

Medicinal plants in the flora of Zhetysu Alatau, Zhetysu Region, Kazakhstan

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ABSTRACT

The composition and ranking of medicinal plant species found in Zhetysu Alatau natural habitat are examined and reported in this study. The floristic analyses revealed that the studied region of Zhetysu Alatau has 201 species of medicinal plants, grouped into 125 genera and 37 families. Fabaceae has thirteen, Apiaceae eight, Rosaceae fourteen, Asteraceae twenty-one, and Lamiaceae twelve species. Additionally, information is provided on the stocks of significant medicinal plants in Zhetysu Alatau, including *Inula helenium* L., *Origanum vulgare* L., *Achillea millefolium* L., and *Hypericum perforatum* L.

Keywords: Zhetysu Alatau, Medicinal plants, Prospects, Economic value, Pharmacological activities.

Article type: Research Article.

INTRODUCTION

Since rare raw material deposits and genetic variety have amassed in Kazakhstan's mountainous areas, it is crucial for ecological, economic, and social reasons to preserve and utilize the biodiversity of mountain forest ecosystems. Research on mountain plant resources should be conducted such that the recommendations made may support their preservation even in the face of uniform resource usage and climate change. Zhetysu Alatau is a distinct mountain range with a distinctive environment. Zhetysu Alatau plant reserves are home to a variety of beneficial species, including medicinal ones. *Ephedra equisetina*, *Betula pendula*, *Glycyrrhiza uralensi*, *Crataegus altaica*, *Aconitum soongaricum*, *Berberis sphaerocarpa*, *Inula helenium*, *Ribes nigrum*, *Tanacetum boreale*, and other common medicinal plants can be found in the mountains, hills, and slopes. As a result, Zhetysu Alatau abundance of therapeutic herbs is well recognized. According to V.P. Gluskokov and Gerbari materials from the Institute of Botany and Phytozoology, the flora of Zhetysu Alatau comprises 2168 species, 622 genera, and 112 families (Fig. 1), with 76 unique species that are exclusive to this mountain range. Between 1957 and 1960 The Department of Plant Resources of the Institute of Botany of the Academy of Sciences of the Kazakh SSR, at the request of the Kazakh office of Lekrastrust, conducted scientific expeditions to survey the reserves and distribution of Ephedra horsetail in the Zhetysu Alatau under the leadership of N.V. Pavlova. The results were published in several scientific papers by G.S. Sinitsina, I.A. Gubanova (1966, 1968). Employees of the same department conducted resource studies to identify the most important medicinal plants (Kukenov, *et al.* 1976; Kukenov *et al.* 1988, 1999, 1989; Aidarbaeva 1991, 2021). The promising medicinal plant *Saussurea elegans* Ledeb. was studied, phytochemical studies of biologically active substances (flavonoids, alkaloids, saponins, extractives, free organic acids, vitamin B2 (riboflavin), vitamin C) (Taldybai *et al.* 2021). The localization of some medicinal plants in delta I on the southern macrosurface of the Zhetysu Alatau (Kazakhstan) was studied (Kaliev *et al.* 2023).

Scientists like N.V. Pavlo, M.G. Popov, M.A. Rubetsov, V.P. Gloskokov, A.D. Jangalif, A.L. Kakhtajan, R.V. Kamelin, G.S. Sinitzin, M.K. Koknov, M.S. Baytenov, R.A. Aghoba, D.K. Aydarbayeva, *et al.* examined the flora and species of valuable economic plants of Zhetysu Alatau. This study aims to conduct a thorough evaluation of Zhetysu Alatau medicinal plants to facilitate a more thorough and balanced utilization of regional resources. (Aidarbayeva 2021)

MATERIALS AND METHODS

This research was done on the wilding medicinal plants of Zhetysu Alatau. Various scientific methods such as resource science, geobotany, mapping, and phytochemistry have been used to identify compounds with biological activity. The path method is used to verify the sources. Reserves of raw materials are calculated using model samples or field calculation methods based on certain properties. The length of restoration of each reservoir for each species is considered when calculating the amount of exploitable reserves and the potential annual collection volume. The description of plant communities that contain study objectives is done using geobotanical methods. The material in the publications "Kazakhstan Flora," "Kazakhstan Plants Identification," and "Kazakhstan and Central Asian Plants Identification" served as the basis for the identification of the species. A synopsis of the work done by S.K. Cherpanov and others served as the basis for the type nomenclature.

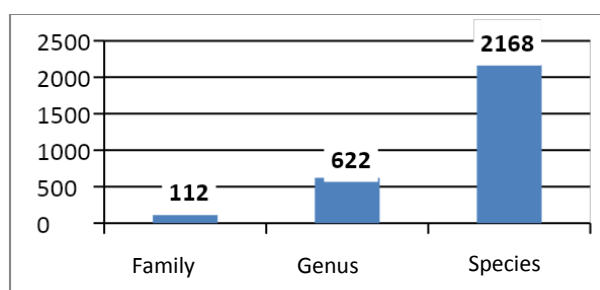


Fig. 1. Distribution of types of plants based on the systematic groups.

Version 1.1 of the Plant List Database for 2013 was utilized to identify the materials. Using the APG IV (Phylogenetic Group of Covering Plants) method, the size of the petaloid plant family is estimated (2020). Identification of drug types based on drug-related information found in the literature, with groupings being divided according to pharmacotherapeutic effects and official and popular medicine types. Based on the broadest extent, the most evident area, and the potential raw material deposits, the types of medications identified are categorized into three categories:

- 1) widely dispersed species that contribute to the formation of significant natural features and are accessible for the commercial collection of raw materials;
- 2) widely distributed species that produce minor natural features and are appropriate for meeting the local pharmacy network's demands for raw materials;
- 3) widely distributed species that do not naturally develop highlights or grow in large enough quantities to be useful for collecting raw materials.

