

ANNOTATION

Doctoral dissertation on the theme: Biological features of *Scabiosa isetensis* and *Scabiosa ochroleuca* on the territory of Central Kazakhstan submitted for the degree of Doctor of Philosophy (PhD) in the specialty "6D060700-Biology"

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Relevance of the thesis work.

Currently, the study of medicinal plants of local natural flora of Kazakhstan is an important aspect of conservation and rational use of biological diversity. Approximately 6000 species of vascular plants grow in the Republic of Kazakhstan, of which about 1500 species are used in folk and official medicine.

The growing interest in medicinal plants is explained by the high pharmacological activity of secondary metabolites of plants, which can exhibit various types of biological activity. The complex action of medicinal herbs creates the potential for their long use while reducing the side effects characteristic of synthetic drugs.

One of the promising species of medicinal plants in Central Kazakhstan are *Scabiosa isetensis* and *Scabiosa ochroleuca*, the raw materials of which have antimicrobial, antioxidant, antifungal activity, and above-ground and underground organs are used in folk medicine for the treatment of respiratory system diseases, skin diseases, as an antidiabetic agent, etc. The above-ground and underground organs are used in the treatment of respiratory system diseases, skin diseases, as an antidiabetic agent.

The object of the study is medicinal plants from the family (Dipsacaceae): *Scabiosa ochroleuca* L. and *Scabiosa isetensis* L.

Purpose of work: ecological, biological and resource assessment of natural populations of *Scabiosa isetensis* and *Scabiosa ochroleuca* in the conditions of Central Kazakhstan, establishing optimal conditions for cryopreservation to preserve genetic diversity.

Objectives of the study:

1 1 Modern assessment of the state of populations of *Scabiosa isetensis* and *Scabiosa ochroleuca* in natural populations of the Karaganda and Ulytau regions (Central Kazakhstan).

2 Determination of raw material reserves, possible volume of raw material procurement in natural populations of *Scabiosa isetensis* and *Scabiosa ochroleuca*, study the dynamics of accumulation of the sum of extractive substances..

3 3. Determination of the main periods and phases of ontogenesis of *Scabiosa isetensis* and *Scabiosa ochroleuca* in natural conditions.

4. Establishing optimal conditions for cryopreservation of *Scabiosa isetensis* and *Scabiosa ochroleuca* seed material.activation.

Theoretical and methodological basis of the study:

The genus *Scabiosa* was first isolated by C. Linnaeus in 1753, in the volume of

18 species known to him at that time. These species come from different continents of the globe: South Africa, Asia (India, Syria), Europe and North America (Cuba). Because the genus had a small number of species, it was not systematically revised. Taxonomic revisions were rather at the regional or country level, such as Spain and the Balearic Islands (Devesa J.A., 1984), and Egypt (El bous M.M., Gazer M., 2016).

According to the flora of the USSR (1957) and Kazakhstan (1965), the genus belongs to the family Dipsacaceae (Greuter W., Burdet H. M., 1985), while in the POWO resource and according to the data of molecular phylogenetic evaluation - to the family Caprifoliaceae (Manning J.C., 2014).

The fundamental summaries "Flora of the USSR" (1934-1965), "Flora of Kazakhstan" (1956-1966), "Central Asia Plant Synopsis" (1968-1994), "Flora of Siberia" (1988-2003) and others were used to establish the species affiliation of taxa. Verification of species was carried out using iNaturalist, Plantarium, and POWO platforms. The names of taxa are given according to the summary by S.K. Cherepanov (1995).

Plant life forms were evaluated according to the system of I.G. Serebryakov (1982) with allocation of the following classes: trees, shrubs, semi-shrubs, semi-shrubs, herbaceous perennials, small perennials (one- and two-year species). Ecological groups of plants were identified in relation to moisture conditions (hygrophytes, mesophytes, mesoxerophytes, xeromesophytes, xerophytes), soil fertility, humus content, light and temperature conditions (Kuminova A.V., 1960, Magarran E., 1992). Aboveground organ resources were evaluated according to the method of A. I. Schroeter, I. L. Krylova and I. L. Borisova (1986). The method of A. A. Uranov (1969) was used to describe ontogenesis, and the population type was determined according to T. A. Rabotnov (1950).

