Received: 01.11.2025. Revised: 13.02.2026. Accepted: 10.03.2026.

Bulletin
of the Kyrgyz National
Agrarian University

Vol. 24, No. 1. 2026

Journal homepage: https://knau-bulletin.com/en

UDC 633.358:613

DOI: 10.63621/bknau./1.2026.18

Amino acid composition of chickpea (*Cicer arietinum* L.) varieties cultivated in the Kyrgyz Republic

Zhyldyz Batyrbasheva*

PhD Doctoral Student
Kyrgyz State Technical University named after I. Razzakov
720044, 66 Ch. Aitmatov Ave., Bishkek, Kyrgyz Republic
https://orcid.org/0009-0002-8718-5855

Abdybek Asanaliev

Doctor of Agricultural Sciences, Professor
Kyrgyz National Agrarian University named after K.I. Skryabin
720005, 68 Mederov Str., Bishkek, Kyrgyz Republic
https://orcid.org/0000-0002-3075-823X

Almaz Imanaliev

Head of the Department of Forestry and Fruit Growing
Kyrgyz National Agrarian University named after K.I. Skryabin
720005, 68 Mederov Str., Bishkek, Kyrgyz Republic
https://orcid.org/0000-0003-1710-9187

Victoria Sultanbaeva

PhD in Agricultural Sciences, Associate Professor
Kyrgyz National Agrarian University named after K.I. Skryabin
720005, 68 Mederov Str., Bishkek, Kyrgyz Republic
https://orcid.org/0000-0002-8914-8778

Abstract. Chickpeas (*Cicer arietinum* L.) are an important source of plant protein, but data on the biochemical composition of varieties cultivated in the Kyrgyz Republic are limited. The aim of the study was to determine the amino acid composition of the grains of three chickpea varieties ('Kyrgyz Local', 'Uzbekistan 32' and 'Yulduz') grown in the republic in order to assess their nutritional value. Average samples were selected according to the ISTA methodology from the 2024 harvest. Amino acid analysis was performed by high-performance liquid chromatography (HPLC) after acid hydrolysis with pre-column derivatisation with phenylisothiocyanate. The study revealed significant varietal differences in the content of individual amino acids. The highest methionine content was recorded in the 'Kyrgyz Local' variety (0.85 g/100 g), followed by 'Yulduz' (0.80 g/100 g) and 'Uzbekistan 32' (0.72 g/100 g). The lysine content ranged from 0.09 g/100 g ('Yulduz') to 0.14 g/100 g ('Kyrgyz Local'). The dominant amino acids in all samples were aspartic acid (2.74-3.69 g/100 g) and cystine (1.53-2.70 g/100 g). The 'Yulduz' variety showed the highest histidine content (1.62 g/100 g), while 'Uzbekistan 32' had the highest tyrosine content (0.65 g/100 g). The results confirm the status of chickpeas as a valuable source of plant protein with a favourable amino acid profile and can be used in the development of balanced diets and functional foods in the Kyrgyz Republic

Keywords: biochemical profile; protein; high-performance liquid chromatography; lysine; methionine; arginine

Suggested Citation: Batyrbasheva, Zh., Asanaliev, A., Imanaliev, A., & Sultanbaeva, V. (2026). Amino acid composition of chickpea (*Cicer arietinum* L.) varieties cultivated in the Kyrgyz Republic. *Bulletin of the Kyrgyz National Agrarian University*, 24(1), 18-27. doi: 10.63621/bknau./1.2026.18.

*Corresponding author

Introduction

With the growing pressure on global agroecosystems and the worsening food security problem, the transition to sustainable food sources is becoming strategically important. Plant proteins play a key role in the formation of healthy, balanced and environmentally responsible diets. Legumes, with their high nutritional value and nitrogen-fixing ability, are a cornerstone in addressing these challenges. According to J. Aschemann-Witzel *et al.* (2021), global demand for plant protein has increased significantly over the past decade due to consumer concerns about the adverse effects of animal-based diets on health and the environment. In the context of a growing shortage of complete protein, legumes are becoming strategically important for food security. According to FAOSTAT (n.d.), global production of chickpeas (*Cicer arietinum* L.) reached 15.9 million tonnes in 2021, making it the third most important legume crop after beans and peas.

Chickpea proteins are highly digestible and have a balanced amino acid composition, making them a promising alternative to animal proteins. The essential amino acid index of chickpeas is 76 on the DIAAS scale, and the crop is characterised by a high content of lysine, an amino acid that is deficient in cereals (Yeasmen & Orsat, 2025). As noted by W. Xu *et al.* (2024), compared to soy protein, chickpea protein has lower allergenicity, better solubility and foaming properties. The amino acid profile of chickpeas varies significantly depending on the variety and growing conditions. Studies of genotypes with different protein contents have shown that the amino acid composition of chickpeas exceeds the WHO recommended values for all essential amino acids and is comparable to that of complete protein sources (Grewal *et al.*, 2023).

In addition to its nutritional value, chickpea is a soil-improving crop due to its ability to fix atmospheric nitrogen through symbiosis with nodule bacteria, which is especially important for cereal crops in crop rotation (Liu *et al.*, 2020). According to S. Salaria *et al.* (2023), increasing the protein content in chickpea seeds has been identified as a priority area for research in crop breeding and genetics. In the Kyrgyz Republic, chickpeas traditionally have the status of a vegetable crop. According to unpublished data from the Ministry of Water Resources... (n.d.) and NSCKR (n.d.), the area sown with chickpeas in Kyrgyzstan in 2024 reached 1,472 hectares with a yield of 15.4 centners per hectare, which puts the crop in second place among legumes after common beans. The main cultivation areas are concentrated in the Osh and Jalal-Abad regions, where mainly locally selected varieties, two selected varieties of Kyrgyz origin ('Rafat' and 'Saira') and the introduced variety 'Uzbekistan 32' are cultivated. However, information on the biochemical composition of the grain of local varieties is extremely limited. E. Torutaeva *et al.* (2014) and A. Asanaliev *et al.* (2017) reported only on the mineral composition and productivity of various chickpea varieties, while data on the amino acid composition are lacking. The aim of this study was to determine the amino acid composition of three chickpea varieties cultivated in the Kyrgyz Republic in order to assess their nutritional value and potential for use in functional foods.

