

IRSTI 34.29.05; 34.31.27

<https://doi.org/10.26577/bb107220263>

Zh.E. Aimenova<sup>1\*</sup>, F.A. Ubaev<sup>1,2</sup>, Sh.E. Duissebayev<sup>1</sup>,  
G.E. Islamova<sup>1</sup>, A.M. Esimova<sup>1</sup>, S.D. Dzhumanov<sup>3</sup>

<sup>1</sup>M. Auezov South Kazakhstan Research University, Shymkent, Kazakhstan

<sup>2</sup>K.A. Yassawi International Kazakh-Turkish University, Turkistan, Kazakhstan

<sup>3</sup>Aksu-Zhabagly State Nature Reserve, Zhabagly, Kazakhstan

\*e-mail: [aimenova.zhanara@gmail.com](mailto:aimenova.zhanara@gmail.com)

## SEED MASS AND HYDRATION CHARACTERISTICS OF *MEDIASIA MACROPHYLLA* (REGEL ET SCHMALH.) PIMENOV

Seed biology plays a crucial role in understanding plant reproduction, adaptation, and persistence in natural ecosystems. Studies of rare and endemic species are particularly important because information on their reproductive characteristics remains limited. The present study provides the first assessment of seed mass and hydration properties of the rare endemic species *Mediasia macrophylla* (Apiaceae). The aim of the study was to analyze seed mass, investigate imbibition dynamics, and visually assess changes in seed appearance during hydration. The research was focused on obtaining quantitative data on seed mass and water uptake characteristics as important components of the species' reproductive biology. The methodology included macromorphological analysis using light microscopy, gravimetric determination of seed mass using batches of 100 seeds, and a gravimetric water uptake test with mass measurements recorded after 1, 3, 6, and 24 hours of soaking. The results demonstrated that *M. macrophylla* seeds are characterized by low mass and low variability among replicates, indicating the stability of seed material within the studied population. The imbibition experiment revealed an intensive initial phase of water uptake followed by a gradual decrease in hydration rate and the attainment of a plateau phase. Visual observations confirmed the quantitative results, demonstrating noticeable changes in seed appearance during hydration. The obtained results provide the first quantitative data on seed mass and hydration properties of *M. macrophylla* and expand current knowledge of reproductive characteristics within the genus *Mediasia*. The practical significance of the study lies in the potential application of these data for the development of conservation programs for rare species and for planning future investigations of the reproductive biology of natural populations.

**Keywords:** *Mediasia macrophylla*, seeds, seed mass, imbibition, seed hydration.

Ж.Е. Айменова<sup>1\*</sup>, Ф.А. Убаев<sup>1,2</sup>, Ш.Е. Дуисебаев<sup>1</sup>,  
Г.Е. Исламова<sup>1</sup>, А.М. Есимова<sup>1</sup>, С.Д. Джуманов<sup>3</sup>

<sup>1</sup>М. Әуезов атындағы Оңтүстік Қазақстан зерттеу университеті, Шымкент, Қазақстан

<sup>2</sup>Қ.А. Ясауи атындағы халықаралық қазақ-түрік университеті, Түркістан, Қазақстан

<sup>3</sup>Ақсу-Жабағылы мемлекеттік табиғи қорығы, Жабағылы, Қазақстан

\*e-mail: [aimenova.zhanara@gmail.com](mailto:aimenova.zhanara@gmail.com)

### *Mediasia macrophylla* (regel et schmalh.) pimenov тұқымдарының массасы және гидратациялық қасиеттері

Өсімдіктердің табиғи экожүйелердегі көбею, бейімделу және тұрақтылық процестерін түсінуде тұқым биологиясының маңызы зор. Әсіресе репродуктивтік сипаттамалары туралы мәліметтері шектеулі сирек және эндемикалық түрлерді зерттеу ерекше өзектілікке ие. Осы жұмыста алғаш рет Апиасеае тұқымдасына жататын сирек эндемик түр — *Mediasia macrophylla* тұқымдарының массасы мен гидратациялық қасиеттері зерттелді. Зерттеудің мақсаты тұқым массасын, олардың ісіну динамикасын талдау және гидратация процесі кезіндегі тұқымдардағы өзгерістерді визуалды бағалау болды. Зерттеу түрдің репродуктивтік биологиясының маңызды сипаттамалары болып табылатын тұқым массасы мен су сіңіру ерекшеліктері жөнінде сандық деректер алуға бағытталды. Зерттеу әдістемесі жарық микроскопиясын қолдана отырып жүргізілген макроморфологиялық талдауды, 100 тұқымнан тұратын үлгілер бойынша тұқым массасын гравиметриялық анықтауды, сондай-ақ массаның 1, 3, 6 және 24 сағаттан кейінгі өзгерістерін тіркеу арқылы су сіңірудің гравиметриялық сынағын қамтыды. Нәтижесінде *M. macrophylla* тұқымдарының массасы төмен және көрсеткіштерінің өзгергіштігі аз екендігі анықталды, бұл популяциядағы тұқым материалының тұрақтылығын көрсетеді. Ісіну тәжірибесі суды қарқынды бастапқы сіңіру фазасын, кейіннен гидратация жылдамдығының бәсеңдеуін және

көрсетті. Визуалды бақылаулар гидратация барысында тұқымдардың сыртқы көрінісінде айқын өзгерістер болатынын көрсете отырып, сандық нәтижелерді растады. Алынған нәтижелер *M. macrophylla* тұқымдарының массасы мен гидратациялық қасиеттері жөніндегі алғашқы сандық деректерді ұсынады және *Mediasia* туысы өкілдерінің репродуктивтік сипаттамалары туралы мәліметтерді толықтырады. Жұмыстың практикалық маңызы алынған деректерді сирек түрлерді сақтау бағдарламаларын әзірлеуде және табиғи популяциялардың репродуктивтік биологиясын одан әрі зерттеуді жоспарлауда қолдану мүмкіндігімен анықталады.