The categorization of species is based on ecological groups that are related to the water regime and life forms. (Serebrjakov 1964) This is in line with the ecomorphological classification of seed plant life forms, which was based on the growth form and vegetative member's duration of life at the time of research. (Korchagin 1964; Krylova 1994), and "Method of determination of reserves of medicinal plants" (Krylova 1981), among other publications, were used as a guide.

RESULTS AND DISCUSSION

Zhetysu Alatau is a mountainous territory that exists independently. It is situated in two botanical regions: the historic southern Mediterranean Sea region (Iran-Tenshan) and the northern boreal region (Siberian-Altaic). The flora of this region is heterogeneous and ephemeral. Orkashir and Jair mountains in China, which rise to a height of 2,500 meters above sea level, are the beginning of the Zytisovsky mountain chain. The Jair meets a level mountain range known as Miley, and the Orkashir forms the Barlik mountain range (3,300 m) close to Kazakhstan's borders. The 400 km long Zhetysu Alatau is made up of two main mountain ranges that are separated

by the Koxu River's long valley, which runs westward and progressively widens. The region is located between the mountains of South Central Asia and South Siberia. At 4622 meters, the northern mountain range has the maximum absolute height as it arcs southward. Despite the strong gravity, the northern slope of this mountain range progressively slopes south and west. Zhetysu Alatau Mountain is located between 44.0° and 46.5° north latitude and 77.5-82.5° east longitude. The Zhetysu Alatau mountain range connects several mountain ranges and divides mountain valleys, or basins, which are mostly spread transversely and progressively narrow toward the west. The deep valley of the Kuksu River (and the Borotala River in the east) splits this core mountain system of Zytsevo along its range into two parts: the southern Kuksoi mountain, which is approximately 100 km long, and the northern Zytsevo mountain, which is approximately 420 km long. This syncline is formed by these two major pillars. The mountain ranges converge over the Kuksu streams to form a mountain core with peaks rising to a height of more than 4,500 meters. The Zhetysu Alatau River receives its primary watershed from this mountain chain, which forms a strong glacier in this area. It is covered across more than 1,000 km² and has more than 150 glaciers in total. The climates of neighbouring plains are very different from those of mountains, particularly when it comes to topographical flexibility, light, heat transport, humidity, precipitation, and other variables. A huge range of climatic conditions exist due to the different territories of Zhetysu Alatau. Studies conducted on the flora of Zytisoski Mountain have led to the identification of 364 species of high-tissue plants, representing 180 genus and 47 families. Thirty percent of the 201 species identified in Alatau Zytisoski's species variety have therapeutic qualities. Some significant families are as follows:

Asteraceae - 21 species, *Lamiaceae* - 12 species, *Rosaceae* - 14 species, *Fabaceae* - 13 species, *Apiaceae* - 8 species, *Poaceae* - 6 species, *Polygonaceae* - 5 species, *Brassicaceae* - 3 species, *Crassulaceae*, *Liliaceae*, *Ranunculaceae*, *Scrophulariaceae*, *Papaveraceae*, *Araceae*, *Boraginaceae*, *Caryophyllaceae*, *Gentianaceae*, *Grossulariaceae*, *Malvaceae* – 2 species each, *Alliaceae*, *Berberidaceae*, *Ephedraceae*, *Hypericaceae*, *Caprifoliaceae*, *Chenopodiaceae*, *Paeoniaceae*, *Peganaceae*, *Alismataceae*, *Asphodelaceae*, *Balsaminaceae*, *Betulaceae*, *Campanulaceae*, *Cupressaceae*, *Elaeagnaceae*, *Equisetaceae*, *Rubiaceae*, *Limoniaceae* – 1 species each. A total of 137 species, or 68.5% of the total species variety of medicinal plants, are parts of seven main families. Thirty families comprise one to three species each, accounting for the remaining sixty-four species (31.5%; Table 1).

Table 1. A taxonomic analysis of the largest families of medicinal plants in the Zhetysu Alatau flora.

Family	Number of reproductions	Total percentage	Species diversity	Total percentage
Asteraceae	21	16.8%	34	17%
Lamiaceae	15	12%	24	12%
Rosaceae	14	11.2%	25	12.5%
Fabaceae	13	10.4%	24	12%
Apiaceae	8	6.4%	10	5%
Poaceae	6	4.8%	9	4.5%
Polygonaceae	5	4%	11	5.5%
Brassicaceae	3	2.4%	3	1.5%
Crassulaceae	2	1.6%	5	2.5%
Liliaceae	2	1.6%	4	2%
Ranunculaceae	2	1.6%	4	2%
Scrophulariaceae	2	1.6%	3	1.5%
Papaveraceae	2	1.6%	3	1.5%
Araceae	2	1.6%	2	1%
Boraginaceae	2	1.6%	2	1%
Caryophyllaceae	2	1.6%	2	1%
Gentianaceae	2	1.6%	2	1%
Grossulariaceae	2	1.6%	2	1%
Malvaceae	2	1.6%	2	1%
Alliaceae	1	0.8%	4	2%
Berberidaceae	1	0.8%	3	1.5%
Ephedraceae	1	0.8%	3	1.5%
Hypericaceae	1	0.8%	3	1.5%
Caprifoliaceae	1	0.8%	2	1%
Chenopodiaceae	1	0.8%	2	1%
Paeoniaceae	1	0.8%	2	1%
Peganaceae	1	0.8%	1	0.5%
Alismataceae	1	0.8%	1	0.5%
Asphodelaceae	1	0.8%	1	0.5%

Balsaminaceae	1	0.8%	1	0.5%
Betulaceae	1	0.8%	1	0.5%
Campanulaceae	1	0.8%	1	0.5%
Cupressaceae	1	0.8%	1	0.5%
Elaeagnaceae	1	0.8%	1	0.5%
Equisetaceae	1	0.8%	1	0.5%
Rubiaceae	1	0.8%	1	0.5%
Limoniaceae	1	0.8%	1	0.5%
Total: 37	125	100%	201	100%

The following groups comprised all medicinal species, based on ecological and morphological classifications:

