Ethnobotanical assessment of medicinal plants in the ecosystems of the Nurata Range, using an integrated approach

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Research

Abstract

Background: Medicinal plants play an essential role in traditional healthcare systems; however, their ethnobotanical importance is often assessed using single-parameter approaches that do not fully reflect their multifunctional value. Integrated evaluation frameworks are therefore required to provide a more comprehensive assessment of medicinal plant resources at the regional scale.

Methods: Ethnobotanical data were obtained from an original database comprising 374 medicinal plant species traditionally used in Uzbekistan. Based on clearly defined selection criteria, 110 species directly associated with the ecosystems of the Nurata Range were selected for analysis. An integrated Ethnobotanical Value Index (EVI) was applied, incorporating five parameters: use diversity, chemical composition richness, diversity of utilized plant parts, diversity of preparation and application methods, and additional functional value. All parameters were standardized and equally weighted.

Results: The calculated EVI values revealed a clear differentiation in ethnobotanical importance among the studied species. Twelve species (11%) were classified as low-value, 46 species (42%) as medium-value, and 52 species (47%) as high-value medicinal plants. Species with high EVI values were characterized by broad use diversity, functional versatility, and high practical adaptability. Based on EVI rankings, the top 20 medicinal plant species were identified as priority ethnobotanical resources in the Nurata Range.

Conclusions: The results demonstrate that the integrated ethnobotanical evaluation approach is effective for assessing medicinal plant importance at the regional level. This framework enables the identification of both widely used and less-studied species with high applied potential and provides a solid methodological basis for conservation prioritization, sustainable use of medicinal plant resources, and future comparative ethnobotanical studies.

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

Background

Medicinal plants have played a fundamental role in human healthcare since the earliest stages of civilization, serving as primary resources for disease prevention and treatment. Across different regions of the world, traditional medical systems have largely relied on natural plant resources, with ethnomedicinal knowledge transmitted across generations through oral traditions and practical experience (Kosimov *et al.* 2023). With the advancement of modern science, the documentation, systematization, and scientific evaluation of such traditional knowledge have become central objectives of ethnobotanical research (Bussmann *et al.* 2016).

In recent decades, increasing global concerns related to biodiversity loss (Orsenigo et al. 2022, 2025, Fenu et al. 2025, Shomurodov & Khabibullaev 2022), ecosystem degradation, and the rapid erosion of traditional knowledge have significantly intensified scientific interest in medicinal plants. A substantial proportion of the world's population continues to depend on plant-based remedies for primary healthcare, and many modern pharmaceutical products are derived directly or indirectly from natural plant sources (Bussmann & Revene 2007; Khojimatov *et al.* 2025). In particular, medicinal plants actively used by local communities but insufficiently assessed from a scientific perspective are increasingly recognized as valuable ecological, cultural, and socio-economic resources (Khojimatov & Bussmann 2020).

Most ethnobotanical studies evaluate the importance of medicinal plants using individual quantitative indices or isolated indicators. Although such approaches provide insights into specific aspects of plant use, they often fail to capture the multidimensional functional value of medicinal species (Tayjanov *et al.* 2021). A comprehensive understanding of ethnobotanical importance requires the simultaneous consideration of multiple parameters, including chemical composition, diversity of utilized plant parts, preparation and application methods, and additional functional roles such as nutritional or cosmetic value. Consequently, integrated evaluation approaches that combine several ethnobotanical indicators have gained increasing attention in recent years (Kosimov *et al.* 2025).

The Nurata Range represents one of the most important natural-geographical and ecological regions of Uzbekistan, characterized by the convergence of diverse ecosystems (Kamelin 1973, Beshko et al. 2025). The presence of foothill plains, semi-arid uplands, and low-mountain ecosystems has facilitated the development of a rich and heterogeneous assemblage of medicinal plant species. Moreover, traditional knowledge related to the use of medicinal plants has been relatively well preserved among local communities inhabiting the Nurata Range, making this region a particularly valuable field laboratory for ethnobotanical research (Zakirov 1974).

