



REVIEW ARTICLE

## Biology of the medicinal plant *Arum korolkowii* Regel (Arum)

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### Abstract

More than five thousand plant species thrive in various zones across Kazakhstan, representing a rich botanical diversity. Unfortunately, numerous plant species are becoming increasingly rare, and some are even threatened with extinction. The significance of utilizing medicinal plants has increased immeasurably in recent decades. The rational combination of medicinal plants holds the potential to expand therapeutic possibilities. However, the future use of medicinal plants may face significant limitations due to the overarching issue of diminishing biodiversity. While efforts to address biodiversity conservation predominantly focus on safeguarding species richness, the intraspecific variability of plants, crucial for population-level adaptation in transforming environments, remains inadequately explored. Particularly, the use of informative methods to study this variability has not received sufficient attention. Theoretical exploration of the population approach to conserving medicinal plant resources is lacking, exacerbated by a scarcity of experimental data in this domain, underscoring the relevance of this research. In light of the aforementioned challenges, it becomes evident that studying red-listed plants is pertinent not only in the context of Kazakhstan but also on a global scale. In this context, our research allowed investigate *Arum Korolkov* (*Arum korolkowii* Regel), a red-listed medicinal plant species found in the territories of Kazakhstan.

### Keywords

Arum; Germination; Poisonous; Red book species; Tubers

### Introduction

A vast number of flora species thrive in the expansive landscapes of Kazakhstan, encompassing trees, shrubs, herbs, and flowers. Despite the abundance of green areas such as forests, meadows, and steppes, numerous plant species are on the verge of extinction. These plants, listed in the Red Book, are protected by the state and cannot be plucked. Currently, the rate of plant species extinction is accelerating due to the increased negative anthropogenic impact on natural objects.

To preserve rare and endangered species, red books and red lists are being created. They include lists of plant and fungal species in need of special protection. These documents are intended to raise general awareness of rare and endangered species and to assist in the development of conservation programs. In our country, the official documents in the field of pro-

tection of rare and endangered species (subspecies, populations) of wild animals, wild plants, and fungi, as well as the most important mechanism for their protection, are the Red Book of the Republic of Kazakhstan. In Kazakhstan, the inclusion of species in the Red Book is legally significant and contributes to the introduction of several restrictions on the use of relevant species in agricultural and other human activities. It results in their isolation as objects of legal protection from other representatives of the animal and plant world and the adoption of special protection measures against them. The main purpose of the Red Book is to identify and account for those species of organisms that may disappear, and for the preservation of which special protection measures are necessary (1–6).

The International Union for Conservation of Nature has identified the gradual decline of the animal and plant world. In response, the idea emerged to individually study each plant listed in the Red Book of Kazakhstan that is under threat. Understanding the representatives listed in the Red Book is crucial to avoid causing irreparable harm through ignorance. Our initial focus was on studying *Arum korolkowii* Regel, one of the plants listed in the Red Book.

The Government of the Republic of Kazakhstan, through Resolution No. 1034 (October 2006) approved a revised list of plants included in the Country's Red Book. The updated list comprises 373 species of plants, 13 species of fungi, and one species of lichens. Notably, among them is Korolkov's Aronnik, which thrives in the protected area of Aksu-dzhabagly (10–12).

The perennial herbaceous plant grows up to 50 cm in height, featuring spherical, somewhat flattened tubers. Its leaves, reaching up to 16 cm in length and 13 cm in width, are heart-shaped, lance-shaped, or triangular, emerging in autumn or, in the southern regions, in early winter. Petioles extend up to 35 cm, displaying an expanded vagina, green with brown stripes.

The peduncles surpass the petiole in length, measuring 40–50 cm, and exhibit reddish stripes. The tube, covering up to 4 cm in length, is narrow, oblong-cylindrical, green both outside and inside, with a white hue. The fold of the bedspread stands erect measuring 14–20 cm in length, narrow-lanceolate, pointed, green outside, greenish-white inside with a pale purple tint. The cob reaches up to 14 cm in length.

