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DETERMINATION OF WATER-SOLUBLE VITAMIN CONTENT IN MARSHMALLOW (ALTHAÉA OFFICINÁLIS)

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Althaéa officinalis, water-soluble vitamins, vitamin B, vitamin PP, vitamin C

Annotation
The article presents the results of determining the amount of water-soluble vitamins, B vitamins, vitamin PP, vitamin C in the vegetative organs of the marshmallow plant (Althaéa officinalis) - leaves and stems using high-performance liquid chromatography and their standards. Presented in the form of diagrams and tables. This plant is rich in vitamins necessary for the body and has a positive effect.

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Introduction. Althaea officinalis is a perennial herbaceous plant belonging to the Malvaceae family. There are 12 species of this plant growing in Central Europe and Asia. Marshmallow (Althaea officinalis) thrives in floodplains, irrigated lands, lake and riverbanks, and other similar environments.

The leaves of Althaea officinalis are ovate, with the lower part usually being triangular-heart-shaped. The edges are irregularly serrated, sometimes slightly divided into three or five lobes, densely covered with soft hairs, giving them a grayish-green color. The leaves are petiolate, with the upper ones having shorter petioles. The flowers are grouped in clusters in the axils of the leaves, with very short pedicels densely covered in soft hairs. The seeds are smooth or slightly wrinkled on the lower side, with small stellate hairs, slightly blunt at the edges, and occur in numbers of 15–18 per fruit. The plant flowers from June to August and bears fruit from July to September.



Morphological structure of medicinal marshmallow (Althaea officinalis)

Research has shown that marshmallow (Althaea officinalis) contains many beneficial substances. In particular, the roots of the plant contain up to 35% mucilaginous substances, up to 37% starch, about 16% sugars, asparagine, betaine, pectin, fats, and about 4.9% mineral salts. The leaves and flowers contain about 0.02% essential oil, carotene, and vitamin C, while the amount of mucilaginous substances in the leaves is half that in the roots.

Marshmallow flowers are considered a nutritious food for children. However, their medicinal properties are inferior to those of the seeds, leaves, and stems.

Medicinal marshmallow has been used in medicine since ancient times. Avicenna (Ibn Sina) used infusions of its roots, leaves, and seeds to treat coughs, hemoptysis, pneumonia, and kidney diseases. The great physician recommended marshmallow root-based medicines as a remedy for softening the chest and expelling phlegm.

Bositkhon Shoshiy (a renowned physician, poet, and translator, and the author of the first medical book in Uzbek, Kanun Bositii) wrote about marshmallow in his work Medicines and Their Names: “Its Greek name is ‘Khtimiy,’ which means ‘highly beneficial.’” He also mentioned that Arabs call this plant hubbūza, Persians shabparak, Turks obim kumoch, and Uzbeks gulxayri or tugmacha.

Medicinal Properties of Marshmallow (Althaea officinalis)

Marshmallow has resolving, softening, and anti-inflammatory properties. Applying its leaves to the head helps reduce brain and ear swelling, promotes wound healing, and relieves pain. Additionally, it aids in the resorption of tumors and inflamed glands.

Marshmallow is highly effective in healing fresh wounds, boils, and tumors in the chest area. It is also beneficial for joint pain caused by bruises or burns. When combined with olive oil, it helps draw out venom from poisonous insect bites. Applying it to burned skin promotes rapid healing.

In traditional medicine in Central Asia, marshmallow is used to treat hemoptysis, tuberculosis, bronchial asthma, cough, and chest pain. A decoction of its roots, leaves, and flowers is used as a soothing remedy and for gargling. During the postpartum period, its root decoction is taken to stop bleeding. Ointments made from its roots, leaves, and flowers are used to treat boils and external wounds. In Tajikistan, this plant is also utilized as a medicinal remedy.

In Uzbekistan, studies have been conducted on the content of water-soluble vitamins in Althaea officinalis.

Experimental Part.

Reagents and Equipment Used. Vitamin B12 was purchased from Rhydburg Pharmaceuticals (Germany), Vitamin C from Carl Roth GmbH (Germany), Vitamin B9 from DSM Nutritional Products GmbH (Germany), and Vitamins B_1, B_2, B_3, B_6, and PP from BLDPharm (China). For the analysis, high-purity water for HPLC, acetonitrile, chemically pure acetic acid, and sodium hydroxide were used.

The determination of water-soluble vitamins in the plant material was carried out using the high-performance liquid chromatograph LC-40 Nexera Lite, manufactured by the Japanese company Shimadzu.

