS	5	Eligibility criteria	Methods - Systematic Literature Review Protocol (Inclusion/Exclusion Criteria)
	6	Information sources	Methods - Systematic Literature Review Protocol (Databases Searched)
	7	Search strategy	Methods - Systematic Literature Review Protocol (Search Strings); Supplementary File 1
	8	Selection process	Methods - Systematic Literature Review Protocol (Study Selection Process); Figure 3
	9	Data collection process	Methods - Systematic Literature Review Protocol (Analysis of Correspondence; Narrative Synthesis)
	10a	Data items (Outcomes sought)	Methods - Systematic Literature Review Protocol (Inclusion Criteria: phytochemistry, pharmacology, ethnomedicine)
	10b	Data items (Other variables)	Methods - Systematic Literature Review Protocol (Species names, ecological characteristics)
	11	Risk of bias assessment	Not formally assessed due to heterogeneity of study designs; qualitative appraisal performed (Methods, Section 2.5)
	12	Effect measures	Not applicable (no quantitative synthesis/meta-analysis)
	13a	Synthesis methods (Study grouping)	Methods - Systematic Literature Review Protocol (Analysis of Correspondence)
	13b	Synthesis methods (Data preparation)	Not applicable (Narrative synthesis employed)
	13c	Synthesis methods (Presentation methods)	Tables and figures in Results (Tables 1, 2, 3, 4)
	13d	Synthesis methods	Narrative and integrative synthesis (Methods, Section 2.5)

Section	Item #	Checklist item	Location where item is reported
		(Synthesis methods)	
	13e	Synthesis methods (Exploration of heterogeneity)	Qualitative comparison across species and climatic gradients (Methods, Section 2.5.3)
	13f	Synthesis methods (Sensitivity analyses)	Not applicable
	14	Reporting bias assessment	Not assessed
	15	Certainty assessment	Not formally assessed
RESULTS	16a	Study selection (Search results)	Methods - Systematic Literature Review Protocol (Study Selection Process); Figure 3 (420 records identified; 110 duplicates removed; 310 screened; 95 full-text assessed; 79 included)
	16b	Study selection (Excluded studies)	Results - Study Selection Process (3 studies excluded for insufficient methodological detail or relevance)
	17	Study characteristics	Results - Use-Report Distribution and Cultural Salience; Table 2; Species-specific synthesis
	18	Risk of bias in studies	Not applicable
	19	Results of individual studies	Results - Narrative synthesis; Section 3.3 (Emic Illness Categories); Section 3.4 (Floristic Regionalization)
	20a	Synthesis results (Results of syntheses)	Results - Comparative synthesis; Section 3.7 (Synthesis and Implications)
	20b	Synthesis results (Statistical syntheses)	Not applicable
	20c	Synthesis results (Heterogeneity exploration)	Results - Interpretive Synthesis of Climate-Phytochemistry Relationships (Section 2.5.3)
	20d	Synthesis results (Sensitivity analyses)	Not applicable
	21	Reporting biases	Not assessed
	22	Certainty of evidence	Not assessed
DISCUSSION	23a	Discussion (Interpretation)	Discussion (Section 3.1 - 3.8)
	23b	Discussion (Evidence limitations)	Discussion (Section 3.7 Synthesis and Implications)
	23c	Discussion (Review limitations)	Methods (Section 2.5); Discussion (Section 3.7)
	23d	Discussion (Implications)	Discussion and Conclusion (Section 4)
OTHER INFORMATION	24a	Registration	Not registered
	24b	Protocol	Protocol detailed in Methods (Section 2.5), but not pre-registered externally
	24c	Amendments	Not applicable
	25	Support	Not reported in text (implied institutional support)
	26	Competing interests	Declarations section
	27	Data availability	Supplementary Materials (Supplementary File 2)

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