

Amino Acid Content in the Seeds of Vetch Varieties Under Saline Soil Conditions

U. T. Jumanov¹, T. X. Kuliye², Sh. Payonov³, J. DJaborov⁴, M. Safarova⁵.

^{1,2,3,4,5}. Gulistan State University, Research Institute of Agrobiotechnologies and Biochemistry, Research Institute of Grain and Leguminous Crops, Surkhandarya Research Station

Received: 2026, 04, Feb

Accepted: 2026, 10, Mar

Published: 2026, 22, Apr

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Annotation: This article presents data on the amino acid content in the seeds of vetch varieties Mirzacho‘l-1 (*Vicia villosa* Roth) and Mirzacho‘l-2 (*Vicia sativa* L.). The total amino acid content was 28.03 g/mg in the Mirzacho‘l-1 variety and 32.08 g/mg in the Mirzacho‘l-2 variety. Among the studied amino acids, the proportion of aspartate accounted for 36.62% in Mirzacho‘l-1 and 40.2% in Mirzacho‘l-2. The presence and activity of essential amino acids such as isoleucine, phenylalanine, and leucine contribute to the tolerance of vetch to saline conditions and low temperatures. It was determined that lysine is a limiting amino acid in vetch varieties. The Mirzacho‘l-1 variety is recommended for use as livestock feed and as a green manure (sideral) crop, while the Mirzacho‘l-2 variety is recommended for grain production under slightly saline soil conditions when sown in autumn and early spring.

Keywords: Vetch varieties, salt tolerance, amino acids, essential amino acids, limiting amino acid, biological value of protein, stress tolerance, green manure crop, forage crop.

Introduction

Vetch (*Vicia* L.) belongs to the legume family, with about 120 species distributed worldwide, of which nearly 10 species occur in Uzbekistan. Currently, 53 species of vetch are used as forage for livestock and as green manure (sideral) crops. Vetch species exhibit strong variability in their tolerance to moisture and low temperatures. Therefore, vetch is widely distributed across different regions of the world and under diverse soil and climatic conditions.

Early-maturing and drought-tolerant vetch species have been identified in Afghanistan and Australia, while moisture- and cold-tolerant species are distributed in European regions. It has been reported that vetch species can tolerate temperatures as low as -30 to -35°C . Vetch is demanding with respect to soil acidity, and its optimal growth and development occur at a soil pH of 6.0–7.0.

Vetch is considered a highly nutritious forage crop for livestock. Its composition includes 18–25% protein, 3.6% crude fat, 18.6% crude fiber, and 1.8% ash, and 100 kg of green biomass contains 16 feed units. The total content of essential amino acids in vetch ranges from 65 to 80 g, with lysine accounting for 4.9–6.30% of the total [1].

In narrow-leaved vetch (*Vicia angustifolia* L.), the amino acid content was found to be 1.606 mg/g in the stem, 1.2782 mg/g in the roots, and 6.30 mg/g in the seeds. In addition, the threonine content in this species was 0.341 mg/g. The proline content was recorded as 0.256 mg/g in the stem and 0.244 mg/g in the roots. This species has been recommended as a forage crop for livestock [2].

It is well known that proline plays an important role in determining plant tolerance to stress conditions. An increase in proline content has been observed in genotypes resistant to saline environments. This is associated with the ability of proline to retain water in cells and regulate ion balance in salt-tolerant genotypes [3].

An increase in proline content under stress conditions has also been noted in vetch species. In addition, amino acids such as alanine, valine, threonine, lysine, and arginine have been found to play an important role in cold tolerance of vetch. During the dormancy period, an increase in the levels of these amino acids enhances the cold resistance of vetch [4].

Among vetch species, hairy vetch (*Vicia villosa* Roth) has been recognized as salt-tolerant [5]. This conclusion was obtained through statistical analysis of quantitative traits of vetch under both non-saline and saline soil conditions. Although the effect of soil salinity on quantitative traits such as pod weight, pod length, and seed weight ranged from 5% to 17%, the similarity of correlation matrices reached 91.6%. Based on these indicators, hairy vetch was classified as salt-tolerant [6].