Preparation of Standard Solutions. Standard solutions of Vitamins C (CAS 50-81-7), B_1 (CAS 59-43-8), B_6 (CAS 58-56-0), B_3 (CAS 59-67-6), B_{12} (CAS 68–19–9), and PP (CAS 98-92-0) with a concentration of 100 mg/L were prepared by dissolving 5 mg of each vitamin in 50 mL of 0.1 N HCl solution.

Standard solutions of Vitamins B_2 (CAS 83-88-5) and B_9 (CAS 59-30-3) were prepared by dissolving 5 mg of each vitamin in 50 mL of 0.025% sodium hydroxide solution.

Then, 200 µL from the initial solutions of Vitamins B1, B_6, B_3, B_{12}, and PP were taken and mixed, resulting in a solution with a concentration of 14.286 mg/L for each vitamin. Similarly, standard solutions with concentrations of 7.143 mg/L, 3.571 mg/L, and 1.786 mg/L were prepared.

Additionally, standard solutions of Vitamin C with concentrations of 286 mg/L, 143 mg/L, 71.5 mg/L, and 57.2 mg/L were prepared.

For constructing the calibration curve, pure water was used as the solution with a concentration of 0 mg/l

Preparation of Sample Extract. For the extraction of water-soluble vitamins from the sample, 1 g of the substance was placed in a 50 mL conical flask, and then 25 mL of 0.1 N HCl solution was added. The mixture was subjected to extraction in an ultrasonic bath (GT SONIC-D3, China) at a temperature of 60°C for 20 minutes.

After the extraction, the mixture was cooled, filtered, and the volume was adjusted to 25 mL with water in a volumetric flask. Then, 1.5 mL of the extract was filtered through a 0.22 µm syringe filter, placed into a vial, and used for analysis.

Chromatographic Conditions. Vitamin Determination:

The analysis of the standard solutions and the sample extract was conducted using High-Performance Liquid Chromatography (HPLC) on the LC-40 Nexera Lite system, which includes the LC-40D pump, SIL-40 autosampler, and SPD-M40 photodiode array detector (PDA). Data processing was carried out using LabSolutions software (ver. 6.92).

An reverse-phase Shim-pack GIST C18 column (150 × 4.6 mm, 5 µm, Shimadzu, Japan) was used, and a gradient mobile phase consisting of acetonitrile (A) and a 0.25% acetic acid solution in water (B) was employed (Table 1).

Analysis Conditions:

Injection volume: 10 µL

Flow rate: 0.6 mL/min

Column thermostat temperature: 40 °C

Analytical signal (peak area) was recorded at three wavelengths: 265 nm, 291 nm, and 550 nm (Figures 1–3).

Table 1. Mobile phase gradient program for determining vitamins.

Time, minute	Acetonitrile (A), %	0.5% acetic acid (B), %
0	0	100
3	0	100
14	20	80
17	50	50
18	0	100
25	Termination	

Table 2. Mobile phase gradient program for vitamin C determination.

Time, minute	Acetonitrile (A), %	0.5% acetic acid (B), %
0	0	100
2	0	100
6	50	50
6,01	0	100
15	Termination	

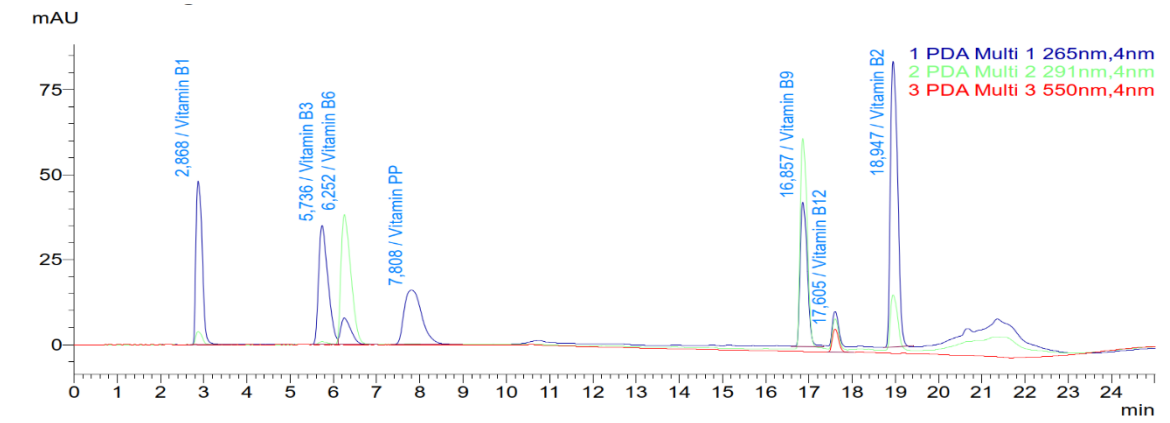


Figure 1. Chromatogram of a standard vitamin solution.