Six species (3%) of trees

23 species (11%) of shrubs

14 species (7%) of semi-shrubs

28 species (14%) of annual and biennial herbaceous plants

128 species (64%) of perennial herbaceous plants

Two species (1%) of cereals (Fig. 2)

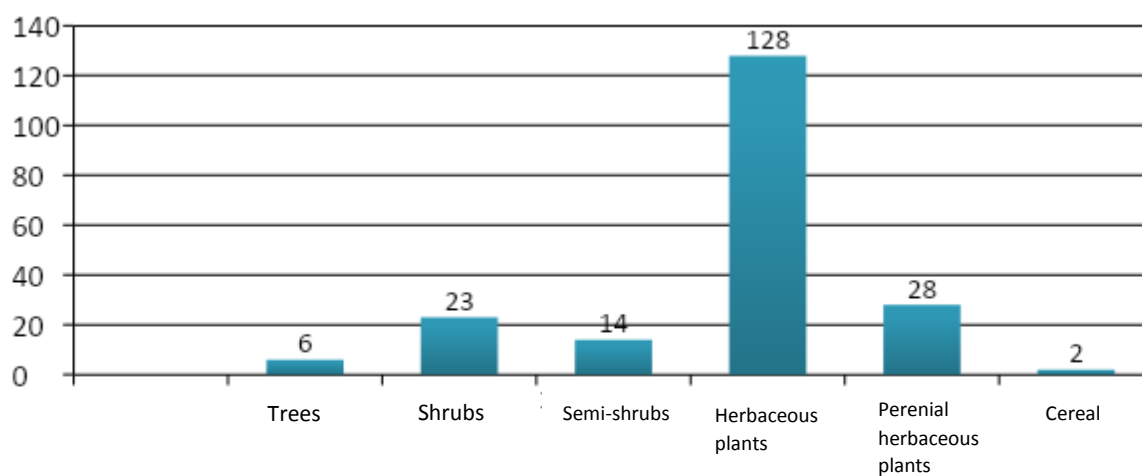


Fig. 2. The proportion of life forms of medicinal plants in the Zhetysu Alatau flora based on the I.G. Serebryakov data.

Classifying the plants based on ecological groups concerning the moisture conditions indicated the following superiority:

Mesophytes: 84 species (55.9%);

Xerophytes: 52 species (19.4%);

Mesozorophytes: 30 species (16.1%);

Xeromesophytes: 24 species (13.7%);

Hydrophytes: 11 species (6.3%; Fig. 3).

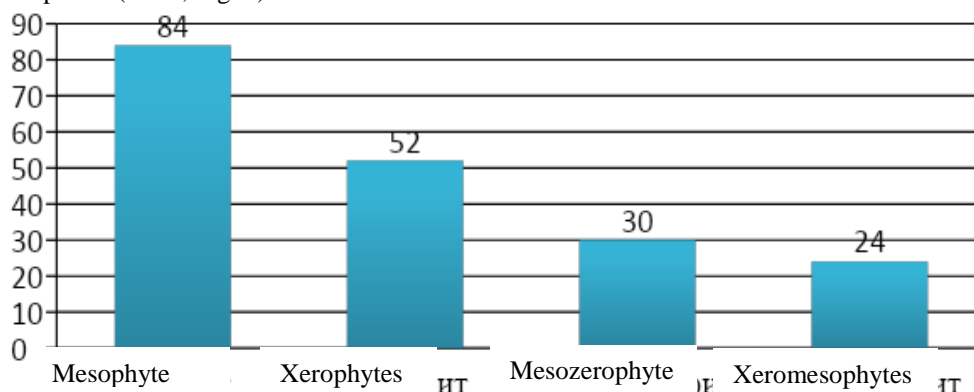


Fig. 3. The plant classification based on the ecological groups

Mesophyte herbaceous plants dominate the current ratio of life forms to ecological groups, indicating moderate ambient moisture conditions. Other biological groups, however, show that there are not many environments near

groundwater or with surface water supplies. Among the 201 species of medicinal plants identified, 201 species (100%) are utilized in traditional medicine, 56 species (27.9%) in official medicine, and 40 species (19.9%) in oriental medicine (Table 2).

Table 2. Medicinal plants list of Flora Zhetysu Alatau.

