

## Brief information about the project

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| Name of the project | To consider the possibility of studying and practical use of the current state of natural populations of some valuable medicinal plant species in Kazakhstan                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Relevance           | <p>The question of conserving the flora of Kazakhstan and its effective use is one of the strategic tasks at the state level. The focus is on the reduction of natural populations; according to the latest data, the stocks of valuable medicinal plants in the country have sharply decreased. For example, the population of species such as <i>Calligonum leucocladum</i>, selected as the object of study, has decreased by up to 30% over the last 20 years. This situation creates a threat of biodiversity loss due to anthropogenic impact and climate change.</p> <p>The dependence of the pharmaceutical industry on herbal raw materials is also high. More than 40% of the drugs used in world medicine consist of components of plant origin. Despite the fact that in Kazakhstan over the last 5 years the demand for such medicines has increased by 20%, more than 15% of domestic medicinal plants are on the verge of extinction. In this regard, there is a need for a scientific justification of the raw material base for the production of domestic products that replace imports.</p> <p>The problem of a shortage of complex research is also relevant. The biomorphological, genetic, and phytochemical characteristics of the plants <i>Calligonum leucocladum</i>, <i>Ribes turbinatum</i>, and <i>Astragalus ammodendron</i> have not yet been systematically studied. Determining the content of biologically active substances and immunomodulatory properties in them opens up new opportunities for pharmacology.</p> <p>In order to preserve the genetic fund, the use of modern molecular genetic methods is provided, in particular SNP genotyping and DNA extraction. This will allow for an accurate assessment of the genetic diversity of these plants and the development of strategic plans for their protection.</p> <p>The use of GIS technologies in the direction of environmental monitoring will become the basis for accurate mapping of the distribution range of plants and increasing the effectiveness of environmental protection measures.</p> <p>This research, in addition to its fundamental scientific significance, makes a direct contribution to the sustainable use of the country's medicinal resources and the preservation of the ecological balance.</p> |
| Purpose             | A comprehensive study of the biomorphological features, population characteristics, genetic diversity, and intra- and inter-population differentiation of three insufficiently studied species of valuable medicinal plants growing in Kazakhstan ( <i>C. leucocladum</i> , <i>R. turbinatum</i> , and <i>A. ammodendron</i> ).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Objectives          | <ol style="list-style-type: none"><li>1. Analysis of data on the range and ecology of the studied plants and expedition planning.</li><li>2. Search for plant populations, study of soil composition and microclimate of their habitat.</li><li>3. Comprehensive assessment of the main biologically active compounds in the plants.</li><li>4. Determination of seed productivity and description of morpho-anatomical features.</li><li>5. Analysis of genetic diversity and the degree of inter-population differentiation.</li><li>6. Comprehensive assessment of the state of populations (abundance, age spectrum).</li></ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

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| Expected and achieved results                                                                                                      | <p>Within the framework of the project, scientific foundations for the conservation and use of medicinal plants in Kazakhstan will be developed. Based on the research results, it is planned to publish at least three articles in international journals indexed in Web of Science (Q1-Q3) or Scopus (with a percentile above 60), as well as two articles in publications recommended by the COXON (Committee for Quality Assurance in the Sphere of Education and Science). For the purpose of systematizing scientific results, a collective monograph will be published, and patents will be obtained to protect intellectual property rights.</p> <p>As part of personnel training, the defense of a dissertation by at least one Doctor of Philosophy (PhD) is envisaged. On a practical level, technical specifications will be developed for obtaining biologically active additives from the plants <i>C. leucocladum</i>, <i>R. turbinatum</i>, and <i>A. ammodendron</i>, as well as a protocol for cultivating aseptic cells. Furthermore, specific recommendations will be prepared for placing these rare species under state protection, which will pave the way for the development of a raw material base for the domestic pharmaceutical industry. During the current period from July to December 2025, a number of significant results were achieved under the project.</p> <p>As part of the research and development activities, an analytical review was conducted on the study of plant species of the families <i>Tamaricaceae</i>, <i>Grossulariaceae</i>, and <i>Fabaceae</i> at both international and national levels, and a comprehensive database was formed. As a result of expeditionary field work in the Koksu district of the Zhetysu region, natural populations of the plant <i>Calligonum leucocladum</i> were studied, and three specific coenopopulations were identified. A full description of their age composition, density, and biometric characteristics was provided.</p> <p>In the molecular genetic direction, sequencing of the complete chloroplast genomes of three populations collected from different geographical zones of Kazakhstan was performed, followed by a comparative analysis. During the study, specific structural changes were identified in the genome of the P3 population, determining local ecological adaptation.</p> <p>There are also significant achievements in the publication of project results. In particular, two articles have been prepared for high-ranking international publications: an article in the journal "ES Energy and Environment" (Scopus 87%) has already been published, and a paper in the journal "ES Food &amp; Agroforestry" (Scopus 97%) has been accepted for print. In addition, special report materials were prepared for an international conference in Italy. These results confirm the high-quality fulfillment of the tasks for the first year of the project.</p> |
| Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles | <p>Bekzat M. Tynybekov<br/> Web of Science ResearcherID LRV-1810-2024<br/> <a href="https://www.webofscience.com/wos/author/record/65129904">https://www.webofscience.com/wos/author/record/65129904</a><br/> Scopus Author ID – 55920493500<br/> <a href="https://orcid.org/0009-0003-6176-2113">https://orcid.org/0009-0003-6176-2113</a></p> <p>Alibek Ydyrys<br/> Author ID – M-5723-2013<br/> <a href="https://www.webofscience.com/wos/author/record/1477427">https://www.webofscience.com/wos/author/record/1477427</a><br/> Scopus Author ID - 57203985421<br/> <a href="https://www.scopus.com/authid/detail.uri?authorId=57203985421n">https://www.scopus.com/authid/detail.uri?authorId=57203985421n</a><br/> <a href="https://orcid.org/0000-0002-5561-0856">https://orcid.org/0000-0002-5561-0856</a></p> <p>Akmaral S. Nurmakhanova<br/> Web of Science ResearcherIDL RV-1810-2024<br/> <a href="https://www.webofscience.com/wos/author/record/26900687">https://www.webofscience.com/wos/author/record/26900687</a></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

