Linking ethnobotanical knowledge with phytochemical diversity: an integrated assessment of medicinal plants in the Boysun Botanical-Geographical Region (Southern Uzbekistan)

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Research

Abstract

Background: Medicinal plants play a fundamental role in traditional healthcare systems, particularly in regions with high floristic diversity such as Central Asia. However, their ethnobotanical importance is often evaluated using fragmented or single-parameter approaches, which do not fully capture their multifunctional and ecological significance. Therefore, integrated assessment frameworks are required to provide a more comprehensive evaluation of medicinal plant resources.

Methods: Floristic data were collected through field studies conducted in the Boysun Botanical-Geographical Region during 2011-2016 and supplemented by herbarium and literature sources, whereas ethnobotanical data were obtained through semi-structured interviews conducted in Machay and Qizilnaur villages during 2021-2024. A total of 265 medicinal plant species were identified, of which 78 species were selected for detailed ethnobotanical evaluation. An integrated Ethnobotanical Value Index (EVI) was applied, incorporating five parameters: use diversity, phytochemical richness, diversity of utilized plant parts, diversity of preparation and application methods, and additional functional value. The five EVI components were evaluated using predefined scoring criteria, and the phytochemical component was quantified according to the number of documented major phytochemical classes reported in the scientific literature.

Results: The recalculated EVI values revealed clear variation in ethnobotanical importance among species. Of the 78 species evaluated, 16 (20.5%) were classified as having low ethnobotanical value, 32 (41.0%) as having medium value, and 30 (38.5%) as having high value. High-EVI species were characterized by diverse medicinal uses, documented phytochemical richness, multiple utilized plant parts, varied preparation methods, and additional functional values. All 30 species classified as having high ethnobotanical value (EVI ≥ 3.0) were retained for detailed presentation and represent priority candidates for further pharmacological and phytochemical investigation.

Conclusions: The integrated EVI approach enabled comparative assessment of the ethnobotanical importance of medicinal plants in the Boysun region. The findings identify species of high ethnobotanical value that warrant further pharmacological and phytochemical investigation and, when considered together with existing national conservation assessments, may contribute to future strategies for the sustainable use and conservation of medicinal plant resources.

Keywords: medicinal plants; ethnobotany; Ethnobotanical Value Index (EVI); integrated assessment; Boysun region; biodiversity; traditional medicine

Background

In recent decades, the use of medicinal plants and their role within traditional knowledge systems have become a major focus of the global scientific community (Heinrich *et al.* 2020; WHO, 2013). According to the World Health Organization, a substantial proportion of the world's population continues to rely on plant-based remedies for primary healthcare (WHO, 2013). This has increased the importance of ethnobotanical research not only for preserving cultural heritage, but also for identifying new bioactive compounds and pharmacological resources (Fabricant & Farnsworth, 2001; Heinrich *et al.* 2020).

At the global scale, particularly in Brazil, India, and African regions, numerous studies have demonstrated a significant relationship between the ethnobotanical use of medicinal plants and their phytochemical composition (Albuquerque *et al.* 2014; Pandey *et al.* 2013). Many investigations have shown that bioactive compounds such as flavonoids, alkaloids, and terpenoids are closely associated with traditional therapeutic applications (Rates, 2001; Veeresham, 2012). However, in Central Asia, such integrated approaches remain insufficiently developed, and existing studies are often descriptive in nature and rarely supported by robust quantitative analyses (Khojimatov *et al.* 2025; Kosimov *et al.* 2026b; Tojibaev *et al.* 2022).

Central Asia, and Uzbekistan in particular, is distinguished by remarkable floristic richness and a unique biogeographical position (Takhtajan, 1986; Tojibaev *et al.* 2022). This region represents a transitional zone where Palearctic and ancient Mediterranean floristic elements intersect (Takhtajan, 1986). Despite this, the relationship between ethnobotanical knowledge and phytochemical diversity has not been systematically investigated in the region, representing a clear gap in the global scientific literature (Kosimov *et al.* 2026b).

The Boysun Botanical-Geographical Region is one of the most complex and ecologically rich territories of southern Uzbekistan (Turginov, 2017). It is characterized by a highly heterogeneous relief, pronounced altitudinal zonation, and diverse microclimatic conditions (Kamelin, 1990). As a result, the region supports exceptionally high plant diversity. At the same time, local communities have preserved ethnobotanical knowledge developed over centuries, including extensive experience in the use of wild medicinal plants (Khojimatov *et al.* 2025; Kosimov *et al.* 2026b). Nevertheless, this knowledge has not yet been adequately assessed using a systematic and quantitative framework.

Most previous studies in the region have been limited to floristic inventories or isolated ethnobotanical observations, while integrated approaches necessary for evaluating the relative importance of medicinal plants and their pharmacological potential remain insufficiently applied. In particular, studies that comprehensively examine the relationship between traditional use and phytochemical composition are still very limited (Heinrich *et al.* 2020).

The present study was designed to address this scientific gap by providing an integrated assessment of the floristic diversity, ethnobotanical use, and phytochemical composition of medicinal plants in the Boysun Botanical-Geographical Region. Of the 265 medicinal plant species recorded in the region, 78 ethnobotanically important species were selected for detailed analysis. These species were evaluated in terms of their use spectrum, traditional application patterns, and principal phytochemical components using an integrated analytical approach.

To assess the relative importance of medicinal plants, the Ethnobotanical Value Index (EVI) framework previously introduced and applied by Kosimov *et al. (*2026a) was used. The EVI builds on the broader tradition of quantitative ethnobotanical assessment represented by established approaches such as those of Phillips &and Gentry (1993) and Tardío & Pardo-de-Santayana (2008), while integrating multiple dimensions of medicinal plant importance into a single comparative framework.