Literature Review

The biochemical composition of chickpea proteins is characterised by a significant variety of fractions and high nutritional value. Chickpea proteins, like pea proteins, are mainly represented by albumins and globulins, which account for up to 97% of their mass (Dhaliwal *et al.*, 2021). A detailed analysis of protein fractions shows that chickpea proteins contain globulins (56 g/100 g), albumins (12 g/100 g), glutelins (18 g/100 g), prolamins (3 g/100 g) and residual proteins. According to Y. Chang *et al.* (2011), chickpea proteins have a higher content of glutelins than other legumes, which determines their unique functional properties. According to A. Olagunju *et al.* (2018), an important advantage of legume proteins is their hypoallergenicity compared to other plant proteins. To isolate chickpea protein fractions, it is preferable to use salt solutions at a concentration of 0.5-3.0 mol·L^{-1}, which ensures effective extraction while preserving the native properties of the protein. Legume proteins have a wide range of techno- and biofunctional applications comparable to those of animal and dairy proteins, providing numerous health benefits (Glusac *et al.*, 2020).

The amino acid profile of chickpeas is of particular interest in terms of nutritional value. Legumes have significant potential in terms of eliminating protein deficiency, as they are a source of essential amino acids. As noted by I. Pankina & L. Borisova (2016), unlike cereal proteins, legume proteins contain higher amounts of essential amino acids, including threonine, isoleucine, leucine, valine, phenylalanine, lysine, and tryptophan. Among them, lysine plays an important role, participating in various biochemical processes in the bodies of animals and humans and often being a limiting amino acid in cereal crops. Chickpeas are cultivated worldwide as a legume rich not only in protein but also in vitamins, carbohydrates, polyphenols, fatty acids, fibre and flavonoids (Patil *et al.*, 2024). Chickpea grains contain antioxidants that can be included in various concentrates and have a positive effect on the body's immunity. Due to its abundance of essential amino acids, especially lysine, and high digestibility, chickpeas are considered a promising substitute for animal proteins. A comparative analysis of the functional properties of various plant proteins shows the advantages of chickpea protein. Chickpeas are highly valued as a source of protein due to their high digestibility, biological value and balanced amino acid composition. However, it should be noted that chickpeas have limitations in terms of their content of sulphur-containing amino acids, including methionine and cysteine (Koul *et al.*, 2022). Despite this limitation, chickpeas are an attractive source of protein for the development of protein-enriched ingredients and functional foods (Yeasmen & Orsat, 2025).

According to F. Roy *et al*. (2010), in the modern context, the number of hungry people in the world continues to grow, reaching one third of the Earth's population, with a significant portion of the population experiencing a deficiency of complete protein. Concerns about high cholesterol levels in food, food allergies, high prices for animal products, and the negative environmental impact of their production have led to a significant increase in interest in alternative sources of protein (Zotikov, 2016). In this regard, plant proteins, in particular chickpea protein, have gained considerable popularity in the food industry as an environmentally sustainable and cost-effective source of high-quality protein. The urgency of solving the problem of providing the population with complete protein determines the need for a comprehensive analysis of the chickpea raw material base, including a detailed study of the amino acid composition of different varieties. Amino acid analysis of chickpea grains cultivated in different regions is of considerable scientific and practical interest for optimising the production of functional foods and developing balanced diets.

Materials and Methods

The study was conducted in 2024-2025 at the Kyrgyz State Technical University named after I. Razzakov and the Kyrgyz National Agrarian University named after K.I. Skryabin. The objects of the study were three varieties of chickpea (*Cicer arietinum* L.): 'Kyrgyz Local', 'Yulduz' and 'Uzbekistan 32'. The varieties were grown on northern foothill grey soils with natural moisture. For chickpea cultivation, autumn ploughing was carried out to a depth of 20 cm, and no mineral fertilisers were applied during ploughing. When sowing in rows, simple granulated superphosphate was applied at a dose of P_{20} per 1 ha of active ingredient. Sowing was carried out at the end of April 2024 with row spacing of 45 cm and a sowing rate of 0.4 million viable seeds per hectare. All operations were carried out in strict accordance with the Convention on Biological Diversity (1992).

Harvesting was carried out in the third decade of August 2024 when full biological ripeness was reached. Average grain samples weighing 1 kg from each variety were selected in accordance with ISTA (n.d.) methods from the 2024 harvest. Prior to analysis, the grain samples were stored in a dry, ventilated room at a temperature of 18-20°C and a relative humidity of no more than 60%. The moisture content of the grain was 10-11%. The dry matter content was determined by weighting the grain in an oven according to GOST 31640-2012 (2020). The amino acid composition was studied in 2025 in the analytical laboratory of the Kyrgyz State Technical University named after I. Razzakov. The total amino acid content in the samples was determined by high-performance liquid chromatography (HPLC) after preliminary acid hydrolysis. Hydrolysis of a 100 mg sample was carried out in 6 M HCl at 110°C for 13 hours in sealed glass ampoules in a nitrogen atmosphere to prevent oxidation. The amino acid derivatisation process was carried out using phenylisothiocyanate (PITC). After hydrolysis, 1,000 µl of the sample was dried under vacuum. Then, 150 µl of 0.1 mol NaOH, 50 µl of deionised water and 350 µl of PITC reagent (propanol/PITC/TEA [8:1:1, v/v/v]) were added and kept at room temperature for 30 minutes for the reaction to proceed. PITC was removed in a nitrogen atmosphere, and the derivatised sample was redissolved in 1.5 mL of water. The sample was filtered through a syringe filter (0.45 µm) and injected into the HPLC system in a volume of 10 µl. Two mobile phases were used for the separation of amino acid derivatives by HPLC. Mobile phase A consisted of 99% HPLC-grade acetonitrile and 1% acetic acid, while mobile phase B consisted of 99.9% HPLC-grade water, 0.1% acetic acid, and 0.1 mol sodium acetate. All buffers were filtered through a 0.2 µm pore size filter and degassed.

