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DETERMINATION OF VITAMINS IN *POLYGONUM AVICULARE* L. USING CAPILLARY ELECTROPHORESIS

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Abstract. This study presents the quantitative analysis of water-soluble and fat-soluble vitamins in the aerial parts of *Polygonum aviculare* L. (Polygonaceae) using capillary electrophoresis. B-group vitamins (B1, B2, B3, B5, B6, B9), as well as vitamins C and E, were determined. *Polygonum aviculare* L. is a valuable medicinal plant widely used in traditional medicine. Infusions prepared from the aerial parts collected during flowering exhibit anti-inflammatory, hemostatic, hypotensive, diuretic, and vitamin effects, and are used in the treatment of chronic gastritis, gastric ulcers, bronchitis, kidney stones, uterine bleeding, cystitis, pulmonary tuberculosis, and other diseases. The study object included the leaves, stems, and roots of *Polygonum aviculare* L., collected in September 2024 in Akzhar village, Karasai district, Almaty region. Vitamin content was determined by capillary electrophoresis, micellar electrokinetic chromatography, and vitamin E was quantified according to GOST 27547–87. Results showed the distribution of vitamins B1, B2, B3, B5, B6, B9, and vitamins C and E

in different morphological parts. B1 content in leaves was 2.75 times lower than in stems and roots. B2 content in stems and roots was 1.86 and 2.65 times lower than in leaves, respectively. B6 was predominantly in leaves. Vitamin C content was 0.18 mg/100 g in leaves, 1.17 times higher in stems, and 2.65 times lower in roots. Vitamins B3 and B5 were mainly present in stems, B9 only in leaves (0.003 mg/100 g). Vitamin E (α-, γ-, and σ-tocopherols) showed uneven distribution: α-tocopherol predominated in roots and stems, γ-tocopherol in roots, σ-tocopherol in leaves and stems. The results confirm the high vitamin value of *Polygonum aviculare* L. and support its application in pharmacology and herbal preparations.

Keywords: *Polygonum aviculare* L., vitamins, B-group vitamins, vitamin C, vitamin E, capillary electrophoresis, plant morphological parts

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POLYGONUM AVICULARE L. ӨСІМДІГІНІҢ ҚҰРАМЫНДАҒЫ ДӘРУМЕНДЕРДІ КАПИЛЛЯРЛЫ ЭЛЕКТРОФОРЕЗ ӘДІСІМЕН АНЫҚТАУ

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Аннотация. Бұл жұмыста *Polygonum aviculare* L. (Polygonaceae) өсімдігінің жер үсті бөлігіндегі суда еритін және суда ерімейтін дәрумендердің сандық мөлшері капиллярлық электрофорез әдісімен анықталды. Зерттеу барысында В тобы дәрумендері (В1, В2, В3, В5, В6, В9), сондай-ақ С және Е дәрумендерінің

мөлшері анықталды. *Polygonum aviculare* L. – халықтық медицинада кеңінен қолданылатын құнды дәрілік өсімдік. Өсімдіктің гүлдену кезеңінде жиналған жер үсті бөлігінен дайындалған тұнбалар қабынуға қарсы, қан тоқтататын, гипотензивті, несеп айдағыш және дәрумендік әсерге ие болып, созылмалы гастрит, асқазан жарасы, бронхит, бүйрек тастары, жатырдан қан кету, цистит, өкпе туберкулезі және басқа да ауруларды емдеуде қолданылады. Зерттеу нысаны ретінде Алматы облысы, Қарасай ауданы, Ақжар елді мекенінен 2024 жылдың қыркүйек айында жиналған *Polygonum aviculare* L. өсімдігінің жапырағы, сабағы және тамыры пайдаланылды. Дәрумендердің сандық мөлшері капиллярлық электрофорез, мицеллярлық электрокинетикалық хроматография әдістерімен, ал Е дәрумені ГОСТ 27547–87 әдісі бойынша анықталды. Зерттеу нәтижелері бойынша В1 (тиамин хлориді), В2 (рибофлавин), В3 (пантотен қышқылы), В5 (никотин қышқылы), В6 (пиридоксин), В9 (фолий қышқылы) және С (аскорбин қышқылы), Е дәрумендерінің өсімдіктің әртүрлі морфологиялық бөліктерінде таралу ерекшеліктері анықталды. Жапырақтағы В1 дәруменінің мөлшері сабағы мен тамырына қарағанда 2,75 есе төмен болды. В2 дәрумені сабағында 1,86 есе, тамырында 2,65 есе аз, В6 дәрумені жапырақта басым болды. С дәрумені жапырақта 0,18 мг/100 г құрап, сабағында 1,17 есе көп, тамырында 2,65 есе аз. В3 және В5 дәрумендері негізінен сабағында, В9 тек жапырағында анықталды. Е дәруменінің α-, γ-, σ-токоферолдары әртүрлі бөліктерде әркелкі таралғаны көрсетілді. Алынған нәтижелер *Polygonum aviculare* L. өсімдігінің дәрумендік құндылығын ғылыми тұрғыдан дәлелдеп, оны фармакология мен фитопрепараттарда қолдану мүмкіндігін көрсетеді.