Accordingly, this study aimed to: (i) compile and characterize the medicinal plant diversity of the Boysun Botanical-Geographical Region; (ii) document traditional uses and evaluate the ethnobotanical importance of selected medicinal species using the Ethnobotanical Value Index (EVI); (iii) summarize the major groups of biologically active compounds reported for these species based on published scientific literature; (iv) identify species of potential pharmacological interest by integrating ethnobotanical importance with literature-based phytochemical information; and (v) identify medicinal plant species requiring conservation attention based on the most recent national assessment of threatened vascular plants of Uzbekistan.

Materials and Methods

Research area

The study was conducted in the Boysun Botanical-Geographical Region, located in southern Uzbekistan. According to the botanical-geographical regionalization of Uzbekistan proposed by Tojibaev *et al.* (2016), the Boysun (Baysun) district (I-6-c) belongs to the Western Hissar region of the Central Asian Mountain Province (Figure 1).

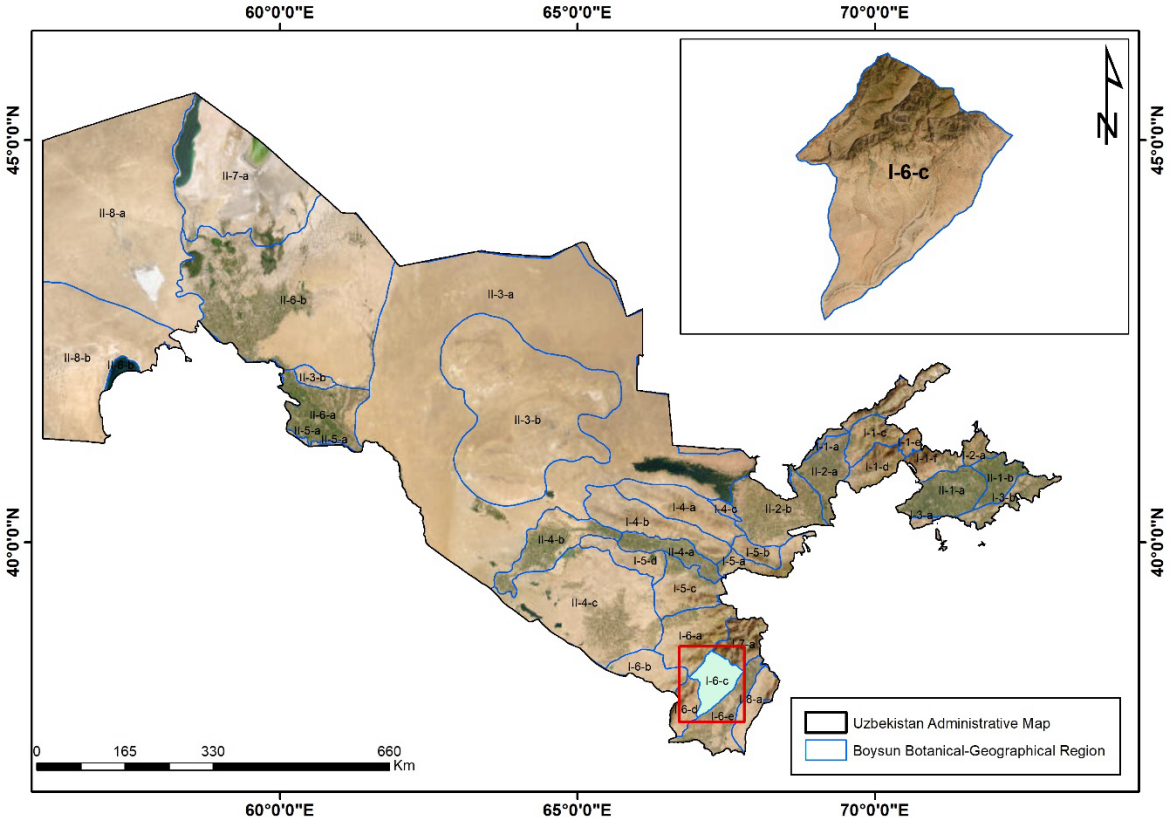


Figure 1. Location of the Boysun Botanical-Geographical Region in southern Uzbekistan and its biogeographical classification.

The Boysun region is characterized by a complex geomorphological structure, a sharply continental climate, and well-defined altitudinal gradients. It represents a transitional zone between the Turan lowlands and the mountainous floristic elements of Central Asia, which contributes to its high floristic diversity.

Based on ecological conditions and altitudinal variation, the study area was divided into four main zones:

1. Lower (semi-desert) zone
2. Foothill zone
3. Middle mountain zone
4. High mountain zone

This zonation framework was used as a basis for analyzing the ecological distribution of plant species and assessing their spatial patterns across the study area.

Floristic data collection

Floristic data were compiled based on field investigations conducted in the Boysun Botanical-Geographical Region during 2011-2016, as well as data obtained within the framework of the research project A-FA-2021-144 (2021-2024), entitled "Creation of an electronic depository of medicinal and endangered plant species used in traditional medicine of Uzbekistan." The dataset was assembled using multiple complementary sources:

1. Results of field surveys and floristic inventories carried out in the Boysun region (2011-2016);
2. Analysis of herbarium specimens preserved in the Central Herbarium (TASH) of the Institute of Botany, Academy of Sciences of Uzbekistan;
3. Data derived from scientific literature, floristic monographs, and taxonomic identification keys;
4. Digitized datasets and systematized resources developed within the A-FA-2021-144 research project.

Taxonomic identification and classification were performed according to the system of A.L. Takhtajan, ensuring consistency with internationally recognized floristic standards.

The reliability of the data was ensured through cross-validation of field observations, herbarium materials, and literature sources, as well as verification against the electronic database developed within the framework of the research project.

Ethnobotanical data collection

Ethnobotanical data were collected during 2021-2024 through semi-structured interviews conducted with local inhabitants of Machay and Qizilnaur villages in the Boysun Botanical-Geographical Region. A total of 19 informants were interviewed, with an average age of 57 years; seven of them were women. The majority of respondents were shepherds and elderly individuals possessing extensive traditional knowledge of medicinal plants. Informants were selected based on their practical experience and knowledge of locally used medicinal plants, with particular emphasis on individuals recognized within their communities as knowledgeable about traditional plant use. All interviews were conducted in the Uzbek language. Prior to each interview, the purpose of the study was explained to the participant, and oral informed consent was obtained before any ethnobotanical information was recorded. Participation was voluntary, and the information obtained from the informants was used in aggregated and anonymized form.