The appendage of the cob is up to 30 cm long, cylindrical, purplish-brown at the bottom, and dull cream in the upper half, adorned with a thick red-brown marble pattern. The berry produced by this plant, and it typically blooms in June. Notably, it exhibits frost resistance to minus 23 °C. This plant prefers rocky soils, demonstrating a preference for moisture while also exhibiting relative drought resistance (13–16). The scientific classification of Arum is in Table 1

Korolkov's Aronnik can be found among the rocks and shady gorges of Central Asia, China, and Iran. This plant has a spherical, slightly flattened tuber. The leaf blade has a triangular or heart-shaped lance-shaped shape. The petiole on which the leaf is located is twice as

long as the plate. The stem with red stripes reaches a height of 60 cm. The green blanket is rolled into a rather narrow tube. Its length is twice the length of the cob, and the color is green outside and whitish inside. The reddish, cylindrical appendage is twice as large as the cob. Notably, the aronnik Korolkov's inflorescences and red spherical fruits contribute to its striking decorative appeal, especially during the autumn season. Korolkov's Aronnik exhibits slow germination and thrives in well-drained, loose, and fertile substrates, avoiding excess moisture. It favors shaded environments, such as under trees or on the north side of buildings. Winter protection is advisable, often achieved by covering the plant with a layer of leaves.

This plant reproduces both through vegetative

**Table 1:** Botanical classification of Arum

|                               |   |
|-------------------------------|---|
| Domain                        | Eukaryotes                                  |
| Kingdom                       | Plants                                      |
| Sub-kingdom                   | Green plants                                |
| The treasure:                 | Higher plants, vascular plants, seed plants |
| Department:                   | Flowering, angiosperms – Magnoliophita      |
| Class: Monocots –             | Liliopsida                                  |
| Order:                        | Chastukhotsvetnyye                          |
| Family:                       | Araceae – Araceae Juss.                     |
| Subfamily:                    | Aroid                                       |
| Tribe:                        | Astereae                                    |
| Genus:                        | Aronnik – Arum L.                           |
| Type:                         | Aronnik Korolkov                            |
| International Botanical name: | <i>Arum korolkowii</i> Regel                |

means and seeds. It's important to note that Korolkov's Aronnik contains several alkaloids, with aronin being very toxic. Aronin can locally irritate, especially mucous membranes, and despite being a volatile substance, it has the potential to paralyze the central nervous system. The tubers of the plant are even more poisonous. Care should be taken to handle this plant with caution due to its toxic nature. Arum plants possess horizontally spreading rhizomes with tuberous structures that are hemispherical or ovoid. These perennial grasses are typically small, rarely exceeding a height of 60 cm, and undergo a period of rest. Foliage development occurs only after the completion of the flowering process. A significant number of leaf plates are produced, arranged in a spiral order along the stem. The leaves feature sheaths, and there are 2–3 leaves with petioles. The length of leaf sheaths can vary from short to elongated. The petiole at the base is characterized by an extension resembling a vagina. Leaf shapes range from heart-shaped to arrow-like or arrow-lance-shaped. On the leaf surface, primary veins exhibit a feathery outline, forming at least one common single vein, creating a pattern resembling a mesh formed by higher-order veins.

The flowering period of Arum occurs in June, when the soil is thoroughly warmed by the sun, yet an openwork shade

is provided beneath the tree crowns. Atop a bare and robust flowering stem, an inflorescence develops, often resembling an *Arisaema* cob, akin to "sisters" in the family. Inflorescence consists of small buds that collectively form a cob, exhibiting petals in shades of red, bright pink, yellowish, or creamy pink when in full bloom. The flowers are unisexual and lack a perianth. After a brief period, a leaf-like bract envelops the cob. This leaf exhibits a dense texture, with dimensions that can reach up to 0.5 m in length and 10 cm in width. The leaf covering typically has an olive or light green hue, although some varieties feature stripes and specks in different tones on the surface. Despite its exterior, the inner side of the leaf reveals a strikingly beautiful bright purple color. Due to its foliage and inflorescences, the *Arum* bears a striking resemblance to calla lilies. During summer, once the flowering stage concludes and pollinators like flies (attracted to meat, manure, or carrion) and, for the *Canofoloid* variety of *Aronica*, mosquitoes have played their role, the berries begin to ripen. These fruits are exceptionally fleshy, presenting hues of red or orange. Inside the fruit, several seeds take on shapes ranging from ellipsoid to ovoid. Interestingly, as August arrives, all the foliage withers away, leaving only the stem adorned with vibrant scarlet and glossy fruits, creating a striking visual display.