Family	Genus	Species	Usage in official medicine	Usage in traditional medicine	Oriental medicine	
Alliaceae J. Agardh	<i>Allium</i>	<i>Allium obliquum</i>		+	+	
		<i>Allium petraeum</i>		+		
		<i>Allium turkestanicum</i>		+		
		<i>Allium semenowii</i>		+		
Alismataceae Vent.	<i>Alisma</i>	<i>Alisma plantago-aquatica</i>		+		
Apiaceae Lindl.	<i>Angelica</i>	<i>Angelica decurrens</i>		+	+	
		<i>Angelica sylvestris</i>		+	+	
	<i>Cenolophium</i>	<i>Cenolophium denudatum</i>		+		
	<i>Ferula</i>	<i>Ferula ovina</i>		+		
		<i>Ferula caspica</i>		+		
		<i>Ferula foetida</i>	+	+	+	
	<i>Siella</i>	<i>Siella erecta</i>		+		
	<i>Sium</i>	<i>Sium latifolium</i>		+		
	<i>Oenanthe</i>	<i>Oenanthe aquatica</i>	+	+		
	<i>Peucedanum</i>	<i>Peucedanum morisonii</i>	+	+		
Asphodelaceae Juss.	<i>Eremurus</i>	<i>Eremurus altaicus</i>		+		
Asteraceae Dumort.	<i>Achillea</i>	<i>Achillea Biebersteinii</i>		+		
		<i>Achillea millefolium</i>	+	+		
		<i>Achillea nobilis</i>		+		
		<i>Achillea setacea</i>		+	+	
	<i>Ajania</i>	<i>Ajania fastigiata</i>		+		
	<i>Artemisia</i>	<i>Artemisia absinthium</i>	+	+	+	
		<i>Artemisia annua</i>		+	+	
		<i>Artemisia austriaca</i>		+		
		<i>Artemisia dracunculus</i>		+		
		<i>Artemisia frigida</i>		+	+	
		<i>Artemisia rutifolia</i>		+		
		<i>Artemisia santolinifolia</i>		+	+	
		<i>Artemisia sublessingiana</i>		+		
		<i>Alfredia</i>	<i>Alfredia cernua</i>		+	
		<i>Centaurea</i>	<i>Centaurea cyanus</i>	+	+	+
	<i>Crupina</i>	<i>Crupina vulgaris</i>		+		
	<i>Crepis</i>	<i>Crepis sibirica</i>		+		
	<i>Cnicus</i>	<i>Cnicus benedictus</i>	+	+		
	<i>Echinops</i>	<i>Echinops chantavicus</i>		+		
	<i>Inula</i>	<i>Inula britannica</i>		+	+	
		<i>Inula helenium</i>	+	+		
		<i>Inula caspia</i>		+		
	<i>Saussurea</i>	<i>Saussurea elegans</i>		+		
	<i>Serratula</i>	<i>Serratula coronata</i>	+	+		
	<i>Solidago</i>	<i>Solidago virgaurea</i>	+	+	+	
	<i>Lactuca</i>	<i>Lactuca serriola</i>		+		
	<i>Ligularia</i>	<i>Ligularia altaica</i>		+		
	<i>Matricaria</i>	<i>Matricaria recutita</i>		+		
		<i>Matricaria</i>		+		
		<i>matricarioides</i>		+		
<i>Tanacetum</i>	<i>Tanacetum vulgare</i>	+	+			
<i>Tussilago</i>	<i>Tussilago farfara</i>	+	+			
<i>Rhaponticum</i>	<i>Rhaponticum</i>	+	+			
	<i>carthamoides</i>		+			
<i>Onopordum</i>	<i>Onopordum acanthium</i>		+			
<i>Helichrysum</i>	<i>Helichrysum arenarium</i>	+	+			
Araceae Juss.	<i>Acorus</i>	<i>Acorus calomus</i>	+	+		

	<i>Arum</i>	<i>Arum korolkovii</i>		+	
Balsaminaceae F.Rich	<i>Impatiens</i>	<i>Impatiens parviflora</i>		+	
Berberidaceae Juss.	<i>Berberis</i>	<i>Berberis sphaerocarpa</i>		+	
		<i>Berberis vulgaris</i>		+	
		<i>Berberis sibirica</i>		+	
Betulaceae S.F. Gray.	<i>Betula</i>	<i>Betula pendula</i>		+	
Boraginaceae Juss.	<i>Pulmonaria</i>	<i>Pulmonaria mollissima</i>		+	
	<i>Cynoglossum</i>	<i>Cynoglossum officinale</i>		+	
Brassicaceae Burnett.	<i>Bunios</i>	<i>Bunios orientalis</i>		+	
	<i>Cardamine</i>	<i>Cardamine impatiens</i>		+	
	<i>Hesperis</i>	<i>Hesperis sibirica</i>		+	
Campanulaceae Juss.	<i>Campanula</i>	<i>Campanula glomerata</i>		+	+
Caprifoliaceae Juss.	<i>Lonicera</i>	<i>Lonicera tatarica</i>		+	
		<i>Lonicera nummulariifolia</i>		+	
Caryophyllaceae Juss.	<i>Oberna</i>	<i>Oberna behen</i>		+	
	<i>Melandrium</i>	<i>Melandrium album</i>		+	
Crassulaceae DC.	<i>Sedum</i>	<i>Sedum alberti</i>		+	
		<i>Sedum hybridum</i>	+	+	
	<i>Rhodiola</i>	<i>Rhodiola linearifolia</i>		+	
		<i>Rhodiola coccinea</i>		+	
		<i>Rhodiola rosea</i>	+	+	
Cupressaceae Rich. ex. Bartl.	<i>Juniperus</i>	<i>Juniperus sabina</i>		+	+
Chenopodiaceae Less.	<i>Chenopodium</i>	<i>Chenopodium botrys</i>		+	
		<i>Chenopodium hybridum</i>		+	
Ephedraceae Dumort.	<i>Ephedra</i>	<i>Ephedra equisetina</i>	+	+	
		<i>Ephedra intermedia</i>	+	+	+
		<i>Ephedra distachya</i>		+	+
Elaeagnaceae Juss.	<i>Hippophae</i>	<i>Hippophae rhamnoides</i>		+	
Equisetaceae Rich. ex DC.	<i>Equisetum</i>	<i>Equisetum arvense</i>		+	+
Fabaceae Lindl.	<i>Astragalus</i>	<i>Astragalus onobrychis</i>		+	
		<i>Astragalus sieversianus</i>		+	
	<i>Caragana</i>	<i>Caragana aurantiaca</i>		+	
		<i>Caragana frutex</i>		+	
	<i>Lathyrus</i>	<i>Lathyrus humilis</i>		+	
		<i>Lathyrus pisiformis</i>		+	
		<i>Lathyrus pratensis</i>		+	
		<i>Lathyrus tuberosus</i>		+	
	<i>Medicago</i>	<i>Medicago lupulina</i>		+	
		<i>Medicago sativa</i>	+	+	
	<i>Melilotus</i>	<i>Melilotus officinalis</i>	+	+	
	<i>Ononis</i>	<i>Ononis arvensis</i>	+	+	
	<i>Oxytropis</i>	<i>Oxytropis glabra</i>		+	+
		<i>Oxytropis lapponica</i>		+	
	<i>Psoralea</i>	<i>Psoralea drupaceae</i>	+	+	
	<i>Trifolium</i>	<i>Trifolium pratense</i>		+	
		<i>Trifolium repens</i>		+	
		<i>Trifolium lupinaster</i>		+	
	<i>Vicia</i>	<i>Vicia cracca</i>		+	
		<i>Vicia sylvatica</i>		+	
	<i>Glycyrrhiza</i>	<i>Glycyrrhiza uralensis</i>	+	+	+
	<i>Sphaerophysa</i>	<i>Sphaerophysa salsula</i>		+	
	<i>Hedysarum</i>	<i>Hedysarum flavescens</i>		+	
		<i>Hedysarum neglectum</i>		+	+
Gentianaceae Juss.	<i>Gentiana</i>	<i>Gentiana tianschanica</i>		+	