For each medicinal plant species, the following information was systematically recorded:

1. plant parts used;
2. therapeutic applications (disease categories);
3. methods of preparation;
4. frequency of use.

A total of 78 medicinal plant species were documented with complete ethnobotanical information and included in the subsequent analyses.

Ethnobotanical indices

To evaluate the relative importance of medicinal plants, the Ethnobotanical Value Index (EVI) was applied following the integrated framework previously used by Kosimov *et al.* (2026a). The index combines five dimensions: diversity of medicinal uses (U), literature-based phytochemical richness (C), diversity of utilized plant parts (P), diversity of preparation and application methods (R), and additional functional value (A), thereby providing a multidimensional comparative measure of ethnobotanical importance.

Each EVI component was evaluated using predefined ordinal scoring criteria. The Ethnobotanical Value Index (EVI) was calculated from the component scores according to the following formula:

$$EVI = (U + C + P + R + A) / n$$

where U represents use diversity, C represents phytochemical richness, P represents the diversity of utilized plant parts, R represents the diversity of preparation and application methods, A represents additional functional value, and n denotes the number of parameters included in the index (n = 5).

The EVI framework followed the integrated approach previously applied by Kosimov *et al.* (2026a). Use diversity (U) represented the diversity of documented medicinal-use categories; chemical composition richness (C) represented the diversity of major groups of biologically active compounds reported for each species; utilized plant parts (P) represented the diversity of plant organs used; preparation and application methods (R) represented the diversity of documented preparation and administration methods; and additional functional value (A) represented non-medicinal uses, including nutritional, cosmetic, preventive, economic, and household applications. The final EVI was calculated as the arithmetic mean of the five component scores.

To ensure reproducibility, all EVI components were evaluated using predefined scoring criteria. Use diversity (U) was scored according to the number of documented therapeutic domains: one domain = 1, two domains = 2, three domains = 3, four-five domains = 4, and six or more domains = 5. The phytochemical richness component (C) was quantified according to the number of major phytochemical classes documented for each species in the published scientific literature. Species with 0-1 documented phytochemical classes received a score of 1, those with 2-3 classes a score of 2, those with 4-5 classes a score of 3, those with 6-7 classes a score of 4, and those with eight or more classes a score of 5. Only explicitly reported phytochemical classes were counted, thereby replacing the previous qualitative categories with a transparent and reproducible quantitative criterion. Diversity of utilized plant parts (P) was scored as 1 for one plant part, 2 for two plant parts, and 3 for three or more plant parts or use of the whole plant. Preparation diversity (R) was scored as 1 when no specific preparation was documented, 2 for a single preparation method, and 3 for multiple preparation methods. Additional functional value (A) was scored as 1 when no additional functional use was documented (or only a cautionary note was available), 2 for a general additional-use indication, and 3 when one or more clearly documented functional values beyond medicinal use were recorded. The final EVI was calculated from the five component scores using the formula presented above.

For interpretation, species were classified into three ethnobotanical value categories based on their final EVI scores: low value (EVI < 2.0), medium value (EVI = 2.0-2.99), and high value (EVI ≥ 3.0). These thresholds were used as operational categories for comparative analysis within the present dataset.

Species were ranked according to their final EVI scores. Because several species had identical EVI values at the upper-value boundary, no arbitrary secondary tie-breaking criterion was applied. Therefore, all species classified as high ethnobotanical value (EVI ≥ 3.0) were retained for detailed presentation.

Literature-based phytochemical assessment

Phytochemical information for the selected medicinal plant species was compiled exclusively from published scientific literature; no laboratory-based phytochemical analyses were performed as part of the present study. Information on the major groups of biologically active compounds reported for each species was collected from relevant peer-reviewed publications and used for comparative assessment within the EVI framework. Therefore, the phytochemical component of this study represents a literature-based synthesis rather than experimental chemical profiling of plant material collected in the Boysun region.

For each species, the major phytochemical classes explicitly reported in the consulted literature were recorded and counted. These counts formed the quantitative basis of the C component of the EVI. The literature source(s) supporting the phytochemical information and the resulting component score for each species are provided in Supplementary Table S1, allowing independent verification and replication of the assessment.

Conservation status assessment

The conservation status of the medicinal plant species was verified using the most recent national assessment of threatened vascular plants of Uzbekistan (Shomurodov *et al.* 2026), in which the national threatened flora was reassessed according to the IUCN Red List Categories and Criteria (version 3.1). Species included in the present dataset were cross-checked against this updated national assessment to identify taxa of conservation concern. No independent IUCN Red List assessment was conducted as part of the present study.

Data analysis

The collected data were analyzed using an integrated approach encompassing floristic, ecological, ethnobotanical, and phytochemical perspectives. Floristic analysis was conducted at the levels of families and genera to assess taxonomic structure. Ecological analysis focused on species distribution across different altitudinal zones. Ethnobotanical analysis was performed based on disease categories to evaluate patterns of traditional plant use. Literature-based phytochemical information was comparatively assessed by classifying the selected species according to the major groups of bioactive compounds reported in published scientific sources. The results were presented using tables and graphical representations to facilitate interpretation and comparison.

Results

Ethnobotanical evaluation of medicinal plants in the Boysun Botanical-Geographical Region

Floristic investigations and the integration of field, herbarium, and literature data resulted in a checklist of 1,564 vascular plant species for the Boysun Botanical-Geographical Region. Of these, 265 species were identified as medicinal plants, and 78 species with complete ethnobotanical information were included in the detailed EVI-based evaluation. The selected taxa represented diverse systematic groups, with Asteraceae being the most represented family, followed by Lamiaceae, while Apiaceae, Brassicaceae, Malvaceae, and Polygonaceae were also well represented. This pattern reflects the high floristic diversity of the region and the broad taxonomic spectrum of its medicinal plant resources.

