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Evaluation of the ethnobotanical uses and cenopopulation structures of selected legume species in Karabakh lowland

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Abstract: The study was conducted during 2023 and 2024 in the lowland areas of Karabakh, specifically in the districts of Tartar, Aghjabadi, Barda, and Aghdam, using ethnobotanical and phytosociological methods. The main objective of the research was to assess the cenopopulations of widely distributed leguminous species traditionally used in folk medicine and to document the associated indigenous knowledge. It was found that the value of use was the highest in *Melilotus officinalis* (0.70), *Trifolium repens* and *T. pratense* (both 0.61) according to the number of citations, while *Glycyrrhiza glabra* (91.06%) and *Coronilla varia* (98.37%) had higher reliability degree in some diseases. These plants are primarily employed by local communities in the treatment of rheumatism, gastrointestinal, and respiratory ailments. Considering their high use value and wide range of applications, the ontogenetic structure and status of their cenopopulations were evaluated within the plant communities where they occur. Based on the development of ontogenetic stages, the following patterns were observed: cenopopulations II and VI exhibited centralized ontogenetic spectra; population IV displayed a bimodal structure; populations I and V were left-skewed; while population III was right-skewed. Evaluation of age and efficiency indices showed that cenopopulations I, IV, V, and VI are of transitional type ($\Delta = 0.44–0.54$; $\omega = 0.53–0.71$), population II is mature, and population III is aged ($\Delta = 0.47–0.57$; $\omega = 0.60–0.71$).

Keywords: *ethnobotany, Glycyrrhiza glabra, indigenous knowledge, Ononis arvensis, ontogenetic structure, Trifolium repens*

INTRODUCTION

The role of useful plant species in natural ecosystems, their significance in national economies, and their efficient and sustainable use are key factors in ensuring biodiversity conservation and sustainability [Heywood, 2013; Ibadullayeva, 2020; Anil, 2022]. Among local communities, the use of beneficial plants is rooted in indigenous knowledge and meets the demand for medicinal and fodder resources [Bousta, Ennabili, 2011]. According to the World Health Organization (WHO), medicinal plants – a major subset of useful plants – fulfill the healthcare needs of approximately 80% of the global population [World Health Statistics, 2024].

Traditional medicine, based on natural resources, is considered essential due to its accessibility, affordability, and practicality, even in the most remote regions. Unlike scientific medicine, traditional medicine is a non-conventional form of healing that transmits knowledge about the use of natural remedies from generation to generation. It is shaped by the customs, traditions, cultures, and millennia-old practices of diverse peoples [Ralte, Singh, 2024].

Different cultures have their own unique methods of using and administering plants. In order to collect the knowledge acquired by different ethnic groups living in various regions – often through centuries of practical experience – and to identify new potential uses of natural resources, systematic ethnobotanical studies have been conducted in Azerbaijan over the past decade [Aghayeva, Ibadullayeva, 2012; Ibadullayeva et al., 2017; Ibadullayeva, 2024]. Such studies contribute to the renewal of existing knowledge and lead to scientifically grounded conclusions based on more accurate and reliable information.

Currently, in the fields of botany and plant ecology, the population-ontogenetic research method for medicinal plants is used to characterize the individual development of a species within a specific plant community [Smirnova, 1976]. One of the key features of each cenopopulation (CP) is its ontogenetic spectrum. The absence or

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weak representation of any particular ontogenetic stage may lead to the degradation of the CPs, resulting in processes such as succession and fluctuation. Preventing such outcomes begins with identifying the condition and typological characteristics of the plant communities from which medicinal plants are harvested.

The main objective of this study is to assess the CPs of leguminous species that are widely distributed and traditionally used in folk medicine in the lowland regions of Karabakh. Additionally, the study aims to scientifically validate and document traditional knowledge related to these species and to contribute to the advancement of ethnobotanical science in the region.

MATERIALS AND METHODS

This study was conducted during 2023–2024 in the lowland districts of Karabakh. The main objective was to collect data on plant species widely used by the local population for various purposes and to inform communities about additional medicinal uses recognized in global scientific literature.

