

SHORT COMMUNICATION

Genetic resources, distribution area, cultivation history and results of breeding almonds in Azerbaijan

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ABSTRACT

The article discusses the features of genetic resources, areas of distribution of species and historical regions of almond cultivation in Nakhchivan, Azerbaijan, also the results of the study of local and introduced varieties of almond (*Prunus dulcis* (Mill.) D.A. Webb), common in the Shakhbuz and Julfa districts. These varieties - ripening at different times, with high biomorphological and economic indicators, resistant to biotic and abiotic stress factors of the environment have great prospects for growing almonds in Azerbaijan. The agrobiological characteristics of these almond varieties were studied and pomological indicators were given - flowering period, average weight, height, diameter, peel color, kernel color, weight and taste of the fruit of each variety were studied separately and assessed on a 5-point scale. The studied varieties received the following ratings - Dash Badam - 4.9, Sarayi - 4.7, Ketan Koynek - 4.6, Gosha Lepe - 4.8, Kurdashi - 4.6, Sugra - 4.4, Kaghız Badam - 4.8, Nonpareil - 4.7 and Nec Plus Ultra - 4.8 points. The study of almond genetic resources in the region not only contributes to the preservation of biodiversity but also supports the development of agronomy and agriculture in the country.

Keywords: Almond, introduced, local, pomology, variety.

INTRODUCTION

Almonds are one of the promising crops grown in the arid conditions of USA (California), Australia Spain, Turkey, Morocco, Iran, Iraq, Central Asia, Turkmenistan, Tajikistan, Afghanistan, Portugal, etc. These countries contain the main almond growing areas (Rahemi, 2002, Chepinoga 2020, Llompartet *al.*, 2024). Almonds are rich in beneficial nutrients, including proteins, healthy fats, vitamins (especially E and B), minerals

(magnesium, calcium, iron), and fiber (Hasanov and Aliev 2011). This makes them an excellent addition to the diet for maintaining health. Almonds contain monounsaturated fats, which help lower levels of bad cholesterol (LDL) and increase levels of good cholesterol (HDL). This supports heart and vascular health. Vitamin E and other antioxidants in almonds help protect cells from oxidative stress and inflammation, which can reduce the risk of chronic diseases. Despite their high calorie

content, almonds can aid in weight management. Their high fiber and protein content creates a feeling of fullness, which can reduce overall calorie intake. Almonds may also promote improved metabolism due to their magnesium content, which plays a crucial role in carbohydrate and fat metabolism. Almonds can be used in various forms: whole, sliced, as oil or milk. This makes them an ideal ingredient for both sweet and savory dishes, snacks, desserts, and even beverages. Almonds and almond-based products (such as almond flour) are excellent alternatives to wheat for people with gluten intolerance or celiac disease. Regular consumption of almonds is associated with a lower risk of cardiovascular diseases, type 2 diabetes, and certain types of cancer due to their nutritional properties and ability to enhance overall health. Replacing some ingredients with almonds can help reduce the calorie content of dishes without sacrificing flavor and texture. For example, adding almond milk instead of cow's milk in smoothies or coffee. The study of the biological and agricultural characteristics of almond varieties and forms and other fruit crops includes several key aspects that help understand their agronomic traits and conditions for successful cultivation (Musayev 2019, Musayev, and Hajiyeu 2024). Different almond varieties may exhibit varying levels of resilience to climatic conditions such as temperature, humidity, and precipitation. Research helps identify which varieties are best suited for specific regions (Bayramov 2022, Musayev and Hajiyeu 2023).

OBSERVATIONS

Along with other fruit plants, almond is one of the oldest fruit plants in the Republic of Azerbaijan. There are three species of almonds found in the wild flora of Azerbaijan. The Common or sweet almond (*Prunus dulcis* (Mill.) D.A.Webb) grows in Azerbaijan on the northeastern slopes of the Greater Caucasus, as well as in the central and southern parts of the Lesser Caucasus. The Mountain or fenzls almond (*Prunus fenzliana* Fritsch.) is found in the

central and southern regions of the Lesser Caucasus in Azerbaijan (Ladizinsky, 1999) (in Zangilan), in the highlands of the Nakhchivan Autonomous Republic, and in Diabar (Talış region). It occurs on rocky areas and in coastal thickets in the middle and upper mountain belts. The Nairi almond (*Prunus nairica* (Fed. & Takht.) Eisenman) is noted on dry, stony, and rocky slopes in the southern part of the Lesser Caucasus and Nakhchivan. As a cold-resistant species of almond, it can be found in the Nakhchivan autonomous Republic at altitudes ranging from 1,700-1,900 meters above sea level to 2,300-2,400 meters. Of these, only one species - common or sweet almond (*Prunus dulcis* (Mill.) D.A.Webb) is cultivated (Martínez-Gómez *et al.*, 2007).