	<i>Geranium</i>	<i>Geranium collinum</i>		+	
Hypericaceae Juss.	<i>Hypericum</i>	<i>Hypericum scabrum</i>		+	
		<i>Hypericum perforatum</i>	+	+	
		<i>Hypericum elongatum</i>		+	
Grossulariaceae DC.	<i>Ribes</i>	<i>Ribes nigrum</i>	+	+	
Lamiaceae Lindl.	<i>Grossularia</i>	<i>Grossularia acicularis</i>		+	
	<i>Amethystea</i>	<i>Amethystea coerulea</i>		+	
	<i>Dracocephalum</i>	<i>Dracocephalum oblongifolium</i>		+	
	<i>Hyssopus</i>	<i>Hyssopus ambiguus</i>		+	
		<i>Hyssopus cuspidatus</i>		+	
	<i>Nepeta</i>	<i>Nepeta pannonica</i>		+	
	<i>Origanum</i>	<i>Origanum vulgare</i>	+	+	
	<i>Lamium</i>	<i>Lamium amplexicaule</i>		+	
		<i>Leonurus glaucescens</i>		+	
	<i>Mentha</i>	<i>Mentha asiatica</i> Boriss.		+	
		<i>Mentha arvensis</i>		+	
		<i>Mentha longifolia</i>		+	
	<i>Melilotus</i>	<i>Melilotus officinales</i>		+	
	<i>Melissa</i>	<i>Melissa officinalis</i>	+	+	
	<i>Salvia</i>	<i>Salvia nemorosa</i>		+	
		<i>Salvia deserta</i>		+	
		<i>Salvia macrosiphon</i>		+	
		<i>Salvia sclarea</i>	+	+	
		<i>Salvia stepposa</i>		+	
		<i>Stachys</i>	<i>Stachys sylvatica</i>		+
		<i>Thymus</i>	<i>Thymus marschallianus</i>		+
		<i>Thymus sibiricus</i>		+	
	<i>Teucrium</i>	<i>Teucrium scordioides</i>		+	
	<i>Scutellaria</i>	<i>Scutellaria galericulata</i>		+	
	<i>Marrubium</i>	<i>Marrubium vulgare</i>	+	+	
Liliaceae Juss.	<i>Fritillaria</i>	<i>Fritillaria pallidiflora</i>		+	
		<i>Fritillaria verticillata</i>		+	
		<i>Fritillaria walujewii</i>		+	
	<i>Lilium</i>	<i>Lilium martagon</i>		+	
Limoniaceae Ser.	<i>Goniolimon</i>	<i>Goniolimon speciosum</i>		+	
Malvaceae Juss.	<i>Malva</i>	<i>Malva thuringiaca</i>		+	
	<i>Althaea</i>	<i>Althaea officinalis</i>	+	+	
Papaveraceae Juss.	<i>Chelidonium</i>	<i>Chelidonium majus</i>	+	+	
	<i>Papaver</i>	<i>Papaver croceum</i>		+	
		<i>Papaver pavoninum</i>		+	
Poaceae Barnhart.	<i>Agrostis</i>	<i>Agrostis gigantea</i>		+	
	<i>Leymus</i>	<i>Leymus angustus</i>		+	
	<i>Melica</i>	<i>Melica altissima</i>		+	
		<i>Melica transsilvanica</i>		+	
	<i>Milium</i>	<i>Milium effusum</i>		+	
	<i>Poa</i>	<i>Poa angustifolia</i>		+	
		<i>Poa bulbosa</i>		+	
		<i>Stipa</i>	<i>Stipa capillata</i>		+
			<i>Stipa caucasica</i>		+
	Paeoniaceae Rudolphi.	<i>Paeonia</i>	<i>Paeonia anomala</i>	+	+
<i>Paeonia hybrida</i>				+	
<i>Atraphaxis frutescens</i>				+	
Polygonaceae Juss.	<i>Atraphaxis</i>	<i>Atraphaxis pyrifolia</i>		+	
		<i>Fallopia</i>	<i>Fallopia convolvulus</i>		+
		<i>Polygonum</i>	<i>Polygonum olpinum</i>		+
		<i>Polygonum hydropiper</i>		+	
		<i>Polygonum patulum</i>		+	

	<i>Rheum</i>	<i>Rheum cordatum</i>		+	
		<i>Rheum wittrockii</i>			+
		<i>Rheum tataricum</i>	+		+
	<i>Rumex</i>	<i>Rumex confertus</i>	+		+
		<i>Rumex crispus</i>			+
Ranunculaceae Juss.	<i>Aconitum</i>	<i>Aconitum soongaricum</i>	+		+
		<i>Aconitum leucostomum</i>	+		+
	<i>Delphinium</i>	<i>Delphinium elatum</i>	+		+
		<i>Delphinium dictyocarpum</i>	+		+
Rosaceae Juss.	<i>Agrimonia</i>	<i>Agrimonia asiatica</i>			+
	<i>Armeniaca</i>	<i>Armeniaca vulgaris</i>	+		+
	<i>Crataegus</i>	<i>Crataegus songarica</i>			+
		<i>Crataegus korolkowii</i>	+		+
		<i>Crataegus altaica</i>			+
		<i>Crataegus sanguinea</i>	+		+
	<i>Fragaria</i>	<i>Fragaria vesca</i>	+		+
	<i>Filipendula</i>	<i>Filipendula ulmaria</i>	+		+
	<i>Geum</i>	<i>Geum urbanum</i>	+		+
	<i>Padus</i>	<i>Padus avium</i>	+		+
	<i>Potentilla</i>	<i>Potentilla orientalis</i>			+
		<i>Potentilla impolita</i>			+
	<i>Rosa</i>	<i>Rosa acicularis</i>	+		+
		<i>Rosa alberti</i>	+		+
		<i>Rosa beggerana</i>	+		+
		<i>Rosa canina</i>	+		+
		<i>Rosa platyacantha</i>			+
		<i>Rosa spinosissima</i>			+
		<i>Rosa laxa</i>	+		+
	<i>Rubus</i>	<i>Rubus caesius</i>			+
		<i>Rubus idaeus</i>	+		+
	<i>Sanguisorba</i>	<i>Sanguisorba officinalis</i>	+		+
	<i>Sorbus</i>	<i>Sorbus tianschanica</i>			+
	<i>Spiraea</i>	<i>Spiraea hypericifolia</i>			+
	<i>Malus</i>	<i>Malus sieversii</i>	+		+
Rubiaceae Juss.	<i>Galium</i>	<i>Galium aparine</i>			+
Scrophulariaceae Juss.	<i>Gratiola</i>	<i>Gratiola officinalis</i>	+		+
	<i>Verbascum</i>	<i>Verbascum orientale</i>			+
		<i>Verbascum songaricum</i>			+
Peganaceae (Engl) Tiegh. ex Takht.	<i>Peganum</i>	<i>Peganum harmala</i>	+		+