From the above data, it can be concluded that the content of amino acids plays an important role in determining the adaptability of plants to environmental conditions. Based on this, the present study was conducted. The main objective of the study was to compare the Mirzacho‘1-1 and Mirzacho‘1-2 varieties of vetch in terms of their amino acid profiles.

Research Object: The varieties “Mirzacho‘1-1” and “Mirzacho‘1-2”, belonging to vetch species (*Vicia* L.), were selected as the objects of the study.

The “Mirzacho‘1-1” variety of vetch belongs to hairy vetch (*Vicia villosa* Roth) and is an annual herbaceous plant. The stem is prostrate, 150–180 cm in length, and in some cases reaches 200–220 cm; it is branched and covered with fine hairs. The first pod is formed at the 20th–21st nodes [7].

The leaves are compound pinnate; tendrils are present instead of the terminal leaflet. The leaflets are oval-elongated in shape and covered with hairs. The inflorescence is a multi-flowered elongated raceme, with a short peduncle. The corolla length is 12–16 mm, and the flowers are purple in color. Flowering occurs in May–June. Each inflorescence contains up to 20–25 flowers. Pollination occurs with the help of insects. The weight of 1000 seeds is 30–31 g.

The “Mirzacho‘1-2” variety of vetch belongs to common vetch (*Vicia sativa* L.) and is an annual herbaceous plant. The stem is prostrate, 85–95 cm in length, branched, and covered with fine hairs.

The leaves are compound pinnate, with tendrils instead of the terminal leaflet. The leaflets are elongated-linear in shape with a slightly truncated tip and are sparsely covered with hairs. The petiole length is uniform. The midrib of the leaf slightly protrudes beyond the tip, and the leaf margins are entire[8].

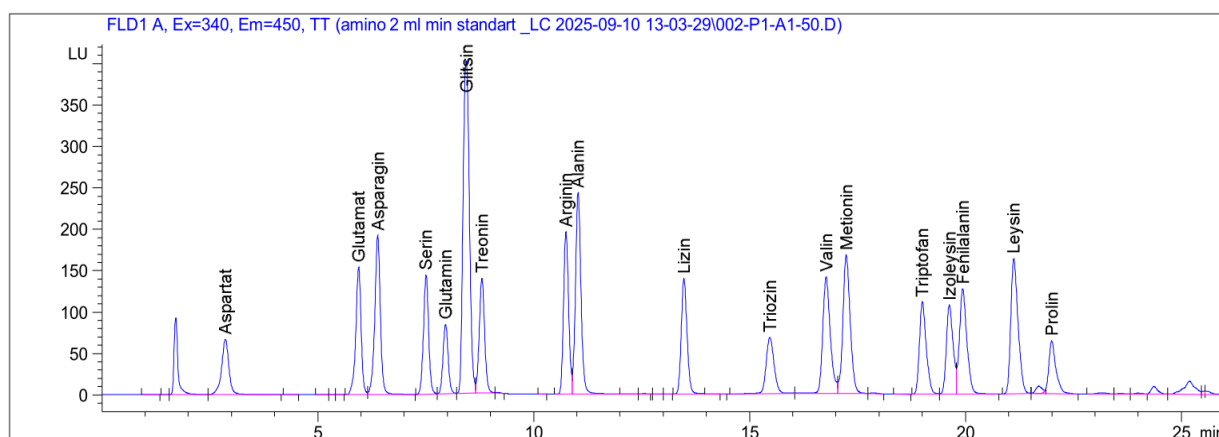
The inflorescence consists of 1–2 flowers located in the leaf axils on short peduncles. The corolla length is 12–18 mm. The flower color is purple-red. Flowering occurs in April–May[9].

The seeds are medium-sized, spherical, slightly compressed (flattened), and glossy. Their color is dark brown with black mottling on the surface. The weight of 1000 seeds is 41–42 g. The pod length is 5–7 cm, containing 4–5 seeds.

These varieties were studied in a slightly saline experimental field of the Research Institute of Agrobiotechnologies and Biochemistry at Gulistan State University.