To assess the relative ethnobotanical importance of these species, the Ethnobotanical Value Index (EVI) was calculated using an integrated approach. This index enables a comprehensive evaluation by incorporating multiple parameters, including diversity of use (U), phytochemical richness (C), plant parts utilized (P), methods of preparation and application (R), and additional functional significance (A).

Classification of species based on EVI values

Based on the calculated EVI values, all recorded species were classified into three main categories: low ethnobotanical importance (EVI < 2.0), medium importance (EVI = 2.0-2.99), and high ethnobotanical importance (EVI ≥ 3.0).

The distribution of the recalculated EVI values showed clear variation among the analyzed species. Of the 78 species, 16 (20.5%) were classified as having low ethnobotanical importance, 32 (41.0%) as having medium importance, and 30 (38.5%) as having high importance (Figure 2). Thus, medium- and high-value species constituted the majority of the analyzed medicinal plants.

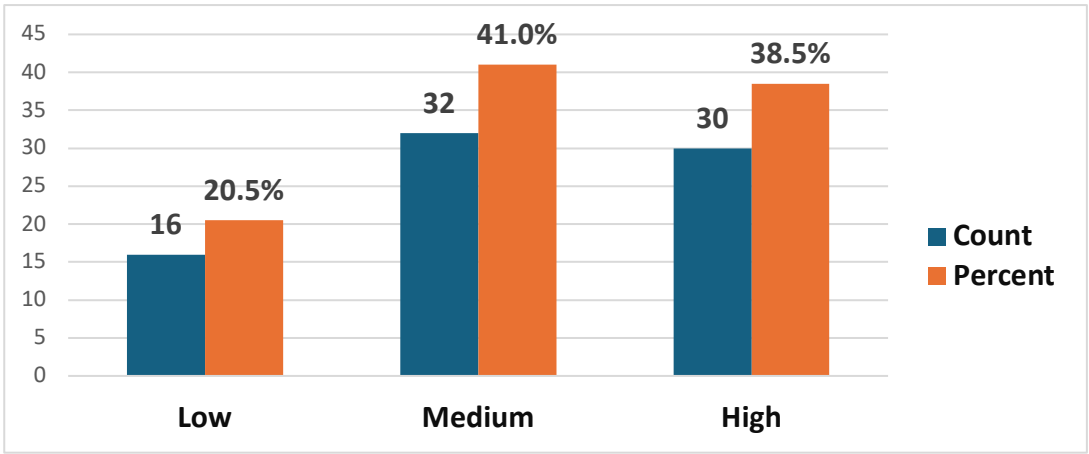


Figure 2. Distribution of the 78 medicinal plant species among Ethnobotanical Value Index (EVI) categories after recalculation using the revised quantitative phytochemical scoring criterion. Categories: Low (EVI < 2.0), Medium (EVI = 2.0-2.99), and High (EVI ≥ 3.0).

Species with high ethnobotanical value (EVI ≥ 3.0)

Based on the recalculated EVI values, 30 medicinal plant species were classified as having high ethnobotanical importance (EVI ≥ 3.0) and are presented in Table 1. These species showed comparatively high scores across one or more EVI components, reflecting broad medicinal-use diversity, documented phytochemical richness, diversity of utilized plant parts, preparation methods, and/or additional functional values (Table 1). These species are characterized by a high diversity of medicinal uses, multifunctional applications, and high scores across several EVI components.

Species included in this group exhibit several common features. They are typically used for the treatment of multiple disease categories, involve the utilization of different plant parts (such as roots, leaves, flowers, and fruits), and are prepared using diverse methods, including infusions, decoctions, powders, and other traditional formulations. In addition to their medicinal applications, many of these species are also used for nutritional, preventive, or other purposes.

Therefore, these taxa can be regarded as priority ethnobotanical resources of the region and represent promising candidates for further pharmacological and phytochemical investigations.

Conservation status of the analyzed medicinal plants

Cross-referencing all 78 medicinal plant species analyzed in this study with the most recent national assessment of threatened vascular plants of Uzbekistan (Shomurodov *et al.* 2026) identified one species of current national conservation concern. *Colchicum kesselringii* Regel, which had a high ethnobotanical value in the present assessment (EVI = 3.4), is classified as Vulnerable (VU) under criteria B2b(ii,iii,iv,v); C1. Under the scientific names used in the present dataset, no other analyzed species matched the current list of 317 taxa proposed for the updated National Red Data Book. Notably, *Allium suworowii* Regel (EVI = 3.2) was reported by Shomurodov *et al.* (2026) among taxa previously excluded from the national threatened-species list following evidence of population increase and expansion of its distribution range. Thus, *C. kesselringii* represents the principal conservation-priority species identified among the 78 medicinal plants assessed in the present study.

Structural characteristics of ethnobotanical resources

The analysis of ethnobotanical resources revealed distinct structural patterns in the functional significance of medicinal plant species in the Boysun Botanical-Geographical Region. Species with high EVI values were generally characterized by greater diversity of medicinal uses, richer literature-reported phytochemical information, use of multiple plant parts, diverse preparation methods, and additional functional values. In contrast, species with low EVI values tended to have more limited documented uses and lower scores across several EVI components. This differentiation reflects variation in the multidimensional ethnobotanical importance of the analyzed taxa.

Furthermore, the distribution of medicinal plant species across taxonomic families showed that Asteraceae was the most represented family, followed by Lamiaceae, while Apiaceae, Brassicaceae, Malvaceae, and Polygonaceae were also well represented (Figure 3).

Overall, these findings indicate a structured but broadly distributed ethnobotanical system in the region, in which a substantial proportion of the analyzed species exhibit medium to high functional importance within traditional medicinal practices.

