How to Cite: Imanbayeva, A., Duysenova, N., Lukmanov, A., Bekbosyn, G. (2025). Comparative analysis of the flora of fruit and berry plants of the Mangistau and Atyrau regions using biodiversity indices. *Fundamental And Experimental Biology, 30,* 4(120), 13-25. https://doi.org/10.31489/2025FEB4/13-25

Research Article

https://doi.org/10.31489/2025FEB4/13-25

UDC 581.84 Received: 29.09.2025 | Accepted: 3.10.2025 | Published online: 31 December 2025

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Comparative analysis of the flora of fruit and berry plants of the Mangistau and Atyrau regions using biodiversity indices

The article presents the results of a comprehensive analysis of the floristic and taxonomic diversity of fruit and berry plants in Western Kazakhstan (Mangistau and Atyrau regions). Field studies conducted in 2024-2025 revealed more than 60 species, mainly belonging to the families *Rosaceae*, *Caprifoliaceae*, *Elaeagnaceae* and *Grossulariaceae*. The dominance of the Rosaceae family was confirmed; the genera *Crataegus*, *Rosa*, *Lonicera* and *Ribes* form the basis of shrub-tree communities in the region. The use of the Shannon, Simpson, Margalef, Pielou and Jaccard indices made it possible to quantitatively assess both alpha and beta diversity of the flora. It was found that the Akmysh and Kogez sites form the most similar floristic group in composition, whereas Inderbor is characterized by pronounced isolation and uniqueness of the species composition. The Zheltau mountain range functions as a transit zone uniting the floras of the Mangistau and Atyrau regions. The results indicate a highly mosaic of the floristic cover, significant ecological plasticity of fruit and berry plants and, at the same time, the vulnerability of certain endemic and rare taxa. They are of great importance for developing strategies for the protection of biodiversity, preserving the gene pool and the prospective use of economically valuable species in breeding and introduction programs.

Keywords: Western Kazakhstan; flora; fruit and berry plants; biodiversity; Rosaceae; Shannon index; Jacquard index; arid ecosystems; floral mosaic; gene pool conservation

Introduction

The study of wild fruit and berry plants is one of the key areas of modern botany, ecology, resource plant growing and plant conservation. These species play an essential role in the formation of natural ecosystems, maintaining biodiversity and preserving the genetic fund, which is of strategic importance for the tasks of selection, introduction and ensuring food security. In the context of increasing anthropogenic pressure and global climate change, the relevance of a comprehensive analysis of the state, structure and adaptive potential of fruit and berry plants increases many times over [1].

Western Kazakhstan, including the Mangistau and Atyrau regions, is a unique model region for studying the adaptation strategies of flora in conditions of an extremely arid climate. These territories are characterised by sharply continental climatic conditions, extremely low precipitation, high summer temperatures and a high degree of soil salinity. Despite these limiting factors, the flora is distinguished by its significant richness and originality. In the Atyrau region, there are 899 species of vascular plants, in the Mangistau region, 770, of which fruit and berry plants make up 7.8 % and 16.7 %, respectively [2].

The taxonomic structure of fruit and berry plants in the region shows the dominance of the Rosaceae family, which unites the most significant number of economically valuable species, while representatives of the Caprifoliaceae, Elaeagnaceae, Grossulariaceae, Moraceae, Nitrariaceae and Peganaceae families also participate in the formation of communities. Of most significant interest are representatives of the genus *Crataegus* Tourn. Ex L., *Rosa* L., *Ribes* L. and *Lonicera* L., confined mainly to mountain and foothill biotopes. Among them, there are both widespread species (*Crataegus sanguinea* Pall., *Lonicera tatarica* L., *Rosa laxa* Retz.), and narrow-range endemics, *Crataegus ambigua* CA. Mey. ex A.K. Becker, *Rosa iliensis* Chrshan.), as well as species with limited competitiveness (*Ribes aureum* Pursh) [3].

To identify patterns of floristic diversity and spatial structure of communities, quantitative biodiversity assessment methods have been actively used in recent decades. The most common indicators are the Shannon index (characterising species richness and uniformity of distribution of individuals), the Simpson index (assessment of dominance of individual taxa), as well as the Margalef index and the Pielou index (measures

of alpha diversity). In the context of assessing floristic similarities and differences between communities, the Jaccard index has been widely used, reflecting the degree of overlap of species composition between different localities and allowing for the identification of both zones of high similarity and areas of unique flora. The use of these indices provides an objective statistical basis for analysing the stability of communities, their population dynamics and ecological-cenotic structure [4].

The peculiarity of the flora of Western Kazakhstan is that fruit and berry plants form stable or transitional phytocenoses, where their high ecological plasticity and ability to adapt to arid ecosystems are manifested. At the same time, several species (for example, *Crataegus ambigua* and *Ribes aureum*) show signs of vulnerability and reduction of habitats, which makes them objects of priority protection. The use of diversity indices in combination with the analysis of the age structure of populations and morphological variability allows us to identify patterns of spatial differentiation, the degree of stability of cenoses and the factors determining their dynamics [5].