Түйін сөздер: *Polygonum aviculare* L., дәрумендер, В дәрумендері, С дәрумені, Е дәрумені, капиллярлық электрофорез, өсімдіктің морфологиялық бөліктері

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ОПРЕДЕЛЕНИЕ ВИТАМИНОВ СОДЕРЖАЩИХСЯ В РАСТЕНИИ POLYGONUM AVICULARE L., МЕТОДОМ КАПИЛЛЯРНОГО ЭЛЕКТРОФОРЕЗА

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Аннотация. В данной работе представлены результаты количественного анализа водорастворимых и жирорастворимых витаминов в надземной части растения *Polygonum aviculare* L. (Polygonaceae) методом капиллярного электрофореза. Были определены витамины группы В (В1, В2, В3, В5, В6, В9), а также витамины С и Е. *Polygonum aviculare* L. является ценным лекарственным растением, широко используемым в народной медицине. Настои из надземной части растения, собранной в период цветения, обладают противовоспалительным, гемостатическим, гипотензивным, диуретическим и витаминным действием и применяются при хроническом гастрите, язвенной болезни, бронхите, камнях в почках, маточных кровотечениях, цистите, туберкулезе лёгких и других заболеваниях. Объектом исследования служили листья, стебли и корни *Polygonum aviculare* L., собранные в сентябре 2024 года в селе Акжар Карасайского района Алматинской области. Количественный состав витаминов определялся методами капиллярного электрофореза и мицеллярной электрокинетической хроматографии, а содержание витамина Е - по ГОСТ 27547–87. Результаты показали различное распределение витаминов В1, В2, В3, В5, В6, В9, а также витаминов С и Е в различных морфологических частях растения. Так, содержание витамина В1 в листьях оказалось в 2,75 раза ниже, чем в стеблях и корнях. Витамин В2 содержится в стебле в 1,86 раза, а в корне в 2,65 раза меньше, чем в листьях. Витамин В6 преимущественно сосредоточен в листьях. Содержание витамина С составило 0,18 мг/100 г в листьях, в стебле - в 1,17 раза больше, а в корне - в 2,65 раза меньше. Витамины В3 и В5 обнаружены преимущественно в стебле, витамин В9 - только в листьях (0,003 мг/100 г). Витамин Е (α-, γ- и δ-токоферолы) распределяется неравномерно: α-токоферол преобладает в корнях и стеблях, γ-токоферол - в корнях, δ-токоферол - в листьях и стеблях. Полученные данные подтверждают высокую витаминную ценность *Polygonum aviculare* L. и обосновывают его использование в фармакологии и разработке фитопрепаратов.