Collection and identification of plant specimens. Field expeditions were organized throughout the year to Tartar, Aghjabadi, Barda, and Aghdam districts in the Karabakh lowland. Interviews were carried out in the three districts mentioned above, as well as in the Shamkir, Goranboy, Ganja, and Gazakh districts, where the population from these districts moved as refugees. These expeditions were carried out six times each year. In total, 68 plant specimens were collected, and deposited to the Herbarium of the Institute of Botany (BAK). Plant identification was conducted using the "Flora of Azerbaijan" [1954], while nomenclatural updates were made in accordance with The World Flora Online database [WFO, 2025].

Ethnobotanical surveys. Information on the ethnobotanical value of the plants was obtained from 65 local residents aged 40 and above, residing in the study area. Ethnobotanical methods and techniques were employed during semi-structured interviews [Chursin, 1929; Cotton, 1996]. The interviews were conducted across 21 villages within the study region.

Among the participants, 44 were women, 11 men, and 10 traditional healers (Fig. 1). Initially, data were collected on common and frequently treated ailments, local names of plants, their uses, habitats, methods of harvesting and drying. Special survey forms were developed for questionnaire-based interviews. During this process, the participants' traditional knowledge about medicinal plants was recorded and documented.

Phytosociological methods. In the classification of vegetation, classical ecological-phytosociological and dominance principles were applied, based on the works of prominent researchers [Lavrenko, 1957]. Geobotanical descriptions were carried out using the structural and compositional characteristics of plant communities, as well as floristic and geobotanical indicators as key criteria.

To characterize the developmental stages of individual plants, the concept of discrete ontogenetic description was employed [Jivatovski, 2001]. During the fieldwork, sample plots were established within the phytocenoses,

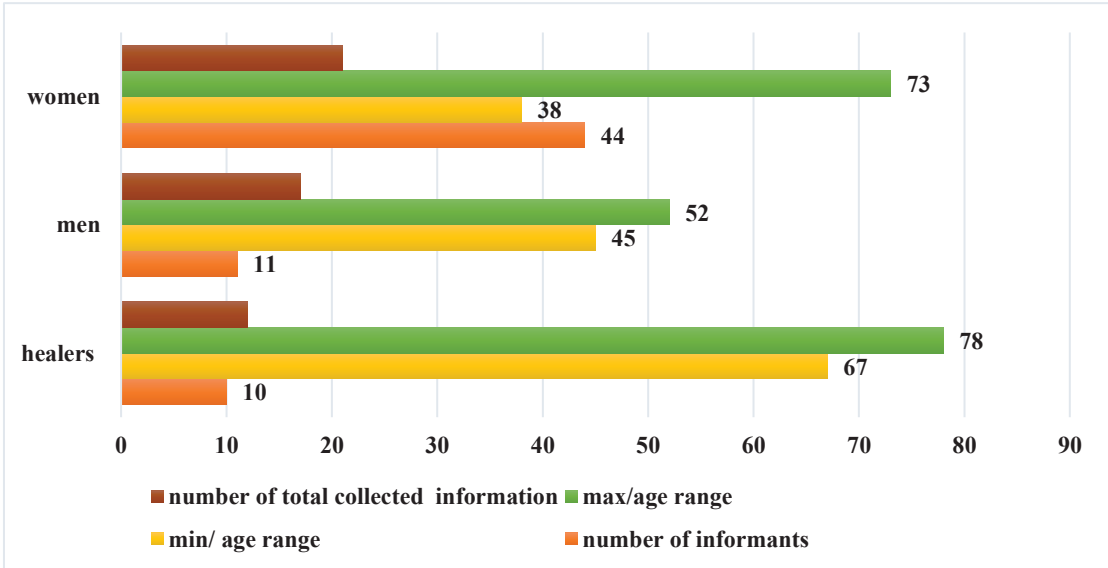

Figure 1. Ethnobotanical surveys (2023-2025 years) conducted among the local population in the lowland areas of Karabakh.

and the ontogenetic stages of plants were recorded and analyzed accordingly. The integral characteristics of the demographic structure within each cenopopulation were determined using age and vitality (effectiveness) indices.