Despite this significance, ethnobotanical resources of medicinal plants in the ecosystems of the Nurata Range have predominantly been studied at a descriptive level. Comprehensive assessments aimed at determining relative ethnobotanical importance, identifying priority species, and conducting regionally comparative analyses remain limited. In particular, the application of integrated, multi-parameter evaluation frameworks to assess the ethnobotanical value of medicinal plants at the regional scale has been insufficiently explored.

These considerations highlight the necessity of investigating the ethnobotanical importance of medicinal plants in the Nurata Range using an integrated evaluation approach. Such studies not only provide a scientific basis for assessing regional ethnobotanical resources but also support their conservation and sustainable use, while establishing a methodological framework for comparative analyses across different regions and mountain systems.

Materials and Methods

Research area

Field studies were conducted in the Nurata Range, located in the central part of Uzbekistan (Figure 1). Geographically, the Nurata Range is situated between the Kyzylkum Desert and the Zarafshan Valley and is characterized by a high diversity of natural and geographical conditions (Zakirov, 1971). This mountain system integrates a complex of landscapes and ecosystems typical of foothill and low-mountain regions of Central Asia (Geographical Atlas of Uzbekistan, 2012).

The relief of the study area comprises foothill plains, undulating uplands, and low-mountain massifs, where altitudinal gradients play a crucial role in shaping ecosystem structure and vegetation patterns. The climate is sharply continental, characterized by high temperatures and pronounced aridity during summer, and relatively cold winters with limited precipitation. These climatic conditions favor the widespread development of xerophytic and mesoxerophytic plant species typical of mountain and foothill ecosystems (Zakirov 1969).

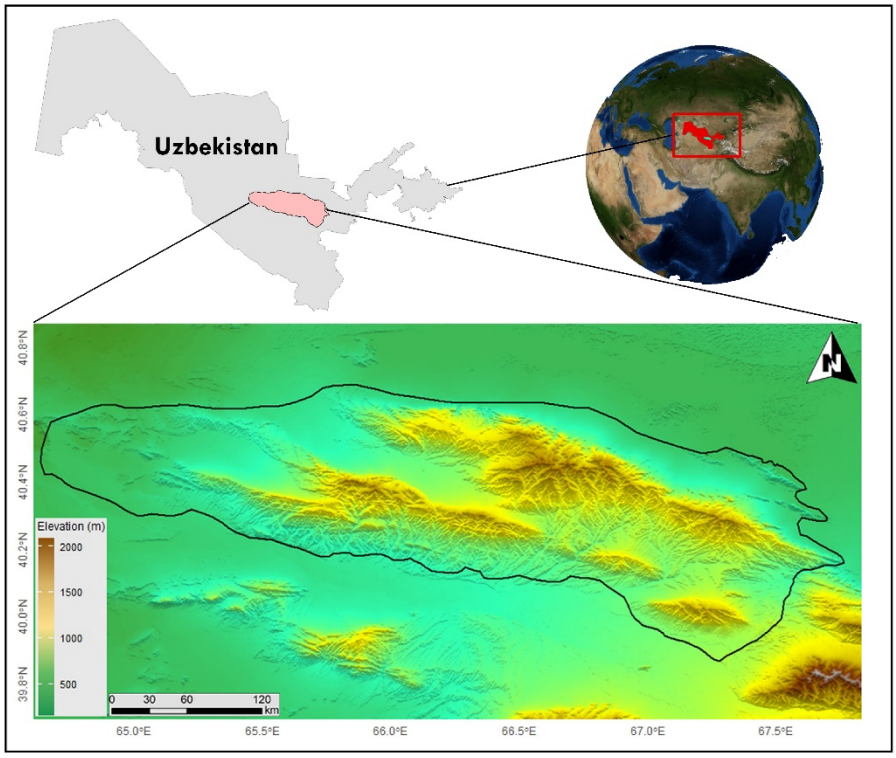

Figure 1. Geographical location and topographic characteristics of the Nurata Range, Uzbekistan.

Within the Nurata Range, desert-adjacent foothill ecosystems, upland steppe communities, and mountain vegetation belts are closely interconnected, forming a pronounced ecological mosaic. Such landscape heterogeneity promotes the development of medicinal plants across a wide range of ecological groups and life forms. This pattern, typical of Central Asian Mountain regions, represents one of the key factors determining both floristic richness and ethnobotanical significance of medicinal plant resources (Pimenov & Beshko 2022).

