IRSTI 31.23.99 https://doi.org/10.26577/ijbch.2020.v13.i1.20

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Amino acid composition of some plants growing in the conditions of Northern Kazakhstan

Abstract. Using gas chromatography, the amino acid composition of plants of the species *Amaranthus retroflexus L., Atriplex fera L. Bunge, Elytrigia repens L. Nevski, Bassia hyssopifolia (Pall.) Kuntze, Xanthium strumarium L.,* growing in the conditions of Northern Kazakhstan was established. The studied plants contain a number of essential and partially replaceable amino acids, such as lysine, leucine and isoleucine, methionine, valine, threonine, arginine, histidine, tryptophan and phenylalanine. Glutamine amino acid, aspartic acid, alanine, arginine, leucine, and isoleucine are found in the largest quantities. *Xanthium strumarium L.* also contains a large amount of proline. 20 amino acids were detected, including traces of ornithine and hydroxyproline for *Amaranthus retroflexus L., Atriplex fera L., Elytrigia repens L., Xanthium strumarium L.* For plants of the species *Bassia hyssopifolia (Pall.) Kuntze*, the presence of 18 amino acids was recorded and it was noted that the accumulation of amino acids is lower compared to other species that we have previously studied. The amino acid composition of plants growing in the conditions of Northern Kazakhstan has its own characteristics. Differences in the qualitative and quantitative amino acid composition of the studied species were established with known data on plants growing in the climatic conditions of Northern Siberia and Southern Kazakhstan for *Amaranthus retroflexus L., Elytrigia repens L., Xanthium strumarium L.*

Key words: amino acids, *Amaranthus retroflexus L., Atriplex fera L. Bunge, Elytrigia repens L. Nevski, Bassia hyssopifolia (Pall.) Kuntze, Xanthium strumarium L.*

Introduction

In the condition of the agricultural orientation of the Northern region of Kazakhstan, the search of plants with the rich amount of protein and free amino acids, suitable as feed additives for farm animals and raw materials for obtaining of biologically active substances necessary in the medical and food industry, becomes urgent.

The aim of our research was studying of the amino acid composition of some wild plants from the flora of Northern Kazakhstan.

In addition to studying the qualitative and quantitative amino acid composition, the objective of the research was determining differences in the content and component composition of amino acids compared with the available data on plants growing in other geographical conditions.

Amaranthus retroflexus L., Atriplex fera L. Bunge, Elytrigia repens L. Nevski, Bassia hyssopifolia (Pall.) Kuntze, Xanthium strumarium L. growing in the conditions of Northern Kazakhstan were taken as objects of study. All plants are widespread and they form the large raw materials arrays, with *Amaranthus retroflexus L., Atriplex fera L., Elytrigia repens L.* compete. The amino acid composition of *Amaranthus retroflexus L., Elytrigia repens L.* contains numerous data on plants of some climatic zones. For *Atriplex fera L.*, *Xanthium strumarium L.*, there are data on the qualitative amino acid composition, while the quantitative composition in the literature is not adequately covered. *Bassia hyssopifolia (Pall.)* is almost not studied.

It is known that the proteins of various types of *Amaranthus* can differ in the quantitative composition of amino acids [1]. The amino acid composition of *Amaranthus Caudatus L., Amaranthus hypohondriacus L., Amaranthus cruentus L., Amaranthus edulis L., Amaranthus hybridus L.* was studied. It has been established that in various species of amaranth, seeds are richest in arginine, serine, leucine and isoleucine [2]. For plants of *Amaranthus* species, a high

lysine content is observed, which determines the usefulness of the protein. The amino acid composition of *Amaranthus caudatus L.* seeds was studied by Korejskoj I.M., Parfenovym A.A and coauthors. 19 amino acids, of which 8 are essential and 11 are non-essential was found. Traces of cystine and ornithine are noted [3, 4].

The amino acid composition of *Amaranthus retroflexus L.* seeds studied for plants growing in Central Yakutia. The content of 14 amino acids was revealed and the dominance of arginine, serine, leucine and isoleucine was established [5, 6].

According to some reports, growing *Amaranthus* at low ambient temperatures leads to a redistribution of amino acids in the overall complex: the content of serine, glutamate, proline, alanine, isoleucine and lysine increases [7].

According to *Elytrigia repens L.*, there are data on the content of a large number of lectins [8].

Elevsjuzova A.T. and Aralbaeva A.N. investigated the amino acid composition of the stems, rhizomes and seeds of *Elytrigia repens L.* growing in the conditions of Southern Kazakhstan. The authors note a high content of essential acid threonine. The limiting amino acids are phenylalanine and methionine [9].

Voronov I.V. carried out a comparative studying of the amino acid composition of seeds and middle leaves of *Atriplex patula L.* and *Amaranthus retroflexus L.* of flora of Central Yakutia. The presence of 14 amino acids was revealed, including 9 essential amino acids (lysine, leucine and isoleucine, methionine, valine, threonine, arginine, histidine and phenylalanine). Essential amino acids are tyrosine, proline, serine, alanine, and glycine. The author notes the absence of the histidine amino acid and the low content of phenylalanine in the seeds and leaves of *Atriplex patula L.* as compared to *Amaranthus retroflexus L.* [6].

