Method For Obtaining Herbal Substances of Arum Korolkowii in The Conditions of Hydroponics

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Abstract
The article describes the methods of growing *Arum korolkowii* in both traditional and modern ways, such as hydroponics. The vegetative stages of Arum were described. It is concluded that hydroponic cultivation can be performed using various techniques, such as deep-sea culture, passive (wick) system, hydroponic pot (periodic flooding system), and aeroponics. The purpose of the study is the cultivation of medicinal plants on a hydroponic installation. The system of studying deep-sea cultures is used in the work. In parallel, experiments of the traditional cultivation method were carried out, and a comparative analysis of all indicators was performed. The study has revealed that the difference between the hydroponic method of cultivation and the traditional one is that the plant needs trace elements, and the harvest is high-quality and abundant, which prevents diseases and pests, thereby excluding the need for using toxic chemicals. Thus, we get the product that is organic, nutritious, and available at any time of the year.

Keywords*: Arum korolkowii*, hydroponics, rare plants, light expanded clay aggregate, vermiculite, cultivation of plants, nutrient fertilizers.

Introduction

Arum korolkowii is a rare medicinal plant growing on the territory of the South Kazakhstan region. Perennial plants of Arum korolkowii are one of the main species of herbaceous plants of the Arum family of the Arum genus. They grow and bloom in spring and summer, die off every summer and winter, and grow back in spring from their rootstocks or other wintering structures. They have round flattened tubers. The petiole is a modified flattened-round shortened shoot of the plant [1].

The plant has numerous sheathed leaves extended from the base to one third and twice as long as the lamina, which are located spirally. The sheath can be long or short.

The flowered stem is 50-60 cm high, and it is equal to or exceeds the petiole [2].

There is one inflorescence in a sympoidal unit, which has its specific features: it is twice as long as the spadix; the spathe is green, rolled into a narrow tube or hidden among the leaves. It grows simultaneously with the leaves, squeezed between the leaf blade and the tube. The tube shape may vary from ellipsoid to cylindrical one [3].

The leaf blade is pointed, looks differently, can be sharp or blunt, heart–shaped, triangular, or spear-shaped. During blooming, it is vertical, extended, sometimes twisted into a spiral. The leaf blade often covers the lower part of the spadix [4].

The spadix is lancet-shaped, elongated, with a pointed limb, whitish on the inside. The appendage is reddish, cylindrical, extending the fruitful part of the spadix by

1½—2 times. The interval is occasionally absent, short, and separates the female and male areas. It consists of pistillodes, the infertile flowers. After them, there are filiform appendages, expanded at the bottom and directed upwards. The male area is conical, cylindrical, hemispherical or ellipsoid. The interval between the appendage and the male area consists of the staminodes, the infertile flowers directed downward. The infertile apical appendage often has a pedicle and extends sharply or gradually into a conical or cylindrical mace [5].

The flowers are unisexual. The female area of the flower is cylindrical and is located in the lower part of the spandix. The staminate flower contains 2 – 5 stamens, the anther filament are different and short. The moss capsules are short-obovate, are opened apically and located opposite each other. The gynaeceum of a pistillate flower is blunt and oblong; the ovary is unilocular. The funicule and stylar are short; the shape of the placenta varies from semi-basal to parietal; the stigma is hemispherical [6].

The flower stalk has no leaves and can have different length (shorter than the petioles or much longer).

Arum korolkowii has infertile threefarious flowers flattened at the base. The fruits of Arum are red oblong-pyramidal berries with a diameter of 4 – 6 mm and a length of 5 – 9 mm.

The study of the environmental features of *Arum korolkowii* and its spread has shown that the plant can be found on the territory from Western China to Europe (Great Britain, Austria, the Netherlands, Denmark, Ireland, Germany, Hungary, Poland, Corsica, Portugal, France, Sardinia, Bulgaria, Italy, Ukraine, Morocco, Algeria, Tunisia, Canary Islands, Kazakhstan, Madeira, Turkmenistan, Kyrgyzstan, Uzbekistan, Cyprus, Tajikistan, Iraq, China, Afghanistan, Iran, Pakistan, etc.). It grows at an altitude of up to 4400 m above sea level in subtropical and moderate climate zones, on rocky soil, among in the forest litter and among shrubs, along the riverbanks, on pastures and wastelands [7].