Prunus dulcis are an important agricultural crop in Azerbaijan, where their cultivation has a long history. The country has favorable climatic conditions for almond cultivation, especially in regions with a warm and dry climate. The remaining almond forests around the famous "Badamly" spring (the name means "Almond" or "With Almond") and in the mountainous part of the Shahbuz district of the Nakhchivan Autonomous Republic testify to the fact that there were once large almond forests here since ancient times.

In Azerbaijan, almonds are mainly cultivated in the following 4- regions:

1. Absheron region: Almond cultivation in the Absheron region of Azerbaijan has a long and interesting history closely linked to the climatic and geographical features of this area. The Absheron Peninsula, located on the coast of the Caspian Sea, has a mild climate with warm summers and moderately cold winters, creating favorable conditions for growing various fruit crops, including almonds. Almonds have been cultivated in this region since ancient times, as evidenced by archaeological finds and historical sources. In traditional agriculture in Absheron, almonds held an important place among nut-bearing crops. Local residents used almonds not only as a food product but

also in folk medicine. Almond cultivation was common in private gardens and small farms. During the Soviet period, attempts were made to systematize and expand almond production in the Absheron region. Specialized nurseries were established, and new agronomic methods aimed at increasing yield and disease resistance of trees were introduced. Today, almond cultivation in Absheron continues to develop. Almond orchards are combined with other crops, contributing to sustainable agricultural development (Khidirova *et al.*, 2016, Khidirova and Asgarbeyli 2017, Khidirova and Mamedova 2019).

2. Nakhchivan AR: This autonomous region also has traditions of almond cultivation that are adapted to local conditions. A large number of local varieties and forms of almonds are concentrated here. Almond cultivation in Nakhchivan has deep cultural roots and is an important part of the local economy and agriculture (Taghiyev *et al.*, 1990, Bayramov 2022).

3. Shirvan region: This region is also known for its agriculture, including almond cultivation. The region is suitable for growing almonds due to its warm climate, sufficient sunny days, and good solar insolation that contribute to the healthy growth and fruiting of trees (Taghiyev *et al.*, 1990, Hasanov and Aliev 2011).

4. Karabakh region: After the restoration of agriculture in the liberated territories of Karabakh, there is also a growing interest in reviving traditional crops, including almonds.

Since ancient times, folk breeders have created valuable varieties and forms of almonds that are distinguished by fruit size, appearance, yield, taste, aroma, oiliness and resistance to diseases and pests. Below are descriptions of 9 local and introduced almond varieties common in Shahbuz and Julfa districts.

1. Dash Badam (meaning - Stone almond): Commonly found in personal subsidiary farms in the villages of Badamly, Selesuz,

Shada, Ayrndzh, and others in the Shahbuz and Julfa districts. The tree reaches a height of 5–6 meters with a pyramidal crown. The bark of the trunk is grayish-brown. Annual shoots are 25–35 cm long. The leaves are broad-lanceolate, pointed, and light green in color. It blooms in early March. The fruit is wide, elongated, large, weighing 9–12 grams, and has a flat shape. The fruit stalk is very short, as if attached directly to the fruit itself. The length of the fruit stalk is 0.3–0.4 mm, and its thickness is 0.5–1 mm. The shell color is gray, while the kernel is light brown and not very hard. Each tree yields an average of 25–28 kg of fruit. It ripens in early August. The dry pericarp easily separates from the stone upon ripening. The fruits are mainly used fresh for obtaining kernels. The tasting score is 4.9 points.

2. Sarayi: This variety is commonly found in private yards, mainly in the villages of Selesg, Daylahli, Kolani, Mahmudoba, and Nurs in the Shahbuz district. It is one of the most widespread ancient local varieties in the Nakhchivan Autonomous Republic. The tree is of medium height, reaching 4–6 meters, with a high inverted pyramidal crown. The trunk is brown in color. Depending on the growing area, it blooms from late March to the second decade of April. The fruits are medium-sized, oval in shape, weighing 8–10 grams, with a height of 9–14 mm, a length of 30–32 mm, and a diameter of 11–13 mm. The pericarp is of medium thickness, cracked on the surface, and dark gray in color. The fruit kernel is soft and oily. This is a very productive variety, yielding an average of 15–17 kg of fruit per tree. The fruit stalk is almost completely fused with the fruit branch. Harvesting occurs at the end of August. It is resistant to diseases and pests. The tasting score is 4.7 points.