Local communities inhabiting the Nurata Range have relied on natural plant resources for centuries in their daily lives, particularly in healthcare practices and traditional medicine (Zakirov, 1974). The preservation of traditional knowledge related to the use of medicinal plants in mountain and foothill areas represents a common feature of Central Asian highland regions and has been documented in numerous ethnobotanical studies (Malik & Malik 2021).

The combination of favorable natural conditions, high ecosystem diversity, and relatively limited anthropogenic pressure distinguishes the Nurata Range as an important scientific field for the investigation of ethnobotanical resources of medicinal plants. Accordingly, this region was selected as the focal study area to provide a robust basis for regional ethnobotanical evaluation.

Collection of ethnobotanical data

The ethnobotanical data used in this study are based on an original database developed during previous large-scale research projects aimed at documenting medicinal plants traditionally used in folk medicine across Uzbekistan. In the present study, this dataset was analyzed for the first time using a regional integrated evaluation approach, with a specific focus on the ecosystems of the Nurata Range.

Ethnobotanical information was collected following a comprehensive and multi-source approach. The primary dataset comprised records of 374 medicinal plant species and was compiled through a combination of field observations, oral information obtained from local inhabitants, written sources related to traditional medicine, peer-reviewed scientific publications, and analyses of publicly available literature. All collected data were carefully systematized, verified across multiple sources, and adapted for regional analysis before being used in subsequent ethnobotanical evaluation procedures.

Selection criteria of plant species

The selection of medicinal plant species for analysis in this study was based on a set of clearly defined criteria. At the initial stage, a previously established ethnobotanical database documenting medicinal plants traditionally used in Uzbekistan was employed. This database comprised 374 medicinal plant species and served as the primary source for regional assessment.

To ensure regional relevance, a series of selection criteria was applied to identify species directly associated with the ecosystems of the Nurata Range. Priority was given to plant species whose natural distribution had been recorded within the Nurata Range, or which were actively used by local communities for medicinal purposes in this area. Species lacking a clear ecological or ethnobotanical linkage to the region were excluded from further analysis.

In the subsequent stage, the adequacy and reliability of ethnobotanical information for the selected species were critically evaluated. Species whose medicinal use was reported in only a single source or based on unverified information were excluded. Only species supported by multiple independent sources, with clearly documented use categories and preparation methods, were included in the final dataset. Additionally, the availability of parameters required for integrated ethnobotanical evaluation was considered a key selection criterion.

Species for which sufficient information was available regarding chemical composition, diversity of utilized plant parts, preparation and application methods, and additional functional roles were selected for integrated assessment. Based on these criteria, 110 species were retained from the initial pool of 374 medicinal plants. These species were designated as the primary analytical units for evaluating ethnobotanical importance within the ecosystems of the Nurata Range using an integrated approach. Species were collected in the field, identified with pertinent literature, and vouchers deposited in the Herbarium of the Institute of Botany. Species names follow Plants of the world online (www.plantsoftheworldonline.org)

Unlike single-parameter indices (e.g., Use Value or Relative Frequency of Citation), the proposed Ethnobotanical Value Index (EVI) integrates functional, chemical, and applied dimensions, allowing for a more balanced and comprehensive assessment of ethnobotanical importance at the regional scale.

Ethnobotanical indices and integrated evaluation (EVI)

To assess the ethnobotanical importance of medicinal plants, this study applied an integrated evaluation approach developed on the basis of existing ethnobotanical assessment frameworks and commonly used quantitative indices. This approach combines parameters reflecting use intensity, functional diversity, and practical relevance of medicinal plants, as widely applied in ethnobotanical research (Martin, 1995; Khojimatov *et al.* 2025).

Within this integrated framework, the Ethnobotanical Value Index (EVI) was employed to provide a comprehensive representation of the relative importance of medicinal plant species in traditional medicine. The EVI is based on the principle of synthesizing multiple ethnobotanical indicators into a single, comparable metric and incorporates five core parameters: (1) diversity of medicinal uses, (2) richness of chemical composition, (3) diversity of utilized plant parts, (4) diversity of preparation and application methods, and (5) additional functional value beyond medicinal use. By integrating these dimensions, the EVI enables a balanced and standardized assessment of ethnobotanical value, facilitating meaningful comparisons among species at the regional scale (Bussmann *et al.* 2020).