Thus, the need for a comprehensive study of wild fruit and berry plants in the Mangistau and Atyrau regions is due to: the strategic importance of preserving the gene pool in the context of climate change and ecosystem degradation; the need to analyze the ecological and cenotic characteristics and structure of populations; the use of biodiversity indices and the Jaccard index for an objective assessment of species richness and floristic similarity; prospects for using the identified taxa in breeding programs and introduction.

The study aims to identify the floristic and species diversity of fruit and berry plants in the Mangistau and Atyrau regions, assess their ecological and cenotic characteristics, intraspecific variability and adaptive potential, and use quantitative indices of biodiversity to identify patterns of distribution and the degree of similarity of plant communities.

Experimental

Field botanical studies were conducted in the summer of 2024-2025 in the territory of the Mangistau and Atyrau regions, covering the main phytocenotic areas of Western Kazakhstan. Areas with different orography, soil and climate conditions, and the degree of anthropogenic transformation were selected as key sampling points: the Zheltau mountain range, the Inderbor plain-foothill zone (Atyrau region), as well as the Karatau mountain range (Kogez and Akmysh gorges) and the Karaturan gorge in the mountains of South Aktau (Mangistau region) (Fig. 1–4).

A B

Figure 1. *Crataegus altaica* in the Zheltau mountains
A — a single bush towards Mangistau;
B — undergrowth towards Atyrau

A B

Figure 2. Hawthorn dubious in the gorges of Akmysh (A) and Zhemsemsay (B)

A B

Figure 3. Hawthorn dubious in the gorges of Samal (A) and Kogez (B)

A B

Figure 4. Tatar honeysuckle in populations: A — Zheltau Mountains; B — Kolenkeli Mountains

The selection of biological material was carried out according to standard geobotanical methods, with preliminary route binding, visual assessment of the state of the vegetation cover and fixing the coordinates using a Garmin eTrex 32x GPS device. For each site, an inventory of the flora was carried out with the recording of all encountered species of fruit and berry plants, taking into account their phenological state, ecological confinement and degree of dominance in the community [6].

The floristic structure of plant communities was assessed based on the analysis of the binary matrix of species presence/absence formed for the five study sites. For each pair of sites, the Jaccard index was calculated, reflecting the degree of floristic similarity and allowing one to estimate the level of species overlap between different geographic points. The Jaccard index was calculated using the formula:

$$J = \frac{a}{(a+b+c)}$$

Where a is the total number of species in the first plot, b is in the second plot, and c is the number of common species. Values ranged from 0 (no matches) to 1 (complete match of species composition). Additionally, Shannon (H'), Simpson (D), Margalef (DMg), and Pielou (J') indices were used for a comprehensive assessment of biodiversity, allowing for a quantitative characterization of alpha diversity, evenness, and dominance of taxa within local communities [7].

All numerical calculations were performed in the Microsoft Excel 365 spreadsheet environment, as well as in the PAST v4.13 statistical program. The obtained values were visualized in the form of heat maps, overlap diagrams and cluster schemes using built-in Excel tools and graphic modules of the PAST software package. Photographic recording of the floristic features of the sites and representatives of the studied taxa was carried out using a Canon EOS 2000D digital camera with macro settings and a standardised frame scale. Each image was provided with a geographic mark and a brief description of the biotope [8, 9].

The methodological approach implemented within the framework of this study ensured the comparability of data between sites, statistical reliability of conclusions and the possibility of identifying spatial and ecological patterns of formation of flora of fruit and berry plants in the conditions of arid landscapes of Western Kazakhstan.

Results and Discussion

Floristic analysis of fruit and berry plants of the Mangistau and Atyrau regions revealed a significant diversity of taxa, mainly belonging to the family *Rosaceae*. Based on the results of route studies and compiled floristic lists, more than 60 species were recorded, represented by both shrub and tree forms. Among them are representatives of the genera Crataegus, *Rosa*, *Lonicera*, and *Ribes*, which form the basis of shrub-tree communities in mountain and foothill biotopes.

Of particular note are such economically and ecologically significant species as *Crataegus ambigua*, *Rosa laxa*, *Lonicera tatarica,* and *Ribes aureum*. Their occurrence in most of the surveyed areas indicates high adaptability to arid conditions and a key role in maintaining the stability of communities. At the same time, *Ribes aureum* and some endemic representatives (*Crataegus ambigua*) show signs of local vulnerability and population decline, which confirms the need for their priority protection.