There is a vast array of medicinal properties found in medicinal plants. Accordingly, the potential for treating a range of diseases in 14 groups with Zhetysu Alatau medicinal plants has been examined based on their pharmacotherapeutic activity (Fig. 4). To treat the nervous disorders, the following plants are suggested: *Rhodiola linearifolia*, *Lathyrus pisiformis* and *Oxytropis glabra*. In addition, to treat the digestive tract disease, 21 types of medicinal plants are utilized, including: *Allium semenowii*, *Ferula caspica*, *Peucedanum morisonii*, *Achillea millefolium*, *Ajania fastigiata*, *Artemisia absinthium*, *Artemisia annua*, *Centaurea cyanus*, *Lactuca serriola*, *Tanacetum vulgare*, *Tussilago farfara*, *Helichrysum arenarium*, *Impatiens parviflora*, *Berberis sphaerocarpa*, *Betula pendula*, *Lathyrus tuberosus*, *Melilotus officinalis*, *Ononis arvensis*, *Origanum vulgare*, *Melissa officinalis*, *Marrubium vulgare*, *Milium effusum*, *Rheum wittrockii*, *Rheum tataricum*, *Rumex confertus*, *Rumex crispus*, *Delphinium elatum*, *Agrimonia asiatica*, *Armeniaca vulgaris*, *Filipendula ulmaria*, *Padus avium*, *Rosa acicularis*, *Rosa beggerana*, *Rosa canina*, *Rosa laxa*, *Spiraea hypericifolia* and *Gratiola officinalis*. The following types are suggested as antibacterial: *Allium obliquum*, *Ferula ovina*, *Ferula caspica*, *Peucedanum morisonii*, *Eremurus altaicus*, *Achillea biebersteinii*, *Achillea millefolium*, *Achillea nobilis*, *Ajania fastigiata*, *Artemisia absinthium*, *Artemisia austriaca*, *Artemisia rutifolia*, *Centaurea cyanus*, *Inula britannica*, *Inula helenium*, *Inula caspia*, *Serratula coronata*, *Tussilago farfara*, *Rhaponticum carthamoides*, *Onopordum acanthium*, *Helichrysum*

arenarium, *Arum korolkovii*, *Impatiens parviflora*, *Lonicera tatarica*, *Chenopodium botrys*, *Astragalus sieversianus*, *Caragana frutex*, *Melilotus officinalis*, *Trifolium pratense*, *Hypericum scabrum*, *Salvia macrosiphon*, *Salvia stepposa*, *Scutellaria galericulata*, *Marrubium vulgare*, *Agrostis gigantea*. *Milium effusum*, *Aconitum soongaricum*. *Agrimonia asiatica*, *Fragaria vesca*, *Padus avium*, *Rosa acicularis*, *Sorbus tianschanica*, *Spiraea hypericifolia* and *Malus sieversii*. To treat 26 types of worms, the following anthelmintic is recommended: *Ajania fastigiata*, *Artemisia absinthium*, *Artemisia austriaca*, *Artemisia frigida*, *Artemisia rutifolia*, *Artemisia santolinifolia*, *Artemisia sublessingiana*, *Inula helenium*, *Tanacetum vulgare*, *Bunios orientalis*, *Juniperus sabina*, *Chenopodium botrys*, *Equisetum arvense*, *Hypericum perforatum*, *Hypericum elongatum*, *Mentha arvensis*, *Teucrium scordioides*, *Rumex confertus*, *Delphinium elatum*. *Geum urbanum*, *Rosa canina*, *Rubus caesius*, *Sanguisorba officinalis*, *Spiraea hypericifolia*, *Gratiola officinalis* and *Peganum harmala*.

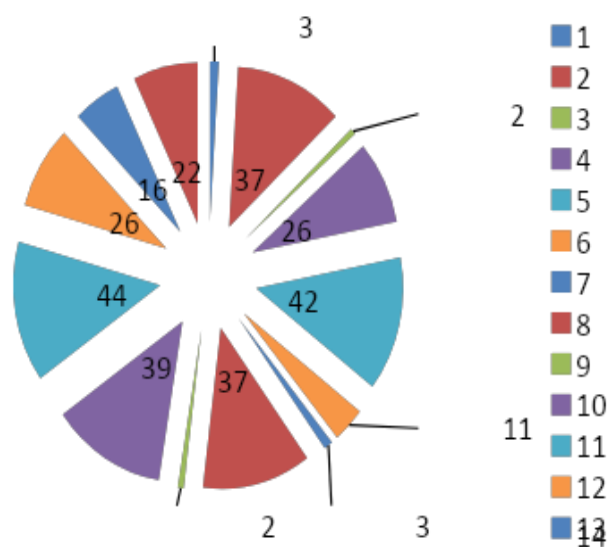


Fig. 4. Ranking of medicinal plants of Zhetysu Alatau based on pharmacotherapeutic activity of pharmacotherapeutic groups: 1. Nervous system, 2. Digestive system, 3. Stimulant, 4. Respiratory tracts, 5. Anti-criminal and anti-inflammatory, 6. Cardiovascular system, 7. Diabetes, 8. pain reliever and wound healer, 9. skin diseases, 10. diuretic, 11. antibacterial, 12. antiworm, 13. antitumor 14. other disorders.