Table 1. Medicinal plant species classified as having high ethnobotanical value (EVI ≥ 3.0) in the Boysun Botanical-Geographical Region based on recalculated EVI values

Voucher number	Species (Scientific name)	Family	Local name	Parts used	EVI value	U	C	P	R	A	Main medicinal uses
O'ETB86	*Capparis spinosa* L.	Capparaceae	Tikanli kovar, kovul	Root bark, flowers, buds, fruits, roots	3.8	5	5	3	3	3	Rheumatism, liver and spleen disorders, toothache, wounds, diabetes
O'ETB148	*Althaea officinalis* L.	Malvaceae	Dorivor gulxayri	Roots, flowers, leaves	3.6	5	5	3	2	3	Respiratory disorders, cough, gastritis, gastric ulcer, colitis, diarrhea
O'ETB54	*Artemisia scoparia* Waldst. & Kit.	Asteraceae	Supurgi shuvoq, burgan	Aerial parts (leaves and flowering parts)	3.4	5	4	3	2	3	Menstrual disorders, gallbladder disorders, digestive problems, cough, rheumatism
O'ETB212	*Urtica dioica* L.	Urticaceae	Ikkiuyli gazandao't	Aerial parts, leaves	3.6	5	5	2	3	3	Hemorrhage, anemia, rheumatism, urinary disorders, liver and skin diseases
O'ETB90	*Colchicum kesselringii* Regel	Colchicaceae	Kesselring savrinjoni	Corms, seeds, flowers	3.4	4	4	3	3	3	Gout, rheumatism, neuralgia, liver and spleen disorders
O'ETB28	*Ferula moschata* (H.Reinsch) Koso-Pol.	Apiaceae	Sumbul	Roots, rhizomes, leaves, bark, flowers	3.4	5	3	3	3	3	Liver disorders, gastralgia, bronchial asthma, neurosis, fever
O'ETB283	*Glycyrrhiza glabra* L.	Fabaceae	Yalong'och shirinmiya	Roots, aerial parts	3.4	5	5	2	2	3	Cough and pulmonary disorders, gastritis, gastric and duodenal ulcers
O'ETB312	*Malva nicaeensis* All.	Malvaceae	Nitsa tugmachaguli	All parts	3.4	5	5	3	3	1	Respiratory disorders, cough, gastrointestinal disorders, cystitis, wounds and burns
O'ETB173	*Plantago lanceolata* L.	Plantaginaceae	Mixchup	Leaves, seeds, roots	3.4	5	5	3	3	1	Cough, bronchitis, asthma, gastrointestinal disorders, wounds
O'ETB171	*Plantago major* L.	Plantaginaceae	Katta zubturum	Leaves	3.4	5	5	1	3	3	Bronchitis, asthma, gastric disorders, wounds, inflammatory conditions
O'ETB330	*Rosa canina* L.	Rosaceae	Itburun na'matak	Fruits, less frequently roots and flowers	3.4	5	5	3	3	1	Cough, colds, pneumonia, bronchopneumonia, loss of appetite
O'ETB49	*Achillea millefolium* L.	Asteraceae	Oddiy bo'ymodaron	Inflorescences, aerial parts	3.2	4	4	2	3	3	Gastrointestinal disorders, gastric ulcer, gastritis, inflammation and bleeding
O'ETB16	*Allium suworowii* Regel	Amaryllidaceae	Suvorov piyozi	Bulbs and young leaves	3.2	4	4	2	3	3	Respiratory disorders, hypertension, impaired circulation, bone and skin disorders
O'ETB103	*Hippophae rhamnoides* L.	Elaeagnaceae	Chakanda	Fruits, leaves	3.2	5	4	2	3	2	Wounds, inflammation, tissue regeneration and vitamin deficiency

O‘ETB336	*Rubus caesius* L.	Rosaceae	Ko‘kimtir maymunjon	Fruits, leaves	3.2	5	5	2	3	1	Inflammation, bleeding, fever, wounds and urinary disorders
O‘ETB325	*Rumex crispus* L.	Polygonaceae	Jingalak otquloq	Roots, leaves, seeds	3.2	5	4	3	2	2	Gastrointestinal disorders, inflammation, constipation and hepatobiliary disorders
O‘ETB72	*Tussilago farfara* L.	Asteraceae	Oddiy oqqaldirmoq	Aerial and underground parts	3.2	3	5	2	3	3	Bronchitis, laryngitis, bronchiectasis, cough and respiratory disorders
O‘ETB317	*Abutilon theophrasti* Medik.	Malvaceae	G‘o‘zor	All parts	3.0	5	5	3	1	1	Colds, cough, digestive disorders and other traditional medicinal uses
O‘ETB50	*Achillea filipendulina* Lam.	Asteraceae	Tobulg‘ibargli bo‘ymodaron, dastarbosh	Aerial parts	3.0	5	3	1	3	3	Heart and gastric disorders, cholecystitis, cholangitis, insomnia and urinary disorders
O‘ETB79	*Capsella bursa-pastoris* (L.) Medik.	Brassicaceae	Oddiy jag‘jag‘, achambiti	Aerial and underground parts, seeds	3.0	4	4	3	3	1	Uterine bleeding, gynecological disorders and pulmonary bleeding
O‘ETB207	*Datura stramonium* L.	Solanaceae	Bangidevona	All parts	3.0	5	3	3	3	1	Spasmodic cough, bronchial spasms and respiratory disorders
O‘ETB320	*Epilobium hirsutum* L.	Onagraceae	Qizilqon	All parts	3.0	4	5	3	2	1	Inflammation, wounds, bleeding, gastrointestinal complaints and sedative uses
O‘ETB107	*Equisetum arvense* L.	Equisetaceae	Dala qirqbo‘g‘imi	Aerial parts	3.0	5	5	1	3	1	Edema, urinary tract disorders, urinary stones, uterine and hemorrhoidal bleeding
O‘ETB300	*Lagochilus seravschanicus* Knorring	Lamiaceae	Bozulbang	Aerial parts	3.0	5	5	1	3	1	Hypertension, hepatitis, cholecystitis, urinary disorders, respiratory and gastrointestinal diseases
O‘ETB127	*Leonurus turkestanicus* V.I. Krecz. & Kuprian.	Lamiaceae	Turkiston arslonqulog‘i	Upper aerial parts with stems	3.0	5	3	1	3	3	Cardiovascular disorders, hypertension, insomnia, cough, bronchitis and nervous disorders
O‘ETB314	*Malva sylvestris* L.	Malvaceae	O‘rmon tugmachaguli	All parts	3.0	5	4	3	2	1	Gastrointestinal, liver and respiratory disorders, bronchitis and gynecological conditions
O‘ETB301	*Marrubium anisodon* K.Koch	Lamiaceae	Dovol-tege	Aerial parts	3.0	5	5	1	3	1	Diarrhea, gastrointestinal disorders, internal bleeding, colds, epilepsy and nervous disorders
O‘ETB371	*Polygonum aviculare* L.	Polygonaceae	Qizil tariq	Tincture, extract	3.0	5	5	1	1	3	Kidney, liver, gastric and urinary disorders, tuberculosis, hemorrhoids and gout

