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Screening of medicinal plants in the Ulytau region and their general characteristics

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Abstract. The article presents a screening of medicinal plants in the Ulytau region (Central Kazakhstan) and an analysis of their botanical and ecological characteristics. Field studies conducted in 2024–2025 in the Zhanaarka and Ulytau districts identified 502 species belonging to 315 genera and more than 40 families of higher vascular plants. The highest species diversity was recorded in the families *Asteraceae, Lamiaceae, Fabaceae, Papaveraceae, and Campanulaceae*. Analysis of life forms revealed the predominance of perennial herbaceous plants (65–70%), indicating the adaptive capacity of the flora under sharply continental climatic conditions. Annual and biennial species accounted for approximately 15% and 8–10% of the flora, respectively, whereas shrubs, trees, and vines were considerably less represented. The analysis of medicinal plant applications showed that about 400 species are used in folk medicine, around 180 species in official medicine, and from 10 to 120 species in Eastern medicine, experimental medicine, veterinary medicine, Western medicine, and homeopathy. The results confirm the high taxonomic and ecological significance of the medicinal flora of the Ulytau region and demonstrate its potential as a source of biologically active compounds for pharmacology and medicine.

Keywords: medicinal plants, flora of the Ulytau region, taxonomic diversity, life forms, traditional medicine, biologically active compounds, Central Kazakhstan

Introduction

Medicinal plant research has become an important field of botanical science in Kazakhstan. Medicinal plants have been widely used since ancient times as sources of essential oils, alkaloids, tannins, flavonoids, and other biologically active compounds. Historical records indicate that numerous plant species were traditionally applied in Turkic folk medicine for the treatment of

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various diseases. At present, medicinal plants continue to play a significant role in folk and official medicine, and their pharmacological properties have been extensively described in scientific literature [1].

Currently, various species of medicinal plants are widely used in folk, official, Eastern, and veterinary medicine. Species of the *genera Ziziphora, Artemisia, Mentha × piperita L.,* and *Allium* are traditionally used in the treatment of cardiovascular diseases, inflammatory processes, and bacterial infections [2–5]. Approximately 30 species of medicinal plants have also been reported for the treatment of skin diseases in traditional medicine [6]. In addition, medicinal plants are extensively applied in phytotherapy and Eastern medicinal practices [7]. Many species possess pharmacologically active compounds that are used not only in human medicine but also in veterinary practice and animal husbandry [8].

Recent studies in Kazakhstan have focused on the taxonomic diversity, biological activity, and resource potential of medicinal plants belonging to the leading plant families [9,10]. Considerable attention has also been devoted to the assessment of wild medicinal plant resources and their practical significance [11]. According to current floristic data, the flora of Kazakhstan includes more than 6,000 species of higher vascular plants, of which approximately 1,406 species are classified as medicinal plants. Information on their taxonomy, ecology, and geographical distribution across floristic regions has been widely reported in botanical studies [12]. In addition, investigations of the flora and plant resources of Central Asia indicate the presence of more than 2,000 medicinal plant species in the region [13].

The study area covers the territory of the Ulytau district with a total area of 12,293,105 hectares. The climate of the Ulytau region is sharply continental and arid, with pronounced seasonal temperature fluctuations. Snow cover generally varies between 12 and 20 cm, increasing from the southern to the northern parts of the region. In some locations, snow depth may reach 40 cm, and soils freeze to depths of up to 2 m during winter.

The winter period in the Ulytau region is characterized by frequent blizzards and snowdrifts caused by extensive open plains. Spring is marked by a rapid transition from low winter temperatures to warmer climatic conditions. During the summer season, prolonged droughts accompanied by strong winds and dust storms intensify moisture evaporation and contribute to soil degradation processes. These environmental conditions negatively affect vegetation communities and promote the development of adaptive mechanisms in the regional flora under arid climatic conditions [14,15].

The ecological conditions of the Ulytau region are characterized by arid climate, drought processes, soil degradation, and anthropogenic environmental impacts. According to available environmental data, atmospheric pollution and contamination of water bodies and topsoil by heavy metals have been recorded in several areas of the region. These factors negatively affect ecologically significant plant communities and natural vegetation resources. In addition, the flora of the Ulytau region includes a number of rare and protected species listed in the Red Book of Kazakhstan that require special conservation measures [16].

