Amino acid composition of species of the genus Atriplex L. growing in the Aral Sea (Uzbekistan)

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Abstract. The largest number of plant cover species on saline soils of Uzbekistan belongs to the family *Chenopodiaceae* Vent. Plant origin is a promising and accessible source for isolating substances containing amino acids. In this regard, we conducted studies on the study of the amino acid and elemental composition of *Atriplex aucheri Moq*. plants and *Atriplex tatarica* L. The ability to withstand the type of stress factors is necessary and survival in this environment requires a profound restructuring of plant metabolism, photosynthesis and transpiration, as well as the biosynthesis of adaptogenic substances. Therefore, these plants are potential candidates for the creation of new biologically active substances, stress-protective combinations of macro and microelements, which may be promising for further biotechnological, agricultural and biomedical use. As a result of the analysis, 20 free amino acids were identified in the studied species of the genus *Atriplex*, of which 10 are essential - threonine, arginine, valine, methionine, isoleucine, histidine, tryptophan, phenylalanine, lysine, leucine. Comparison of the content of amino acids showed that the amount of methionine was the highest in both species.

1 Introduction

The beneficial properties of medicinal plants are due to the content of macro- and microelements in their composition, as well as a variety of biologically active substances with high physiological activity, pronounced organ-protective, and biostimulating properties.

Currently, one of the most promising areas for the creation of new drugs is the search for physiologically active compounds through the synthesis and chemical study of plant objects. Most of the Republic of Uzbekistan has arid territories; more than 300 species of halophytic plants have been registered on saline soils of the republic, including 187 species from the *Chenopodiaceae* family with different salinity tolerance ranges [1]. The results of numerous experiments indicate that fodder shrubs, subshrubs and annuals from the family. *Chenopodiaceae* are extremely promising for use in the ecological restoration and increase in the productivity of degraded pastoral lands in the arid regions of the world. The cultivation of halophyte plants can contribute to the creation of highly productive long-term pasture communities on secondary saline lands, as well as their effective use as medicinal

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raw materials, since the chemical composition of this family is very diverse and unique. It is represented by various amino acids, carbohydrates, phenolic compounds (flavonoids, isoflavones, xanthones, tannins, etc.), essential oils, etc. [2].

It should be noted that for many valuable halophytes, identification has not been developed at the proper modern level; therefore, the development of molecular biological approaches to the study of medicinal and fodder species of halophytes is relevant. Medicinal plants have certain advantages over synthetic drugs, since when they are used, the body receives a whole complex of biologically active substances, which act more gently, synergistically and have a wider spectrum of action than synthetic drugs and have significantly fewer side effects [3].

In this regard, studies of the component composition of plants growing in the extreme climatic conditions of the chul are promising, for this it is necessary to determine the main classes of biologically active substances, one of which are amino acids, which are the main structural units of the human body and play a huge role in the biosynthesis of biologically active compounds, proteins and peptides.

Taking into account the specific conditions of the Aralkum, we studied the plants of this region and the amount of macro- and microelements contained in them. Biogeochemical studies of vegetation in Uzbekistan were aimed primarily at identifying regional features of the accumulation of microelements and assessing their background concentrations.

In connection with the intensifying process of desertification, the question of the introduction of wild-growing halophytes into the culture and their use for medicinal purposes is acute. The largest number of plant cover species of saline soils in Uzbekistan belongs to the *Chenopodiaceae* family, many of whose representatives have valuable fodder potential and are medicinal [4]. The issue of finding new sources of biologically active substances of plant origin for the development of domestic drugs rich in protein and bioelement composition remains relevant. In this regard, the choice of plants that are potentially promising species for study was also determined: *Atriplex aucheri* and *Atriplex tatarica*, growing in the conditions of the dried bottom of the Aral Sea, to identify the features of the intake and accumulation of amino acids by plants of the genus *Atriplex* in conditions of technogenic pollution and evaluate the possibilities of agricultural practices for obtaining environmentally friendly products.