O‘ETB69	*Silybum marianum* (L.) Gaertn.	Asteraceae	Qushqo‘nmas	Mature dried fruits, seeds, oil and roots	3.0	5	3	3	3	1	Hepatitis, cirrhosis, cholecystitis, gallstone disease and gastrointestinal disorders
O‘ETB71	*Taraxacum officinale* F.H.Wigg.	Asteraceae	Dorivor momoqaymoq	Flowers, roots and rhizomes	3.0	4	4	3	2	2	Digestive disorders, loss of appetite, cholecystitis, hepatobiliary disorders and constipation

Note: U = diversity of medicinal uses; C = literature-based phytochemical richness; P = diversity of utilized plant parts; R = diversity of preparation and application methods; A = additional functional value. The EVI values presented here were recalculated using the revised quantitative scoring criterion for the phytochemical component (C).

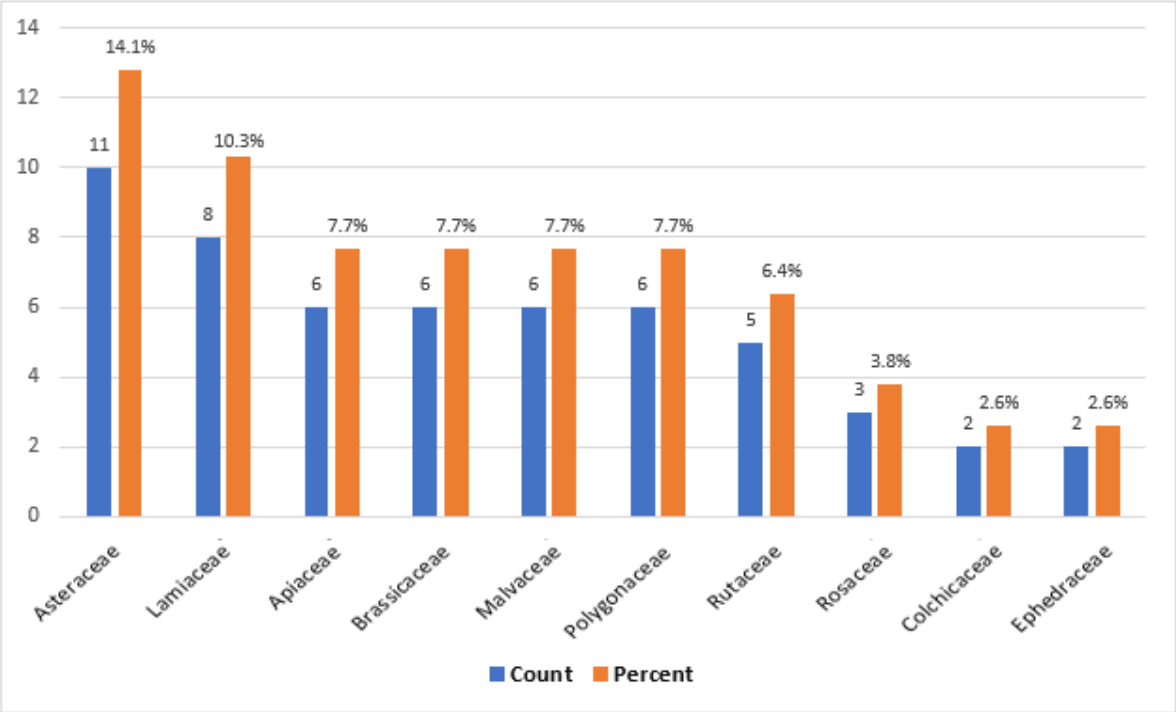


Figure 3. Distribution of medicinal plant species across plant families in the Boysun Botanical-Geographical Region.

The analysis showed that species with high EVI values generally combined multiple medicinal-use categories with greater documented phytochemical richness, use of several plant parts, diverse preparation and application methods, and/or additional functional values. In contrast, low-EVI species received lower scores across several of these predefined components. These patterns reflect the structure of the EVI framework and should therefore be interpreted as comparative differences within the present dataset.

Distribution of medicinal plant uses across disease categories

The analysis of ethnobotanical data revealed clear patterns in the use of medicinal plants across different disease categories in the Boysun Botanical-Geographical Region. The majority of plant-based remedies were associated with the treatment of gastrointestinal, respiratory, and inflammatory disorders, reflecting the primary health concerns of the local population.

A considerable proportion of species was also used for neurological and sedative purposes, as well as for the management of infectious and febrile conditions. These patterns indicate that traditional medicinal practices in the region are closely adapted to local environmental conditions, lifestyle factors, and prevailing health challenges (Figure 4).

The diversity of disease categories further demonstrates the multifunctional nature of medicinal plants, with many species being applied to treat multiple conditions. This highlights the flexibility and resilience of traditional knowledge systems, where plant resources are utilized in a broad and adaptive manner.

Overall, the distribution of medicinal plant uses across disease categories underscores the importance of ethnobotanical knowledge in supporting primary healthcare and maintaining community well-being in the region.