**Түйін сөздер:** *Mediasia macrophylla*, тұқымдар, тұқым массасы, ісіну қабілеті, тұқымдардың гидратациясы.

Ж.Е. Айменова<sup>1\*</sup>, Ф.А. Убаев<sup>1,2</sup>, Ш.Е. Дуисебаев<sup>1</sup>, Г.Е. Исламова<sup>1</sup>,  
А.М. Есимова<sup>1</sup>, С.Д. Джуманов<sup>3</sup>

<sup>1</sup>Южно-Казахстанский исследовательский университет им. М. Ауэзова, Шымкент, Казахстан

<sup>2</sup>Международный казахско-турецкий университет им. Х.А. Ясави, Туркестан, Казахстан

<sup>3</sup>Аксу-Джабаглинский государственный природный заповедник, Жабағлы, Казахстан

\*e-mail: aimenova.zhanara@gmail.com

### Масса семян и гидратационные свойства *Mediasia macrophylla* (regel et schmalh.) pimenov

Семенная биология играет ключевую роль в понимании процессов воспроизводства, адаптации и устойчивости растений в природных экосистемах. Особую актуальность приобретают исследования редких и эндемичных видов, для которых сведения о репродуктивных характеристиках остаются ограниченными. В данной работе впервые проведено исследование массы семян и гидратационных свойств редкого эндемичного вида *Mediasia macrophylla* (Ariaceae). Целью исследования являлся анализ массы семян, динамики их набухания и визуальная оценка изменений семян в процессе гидратации. Исследование направлено на получение количественных данных о массе семян и особенностях водопоглощения как важных характеристиках репродуктивной биологии вида. Методология исследования включала макроморфологический анализ с использованием световой микроскопии, гравиметрическое определение массы семян партиями по 100 семян, а также гравиметрический тест водопоглощения с регистрацией изменений массы через 1, 3, 6 и 24 часа. В результате установлено, что семена *M. macrophylla* характеризуются малой массой и низкой вариабельностью показателей, что свидетельствует о стабильности семенного материала популяции. Эксперимент по набухаемости выявил интенсивную начальную фазу водопоглощения с последующим замедлением скорости гидратации и выходом на плато. Визуальные наблюдения подтвердили количественные данные, свидетельствуя о заметных изменениях внешнего вида семян в процессе гидратации. Полученные результаты предоставляют первые количественные данные о массе семян и гидратационных свойствах *M. macrophylla* и расширяют сведения о репродуктивных характеристиках представителей рода *Mediasia*. Практическая значимость работы заключается в возможности использования полученных данных при разработке программ сохранения редких видов и планировании дальнейших исследований репродуктивной биологии природных популяций.

**Ключевые слова:** *Mediasia macrophylla*, семена, масса семян, набухаемость, гидратация семян.

#### Abbreviations

GBIF – Global Biodiversity Information Facility; TSW – thousand seed weight

#### Introduction

Seeds represent a pivotal stage in the plant life cycle, governing the processes of reproduction, dispersal, and species adaptation to environmental conditions. The morphological and physiological characteristics of seeds, including their mass, dimensions, and hydration properties, play a crucial role in shaping plant survival strategies across di-

verse ecosystems (Bewley et al., 2012; Baskin et al., 2001). In recent decades, research in seed biology has gained particular significance due to the urgent need for biodiversity conservation, especially for rare and endemic species sensitive to climate change and anthropogenic impact (Fenner & Thompson, 2005; Hajib et al., 2023; Sanchez et al., 2022).

Seed mass is one of the most widely studied parameters, regarded as a critical ecological and evolutionary trait. Numerous studies have demonstrated that seed mass is linked to environmental conditions, germination strategies, and seedling competitiveness (Westoby et al., 1996; Moles et al., 2005; Leishman et al., 2000). Small seeds are generally

characterized by a high dispersal capacity and a rapid response to favorable conditions, whereas larger seeds possess greater nutrient reserves that enhance seedling resilience (Willson & Traveset, 2000).

An equally vital aspect of seed biology is the imbibition process, which represents the initial phase of germination associated with water uptake and the activation of metabolic processes (Farooq et al., 2022; Nakabayashi et al., 2025). Seed water uptake kinetics are widely used to assess seed coat permeability, the presence of dormancy, and physiological readiness for germination (Upreti et al., 2024). Similar patterns of rapid initial water uptake followed by a gradual decrease in hydration rate have been reported for many herbaceous plant species during seed imbibition (Bhatt et al., 2016).

The Apiaceae family (umbellifers) represents a large and morphologically diverse group of flowering plants, widely distributed throughout the temperate regions of Eurasia (Kozuharova et al., 2024; Kljuykov et al., 2021). Seeds within this family are characterized by prominent longitudinal ribbing, relatively low mass, and specific fruit morphology (Pimenov & Leonov, 2004; Sayed-Ahmad et al., 2017). Several studies have demonstrated that the morphometric characteristics of Apiaceae seeds possess high taxonomic significance and can be utilized to refine the systematic position of species (Cai et al., 2022; Kalsoom et al., 2019).

Despite the substantial body of research dedicated to the seed biology of widespread Apiaceae

representatives, data regarding rare and endemic species of Central Asia remain extremely limited (Mamadaliyeva et al., 2018). In this context, the genus *Mediasia* is of particular interest, as it comprises narrow-range species confined to the mountain ecosystems of the Western Tien Shan.

The subject of this study is the rare endemic species *Mediasia macrophylla* (Regel) Pimenov (Apiaceae). *M. macrophylla* is a rare endemic species for which literature data primarily focus on its distribution and general plant morphology, whereas the quantitative characteristics of its seeds remain virtually unstudied (Kurimoto et al., 2011).