The Ulytau region is located in Central Kazakhstan and occupies an area of approximately 42,000 km^2. The territory includes diverse natural landscapes, including steppe plains, foothill ecosystems, and semi-desert zones. Such environmental heterogeneity contributes to the formation of stable ecosystems and supports considerable biological diversity adapted to arid continental environments.

Wild tulips represent rare endemic plant species and are considered one of the natural symbols of the Ulytau region. These species serve not only as important components of regional biodiversity but also as indicators of the ecological condition of natural ecosystems. The fau-

na of the Ulytau region is highly diverse and includes numerous species typical of steppe and semi-desert ecosystems.

The steppes of the Ulytau region provide habitat for the saiga antelope (*Saiga tatarica*), a species included in the Red Book of Kazakhstan. The region is also an important breeding area for the steppe eagle (*Aquila nipalensis*), which regularly nests within the territory during the reproductive season. Small mammals, including jerboas, hedgehogs, and ground squirrels, are widespread, together with numerous reptile and insect species typical of steppe and semi-desert landscapes. The observed species diversity emphasizes the ecological importance of the Ulytau region as one of the key natural areas of Central Kazakhstan.

The natural heritage of the region possesses not only ecological but also cultural and historical value. In recent years, increased attention has been devoted to the conservation of rare plant and animal species and to the restoration of degraded ecosystems. Environmental protection measures and ecological monitoring programs are aimed at preserving the biological diversity and ensuring the sustainable development of the Ulytau region for future generations [17,18].

The present study is regional in scope and focuses on medicinal plant species distributed within the Ulytau region. In 2024–2025, targeted expeditionary surveys were conducted in the Zhanaarka and Ulytau districts of Central Kazakhstan within the framework of the program "Creation of the Plant Cadastre of the Ulytau Region" aimed at implementing the objectives of the Law of the Republic of Kazakhstan "On the Plant World" and ensuring the sustainable use of regional botanical resources. The main objective of the research was to investigate the taxonomic diversity and distribution of medicinal plant species in the study area.

Materials and research methods

The Ulytau Mountains are situated within the semi-desert zone of Central Kazakhstan. The region is characterized by low annual precipitation, intense solar radiation, and high evaporation during the summer months, resulting in limited soil moisture. These climatic conditions influence the composition of vegetation communities and the development of local soils.

Northeastern winds dominate throughout the year and contribute to the redistribution of snow cover during winter. Snow accumulates mainly in depressions and valleys, whereas open areas remain relatively snow-free. During spring snowmelt, a considerable part of the water drains into river systems, reducing moisture retention in the soil. In summer, strong winds increase evaporation and enhance soil drying.

Vegetation patterns in the Ulytau region are determined by topography, soil conditions, and moisture availability. The region belongs to the western part of the Central Kazakhstan low-mountain province and is dominated by desertified steppe communities with wormwood-grass vegetation, rocky outcrops, ravines, and gullies [19]. Elevations in the western part of the territory range from 300 to 1135 m above sea level.

The soils of the Ulytau region are represented mainly by light chestnut soil types with varying mechanical composition. Rocky and stony soils associated with eluvial deposits are common in mountainous areas, while sandy loam and loam soils are characteristic of river terraces, plains, and foothill zones. Saline and carbonate soils, including solonchaks, are also widely distributed throughout the region and are typical of the arid landscapes of Central Kazakhstan.

The medicinal flora of Kazakhstan comprises approximately 1,406 species belonging to 134 plant families [20]. Field surveys carried out in 2024–2025 covered the main parts of the Ulytau region, including Betpakdala, the Zhanaarka district, and the Ulytau mountain system. During the study, 502 medicinal plant species representing 315 genera were recorded.

The collected data included information on taxonomic composition at the family, genus, and species levels, as well as analyses of life forms, including perennial and annual herbaceous plants, shrubs, trees, and vines. Ecological characteristics and the presence of biologically active compounds, such as alkaloids, flavonoids, vitamins, essential oils, terpenoids, and saponins, were also considered. Information on the medicinal use of species in folk, official, Eastern, and veterinary medicine was analyzed using published sources, including the Annotated List of Medicinal Plants of Kazakhstan, Flora of Ulytau, and Flora of Greater Ulytau [21–23].