The ultra structure of the seed surface was described as recommended by E. Cervantes et al. (2016), D. G. Gabr (2018), J.-H. Song et al. (2018), N. D. Hallam (1970), S. Ray et al. (2014), Z. Lubna et al. (2019), M. Bona (2020)]. Data analysis was performed in the R environment (<http://dx.doi.org/10.2307/2963459>). Species richness (alpha diversity) was calculated for each area. To characterize biodiversity, the following indices were calculated as recommended by Maggaran (1992).

The author's personal contribution to the scientific results. The author personally developed the research program, conducted field expeditions, collection of herbarium and seed material, analysis of the state of communities with *Scabiosa pale yellow* and *Scabiosa isetskaia* on the territory of Central Kazakhstan with the assessment of raw material reserves, performed research on cryopreservation of seed material. The author was personally engaged in the collection of initial data, statistical processing and analysis of the results obtained.

Scientific novelty and significance of the thesis work.

For the first time the current state of communities with *Scabiosa ochroleuca* and *Scabiosa isetensis* on the territory of Central Kazakhstan was investigated, populations suitable for practical use were determined. According to the relative floristic composition in the conditions of Central Kazakhstan in the community with participation of *Scabiosa ochroleuca* 142 species were identified and in the

community with participation of *Scabiosa isetensis* 79 species were identified and for the first time the map of distribution of both species of genus *Scabiosa* on the territory of Central Kazakhstan was created.

The ontogenetic spectra of the studied populations of *Scabiosa ochroleuca* and *Scabiosa isetensis* were compiled for the first time.

For the first time, the optimal phases of harvesting *Scabiosa* raw material were determined and populations with high content of active substances were established.

The quantitative content of the sum of extractive substances by vegetation phases was established for the first time.

Morphology and biology of germination of seeds of *Scabiosa ochroleuca* and *Scabiosa isetensis* were investigated for the first time, and storage periods under traditional conditions were established.

The viability of *Scabiosa ochroleuca* and *Scabiosa isetensis* seeds depending on the type of container and defrosting conditions was estimated for the first time and an algorithm for freezing of seed material in liquid nitrogen was developed.

Provisions for defense:

Current status of populations and plant resources of *Scabiosa isetensis* and *Scabiosa ochroleuca* in Central Kazakhstan.

Floristic composition of communities with *Scabiosa isetensis* and *Scabiosa ochroleuca* species.

Dynamics of accumulation of biologically active substances in raw materials by vegetation phases and place of growth.

Germination conditions of *Scabiosa isetensis* and *Scabiosa ochroleuca* seeds.

Algorithm and practical recommendations for cryopreservation of seed material of *Scabiosa isetensis* and *Scabiosa ochroleuca* plants.

Conclusion.

1. The composition of the flora of plant communities with populations of *Scabiosa isetensis* and *Scabiosa ochroleuca* was determined. In populations with *Scabiosa ochroleuca*, 142 species from 98 genera and 31 families were described. The leading families in communities with *Scabiosa* pale yellow are *Asteraceae* (42 species or 29.5%), *Poaceae*, *Rosaceae* (12 species or 8.4% each), *Fabaceae* (9 species or 6.33%). The leading four families account for 52.81% of the total species composition of the community flora. Alpha diversity in communities with *Scabiosa ochroleuca* ranged from 50 to 70, Shannon index from 3.82 to 4.17, Piel alignment from 0.97-0.98, and Simpson index from 0.97-0.98. For populations of *Scabiosa isetensis* 79 species from 56 genera and 23 families were found to grow. The leading families are *Asteraceae* (24 species or 30.37%), *Fabaceae* (8 species or 10.2%) and *Rosaceae* (5 species or 6.3%), i.e. these 3 families account for 46.8% of the total species composition of communities. Alpha diversity for communities with *Scabiosa isetensis* varied from 26 to 51, Shannon index - from 3.23 to 3.87, Piel alignment - 0.97-0.99, Simpson index - 0.96 -0.98.