The young leaves of *Atriplex* species are valuable sources of vitamins and are used in spring (instead of spinach) as green leafy vegetables. The leaves contain organic acids (A. laciniata L.), coumarins and flavonoids (A. rosea L.), alkaloids (A. halimus L.), and phosphatidylglycerol (A. prostrata Baucher ex DC.) [5-6].

Both species of *Atriplex* are annual herbaceous plants, 30–40 cm high. In folk medicine, decoctions and infusions from the aerial parts of both species are used as a diuretic, antibacterial, anti-inflammatory, and choleretic agent [7]. Phenolic compounds (flavonoids and phenolcarboxylic acids), tannins, saponins, alkaloids, triterpenoids were found in plants of some species of the genus *Atriplex*; essential oil and vitamin C are contained in insignificant amounts [8].

2 Materials and methods

The material for the study was the vegetative parts of two Atriplex species, the plants were collected in August on the dried bottom of the Aral Sea 44.135556:58.87, during the flowering period (August, 2022), accumulation of macro- and microelements in it. Gray-brown, sandy, desert and takyr-like automorphic soils are common in this region. All of them are characterized by the absence of sod, the presence of an earthy porous crust on the surface, low humus content (0.3–1.0%), low absorption capacity (6–10 meq/100 g of soil), high carbonate content, and the presence of salt horizons in the profile, which can located at

different depths depending on the features of the hydrothermal regime, hydrogeological and geochemical conditions [9].

Analysis of free amino acids. The isolation of free amino acids was carried out as follows: the dried plant material was extracted with water (hydraulic ratio 1/10) with constant stirring for 8 hours at room temperature. Proteins and peptides were precipitated from the aqueous extract by adding an equal volume of 10% TCA. After 10 min, the precipitate was separated by centrifugation at 8000 rpm. 0.1 ml of the supernatant was freeze-dried.

Determination of free amino acids in the form of their PTC derivatives was carried out by the method of Steven A. and Cohen Daviel J [10]. For the synthesis of PTC (phenylthiocarbomayl) derivatives of amino acids, a solution consisting of TEA + ethanol + water in a ratio of 1:7:1 was prepared and 250 ml were added to the dried samples under study. Kept for 10 min, and evaporated to dryness under vacuum. This step was repeated twice to neutralize the TCAA and to achieve an alkaline reaction medium. Next, a solution was prepared consisting of TEA + ethanol + water + FITC in a ratio of 1:7:1:1 and added to the samples in 250 ml increments. Kept for 30 min, and evaporated to dryness under vacuum. PTC derivatives of standard amino acids were synthesized in a similar way.

Identification of PTC-amino acids. The identification of PTC amino acids was carried out on an Agilent Technologies 1200 series chromatograph with a DAD detector. A 75 x 4.6 mm Discovery HS C_{18}, 3.5 µm column was used. Solution A: 0.14M CH_3COONa + 0.05% TEA pH 6.4, B: CH_3CN. Flow rate 1.2 ml/min, absorbance 269 nm. Gradient %B/min: 1-6%/0-5 min; 6-30%/5.1-40 min; 30-60%/40.1-45 min; 60-1%/45.1-50 min.

Qualitative analysis and quantitative calculation of the concentration of the studied free amino acids were compared with the peak areas of the standard and studied PTC-amino acids.

3 Results and Discussion

In the studied species of the genus *Atriplex*, 20 free amino acids were identified, of which 10 are essential - threonine, arginine, tyrosine, valine, methionine, isoleucine, histidine, tryptophan, phenylalanine, lysine, leucine. Comparison of the content of amino acids showed that in both species the amount of methionine was the highest (Table 1). Further, arginine, cysteine, and tryptophan dominated in *Atriplex aucheri.* In the species *A. tatarica* for methionine - the largest amount was noted - proline, tyrosine, valine.