Age coefficient (Δ) $$\Delta = \frac{\sum k_i \cdot n_i}{N}$$

Here, i represents the ontogenetic stage, k_i is the value assigned to that stage, n_i is the number of individuals in stage i, N is the total number of individuals in the population, and i also reflects the state of the population.

Vitality coefficient (ω) $$\omega = \frac{\sum n_i \cdot e_i}{\sum n_i}$$

where n_i is the number of plants, i is the condition, and e_i is the efficiency of the plant.

The absolute maximum classification criterion of A.A. Uranov and O.V. Smirnov [Smirnov, 1976] and the delta omega classification of L.A. Zhivatovsky [Zhivatovsky, 2001] were used to determine the type of CPs.

RESULTS AND DISCUSSION

Based on our findings, the majority of the twelve leguminous species used for medicinal purposes are herbaceous plants, distributed across various habitats ranging from plains to mountainous rocky slopes, cultivated fields, meadows, and shrublands. Among these species, *Ononis arvensis* L., *Trifolium repens* L., and *Glycyrrhiza glabra* L. were recorded within six cenopopulations in the Aghjabadi and Barda districts. These populations were associated with plant communities such as wormwood-grassland, grassland-barren brome (*Cynodonetum dactylon-Glycyrrhizosum glabra*) and tamarisk-horned bean-fescue (*Tamarixeta-Alhagietum-Aeluropusosum*) assemblages.

Considering the high use value and broad application of all three species, the ontogenetic structure and condition of their CPs in the communities where they are collected were assessed (Tab. 1). During ontogenesis, plants undergo significant morphological, physiological, and biochemical changes. Accounting for ontogenetic variability is crucial both in botanical research and practical plant cultivation. To obtain reliable data, it is necessary to analyze traits at specific stages of ontogenesis. Adverse environmental factors such as drought, frost, soil salinity, and other stresses can significantly affect plant ontogenesis, leading to disturbances in growth and generative processes. Prolonged exposure to stress may cause premature aging and reduced productivity of plants. Therefore, it is important to study plant responses to stress in order to identify self-regulation mechanisms during ontogenesis under unfavorable conditions.

As shown in the table, the juvenile stage was not recorded in four of the six CPs. However, individuals from all other ontogenetic stages were fully represented. In this regard, all CPs were considered normal, with observed dynamics in individual development (Fig. 1). Only in *Glycyrrhiza glabra* at the fifth CP, despite the presence of the senile stage, a high number of immature individuals and deviations were observed. This can be explained by the extended growing season and ongoing regeneration processes within that particular plant community.

According to the characteristics of the ontogenetic types, CP II and VI are centralized, IV is bimodal, I and V are left-skewed, and III is right-skewed [Zaugolnov, 1994]. A left-skewed spectrum is characterized by a predominance of pre-generative individuals. The centralized spectrum indicates a dominance of middle-aged generative individuals, the bimodal spectrum shows predominance of two ontogenetic types, while the right-skewed spectrum is dominated by post-generative individuals.

The age index serves to determine the type of CP, whereas the efficiency index is used to evaluate the productivity of the CPs. Based on the evaluation of the age and efficiency indices, it was found that CPs I, IV, V and VI are transitional types (Δ = 0.44–0.54; ω = 0.53–0.71), II is mature, and III is aged (Δ = 0.47–0.57; ω = 0.60–0.71) (Fig. 2).

The ability of plants to resist adverse environmental factors, stress, and diseases largely depends on their developmental stage. Young plants are generally the most resilient, whereas older plants tend to be more susceptible to damage.

Statistical analysis of the surveys allowed for the calculation of the use value (UV) of species utilized in ethnobotany, as well as fidelity level (FL), which indicates the reliability of their use in treating various diseases. It was found that *Melilotus officinalis* (L. Pall.) (0.70), *Trifolium repens* L. and *T. pratense* L. (both with a use value of 0.61) had the highest use values based on the number of citations. Meanwhile, *Glycyrrhiza glabra* L. (91.06%) and *Coronilla varia* L. (98.37%) exhibited the highest fidelity levels for gastrointestinal and urinary tract diseases, respectively, according to citation frequency [Ibadullayeva et al., 2024]. Infusions prepared from these plants are commonly administered

Table 1. Ontogenetic structure of the cenopopulations where the species are distributed (2023-2024).