Ключевые слова: *Polygonum aviculare* L., витамины, витамины группы В, витамин С, витамин Е, капиллярный электрофорез, морфологические части растения

Introduction. For centuries, natural raw materials have served as the primary source for medicinal compounds. At the present stage, special attention is given to the development and use of plant-based medicinal preparations, reflecting a stable trend aimed at expanding the range of domestic herbal products. This interest is explained by the relatively low toxicity of medicinal plant raw materials, their non-addictive properties, and the rare occurrence of allergic reactions. Medicinal plants play an important role

for both humans and society. Their value is determined by the presence of biologically active compounds, such as alkaloids, tannins, flavonoids, phenolic compounds, and vitamins, which exert specific physiological effects on the human body. These properties provide the basis for the pharmacological use of plants and their application for dietary and therapeutic purposes (Kaliyeva et al., 2024; Rakhimberdiyeva et al., 2022).

Several studies on *Polygonum aviculare* L. have demonstrated that its accumulation of biologically active compounds, particularly flavonoids, is dependent on environmental factors. Specifically, research conducted on the synanthropic flora of the Rostov region assessed the relative content of avicularin flavonoids in plants collected at varying distances from railways and low-intensity roads. These findings indicate that anthropogenic influences directly affect the biosynthesis of secondary metabolites.

Polygonum aviculare L., commonly known as common knotgrass, is an annual plant belonging to the genus *Polygonum* of the family *Polygonaceae*. To date, more than 300 species within this genus have been described. Members of the genus Polygonum have historically been used by various cultures in traditional medicine as both dietary and medicinal plants. This species is widely distributed across Central Asia, the Caucasus, Eastern and Western Siberia, the Far East, North America, Africa, and Australia.

Literary review. In traditional medicine, Polygonum aviculare has been used in the form of tinctures, ointments, and powders to treat cardiovascular diseases, as well as for its anti-inflammatory and hemostatic effects, and in the management of diabetes, nervous system disorders, cough, skin diseases, anemia, diarrhea, hypertension, hepatitis, cancer, snake bites, and various urological conditions (Bralley et al., 2008; Hasan, 2009; Wang et al., 2005; Yim et al., 2000). Additionally, knotgrass has been shown to possess antibacterial and antiviral properties, which are directly associated with its chemical composition. Representatives of the family *Polygonaceae* have been reported to contain vitamins, macro- and microelements, flavonoids, triterpenoids, anthraquinones, coumarins, phenylpropanoids, lignans, sesquiterpenoids, stilbenoids, tannins, and other biologically active compounds (Hyoung et al., 1994; Jansone, 2015).

N.M. Mukhitdinov, R.A. Muzychkina, and colleagues were the first to conduct a comparative phytochemical study of four *Polygonum* species in relation to their growth regions and experimentally identified the species suitable for large-scale production (Muchitdinov et al., 2015).According to the literature, knotgrass contains avicularin flavonoids, up to 0.9% ascorbic acid of dry weight, vitamins K and E, carotene, silicic acid and its soluble compounds, resins, bitter substances, mucilage, oils, sugars, up to 0.35% tannins, and trace amounts of essential oils.N. Tupitsina conducted a comprehensive study of representatives of the family *Polygonaceae Juss*. occurring in the southern flora of the Krasnoyarsk region, covering 54 species belonging to 13 genera and 4 taxa of the subfamily *Polygonoideae*.

N.A. Yunuskhojaeva and V.N. Abdullabekova studied the chemical composition of *Polygonum aviculare* L. and isolated the flavonoids avicularin, liquiritin, and cinnaroside from the aerial parts of the plant, while also determining the content of polysaccharides, macro- and microelements, and vitamin K_1 (Yunuskhojaeva et al., 2012). Using an ultrasonic bath method, a 14% ethanol extract of *Polygonum aviculare* L. was found to

contain a high level of phenolic compounds (976 mg GAE/g) (Holmatova et al., 2024). According to studies, the total protein content is higher in leaves than in roots, and using HPLC, 20 amino acids were identified in leaves compared to 19 in roots. Regarding water-soluble vitamins, 4 were detected in leaves and 2 in roots. These findings support the feasibility of using different parts of the plant in the production of medicinal preparations and biologically active supplements.The results of the study indicate that under normal anthropogenic influence, the synthesis of polyphenolic compounds can be induced, whereas complex toxic stress leads to suppression of the antioxidant system and a decrease in the biosynthesis of phenolic compounds. These conclusions are consistent with similar studies conducted in the Voronezh region and provide insights into the general patterns of flavonoid biosynthesis across different ecotopes (Selivanova et al., 2022).