Ethnobotanical parameters

Use diversity (U) reflects the number of distinct medicinal use categories attributed to each plant species in traditional medicine. Medicinal uses were systematized according to disease groups and general health-promoting purposes. The value of U for each species was expressed as a score corresponding to the total number of documented use categories.

Chemical composition richness (C) was assessed based on the number of groups of biologically active compounds identified in plant species or reported in the literature, including alkaloids, flavonoids, essential oils, glycosides, and other secondary metabolites. Information on chemical composition was compiled and synthesized from available scientific publications and open-access sources.

Diversity of utilized plant parts (P) represents the range of plant organs used in traditional medicine, such as roots, stems, leaves, flowers, fruits, seeds, and other parts. Species for which multiple plant parts were used were assigned higher scores, reflecting their broader practical applicability.

Preparation and application methods (R) were evaluated based on the number of different techniques employed for medicinal use of plant raw materials, including infusions, decoctions, powders, ointments, and external applications. This parameter reflects the practical versatility and adaptability of each species in traditional medicinal practices.

Additional functional value (A) denotes non-medicinal uses of plant species, including nutritional, cosmetic, preventive, or other economic and household applications. The inclusion of this parameter allows the assessment to account for multifunctional roles of medicinal plants beyond therapeutic use.

Calculation of the Ethnobotanical Value Index (EVI)

For each parameter, values were standardized using a predefined scoring system to ensure comparability across species. The Ethnobotanical Value Index (EVI) was then calculated as the arithmetic mean of the standardized parameter values according to the following formula:

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

where:

U- represents use diversity,

C- represents chemical composition 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).

This approach assigns equal weight to each parameter, thereby preventing dominance of any single dimension and allowing a balanced assessment of ethnobotanical importance across species.

Ranking and comparison

Based on the calculated EVI values, all evaluated species were ranked according to their relative ethnobotanical importance. This ranking was used to identify priority medicinal plant species with high ethnobotanical value and to support subsequent analytical comparisons. The results of the integrated evaluation provide a methodological framework for comparing medicinal plant resources at the regional level and offer a basis for future comparative ethnobotanical studies across different regions and ecosystems.

Results and Discussion

Results

As a result of the integrated ethnobotanical assessment of medicinal plants in the ecosystems of the Nurata Range, Ethnobotanical Value Index (EVI) values were calculated for 110 selected species. Based on their EVI values, 12 species (11%) were classified as low-value, 46 species (42%) as medium-value, and 52 species (47%) as high-value medicinal plants (Figure 2). This distribution reflects an uneven pattern in both the intensity and diversity of medicinal plant use within the regional flora.

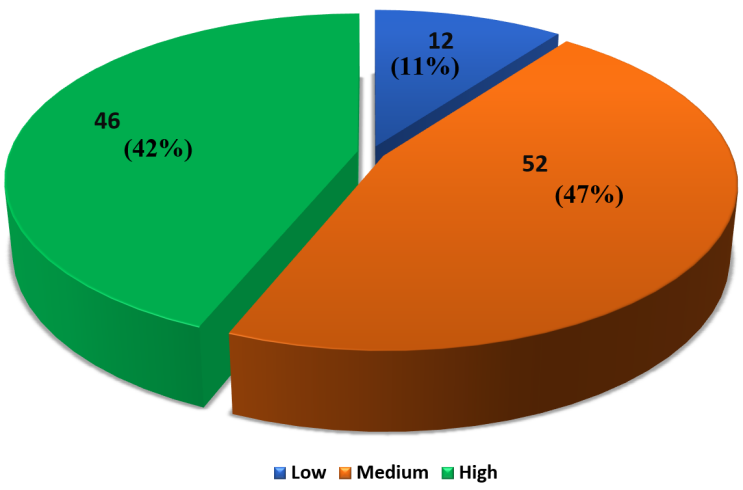

Figure 2. Distribution of medicinal plant species across low, medium, and high ethnobotanical value groups based on EVI classification in the Nurata Range.