CP	Ontogenetic age states/conditions								∑
	j	im	v	g_1	g_2	g_3	ss	s	
Ononis arvensis L.									
I CP	4	9	18	14	10	11	8	7	81
II CP	-	11	15	16	13	8	4	6	73
∑	4	20	33	30	23	19	12	13	154
%	2.60	12.98	21.43	19.48	14.94	12.34	7.79	8.44	100.0
Trifolium repens L.									
III CP	-	5	12	12	10	8	19	13	79
IV CP	-	7	22	17	16	20	15	12	109
∑	-	12	34	29	26	28	34	25	188
%	-	6.38	18.09	15.43	13.83	14.88	18.09	13.30	100.0
Glycyrrhiza glabra L.									
V CP	-	13	23	20	19	24	28	19	146
VI CP	5	15	19	24	32	27	19	17	158
∑	5	28	42	44	51	51	47	36	304
%	1.64	9.21	13.82	14.47	16.78	16.78	15.46	11.84	100.0

as liquids or decoctions, as well as in the form of powdered dried herbs.

Glycyrrhiza glabra L. was found predominantly along riverbanks and in grasslands within the study area. Among the local population, the root and stem of this plant are traditionally used as decoctions to treat gastrointestinal disorders, bronchitis, asthma, malaria, and fungal infections. Numerous bioactive compounds, primarily triterpenes, saponins, and flavonoids, have been isolated from this species [Belova, Alexandrovich, Egorov, 2023]. It exhibits various pharmacological effects, including antioxidant, antiviral, antimicrobial, sedative, antitussive, and others [Sharma, et al., 2017].

Ononis arvensis L. is commonly found as part of the diverse herbaceous composition of grasslands. The aqueous infusion of this species is used in ethnopharmacology for the treatment of rheumatism, urinary tract infections, and skin diseases. Flavonoids,

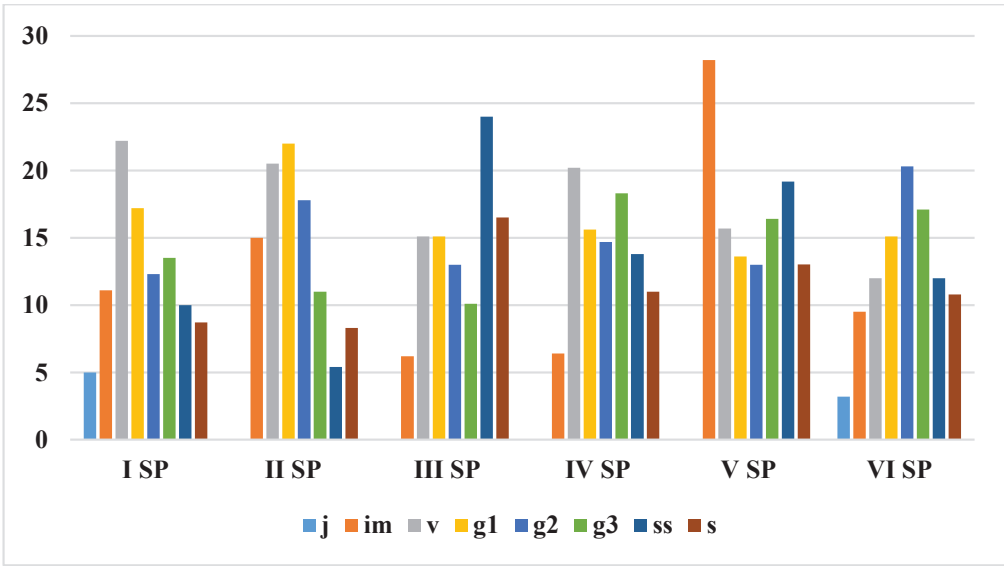

Figure 2. Ontogenetic dynamics in cenopopulations: I–II SP *Ononis arvensis*; III–IV SP *Trifolium repens*; V–VI SP *Glycyrrhiza glabra* (2023-2024).