There are sixteen diseases related to underweight that are treated differently, including: *Angelica decurrens*, *Anthriscus sylvestris*, *Achillea setacea*, *Artemisia annua*, *Artemisia austriaca*, *Artemisia rutifolia*, *Artemisia santolinifolia*, *Artemisia sublessingiana*, *Cynoglossum officinale*, *Melandrium album*, *Ononis arvensis*. *Chelidonium majus*, *Rheum tataricum*, *Rumex crispus*, *Aconitum soongaricum* and *Galium aparine*. 42 types have anti-fever and anti-inflammatory effects, such as *Angelica decurrens*, *Achillea nobilis*, *Achillea setacea*, *Artemisia annua*, *Artemisia santolinifolia*, *Cnicus benedictus*, *Inula helenium*, *Lactuca serriola*, *Tanacetum vulgare*, *Tussilago farfara*, *Helichrysum arenarium* *Berberis sphaerocarpa*, *Berberis sibirica*, *Betula pendula*, *Cynoglossum officinale*, *Rhodiola coccinea*, *Rhodiola rosea*, *Juniperus sabina*, *Ephedra equisetina*, *Ephedra distachya*, *Equisetum arvense*, *Lathyrus pratensis*, *Melilotus officinalis*, *Ononis arvensis*, *Oxytropis glabra*, *Trifolium pratense*, *Glycyrrhiza uralensis*, *Hypericum scabrum*, *Hypericum perforatum*, *Ribes nigrum*, *Amethystea coerulea*, *Mentha arvensis*, *Fritillaria verticillata*. *Lilium martagon*, *Althaea officinalis*, *Fragaria vesca*, *Filipendula ulmaria*, *Geum urbanum*, *Rosa acicularis*, *Rosa canina*, *Rubus caesius* and *Peganum harmala*. 11 types of drugs are recommended for the treatment of cardiovascular diseases: *Ajania fastigiata*, *Arum korolkovii*, *Ephedra equisetina*, *Oxytropis glabra*, *Hedysarum flavescens*, *Hypericum perforatum*, *Salvia macrosiphon*, *Stachys sylvatica*, *Scutellaria galericulata*, *Crataegus korolkowii* and *Crataegus sanguinea*. Three types of drugs are recommended for the treatment of type 1 diabetes: *Artemisia dracuncululus*, *Medicago sativa* and *Glycyrrhiza uralensis*. A total of 32 types have analgesic and wound healing effects: *Anthriscus sylvestris*, *Ferula caspica*, *Achillea biebersteinii*, *Artemisia frigida*, *Artemisia rutifolia*, *Centaurea cyanus*, *Inula britannica*, *Serratula coronata*, *Onopordum acanthium*, *Acorus calomus*, *Berberis sibirica*, *Campanula glomerata*, *Sedum hybridum*. *Rhodiola coccinea*, *Rhodiola rosea*, *Chenopodium hybridum*, *Ephedra equisetina*, *Equisetum arvense*, *Medicago lupulina*, *Medicago sativa*, *Psoralea drupaceae*, *Trifolium pratense*, *Hypericum perforatum*, *Grossularia acicularis*, *Origanum vulgare*, *Lamium amplexicaule*, *Mentha arvensis*, *Mentha longifolia*, *Salvia*

sclarea, *Stachys sylvatica*, *Thymus marshallianus*, *Lilium martagon*, *Rumex confertus* *Rumex crispus*, *Fragaria vesca*, *Geum urbanum* and *Sanguisorba officinalis*. Based on their abundance, the medicinal plants were classified to evaluate their potential for use. The first group of plants have a large habitat that may be used for the industrial extraction of raw resources. Eight species make up this group including *Rheum tataricum*, *Peganum harmala*, *Anabasis salsa* and others. The second group, with a wide range but having small reserves of raw materials, includes 10 species, among them, *Anabasis aphylla*, *Artemisia austriaca*, *Euphorbia seguieriana*, sweet clover and others. The third category consists of 69 widely distributed species that develop irregularly and are not appropriate candidates for collecting. This category includes the majority of therapeutic plants. Six rare plant species that are in risk of going extinct are included in the fourth group and cannot be collected. The resource study was conducted in the southeast macroscales of the Zhetysu mountain range of Alatau during the 2021–2020 cropping season. Broad distribution and the existence of valuable industrial plants like thousand-leaf plants, tall primroses, borage flowers, and unique plants. The origins of these kinds were analysed per this issue. *Inula helenium* L. grows in profusion along the highway, in the plains between the mountains, and along the ridge, particularly beside the rivers and streams. It even grows atop the hills. The Lepsy River basin, the lowlands between the mountains, and the Tentek River basin are home to the most notable watersheds. Many correlations were found between Dehmirbo involvement in the Tentek River basin. The sedge-shrub-herb community is the most prevalent form of plant community in this area and comprises more than 30 plant species (*Polygonum coriarium*, *Ferula soongarica*, *Verbascum songoricum*, *Salvia stepposa*, *Achillea millefolium*, *Hypericum perforatum*, *Leonurus* etc.). Ten to fifteen samples of Dehmirbo are found per five square meters. The shrub-shrub-dehmirbo combination is distinguished by the prominent involvement of shrubs, such as *Spiraea hypericifolia*, *Rosa beggerana*, and *Lonicera tatarica*. Its floral composition is inferior (20-25 species) and the quantity of Dehmirbo is 15-16 specimens per 5 m². There are a few apple trees in the dehmirbo-shrub-herbaceous combination. This association has a higher diversity of grassland plants (35 species), with 12 to 13 specimens of Dehmirbo per 5 m². The ponds cover an area of 115 hectares, the mean weight of Dehmirbo root is 165 grams, and the total dry rootstock is 4.5 tons. The following correlations were discovered in Crotoe Gorge with the involvement of the towering Dehmirbo:

This community has 40 different plant species including shrubs and grasslands. In this neighbourhood, there are nine to eleven Dehmirbo samples for every five m². This relationship also includes *Hypericum perforatum*, *Origanum vulgare*, and *Achillea millefolium* as therapeutic plants related to St. John's wort. Accordingly, a collaborative enumeration of these species' sources was done in areas of 10 by 10 m².

