

ANNOTATION

dissertation work for the degree of Doctor of Philosophy (Ph. D) in the specialty
"8D0510 - Biology"

KORBOZOVA NAZYM KURMANBAEVNA

Study of the impact of abiotic stress factors on the composition of biologically active substances of *Rhodiola semenovii* Boriss

General description of work. The dissertation work is devoted to the study of the impact of various abiotic stress factors on biologically active substances and on the morphophysiological parameters of the plant *Rhodiola semenovii* Boriss

Relevance of the research topic. In the arid conditions of the sharply continental climate of Kazakhstan, plants are constantly under the influence of various environmental stress factors. In this case, a number of protective mechanisms can be activated and then qualitatively and/or quantitatively affect plant metabolites. Crassulaceae family plants are natural accumulators of organic acids. The use of the healing potential of plants has been known to mankind since ancient times. Recently, the range of plant-based biologically active substances used in medical practice, the food industry, and agriculture has grown.

Higher plants are a unique source of compounds used in the pharmaceutical industry, both in pure form and after various chemical transformations.

Biologically active additives belong to the class of natural components of micronutrients that have a pronounced physiological and health-improving effect on the body and its main regulatory and metabolic processes.

The therapeutic properties of medicinal plants are associated with the presence of a large number of various bioactive substances such as glycosides, flavonoids, vitamins, etc., which are synthesized in plant tissues as secondary metabolites, have antioxidant activity and modulate hormonal balance. Structural diversity and a wide range of biological activity of secondary metabolites make them an indispensable basis for many pharmaceutical preparations.

The phytochemical composition of plants can vary depending on the type of organ and stage of development, as well as changes in environmental conditions, such as solar insolation, air temperature, fertility, soil moisture and salinity.

Secondary metabolites are synthesized in response to environmental stresses as an element of plant defense mechanisms, which contributes to their survival and adaptation throughout life. The predominant abiotic stressors include drought, low and high temperatures, soil salinity and acidification, intense light, air deficiency and nutrient deficiency. In addition to natural and climatic factors, the chemical composition of plants is also influenced by anthropogenic factors.

Plants of the Crassulaceae family are succulents resistant to many extreme environmental factors, which makes them especially important in today's rapidly

changing climate. The life cycles of these species are due to significant temperature fluctuations during the day, intense solar radiation, summer snowfalls and, conversely, the bare soil in winter and its deep freezing. Representatives of Crassulaceae are natural accumulators of BAS prices. Thus, the well-known representative of Crassulaceae *Rhodiola rosea* L. has been used for centuries by folk medicine both in Europe and in Asia as a highly effective natural adaptogen and immunostimulant, but at present, due to high commercial demand, it is an endangered species and therefore is listed in the Red Books of many countries. In this regard, a full study of other members of this family is required, both in terms of their biological and pharmacological activity, as well as numerous ways of adapting to abiotic stress factors.

Plants *Rhodiola semenovii* (Regel & Herder) Boriss. are also historically used in folk medicine of Central Asia as a source of adaptogenic, choloretic, tonic, anti-inflammatory, hypoglycemic and antioxidant properties. Analysis of the influence of stress factors on the morphophysiological parameters and composition of biologically active substances of the organs of the Kazakh plant *R. semenovii* can reveal both new theoretical aspects of plant adaptation to adverse conditions and new alternative possibilities for obtaining valuable domestic herbal remedies. In addition to the effect on the functioning of the thyroid gland, BAS in the plant *R. semenovii*, according to some authors, has antiarrhythmic, antihypertensive properties. In our experiments, we also conducted such studies to determine the antiarrhythmic and antihypertensive properties of the *R. semenovii* plant.

Analysis of the influence of stress factors on the morphophysiological parameters and composition of biologically active substances of the organs of the Kazakh plant *Rhodiola semenovii* Boriss. will make it possible to reveal both new theoretical aspects of plant adaptation to adverse conditions, and new alternative possibilities for obtaining valuable domestic phytopreparations.

Purpose of the study. To study the effect of stress factors on the pharmacological properties of biologically active components of the *R. semenovii* plant.

Research objectives:

1. To study the chemical composition and phytochemical content of the main groups of biologically active substances (BAS) of various organs of *R. semenovii*, depending on the vegetation phase of the plant *in situ*;

2. To study the effect of stress factors on the morphophysiological parameters and phytochemical content of biologically active substances in various organs of the *R. semenovii* plant.

3. To analyze the acute and chronic toxicity of chemical fractions from the plant *R. semenovii*.

4. To study the antihypothyroid, antiarrhythmic and antihypertensive potential of *R. semenovii* plant extract.

5. To give recommendations on the use of the *R. semenovii* plant for the creation of a domestic phytopreparation.

Object of study – *Rhodiola semenovii* (Regel & Herder) Boriss.

Research methods – during the research work on the topic of dissertations, the following methods were used: botanical, anatomical, physiological, phytochemical, histological, pharmacological, hematological.

Scientific novelty of the research.

The novelty of the research lies in the fact that for the first time, using gas chromatography-mass spectrometry, the metabolic profile of *R. semenovii* was studied in the context of donor-acceptor interactions in the dynamics of vegetation in situ in the foothills of the Zailiysky Alatau.