MATERIALS AND METHODS

A total of 200 seeds will be used for this experiment. The materials needed for creating the hydroponic system are the following:

1. Big plastic containers, (yogurt containers are used for recycling reason) included water with a big hole for the small plastic container to fix it in the middle of the big container.
2. Small plastic container with small holes that allows water enter inside it.
3. Small hydro stones to hold the plant.
4. Nutrient solution A, which consist of calcium and iron chelate.
5. Air pump device, which contains air hose end by an air stone.
6. Nutrient solution B, which consist of magnesium sulfate, potassium, copper sulfide, zinc sulfide and manganese sulfide.
7. Water. For the traditional soil planting the following materials are used:

- Plastic container with small holes at the bottom.
- Planting soil.
- A and B nutrient solutions, as the one used for hydroponic system. ICMIE 131-3
- Water for irrigation. For both systems, a meter was used to measure the length of the plant and pH meter was used to measure the pH degree. After conducting the experiment, the results of the two systems will be analyzed and compared using statistical experimental design approach. The analysis of variance (ANOVA) test

will be conducted to test the hypothesis, whether the hydroponic system is better than the traditional system or not [8].

RESULTS

Studies of the cultivation of *Arum korolkowii* in the form of a continuous-flow culture. The plants were grown in plastic pots with a diameter of 60 mm and a height of 51 mm. The pots were placed in plastic cassettes, 54 pots in each cassette. A mixture of peat and perlite at the ratio of 2:1 was used as a substrate. The seeds were sown manually, 5-7 pieces per pot, on January 26. After sowing, the soil was watered. Arum was grown without using the germination chambers. Right after the sowing, the cassettes were placed on tables in the seedling compartment. Seedlings were illuminated around the clock at 7000 lux. Watering and fertilizing of plants were carried out using a moving boom with spray nozzles. The air temperature in the seedling compartment was maintained within 18-20 °C. The appearance of the plants was evaluated. During harvesting, the duration of cultivation from sowing to marketability was assessed and the height of the plants was measured.

The main mechanism of hydroponics is the involvement of the root system. The authors show that this method can provide various products of plant origin to people who live in various climatic and natural conditions [9].

The data of many studies have established that hydroponics is a convenient, affordable and effective way of growing plants in extreme simple conditions. One of the main advantages of this method is that the herbs obtained are organic and do not contain harmful substances [10].

The first leaves with a length of 15-20 cm appear in early April. After that, the light yellow spadix inflorescence with a spathe leave appears. At this stage, the large leaves start withering. Only the spadix remains on which green berries appear, and in mid-June, these berries become bright red. Hydroponics is hydroponic cultivation of various herbs with the use of a certain multi-component substrate. The technological features of the hydroponic method facilitate the mechanisms of plant cultivation The main opportunity is the automation of all stages of herb care. Hydroponics also involves automated control of light and temperature conditions, as well as mineral fertilizing. Another advantage of this method is the programming of the ionic composition of nutrition, which allows regulating the mineral parameters of the plant [11].

Many scientific works have shown that the characteristics of herbs obtained with the use of hydroponic cultivation are distinguished by the high quality of products. This is caused by the conservation of the underground root system, stabilization of fertilization processes, and rapid fruit formation. On the other hand, these plants have a high concentration of essential oils, vitamins, proteins, organic acids, and sugars. Moreover, the resulting yield exceeds the one obtained through natural cultivation by several times [12]