The lack of data regarding seed mass, hydration properties, and macromorphological features of *M. macrophylla* represents a significant gap in the study of this species' biology, hindering the assessment of its reproductive potential and adaptive strategies. Under the conditions of increasing anthropogenic pressure and climate change, obtaining such data is of particular practical importance for developing conservation measures for rare endemic plants (Mariano & Christianini, 2021).

The study focuses on the morphometric and physiological characteristics of its seeds. The species under investigation grows in the mountain ecosystems of the Western Tien Shan, forming dense basal leaf rosettes adapted to rocky slopes and open habitats. The general plant habit and the characteristic features of its above-ground parts are shown in Figure 1.

**Figure 1**

Natural habit of *M. macrophylla* in the Western Tien Shan: (A) general view of the plant in its habitat on a rocky slope; (B) basal leaf rosette and characteristic morphological features of the above-ground parts



The aim of this work is a comprehensive experimental study of *M. macrophylla* seed mass and imbibition dynamics, as well as a visual assessment of macromorphological changes during the hydration process.

To achieve this goal, the following objectives were formulated:

- to determine seed mass using gravimetric analysis;
- to calculate the average single-seed mass and the thousand-seed weight (TSW);
- to investigate the dynamics of seed water uptake during the soaking process;
- to analyze the pattern of seed imbibition based on quantitative and visual data.

The primary research methods included gravimetric techniques for determining seed mass and water uptake, as well as macrophotography to document seeds during the imbibition process. The research approach is based on a combination of quantitative analysis and visual interpretation of morphological changes.

The research hypothesis is that the seeds of *M. macrophylla*, similar to most representatives of the

Apiaceae family, are characterized by low mass and a high initial water uptake rate, which ensures a rapid initiation of germination processes under natural conditions.

The scientific significance of this work lies in providing new experimental data on the seed biology of the rare endemic species *M. macrophylla*, which has previously been virtually unstudied in this regard. The practical importance consists in the potential application of these results for assessing the reproductive potential of populations and developing conservation strategies for rare flora species of the Western Tien Shan.

## Materials and methods

### *Study Object and Sample Preparation*

The study object was the rare endemic species *Mediasia macrophylla* (Regel & Schmalh.) Pimenov (Apiaceae). To confirm the species' distribution within the study area, data analysis was conducted using global biodiversity information aggregators, namely GBIF and iNaturalist; summarized records of the species from these databases are presented in Table 1.

**Table 1**

*Analysis of M. macrophylla occurrence in international information systems (as of January 20, 2026)*

№	Country or area	Coordinates	Event date	Dataset
1	Kazakhstan	42.1N, 70.0E	2025 May 06	iNaturalist Research-grade Observations
2	Uzbekistan	41.5N, 70.0E	2024 Jun 07	iNaturalist Research-grade Observations
3	Uzbekistan	42.0N, 70.5E	2024 Jul 19	iNaturalist Research-grade Observations
4	Uzbekistan	38.7N, 67.9E	2023 Aug 20	iNaturalist Research-grade Observations
5	Kazakhstan	42.4N, 70.6E	2016 Jun 18	iNaturalist Research-grade Observations
6	Kyrgyzstan		2016 Aug 01	Moscow University Herbarium (MW)
7	Kyrgyzstan	40.0N, 72.1E	2015 Jul 02	OPUN – Middle Asia
8	Uzbekistan	38.8N, 67.1E	2010 Jul 13	Moscow University Herbarium (MW)
9	Kyrgyzstan	41.7N, 70.7E	1996 Jun 16	Moscow University Herbarium (MW)
10	Uzbekistan	41.6N, 70.1E	1993 Jun 09	Vascular plant collections of the Botanical Museum, University of Oulu (OULU)
11	Kyrgyzstan	39.8N, 71.9E	1987 Jul 13	Moscow University Herbarium (MW)
12	Kyrgyzstan	41.7N, 70.6E	1986 Aug 04	Moscow University Herbarium (MW)
13	Kyrgyzstan	41.9N, 71.0E	1986 Aug 07	Moscow University Herbarium (MW)
14	Kazakhstan	42.0N, 70.0E	1982 Aug 22	Moscow University Herbarium (MW)
15	Kyrgyzstan	40.2N, 73.0E	1981 Jul 17	Moscow University Herbarium (MW)
16	Kyrgyzstan	40.6N, 73.5E	1981 Jul 20	Moscow University Herbarium (MW)
17	Tajikistan	38.6N, 70.7E	1976 Jul 10	Moscow University Herbarium (MW)
18	Tajikistan	38.1N, 70.3E	1975 Aug 03	Moscow University Herbarium (MW)

*Note: Herbarium acronyms are used according to Index Herbariorum: MW – Moscow University Herbarium, OULU – University of Oulu Herbarium.*

Prior to compiling the table, the data underwent preliminary verification: records with obvious coordinate errors, duplicates, and occurrences with low georeferencing accuracy were excluded. This facilitated the formation of a representative sample of unique spatio-temporal registrations of the species within its natural range.

The analysis of spatio-temporal data from global information systems (Table 1) confirms the status of *M. macrophylla* as a Central Asian endemic with a narrow-range distribution covering the Tien Shan and Pamir-Alay Mountain systems within Kazakhstan, Uzbekistan, Kyrgyzstan, and Tajikistan.

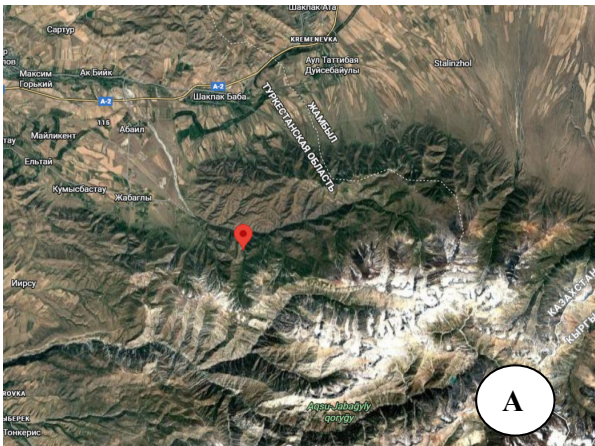
The presence of verified records from the Kishi-Kaindy gorge (Aksu-Zhabagly State Nature Reserve), spanning more than 40 years (from 1982 to 2025), indicates the stability of this population.