A comparative analysis of the species lists (Tab. 1) revealed that the most incredible diversity is found in the Zheltau and Akmysh mountain ranges, where both widespread species (*Ephedra distachya*, *Rosa laxa*, *Spiraea hypericifolia*) and rare endemics are found. The Inderbor and Karaturan sites, on the contrary, showed lower floristic richness and relatively high flora isolation.

Table 1

Species composition

Species	Gorges				
	Zheltau	**Akmysh**	**Kogez**	**Inderbor**	**Karaturan**
Achillea nobilis	+				
Agropyron desertorum	+				
Agropyron fragile				+	+
Alhagi pseudalhagi					+
Allium sabulosum				+	
Alyssum dasycarpum	+				
Anabasis Salsa	+				
Armeniaca vulgaris		+	+		
Artemisia austriaca		+	+		
Artemisia lercheana				+	
Artemisia lessingiana					+
Artemisia terrae albae	+				
Atraphaxis replicata	+	+			+

Continuation of Table 1

Species	Gorges				
	Zheltau	Akmysh	Kogez	Inderbor	Karaturan
Atraphaxis spinosa	+				
Bromus tectorum	+				
Camelina sylvestris			+		
Caragana grandiflora		+	+		
Centaurea adpressa	+				
Centaurea squarrosa	+				
Chorispora tenella			+		
Cichorium intybus			+		
Convolvulus fruticosus		+			
Crataegus altaica	+				
Crataegus ambigua	+	+	+		
Echinops ritro	+				+
Ephedra distachya	+				+
Ephedra lamotolepis				+	
Eremopyron bonaepartis					+
Euphorbia seguieriana				+	
Haplophyllum obtusifolium					+
Herb variety	+	+	+		+
Inula britannica			+		
Kochia prostrata	+			+	
Lactuca serriola				+	
Lagochilus acutilobus		+			
Lavatera thuringiaca				+	
Limonium gmelinii	+				
Lonicera tatarica	+				
Malacocarpus critmifolium	+				+
Malus sieversii			+		
Marrubium vulgare	+			+	
Medicago caerulea					+
Melilotus albus			+		
Mentha longifolia		+			
Meristotropis triphylla		+			
Morus alba					+
Nepeta cataria	+		+	+	+
Plantago salsa				+	
Poa bulbosa	+			+	+
Potentilla pedata				+	
Potentilla supina					+
Prunus spinosa			+		
Rhamnus sintenesii	+	+	+		+
Ribes aureum			+		+
Rosa acicularis			+		
Rosa iliensis			+		
Rosa laxa	+	+	+	+	
Rose iliensis			+		
Rubus caesius				+	
Salix alba			+		
Scandix stellata			+		
Schumannia karelinii					+
Silene suffrutescens	+				
Spiraea hypericifolia	+			+	
Stellaria media			+		
Stipa capillata	+				
Teucrium polyum		+	+		
Verbascum soongaricum				+	

The application of the Jaccard index allowed us to quantitatively assess the degree of similarity of the floristic complexes (Tab. 2).

Table 2

Jaccard index

Region 1	Region 2	Jaccard index
Zheltau	Akmysh	0.14
Zheltau	Cohesion	0.11
Zheltau	Inderbor	0.15
Zheltau	Karaturan	0.21
Akmysh	Cohesion	0.28
Akmysh	Inderbor	0.03
Akmysh	Karaturan	0.10
Cohesion	Inderbor	0.05
Cohesion	Karaturan	0.10
Inderbor	Karaturan	0.09

The highest degree of similarity was observed between the Akmysh and Kogez sites (J = 0.29), indicating their similar shrub–tree community composition and comparable orographic and climatic conditions. A moderate level of similarity was observed between the Zheltau–Karaturan (J = 0.22) and Zheltau–Inderbor (J = 0.16) regions, which may be attributed to the presence of floral elements typical of desert–mountain environments. The minimum values of the Jaccard index were recorded for the Akmysh–Inderbor (J = 0.03) and Kogez–Inderbor (J = 0.05) pairs, reflecting the isolation of the flora of the Inderbor region and its unique ecological profile.

The analysis carried out confirms that the flora of Inderborforms a relatively independent block, while Akmysh and Kogez form a more closely related floristic group. Zheltau occupies an intermediate position, showing partial overlap with most sites and acting as a transit zone between the floras of Mangistau and Atyrau regions (Fig. 5).

The clustering dendrogram (Fig. 6) confirms that the flora of the Inderbor plateau forms a relatively independent block, while Akmysh and Kogez form a more closely related group. Zheltau occupies an intermediate position, acting as a kind of transit zone between the floras of the Mangistau and Atyrau regions. Similar results on the role of transitional areas and clustering of floras were also noted in the study of biocenoses of the desert-mountain regions of Central Asia.