Species with high EVI values were predominantly characterized by multiple medicinal use categories, a rich content of biologically active compounds, the utilization of several plant parts, and a wide variety of preparation and application methods. In many cases, these species were used not only in traditional medicine but also for nutritional, preventive, or cosmetic purposes, resulting in a higher integrated ethnobotanical value. Based on the EVI ranking, the top 20 medicinal plant species with the highest ethnobotanical importance were identified (Table 1). These priority species represent the most frequently and widely used medicinal plants by local communities in the Nurata Range and are distinguished by high use diversity, practical versatility, and multifunctional value.

In contrast, species with medium and low EVI values were found to be applied more selectively in traditional medicine, often limited to specific diseases or conditions. Such species were typically characterized by the use of a single plant part or a restricted number of preparation methods, indicating a selective structure of ethnobotanical knowledge and suggesting that the full potential of some medicinal plant species has not yet been fully explored.

Discussion

The results of this study demonstrate a pronounced differentiation in the ethnobotanical importance of medicinal plants within the ecosystems of the Nurata Range. The EVI values obtained through the integrated evaluation approach made it possible to identify not only widely used medicinal species but also less well-known plants with high practical potential. This finding highlights a key advantage of the integrated approach over traditional single-index assessment methods, which often emphasize only frequency of use and may overlook multifunctional species with broader ethnobotanical significance.

By incorporating functional diversity and practical adaptability alongside use intensity, the integrated evaluation approach provides a more comprehensive assessment of ethnobotanical importance. In particular, the inclusion of chemical composition richness and additional functional value enabled a more accurate identification of species with substantial applied potential that might otherwise be underestimated. This multidimensional perspective offers a stronger scientific basis for prioritizing medicinal plant species in conservation planning and resource management.

The present study represents one of the first attempts to apply an integrated ethnobotanical evaluation framework at the regional scale, using the ecosystems of the Nurata Range as a case study. The results demonstrate the applicability and robustness of this approach for regional assessments and support its potential use in other mountain systems and ecological regions of Uzbekistan. Future comparative studies employing this framework may contribute to identifying regional patterns of ethnobotanical priority, guiding conservation efforts, and developing strategies for the sustainable use of medicinal plant resources.

Conclusions

This study aimed to assess the ethnobotanical importance of medicinal plants in the ecosystems of the Nurata Range using an integrated evaluation approach. The Ethnobotanical Value Index (EVI) was calculated for 110 selected medicinal plant species, revealing a clear differentiation in levels of ethnobotanical importance within the regional flora. The results confirmed that species with high EVI values are characterized by broad use diversity, functional versatility, and high practical adaptability.

Based on EVI rankings, the top 20 medicinal plant species were identified as priority ethnobotanical resources in the ecosystems of the Nurata Range (Figure 3). Importantly, the integrated approach enabled the identification not only of widely used medicinal plants but also of less-studied species with high applied potential that may otherwise remain underestimated. These findings demonstrate the effectiveness of the integrated ethnobotanical evaluation framework at the regional scale and highlight its value for supporting conservation prioritization and sustainable resource management.

Overall, the results indicate that the proposed integrated approach provides a robust methodological basis for assessing ethnobotanical resources and can be successfully applied to other mountain systems and regions. Its broader implementation may facilitate comparative ethnobotanical studies, contribute to identifying regional priorities, and support the development of evidence-based strategies for the conservation and sustainable use of medicinal plant diversity.

Table 1. Top 20 medicinal plants based on EVI values (Nurata Range)