At the same time, the limited number of unique species registrations over recent decades confirms its rarity, justifying the need for detailed studies of its reproductive biology and seed productivity to develop biodiversity conservation measures for the region.

Seed material was collected from a natural population on the north-western slope of the Kishi-Kaindy gorge during the phase of full physiological maturity in September 2025 (Figure 2). Prior to the experiments, the seeds were cleaned of plant debris and impurities and brought to an air-dry state at room temperature. All analyses were performed using uniformly prepared material, which is an essential requirement for obtaining comparable and reproducible results in seed research (International Seed Testing Association, 2023).

**Figure 2**

Location of the collection site and seed samples: (A) localization of the collection site in the Kishi-Kaindy gorge (42°24'08" N, 70°34'53" E) (Image: Google Maps); (B) collected and dried seeds of *M. macrophylla*



#### *Determination of Seed Mass*

Seed mass was determined gravimetrically in accordance with international seed testing standards (International Seed Testing Association, 2023). Weighing was performed using batches of 100 seeds, which is an optimal approach for small-seeded species and is widely applied in seed biology and ecology.

The experiment was conducted in three replicates. The seeds used in the experiment were nat-

urally air-dried after collection and stored under laboratory conditions until analysis. Seed moisture content was not determined separately; therefore, all mass values reported in this study correspond to air-dry seeds. Prior to weighing, the seeds were manually counted using forceps. Weighing was performed on a VL-224V analytical balance (Gosmetr, Russia) with preliminary taring of the weighing boat. For each replicate, the mass of a batch of 100 seeds ( $m_{100}$ ) was recorded.

Based on the obtained data, the mass of a single seed was calculated using the following formula:

$$m_{\text{seed}} = \frac{m_{100}}{100},$$

as well as the calculated 1000-seed weight:

$$m_{1000} = m_{\text{seed}} \cdot 1000.$$

#### *Seed Imbibition and Water Uptake*

Seed imbibition was evaluated using the gravimetric method to determine water uptake. The experiment was conducted in triplicate, using 50 seeds per sample. Dry seeds were pre-weighed to determine the initial mass ( $m_0$ ). The initial mass ( $m_0$ ) corresponded to the mass of air-dry seeds prior to soaking. The samples were then placed in containers with distilled water (10–20 mL) and maintained at room temperature (20–22 °C).

Weighing was performed after 1, 3, 6, and 24 hours. At the specified time intervals, the seeds were removed, blotted dry with filter paper (10–15 s), and immediately weighed to determine the current mass ( $m_t$ ). The percentage of water uptake was calculated using the following formula:

$$W = \frac{m_t - m_0}{m_0} \times 100\%,$$

For each time point, the mean and standard deviation ( $M \pm SD$ ,  $n=3$ ) were calculated. The dynamics of the process were analyzed based on the curves of water uptake versus soaking time, which is a standard approach in studying the hydration properties of seeds (Bewley et al., 2012).

#### *Statistical analysis*

Morphometric measurements and analytical determinations were performed in triplicate ( $n=3$ ). Statistical processing of the results involved calculating the arithmetic mean ( $M$ ) and standard deviation ( $SD$ ). To assess the degree of variability of the studied traits, the coefficient of variation ( $CV$ , %) was calculated. The results are presented in the  $M \pm SD$  format. Mathematical data processing was carried out using the Microsoft Excel 2019 statistical analysis package.

## **Results and discussion**

### *Seed mass of *M. macrophylla**

The results of the gravimetric analysis of *M. macrophylla* seeds are presented in Table 2. The mass of 100-seed batches in three experimental replicates was 0.7770 g, 0.7890 g, and 0.7410 g, respectively.

**Table 2**

*Seed mass of *M. macrophylla* determined by the gravimetric method*

Trial	100-seed mass (g)	Single seed mass	1000-seed weight
1	0.7770	0.00777	7.77
2	0.7890	0.00789	7.89
3	0.7410	0.00741	7.41
Mean $\pm$ SD	0.7690 $\pm$ 0.0245	0.00769 $\pm$ 0.000245	7.69 $\pm$ 0.245

The mean mass of 100 seeds was 0.7690  $\pm$  0.0245 g. Based on these values, the mean single seed mass was calculated to be 0.00769  $\pm$  0.000245 g (7.69  $\pm$  0.245 mg). The calculated thousand seed weight (TSW) was 7.69  $\pm$  0.245 g.