3. Ketan Koynek (meaning -Linen shirt):- This variety is mainly found in the regions of Badamly, Garababa, and Shahbuz. Recently, the variety has spread to other villages as well. It is a late-ripening variety. The tree is of medium height with a wide crown, averaging 3–4 meters tall, with a spherical,

drooping crown that has a diameter of 6–7 meters. It is resistant to frost and drought. It begins to bear fruit 3–4 years after planting and blooms in early March. The flowers are lilac in color, with each flower having one pistil and 10–12 stamens. The lifespan of each flower varies among almond varieties, lasting 4–7 days. Typically, flowering lasts 12–16 days on the tree. This is a very productive variety. The fruits are medium-sized, weighing 9–11 grams, with a height of 10–12 mm and a diameter of 13–16 mm. The pericarp is slightly thin, gray in color, with surface cracks. The shell is very soft. The kernel is brittle and oily. Each tree yields an average of 12–15 kg of fruit. The fruit stalk measures 1.5–2 mm in length and 1 mm in thickness. The stems are not very firmly attached to the stem. The harvest is collected at the end of August. It is not susceptible to diseases and pests. The tasting score is 4.6 points.

4. Gosha Lepe (meaning - Double Kernel): - This variety is found in private household plots in the villages of Tyurkesh, Badamly, Nursu, and Kolani in the Shahbuz district. As the name suggests, the kernel is very large and has a double kernel. The tree is of medium height, reaching 3–4 meters, with a pyramidal-spherical crown. The lower branches are drooping and spreading. The crown diameter is up to 4–5 meters. It blooms in the first decade of March, with white and lilac flowers. The fruits are medium-sized, weighing about 8–9 grams. The surface of the pericarp is bumpy. The length of the fruits is 12–15 mm, and the width is 16 mm. The height of the kernel is half its length. Unlike other varieties, the kernel is very oily and full. The fruit stalk is almost connected to the fruit branch. As they ripen, the fruits do not fall from the tree. The leaves are light green and long-lanceolate. This is a productive variety, with each tree yielding an average of 20–24 kg of fruit. It is indispensable for fresh use and desserts. The trees are resistant to diseases and moderately resistant to pests. The tasting score is 4.8 points.

5. Kurdashi: - This variety is found in household plots and newly established

almond orchards in the villages of Kolani, Ashagy Kishlag, Gyunay Kishlag, Kyuku, and Nursu in the Shahbuz district. Although it is an imported variety, it produces high-quality, abundant yields that are fully adapted to the soil and climatic conditions. The tree is of medium height, reaching 3–4 meters, with a drooping crown that has a diameter of 5–6 meters, an ash-colored trunk, gray buds, and glossy dark green leaves. The leaves are long and lanceolate. It blooms in the first and second decades of April, thus avoiding spring frost due to late flowering. The petals are white and pink. Each flower has 5 petals, 1 pistil, and 9–11 stamens. This is a very productive variety, with medium-sized fruits averaging 9–11 grams, a length of 28–30 mm, a thickness of 10–12 mm, and a diameter of 14–16 mm. The pericarp is of medium thickness, gray in color, and cracked. The kernel is brittle, oily, and tasty. Each tree yields 13–15 kg of fruit. The fruit stalk is longer compared to other varieties, measuring 3–4 mm in length, with a hairy surface and a thickness of 2 mm, firmly attached to the fruit. The stems are tightly attached to the branch, and as the fruit ripens, the pericarp easily cracks, causing the fruits to fall to the ground. Therefore, it's important to harvest the fruits immediately after the skin cracks and they fully ripen; otherwise, most of the fruits may drop. Depending on the growing region, the fruits ripen from late August to mid-September. It is resistant to diseases and pests. The tasting score is 4.6 points. Due to the fragility of the fruits, they are recommended for consumption as a snack.

6. Sugra (meaning - Female name): - This variety is mainly found in the villages of Jamaldin, Gulistan, and Bananiyar. It is a late-ripening variety. The tree is of medium height with a wide crown, averaging 3–4 meters tall, with a spherical, drooping crown that has a diameter of 5–6 meters. It is resistant to frost and drought, beginning to bear fruit 3–4 years after planting. It blooms in early March, with lilac-colored flowers. Each flower has 1 pistil and 10–12 stamens. The lifespan of each flower varies among

almond varieties, lasting 6-7 days, and flowering typically lasts 12-16 days on the tree. This is a very productive variety, with medium-sized fruits weighing 9-11 grams, a width of 15-16 mm, and a length of 20-25 mm. The pericarp is slightly thick, gray in color, with surface cracks. The shell is not very hard, and the kernel is brittle and oily. The fruit stalk measures 1.5-2 mm in length and 1 mm in thickness, with the part connecting to the fruit being slightly larger. The fruit stalks are not very firmly attached to the stem. The harvest is collected at the end of August. It is resistant to diseases and pests, although during very rainy weather, this variety can be affected by aphids. The tasting score is 4.4 points.