Thus, in both species, the amount of methionine turned out to be the highest, followed by Arg, Cys, Trp in *A. aucheri*, and Pro, Phr, Ala in *A. tatarica*.

Methionine - improves memory and stops the degeneration of the nervous system in AIDS patients, there is also evidence that the lack of methionine, N-acetylcysteine, glutamine contributes to the development of HIV (human immunodeficiency virus). Also, methionine is used to treat and prevent diseases and toxic liver damage, with atherosclerosis, it can have a moderate antidepressant effect (apparently due to the effect on the synthesis of adrenaline). It occurs in all organisms as part of protein molecules and is part of the opioid enkephalin peptide. Methionine plays an important role in biosynthetic methylation. There is general agreement that L-methionine is a key precursor of the phytohormone ethylene in higher plants.

In combination with other biologically active substances (phenolic compounds, polysaccharides, organic acids, macro- and microelements), the therapeutic significance of the studied species is emphasized, which makes it possible to create new drugs of combined action based on these species.

Natural and climatic factors affect the content of biologically active substances in plants growing on the dried bottom of the Aral Sea exposed to the strongest salt, dehydration

(drought), thermal stress, as well as the parallel effects of many phytopathogenic microorganisms.

Table 1. Content of free amino acids in species of the genus *Atriplex* (RSD ≤3%).

No.	Amino acids	*A. aucheri*	*A. tatarica*
		Quantity, mg/g	
	Non-essential amino acids		
1.	Aspartic acid	0.10	0.11
2.	Glutamine acid	0.33	0.26
3.	Serene	0.06	0.07
4.	Glycine	0.26	0.78
5.	Asparagine	0.25	0.08
6.	Glutamine	0.55	0.31
7.	Cysteine	0.67	0.28
8.	Alanine	0.44	0.34
9.	Proline	0.25	0.79
10.	Tyrosine	0.10	0.27
Sum:		3.01	3.29
Essential amino acids			
11.	Threonine	0.13	0.16
12.	Arginine	0.76	0.29
13.	Valine	0.13	0.24
14.	Methionine	1.13	1.19
15.	Isoleucine	0.08	0.19
16.	Leucine	0.10	0.25
17.	Histidine	0.14	0.12
18.	tryptophan	0.66	0.24
19.	Phenylalanine	0.38	0.37
20.	Lysine	0.19	0.21
Sum:		3.51	3.26
Total:		6.52	6.55

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Natural and climatic factors affect the content of biologically active substances in plants growing on the dried bottom of the Aral Sea exposed to the strongest salt, dehydration (drought), thermal stress, as well as the parallel effects of many phytopathogenic microorganisms.

It is known that plants growing in the Aral Sea, in terms of physiological and biochemical adaptation to adverse environmental factors, acquire the ability to accumulate more protein, carbohydrates and fat. The latter is consistent with the data of K.N. Toderich et al. [9] on an increase in the content of amino acids in the species *A. tatarica* in the pastures of Karakalpakstan. Thus, the collection of plants growing on the bottom of the Aral Sea and their prospect as a source of natural biologically active substances, in our opinion, is quite justified.

4 Conclusion

Thus, the study of two plant species of the genus Atriplex revealed the presence of a sufficiently large amount of amino acids and mineral elements. Both species had the highest content of free methionine. Arg, Cys, and Trp also dominated in *A. aucheri*, while Pro, Phr, and Ala dominated in *A. tatarica*. The studied plants of the genus *Atriplex* are of

particular interest both in scientific and ecological terms, which allows us to consider them as promising for introduction into culture in the Aralkum, and the assumption that plants have a selective ability to accumulate chemical elements has been experimentally confirmed. It has been established that the more microelements with a wide range of concentrations are combined in one plant, the greater the ecological amplitude of the growth of this plant and, as a result, the higher its adaptive capacity in conditions of technogenic pollution of new valuable drugs of combined action.

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