

ABSTRACT

of the dissertation work of Mamirova Saule titled « **Distribution, current state of populations and perspectives on the use of *Rhaponticum altaicum* (Fisch. ex Spreng.) Soskov in Kazakhstan** » submitted for the academic degree Doctor of Philosophy (PhD), educational program «8D05108-Geobotany»

Relevance of the study. The flora of Kazakhstan is distinguished by its exceptional diversity and its richness, numbering more than 1400 species of medicinal plants belonging to 134 families. The study of their unique medicinal properties, the identification of new effective properties opens up enormous opportunities for the use of plants in official medicine, the pharmaceutical industry and other industries of the country. It should be noted that in recent decades new medicinal plants have been studied and introduced into medicine, previously unknown in either folk or official medicine. In this regard, the genus *Rhaponticum* Vaill is extremely interesting and promising for study. Plants of this genus are distinguished by a rich chemical composition and have valuable medicinal properties. Their main active ingredients are ecdysteroids, sesquiterpene lactones, flavonoids and essential oils.

The best known representative of this genus is *Rhaponticum carthamoides* (Wiild.) Iljin, the chemical structure of the rhizomes of which began to be studied in the middle of the 20th century, and now this plant is widely used in medicine. Extracts and preparations from this plant are characterized by low toxicity, they exhibit tonic, stimulating and adaptogenic properties, and also have an anabolic effect on the body. It should also be noted that the first tonic drug "Ecdysten" was developed earlier on the basis on ecdysterone isolated from the roots of this plant.

At present, the medicinal potential of other species of the genus *Rhaponticum* growing in Kazakhstan remains insufficiently studied. One of these species is *Rhaponticum altaicum* (Fisch. ex Spreng.) Soskov, that is widespread in Northern and Central Kazakhstan. According to preliminary data, this species contains the main biologically active compounds, such as ecdysteroids and sesquiterpene lactones, which makes this plant promising for pharmacological research.

Rh. altaicum is particularly relevant due to the possibility of its use as an alternative source of raw materials instead of *Rh. carthamoides*, which is included in the Red Book of Kazakhstan [16]. In this regard, the study of the distribution, population number, status of populations and potential use of *Rh. altaicum* is of great scientific and practical importance.

Objects of study: populations of *Rh. altaicum* growing in Karaganda and Akmola regions of Kazakhstan and samples of the aboveground and underground parts of this species, harvested in the period from June to July 2022-2023 during the flowering and fruiting phase.

Subject of the research: study of the distribution, floristic composition, age conditions, features of the anatomical structure, ontogenetic structure, chemical composition and biological activity of *Rh. altaicum*.

The aim of the study: To study the current state of populations, ontomorphogenesis, anatomical structure, and patterns of distribution of biologically

active substances in the aboveground and underground parts of *Rhaponticum altaicum* growing in Kazakhstan and assessment of the practical significance of the species.

Research objectives:

1. To study the distribution of species of the genus *Rhaponticum* in the territory of Kazakhstan based on herbarium materials and personal collections;
2. To determine the characteristics of distribution, coenoflora, ecological and phytocenotic confinement and ontogenesis of *Rh. altaicum* in Kazakhstan;
3. To study age structure of *Rh. altaicum* cenopopulations, growing in the Karaganda and Akmola regions;
4. To study anatomical structure of *Rh. altaicum* by age conditions;
5. To study qualitative and quantitative content of ecdysteroids and flavonoids in the aboveground and underground parts of *Rh. altaicum*, collected in Karaganda and Akmola regions;
6. To study biological activity of *Rh. altaicum*, including its cytotoxic, antiradical and antioxidant properties.

Research methods.

Geobotanical studies were carried out using the detailed route method. The characteristics of age states and the ontogenetic structure were studied according to the guidelines of T.A. Rabotnov, A.A. Uranov, O.V. Smirnova et al., L.A. Zhivotovsky. The IBIS program developed by A.A. Zverev was used to process the floristic descriptions. The approaches of I.G. Serebryakov and Raunkier were used to analyze the life forms of the cenoflora. The species were assessed in relation to moisture using the ecological scales of A.N. Shennikov and L.G. Ramensky, as well as in accordance with the methodological developments of N.G. Ilminkikh and A.Yu. Korolyuk. The cenomorph scale of A.L. Belgard was used for the ecological and biological characteristics of plants. The names of the species are given according to the summary of S.A. Abdulina, taking into account obtained modern data (POWO 2025). The families of angiosperms are arranged according to the system of A.L. Takhtadzhyan. When assessing the projective cover, the Braun-Blanquet species abundance point scale was used. Statistical processing of the obtained data was carried out using the Statistica 12.0 program and R program for Windows (R version 3.6.0, 2019). When studying species distribution of the genus *Rhaponticum*, the materials of LE, AA, MW, TASH, KUZ, KG, and TK Herbariums were used. The distribution of plants on the territory of Kazakhstan is shown according to the floristic regions developed by N.V. Pavlov, I.A. Linchevsky, N.I. Rubtsov and P.P. Polyakov, detailed and refined by M.G. Popov for the flora of Kazakhstan.

The mass of 1000 seeds was determined using the method of M.K. Firsova. The study of seed productivity was carried out using the method of I.V. Vainagia.