Chromatographic separation was performed using a Shimadzu Prominence LC-20 system (Shimadzu Corporation, Japan) equipped with a UV detector (SPD-20A) and a fluorescence detector (RF-10AXL). The HPLC system was equipped with a binary pump (LC-20AD), an autosampler (SIL-20AC), a degasser (DGU-20A5) and a column thermostat (CTO-20A), controlled by LCSolution software. Samples and standards were separated on a Thermo Hypersil GOLD C18 (150 mm × 4 mm, 5 µm) HPLC column manufactured by Thermo Fisher Scientific (USA, distributor – India branch). UV detection was performed at a wavelength of 254 nm. The mobile phase flow rate was 0.8 mL/min. The total HPLC analysis time for the separation of derivatised amino acids in a single sample was 43 minutes. The column temperature was maintained at 40°C.

Standard solutions of 18 amino acids were used to calibrate the system: L-aspartic acid (Asp), L-glutamic acid (Glu), L-serine (Ser), L-asparagine (Asn), L-histidine (His), L-arginine (Arg), L-threonine (Thr), L-alanine (Ala), L-proline (Pro), L-cysteine (Cys), L-tyrosine (Tyr), L-valine (Val), L-methionine (Met), L-cystine (Cystine), L-isoleucine (Ile), L-leucine (Leu), L-phenylalanine (Phe) and L-lysine (Lys), purchased from Titan Biotech Ltd (India, Delhi, Netaji Subhash Place). All amino acids were commercially available, pure and of pharmaceutical grade (purity ≥99%). Each amino acid was accurately weighed and dissolved in 0.1 mol HCl to prepare a stock solution with a concentration of 1 mg/mL. Each 1 mL standard solution was evaporated under vacuum and derivatised using the method described above. Five calibration solutions were prepared by serial dilution at the following concentrations for each amino acid: 1, 10, 25, 50 and 100.0 μg/mL. Calibration curves were constructed using the least squares method, with a correlation coefficient of at least 0.998 for all amino acids.

The quantitative content of amino acids in the samples was calculated based on the peak areas and calibration curves, expressing the results in g/100 g of absolutely dry matter. All analyses were performed in triplicate. Statistical data processing was carried out by determining the arithmetic mean values and standard deviations. Statistical analysis was performed using Microsoft Excel 2019 and Statistica 10.0 software. Differences between varieties were considered significant at a significance level of $p < 0.05$.

Results and Discussion

The results of the study to determine the amino acid composition of the 'Yulduz' chickpea variety are presented in Table 1 and Figure 1.

Table 1. Amino acid composition of 'Yulduz' chickpea grains

Amino acids	Retention time, min	Peak area	Concentration in the initial sample, μg/mL	Content, g/100 g dry matter
Aspartic acid	8.599	5,211,277	3,686.17	3.69
Glutamic acid	9.375	1,518,458	757.92	0.76
Serine	10.226	1,258,646	421.67	0.42
Asparagine	10.595	1,303,993	697.76	0.70
Histidine	11.729	3,678,498	1,616.81	1.62
Arginine	12.429	333,678	289.22	0.29
Threonine	12.655	820,705	327.74	0.33
Alanine	13.060	1,074,865	305.68	0.31
Proline	13.413	1,886,110	266.57	0.27
Cysteine	14.684	462,755	53.45	0.05
Tyrosine	16.029	467,679	247.70	0.25
Valine	17.111	478,938	262.30	0.26
Methionine	17.511	1,438,629	795.33	0.80
Cystine	18.010	2,079,349	2,704.21	2.70
Isoleucine	19.019	646,529	215.29	0.22
Leucine	19.474	644,791	374.56	0.37
Phenylalanine	20.136	563,213	308.01	0.31
Lysine	20.962	219,758	93.05	0.09

Source: compiled by the authors

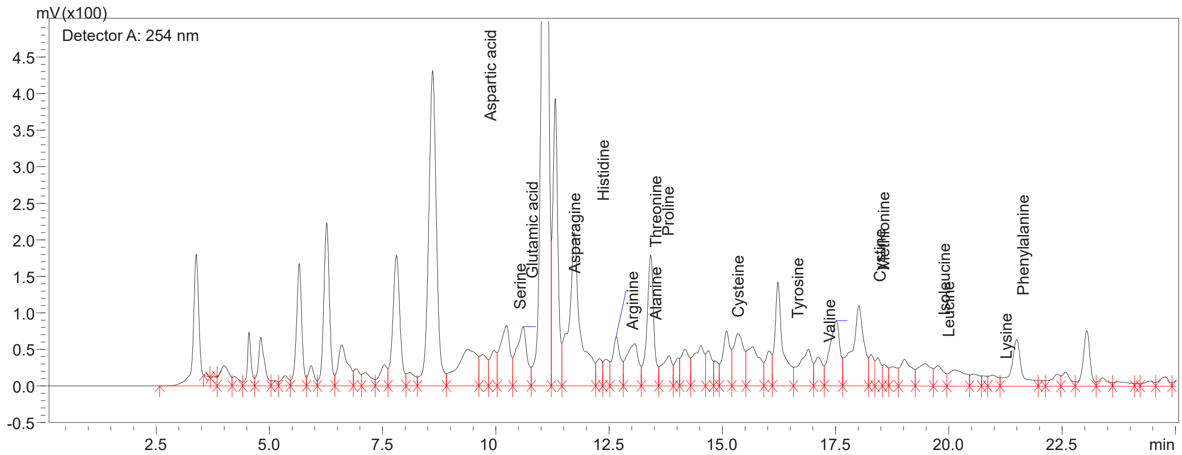

Figure 1. Amino acid composition of the 'Yulduz' variety of chickpeas

Source: authors' development

Table 1 and Figure 1 show that the 'Yulduz' variety has the highest amino acid potential. The grains of this variety are clearly dominated by aspartic acid (3.69 g/100 g) and cystine (2.70 g/100 g), which have the highest values among all three varieties. The high content of glutamic and aspartic acids, as well as histidine, is characteristic of the protein of the 'Yulduz' chickpea variety: the histidine content (1.62 g/100g) is the highest among all three varieties. This variety has an average arginine content. Essential amino acids: methionine (0.80 g/100 g), which is often a limiting amino acid in legumes, has a high value in this variety compared to other essential acids in this table. The lysine content in chickpea protein (0.09 g/100 g) is low. The amino acid composition of the protein of the 'Kyrgyz Local' variety is shown in Table 2 and Figure 2.