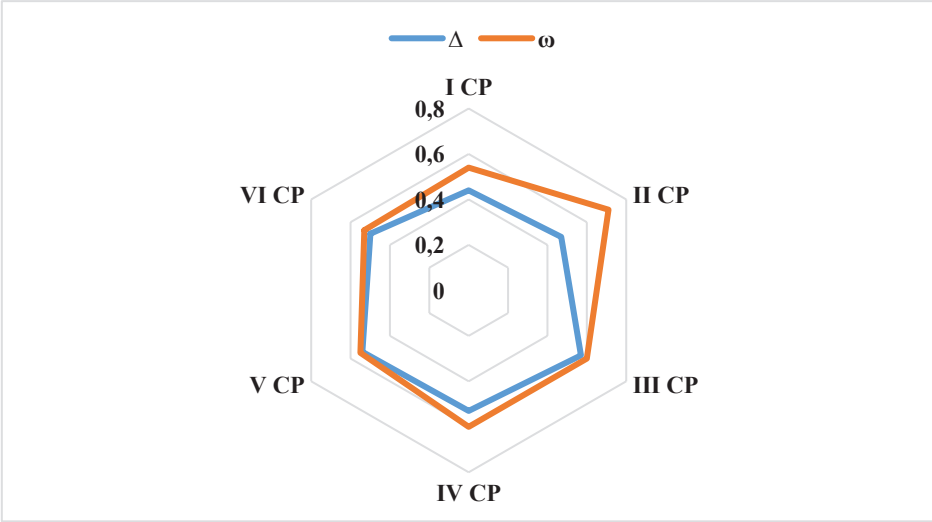

Figure 3. Assessment of the age and efficiency indices of cenopopulations of selected leguminous species in 2023-2024: I–II CP *Ononis arvensis*; III–IV CP *Trifolium repens*; V–VI CP *Glycyrrhiza glabra*.

hydroxycinnamic acids, oxycoumarins such as scopoletin and scopolin, phytosterols, lectins, and certain selected isoflavonoids have been identified in the underground and aboveground parts of the plant [Drenin, Botirov, 2017].

Trifolium repens L. is distributed on rocky slopes and along stream banks. In traditional medicine, it is widely used for treating cough, female reproductive disorders, and rheumatism, as well as serving as fodder and a vegetable crop. The chemical composition of *T. repens* includes various bioactive compounds such as simple phenols, phenolic acids, flavones, isoflavones, pterocarpans, cyanogenic glycosides, saponins, and tannins [Ahmad, Zeb, 2020].

CONCLUSIONS

It was found that *Melilotus officinalis* (0.70), *Trifolium repens* L. and *T. pratense* L. (both 0.61) exhibited the highest use values based on the number of citations. *Glycyrrhiza glabra* L. (91.06%) and *Coronilla varia* L. (98.37%) showed higher fidelity levels for specific diseases based on citation frequency. The ontogenetic structure of six recorded CPs of these species was evaluated. Based on the assessment of age and efficiency indices, CPs I, IV, V, and VI were classified as transitional types, II as mature, and III as aged. Regarding the characteristics of ontogenetic types, CPs II and VI were centralized, IV was bimodal, I and V were left-skewed, and III was right-skewed.

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Qarabağın aran ərazilərində bəzi paxlalı bitki növlərinin etnobotaniki istifadəsinin və senopopulyasiya quruluşlarının qiymətləndirilməsi