In Kazakhstan, research on *Polygonum aviculare* L. over the past decade has been categorized into several directions. Pharmacogenetic and technological studies have led to the development of ointments for dermatological purposes based on P. aviculare extracts, and their quality indicators have been evaluated, representing preclinical-level investigations (Ergazina et al., 2024). The anticorrosive and applied properties of knotgrass extracts have been experimentally studied in the Western Kazakhstan regions, and the reliability of the obtained results was confirmed through methodological rigor. Floristic and botanical reviews have described the distribution and resource potential of *Polygonaceae* representatives within the territory of Kazakhstan, providing an important source of information for future systematic reviews (Abdrakhmanova et al., 2019).

Studies published in international journals have demonstrated the hemostatic and pharmacological activity of dry extracts of *Polygonum aviculare L.* in animal models (Kadyrova et al., 2022).

Additionally, data on its use in traditional medicine have ethnopharmacological significance and play a key role in formulating hypotheses for pharmacological research. Scientific evidence has demonstrated that *Polygonum aviculare* L. exhibits high levels of antioxidant and anti-inflammatory activity, based on its flavonoid and phenolic composition. By activating the Wnt/β-catenin signaling pathway, it accelerates wound healing, enhancing its therapeutic potential. The molecular anti-inflammatory effects of the extract, mediated through HO-1/Nrf2 and NF-κB pathways, contribute to the suppression of inflammatory processes in the body. Published, scientifically validated studies provide robust evidence of the biological activity of *Polygonum aviculare* L. and indicate its significant medicinal and preclinical potential (Jang et al., 2024; Lee et al., 2016; Joriya et al., 2025).

Thus, the study of *Polygonum aviculare* L. is highly relevant, as the plant represents an important raw material for the development of pharmacological preparations and dietary supplements. Its flavonoid and vitamin content exerts beneficial effects on the human body, and research conducted in Kazakhstan, taking into account local ecological conditions and the species' distribution patterns, provides an opportunity to generate novel scientific data.

Materials and Methods. The study material consisted of leaves, stems, and roots

of *Polygonum aviculare* L. collected in September 2024 from Akzhar village, Karasai district, Almaty region. The collected plant material was air-dried at room temperature and ground into powder. The moisture content and ash content of the plant material were determined using gravimetric methods (OFS.1.5.3.0007.15; OFS.1.2.2.2.0013.15). The results of these analyses are presented in Table 1.

Determination of Vitamin Content: Vitamin E in the plant material was determined according to the GOST 27547–87 method, whereas vitamins B1, B2, B3, B5, B6, B9, and C were analyzed using the M04-41-2005 method, i.e., by capillary electrophoresis. The analyses were performed using a Kapel-105M "Lumex" (Russia) instrument.

During vitamin determination, each vitamin was measured at its specific absorption wavelength of 200 nm and 267 nm. Vitamin B5 was analyzed using micellar electrokinetic chromatography at a wavelength of 200 nm. Separation conditions were as follows: borate buffer, pH 8.9; capillary: L_eff/L_total = 65/75 cm, ID = 50 μm; sample injection pressure = 600 mbar·s; operating voltage +25 kV; temperature +30 °C.

Indirect detection was performed under the following conditions: capillary L eff/L_total = 50/60 cm, ID = 75 μm; applied voltage +13 kV; detection wavelength 267 nm; temperature 40 °C; pressure 150 mbar·s; the running buffer contained 10 mM benzimidazole, 5 mM tartaric acid, and 2 mM 18-crown-6.

The results of the study are presented in Tables 2–5, which allow for a comparative assessment of the content and composition of vitamins in different parts of the plant. This methodological approach provided a basis for accurately determining the biochemical composition of Polygonum aviculare L. and evaluating its pharmacological potential.

Results. In this section, the chemical characteristics of the aerial and underground parts of *Polygonum aviculare* L. were determined, and the quantitative composition of vitamins was analyzed using capillary electrophoresis, with the results presented and comprehensively evaluated. The study assessed the content of water-soluble (B-complex and C vitamins) and fat-soluble (E vitamin) biologically active compounds and examined their distribution patterns within the plant matrix.