Table 2. Amino acid composition of the grain of the 'Kyrgyz Local' variety

Amino acids	Retention time, min	Peak area	Concentration in the initial sample, µg/mL	Content, g/100 g dry matter
Aspartic acid	8.545	4,782,908	3,383.17	3.38
Glutamic acid	9.332	1,563,239	780.27	0.78
Serine	10.174	1,349,914	452.24	0.45
Asparagine	10.545	1,089,511	582.99	0.58
Histidine	11.715	2,425,717	1,066.18	1.07
Arginine	12.364	489,249	424.07	0.42
Threonine	12.604	646,977	258.36	0.26
Alanine	13.023	913,005	259.65	0.26
Proline	13.492	1,770,832	250.28	0.25
Cysteine	14.525	1,008,567	116.48	0.12
Tyrosine	16.163	896,952	475.06	0.48
Valine	17.112	437,404	239.55	0.24
Methionine	17.443	1,537,509	850.00	0.85
Cystine	17.973	1,796,575	2,336.46	2.34
Isoleucine	19.311	543,864	181.10	0.18
Leucine	19.572	366,164	212.70	0.21
Phenylalanine	20.173	424,961	232.40	0.23
Lysine	20.965	320,051	135.52	0.14

Source: compiled by the authors

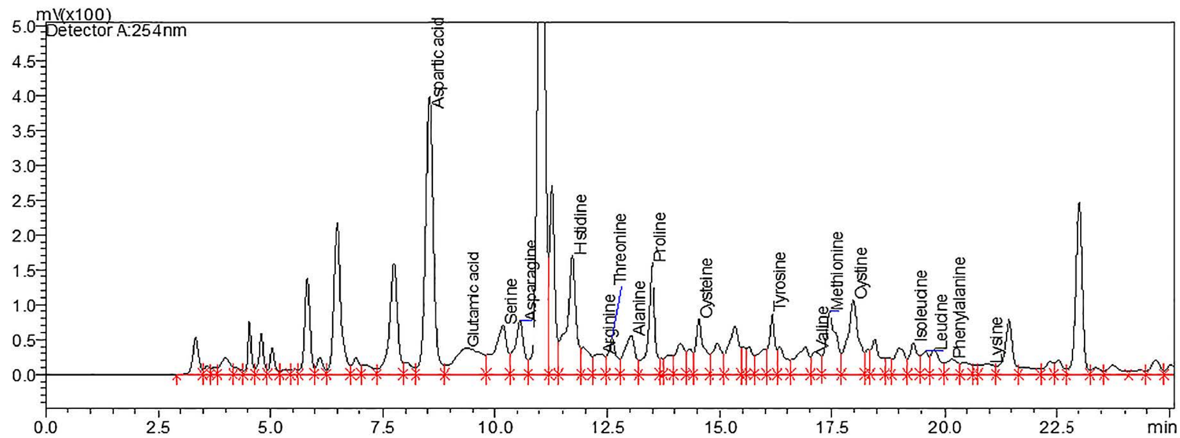

Figure 2. Amino acid composition of 'Kyrgyz Local' variety

Source: authors' development

The data in Table 2 and Figure 2 show that the 'Kyrgyz Local' variety also has high amino acid potential, especially in terms of the content of the essential amino acid methionine. The highest concentrations in the 'Kyrgyz Local' variety are found in aspartic acid (3.38 g/100 g) and cystine (2.34 g/100 g). This variety has the highest content of methionine (0.85 g/100 g) and glutamic acid (0.78 g/100 g) among the three varieties analysed. The arginine content (0.42 g/100 g) is also the highest of the three varieties. The lysine content (0.14 g/100 g) in this sample is higher than in the 'Yulduz' variety, but lower than in 'Uzbekistan 32'. The 'Kyrgyz Local' variety has a high histidine content (1.07 g/100 g) compared to other amino acids in this sample. The amino acid composition of the 'Uzbekistan 32' variety is shown in Table 3 and Figure 3.

Table 3. Amino acid composition of chickpeas of the 'Uzbekistan 32' variety

Amino acids	Retention time, min	Peak area	Concentration in the initial sample, µg/mL	Content, g/100 g dry matter
Aspartic acid	8.534	387,466	2,740.73	2.74
Glutamic acid	9.417	400,186	199.75	0.20
Serine	10.171	1,294,343	433.63	0.43
Asparagine	10.538	870,848	465.98	0.47
Histidine	11.709	1,600,926	703.66	0.70
Arginine	12.253	386,484	334.99	0.33
Threonine	12.567	642,637	256.63	0.26
Alanine	13.286	201,351	57.26	0.06

Table 3. Continued

Amino acids	Retention time, min	Peak area	Concentration in the initial sample, µg/mL	Content, g/100 g dry matter
Proline	13.591	1,446,738	204.47	0.20
Cysteine	14.542	723,982	83.62	0.08
Tyrosine	16.103	1,219,768	646.03	0.65
Valine	16.918	371,809	203.63	0.20
Methionine	17.417	1,296,070	716.52	0.72
Cystine	17.938	1,174,374	1,527.28	1.53
Isoleucine	19.312	550,471	183.30	0.18
Leucine	19.539	325,470	189.06	0.19
Phenylalanine	20.182	388,121	212.26	0.21
Lysine	20.916	308,119	130.47	0.13

Source: compiled by the authors

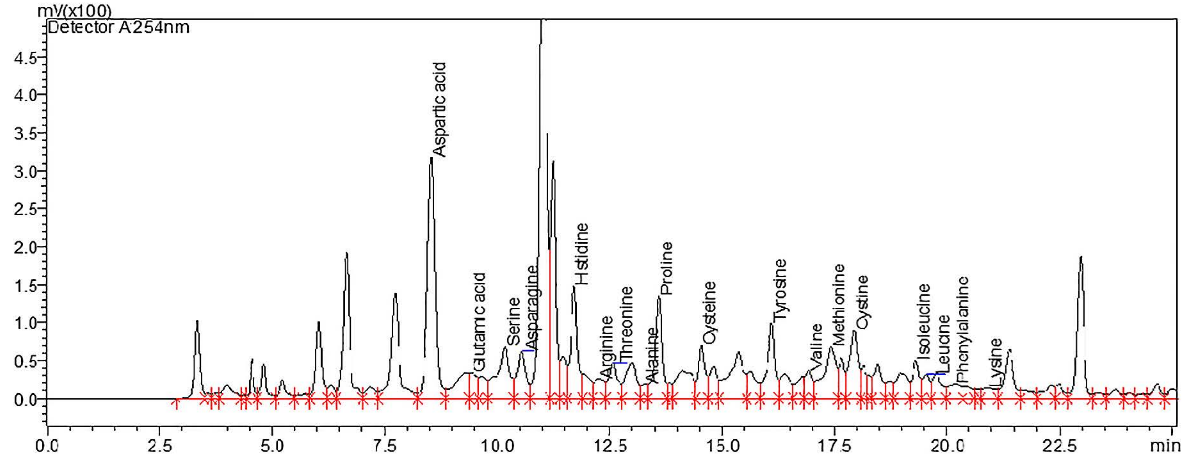

Figure 3. Amino acid composition of chickpeas of the 'Uzbekistan 32' variety
Source: authors' development

Data presented in Table 3 and Figure 3 indicate that 'Uzbekistan 32' possesses a lower overall amino acid profile than its counterparts, save for tyrosine. Notably, although aspartic acid reached its peak concentration at 2.74 g/100 g within this variety, this figure remains the lowest observed among the three varieties compared. This variety has the highest tyrosine content (0.65 g/100 g). The glutamic acid content (0.20 g/100 g) in this sample is significantly lower than in the other two varieties. The cystine content (1.53 g/100 g) is also the lowest among the three varieties. The lysine content (0.13 g/100 g) is average compared to 'Yulduz' (0.09) and 'Kyrgyz Local' (0.14). The 'Uzbekistan 32' variety showed good results in terms of leucine content in the grain. An analysis of the amino acid composition of chickpea grains of the 'Yulduz', 'Kyrgyz Local' and 'Uzbekistan 32' varieties using high-performance liquid chromatography revealed significant differences in the content of certain amino acids, which determine their potential nutritional value. All three varieties studied contain significant amounts of amino acids, confirming the status of chickpeas as an important source of plant protein. Eighteen amino acids were identified in the protein of the varieties studied, the content of which varies depending on the genotype.

Among the essential amino acids, methionine is of particular interest, as its content varied in the samples studied. The highest methionine content was found in the 'Kyrgyz Local' variety (0.85 g/100 g), followed by 'Yulduz' (0.80 g/100 g) and 'Uzbekistan 32' (0.72 g/100 g). These values are consistent with the data of other researchers: for example, S. Onder *et al.* (2023) report methionine content in Turkish chickpea varieties ranging from 0.65 to 0.68 g/100 g, which confirms the deficiency of sulphur-containing amino acids characteristic of legumes. N. Wang & J. Daun (2004) note that common legumes, including chickpeas, field peas, lentils and beans, contain about 1.0 g of methionine and cysteine per 16 g of nitrogen. According to FAO/WHO/UNU requirements, most chickpea varieties are deficient in methionine, which necessitates combining them with protein sources rich in sulphur-containing amino acids (Onder *et al.*, 2023).

The lysine content in the samples studied was relatively low, amounting to 0.09 g/100 g in the 'Yulduz' variety, 0.13 g/100 g in the 'Uzbekistan 32' variety, and 0.14 g/100 g in the 'Kyrgyz Local' variety. These data contrast with the results of studies in other regions. In Pakistani chickpea varieties, according to A. Iqbal *et al.* (2006), lysine was one of the dominant essential amino acids (7.2% of protein), second only to leucine (8.7% of protein) and arginine (8.3% of protein). Turkish studies have shown that lysine is one of the three most common amino acids in chickpea protein isolates, along with glutamic and aspartic acids (Arik Kibar & Aslan, 2024). Studies by international authors confirm significant variability in the amino acid composition of chickpeas depending on the genotype. Turkish scientists have found significant differences in the content of hydrophobic amino acids between varieties: the 'Yasa' variety contained 32% hydrophobic amino acids, while in other isolates their share was about 28% (Onder *et al.*, 2023). The mass fraction of essential amino acids in chickpea protein isolates obtained by various extraction methods in the study by E. Arik Kibar & Ö. Aslan (2024) was 39.5-41.3 g/100 g. S. Grewal *et al.* (2023) demonstrated that the amino acid profile of chickpea genotypes with different protein contents shows a significantly higher average amino acid score for all essential amino acids compared to the WHO recommended values and is comparable to that of complete protein sources, allowing chickpeas to be considered a complete protein source.