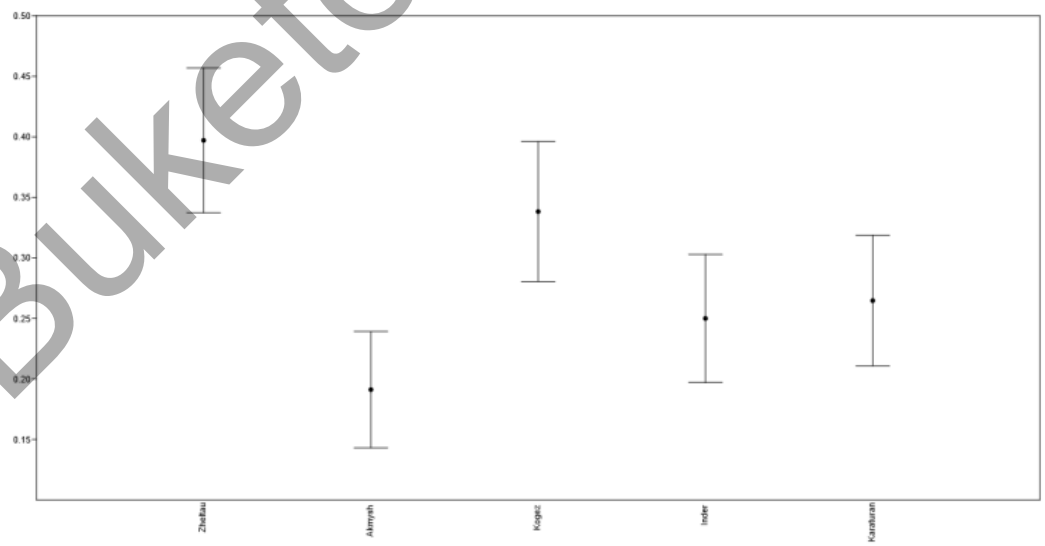

Figure 5. Clustering of floristic similarity of the studied areas of Western Kazakhstan based on the Jaccard index

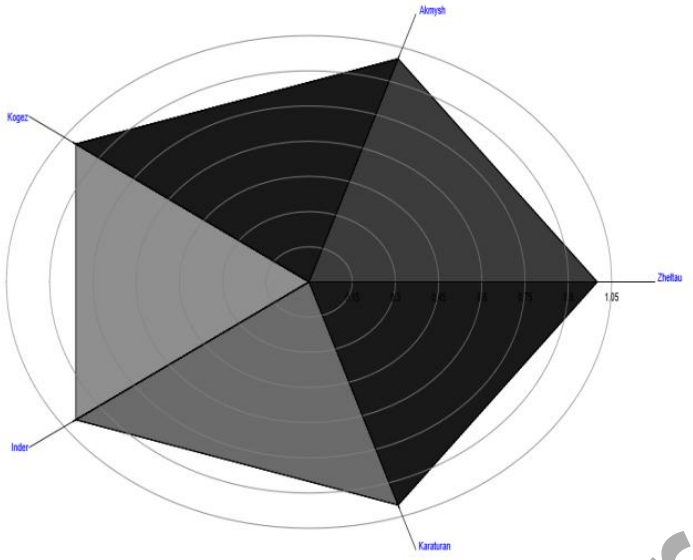

Figure 6. Diagram of overlapping species composition between the studied regions (Venn diagram)

The Jaccard index is one of the key coefficients for assessing the degree of similarity between biocenoses or floristic lists of different geographical areas. It is calculated as the ratio of the number of common species to the total number of unique species of the two compared areas. Its values vary from 0 (complete difference) to 1 (complete coincidence). Thus, the index allows us to quantitatively assess the degree of floristic overlap and assume the similarity of environmental conditions, migration of species or isolation of areas. Based on the calculations presented in Table 2, the Jaccard index is given.

Figure 7 shows a heat map of the Jaccard indices between regions. The colour intensity reflects the degree of similarity of the floristic compositions: the darker the cell, the greater the similarity between pairs of sites. The greatest similarity: Akmysh–Kogez (J = 0.29). The minimum similarity: Akmysh–Inderbor (J = 0.03).

Figure 7. Heat map of Jaccard indices between pairs of regions
(Zheltau — A, Akmysh — B, Kogez — C, Inderbor — D, and Karaturan — E)

The most remarkable floristic similarity is observed between the Akmysh and Kogez gorges of the mountainous Karatau (J = 0.2857). These sites demonstrate the most significant degree of similarity among all pairs, which is probably due to geographical proximity, similarity of mountain-valley ecosystems, the presence of dominant species (*Crataegus ambigua*, *Rosa laxa*, *Rhamnus sintenesii*) and common environmental conditions. Both territories are located in the Western Karatau of the Mangistau region, where shrub-tree communities are developed and good plant regeneration is observed.