The high selectivity and sensitivity of the capillary electrophoresis method allowed for the accurate determination of vitamin content in complex plant material. The obtained results were compared with literature data and scientifically substantiated the pharmacological potential of *Polygonum aviculare* L.

In analyzing the results, the relative proportions of vitamins, their biological significance, and the role of the studied plant as a natural source of antioxidants were considered. As shown in table 1, the moisture and ash content of the plant meet the requirements of GOST standards.

Table 1 - Chemical composition of *Polygonum aviculare* L.

No.	Plant part	Moisture, %	Ash content, %
1	Leaves	4.76 ± 0.1	8.33 ± 0.1
2	Stems	7.32 ± 0.1	10.00 ± 1
3	Roots	7.14 ± 0.1	3.00 ± 0.1

The moisture content of the leaves is relatively low (4.76%), indicating that they can be stored for extended periods without quality loss during drying. The ash content of the stems and roots varies, reflecting differences in the concentration of organic and mineral substances across the different parts of the plant.

Table 2 - Vitamin E content in Polygonum aviculare L., mg/100 g

Plant part/Raw material	Parameter, Unit of measurement	Observed values	Standard according to test method
Leaves	-E: - alpha-Tocopherol - gamma-Tocopherol - sigma- Tocopherol	2.28±0.01 1.07±0.01 0.67±0.015	ГОСТ 27547-87
Stem	-E: - alpha-Tocopherol - gamma-Tocopherol - sigma- Tocopherol	1.12±0.011 - 0.46±0.012	ГОСТ 27547-87
Root	-E: - alpha-Tocopherol - gamma-Tocopherol - sigma- Tocopherol	4.58±0.01 3.96±0.012 -	ГОСТ 27547-87

Based on the results presented in table 2, the α- and γ-tocopherol content is highest in the roots (4.58 and 3.96 mg/100 g, respectively), indicating that vitamin E is a significant nutrient in this part of the plant. The content in leaves and stems is comparatively lower.

Vitamin E exhibits antioxidant activity, protecting cells from aging and stress, and facilitates the absorption of vitamins A and D. It also affects endocrine and reproductive system functions, stimulates muscle activity, supports the metabolism of proteins, fats, and carbohydrates, and serves as an antioxidant. Vitamin E protects cells that produce melanin from damage caused by hormonal changes, regulates melanin synthesis, and thereby prevents the formation of age spots. The highest levels of vitamin E are found in plant oils and nuts. The recommended daily intake is 12–15 mg, and deficiency may lead to infertility and miscarriage (Shchetinina, 2024).

The content of vitamins in the plant material is presented in tables 3–5.

Table 3 - Vitamin content in the leaves of *Polygonum aviculare* L.

№	Time	Component	Height	Start	End	Area	Con-cent. mg\L	Concent. kg/kg	Cocent. mg/100 g
1	6.167	B1(Thiamine chloride)	0.068	6.077	6.338	7.90	0.003	0.0001± 0.00002	0.011±0.002
2	11.078	B2 (Riboflavin)	0.416	10.998	11.472	61.79	0.019	0.00069± 0.00029	0.069±0.029
3	12.028	B6 (Pyridoxine)	0.367	11.852	12.768	79.47	0.018	0.00066± 0.00013	0.066±0.013
4	15.107	C (Ascorbic acid)	0.176	14.743	15.417	27.26	0.05	0.0018± 0.0006	0.18±0.06

5	15.923	B3 (Pantothenic acid)	0.103	15.778	16.028	8.212	0.0062	0.00023± 0.00005	0.023±0.005
6	16.570	B5 (Niacin)	1.117	16.340	16.675	65.95	0.013	0.00047± 0,00009	0.047±0.009
7	18.258	B9 (Folic acid)	0.099	18.153	18.347	6.295	0.00071	0.00003± 0.000005	0.003±0.0005

Based on the data presented in Table 3, the highest vitamin content in the leaves was observed for vitamin C (0.18 mg/100 g). The levels of vitamins B2, B6, and B5 were higher compared to B1, B3, and B9. This indicates that the leaves contribute significantly to the plant's antioxidant activity and play an important role in metabolic processes in the body. B vitamins in the leaves support the function of the nervous, endocrine, and cardiovascular systems, while vitamin C enhances vascular strength and strengthens the immune system.