The plants of the genus *Xanthium* are characterized the presence of a large number of fatty amino acids. So, the amino acid composition of the seeds of *Xanthium californicum L.* was determined by Gubanovoj L.B. and the presence of essential amino acids was revealed [10].

Based on the known data, we hypothesized that the amino acid composition of plants growing in the conditions of Northern Kazakhstan will have its own characteristics.

Materials and methods

The objects of study were air-dried raw materials of *Amaranthus retroflexus L., Atriplex fera L. Bunge, Elytrigia repens L. Nevski, Bassia hyssopifolia (Pall.) Kuntze, Xanthium strumarium L.* Plants were harvested in the Kostanay region in August-September 2019.

The determination of amino acids was carried out by gas chromatography. Chromatography was performed on a CARLO-ERBA- 4200 gas chromatograph.

The dried, crushed feed was hydrolyzed with hydrochloric acid for 24 hours. The obtained hydrolyzate was evaporated three times to dryness in a rotary vacuum evaporator at 40° C and the final precipitate was dissolved in sulfosalicylic acid, after centrifugation at a speed of 2.5 thousand rpm. The amino acids were eluted by NH_4OH through an ion exchange column. The eluates were evaporated to dryness on a rotary evaporator, then a freshly prepared solution of tin chloride II, 2,2-dimethoxypropane and propanol saturated with hydrochloric acid were added to the flask, the mixture were heated at 110 ° C for 20 minutes, and the contents of the flask were again evaporated on a rotary evaporator. Freshly prepared acylating reagent (1 volume of acetic anhydride, 2 volumes of triethylamine, 5 volumes of acetone) was introduced into the flask, the samples were evaporated to dryness, ethyl acetate and saturated sodium chloride solution were added. The contents of the flask were thoroughly mixed and, as two layers formed, they took the top layer (ethyl acetate) for gas chromatographic analysis.

Results and discussion

The analysis of the amino acid composition of the studied plants are shown in Table 1 and Figure 1.

The composition of *Amaranthus retroflexus L., Atriplex fera L., Elytrigia repens L., Xanthium strumarium L.*, growing in the sharply continental climate of Northern Kazakhstan, revealed the presence of 20 amino acids. Glutamate, aspartate, alanine, arginine, leucine, and isoleucine were found in the largest quantities. Traces of ornithine and hydroxyproline were found.

In the aboveground mass of *Xanthium strumarium L.*, the qualitative composition of amino acids is about 20 amino acids, of which asparagine, alanine and proline are found in the greatest amounts. After analysis of literature sources it follows that when studying the amino acid composition of the seeds of *Xanthium californicum* and *Xanthium strumarium L.*, amino acids in mainly total quantities were previously detected [10, 11]. The total amino acid content is 10.4%, of which 31% are irreplaceable and partially replaceable amino acids.

Table 1 – Amino acid composition of the studied plants

№	Amino Acid	Content, mg / 100 g				
		Amaranthus retroflexus L.	*Atriplex fera L.*	*Elytrigia repens L.*	*Bassia hyssopifolia (Pall.)*	*Xanthium strumarium L.*
1	Glutamine	2110	1870	1945	1710	2700
2	Asparagine	1248	980	1126	825	1654
3	Alanine	678	526	620	496	902
4	Arginine	430	328	415	304	431
5	Leucine	412	328	392	305	476
6	Isoleucine	388	306	368	286	439
7	Tyrosine	352	294	335	278	360
8	Proline	338	303	315	288	750
9	Phenylalanine	315	275	298	254	328
10	Glycine	296	195	276	178	365
11	Valine	285	225	270	215	352
12	Histidine	278	246	246	222	259
13	Threonine	240	214	299	204	378
14	Lysine	227	202	212	196	370
15	Serine	225	196	196	180	381
16	Tryptophan	96	75	90	62	110
17	Methionine	67	52	58	45	105
18	Cystine	44	34	35	27	64
19	Ornithine	2	1	1	-	2
20	Oxyproline	2	1	1	-	2