Field surveys were carried out from May to July during the active vegetation period in steppe, foothill, and semi-desert ecosystems of the Ulytau region. Plant identification was performed using morphological characteristics and regional floristic guides, with additional verification based on herbarium collections when necessary. Herbarium specimens were collected, and geographic coordinates of species occurrences were recorded during field observations.

Results

A comparative assessment of medicinal plant species and genera distributed within the natural ecosystems of the Ulytau region was carried out based on their distribution patterns and ecological characteristics. Species were grouped according to the degree of their occurrence and abundance within the study area. The analysis considered the spatial distribution of species, their ecological adaptation, and their influence on vegetation communities and ecosystem structure. Plant taxa were classified into fourteen major groups, and their distribution frequency was evaluated using a scoring scale ranging from 1 to 30.

The scoring system reflected the frequency of species occurrence, population abundance, and ecological adaptability within the study area. Such an approach allowed the identification of species that are well adapted to the environmental conditions of the Ulytau region and play an important role in local vegetation communities. The research results presented in Figure 1 demonstrate the distribution of medicinal plants among more than 40 families of higher vascular plants identified in the region.

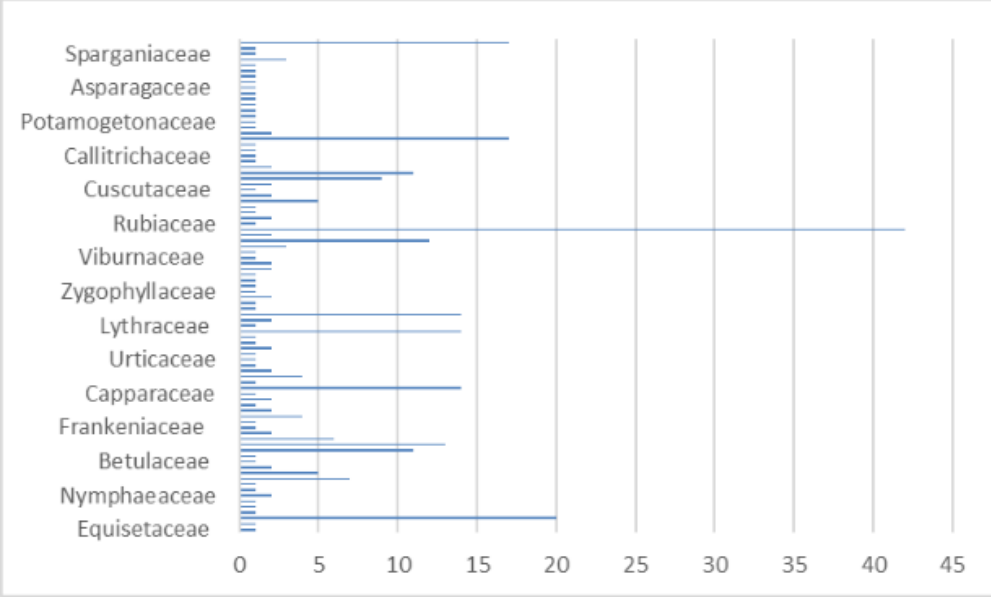

Figure 1. Taxonomic diversity of medicinal plants in the Ulytau region

Among the identified medicinal plant families, the greatest species richness was observed in *Campanulaceae Juss., Papaveraceae Juss., Fabaceae Lindl., Lamiaceae Juss., Asteraceae Bercht. et J. Presl,* and *Poaceae Barnhart*. *Campanulaceae* was represented by more than 120 species and constituted the largest family in the surveyed flora. Representatives of this family were widely distributed throughout the study area.

Other families, including *Papaveraceae, Caryophyllaceae, Brassicaceae,* and *Lamiaceae,* were represented by up to 40 species each. These families constitute an important component of the medicinal flora of the Ulytau region and include numerous species traditionally used for medicinal purposes due to the presence of biologically active compounds such as alkaloids, flavonoids, and saponins.

Families such as *Equisetaceae, Nymphaeaceae, Asphodelaceae,* and *Juncaceae* were represented by only a few species in the study area. Their limited occurrence is likely related to the arid climate and the dominance of steppe and semi-desert plant communities.

Overall, the medicinal flora of the Ulytau region is closely associated with steppe and semi-desert ecosystems. The recorded species diversity confirms the floristic richness of the region and provides a basis for further studies of its medicinal plant resources.