Table 4 - Vitamin content in the stems of Polygonum aviculare L.

№	Time	Component	Hei-ght	Start	End	Area	Con-cent. mg/L	Concent. g/kg	Concent. mg/100g
1	6.005	B1(Thiamine chloride)	0.043	5.838	6.097	4.594	0.0018	0.00004=0.000008	0.004=0.008
2	10342	B2 (Riboflavin)	0.531	10.307	10603	61.69	0.019	0.00037±0.00016	0.037±0.16
3	11.345	B6 (Pyridoxine)	0.266	11.055	12.005	52.42	0.012	0.00023±0.00005	0.023±0.05
4	5.033	C (Ascorbic acid)	0.172	14.283	15.312	61.5	0.11	0.0021=0.0007	0.21=0.07
5	5.817	B3 (Pantothenic acid)	0.902	15.622	15.893	48.1	0.037	0.00072±0.00014	0.072±0.014
6	6.250	B5 (Niacin)	0.508	15.937	16.432	51.24	0.0099	0.00019=0.00005	0.019=0.005
7	7.735	B9 (Folic acid)	0.096	17.388	17.980	16.58	0.0019	0.0000±0.0000	0.00±0.00

According to the results presented in Table 4, the vitamin C content in the stems of Polygonum aviculare L. is the highest, at 0.21 mg/100 g. Vitamins B3, B6, B5, and B1 are present in comparatively lower amounts, while vitamin B9 is detected in minimal quantities. The high concentration of vitamin C enhances the antioxidant properties of the stems. The stems are particularly rich in vitamins B3, B6, and B5, indicating their involvement in enzymatic and metabolic processes. Elevated vitamin C levels contribute to supporting the body's overall defense mechanisms.

Table 5 - Vitamin content in the roots of Polygonum aviculare L.

№	Time	Component	Height	Start	End	Area	Concent. mg/L	Concent. g/kg	Concent. mg/100g
1	5.417	B1 (Thiamine chloride)	0.180	5.345	5.558	4.969	0.0019	0 . 0 0 0 0 4 ± 0.000008	0,004±0.0008
2	11.260	B2 (Riboflavin)	0.141	10.785	11.458	40.99	0.013	0,00026± 0,00011	0,026±0,011
3	12.378	B6 (Pyridoxine)	0.045	12.178	12.557	5.365	0.0012	0,00002± 0.000005	0,002±0.0005
4	14.590	C(Ascorbic acid)	0.145	14.310	14.723	16.73	0.034	0.00068 ±0,00023	0.068±0,023
5	15.712	B3 (Pantothenic acid)	0.088	15.628	15.795	4.019	0.0031	0,00006 ±0.00001	0,006±0.001
6	16.275	B5 (Niacin)	0.948	16.090	16.450	41.56	0,0081	0.00016 ±0.00003	0.016±0.003

According to the results presented in Table 5, the vitamin C content in the roots of Polygonum aviculare L. is 0.068 mg/100 g. Vitamins B2 and B5 are relatively abundant, whereas vitamin B9 was not detected. Vitamins B1, B3, and B6 are present in low amounts. The presence of α- and γ-tocopherols, along with B vitamins in the roots, reflects the plant's nutritional value. Extracts obtained from the roots may be used in pharmacological preparations for their antioxidant and vitamin activity.

Discussion. Comparison of the vitamin concentrations in the leaves, stems, and roots of *Polygonum aviculare* L. reveals significant differences among the plant parts. Vitamin B1 (thiamine) was found at 0.011 mg/100 g in the leaves, whereas its content in the stems and roots was 2.75 times lower than in the leaves. Thiamine plays a crucial role in the function of the nervous system, acetylcholine synthesis, and the metabolism of proteins, carbohydrates, and fats. Additionally, vitamin B1 supports the normal function of the endocrine, cardiovascular, and digestive systems. Thiamine deficiency (hypovitaminosis) can lead to central nervous system dysfunction, fatigue, reduced appetite, and decreased resistance to infections.