*Aronnik* relies on fly pollination, and its aroma, though not pleasant to humans, attracts flies. The purple color of the bract in some varieties even resembles meat. When a fly enticed by the specific scent lands on the cob, the flower collapses the bract, trapping the insect inside for several days at a comfortable temperature for midges, typically around +34 °C (and possibly up to +50 °C according to some sources). During this time, the insects feed on the inner pulp of the bract, becoming full, satisfied, and inadvertently facilitating the pollination process. It's crucial to note that *Aronnik* berries are poisonous, much like the rest of the plant. They contain oxalates of saponins, consisting of needle-like crystals that can irritate the skin and mucous membranes, leading to symptoms such as swelling of the pharynx, difficulty breathing, burning pain, and upset stomach. Handling the plant with gloves is advisable. Interestingly, birds can consume *Aronnik* berries without negative consequences, serving as a means to spread the seeds. Several *Arnica* species, facing the risk of extinction, are listed in the Red Books of some countries in Table 2.

The peculiar and unusual appearance of the *Aronnik* plant, with its grotesque flowers, huge bract, large spotted leaves, and clusters of scarlet shiny berries densely adorning the stem, attracts the interest of gardeners who enjoy experimenting with its cultivation. Despite its spectacular look, *Aronnik* is eradicated as a weed in some countries, showcasing the dual perception of its aesthetic value. The inflorescence is enveloped by a leaf-like covering, almost entirely concealing it. Interestingly, in the UK, the elegant appearance of the *Aronnik* inflorescence has earned it the nickname "Lords and Ladies." However, it is considered a weed in the country due to its prolific self-seeding, spreading from forest and field edges to gardens and vegetable plots.

When the cob blooms, glossy fleshy round red berries with seeds form along its entire length, creating an impressive visual display that many gardeners appreciate.

While official medicine avoids using *Aronnik* due to its toxicity and lack of extensive research, healers in the 18th and 19th centuries found some utility in it. They utilized *Aronnik* as a stimulant, mild laxative, diuretic, and expectorant.

**Table 2.** *Arnica* species, facing the risk of extinction, are listed in the Red Data Books

| Common Name                          | Botanical Name   |
|--------------------------------------|--|
| White-winged arum                    | <i>Arum albispatham</i>  |
| <i>Aronnik</i> alpine                | <i>Agim alpinum</i>  |
| <i>Aronnik</i> of Apulia             | <i>Arum apulum</i>   |
| <i>Aronnik</i> Balansy               | <i>Arum balansanum</i>   |
| <i>Aronnik</i>                       | <i>Arum concinatum</i>   |
| <i>Aronnik</i> of Crete              | <i>Arum creticum</i>   |
| <i>Arum</i> dioscorida               | <i>Arum dioscoridis</i>  |
| <i>Arum</i> Dioscorides of Cyprus    | <i>Arum dioscoridis</i> var. cyprus                              |
| <i>Arum</i> dioscoridis Leopold      | <i>Arum dioscoridis</i> var. liepoldtii                          |
| <i>Arum</i> Dioscorides of Palestine | <i>Arum dioscoridis</i> var. philistaenum                        |
| Common arum                          | <i>Arum dracuncululus</i> / <i>Dracuncululus vulgaris</i>        |
| <i>Arum</i> elongatum                | <i>Arum elongatum</i> / <i>orientale</i> subsp. <i>elongatum</i> |
| <i>Aronnik</i>                       | <i>Arum hygrophilum</i>  |
| <i>Aronnik</i> Italian               | <i>Arum italicum</i>   |
| <i>Aronnik</i> Korolkova             | <i>Arum korolkovii</i> / <i>Biarum sewerzowii</i> )              |
| Spotted arum                         | <i>Arum maculatum</i>  |
| <i>Aronnik</i> oriental              | <i>Arum orientale</i>  |
| <i>Aronnik</i> Palestinian           | <i>Arum palaestinum</i>  |
| <i>Aronnik</i> painted               | <i>Arum pictum</i>   |
| <i>Arum</i> rock                     | <i>Arum rupicola</i>   |