Analysis of life forms demonstrated the predominance of perennial herbaceous plants in the medicinal flora of the Ulytau region, as shown in Figure 2. Perennial species accounted for approximately 65–70% of the total recorded flora. Their dominance is associated with a high degree of adaptation to severe continental climate, including prolonged droughts and significant seasonal temperature fluctuations.

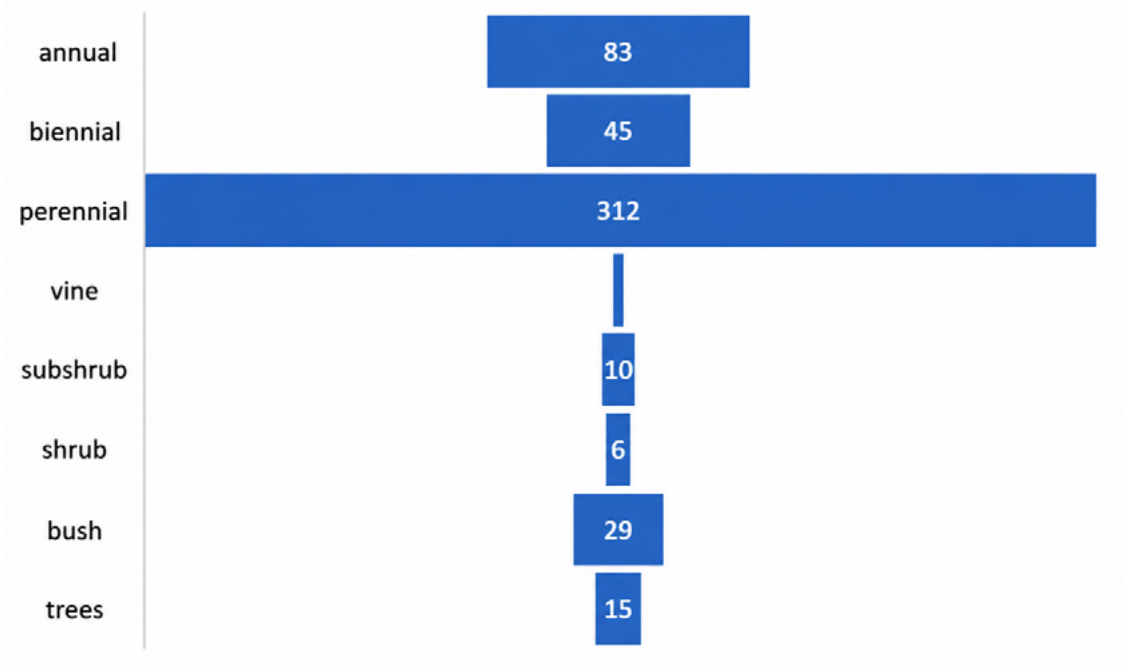

Figure 2. Life forms of medicinal plants in the Ulytau region

Annual plants represented the second largest group, comprising approximately 15% of the identified species. The relatively short life cycle of annual species allows them to successfully complete their development during the limited vegetation period characteristic of steppe and semi-desert ecosystems.

Biennial species accounted for approximately 8–10% of the medicinal flora and were mainly represented by members of the families *Asteraceae* and *Brassicaceae*. These species are characterized by adaptive responses to seasonal fluctuations in temperature and moisture conditions. Trees, shrubs, and semi-shrubs constituted approximately 3–5% of the recorded flora and were primarily distributed within arid habitats of the region. Vines were represented by only a few species due to the unfavorable environmental conditions of the dry steppe and semi-desert landscapes.

The predominance of perennial herbaceous plants indicates the long-term adaptation of the regional flora to continental climatic conditions characterized by hot summers, cold winters, and limited water availability. Such a life-form structure contributes to the ecological stability of vegetation communities under climatic stress conditions.