Səyyarə C. İbadullayeva, Nuri V. Mövsümova, Samirə F. Xudaverdiyeva, Gülnarə Ş. Şirəliyeva, Fərəh F. Əmrahova
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Tədqiqat 2023–2024-cü illərdə Qarabağın aran ərazilərində, xüsusilə Tərtər, Ağcabədi, Bərdə və Ağdam rayonlarında etnobotaniki və fitosenoloji metodlardan istifadə edilməklə aparılmışdır. Bu işin əsas məqsədi xalq təbabətində ənənəvi şəkildə istifadə olunan, geniş yayılmış paxlalı bitki növlərinin senopopulyasiyalarını qiymətləndirmək və onlarla bağlı yerli bilikləri sənədləşdirmək olmuşdur. Məlum olmuşdur ki, *Melilotus officinalis* (0.70), *Trifolium repens* və *T. pratense* (hər ikisində 0.61) növlərində istifadə dəyəri əldə olunmuş istinadların sayına görə ən yüksəkdir, *Glycyrrhiza glabra* (91.06%) və *Coronilla varia* (98.37%) növlərinin isə bəzi xəstəliklərdə etibarlılıq dərəcəsi daha çox olmuşdur. Yerli icmalar bu bitkiləri əsasən revmatizm, həzm sistemi və tənəffüs yolları xəstəliklərinin müalicəsində istifadə edirlər. Yüksək istifadə göstəriciləri və geniş tətbiq sahələri nəzərə alınaraq, bu növlərin yayıldığı bitki birləşmələrində senopopulyasiyalarının ontogenetik quruluşu və vəziyyəti qiymətləndirilmişdir. Ontogenetik mərhələlərin inkişafına əsasən aşağıdakı modellər müəyyən edilmişdir: II və VI senopopulyasiyalar mərkəzləşmiş ontogenetik spektrlə

xarakterizə olunur; IV populyasiya iki zirvəli (bimodal) quruluşa malikdir; I və V populyasiyalar sola meyilli, III populyasiya isə sağa meyillidir. Yaş və effektivlik göstəricilərinin qiymətləndirilməsi göstərmişdir ki, I, IV, V və VI senopopulyasiyalar keçid tipinə (Δ = 0.44–0.54; ω = 0.53–0.71) aiddir; II populyasiya yetkin, III populyasiya isə qocalma mərhələsindədir (Δ = 0.47–0.57; ω = 0.60–0.71).

Açar sözlər: *etnobotanika, Glycyrrhiza glabra, yerli biliklər, Ononis arvensis, ontogenetik quruluş, Trifolium repens*

Оценка этноботанического использования и структуры ценопопуляций отдельных видов бобовых в низинном регионе Карабаха

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Исследование проводилось в 2023–2024 годах в низинных районах Карабаха, а именно в районах Тертер, Агджабеди, Барда и Агдам, с использованием этноботанических и фитоценологических методов. Основной целью работы было оценить ценопопуляции широко распространённых видов семейства бобовых, традиционно применяемых в народной медицине, а также зафиксировать сопутствующие элементы коренных этноботанических знаний. Было установлено, что ценность использования была самой высокой у *Melilotus officinalis* (0.70), *Trifolium repens* и *T. pratense* (оба по 0.61) в соответствии с количеством полученных ссылок, в то время как *Glycyrrhiza glabra* (91.06%) и *Coronilla varia* (98.37%) имели более высокую надеж ность при некоторых заболеваниях. Местное население в основном применяет эти растения для лечения ревматизма, желудочно-кишечных и респираторных заболеваний. Учитывая их высокий коэффициент использования и широкий спектр лечебных применений, была проведена оценка онтогенетической структуры и состояния их ценопопуляций в пределах сообществ, где они произрастают. На основе анализа онтогенетических стадий развития были выявлены следующие закономерности: ценопопуляции II и VI характеризуются централизованными онтогенетическими спектрами; популяция IV – бимодальной структурой; популяции I и V – левосторонней (с уклоном в сторону молодых особей); тогда как популяция III – правосторонней (с преобладанием старых особей). Оценка возрастных и эффективностных индексов показала, что ценопопуляции I, IV, V и VI относятся к переходному типу (Δ = 0.44–0.54; ω = 0.53–0.71), популяция II – к зрелому типу, а популяция III – к стареющему (Δ = 0.47–0.57; ω = 0.60–0.71).

Ключевые слова: *этноботаника, Glycyrrhiza glabra, местные знания, Ononis arvensis, онтогенетическая структура, Trifolium repens*