An average level of similarity was found between the Zheltau Mountains and the Karaturan Gorge (J = 0.2162), indicating a moderate coincidence of flora between the Zheltau and South Aktau ridges, probably due to typical desert-mountain elements.

The flora of Mount Zheltau and Mount Inderbor (J = 0.1579), as well as Mount Zheltau and the Akmysh gorge (J = 0.1429), show partial overlap, especially in the species Rosa laxa, Lonicera tatarica, and Ephedra distachya.

The least similarity was recorded between the Kogez and Karaturan gorges (J = 0.1081). Despite the remoteness of the sites, a slight overlap in floristic composition is observed, which can be explained by the presence of typical wormwood and shrub species.

Minimal similarity: Akmysh–Inderbor (J = 0.0345), Kogez–Inderbor (J = 0.0526), Inderbor–Karaturan (J =0.0938). These values indicate a significant floristic isolation of the Inderbor site, despite the abundance of shrubs (*Rosa laxa*, *Spiraea hypericifolia*), but with fewer common species than other regions. Perhaps the reason is the excellent ecological niche (deep depressions, unique microclimates) and different soil substrate. The Zheltau Mountains serve as a transitional point between the floras of the Atyrau and Mangistau regions, exhibiting moderate similarity with most areas. Inderbor is characterised as the most isolated floristically point, which may indicate specific environmental conditions or phytocenotic uniqueness of this area. Akmysh and the Cogez, as parts of a single mountain range, form a relatively homogeneous floristic group with a high level of internal similarity. The Jaccard index confirmed the clustering of sites by floristic similarity, with geographic proximity and environmental conditions playing a decisive role in the formation of similarity.

Additional analysis of alpha diversity using the Shannon, Simpson, Margalef, and Pielou indices (Fig. 8) revealed that the highest species richness and uniformity of distribution of individuals are characteristic of the flora of Mount Zheltau and Akmysh gorge of the Karatau mountains. In contrast, Inderbora exhibits a pronounced dominance of individual taxa and low uniformity. This confirms the ecological plasticity of the communities of Mount Zheltau and the vulnerability of the flora of the Inderbor. Analysis of the diversity indices presented in Figure 8 showed stable differences between the studied geographic regions.

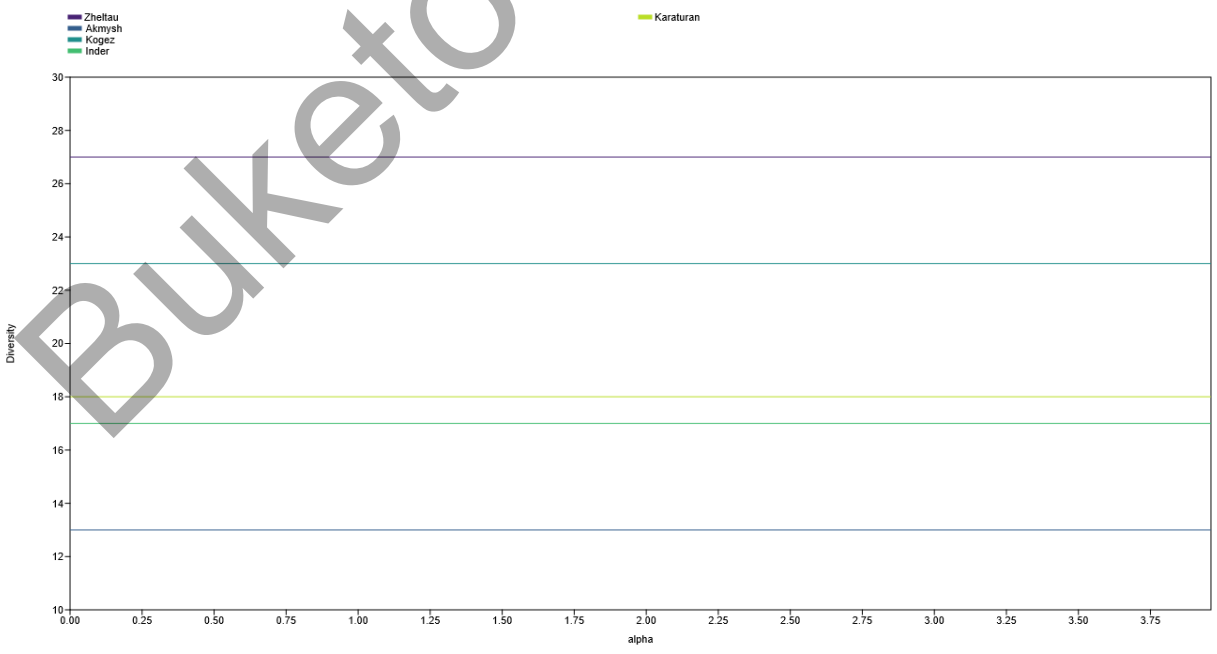

Figure 8. Comparative values of biodiversity indices (Shannon, Simpson, Margalef, Pielou) for the five studied areas