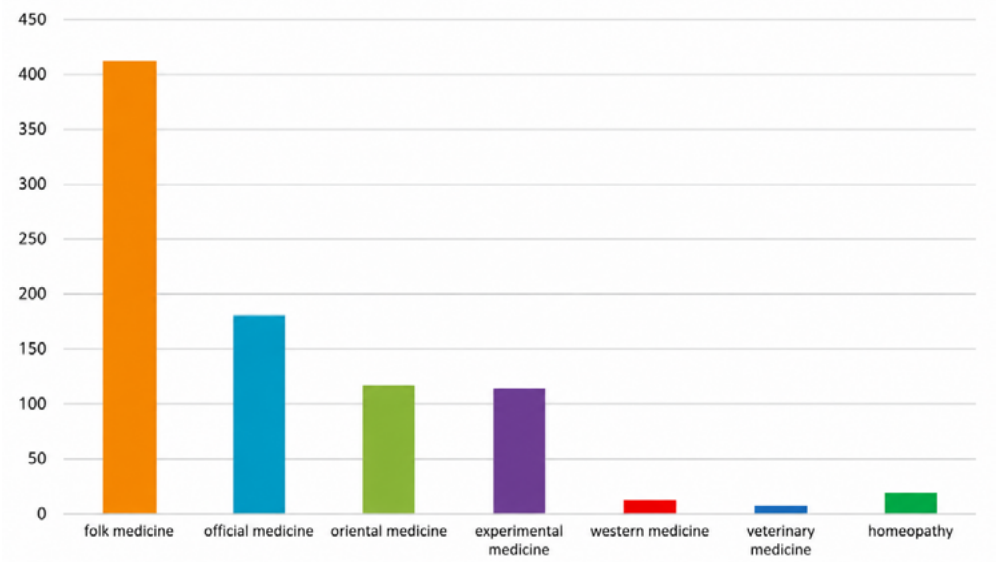

Figure 3. Medicinal plant applications in different medicinal practices

According to Figure 3, approximately 400 medicinal plant species recorded in the Ulytau region are used in folk medicine, representing the largest category of use. This category accounted for the majority of recorded medicinal plant uses in the region. The results suggest that folk medicine remains the principal area of application for medicinal plants in the region.

Official medicine represented the second largest category of medicinal plant application, including approximately 180 species. Approximately 110–120 species were reported in Eastern and experimental medicine, indicating that many medicinal plants of the Ulytau flora are used in different therapeutic traditions. The presence of species in several categories shows that the same medicinal plants are often used for different purposes and in different medicinal traditions.

Western medicine, veterinary medicine, and homeopathy were represented by fewer than 20 species in each category. This distribution indicates that the principal use of medicinal plants in the Ulytau region remains associated with folk and official medicinal practices.

The distribution of biologically active compounds identified in medicinal plants of the Ulytau region is presented in Figure 4. flavonoids, alkaloids, vitamins, tannins, and essential oils were among the most frequently recorded groups of compounds, whereas glycosides, mucilage, and triterpene saponins were represented by considerably fewer species. Flavonoids constituted the most abundant group, whereas glycosides, mucilage, and saponins were recorded less frequently.