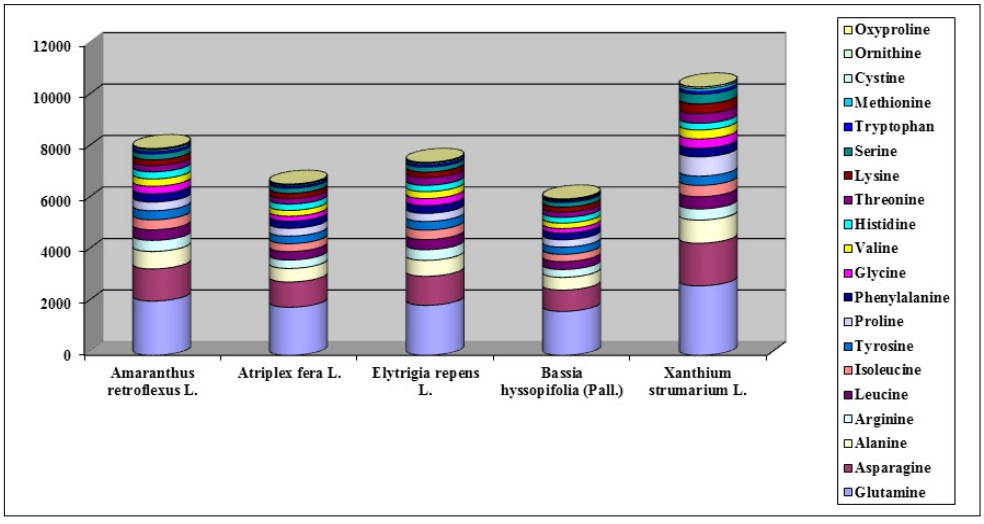

Figure 1 – Amino acids

Amaranthus retroflexus L. contains higher levels of tyrosine, phenylalanine, leucine, isoleucine, and alanine, the amount of arginine, proline, and threonine are lower than the amino acid composition of plants growing in Siberia [5]. It should also be noted a very high content of glutamate and aspartate compared with other types of *Amaranthus* [2-4, 12]. The total amino acid content is 8.0%, of

which 34% are irreplaceable and partially replaceable amino acids.

The amino acid composition of *Atriplex fera L.* in Northern Kazakhstan differs from *Atriplex patula L.* in Southern Siberia. The presence of small amounts of tryptophan, ornithine, oxyproline, cystine is noted. In general, the content of interchangeable and irreplaceable amino acids is higher [6]. The total amino acid content is 6.7 %, of which 34 % are irreplaceable and partially replaceable amino acids.

Differences in the content of essential amino acids *Elytrigia repens L.* are noted in comparison with plants growing in Southern Kazakhstan: the mass fraction of leucine, isoleucine and histidine is higher, and the mass fraction of threonine, valine, arginine is lower [9]. The total amino acid content is 7.5%, of which 35% are irreplaceable and partially replaceable amino acids.

In the studying samples of *Bassia hyssopifolia (Pall.)*, growing near Lake Kushmurun, in Kostanay region, the presence of 18 amino acids was established. Glutamic and aspartic acids were found in the greatest quantities. The amino acid composition of *Bassia hyssopifolia (Pall.)* also includes small amounts of tryptophan, cysteine, methionine. The total amino acid content is 6.1%, of which 34% are irreplaceable and partially replaceable amino acids.

Conclusion

The wild plants containing a large number of amino acids are of interest as the medicinal raw materials, food additives and food supply. Amino acids are a plastic material in the biosynthesis of proteins, nitrogen-containing non-protein substances, such as creatine and choline. Maintaining nitrogen balance in humans and animals depends on them. Plants rich in amino acids are a valuable raw material. The high content of amino acids in plants contributes to their effective effect on the body, as well as improved absorption, prolongation of the therapeutic effect of other biologically active substances [13-16].

As recent studies have shown, in plants about 25-30% of amino acids in free or bound form are contained. The wide distribution of amino acids in plants and their high biological activity contribute to the positive effect on the body of medicinal raw materials and medicines derived from it. So, for example, methionine as a hepatoprotective agent, aspartic acid compounds are used for the treatment of diseases of the cardiovascular system, glutamic acid can be used for the treatment of diseases of the central nervous system, histidine is used for peptic ulcers, aspartic acid are used to normalize coronary circulation, serine are used to normalize fat metabolism, maintaining immunity [1].

The plant species studied by us are characterized by a large list of amino acids. *Amaranthus retroflexus L., Atriplex fera L., Elytrigia repens L., Xanthium strumarium L.* contain 20 amino acids, including trace amounts of ornithine and oxyproline. For plants of the species *Bassia hyssopifolia (Pall.)* the presence of 18 amino acids was recorded and it was noted that the accumulation of amino acids is lower compared to other species studied by us. The studied plants contain irreplaceable and partially replaceable amino acids: lysine, leucine and isoleucine, methionine, valine, threonine, tryptophan, phenylalanine, arginine and histidine, which make up 31-35 % of the total number of amino acids. The total amino acid content varies from 6.1 to 10.4 %.

The obtained experimental data confirm that these plant species can be used as raw materials for the production of biologically active substances necessary in the medical and food industries.

Thus, according to the results of the research, the plants *Amaranthus retroflexus L., Atriplex fera L., Elytrigia repens L., Bassia hyssopifolia (Pall.), Xanthium strumarium L.*, growing in the conditions of Northern Kazakhstan, contain large amounts of amino acids, including essential leucine, isoleucine, arginine, etc., trace amounts of ornithine and oxyproline.

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