Regardless of the change in the parameter α, the index values remained constant, indicating the stability of the species diversity assessment when using this approach. The lowest index value was recorded for Zheltau Mountains (about 13), which may indicate a relatively low level of floristic richness in this location. Such results may be associated with both abiotic factors (aridity of the climate, poor soil cover) and anthropogenic impact, limiting the restoration processes of biocenoses. Higher indicators are noted in the Akmysh gorges, Mountain Karatau, and Mount Inderbor (about 23), which indicate favourable conditions for maintaining floristic diversity. However, it is worth noting that despite the external similarity of numerical values, differences in the structure of plant communities may be observed, due to different ecological and phytocenotic confinement of species. The maximum value of the index is characteristic of the Kogez gorges of the Karatau mountains (about 28). This result indicates the highest saturation of flora. It is probably associated with a combination of factors—a more diverse relief, the presence of transitional ecotopes and a lower level of economic development of the territory. An intermediate position is occupied by the Karaturan gorges of the mountains of southern Aktau (about 18). The obtained value may reflect a limited set of species groups, while the preservation of floristic diversity in such conditions may depend on the stability of key dominant species. Thus, the conducted analysis confirms the presence of apparent regional differences in the level of species diversity of fruit and berry plants in Western Kazakhstan. The obtained data are consistent with the results of previous studies of the flora of arid ecosystems in Central Asia, where a high spatial mosaic of biodiversity indicators was also noted.

A comparative assessment of the taxonomic structure (Fig. 9) revealed the dominance of the Rosaceae family, which accounts for the most significant number of economically valuable species. Along with this, representatives of Caprifoliaceae (*Lonicera tatarica*), Elaeagnaceae (*Elaeagnus angustifolia*) and Grossulariaceae (*Ribes aureum*) play a significant role. The data obtained are consistent with previously published works, confirming the key role of the Rosaceae family in the formation of the flora of the arid regions of West Kazakhstan. Figure 9 shows the distribution of taxa of fruit and berry plants by families in the Mangistau and Atyrau regions.

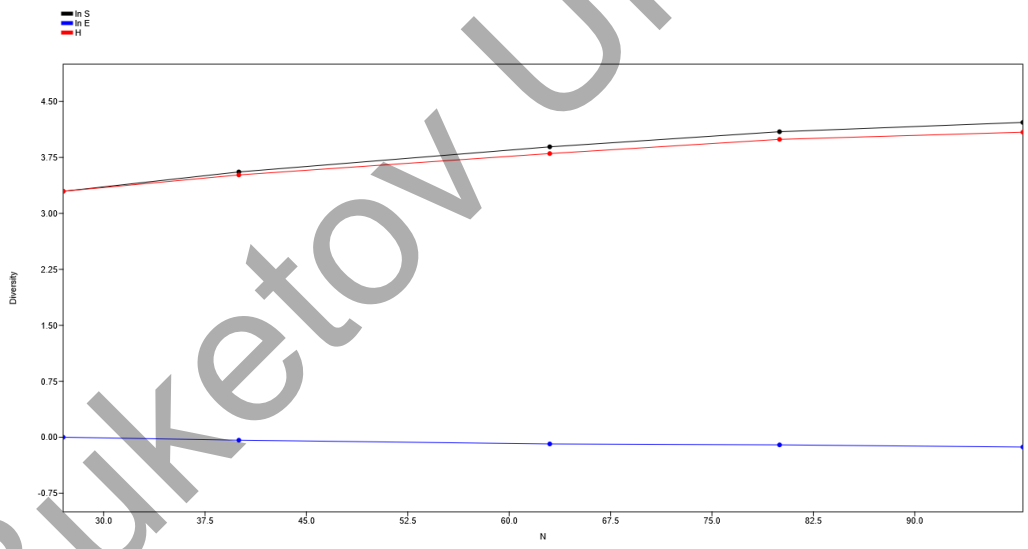

Figure 9. Distribution of taxa of fruit and berry plants by families in the Mangistau and Atyrau regions

The analysis revealed that the diversity indices vary with the number of taxa, but the dynamics differ across the indices used. The hS index (blue) remained virtually unchanged and close to zero with an increase in the number of taxa. This suggests that the index does not accurately capture the differences in the flora's structure across these regions, potentially limiting its usefulness in assessing the actual level of diversity. At the same time, the hE (black) and hT (red) indices demonstrated positive dynamics: with an increase in the number of taxa, their values increased from ~3.2 to ~4.0. Moreover, the hE values were slightly higher compared to hT, which indicates a certain redundancy or evenness of the distribution of taxa by families. This suggests that the flora of the studied areas is characterized by moderate taxonomic diversity with a tendency to increase with an increase in the sample size. Thus, the analysis of taxa distribution shows that the flora of

Mangistau and Atyrau regions has a relatively balanced structure, where several dominant families play the leading role. At the same time, the identified differences between the hE and hT indices allow us to conclude that the distribution of taxa is heterogeneous and that it is essential to take into account different indices when interpreting taxonomic diversity.