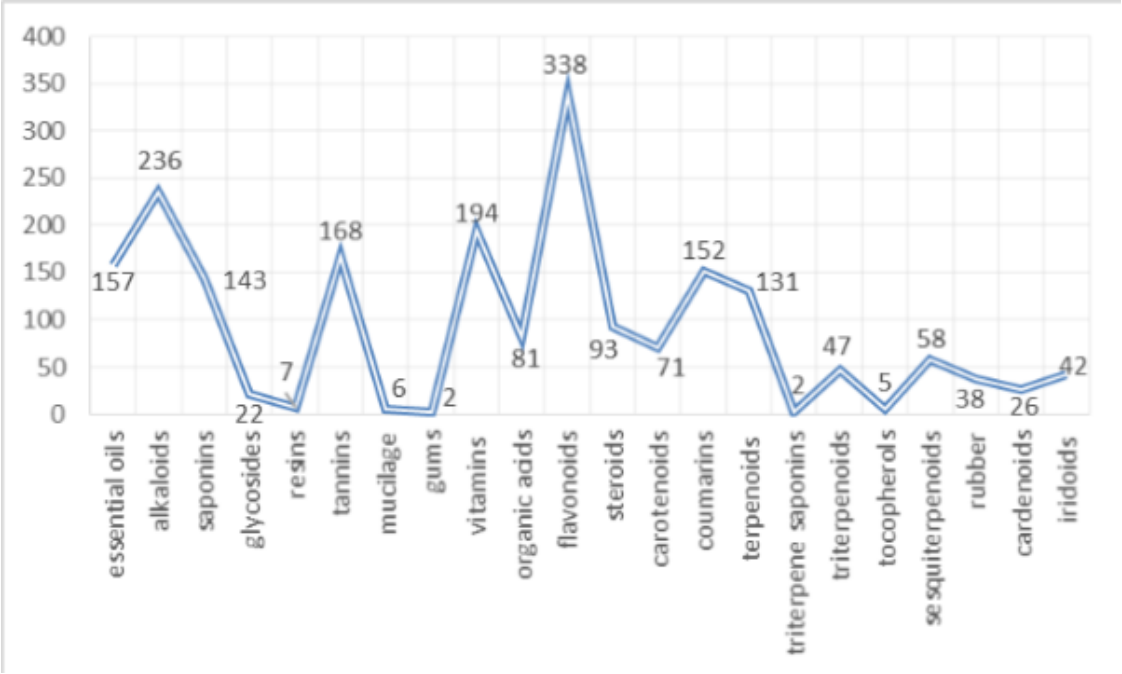

Figure 4. Distribution of biologically active compounds in medicinal plants

The results showed that medicinal plants of the Ulytau region are used in various medicinal practices, with folk medicine representing the largest category of application. Official, Eastern, and experimental medicine also include a substantial number of species, whereas considerably fewer plants are used in Western medicine, veterinary medicine, and homeopathy. These data indicate that medicinal plants of the Ulytau region have a wide range of documented applications in different medicinal practices.

Discussion

A total of 502 medicinal plant species belonging to more than 40 families were identified in the Ulytau region. The families *Campanulaceae, Asteraceae, Lamiaceae, Fabaceae,* and *Papaveraceae* contained the largest numbers of species. Similar patterns are typical of steppe and semi-desert floras of Central Kazakhstan.

The analysis of biologically active compounds showed that flavonoids, alkaloids, tannins, and essential oils were among the most frequently recorded groups in the medicinal plants of the Ulytau region. Similar groups of compounds have been reported for numerous medicinal species and are often associated with their pharmacological properties [24–26]. The obtained results indicate that many plant species occurring in the region may be of interest for further phytochemical studies.

Field surveys conducted in the Ulytau region demonstrated a high level of taxonomic diversity and a wide spectrum of plant life forms characteristic of the vegetation cover of Central Kazakhstan. The flora of the region is represented by heterogeneous steppe and semi-desert plant communities adapted to continental arid ecosystems. The obtained results are consistent with the studies of Kupriyanov et al. (2017) and the Flora of the Ulytau Mountains (2016), which report substantial floristic diversity and considerable medicinal plant resources within the region [27-29].

Comparative analysis of the medicinal flora of the Ulytau region with floristic inventories from other regions of Kazakhstan revealed significant similarities with the vegetation of dry and small-grass steppe ecosystems. At the same time, the flora of the Ulytau region is characterized by a relatively higher representation of the families *Campanulaceae, Lamiaceae,* and *Papaveraceae,* indicating the ecological specificity and floristic uniqueness of the regional vegetation cover [30].

The obtained results contribute to the expansion of current knowledge regarding the medicinal flora of Central Kazakhstan and demonstrate the significant scientific and practical potential of the region for further phytochemical and pharmacological studies. Future investigations should focus on the identification of biologically active compounds, assessment of pharmacological properties, and long-term ecological monitoring of medicinal plant populations under changing environmental conditions. These studies are essential for the conservation of botanical diversity and the sustainable use of medicinal plant resources.

Conclusion

A total of 502 medicinal plant species belonging to 315 genera and more than 40 families were recorded in the Ulytau region. The highest species richness was observed in *Asteraceae, Lamiaceae, Fabaceae, Papaveraceae,* and *Campanulaceae.* The conducted survey of medicinal plants in the Ulytau region confirmed the considerable potential of the regional flora as a source of biologically active natural compounds. The screening revealed high taxonomic diversity, including representatives of more than 40 families of higher vascular plants. The greatest species richness was recorded in the families *Asteraceae, Lamiaceae, Fabaceae, Papaveraceae,* and *Campanulaceae*. The predominance of these taxa reflects not only the floristic richness of the region but also the high adaptive capacity of local plant communities to sharply continental and arid environmental conditions.