2. The spectrum of life forms for both species is dominated by herbaceous perennial plants, ecological groups - mesophytes and xerophytes, which confirm the confinement of taxa to arid territories. However, typical habitats of *Scabiosa*

ochroleuca are characterized by confinement to more humid places, while *Scabiosa isetensis* grows in more arid conditions.

3. The results of the cluster analysis allowed us to identify 3 groups of populations each for *Scabiosa ochroleuca* and *Scabiosa isetensis*. For *Scabiosa ochroleuca*, the first cluster includes 3 communities - populations from Spassky Hills, Karkaraly Mountains and Korneevsky forests, the second cluster is formed by populations from SNPP "Buiratau", the third cluster includes populations from the vicinity of Molodezhny settlement, Bektauata and Ulytau mountains. For *Scabiosa isetensis*, the first cluster includes territories of SNNPP "Buiratau", the second cluster includes communities from the Ulytau Mountains, and the third cluster includes populations from the Aksu-Ayuly hills and the Bektauata Mountains.

4. Morphometric indices of aboveground organs of *Scabiosa isetensis* and *Scabiosa ochroleuca* were studied for the first time. Populations with higher indices of height, number of generative shoots and inflorescence diameter were found. On the basis of morphological indicators, promising populations were identified for seed selection for introduction and seed cryobank.

5. The ontogenetic spectra of the studied populations of *Scabiosa isetensis* and *Scabiosa ochroleuca* in Central Kazakhstan were compiled for the first time. For both species, all populations are characterized by a single type of ontogenetic spectrum, despite inhabiting different geographical locations. The spectrum is of left-sided type with predominance of juvenile individuals.

6. For the first time raw material reserves of above-ground organs of *Scabiosa ochroleuca* were determined on the area of 104.3 ha with the exploitable reserve of 347.56 centners and the volume of possible collection - 204.28 centners; for *Scabiosa isetensis* the total area of thickets was 97 ha, the exploitable reserve was calculated at the level of 228.48 centners, the volume of possible collection - 137.09 centners. The optimal phase of raw material collection is flowering. Populations with maximum accumulation of extractive substances were found.

7. The large cycle of ontogenesis of *Scabiosa isetensis* and *Scabiosa ochroleuca* was studied on the basis of observations in laboratory conditions and natural populations. The large cycle of ontogenesis of *Scabiosa ochroleuca* includes 4 age periods and 4 age states, its duration is 2 years. In *Scabiosa isetensis* the big cycle of ontogenesis includes 3 age periods and 7 age states, the duration of which in the conditions of Central Kazakhstan is 14-20 years.

8. The peculiarities of morphology and ultra structure of seeds of *Scabiosa ochroleuca* and *Scabiosa isetensis* were established for the first time; the germination phases including swelling, appearance of the embryonic root, appearance of the hypocotyl, its bending, appearance of seedling leaves, and appearance of the first true leaf were established. Dependence of morphological, weight indices and germination depending on the place of origin of samples was determined for both species. The duration of storage of seed material of both species of *Scabiosa* under traditional conditions - paper container and cold room - was determined. For seeds of *Scabiosa ochroleuca* the storage duration was 3 years, for seeds of *Scabiosa isetensis* - 2 years. For both species, the positive practice of using separation to select the largest and most

complete seeds for further storage was shown.

9. The conditions of cryopreservation of seeds of *Scabiosa isetensis* and *Scabiosa ochroleuca* were optimized. Plastic containers should be used for storage in liquid nitrogen, defrosting should be carried out on a water bath; the optimal cryoprotectant is 40% glycerol solution. The results obtained allowed us to develop an algorithm for the preparation and organization of long-term storage of *Scabiosa* seeds at supercritical low temperatures, as well as to prepare recommendations on cryopreservation.

Approbation and approval of the results of the work. The results and conclusions of the study are presented in 13 papers, including 1 monograph, 1 article published in the scientific journal included in the Scopus "Online Journal of Biological Science", 6 articles in journals recommended by the Committee for Control in the field of science and higher education of the Republic of Kazakhstan, 5 articles in the proceedings of international scientific conferences.