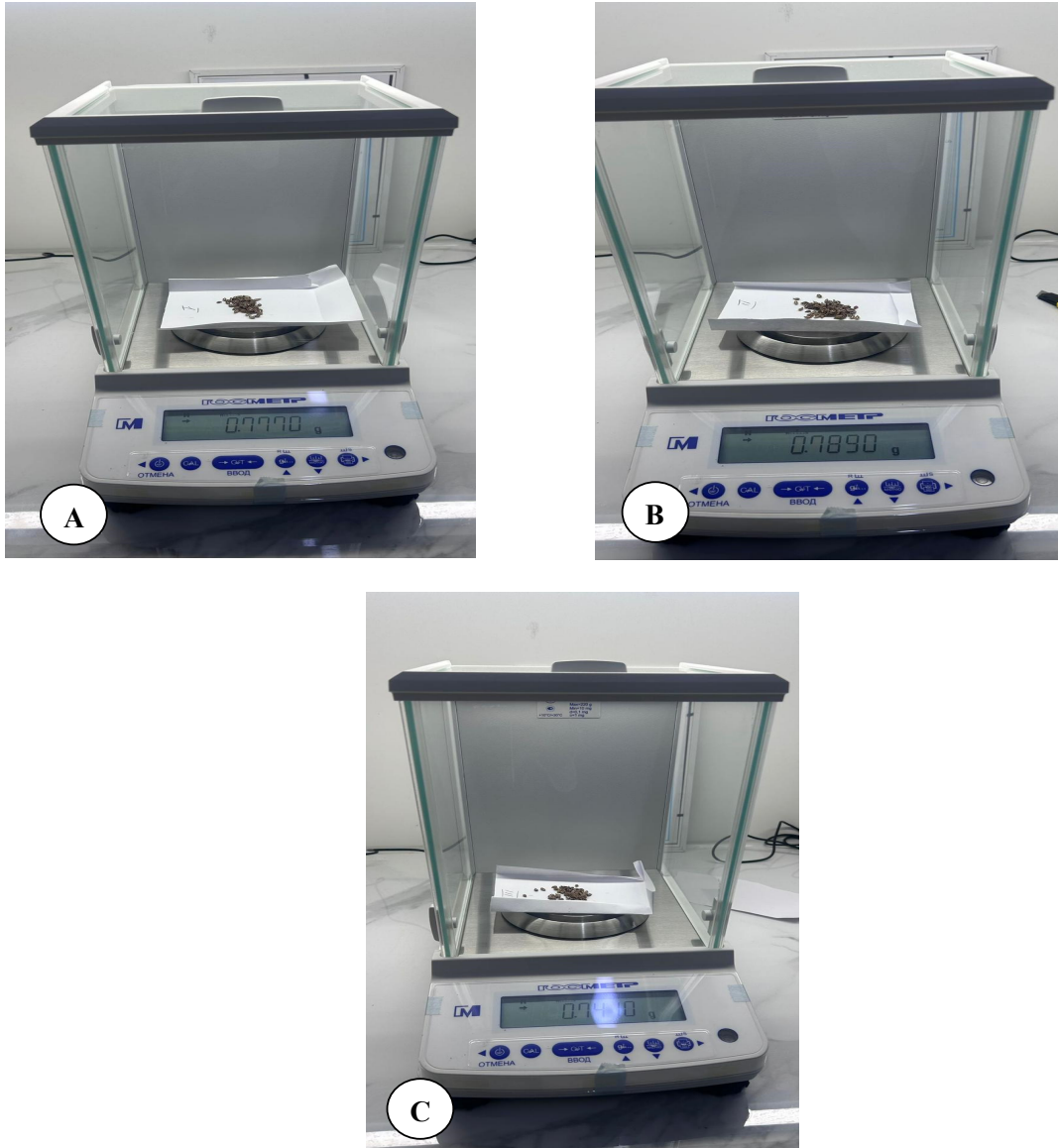
The low variability in seed mass between replicates indicates the relative uniformity of the seed material in the studied population.

The process of gravimetric seed mass determination for each replicate is illustrated in Figure 3, which presents representative photographs of seed batches being weighed on an analytical balance.

The obtained seed mass values characterize *M. macrophylla* as a relatively small-seeded species. Seed mass is known to vary considerably among plant species and is influenced by ecological and evolutionary factors (Westoby et al., 1996; Leishman et al., 2000). The TSW value obtained in the present study falls within the range generally reported for many herbaceous species and provides the first quantitative reference for *M. macrophylla*.

**Figure 3**

Gravimetric determination of *M. macrophylla* seed mass: (A) first replicate of 100-seed batch weighing (0.7770 g); (B) second replicate (0.7890 g); (C) third replicate (0.7410 g)



#### *Seed imbibition in M. macrophylla*

The results of the gravimetric analysis of *M. macrophylla* seed water uptake is presented in Table 3. The seeds were characterized by an intensive initial imbibition stage during the first hours after soaking.

After 1 hour, the water uptake averaged  $51.8 \pm 5.8\%$ . Within just 3 hours, the seed mass more than doubled compared to the dry state, reaching  $100.9 \pm 5.7\%$ . Subsequently, the imbibition rate decreased: water uptake was  $119.1 \pm 6.2\%$  after 6 hours and reached its maximum value of  $138.6 \pm 6.5\%$  after 24 hours (fig.4).

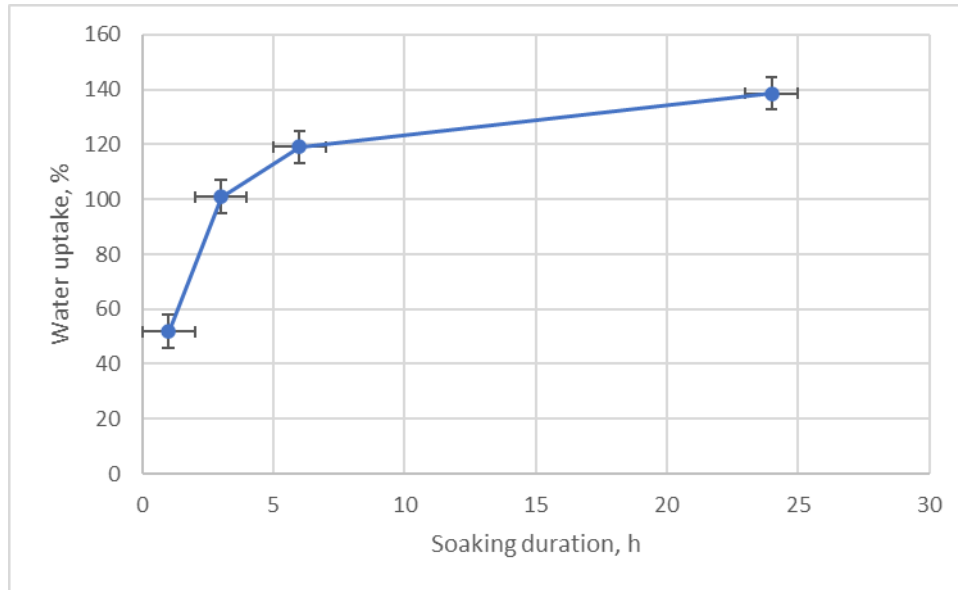
**Table 3**

*Water uptake dynamics of M. macrophylla seeds*

No.	Soaking time (h)	Water uptake (%)
1	1	$51.8 \pm 5.8$
2	3	$100.9 \pm 5.7$
3	6	$119.1 \pm 6.2$
4	24	$138.6 \pm 6.5$