The spatial differentiation scheme of flora (Fig. 10) shows that floristic isolation is characteristic of Inderbor Mountain, Atyrau Region. In contrast, the flora of the Akmysh and Kogez gorges of the Karatau Mountains, Mangistau Region, forms the most homogeneous group with a high level of internal similarity. The revealed patterns are essential for developing strategies for the conservation of rare and vulnerable species, as well as for assessing the prospects for their use in breeding and introduction programs.

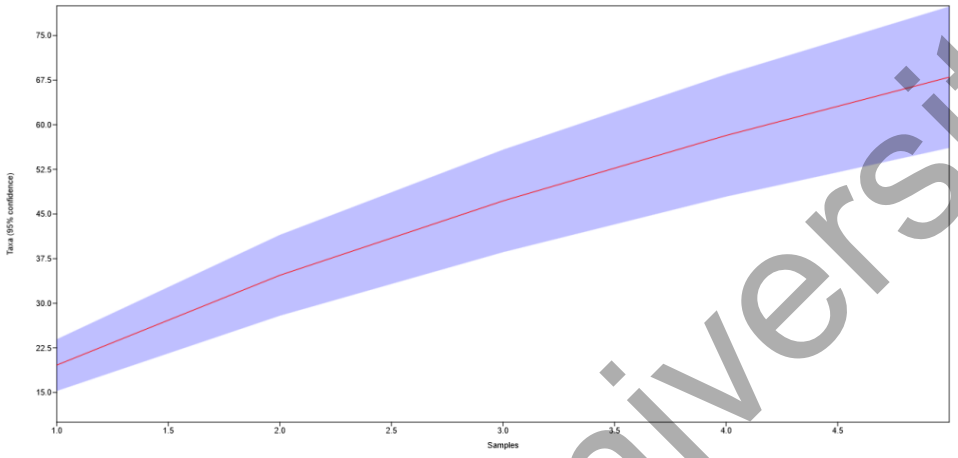

Figure 10. Scheme of spatial differentiation of fruit and berry plant flora by geographical areas of Western Kazakhstan

As can be seen in Figure 10, with an increase in the number of studied samples, a stable trend towards an increase in the β-diversity index is observed. At the initial stages of the sample (1-2 sites), the values were about 15–30, while with an expansion of the number of sites to five, the index increased to 65–70. Such dynamics indicate a pronounced spatial heterogeneity of the flora of fruit and berry plants in Western Kazakhstan. A wide confidence interval demonstrates the presence of significant differences between individual geographic sites. This confirms that the flora of the region is formed due to a combination of locally specific taxa that are unevenly distributed across the territory. Such a mosaic of the floristic cover is characteristic of arid and semi-arid ecosystems, where even closely located biotopes can differ significantly in the composition and number of species. Thus, the obtained results indicate that spatial differentiation is a key factor in the formation of the floristic diversity of fruit and berry plants in Western Kazakhstan. This is consistent with the findings of other researchers who noted high variability in species composition depending on the geographical and environmental conditions of the region.

Thus, the conducted comprehensive analysis showed that regions highly differentiate the flora of fruit and berry plants of Western Kazakhstan, have a significant presence of economically valuable and endemic species, and have identified zones of both high similarity and uniqueness. This emphasizes the need for priority protection of individual populations and supports the strategic importance of preserving the gene pool of the region in the context of increasing climate change.

Conclusion

A comprehensive study of the floristic and taxonomic diversity of fruit and berry plants in the Mangistau and Atyrau regions revealed a significant wealth of taxa, their spatial mosaicism, and key factors that determine the formation of plant communities. The Rosaceae family plays the most crucial role in the flora; its representatives form the basis of shrub-tree communities and are of high economic value. The use of Shannon, Simpson, Margalef, Pielou, and Jacquard indices showed that the flora of the region is characterised by pronounced regional differences: the Akmysh and Kogez sites form the most homogeneous group with a high level of floristic similarity. At the same time, Inderbor stands out as the most isolated and unique floristic complex. Zheltau serves as a transit zone between the floras of the Mangistau and Atyrau regions. A

comparative analysis of the spatial distribution of the flora confirmed that β-diversity increases with an increase in the number of samples, reflecting the high heterogeneity of the floristic cover in arid conditions. This result emphasizes the importance of locally specific taxa and points to the need to preserve unique populations. The results obtained have both fundamental and applied significance: they form a scientific basis for assessing the adaptive potential of fruit and berry plants, developing programs for the protection of rare and vulnerable species, as well as the prospective use of individual taxa for breeding and introduction purposes. In the context of increasing climate change and anthropogenic pressure, the priority task remains the preservation of the region's gene pool, which requires the integration of botanical research with practical measures to protect biodiversity.