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| Usage                                        | <p>Research results will find application in the pharmaceutical industry, biomedicine, and at enterprises for the preparation of domestic medicinal raw materials. Recommendations for the protection of natural populations of <i>C. leucocladum</i>, <i>R. turbinatum</i>, and <i>A. ammodendron</i>, as well as for their inclusion in the list of specially protected natural areas (SPNA), will be submitted for use to the Committee of Forestry and Wildlife of the Ministry of Agriculture of the Republic of Kazakhstan. In addition, the obtained data will be implemented into the educational process of higher educational institutions in such disciplines as "Botany", "Pharmacognosy", and "Ecology".</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Priority compared to real-world alternatives | <p>The advantage of this project compared to existing analogs lies in the comprehensive (geobotanical, phytochemical, and molecular-genetic) study of three rare and valuable medicinal species of the flora of Kazakhstan (<i>C. leucocladum</i>, <i>R. turbinatum</i>, <i>A. ammodendron</i>). For the first time, based on ITS and matK DNA markers, the phylogenetic position of these species has been determined, and the genomic basis of their ecological adaptation has been proven. Furthermore, without being limited to traditional raw material collection, an alternative path for pharmaceutical production is proposed through the development of a protocol for obtaining aseptic callus cells under <i>in vitro</i> conditions, which allows for production without harming natural populations.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| List of publications with links to them      | <p>1. <b>Mussina, M., Tynybekov, B., et al.</b> Assessment of vegetation and soil characteristics of <i>Calligonum leucocladum</i> populations in the Balkhash Region, Kazakhstan // <i>ES Energy and Environment</i>. – 2025. – Vol. 30. – 1809. DOI: <a href="https://dx.doi.org/10.30919/ee1809">https://dx.doi.org/10.30919/ee1809</a> (Scopus Percentile: 87%).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

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|         | <ol style="list-style-type: none"> <li>2. <b>Mussina, M., Tynybekov, B., et al.</b> Comparative chloroplast genomics of <i>Calligonum leucocladum</i> from Kazakhstan: genetic basis for arid adaptation and agroforestry applications // <i>ES Food &amp; Agroforestry</i>. – 2025. (Scopus Percentile: 97%) – Баспада/Accepted.</li> <li>3. <b>Mussina, M., Imanaliyeva, M.</b> Floristic similarity level and ecological assessment of biodiversity (according to the Shannon index) of the <i>Calligonum leucocladum</i> population // <i>International Academic Conference in Italy</i>. – November 13, 2025. – Proceedings.</li> <li>4. <b>Imanaliyeva, M. T., Nurakyn, Z., Tynybekov, B., Ydyrys, A., Nurtayeva, M., Mamytova, N., &amp; Turarova, E.</b> Ecological and geographical features of <i>Astragalus ammodendron</i> (Fabaceae) in Kazakhstan // <i>Experimental Biology</i>. – 2025. – Vol. 104, No. 3. – P. 111-124. DOI: <a href="https://doi.org/10.26577/bb202510439">https://doi.org/10.26577/bb202510439</a></li> <li>5. <b>Mussina, M., Tynybekov, B., Öz, G., Ydyrys, A., Nurtayeva, M., &amp; Imanaliyeva, M.</b> Environmental influence on the phytochemical composition of <i>Calligonum leucocladum</i> populations in Kazakhstan // <i>International Journal of Biology and Chemistry</i>. – 2025. – Vol. 18, No. 2. – P. 26-44. DOI: <a href="https://doi.org/10.26577/IJBCh20251824">https://doi.org/10.26577/IJBCh20251824</a></li> </ol> |
| Patents | Application submitted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |