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STUDY OF THE AMINO ACIDS COMPOSITION OF KOCHIA SCOPARIA (L.) SCHRAD

Actuality*. Kochia scoparia (L.) Schrad is an herbaceous, xerophytic, ornamental plant that belongs to the family Amaranthaceae Juss. In the traditional medicine of China, Japan and Korea, the fruits of Kochia scoparia (L.) Schrad are used to the treatment of skin diseases, eczema, rubella, diabetes, enuresis and rheumatoid arthritis. Extracts from the aerial parts are recommended as hypoglycemic, antinociceptive, anti-inflammatory and anti-allergic agents. According to the literature, Kochia scoparia (L.) Schrad. accumulate triterpenoid glycosides, alkaloids, saponins, and essential oil. However, there is a little information in the literature about the amino acid composition of Kochia scoparia (L.) Schrad.*

The purpose of the work. *The aim of the work was the study of the qualitative composition and determination of the quantitative content of amino acids in the herb of Kochia scoparia (L.) Schrad.*

Materials and methods. *Dried and crushed herb of Kochia scoparia (L.) Schrad. were used to study the amino acid composition. Raw materials were harvested in 2020-2021 in the Kharkiv region. Identification and quantification of amino acids was performed by ion-exchange liquid-column chromatography on an automatic amino acid analyzer T 339.*

Results and discussions. *As a result of the analysis, 18 amino acids were identified in the Kochia scoparia (L.) Schrad herb, 9 of them are classified as essential. The total content of amino acids in herbal drug was 685.69 mg/g. Glutamic (207.62 mg/g) and aspartic (120.94 mg/g) acids prevailed in the Kochia scoparia (L.) Schrad herb quantitatively. Leucine (52.52 mg/g), lysine (46.11 mg/g) and phenylalanine (32.96 mg/g) dominated among essential amino acids in the herb of this plant.*

Conclusions. *The obtained results make it possible to deepen the knowledge about the chemical composition of Kochia scoparia (L.) Schrad. and indicate the prospects for the use of medicinal herbal drugs of this plant as a potential source of herbal medicinals.*

Key words: *Kochia scoparia (L.) Schrad, Amaranthaceae Juss., amino acids, ion-exchange liquid-column chromatography, qualitative and quantitative analysis.*

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ВИВЧЕННЯ АМІНОКИСЛОТНОГО СКЛАДУ КОХІЇ ВІНИЧНОЇ

Актуальність*. Кохія вінична (Kochia scoparia (L.) Schrad) – трав'яниста, ксерофітна декоративна рослина, яка належить до родини амарантових. У традиційній медицині Китаю, Японії та Кореї плоди кохії віничної використовують під час лікування захворювань шкіри, екземи, краснухи, цукрового діабету, енурезу та ревматоїдного артриту; екстракти з надземної частини рекомендують як гіпоглікемічний, антиноцицептивний, протизапальний та протиалергійний засіб. Відомо, що кохія вінична накопичує тритерпеноїдні глікозиди, алкалоїди, сапоніни та ефірну олію. Проте інформації стосовно амінокислотного складу кохії віничної у літературі вкрай мало.*

Мета дослідження *– вивчення якісного складу та визначення кількісного вмісту амінокислот у траві кохії віничної.*

Матеріал і методи. *Для вивчення амінокислотного складу трави кохії віничної використовували висушену та подрібнену сировину, яку заготовляли у 2020–2021 рр. у Харківській області. Ідентифікацію та визначення кількісного вмісту амінокислот проводили методом іонообмінної рідинно-колонкової хроматографії на автоматичному аналізаторі амінокислот Т 339.*

Результати дослідження. *У результаті дослідження у траві кохії віничної ідентифіковано 18 амінокислот, із яких дев'ять належать до незамінних. Загальний уміст амінокислот у цій сировині становив 685,69 мг/г. Кількісно у траві кохії віничної переважали замінні глутамінова (207,62 мг/г) та аспарагінова (120,94 мг/г) кислоти. Серед незамінних амінокислот домінували лейцин (52,52 мг/г), лізин (46,11 мг/г) та фенілаланін (32,96 мг/г).*

Висновок. *Одержані результати дають змогу поглибити знання стосовно хімічного складу кохії віничної та свідчать про перспективність використання цієї рослини як потенційного джерела лікарських рослинних засобів.*

Ключові слова: *кохія вінична, амарантові, амінокислоти, іонообмінна рідинно-колонкова хроматографія, якісний та кількісний аналіз.*

Introduction. Amino acids are the basis of all protein compounds that are synthesized in the body. Almost all organs and tissues consist of proteins. In addition, blood plasma, antibodies, hormones and enzymes are also protein compounds that are formed by amino acids. They are necessary for the restoration of cells, the formation of neurotransmitters, the maintenance of the balance of fluids in the body, the regulation of the secretory function of the digestive glands, the normalization of cholesterol metabolism, and the protection of the body against the action of free radicals (Gairola, 2010; Nisreen, 2019; Hou, 2018).

Glutamic acid is known to be a neurotransmitter compound that stimulates the transmission of impulses in the synapses of the central nervous system, contributes to the detoxification and removal of ammonia from the body and the formation of acetylcholine and ATP (Gairola, 2010). Aspartic acid stimulates the production of growth hormone, testosterone and progesterone, normalizes the functioning of the nervous and endocrine systems (Gairola, 2010). Arginine and carnitine have a positive effect on the work of the heart muscle and they improve memory (Riaz, 2017). Glycine accelerates metabolic processes in brain tissues, has sedative and antioxidant properties (Hou, 2018). Ornithine promotes the production of insulin and somatotropic hormone, normalizes the acid-alkaline balance (Gairola, 2010). Taurine accelerates reparative processes (Riaz, 2017).

Essential amino acids are compounds that are not produced in the body, but are vital for its full functioning. These compounds include tryptophan, leucine, lysine, methionine, phenylalanine, isoleucine, valine, and threonine (Hou, 2015). Tryptophan is necessary for the synthesis of vitamins and neurotransmitters, in particular, serotonin, regulates blood pressure, has anti-depressant and pain-relieving properties (Nisreen, 2019). Leucine promotes the regeneration of connective tissue and normalizes the level of sugar in the blood (Hou, 2015; Hou, 2018). Lysine is necessary for the assimilation of calcium and the prevention of the appearance of atherosclerotic plaques in blood vessels (Nisreen, 2019). Adrenaline, sex hormones and cyanocobalamin are synthesized in the body with the participation of methionine. It also normalizes lipid metabolism (Hou, 2015). Phenylalanine is a precursor of the neurotransmitters dopamine and norepinephrine. This amino acid improves memory, cognitive properties, mood, reduces pain, suppresses appetite, and stimulates libido (Hou, 2018). Isoleucine is necessary for the synthesis of hemoglobin, it promotes the regeneration of muscle tissue (Riaz, 2017). Valine is a source of energy for myocytes (Hou, 2015). Threonine participates in fat metabolism, contributes to the formation of collagen, elastin and antibodies (Hou, 2015).

One of the important tasks of modern pharmacy is the search for new sources of BAC for the creation of drugs based on them with different pharmacological directions. Plants of the genus *Kochia* Roth can be classified as promising and understudied plants. *Kochia scoparia* (L.) Schrad. (syn. *Kochia alata* Bates, syn. *Bassia scoparia* (L.) A.J. Scott) is an annual, herbaceous, xerophytic, ornamental plant (Seitimova, 2016). Scientists have conflicting views on the issue of taxonomy of plants of the *Kochia* Roth genus. Most scientists believe that these plants belong to *Amaranthaceae* Juss. (Wei, 2021; Todorović, 2022). However, some adhere to the outdated classification and refer them to the family *Chenopodiaceae* Vent. (Seitimova, 2016; El-Shamy, 2012; Kumar, 2019).

In traditional Chinese medicine, the fruits of *Kochia scoparia* (L.) Schrad are used to treat skin diseases, eczema, rubella, diabetes, enuresis and rheumatoid arthritis (El-Shamy, 2012; Seitimova, 2016). In Korean and Japanese traditional medicine, extracts from the above-ground part of this plant are recommended to lower serum glucose levels, as an acaricidal agent against *Tetranychus urticae* Koch and an antinociceptive, anti-inflammatory, and anti-allergic agent (El-Shamy, 2012). Kazakh scientists also reported the cardiotonic and diuretic effects of extracts from the aerial part of this plant (Seitimova, 2016). It is known from scientific sources that *Kochia scoparia* (L.) Schrad accumulates triterpenoid glycosides, alkaloids, saponins and essential oil, the main components of which are terpenoids (El-Shamy, 2012). The stems and leaves of this plant contain essential nutrients such as protein, fiber, carbohydrates, as well as carotenoids, ascorbic and nicotinic acids, thiamin, riboflavin and trace elements (Al-Snafi, 2018). There is very little information on the amino acid composition of *Kochia scoparia* (L.) Schrad in the literature. It is known

that about 19 amino acids accumulate in the seeds of this plant, including tryptophan, tyrosine, phenylalanine, methionine, glutamine, ornithine, cysteine, asparagine, lysine, leucine and threonine (Wei, 2021; Houlihan et al., 2019). A group of Kazakh and Pakistani researchers investigated the amino acid composition of a related species of *Kochia prostrata*. During the analysis, 20 amino acids were identified in the aerial part of this plant, including ornithine and oxyproline. Arginine (3.32%) and leucine (3.20%) prevailed among the essential amino acids in this raw material (Seitimova, 2016). Therefore, the study of the amino acid composition of the *Kochia scoparia* (L.) Schrad herb for its in-depth study is relevant.

The purpose of our study. The purpose of the study was the study of the qualitative composition and determination of the quantitative content of amino acids of the *Kochia scoparia* (L.) Schrad herb.

Research materials and methods. For conducting the experiment, we used air-dried herb of the *Kochia scoparia* (L.) Schrad, harvested in 2020–2021 in the Kharkiv region. The identification and determination of the quantitative content of amino acids wer carried out by the method of ion-exchange liquid column chromatography on an automatic amino acid analyzer T 339 in the hydrolysates of the *Kochia scoparia* (L.) Schrad herb. The hydrolysate was prepared using 1.0 g (exact weight) of raw material of the *Kochia scoparia* (L.) Schrad and 6 N hydrochloric acid solution. After removal of hydrochloric acid, the dry residue was dissolved in 0.3 N lithium-citrate buffer with a pH of 2.2 and applied to an ion exchange column of an amino acid analyzer. Photocell signals were recorded by a self-recording potentiometer in the form of chromatograms. The area of the peaks on the chromatograms was calculated and compared with the area of the peaks of amino acids with a known concentration, based on which the absolute amount of each amino acid in the analyzed sample was calculated (Kyslychenko, 2019; Alrikabi, 2021).

Amino acid content in μM (X_1) was calculated according to the formula:

$$X_1 = S_1 / S_o,$$

where S_1 – the area of the amino acid peak in the studied sample; S_o – the peak area of the amino acid in a solution of standard amino acids, the amount of each amino acid in which corresponds to 1 μM.

To express the content in mg, the obtained amount of μM amino acid was multiplied by its corresponding molecular weight (Kyslychenko, 2019; Alrikabi, 2021).

Research results and discussion. In the course of the experiment, 18 amino acids were identified in the cochineal herb, of which 9 were classified as essential (lysine, histidine, arginine, threonine, valine, methionine, isoleucine, leucine, and phenylalanine). The qualitative composition and quantitative content of amino acids in the herb of the *Kochia scoparia* (L.) Schrad are shown in the table 1.

Table 1

Qualitative composition and quantitative content of amino acids in the *Kochia scoparia* (L.) Schrad herb

Amino acids	Content of amino acid, mg/g
Substitutable amino acids	
Gamma-aminobutyric acid	3.16 ± 0.08
Aspartic acid	120.94 ± 0.57
Serine	17.80 ± 0.45
Glutamic acid	207.62 ± 5.19
Proline	30.49 ± 0.76
Glycine	10.68 ± 0.52
Alanine	30.86 ± 1.27
Cystine	1.97 ± 0.05
Tyrosine	53.77 ± 0.59
Essential amino acids	
Lysine	46.11 ± 0.65
Histidine	14.76 ± 0.37
Arginine	23.17 ± 1.01
Threonine	1.36 ± 0.03
Valine	15.57 ± 0.39
Methionine	4.44 ± 0.11
Isoleucine	17.51 ± 0.69
Leucine	52.52 ± 0.88
Phenylalanine	32.96 ± 0.57
The sum of essential amino acids	208.40 ± 5.21
The sum of identified amino acids	685.69 ± 17.4

The total content of amino acids in the herb of the *Kochia scoparia* (L.) Schrad was 685.69 mg/g. About a third of them were essential amino acids (208.40 mg/g).

Glutamic acid was accumulated in the most amount in the studied raw material. Its content was 207.62 mg/g. The content of aspartic acid (120.94 mg/g) was almost twice as low. Tyrosine (53.77 mg/g) was accumulated almost 4 times less than glutamic acid in *Kochia scoparia* (L.) Schrad herb. The content of alanine (30.86 mg/g) and proline (30.49 mg/g) was almost at the same level. Leucine prevailed among the essential amino acids in the studied object. Its content was 52.52 mg/g. The content of lysine was slightly lower and amounted to 46.11 mg/g. The content of arginine (23.17 mg/g) was almost twice as low as the content of lysine in this object. Phenylalanine (32.96 mg/g) accumulated in the studied raw materials almost 1.5 times less than leucine. The content of valine (15.57 mg/g), histidine (14.76 mg/g) and isoleucine (17.51 mg/g) in the *Kochia scoparia*

(L.) Schrad herb did not differ much. These compounds contained almost three times less than leucine. The content of serine and glycine ranged from 10 to 25 mg/g. The content of gamma-aminobutyric acid, cysteine, methionine and threonine did not exceed 5 mg/g.

Conclusions. Using the method of ion-exchange liquid column chromatography, 18 amino acids were identified in the herb *Kochia scoparia* (L.) Schrad, 9 of them were essential. The total content of amino acids in the *Kochia scoparia* (L.) Schrad herb was 685.69 mg/g. About a third of them were essential amino acids (208.40 mg/g).

Substitutable glutamic (207.62 mg/g) and aspartic (120.94 mg/g) acids prevailed quantitatively in the *Kochia scoparia* (L.) Schrad herb. A high content of alanine (50.86 mg/g) in this raw material was noted. Among essential amino acids, leucine (52.52 mg/g), lysine (46.11 mg/g) and phenylalanine (32.96 mg/g) prevailed.

The obtained results do not contradict the data of the literature, but complement and clarify them. The results of the study indicate the promising development of new medicines based on raw material of the *Kochia scoparia* (L.) Schrad.

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