Research methods

The qualitative and quantitative characteristics of amino acids in plant samples were determined using standard samples (Sigma-Aldrich, Germany) by high-performance liquid chromatography (HPLC) (Agilent Technologies, USA) with a fluorescence (FLD) detector on an Agilent 1260 Infinity II system. The chromatogram was obtained as shown below (Figure 1) [10].



Primary data were statistically analyzed using the SPSS-17 software package [11].

Results and Discussion

The results demonstrated that among the non-essential amino acids, serine was not detected in the seeds of the Mirzacho‘1-1 variety, whereas its content in the Mirzacho‘1-2 variety was 0.907 mg/g. The asparagine content was 3.88 mg/g in Mirzacho‘1-1 and 3.51 mg/g in Mirzacho‘1-2 (Figure 1), indicating that its level in Mirzacho‘1-1 was higher by 0.375 mg/g.

The proline content was 4.23 mg/g in Mirzacho‘1-1 and 4.33 mg/g in Mirzacho‘1-2. The alanine content reached 7.32 mg/g in the Mirzacho‘1-2 variety, which is 2.96 mg/g higher than in Mirzacho‘1-1. Among the non-essential amino acids, aspartate content was 10.83 mg/g in Mirzacho‘1-1 and 12.90 mg/g in Mirzacho‘1-2.

The total content of non-essential amino acids amounted to 28.03 mg/g in the Mirzacho‘1-1 variety and 32.08 mg/g in the Mirzacho‘1-2 variety.

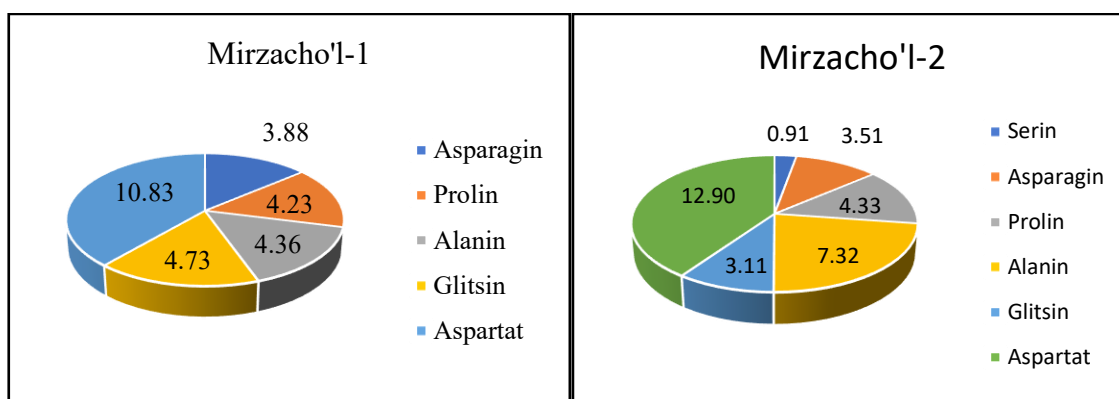


Figure 1. Content of non-essential amino acids in vetch varieties (mg/g)

Essential amino acids determine the biological value of protein. The analysis results showed that the arginine content in the Mirzacho'l-1 variety of vetch was 3.49 mg/g, whereas in the Mirzacho'l-2 variety it was 0.071 mg/g (Figure 2). It was established that the arginine content in Mirzacho'l-1 was higher by 3.338 mg/g compared to Mirzacho'l-2 (Figure 1).

It is known that arginine plays an important role in root growth and is involved in the regulation of cytokinin and chlorophyll synthesis. The lysine content was 0.543 mg/g in the Mirzacho'l-1 variety and 0.509 mg/g in the Mirzacho'l-2 variety[12].

The tyrosine content was 1.127 and 1.202 mg/g, respectively, while phenylalanine was 2.895 and 2.486 mg/g. The isoleucine content was 2.609 mg/g in the Mirzacho'l-1 variety and 2.378 mg/g in the Mirzacho'l-2 variety. According to this amino acid, the Mirzacho'l-1 variety exceeded the Mirzacho'l-2 variety by 0.231 mg/g (Figure 2).