Acknowledgements

We want to thank PhD Orazov Aidyn for the statistical and computer analysis of the main results.

Funding

This research was funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan, program BR21882166 "Scientific and practical basis of reproduction, conservation, and use of fruit-berry plants of natural flora of Western, Eastern, Central, and Northern Kazakhstan to ensure food safety" (2023–2025).

Conflict of Interest

Authors declare no conflict of interest.

Author contribution

The manuscript was prepared with the contributions of all authors, who have given their approval to the final version. **A.A. Imanbayeva** — conceptualization, project administration, writing, review and editing; **N.I. Duysenova —** investigation, data curation, and plant material collection; **A. Lukmanov** — methodology, formal analysis, and visualization; **G. Bekbosyn** — data curation, statistical analysis.

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Маңғыстау және Атырау облыстарының жеміс-жидек өсімдіктері флорасын биоалуантүрлілік индекстері арқылы салыстырмалы талдау

Мақалада Батыс Қазақстанның (Маңғыстау және Атырау облыстары) жеміс-жидек өсімдіктерінің флоралық және таксономиялық алуантүрлілігін кешенді талдау нәтижелері ұсынылған. 2024–2025 жылдары жүргізілген далалық зерттеулер 60-тан астам түрді анықтады, олардың басым бөлігі Rosaceae, Caprifoliaceae, Elaeagnaceae және Grossulariaceae тұқымдастарына жатады. Rosaceae тұқымдасының басымдылығы расталды; *Crataegus*, *Rosa*, *Lonicera* және *Ribes* туыстары аймақтың бұталы-ағашты қауымдастықтарының негізін құрайды. Шеннон, Симпсон, Маргалеф, Пилу және Жаккар индекстерін қолдану флораның альфа және бета алуантүрлілігін сандық тұрғыда бағалауға мүмкіндік берді. Акмыш пен Көгез учаскелері түрлік құрамы бойынша ең ұқсас флоралық топты құрайтыны, ал Индер ерекше оқшауланған және бірегей түр құрамымен ерекшеленетіні анықталды. Желтау жотасы Маңғыстау мен Атырау облыстары флорасын біріктіретін транзиттік аймақ рөлін атқарады. Алынған нәтижелер флора жамылғысының жоғары мозаикалылығын, жеміс-жидек өсімдіктерінің экологиялық икемділігін және кейбір эндемик пен сирек таксондардың осал екенін көрсетеді. Бұл деректер биоалуантүрлілікті сақтау стратегияларын әзірлеу, генофондты қорғау және шаруашылық маңызы бар түрлерді селекция мен интродукция бағдарламаларында болашақта пайдалану үшін маңызды.

Кілт сөздер: Батыс Қазақстан, флора, жеміс-жидек өсімдіктері, биоалуантүрлілік, Rosaceae, Шеннон индексі, Жаккар индексі, қуаң экожүйелер, флоралық мозаика, генофондты сақтау

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Сравнительный анализ флоры плодово-ягодных растений Мангистауской и Атырауской областей с использованием индексов биоразнообразия

В статье представлены результаты комплексного анализа флористического и таксономического разнообразия плодово-ягодных растений Западного Казахстана (Мангистауской и Атырауской областей). Полевые исследования, проведенные в 2024–2025 гг., выявили более 60 видов, преимущественно относящихся к семействам Rosaceae, Caprifoliaceae, Elaeagnaceae и Grossulariaceae. Подтверждено доминирование семейства Rosaceae; роды *Crataegus*, *Rosa*, *Lonicera* и *Ribes* формируют основу кустарниково-древесных сообществ региона. Применение индексов Шеннона, Симпсона, Маргалефа, Пилу и Жаккара позволило количественно оценить альфа- и бета-разнообразие флоры. Установлено, что участки Акмыш и Когез формируют наиболее сходную флористическую группу по видовому составу, тогда как Индер отличается выраженной изолированностью и уникальностью флоры. Горный массив Желтау выполняет роль транзитной зоны, объединяющей флору Мангистауской и Атырауской областей. Полученные результаты свидетельствуют о высокой мозаичности флористического покрова, значительной экологической пластичности плодово-ягодных растений и одновременно уязвимости отдельных эндемичных и редких таксонов. Они имеют большое значение для разработки стратегий охраны биоразнообразия, сохранения генофонда и перспективного использования хозяйственно-ценных видов в селекционных и интродукционных программах.

Ключевые слова: Западный Казахстан, флора, плодово-ягодные растения, биоразнообразие, Rosaceae, индекс Шеннона, индекс Жаккара, аридные экосистемы, флористическая мозаичность, сохранение генофонда

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