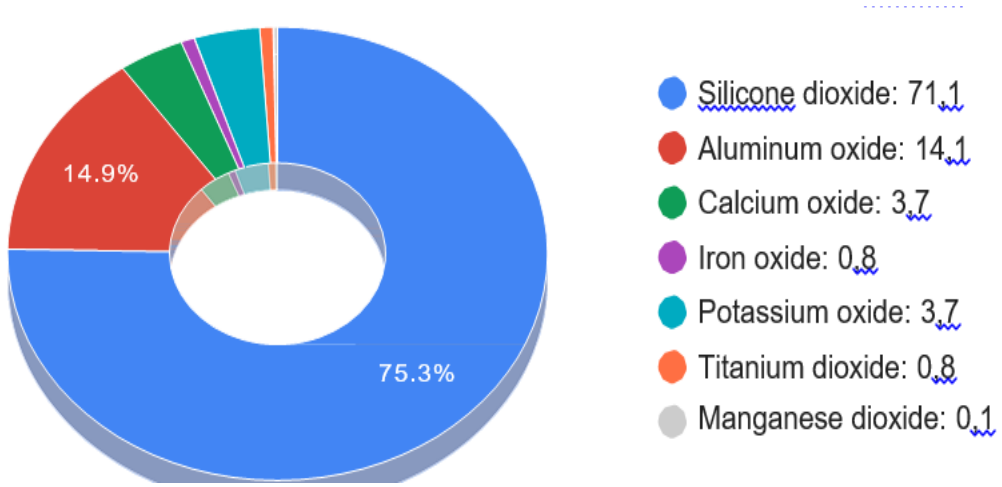

Figure 1. Composition of perlite

The seedlings of *Arum korolkowii* appeared 6 days after sowing. On February 2, the plants had two cotyledonary leaves (Fig. 1); by February 15, they have formed two pairs of the true leaves (Fig. 2). *Arum korolkowii* was being grown in the seedling compartment for 25 days. For further cultivation, the plants were placed in plastic troughs with holes, to which the nutrient solution was supplied. The air temperature was maintained within the range of 17-19 °C, the relative air humidity was at the level of 60-75%; constant illumination was provided. At the end of February, the height of the plants reached an average of 10-12 cm, and the root systems covered the entire volume of the pots. In March, with the increased illumination, the plants began to grow actively. In the second decade, they reached a height of 18-22 cm, and the roots went beyond the limits of the pot (Fig. 3). The yield was harvested on March 22; by this time, the plants have formed a powerful root system, and their height averaged 30-32 cm. Commercial products ready for sale are pots with 3-4 plants in an individual plastic package.

The work has analyzed the modern scientific data on this topic. To compare the traditional cultivation method and hydroponics, the seeds *of Arum korolkowii* were used. The methods of hydroponics was based on studying the root nutrition of plants. The universal nutrient solution produced by Buyskiye Udobreniya was dissolved in bidistilled water. The seeds of *Arum korolkowii* from the collection of South Kazakhstan Medical Academy, South clinical and genetic laboratory, were being grown in this solution. The seeds were also planted in pots with soil and watered every two days. The experiment was carried out in the laboratory of South Kazakhstan Medical Academy, South clinical and genetic, located in the city of Shymkent. The experiment lasted 1 year. The seeds were planted in the soil on August 20, 2020; they were also planted in hydroponics. The hydroponic plant was assembled in the laboratory manually. The plant consists of a container with a nutrient solution, a floating platform, a compressor, a pump for pumping out the solution, and a tank, from which the nutrient solution is supplied. Before the experiment, the seeds were soaked. The following conditions were maintained: continuous light, air temperature of 23-25°C, indoor humidity of 75-80%, pH 5.8-6.5. EC – 3,0-4,0 mCm/cm [13].

Days	pH	EC(ppm)	Temperature (0C)	Seed state
15.07.2020	6.5	0159	25	+
22.07.2020	6.5	0146	25	+
29.07.2020	6.5	0394	26	+
05.08.2020	6,5	0410	26	+
12.08.2020	6,5	0259	25	+
19.08.2020	6,5	0386	25	+
26.08.2020	6,5	0443	25	+
02.09.2020	6,5	0504	25	+

Figure 2. Growing *Arum korolkowii* using hydroponic method

At the moment, there is a possibility of full regulation of the concentration of organic acids, sugars, vitamins, iodine, manganese, copper, and other elements in *Arum korolkowii*. Therefore, many scientists hope that the use of hydroponic cultivation will allow creating medicinal plant growing [14].