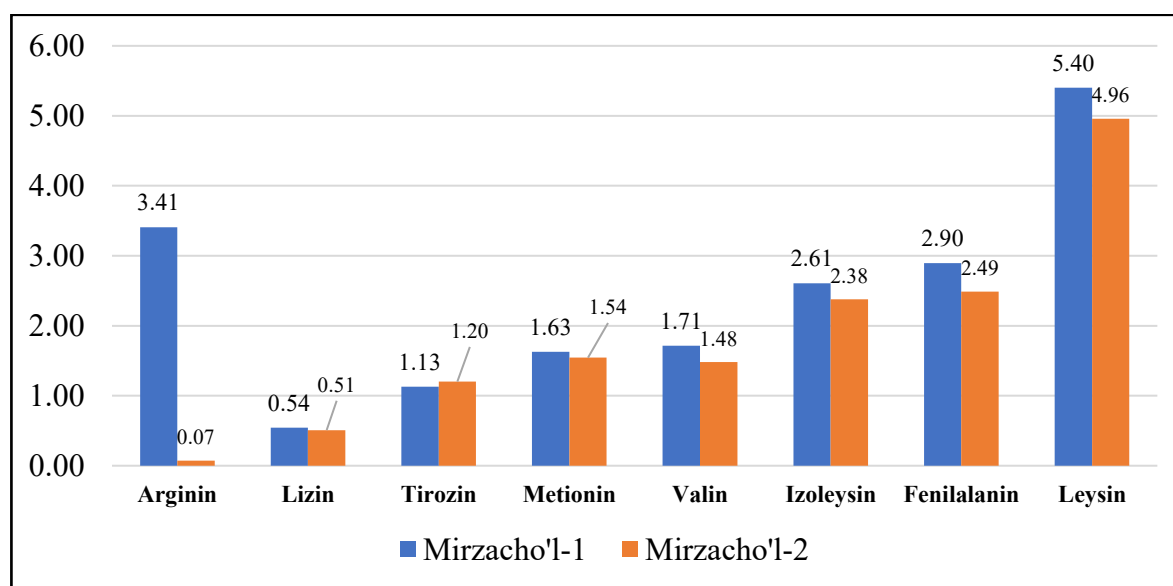


Figure 2. Content of essential amino acids in vetch varieties (mg/g)

Among the essential amino acids, leucine was distinguished by its higher content compared to the other studied amino acids. Its content was 5.401 mg/g in the Mirzacho'l-1 variety and 4.959 mg/g in the Mirzacho'l-2 variety (Figure 2). This value was found to be higher by 0.442 mg/g in the Mirzacho'l-1 variety (Figure 3).

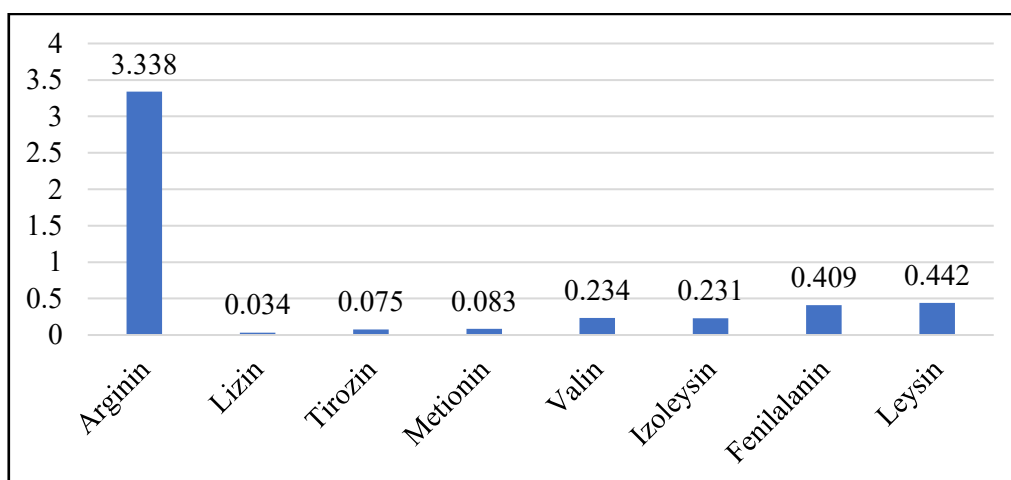


Figure 3. Differences between vetch varieties in terms of essential amino acids. Note: “+” indicates the superiority of the Mirzacho‘1-1 variety.