Voucher number	Species (Scientific name)	Family	Local name	Parts used	EVI value	U	C	P	R	A	Main medicinal uses
O‘ETB24	*Daucus carota* L.	Apiaceae	Sabzi	Roots, aerial parts, seeds	3,8	5	5	3	3	3	Vitamin A deficiency, anemia, metabolic and mineral metabolism disorders, cardiovascular conditions, gastrointestinal and kidney diseases; anti-inflammatory, wound-healing, diuretic and mild laxative uses.
O‘ETB87	*Capparis spinosa* L.	Capparaceae	Tikanli kovar, kovul	Root bark, flowers, buds, fruits, roots	3,8	5	5	3	3	3	Liver and spleen disorders, rheumatism, diabetes-related conditions; anti-inflammatory and tonic uses.
O‘ETB91	*Colchicum kesselringii* Regel	Colchicaceae	Kesselring savrinjoni	Corms, seeds, flowers	3,8	5	5	3	3	3	Rheumatism, gout and joint diseases; analgesic and anti-inflammatory uses (traditional application).
O‘ETB125	*Medicago lupulina* L.	Fabaceae	Qashqar beda	Roots, aerial parts	3,6	5	5	2	3	3	Digestive disorders, general weakness; tonic and mild anti-inflammatory uses.
O‘ETB148	*Melilotus albus* Medik.	Fabaceae	Oq qashqarbeda	Roots, aerial parts	3,6	5	5	2	3	3	Inflammatory conditions, venous insufficiency; mild sedative and antispasmodic uses.
O‘ETB174	*Melilotus officinalis* (L.) Lam.	Fabaceae	Dorivor yo‘ng‘ichqa, Dorivor qashqarbeda	Roots, aerial parts	3,6	5	5	2	3	3	Circulatory disorders, inflammation; anticoagulant, sedative and antispasmodic uses.
O‘ETB175	*Trifolium pratense* L.	Fabaceae	O‘tloq sebargasi	Roots, aerial parts	3,6	5	5	2	3	3	Respiratory and inflammatory conditions, skin diseases; mild sedative and tonic uses.
O‘ETB181	*Trifolium repens* L.	Fabaceae	O‘rmalovchi sebarga, Tÿqqiztepa	Roots, aerial parts	3,6	5	5	2	3	3	Respiratory infections, inflammatory conditions; mild sedative uses.
O‘ETB183	*Juglans regia* L.	Juglandaceae	Yong‘oq	Leaves, flowers, fruit pericarp, green and mature nuts, seeds, seed oil, seed coat and the soft	3,8	5	5	3	3	3	Gastrointestinal disorders, metabolic diseases, skin conditions; antimicrobial and anti-inflammatory uses.

				partitions between them							
O‘ETB326	*Althaea armeniaca* Ten.	Malvaceae	Gulxayri	Roots, flowers, leaves	3,8	5	5	3	3	3	Respiratory tract diseases, cough and gastritis; demulcent and anti-inflammatory uses.
O‘ETB331	*Plantago lanceolata* L.	Plantaginaceae	Mixchup	Leaves, seeds, roots	3,8	5	5	3	3	3	Wound healing, respiratory infections, gastrointestinal disorders; anti-inflammatory and antimicrobial uses.
O‘ETB364	*Platanus orientalis* L.	Platanaceae	Chinor	Leaves, bark, buds, roots	3,8	5	5	3	3	3	Inflammatory conditions, skin diseases; mild antiseptic and antipyretic uses.
O‘ETB231	*Rheum maximowiczii* Losinsk.	Polygalaceae	Maksimovich rovochi	Roots, rhizomes, leaf petioles, stems and their juice	3,8	5	5	3	3	3	Digestive disorders, liver and gallbladder diseases; mild laxative and detoxifying uses.
O‘ETB268	*Rumex crispus* L.	Polygalaceae	Jingalak otquloq	Roots, leaves, seeds	3,8	5	5	3	3	3	Digestive disorders, anemia and skin diseases; mild laxative and blood-purifying uses.
O‘ETB271	*Portulaca oleracea* L.	Portulacaceae	Semizo‘t	Flowers, shoots, seeds, leaves	3,8	5	5	3	3	3	Gastrointestinal disorders, vitamin deficiency, metabolic disturbances; anti-inflammatory and antioxidant uses.
O‘ETB274	*Prunus domestica* L.	Rosaceae	Olcha	Flowers, leaves, fruits, bark	3,6	5	5	3	2	3	Digestive disorders, constipation, metabolic diseases; mild laxative and tonic uses.
O‘ETB275	*Rosa canina* L.	Rosaceae	Itburun namatak	Fruits, rarely roots, flowers	3,8	5	5	3	3	3	Vitamin deficiency, immune support, urinary tract disorders; antioxidant and tonic uses.
O‘ETB276	*Rubus caesius* L.	Rosaceae	Ko‘kimtir maymunjon	Berries, leaves	3,6	5	5	2	3	3	Gastrointestinal disorders, diarrhea and inflammation; astringent and antioxidant uses.
O‘ETB337	*Populus nigra* L.	Salicaceae	Kora terak	Buds, leaves, rarely shoots and bark	3,8	5	5	3	3	3	Inflammatory diseases, respiratory conditions; analgesic and wound-healing uses.
O‘ETB198	*Urtica dioica* L.	Urticaceae	Ikkiuyli gazandao‘t	Aerial parts, leaves	3,6	5	5	2	3	3	Anemia, metabolic disorders, urinary tract diseases; anti-inflammatory and tonic uses.