Distribution of ethnobotanical knowledge in the Boysun region

The results indicate that ethnobotanical knowledge in the Boysun region is highly diverse and distributed across a broad range of medicinal plant species. The predominance of medium- and high-EVI taxa (41.0% and 38.5%, respectively) indicates that ethnobotanical importance is not restricted to a small number of species. Instead, a substantial proportion of the analyzed flora has considerable functional importance within local traditional medicinal practices. This pattern reflects the diversity of therapeutic applications and the multifunctional use of medicinal plants documented in the region.

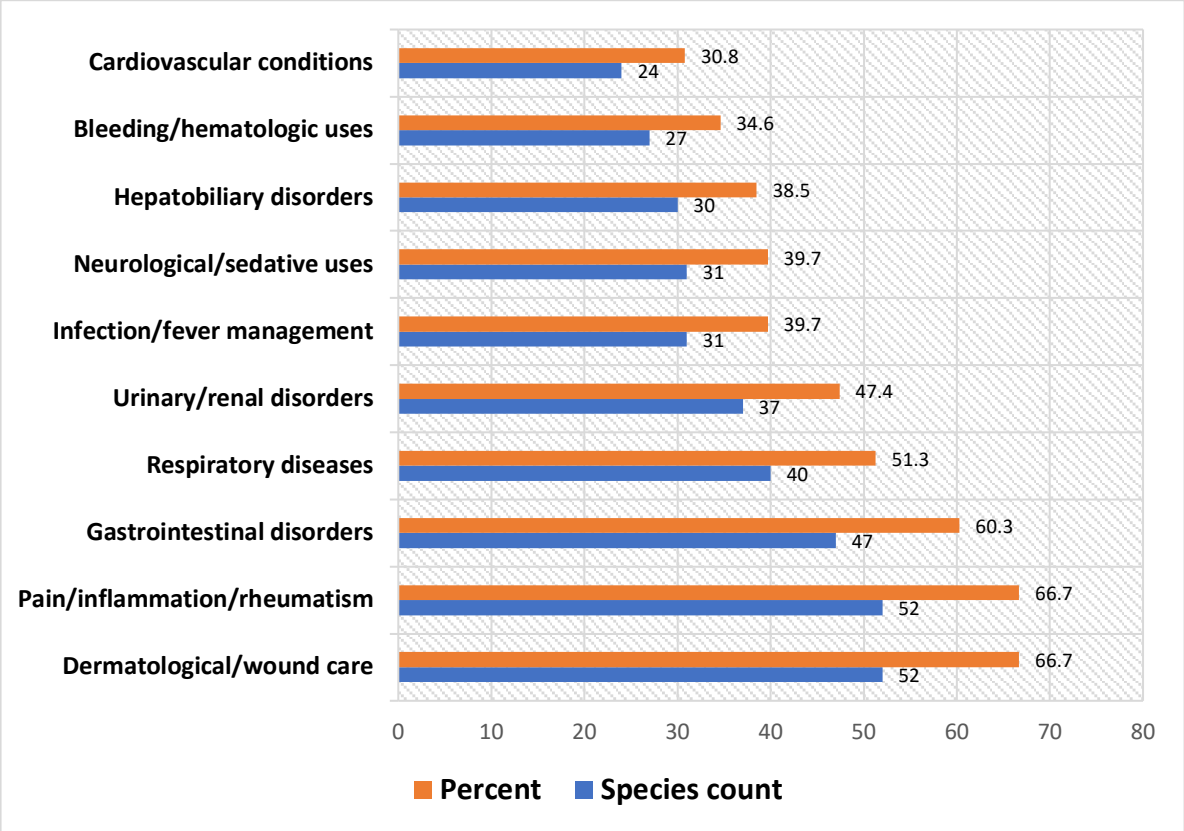


Figure 4. Distribution of medicinal plant uses across major disease categories in the Boysun Botanical-Geographical Region.

Discussion

The results of the present study demonstrate that ethnobotanical knowledge in the Boysun Botanical-Geographical Region is both rich and structurally complex, reflecting long-term interactions between local communities and plant resources. The application of the Ethnobotanical Value Index (EVI) revealed clear differentiation among species, indicating that traditional knowledge shows clear differentiation among taxa, with a substantial proportion of the analyzed species exhibiting medium to high ethnobotanical importance.

The distribution of the recalculated EVI categories showed that medium- and high-value species constituted the majority of the analyzed taxa, accounting for 41.0% and 38.5%, respectively, whereas 20.5% were classified as low-value species. This pattern indicates that traditional medicinal knowledge in the Boysun region encompasses a relatively broad spectrum of functionally important plants rather than being restricted to a small number of highly valued taxa. The substantial proportion of high-EVI species may reflect the diverse therapeutic applications, multiple plant parts used, varied preparation methods, and additional functional values documented for many species in the region.

Species with high EVI values, including *Capparis spinosa*, *Ferula moschata*, *Althaea officinalis*, and *Artemisia scoparia*, were characterized by broad documented therapeutic applications and relatively high scores across multiple EVI components. These taxa are characterized by multifunctionality, the use of multiple plant parts, and a wide range of preparation methods. Such features significantly contribute to their elevated ethnobotanical importance and highlight their potential as promising candidates for further pharmacological and phytochemical investigations.

The taxonomic distribution of the analyzed medicinal plants was characterized by the predominance of Asteraceae and Lamiaceae, with Apiaceae, Brassicaceae, Malvaceae, and Polygonaceae also well represented. These families are known for their high species richness and their abundance of bioactive compounds, including flavonoids, alkaloids, and essential oils. This observation suggests a strong relationship between floristic composition and ethnobotanical relevance.

The integration of ethnobotanical and phytochemical data provides deeper insight into the functional significance of medicinal plants. Species with high EVI values often correspond to those reported in the literature as rich sources of biologically active compounds, supporting the hypothesis that traditional knowledge systems are, to some extent, empirically

grounded in pharmacological efficacy (Heinrich *et al.* 2020; Rates, 2001). This reinforces the value of ethnobotanical approaches in the discovery of new therapeutic agents.