In general, the Mirzacho‘1-1 and Mirzacho‘1-2 varieties of vetch differed in terms of amino acid content. Among the non-essential amino acids, glutamate, glutamine, threonine, and tryptophan were not detected in vetch seeds. The total content of non-essential amino acids was 28.03 mg/g (59.2%) in the Mirzacho‘1-1 variety and 32.08 mg/g (66.7%) in the Mirzacho‘1-2 variety. Among these acids, the proportion of aspartate was 38.62% in Mirzacho‘1-1 and 40.2% in Mirzacho‘1-2.

The total content of essential amino acids was 19.33 mg/g in the Mirzacho‘1-1 variety and 14.63 mg/g in the Mirzacho‘1-2 variety. In the Mirzacho‘1-1 variety, the essential amino acids were arranged in the following ascending order: lysine (0.54) < tyrosine (1.13) < methionine (1.63) < valine (1.71) < isoleucine (2.61) < phenylalanine (2.90) < arginine (3.41) < leucine (5.40).

Based on these data, lysine was identified as the limiting amino acid in the Mirzacho‘1-1 variety [13].

A similar pattern was observed in the Mirzacho‘1-2 variety: arginine (0.07) < lysine (0.51) < tyrosine (1.20) < valine (1.48) < methionine (1.54) < isoleucine (2.38) < phenylalanine (2.49) < leucine (4.96 mg/g). In this variety, arginine and lysine were identified as limiting amino acids.

Based on these data, the increased activity of amino acids such as aspartate, isoleucine, phenylalanine, and leucine indicates their role in providing tolerance to soil salinity and low temperatures. Similar findings have also been reported by other researchers. It has been established that amino acids such as lysine, glutamic acid, glycine, and histidine contribute to the absorption of nutrients in plants, while arginine, tyrosine, threonine, valine, serine, and alanine are involved in regulating metabolic processes. In addition, aspartate, phenylalanine, isoleucine, and leucine have been recognized for enhancing stress tolerance in plants [14].

Based on the results of determining amino acid content in vetch varieties and long-term breeding studies, vetch has been recognized as tolerant to saline environments. This is also evident from the data presented in Figure 4.

Vetch plants sown in autumn protected the soil surface from rain and wind erosion and improved soil fertility when used as a green manure (sideral) crop. Based on these findings, the Mirzacho‘1-1 variety of vetch is recommended for autumn sowing as a forage and green manure crop, while the Mirzacho‘1-2 variety is recommended for spring sowing for grain production [15].



Figure 4. Growth and development of the Mirzacho'1-1 vetch variety under slightly saline soil conditions,

Conclusion

1. The total content of non-essential amino acids was 28.03 mg/g in the Mirzacho'1-1 variety, accounting for 51.19% of the total amino acids, whereas in the Mirzacho'1-2 variety it was 32.08 mg/g, representing 68.68%.
2. Among the non-essential amino acids, the proportion of aspartate was 36.62% in the Mirzacho'1-1 variety and 40.2% in the Mirzacho'1-2 variety.
3. The proportion of amino acids such as isoleucine, phenylalanine, and leucine (13–33%) contributed to the tolerance of vetch varieties to saline environments and low temperatures. It was also determined that lysine is a limiting amino acid in vetch varieties.

The proportion of essential amino acids was 40.8% in the Mirzacho'1-1 variety and 31.3% in the Mirzacho'1-2 variety, indicating a higher biological value of protein in the Mirzacho'1-1 variety. These varieties are recommended for use as forage crops and as green manure (sideral) crops.

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