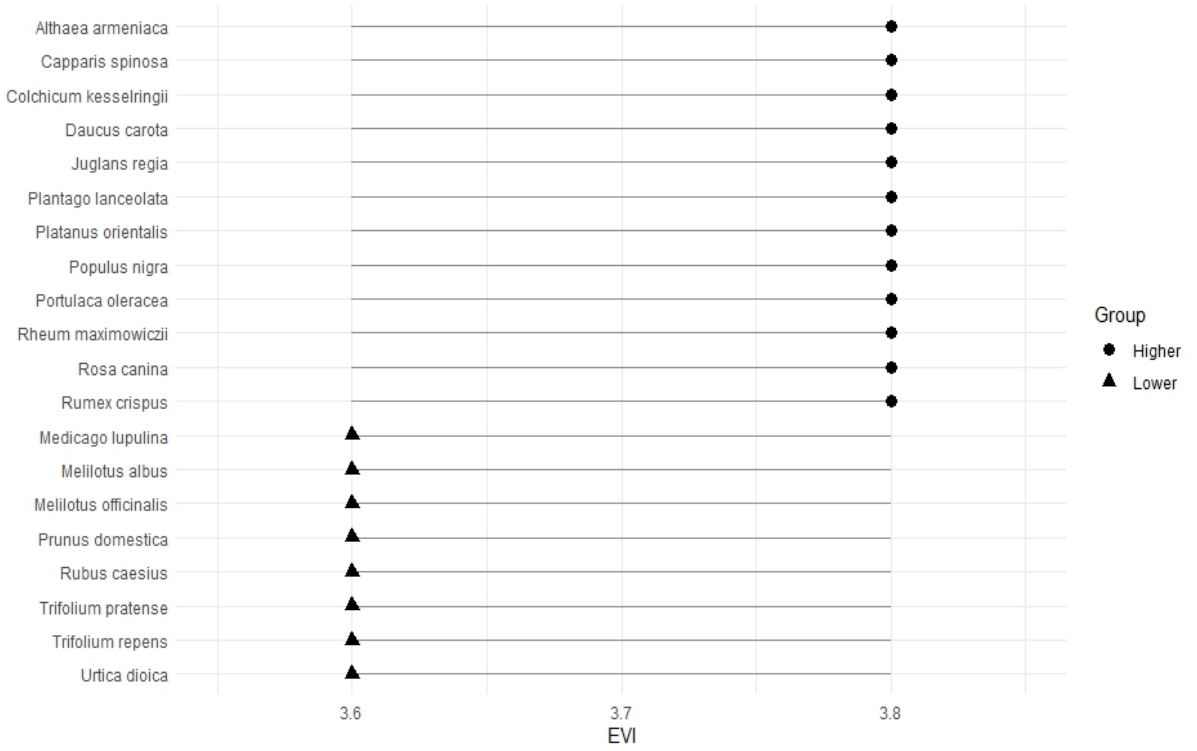

Figure 3. Ethnobotanical Value Index (EVI) distribution of the top 20 medicinal plant species in the Nurata Range.

Declarations

Ethics approval and consent to participate: All ethnobotanical research activities were conducted in accordance with internationally accepted ethical guidelines for ethnobotanical studies. Information obtained from local inhabitants was used exclusively in an aggregated and anonymized form for scientific research purposes. Oral informed consent was obtained from all participants prior to data collection.

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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Authors’ contributions: All authors contributed to the study conception and design. Data collection and analysis were performed collaboratively, and all authors participated in manuscript preparation. All authors read and approved the final version of the manuscript.

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