The distribution of medicinal plant uses across disease categories reflects the health priorities of the local population. The predominance of treatments related to gastrointestinal, respiratory, and inflammatory disorders indicates that traditional medicinal practices are closely adapted to local environmental conditions and lifestyle factors.

Comparison with ethnobotanical studies from other regions, including the Nuratau Mountain Range and the Middle Syrdarya floristic district, indicates that the structure of traditional plant knowledge may vary among regions depending on ecological conditions, floristic composition, and cultural traditions. In the present Boysun dataset, the relatively high proportions of both medium- and high-EVI species suggest a broad distribution of ethnobotanical importance across the analyzed medicinal flora. These findings emphasize the regional specificity of ethnobotanical knowledge and highlight the need for caution when directly generalizing patterns observed in one botanical-geographical region to another.

Despite these findings, several limitations should be acknowledged. The phytochemical analysis was primarily based on literature sources, which may not fully capture intraspecific variability in chemical composition across local populations. In addition, the ethnobotanical component was based on interviews with 19 informants. Although these informants possessed practical knowledge of locally used medicinal plants, the relatively small sample size limits the broader generalization of the ethnobotanical findings across the entire Boysun region. Ethnobotanical data collected through semi-structured interviews may also involve a degree of subjectivity. Future studies should therefore include a larger and more diverse group of informants and incorporate experimental phytochemical analyses to further validate and strengthen the present findings.

Overall, this study highlights the importance of integrating ethnobotanical knowledge with phytochemical data to better understand the functional roles of medicinal plants. The identification of species with high ethnobotanical value provides a scientific basis for their conservation, sustainable use, and further pharmacological exploration in the Boysun Botanical-Geographical Region.

The EVI results should also be interpreted in light of the methodological structure of the index. The index combines five predefined ordinal component scores to provide an integrated comparative measure of ethnobotanical importance rather than an absolute measure of cultural significance. In addition, the operational thresholds used to classify species into low-, medium-, and high-value categories were defined for comparative interpretation within the present dataset. Consequently, these categories should not be regarded as universal ethnobotanical thresholds. Future studies involving larger informant samples and application of the EVI framework in other regions would be useful for testing the robustness and broader applicability of the proposed classification.

From a conservation perspective, cross-referencing all 78 medicinal plant species with the most recent national assessment of threatened vascular plants of Uzbekistan identified *Colchicum kesselringii* as the only species currently included among the taxa proposed for the updated National Red Data Book (Shomurodov *et al.* 2026). The species is classified as Vulnerable (VU) and also showed a high ethnobotanical value in the present study (EVI = 3.4), highlighting an important intersection between traditional medicinal use and conservation concern. In contrast, *Allium suworowii*, which also had a high EVI (3.2), was reported as having been excluded from the national threatened-species list following evidence of population increase and range expansion. High ethnobotanical value should therefore not be interpreted as evidence of conservation risk in itself; rather, ethnobotanical importance and conservation status should be evaluated independently and then considered together. This distinction is particularly relevant for *C. kesselringii*, because collection from natural populations may represent an additional pressure on already vulnerable populations. Sustainable harvesting practices and continued population monitoring should therefore be prioritized for medicinal species in which high ethnobotanical importance coincides with recognized conservation concern.

Conclusion

This study provides an integrated assessment of medicinal plant diversity, traditional uses, and literature-based phytochemical information in the Boysun Botanical-Geographical Region. The EVI-based evaluation revealed a broad distribution of ethnobotanical importance across the analyzed medicinal flora, with medium- and high-value species accounting for 41.0% and 38.5% of the dataset, respectively. These findings indicate that traditional medicinal knowledge in the region is associated with a diverse range of functionally important plant species rather than being concentrated within a limited group of taxa.

The EVI provided a structured comparative framework for identifying priority species and assessing their relative importance within the analyzed dataset. High-value taxa were characterized by multifunctional medicinal uses, diverse utilized plant parts, varied preparation methods, and additional functional values, highlighting their potential for further pharmacological and phytochemical research.

The integration of ethnobotanical data with literature-based phytochemical information indicated that several highly valued medicinal species are also reported in the scientific literature to contain diverse groups of biologically active compounds, supporting the relevance of ethnobotanical approaches in the search for new therapeutic agents. Furthermore, the distribution of plant uses across disease categories reflects the adaptation of traditional knowledge to local environmental conditions and health needs.

Overall, the findings of this study provide a scientific basis for the conservation and sustainable use of medicinal plant resources in the Boysun region. The identification of key ethnobotanical species contributes to the development of evidence-based strategies for biodiversity management, as well as to future pharmacological exploration and the preservation of traditional knowledge systems.

Declarations

Ethics approval and consent to participate: Formal ethics committee approval was not obtained for this study. Prior to each interview, the purpose of the research was explained to the participants, and oral informed consent was obtained before any ethnobotanical information was recorded. Participation was voluntary, and all information obtained from the informants was analyzed and reported in aggregated and anonymized form.

Consent for publication: Not applicable.

Availability of data and materials: The ethnobotanical data supporting the findings of this study are stored by the authors and are available upon reasonable request.

Competing interests: The authors declare that they have no competing interests.

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Author contributions: All authors contributed to the study conception and design. Data collection and analysis were performed collaboratively, and all authors participated in manuscript preparation. D.M.A. contributed to medical validation of the documented traditional therapeutic uses of the medicinal plant species, verification of disease categories and medical terminology, clinical interpretation and clarification of ethnobotanical information, and critical review and editing of the revised manuscript. H.I.M. contributed to independent medical verification of the reported therapeutic applications of the medicinal plant species, assessment of the accuracy and consistency of clinical terminology and therapeutic indications, validation of medical content during manuscript revision, and critical review and editing of the revised and final versions of the manuscript. All authors read and approved the final version of the manuscript.

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