**Figure 4**

Water uptake dynamics of *M. macrophylla* seeds during soaking ( $M \pm SD$ ,  $n = 3$ )



The resulting imbibition curve is characterized by rapid water uptake during the initial hours of soaking, followed by a gradual decrease in the hydration rate and stabilization of the process. Similar patterns of water absorption have been reported for many herba-

ceous plant species and representatives of the Apiaceae family (Louf et al., 2018; Moret-Fernández et al., 2024). Visual changes in the seeds during the imbibition process, including increases in size and changes in coloration, are presented in Figure 5.

**Figure 5**

Appearance of *M. macrophylla* seeds after imbibition in water: (A) general view of seeds in a Petri dish; (B) magnified image of imbibed seeds showing a distinct increase in volume and changes in coloration



The present study provides the first quantitative data on seed mass and hydration characteristics of *Mediasia macrophylla*, a rare endemic species of the Western Tien Shan. Seed mass is considered

one of the most important functional traits influencing plant regeneration, dispersal, and establishment processes and is widely used in ecological and evolutionary studies (Westoby et al., 1996; Leish-

man et al., 2000). The calculated thousand-seed weight (TSW) of *M. macrophylla* was  $7.69 \pm 0.25$  g, indicating that the species belongs to the group of relatively small-seeded plants. This observation is consistent with the general characteristics reported for many representatives of the Apiaceae family, whose diaspores are typically characterized by relatively low seed mass and specific fruit morphology (Kljuykov et al., 2021).

Previous studies have demonstrated that seed mass varies substantially among species and is influenced by both phylogenetic and environmental factors (Westoby et al., 1996; Moles et al., 2005). Although direct comparative data for other species of the genus *Mediasia* are currently unavailable, the values obtained in the present study provide the first quantitative reference for future comparative investigations. The relatively low variability observed among replicates suggests a high degree of uniformity of the analyzed seed sample under the conditions of the studied population.

Water uptake is a prerequisite for seed germination because hydration activates numerous physiological and biochemical processes within the embryo and storage tissues. According to Upretee et al. (2024), the rate and extent of water absorption depend on seed coat permeability, seed structure, and physicochemical properties of the seed tissues. In the present study, *M. macrophylla* seeds exhibited rapid water absorption during the first hours of soaking, followed by a gradual decrease in the hydration rate. Similar patterns have been reported for many herbaceous plant species and are generally regarded as characteristic of the initial stages of seed hydration (Farooq et al., 2022).

The ability of *M. macrophylla* seeds to absorb substantial amounts of water within a relatively short period indicates effective hydration of seed tissues under experimental conditions. After 24 hours of soaking, water uptake reached 138.6%, demonstrating a pronounced capacity for water absorption. Such hydration dynamics are consistent with the activation of physiological processes that generally accompany the early stages of seed germination. However, germination tests, seed viability assessment, and dormancy studies were beyond the scope of the present work. Therefore, the relationship between water uptake character-

istics and actual germination performance of *M. macrophylla* remains unclear and requires further investigation.

The present study has several limitations. Seed moisture content was not determined separately prior to the experiment, and all mass measurements refer to air-dry seeds. In addition, the study focused exclusively on seed mass and hydration properties and did not include germination, dormancy, or viability assessments. Nevertheless, the obtained results expand the currently limited knowledge of the genus *Mediasia* and provide baseline information for future studies of seed germination, reproductive characteristics, population ecology, and conservation of this rare endemic species.

## Conclusion

This study characterized seed mass and hydration properties of the rare endemic species *M. macrophylla* (Regel et Schmalh.) Pimenov. The seeds were found to have a relatively low thousand-seed weight ( $7.69 \pm 0.25$  g) and a high capacity for water uptake, reaching 138.6% after 24 hours of soaking. Rapid hydration occurred during the initial hours of imbibition, followed by a gradual decrease in the rate of water absorption. These findings provide baseline information on the seed characteristics of *M. macrophylla* and may support future studies aimed at understanding the reproductive ecology and conservation of this species.

## Acknowledgements

We are grateful to the Science Department of the Aksu-Zhabagly Nature Reserve for their assistance.

## Author Contributions

Aimenova Zh.E.: Conceptualization, Methodology, Investigation, Formal Analysis, Data Curation, Writing – Original Draft, Writing – Review & Editing; Ubaev F.A.: Investigation, Data Curation, Visualization.; Duissebayev Sh.E.: Investigation, Formal Analysis, Visualization; Islamova G.E.: Investigation, Data Curation, Validation; Esimova A.M.: Methodology, Supervision, Writing – Review & Editing; Dzhumanov S.D.: Resources, Investigation, Validation.