In Victorian times, the language of flowers attributed a meaning of hot passion to *Aronnik* due to the distinctive shape of its cob and the elevated temperature within the bract during the pollination process.

In contemporary folk medicine, crushed *Aronnik* tubers are externally applied in a mixture with honey to address skin issues such as ulcers and lichens. The tubers of the spotted *Aronnik* are utilized for the treatment of digestive diseases, rheumatism, neuralgia, and respiratory conditions. The tubers of *Aronnik* Korolkov, a variety common in Central Asia, are used to prepare an infusion for potency. Homeopathic medicines for oral cavity, upper respiratory tract, and vocal cord ailments are also derived from *Aronnik*. It's noteworthy that *Aronnik* tubers lose their toxicity after heat treatment. In earlier times, before the advent of potatoes, they were consumed and employed for starching clothes. Additionally, the leaves, containing soapy saponins, were used for washing. In conclusion, an analysis of the species composition of protected species, based on their geographical flora, suggests that the most diverse range of geographical flora is found in Tianshan and the mountains of Southern Kazakhstan. It is in these regions that the unique species of Korolkov's *Aronnik* thrives.

## Discussion

From the global repository of higher plants, approximately 1,500 species are used for medicinal purposes. In 1980,

their harvesting amounted to about 20 thousand tons annually. Due to intensive harvesting, the stocks of some economically valuable plant species, including medicinal ones, were significantly depleted. There are individuals for whom plants are just raw materials, an object for profit. The protection of rare and endangered plants is undertaken through various means: the first involves a complete ban on the collection of these species; the second entails safeguarding rare species in nature reserves and sanctuaries; the third involves establishing collection sites and reserves within botanical gardens.

In recent years, worldwide, the intensive industrial development and involvement in the economic utilization of natural resources have led to a decline in medicinal plant availability. Urgent steps are needed to protect rare plant species. Numerous species listed in the Red Book of Kazakhstan meet international criteria, heightening their vulnerability and conservation importance. This work is focused on implementing timely measures to prevent the violation and destruction of the natural and ecological framework through the monitoring of species and valuable territories. The preservation of this framework is necessary for the future well-being of the younger generation. For the studied *Arum korolkowii*, essential measures include the preservation of existing habitats, monitoring of the state of known cenopopulations, identification of limiting factors affecting cenopopulations, and the search for new locations of the species. Eco-education is also pertinent, involving the distribution of leaflets containing information and publications in newspapers and magazines about biological features and the negative impact of anthropogenic factors, especially the tearing of inflorescences. Considering that, Arrowroot reproduces vegetatively and by seeds, spreading through self-seeding, its proliferation needs to be controlled. Therefore, studying the germination process of *Arum korolkowii* seeds and exploring methods to enhance them is crucial for the further reproduction and distribution of this medicinal plant.

## Conclusion

Taking into account all the circumstances described above, we draw the attention of world scientists and leaders of countries to the current state of natural disasters, which will entail irreversible consequences in the future if attention is not increased towards the requirements and conservation efforts for the rarest plants. If the current state of nature is not addressed, future generations will study endangered plants and animals from the Red Book through pictures and drawings.

## Authors contributions

(ShA, AzA); Designing of the experiments (AY, MM, BJA, AB); Contribution of experimental materials (AY, AB, AAN); Execution of field/lab experiments and data collection (AY); Analysis of data and interpretation (AY); Preparation of the manuscript (AY).

## Compliance with ethical standards

**Conflict of interest:** Authors do not have any conflict of interests to declare.

**Ethical issues:** None.

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