The study of the qualitative and quantitative composition of ecdysteroids and the sum of flavonoids in the extracts of *Rh. altaicum* was carried out by thin-layer chromatography (TLC) and high-performance liquid chromatography (HPLC). The determination of the antiradical activity of obtained extracts was done by the FRAP method; the determination of the antioxidant activity was done by inhibiting the

DPPH radical. The study of cytotoxic activity was carried out by the survival method of sea crustaceans *Artemia salina*.

Scientific novelty of the study:

1. For the first time, the detailed distribution of species of the genus *Rhaponticum* in the territory of Kazakhstan was studied;
2. The floristic composition and ecological phytocenotic characteristics of communities with the participation of *Rh. altaicum* were studied in the territory of Northern and Central Kazakhstan;
3. *Rh. altaicum* characteristic features of ontomorphogenesis have been determined;
4. The age structure of *Rh. altaicum* cenopopulations was studied in the territory of Northern and Central Kazakhstan;
5. The anatomical structure features of the vegetative organs of *Rh. altaicum* in the process of ontogenesis are noted and described;
6. The qualitative and quantitative composition of ecdysteroids and flavonoids in the aboveground and underground parts of *Rh. altaicum* collected in Akmola and Karaganda regions at different stages of development was established;
7. The antiradical, antioxidant and cytotoxic activities of extracts from the aboveground and underground parts of *Rh. altaicum*, growing in the Karaganda and Akmola regions, were studied.

The theoretical significance lies in expanding knowledge about the current state of *Rh. altaicum* populations and its status, chemical composition and biological activity of its aboveground and underground parts; as well as morphological and anatomical features of *Rh. altaicum* in the process of ontogenesis. The data obtained will allow planning effective measures for the protection of *Rh. altaicum* and, in general, the discussion of biodiversity in Kazakhstan.

Practical significance:

- The study results can be used for the introduction of *Rh. altaicum* as an alternative herbal medicinal raw material: it is a source of valuable biologically active substances (ecdysteroids and flavonoids), and for its further introduction;
- A map was compiled: it shows the genus *Rhaponticum* range in the territory of Kazakhstan;
- A key solution to identifying species of the genus *Rhaponticum* in Kazakhstan is proposed;
- Herbarium sheets of the studied species were collected, processed and transferred to the Herbarium Fund of the Astana Botanical Garden (NUR).

The main provisions of the dissertation submitted for defense:

- The genus *Rhaponticum* in Kazakhstan is represented by 6 species.
- *Rh. altaicum* is distributed in thirteen floristic regions of Kazakhstan and it is a part of meadow-marsh phytocenoses. Populations of *Rh. altaicum* are incomplete with a predominance of pregenerative individuals.
- Ontogenesis of *Rh. altaicum* consists of four periods (latent, virginal, reproductive, senile) and 9 age states.
- The aboveground and underground parts of *Rh. altaicum* contain a large amount of ecdysteroids and flavonoids, which have high biological activity.

Personal contribution of the PhD student. The author has analyzed on her own the current state of *Rh. altaicum* populations, has determined the floristic composition of communities, studied anatomical structure features of the studied species, determined chemical composition and biological activity of extracts of the aboveground and underground parts of *Rh. altaicum*. The articles were written with co-authors, with the author's personal contribution being the main one.

Connection with the plan of the main scientific works.

The dissertation work was carried out within the framework of the targeted financing program of the Scientific Research Institute of the Ministry of Education and Science of the Republic of Kazakhstan No. BR 18574125 "Study of the current state of species diversity of vascular plants of Kazakhstan using modern methods of botany, molecular genetics and bioinformatics " and also within the framework of the grant project financed by the Scientific Research Institute of the Ministry of Education and Science of the Republic of Kazakhstan IRN AP19680461 "Current state of populations and resource potential of the medicinal flora of the Kazakhstan part of the Southern and Western Altai".

Approbation of the work.

The materials of the dissertation work were reported and discussed at:

- International scientific conference "Biological diversity of the Asian steppes", Kostanay, Kazakhstan, 2022;
- International online scientific conference «Asian Grassland Conference», 2022;
- International scientific conference of students and young scientists "FARABI ƏLEMI", Almaty, Kazakhstan, 2022;
- International scientific conference "Russian Geobotany: Results and Prospects" (for the 100th anniversary of the Department of Geobotany BIN), St. Petersburg, Russia, 2022;
- International scientific conference of students and young scientists "FARABI ƏLEMI", Almaty, Kazakhstan, 2023;
- XVII International scientific and practical conference "Problems of botany of Southern Siberia and Mongolia", Barnaul, Russia, 2023;
- International scientific and practical conference of young scientists "Ideas of N.V. Pavlov through the eyes of a new generation of botanists", Almaty, Kazakhstan, 2024.

Publications.

The main content of the dissertation is reflected in 13 printed works, including 2 article in an international peer-reviewed journal with an impact factor cited in Scopus; 3 articles from the list of publications are recommended by the Committee for Control in the Sphere of Education and Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan for the publication of the main results of scientific activity, 8 articles and abstracts are included in the materials of international and national conferences, 3 of which are foreign publications.

Structure of the dissertation. The dissertation is presented on 139 pages and consists of designations and abbreviations, introduction, literature review, materials

and methods, results and discussion, conclusion and a list of references from 239 titles; it contains 22 tables, 45 figures and 7 appendices.