## References

- Baskin, C. C., & Baskin, J. M. (2001). *Seeds: Ecology, biogeography, and evolution of dormancy and germination*. Academic Press.
- Bewley, J. D., Bradford, K. J., Hilhorst, H. W. M., & Nonogaki, H. (2012). *Seeds: Physiology of development, germination and dormancy* (3rd ed.). Springer. [https://doi.org/10.1007/978-1-4614-4693-4\\_6](https://doi.org/10.1007/978-1-4614-4693-4_6)
- Bhatt, A., Santo, A., & Gallacher, D. (2016). Seed mucilage effect on water uptake and germination in five species from the hyper-arid Arabian Desert. *Journal of Arid Environments*, 128, 73–79. <https://doi.org/10.1016/j.jaridenv.2016.01.008>
- Cai, J., Zhou, S., Mo, Z., & colleagues. (2022). The phylogeny of *Seseli* (Apiaceae, Apioideae): Insights from molecular and morphological data. *BMC Plant Biology*, 22(1), 534. <https://doi.org/10.1186/s12870-022-03919-9>
- Farooq, M. A., Nadeem, F., Gogoi, N., Ullah, A., Alghamdi, S. S., Siddique, K. H. M., & Farooq, M. (2022). Underlying biochemical and molecular mechanisms for seed germination. *International Journal of Molecular Sciences*, 23(15), 8502. <https://doi.org/10.3390/ijms23158502>
- Fenner, M., & Thompson, K. (2005). *The ecology of seeds*. Cambridge University Press.
- Hajib, A., El Atki, Y., Ait Bouyahya, A., Balahbib, A., Boukhatem, M. N., & Abdelguerfi-Laouar, M. (2023). Apiaceae family: An important source of petroselinic fatty acid: Abundance, biosynthesis, chemistry, and biological properties. *Biomolecules*, 13(11), 1675. <https://doi.org/10.3390/biom13111675>
- International Seed Testing Association. (2023). *International rules for seed testing 2023*. International Seed Testing Association.
- Kalsoon, N., Jan, S. A., Gul, S., & colleagues. (2019). Investigating schizocarp morphology as a taxonomic tool in study of Apiaceae family by utilizing LM and SEM techniques. *Microscopy Research and Technique*, 82(7), 1012–1020. <https://doi.org/10.1002/jemt.23248>
- Kljuykov, E. V., Degtjareva, G. V., Zakharova, E. A., & Pimenov, M. G. (2021). Most important carpological anatomical characters in the taxonomy of Apiaceae. *Botanical Journal of the Linnean Society*, 195(3), 532–544. <https://doi.org/10.1093/botlinnean/boaa082>
- Kozuharova, E., Benković, E. T., Benković, V., & colleagues. (2024). Wild species from the family Apiaceae traditionally used as food in some Mediterranean countries. *Plants*, 13(16), 2324. <https://doi.org/10.3390/plants13162324>
- Kurimoto, S., Kashiwada, Y., Lee, K. H., Takaiishi, Y., & colleagues. (2011). Four new glucosides from the aerial parts of *Mediasia macrophylla*. *Journal of Natural Medicines*, 65(1), 180–185. <https://doi.org/10.1007/s11418-010-0444-3>
- Leishman, M. R., Wright, I. J., Moles, A. T., & Westoby, M. (2000). The evolutionary ecology of seed size. In M. Fenner (Ed.), *Seeds: The ecology of regeneration in plant communities* (2nd ed., pp. 31–57). CABI Publishing.
- Louf, J. F., Zheng, Y., Kumar, A., Bohr, T., Gundlach, C., Harholt, J., & Jensen, K. H. (2018). Imbibition in plant seeds. *Physical Review E*, 98(4), 042403. <https://doi.org/10.1103/PhysRevE.98.042403>
- Mamadaliyeva, N. Z., Akramov, D. K., Ovidi, E., Tiezzi, A., Nahar, L., Azimova, S. S., & Sarker, S. D. (2018). Composition of essential oils from four Apiaceae and Asteraceae species growing in Uzbekistan. *Natural Product Research*, 32(9), 1118–1122. <https://doi.org/10.1080/14786419.2017.1375928>
- Mariano, V., & Christianini, A. V. (2021). Effects of anthropogenic disturbance on seed germination under field conditions: A meta-analysis. *Acta Oecologica*, 113, 103791. <https://doi.org/10.1016/j.actao.2021.103791>
- Moles, A. T., Ackerly, D. D., Webb, C. O., Tweddle, J. C., Dickie, J. B., & Westoby, M. (2005). Factors that shape seed mass evolution. *Proceedings of the National Academy of Sciences*, 102(30), 10540–10544. <https://doi.org/10.1073/pnas.0501473102>
- Moret-Fernández, D., Tormo, J., & Latorre, B. (2024). A new methodology to characterize the kinetics of a seed during the imbibition process. *Plant and Soil*, 498(1–2), 181–197. <https://doi.org/10.1007/s11104-023-06427-3>
- Nakabayashi, K., Hayashi, T., Kimura, T., & colleagues. (2025). Morphological dormancy, embryo growth and pericarp restraint during crop and wild Apiaceae mericarp germination in response to ambient temperature. *Planta*, 262(6), Article 126. <https://doi.org/10.1007/s00425-025-04850-7>
- Pimenov, M. G., & Leonov, M. V. (2004). The Asian Umbelliferae biodiversity database (ASIUM) with particular reference to South-West Asian taxa. *Turkish Journal of Botany*, 28(1), 139–145.
- Sánchez, M., Peris-Felipo, F. J., Segura, I., Roselló, M., & Calabuig, A. (2022). Pollination by the hoverfly *Eristalinus aeneus* (Diptera: Syrphidae) in two hybrid seed crops: Celery and fennel (Apiaceae). *The Journal of Agricultural Science*, 160(3–4), 194–206. <https://doi.org/10.1017/S0021859622000314>
- Sayed-Ahmad, B., Talou, T., Saad, Z., Hijazi, A., & Merah, O. (2017). The Apiaceae: Ethnomedicinal family as source for industrial uses. *Industrial Crops and Products*, 109, 661–671. <https://doi.org/10.1016/j.indcrop.2017.09.027>
- Upreti, P., Bandara, M. S., & Tanino, K. K. (2024). The role of seed characteristics on water uptake preceding germination. *Seeds*, 3(4), 559–574. <https://doi.org/10.3390/seeds3040038>
- Westoby, M., Leishman, M., & Lord, J. (1996). Comparative ecology of seed size and dispersal. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 351(1345), 1309–1318. <https://doi.org/10.1098/rstb.1996.0114>
- Willson, M. F., & Traveset, A. (2000). The ecology of seed dispersal. In M. Fenner (Ed.), *Seeds: The ecology of regeneration in plant communities* (2nd ed., pp. 85–110). CABI Publishing.