7. *Kaghız Badam* (meaning - *Paper Almond*): - This variety is planted and grown in private household plots in most villages of the Julfa district. As the name suggests, its pericarp is very soft and easily breaks with fingers. The tree is of medium size, reaching 3-4 meters in height, with a pyramidal crown. The lower branches are drooping and spreading, with a crown diameter of up to 4-5 meters. It blooms in the first decade of March, with white and lilac flowers. The fruits are medium-sized, weighing about 8-9 grams, with a pericarp surface that is bumpy. The fruits measure 15-20 mm in length and 15 mm in width. The height of the kernel is half its length. Unlike other varieties, the kernel is very oily and full. The fruit stalk is almost completely fused with the fruit branch, and as it ripens, it easily falls from the tree. The leaves are light green and long-lanceolate. This is a productive variety, yielding an average of 25-30 kg of fruit per tree. It is indispensable for fresh use and desserts. The trees are resistant to diseases and moderately resistant to pests. The tasting score is 4.8 points.

8. *Nonpareil*: This variety was recently introduced to the Nakhchivan Autonomous Republic. Although it is an imported variety, it is fully adapted to the soil and climatic conditions of Nakhchivan, including the Shahbuz region, and produces high-quality

products. *Nonpareil* is cultivated in the villages of Mahmudoba, Nursu, and Gyzyk Kishlag. Recently, its cultivation area has expanded, and it is widely used for establishing new almond orchards. The trees reach a height of 3.5-4 meters with a flat-pyramidal crown. The trunk is silvery and shiny, the branches are dark gray, and the leaves are thin and long, lanceolate. The variety blooms late and bears fruit every year, starting to bloom in the Shahbuz region at the end of April, making it resistant to spring frosts. The fruits are 35-40 mm long, 15-20 mm wide, and 10-12 mm thick, with an average weight of each fruit ranging from 0.9 to 12 grams. The yield per tree is 15-18 kg. The skin of the fruit is very thin and light gray. The kernel is flat, very oily, and sweet, with a kernel yield of 56% and an oil content of 53%. When ripe, the kernel splits, but the shell remains in place. The peduncle is firmly attached to the branch, with a thickness of 3 mm and a length of 1.5-2 mm. The fruits ripen at the end of September and are resistant to diseases and pests. The tasting score is 4.7 points.

9. *NecPlus Ultra*: This variety was introduced to the Shahbuz region in the last 20 years. It produces high-quality and abundant yields, fully adapted to the soil and climatic conditions. It is widespread in the villages of Daylahli, Selesuz, and Badamly. This variety has become popular in many parts of the world and is considered very valuable. The tree is large, reaching a height of 3-4 meters with dense foliage. The leaves are broad and dark green. The trunk has a dark silvery color and cracked bark. The variety blooms late and annually produces a rich, high-quality harvest. The fruits have an oval shape, with an average weight of each fruit being 0.7-0.9 grams, a length of 25-30 mm, a thickness of 18-20 mm, and a width of 1.5-1.7 mm. These fruits are consumed as snacks. The kernel constitutes 57% of the fruit, and the oil content is 53%. The peduncle is firmly attached to the branch, so even if the shell splits upon ripening, the fruit does not fall from the tree. The variety is

resistant to diseases and pests, and the tasting score is 4.8 points.

CONCLUSION

The study of biomanagement characteristics of almond varieties includes several key aspects that help to understand their agronomic characteristics and conditions for successful cultivation. Here are some of them:

- **Resistance to diseases and pests:** The study of biological and agricultural features involves assessing the resistance of varieties to common diseases (such as fungal infections) and pests. This is crucial for reducing crop losses and minimizing the use of chemical pesticides.
- **Fruiting and yield:** Research focuses on fruiting characteristics, such as flowering time, quantity, and quality of fruits. This allows for the evaluation of which varieties provide the highest yields and best flavor qualities.
- **Nutrient requirements:** Different varieties may have different nutrient requirements. Studying these needs helps optimize fertilization and improve growth conditions to achieve maximum productivity.
- **Environmental aspects:** The examination of biological and agricultural features also includes assessing environmental impacts, including resource use and effects on biodiversity. Sustainable practices can help minimize negative impacts on ecosystems.
- **Fruit quality:** Analyzing the chemical composition of fruits (such as oil, sugar, and vitamin content) allows for the evaluation of nutritional value and market appeal of various varieties. The study of the biological and agricultural characteristics of almond varieties and forms plays a vital role in advancing agronomy and sustainable

agriculture, contributing to increased productivity and product quality.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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