It is important to note that the deficiency of sulphur-containing amino acids in chickpeas can be compensated for by combining them with cereal crops rich in methionine and cysteine. This practice is widespread in Asian countries, where legumes are traditionally consumed together with cereals, which allows the body's daily requirement for essential amino acids to be met (Zia-Ul-Haq *et al.*, 2007). A comparative analysis of various legumes showed that *Vigna unguiculata* (cowpea) is the richest in total essential amino acids, while *Cicer arietinum* (chickpea) has lower levels. Similarly, *Glycine max* (soybean) surpasses chickpea in terms of the total amount of replaceable and total amino acids (Köse *et al.*, 2024). The results obtained demonstrate that the protein of the studied chickpea varieties is characterised by a diverse amino acid composition, including 18 identified amino acids, the content of which varies significantly depending on the variety. The identified differences determine the specific nutritional characteristics of each variety and their potential for use in the development of functional foods.

Conclusions

A study of the amino acid composition of three varieties of chickpea (*Cicer arietinum* L.) – 'Kyrgyz Local', 'Uzbekistan 32' and 'Yulduz' – cultivated in the Kyrgyz Republic revealed significant varietal differences in their biochemical profiles. The differences in amino acid composition confirm that varietal characteristics and, possibly, growing conditions affect the chemical composition of chickpeas. Analysis performed by high-performance liquid chromatography with pre-column derivatisation with phenylisothiocyanate showed that the dominant amino acids in all samples are aspartic acid (content 2.74-3.69 g/100 g) and cystine (1.53-2.70 g/100 g), which confirms the high level of non-polar and sulphur-containing components in chickpea protein. The 'Yulduz' variety stands out for its maximum content of histidine (1.62 g/100 g) and methionine (0.80 g/100 g), as well as aspartic acid (3.69 g/100 g) and cystine (2.70 g/100 g), demonstrating excellent amino acid potential for enriching diets. The 'Kyrgyz Local' variety has the highest content of methionine (0.85 g/100 g), glutamic acid (0.78 g/100 g) and arginine (0.42 g/100 g), which makes it promising for improving soil nitrogen balance and nutrition. The 'Uzbekistan 32' variety is characterised by peak values of aspartic acid (2.74 g/100 g), cystine (1.53 g/100 g) and tyrosine (0.65 g/100 g), although it shows lower values for methionine (0.72 g/100 g).

Despite the overall high concentration of essential amino acids such as leucine (0.19-0.37 g/100 g), valine (0.20-0.26 g/100 g) and phenylalanine (0.21-0.31 g/100 g), the lysine content remains a limiting factor – from 0.09 g/100 g in 'Yulduz' to 0.14 g/100 g in 'Kyrgyz Local', which requires combining with cereals to achieve a complete profile. These results are consistent with global data on chickpeas as a valuable source of plant protein, but highlight the need for local biofortification to increase the level of sulphur-containing amino acids. The research results suggest that chickpeas have significant amino acid potential for strengthening food security and transitioning to sustainable nutrition in Kyrgyzstan. The high protein content with a favourable amino acid profile, combined with the agroecological sustainability of the crop, makes chickpeas a strategically important resource. Further research is needed on the amino acid composition of chickpea protein depending on other agronomic practices, including the influence of predecessors, fertilisers, sowing dates and rates.

Acknowledgements

None.

Funding

None.

Conflict of Interest

None.

References

[1] Arik Kibar, E.A., & Aslan, Ö. (2024). Ultrasound-assisted extraction of chickpea proteins and their functional and technological properties. *Food Technology and Biotechnology*, 62(4), 488-500. doi: 10.17113/ftb.62.04.24.8502.

[2] Asanaliev, A.Zh., Sultanbaeva, V.A., Khegay, S.V., & Sodombekov, I.S. (2017). Chickpea productivity depending on sowing dates and patterns in the foothill zone of the Chui Valley. *Advances in Modern Natural Science*, 3, 46-50.