**Information about the authors:**

Aimenova Zhanar Erkenovna (corresponding author) – PhD, Head of the Phytochemistry laboratory at M. Auezov South Kazakhstan Research University (Shymkent, Kazakhstan, e-mail: aimenova.zhanara@gmail.com).

Ubaev Furkat Abdivahapuly – master, PhD student at M. Auezov South Kazakhstan Research University (Shymkent, Kazakhstan, e-mail: furkhat.ubaev@mail.ru); Leading Researcher at Research Institute “Botanical Garden” of K.A. Yasawi International Kazakh-Turkish University (Turkistan, Kazakhstan).

Duissebayev Shyngiskan Ergalievich – master, Researcher at Phytochemistry laboratory at M. Auezov South Kazakhstan Research University (Shymkent, Kazakhstan, e-mail: shyngys.86@mail.ru).

Islamova Gulnur Erkinbaevna – master, Researcher at Phytochemistry laboratory at M. Auezov South Kazakhstan Research University (Shymkent, Kazakhstan, e-mail: gulnura\_87\_kz@mail.ru).

Esimova Anar Madenovna – candidate of chemical sciences, Associated Professor at the Department of Biotechnology at M. Auezov South Kazakhstan Research University (Shymkent, Kazakhstan, e-mail: anar\_esimova@mail.ru).

Dzhumanov Smatulla Dzhoraeovich – Head of the Department of Science and Monitoring at Aksu-Jabagly State Nature Reserve (Zhabagly village, Kazakhstan, e-mail: samat.reserve@mail.ru).

**Авторлар туралы мәлімет:**

Айменова Жанар Еркеновна (хат-хабарларға жауапты автор) – PhD, М. Әуезов атындағы Оңтүстік Қазақстан зерттеу университетінің «Фитохимия» ғылыми-зерттеу зертханасының меңгерушісі (Шымкент, Қазақстан, e-mail: aimenova.zhanara@gmail.com).

Убаев Фуркат Абдивахапұлы – магистр, М. Әуезов атындағы Оңтүстік Қазақстан зерттеу университетінің докторанты (Шымкент, Қазақстан, e-mail: furkhat.ubaev@mail.ru); Қ.А. Ясауи атындағы халықаралық қазақ-түрік университетінің «Ботаникалық бақ» ғылыми-зерттеу институтының жетекші ғылыми қызметкері (Түркістан, Қазақстан).

Дүйсебаев Шыңғысқан Ергалиевич – магистр, М. Әуезов атындағы Оңтүстік Қазақстан зерттеу университетінің «Фитохимия» ғылыми-зерттеу зертханасының ғылыми қызметкері (Шымкент, Қазақстан, e-mail: shyngys.86@mail.ru).

Исламова Гүлнұр Еркінбайқызы – магистр, М. Әуезов атындағы Оңтүстік Қазақстан зерттеу университетінің «Фитохимия» ғылыми-зерттеу зертханасының ғылыми қызметкері (Шымкент, Қазақстан, e-mail: gulnura\_87\_kz@mail.ru).

Есимова Анар Маденовна – химия ғылымдарының кандидаты, М. Әуезов атындағы Оңтүстік Қазақстан зерттеу университетінің биотехнология кафедрасының қауымдастырылған профессоры (Шымкент, Қазақстан, e-mail: anar\_esimova@mail.ru).

Джуманов Сматулла Джораевич – Ақсу-Жабағлы мемлекеттік табиғи қорығының ғылым және мониторинг бөлімінің басшысы (Жабағлы ауылы, Қазақстан, e-mail: samat.reserve@mail.ru).

**Сведения об авторах:**

Айменова Жанар Еркеновна (автор для корреспонденции) – PhD, заведующая научно-исследовательской лабораторией «Фитохимия» Южно-Казахстанского исследовательского университета имени М. Ауэзова (Шымкент, Казахстан, e-mail: aimenova.zhanara@gmail.com).

Убаев Фуркат Абдивахапұлы – магистр, докторант Южно-Казахстанского исследовательского университета имени М. Ауэзова (Шымкент, Казахстан, e-mail: furkhat.ubaev@mail.ru); ведущий научный сотрудник научно-исследовательского института «Ботанический сад» международного казахско-турецкого университета им. Х.А. Ясауи (Туркестан, Казахстан).

Дүйсебаев Шыңысқан Ергалиевич – магистр, научный сотрудник научно-исследовательской лаборатории «Фитохимия» Южно-Казахстанского исследовательского университета имени М. Ауэзова (Шымкент, Казахстан, e-mail: shyngys.86@mail.ru).

Исламова Гүлнұр Еркінбаевна – магистр, научный сотрудник научно-исследовательской лаборатории «Фитохимия» Южно-Казахстанского исследовательского университета имени М. Ауэзова (Шымкент, Казахстан, e-mail: gulnura\_87\_kz@mail.ru).

Есимова Анар Маденовна – кандидат химических наук, доцент кафедры биотехнологии Южно-Казахстанского исследовательского университета имени М. Ауэзова (Шымкент, Казахстан, e-mail: anar\_esimova@mail.ru).

Джуманов Сматулла Джораевич – начальник отдела науки и мониторинга Ақсу-Жабағлы государственного природного заповедника (Жабағлы, Казахстан, e-mail: samat.reserve@mail.ru).

Received February 2, 2026

Accepted June 15, 2026