The obtained results demonstrate the significant ecological, pharmacological, and practical importance of the medicinal flora of the Ulytau region. The identified plant resources may serve as promising sources of biologically active compounds for pharmaceutical, phytochemical, and biotechnological applications. Further investigations should focus on detailed phytochemical screening, evaluation of pharmacological activity, and long-term ecological monitoring of medicinal plant populations to ensure the conservation and sustainable use of regional biodiversity.

Author Contributions

Sh.A. – formal analysis, collecting information and writing**; S.A.** and **G.T.–** supervisor of the study, critically revising its content; **B.B.**- conceptualization.

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Conflicts of Interest

The authors declare no conflicts of interest.

Compliance with ethical standards

This article does not contain a description of studies performed by the authors involving people or using animals as objects.

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Скрининг лекарственных растений в Улытауской области и их общие характеристики

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Аннотация. В статье представлен скрининг лекарственных растений в Улытауской области (Центральный Казахстан) и их общих ботанических и экологических свойств. В 2024-2025 годах были проведены полевые исследования в Жанааркинских и Улытауских районах, в ходе которых было обнаружено 502 вида из 315 родов и более 40 семейств высших сосудистых растений. Наибольшее видовое разнообразие наблюдалось в семействах *Asteraceae, Lamiaceae, Fabaceae, Papaveraceae* и *Campanulaceae*. Анализ жизненных форм показал преобладание многолетних травянистых растений (65-70%), что свидетельствует об экологической гибкости флоры в условиях резко континентального климата. Однолетние и двулетние виды составляют 15% и 8-10% флоры соответственно, в то время как кустарники, деревья и лианы встречаются гораздо реже. Изучение применения лекарственных растений показало, что количество видов, используемых в народной медицине, - около 400, в официальной медицине — около 180, а в восточной, экспериментальной, западной медицине, ветеринарии и гомеопатии - от 10 до 120 видов. Работа подтверждает высокую таксономическую и экологическую ценность лекарственной флоры Улытауской области и дополнительно акцентирует внимание на ее роли как источника природных биологически активных соединений для фармакологии и медицины.

Ключевые слова: лекарственные растения, флора Улытауской области, таксономическое разнообразие, формы жизни, народная медицина, биологически активные соединения, Центральный Казахстан.

Ұлытау облысындағы дәрілік өсімдіктердің скринингі және олардың жалпы сипаттамалары

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Аңдатпа. Бұл мақалада Ұлытау аймағындағы (Орталық Қазақстан) дәрілік өсімдіктердің скринингі және олардың жалпы ботаникалық және экологиялық қасиеттері ұсынылған. 2024-2025 жылдары Жаңаарқа және Ұлытау аудандарында далалық зерттеулер жүргізілді, оның барысында 315 туыстан және 40-тан астам жоғары сатыдағы тамырлы өсімдіктер тұқымдасынан 502 түр анықталды. Түрлердің ең жоғары әртүрлілігі *Asteraceae, Lamiaceae, Fabaceae, Papaveraceae* және *Campanulaceae* тұқымдастарында байқалды. Тіршілік

формаларын талдау көпжылдық шөптесін өсімдіктердің басым екенін (65-70%) анықтады, бұл күрт континенталды климатта флораның экологиялық икемділігін көрсетеді. Біржылдық және екіжылдық түрлер флораның сәйкесінше 15% және 8-10% құрайды, ал бұталар, ағаштар және лианалар әлдеқайда сирек кездеседі. Дәрілік өсімдіктерді пайдалануды зерттеу халық медицинасында қолданылатын түрлердің саны (шамамен 400 түрі) дәстүрлі медицинада шамамен 180 екенін, ал шығыс, эксперименттік және батыс медицинасында, ветеринарияда және гомеопатияда 10-нан 120-ға дейін түрі қолданылатынын анықтады. Зерттеу Ұлытау аймағының дәрілік флорасының жоғары таксономиялық және экологиялық құндылығын растайды және оның фармакология мен медицина үшін табиғи биологиялық белсенді қосылыстардың көзі ретіндегі рөлін одан әрі атап көрсетеді.

Түйін сөздер: дәрілік өсімдіктер, Ұлытау облысының флорасы, таксономиялық әртүрлілік, тіршілік формалары, халық медицинасы, биологиялық белсенді қосылыстар, Орталық Қазақстан.

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