[3] Aschemann-Witzel, J., Gantriis, R.F., Fraga, P., & Perez-Cueto, F.J.A. (2021). Plant-based food and protein trend from a business perspective: Markets, consumers, and the challenges and opportunities in the future. *Critical Reviews in Food Science and Nutrition*, 61(18), 3119-3128. doi: 10.1080/10408398.2020.1793730.
[4] Chang, Y.W., Alli, I., Konishi, Y., & Ziomek, E. (2011). Characterization of protein fractions from chickpea (*Cicer arietinum* L.) and oat (*Avena sativa* L.) seeds using proteomic techniques. *Food Research International*, 44(9), 3094-3104. doi: 10.1016/j.foodres.2011.08.001.
[5] Convention on Biological Diversity. (1992, June). Retrieved from https://www.cbd.int/.
[6] Dhaliwal, S.K., Salaria P., & Kaushik, P. (2021). Pea seed proteins: A nutritional and nutraceutical update. In J.C. Jimenez-Lopez (Ed.), *Grain and seed proteins functionality* (Chapter 7). London: IntechOpen. doi: 10.5772/intechopen.95323.
[7] FAOSTAT. (n.d.). *Crops and livestock products*. Retrieved from https://www.fao.org/faostat/en/#data/QCL.
[8] Glusac, J., Isaschar-Ovdat, S., & Fishman, A. (2020). Transglutaminase modifies the physical stability and digestibility of chickpea protein-stabilized oil-in-water emulsions. *Food Chemistry*, 315, article number 126301. doi: 10.1016/j.foodchem.2020.126301.
[9] GOST 31640-2012. (2020). *Feed. Methods for determining dry matter content*. Retrieved from https://meganorm.ru/Data/523/52337.pdf.
[10] Grewal, S.K., *et al*. (2023) Characterization of chickpea cultivars and trait specific germplasm for grain protein content and amino acids composition and identification of potential donors for genetic improvement of its nutritional quality. *Plant Genetic Resources*, 20(6), 383-393. doi: 10.1017/S147926212300028X.
[11] International Seed Testing Association (ISTA). (n.d.). *International rules for seed testing*. Retrieved from https://www.seedtest.org/en/publications/international-rules-seed-testing.htmL.
[12] Iqbal, A., Ateeq, N., Khalil, I.A., Perveen, S., & Saleemullah, S. (2006). Physicochemical characteristics and amino acid profile of chickpea cultivars grown in Pakistan. *Journal of Foodservice*, 17, 94-101. doi: 10.1111/j.1745-4506.2006.00024.x.
[13] Köse, N., Karatas, F., & Saydam, S. (2024). Comparison of total protein and amino acid content of some legumes types. *MW Journal of Science*, 1(3), 8-17. doi: 10.5281/zenodo.14582470.
[14] Koul, B., Sharma, K., Sehgal, V., Yadav, D., Mishra, M., & Bharadwaj, C. (2022). Chickpea (*Cicer arietinum* L.) biology and biotechnology: From domestication to biofortification and biopharming. *Plants*, 11(21), article number 2926. doi: 10.3390/plants11212926.
[15] Liu, K., Bandara, M., Hamel, C., Knight, J.D., & Gan, Y. (2020). Intensifying crop rotations with pulse crops enhances system productivity and soil organic carbon in semi-arid environments. *Field Crops Research*, 248, article number 107657. doi: 10.1016/j.fcr.2019.107657.
[16] Ministry of Water Resources, Agriculture and Processing Industry of the Kyrgyz Republic (n.d.). Retrieved from https://agro.gov.kg/.
[17] National Statistical Committee of the Kyrgyz Republic (NSCKR). (n.d.). Retrieved from https://stat.gov.kg/en/.
[18] Olagunju, A.I., Omoba, O.S., Enujiugha, V.N., Alashi, A.M., & Aluko, R.E. (2018). Antioxidant properties, ACE/renin inhibitory activities of pigeon pea hydrolysates and effects on systolic blood pressure of spontaneously hypertensive rats. *Food Science & Nutrition*, 6(7), 1879-1889. doi: 10.1002/fsn3.740.
[19] Onder, S., Karaca, A.C., Ozcelik, B., Alamri, A.S., Ibrahim, S.A., & Galanakis, C.M. (2023). Exploring the amino-acid composition, secondary structure, and physicochemical and functional properties of chickpea protein isolates. *ACS Omega*, 8(1), 1486-1495. doi: 10.1021/acsomega.2c06912.
[20] Pankina, I.A., & Borisova, L.M. (2016). Grain legumes' swelling and solubility of their dry solids. *Scientific Journal of ITMO University. Processes and Food Production Equipment*, 2, 13-20. doi: 10.17586/2310-1164-2016-9-2-13-20.
[21] Patil, N.D., Bains, A., Sridhar, K., Bhaswant, M., Kaur, S., Tripathi, M., Lanterbecq, D., Chawla, P., & Sharma, M. (2024). Extraction, modification, biofunctionality, and food applications of chickpea (*Cicer arietinum*) protein: An up-to-date review. *Foods*, 13(9), article number 1398. doi: 10.3390/foods13091398.
[22] Roy, F., Boye, J.I., & Simpson, B.K. (2010). Bioactive proteins and peptides in pulse crops: Pea, chickpea and lentil. *Food Research International*, 43(2), 432-442. doi: 10.1016/j.foodres.2009.09.002.
[23] Salaria, S., Boatwright, J.L., Johnson, N., Madurapperumage, A., Joshi, P., Thavarajah, P., Vandemark, G., & Thavarajah, D. (2023). Fatty acid composition and genome-wide associations of a chickpea (*Cicer arietinum* L.) diversity panel for biofortification efforts. *Scientific Reports*, 13, article number 14002. doi: 10.1038/s41598-023-41274-3.
[24] Torutaeva, E., Asanaliev, A., Prieto-Linde, M.L., Zborowska, A., Ortiz, R., Bryngelsson, T., & Garkava-Gustavsson, L. (2014). Evaluation of microsatellite-based genetic diversity, protein and mineral content in chickpea accessions grown in Kyrgyzstan. *Hereditas*, 151, 81-90. doi: 10.1111/hrd2.00042.
[25] Wang, N., & Daun, J.K. (2004). The chemical composition and nutritive value of Canadian pulses. *Canadian Grain Commission Report*, 28, 19-29.

[26] Xu, W., McClements, D.J., Xu, Z., Meng, M., Zou, Y., Chen, G., Jin, Z., & Chen, L. (2024). Optimization of emulsion properties of chickpea protein and its application in food. *Journal of the American Oil Chemists' Society*, 101(10), 971-980. doi: 10.1002/aocs.12816.
[27] Yeasmen, N., & Orsat, V. (2025). Industrial processing of chickpeas (*Cicer arietinum*) for protein production. *Crop Science*, 65, article number e21361. doi: 10.1002/csc2.21361.
[28] Zia-Ul-Haq, M., Iqbal, S., Ahmad, S., Imran, M., Niaz, A., & Bhanger, M.I. (2007). Nutritional and compositional study of desi chickpea (*Cicer arietinum* L.) cultivars grown in Punjab, Pakistan. *Food Chemistry*, 105(4), 1357-1363. doi: 10.1016/j.foodchem.2007.05.004.
[29] Zotikov, V.I., Naumkina, T.S., Sidorenko, V.S., Gryadunova, N.V., & Naumkin, V.V. (2016). Leguminous crops – an important factor in sustainable, environmentally-oriented agriculture. *Legumes and Groat Crops*, 17(1), 6-13.