The effect of abiotic stress factors on the morphophysiological parameters and phytochemical composition of the *R. semenovii* plant was studied for the first time.

For the first time, the antihypothyroid, antiarrhythmic, and hypotensive potential of the *R. semenovii* plant root extract was evaluated on the model of mercazolilic hypothyroidism.

Theoretical and practical significance of the research is that, with a sufficiently high degree of correlation, some regularities in the synthesis and redistribution of metabolites both in the root and in the shoot in *R. semenovii* plants during the growing season, which are affected by donor-acceptor interactions, were revealed, and it was also shown that the antioxidant system in plant tissues it is multicomponent and includes secondary metabolites of pharmaceutical value; the functional interaction of antioxidant components is due to adaptive stress responses of the organism.

The practical significance lies in the fact that a positive dynamics of salidroside accumulation in the shoots of *R. semenovii* was revealed during the growing season with a maximum during seed maturation, which can serve as a basis for recommending the collection of plant material during this period without destroying the root system of the plant. Morpho-physiological indicators have been identified that can serve as indicators of the adaptive potential of *R. semenovii* under stressful conditions. Recommendations have been developed for the correction of experimental subclinical hypothyroidism using *R. semenovii* extract, both alone and in combination with potassium iodide at concentrations of 2.5 mg/100 g and 2.5 mg/100 g.

In general, the results obtained can be used both for understanding the mechanisms of protection against adverse conditions, and for approaches to the targeted synthesis of valuable biologically active substances.

Basic provisions for defense:

1. An increase in the content of salidroside in the above-ground organs in the dynamics of vegetation with its maximum value during the period of seed maturation allows us to recommend the collection of the above-ground part of *R. semenovii* for pharmaceutical purposes without damaging the root system.

2. Changes in the morphophysiological reactions and phytochemical composition of *R. semenovii* roots and shoots under abiotic stresses can serve as indicators of the adaptive potential of plants and an approach to the targeted synthesis of secondary metabolites valuable for pharmaceutical use.

3. *R. semenovii* extract, both alone and in combination with potassium iodide, is a safe and effective means of correcting and stabilizing hypothyroid conditions.

Connection with the plan of main scientific works. The dissertation work was carried out within the framework of the project AP08855699 "Influence of abiotic stress factors on morphophysiological and phytochemical aspects of adaptation and biological activity of the Kazakh plant *Rhodiola semenovii* Boriss." MES RK for 2020-2022. Scientific supervisor of the project Ph.D., assoc. Professor N.V. Terletsкая.

Author's personal contribution. Defining the purpose and objectives of the dissertation work, conducting experiments, processing the results of the study, statistical analysis of the data obtained. The literature review, the preparation of abstracts and articles for publication, the main results presented in the dissertation, were carried out with the participation of joint authors. Experimental studies on toxicity, development of an experimental model and experiments on correction with *R. semenovii* B extract were carried out in accordance with the guidelines on the principles of conducting animal studies, approved by the Order of the Minister of Health of the Republic of Kazakhstan dated December 11, 2020 No. RK DSM-255/2020. Registered with the Ministry of Justice of the Republic of Kazakhstan on December 15, 2020, No. 21794. During the experiment, methods such as the "open field" test, experimental hypothyroidism model, "adrenaline arrhythmia", "formalin edema" tests were used.

Photosynthetic activity parameters were assessed using a Junior-PAM fluorimeter.

Research Approbation. The results of the dissertation work were reported and published at international scientific and practical conferences: International scientific and practical conference "Actual problems of biodiversity and biotechnology", dedicated to the Year of Youth in the Republic of Kazakhstan. Nur-Sultan (20.10.2019); The XVI International Scientific Conference of Students and Postgraduates was dedicated to the 75th birthday of the Faculty of Biology and 90th birthday of M. Derkach (Lviv, 27-29 April 2020); International scientific and practical conference "Actual problems of ecology and nature management", Moscow, April 22-24, 2021. First All-Russian School for Young Scientists in Medical Chemistry MEDCHEMSCHOOL2021 July 4-9, 2021, Novosibirsk, Russia; XI International Symposium "Phenolic Compounds: Fundamental and Applied Aspects" (Moscow, April 11-15, 2022).

The main results of the dissertation were annually heard at the scientific and technical council of the Faculty of Biology and Biotechnology, at meetings of the Department of Biodiversity and Biresources of KazNU. Al-Farabi and the Scientific Council of the RSE on REM "Institute of Genetics and Physiology". The results of the dissertation work are included in the Report on the research work on the project AP08855699.

Publications. The main content of the dissertation was published in 11 publications, including 3 articles in international peer-reviewed journals with an impact factor included in the Scopus and Web of Science databases; 3 articles in

journals from the list of publications recommended by the Committee for Quality Assurance in Education and Science (KOKSON) of the Ministry of Education and Science of the Republic of Kazakhstan for the publication of the main results of scientific activity, 5 abstracts in the materials of international and republican conferences, of which 3 are foreign.

Structure and scope of work. The dissertation consists of 116 pages of text and introduction, reviews of literature, materials and methods, results and discussion, conclusion, 209 bibliographies, 3 appendices, 21 tables, 23 figures.