Prognostic control ensured that the duration of the main phenological phases of Arum growth was taken into account. In the course of monitoring the main stages of ontogenesis, it was found that the influencing factors were the method of cultivation and its conditions. Therefore, in the conditions of low-volume hydroponic cultivation, the first seedlings were found 3-4 days after planting; however, for soil cultivation this period was 20-25 days. This dynamics is also reflected at the following stages of vegetation growth [15].

Light regime	Temperature	Watering date	Change of nutrient solution	Emergence of seedlings	pH	Ec (ppm)
0,25-0,35	20-25C°	04.01.2021	04.01.2021	04.01.2021	6,5	0,434
0,25-0,35	20-25C°	11.01.2021	11.01.2021	11.01.2021	6.5	0,407
0,25-0,35	20-25C°	18.01.2021	18.01.2021	18.01.2021	6.5	0,386
0,25-0,35	20-25C°	25.01.2021	25.01.2021	25.01.2021	6-6.5	0,479
0,25-0,35	20-25C°	01.02.2021	01.02.2021	01.02.2021	6.5	0,410
0,25-0,35	20-25C°	08.02.2021	08.02.2021	08.02.2021	6.5	0,146
0,25-0,35	20-25C°	15.02.2021	15.02.2021	15.02.2021	6.5	0,159
0,25-0,35	20-25C°	22.02.2021	22.02.2021	22.02.2021	6.5	0,255
0,25-0,35	20-25C°	01.03.2021	01.03.2021	01.03.2021	6.5	0,394
0,25-0,35	20-25C°	08.03.2021	08.03.2021	08.03.2021	6.5	0,394
0,25-0,35	20-25C°	15.03.2021	15.03.2021	15.03.2021	6.5	0,394
0,25-0,35	20-25C°	22.03.2021	22.03.2021	22.03.2021	6.5	0,394
0,25-0,35	20-25C°	29.03.2021	29.03.2021	29.03.2021	6.5	0,394
0,25-0,35	20-25C°	05.04.2021	05.04.2021	05.04.2021	6.5	0,394
0,25-0,35	20-25C°	12.04.2021.	12.04.2021.	12.04.2021.	6.5	0,394
0,25-0,35	20-25C°	19.04.2021	19.04.2021	19.04.2021	6.5	0,394

Discussion

A comparative analysis of substrates for hydroponic cultivation of *Arum korolkowii* in the laboratory conditions was carried out. The differences are due to several factors that meet the requirements for substrates. Methods of cultivating *Arum korolkowii* in the laboratory conditions were studied. The traditional method of growing on soil showed the lowest results, although all necessary rules were observed, such as light, watering, room temperature, pH of the environment, etc. Drip watering is very convenient and effective when growing plants in greenhouses. In the laboratory, it is not effective, and even harmful. The most promising method of growing plants is hydroponics. Such substrates as perlite, vermiculite, sand, and mineral wool had no positive effect in growing *Arum korolkowii*. In the course of research, we found out that *Arum korolkowii* is a very delicate plant that requires special attention.

Conclusion: According to the research results, the most effective method of cultivating plants is hydroponics with the use of light expanded clay aggregate as a substrate. Soil cultivation is the most ineffective way of growing arum, since the seeds sprout for a long time and it takes a year to get a seedling of 9.5 cm. Hydroponic cultivation with the use of vermiculite did not bring a good yield as well since arum became inviable when the leaves appeared. Drip cultivation led to the yellow spots and withering of leaves. This method has also proved to be ineffective

since it leads to plant withering. The results of the research allow us to recommend hydroponic cultivation of Arum. When growing it, no additional costs or special nutrient solution are required, which allows it to be successfully combined with other crops. Green products have an attractive appearance, aroma, and excellent taste.

Conflict of Interest: The authors claim no conflicts of interest are apparent.

Author's Contribution Statement: A.Y did most of the work, including the experiment design, parameters measurements, data analysis, and paper writing. K.A and A.B helped in the statistical analysis.

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