The concentration of vitamin B2 (riboflavin) in stems was 1.86 times lower, and in roots 2.65 times lower than in the leaves. Riboflavin, as a component of various enzymes, supports visual acuity, skin and mucous membrane health, liver function, and hematopoiesis. Its primary sources include animal products (beef liver, eggs, cheese, mackerel) and plant products (buckwheat, green peas). The recommended daily intake is 2–3 mg. Vitamin B3 (pantothenic acid / niacin) was measured at 0.023 mg/100 g in the leaves, 3.13 times higher in stems, and 3.83 times lower in roots. Vitamin B3 is a cofactor in enzymatic reactions, participates in cellular respiration, blood formation, and the dilation of capillaries. It is abundant in meat products but poorly absorbed from cereals. Deficiency may cause impaired hormone synthesis and lead to digestive and nervous system disorders.

Vitamin B5 (pantothenic acid) was found at 0.047 mg/100 g in the leaves, 2.47

times higher in stems, and 2.94 times lower in roots. B5 is involved in the synthesis of fatty acids, steroid hormones, and other biologically important compounds. The daily requirement is 4–12 mg; deficiency can result in general weakness, neuromotor disorders, and dermatitis.

Vitamin B6 (pyridoxine) was present at 0.066 mg/100 g in leaves, 2.87 times higher in stems, and 33 times lower in roots. Vitamin B6 is essential for amino acid absorption, regulation of fat and cholesterol metabolism, and hemoglobin formation. Its presence in the leaves contributes significantly to the biological activity of the plant.

Vitamin C (ascorbic acid) was detected at 0.18 mg/100 g in leaves, 1.17 times higher in stems, and 2.65 times lower in roots, with the highest concentration observed in the stems. Vitamin C exhibits antioxidant activity, strengthens the immune system, and supports the structural integrity of bones and joints. Deficiency is associated with scurvy.

Vitamin B9 (folic acid) was detected exclusively in the leaves (0.003 mg/100 g). Folic acid is crucial for enzyme synthesis, stimulates hematopoiesis, and participates in cell division processes. Its main dietary sources include green leafy vegetables, meat, liver, dairy products, and yeast.

Comparison of vitamin content in the leaves, stems, and roots of *Polygonum aviculare* L. revealed the following patterns:

- Vitamin B1 was most abundant in the leaves, while its concentration in the stems and roots was 2–3 times lower.
- Vitamin B2 was relatively higher in the roots, with lower levels observed in the stems and leaves.
- Vitamin C exhibited the highest concentration in the stems, moderate levels in the leaves, and the lowest in the roots.
- Vitamins B3, B5, and B6 were present in all plant parts, with maximum concentrations observed in the leaves and stems.
- Vitamin B9 was detected exclusively in the leaves.

These results indicate that the vitamin composition varies among different parts of *Polygonum aviculare* L., reflecting its pharmacological and nutritional value. The leaves and stems exhibit high antioxidant and vitamin activity, whereas the roots are characterized by a predominance of α- and γ-tocopherols, highlighting their potential use in pharmacological preparations.

Conclusion. The results of this study allowed for the precise quantification of water- and fat-soluble vitamins (B1, B2, B3, B5, B9, C, and E) in the leaves, stems, and roots of Polygonum aviculare L. The analytical methods employed—capillary electrophoresis, HPLC, and GOST standard procedures—provided reliable, highly sensitive, and reproducible determination of vitamin content within the complex plant matrix.

The measured vitamin levels confirm that Polygonum aviculare L. represents a rich source of biologically active compounds. These findings substantiate the plant's high nutritional value and support its use for therapeutic and prophylactic purposes. Furthermore, Polygonum aviculare L. has been identified as a scientifically and practically significant phytochemical resource with considerable potential.

Overall, the study demonstrates the applicability of Polygonum aviculare L. in

traditional medicine, pharmaceutical formulations, and the production of functional food products. These data provide a solid scientific basis for its future research and industrial utilization.

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