Table 3. Reserves of the most important medicinal plants in the Zhetysu mountain range of Alatau.

№	Types of plants	Place of growing the bushes	Area, hectares	Withdrawal balance
1	<i>Inula helenium</i> L.	Between the two Tantak Rivers	115	4.5 ± 0.6
2	<i>Origanum vulgare</i> L.	Darreh-ye Karteh	125	9.0 ± 1.1
		Darreh-ye Karteh, on the way to Sib Sanctuary	538.5	56.0 ± 2.6
3	<i>Achillea millefolium</i> L.	Wildflower meadows near the village of Lapsink	252	12.0 ± 1.3
		The plains full of wildflowers of the Qarasirq valley	158	26.2 ± 5.0
		The edge of the Lapse River	180	3.5 ± 0.4
		Darreh-ye Karteh, on the way to Sib Sanctuary	800	105.0 ± 13.3
4	<i>Hypericum perforatum</i> L.	The edge of the Lapse River	152	21.5 ± 0.1
		Wildflower meadows near the Lapsink village	110	52.9 ± 11.8
		Darreh-ye Karteh, on the way to Sib Sanctuary	508	92.0 ± 15.7
		between the two Tantak rivers	43.7	6.5 ± 1.1
		The edge of the Lapse River	120	3.0 ± 0.3

An association of vegetation in which the dominating species are Lemongrass (*Tanacetum vulgare*) and *Angelica* (*Angelica archangelica*) is known as the Lemongrass-Angelica association. These correlations are typically observed in damp regions, such as those beside rivers and streams. Compared to other plant associations, their distribution is more restricted, with six to eight lemon balm samples in each sample. Badranjbouye is highly prevalent in these connections, accounting for 18 to 21 samples per sample. A single raw lemongrass root weighs 295 grams on average. The association's stands covered 125 hectares in the studied valley, and an estimated 9.0

tons of dried roots were in reserve there. Of the 240 hectares that make up Badranjbouye stands, 125 hectares are investigated in the valley. There are 13.5 tons of dry roots in reserve overall, with 9.0 tons located in the valley. Since lemongrass must be replanted after harvest, 3.0 tons should be the maximum volume harvested annually in these settings. Large amounts of *Hypericum perforatum* have been found in the Darreh-ye Karteh on the approach to the Sib Sanctuary, in the basins of the Tentak and Lapse rivers, and in a variety of grassland meadows close to the settlement of Lepsisk. Over 101.5 tons of air-dry mass makes up the whole exploitation resource of these locations (Table 3). *Achillea millefolium* L., also known as the common thousand-leaf plant, is found in large numbers in various regions. It grows in meadows, plains, hills, and plain slopes. People were counted in the Crotte Valley, in the varied meadows along the riverbank at Lapsink, and on the route to the Apple Protected Area (Table 3). More than 179.4 tons of high dry population material from above ground makes up the whole inventory of material exploited. *Origanum vulgare* L. grows in a variety of mountainside meadows. The same locations—Gore Croto, the route to the Sib protected area, the several grasslands in the Qarasirq group, and the banks of the Lapse River—were used to count the entities (Table 3). The aggregate exploitation inventory comprises about 97.7 tons of above-ground high-dry population materials. Fieldwork has shown significant changes in the Zhetysu Mountains' vegetation in Alatau. The growth of agriculture in the intermountain valleys and the increased breeding of animals and fires are the primary causes of these changes. Consequently, it is vital to conduct current research on the resources of Zhetysu Alatau medicinal plants and plant replacements as well as to provide the scientific foundation for their best possible application. Accordingly, the following are the primary routes for the best utilization and preservation of natural populations of medicinal plants:

- The requirement to follow the criteria created for the collecting and desiccation of medicinal materials; these standards stipulate that a certain collection schedule must be followed to guarantee the preservation of the necessary plant population.
- The complete ban on private persons collecting medicinal species, may result in a lack of pharmaceuticals and other medical supplies.
- Looking for substitutes, or sources of medications with pharmacological effects similar to those of uncommon therapeutic species, i.e. researching and bringing in high-yielding plants with naturally occurring bioactive compounds for the commercial cycle.

CONCLUSION

In Zhetysu Alatau flora, 201 species of medicinal plants from 125 genera and 37 families have been recognized. A total of 201 species are utilized in folk medicine, out of which 40 are employed in oriental medicine and 56 in official medicine. Vascular plants are grouped ecologically according to humidity. The majority of them (84 species) are classified as mesophytes, while the remaining 11 species are hydrophyte plants. Perennial herbaceous plants have the maximum number of species (128), whereas cluster plants have the minimum (2 species). Based on their potential to cure disorders of the neurological system, digestive system, cardiovascular system, antibacterial, antiworm, sunscreen, and other conditions, all of these species are grouped into 14 categories according to their pharmacotherapeutic activity. These groups include those that can reduce fever and those that have analgesic, healing, and anti-inflammatory properties. 201 species of medical plants have been identified via study on the resources in Zhetysu Alatau. Four of these species are industrial plants: *Achillea millefolium*, *Origanum vulgare*, *Hypericum perforatum*, and *Jnula helenium*. A complete prohibition on private persons collecting medicinal species for commercial purposes may be established, as this might result in the eradication of these plants.

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