Кыргыз Республикасында өстүрүлгөн нокот сортторунун (*Cicer arietinum* L.) данынын аминокислоталык курамы

Жылдыз Батырбашиева
PhD докторант
И. Раззаков атындагы Кыргыз мамлекеттик техникалык университети
720044, Ч. Айтматов просп., 66, Бишкек ш., Кыргыз Республикасы
https://orcid.org/0009-0002-8718-5855

Абдыбек Асаналиев
Айыл чарба илимдеринин доктору, профессор
К.И. Скрябин атындагы Кыргыз улуттук агрардык университети
720005, Медеров көч., 68, Бишкек ш., Кыргыз Республикасы
https://orcid.org/0000-0002-3075-823X

Алмаз Иманалиев
Токой чарбасы жана мөмө-жемиш өстүрүү кафедрасынын башчысы
К.И. Скрябин атындагы Кыргыз улуттук агрардык университети
720005, Медеров көч., 68, Бишкек ш., Кыргыз Республикасы
https://orcid.org/0000-0003-1710-9187

Виктория Султанбаева
Айыл чарба илимдеринин кандидаты, доцент
К.И. Скрябин атындагы Кыргыз улуттук агрардык университети
720005, Медеров көч., 68, Бишкек ш., Кыргыз Республикасы
https://orcid.org/0000-0002-8914-8778

Аннотация. Нокот (*Cicer arietinum* L.) өсүмдүк протеининин маанилүү булагы болуп саналат; бирок, Кыргыз Республикасында өстүрүлгөн сорттордун биохимиялык курамы боюнча маалыматтар чектелүү. Бул изилдөөнүн максаты өлкөдө өстүрүлгөн үч нокот сортунун ('Кыргыз жергиликтүү', 'Өзбекистан 32' жана 'Жылдыз') данынын аминокислота курамын аныктоо жана алардын азыктык баалуулугун аныктоо болгон. Орточо үлгүлөр 2024-жылдагы түшүмдөн ISTAнын ыкмасы боюнча чогултулган. Аминокислота анализи фенил изотиоцианат менен алдын ала колонка дериватизациясы менен кислота гидролизинен кийин жогорку натыйжалуу суюк хроматография (HPLC) аркылуу жүргүзүлдү. Изилдөө айрым аминокислоталардын курамы боюнча олуттуу сорттук айырмачылыктарды аныктады. Метиониндин эң жогорку курамы 'Кыргыз жергиликтүү' сортунда (0,85 г/100 г), андан кийин 'Жылдыз' (0,80 г/100 г) жана 'Өзбекистан 32' (0,72 г/100 г) сортунда катталган. Лизиндин курамы 0,09 г/100 г-дан ('Жылдыз') 0,14 г/100 г-га ('Кыргыз жергиликтүү') чейин өзгөрүп турган. Бардык үлгүлөрдөгү басымдуу аминокислоталар аспарагин кислотасы (2,74-3,69 г/100 г) жана цистин (1,53-2,70 г/100 г) болгон. 'Жылдыз' сорту гистидиндин максималдуу курамын (1,62 г/100 г) жана 'Өзбекистан 32' тирозинди (0,65 г/100 г) көрсөткөн. Алынган жыйынтыктар нокоттун жагымдуу аминокислота профилине ээ болгон өсүмдүк протеининин баалуу булагы макамын тастыктайт жана Кыргыз Республикасында тең салмактуу тамактанууну жана функционалдык азыктарды иштеп чыгууда колдонулушу мүмкүн

Негизги сөздөр: биохимиялык профиль; белок; жогорку натыйжалуу суюктук хроматографиясы; лизин; метионин; аргинин

Аминокислотный состав зерна сортов нута (*Cicer arietinum* L.), культивируемых в Кыргызской Республике

Жылдыз Батырбашиева
PhD докторант
Кыргызский государственный технический университет им. И. Раззакова
720044, просп. Ч. Айтматова, 66, г. Бишкек, Кыргызская Республика
https://orcid.org/0009-0002-8718-5855

Абдыбек Асаналиев
Доктор сельскохозяйственных наук, профессор
Кыргызский национальный аграрный университет им. К.И. Скрябина
720005, ул. Медерова, 68, г. Бишкек, Кыргызская Республика
https://orcid.org/0000-0002-3075-823X

Алмаз Иманалиев
Заведующий кафедрой лесоводства и плодоводства
Кыргызский национальный аграрный университет им. К.И. Скрябина
720005, ул. Медерова, 68, г. Бишкек, Кыргызская Республика
https://orcid.org/0000-0003-1710-9187

Виктория Султанбаева
Кандидат сельскохозяйственных наук, доцент
Кыргызский национальный аграрный университет им. К.И. Скрябина
720005, ул. Медерова, 68, г. Бишкек, Кыргызская Республика
https://orcid.org/0000-0002-8914-8778

Аннотация. Нут (*Cicer arietinum* L.) является важным источником растительного белка, однако данные о биохимическом составе сортов, культивируемых в Кыргызской Республике, ограничены. Целью исследования было определение аминокислотного состава зерна трех сортов нута (‘Кыргызский местный’, ‘Узбекистанский 32’ и ‘Юлдуз’), выращиваемых в республике, для оценки их пищевой ценности. Средние образцы отбирали согласно методике ISTA с урожая 2024 года. Аминокислотный анализ проводили методом высокоэффективной жидкостной хроматографии (ВЭЖХ) после кислотного гидролиза с предколоночной дериватизацией фенилизотиоцианатом. Исследование выявило существенные сортовые различия в содержании отдельных аминокислот. Наибольшее содержание метионина зафиксировано в сорте ‘Кыргызский местный’ (0,85 г/100 г), за которым следуют ‘Юлдуз’ (0,80 г/100 г) и ‘Узбекистанский 32’ (0,72 г/100 г). Содержание лизина варьировало от 0,09 г/100 г (‘Юлдуз’) до 0,14 г/100 г (‘Кыргызский местный’). Доминирующими аминокислотами во всех образцах были аспарагиновая кислота (2,74-3,69 г/100 г) и цистин (1,53-2,70 г/100 г). Сорт ‘Юлдуз’ продемонстрировал максимальное содержание гистидина (1,62 г/100 г), а ‘Узбекистанский 32’ – тирозина (0,65 г/100 г). Полученные результаты подтверждают статус нута как ценного источника растительного белка с благоприятным аминокислотным профилем и могут быть использованы при разработке сбалансированных рационов питания и функциональных пищевых продуктов в условиях Кыргызской Республики

Ключевые слова: биохимический профиль; белок; высокоэффективная жидкостная хроматография; лизин; метионин; аргинин