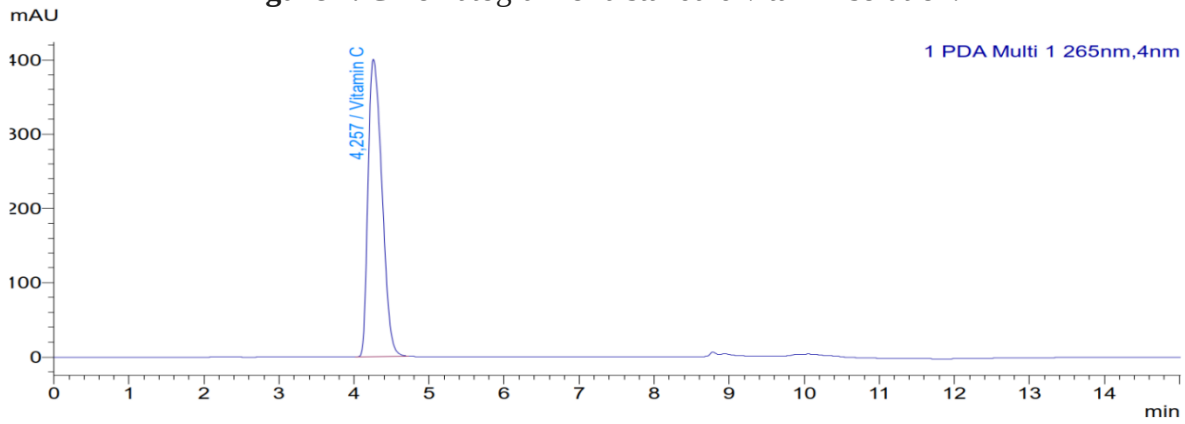


Figure 2. Chromatogram of a standard solution of vitamin C

Results obtained. Determination of vitamins in an extract sample. A chromatogram of the sample extract was obtained (Fig. 3, 4), based on the results of which the amount of vitamins in 100 g of dry mass of the plant was calculated using the following formula and presented in Table 3.

$$X = \frac{C_{vit} \cdot V_{ekstrakt}}{m_{namuna}} \cdot 100\ g$$

Here X is the amount of vitamins in 100 g of fruit, mg; Cvit – concentration of vitamin in the extract, determined by the USS method, mg/l; Vextract – volume of sample extract, l; sample - mass of the sample taken to prepare the extract

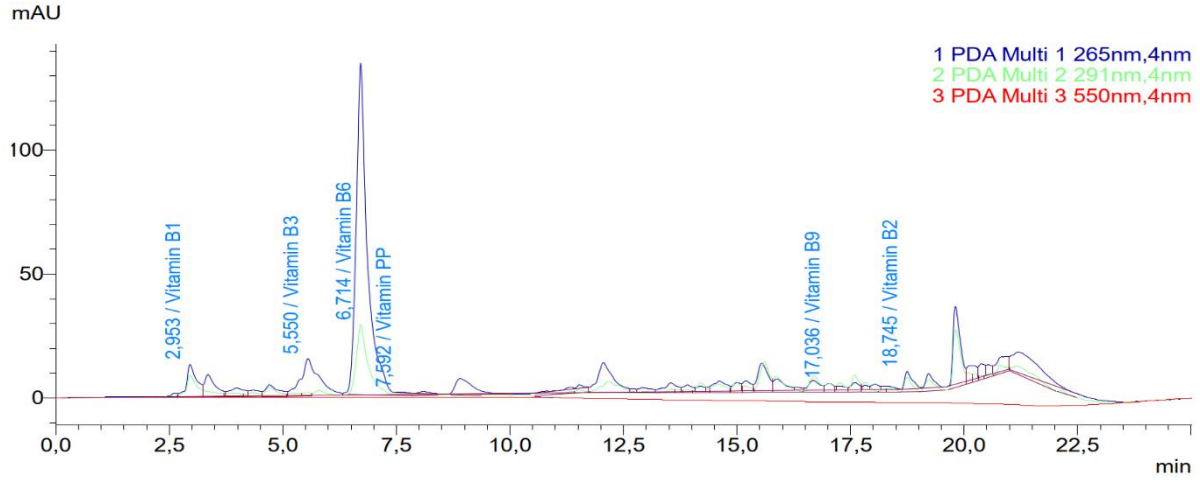


Figure 3. Chromatogram for determining vitamins in a sample extract.

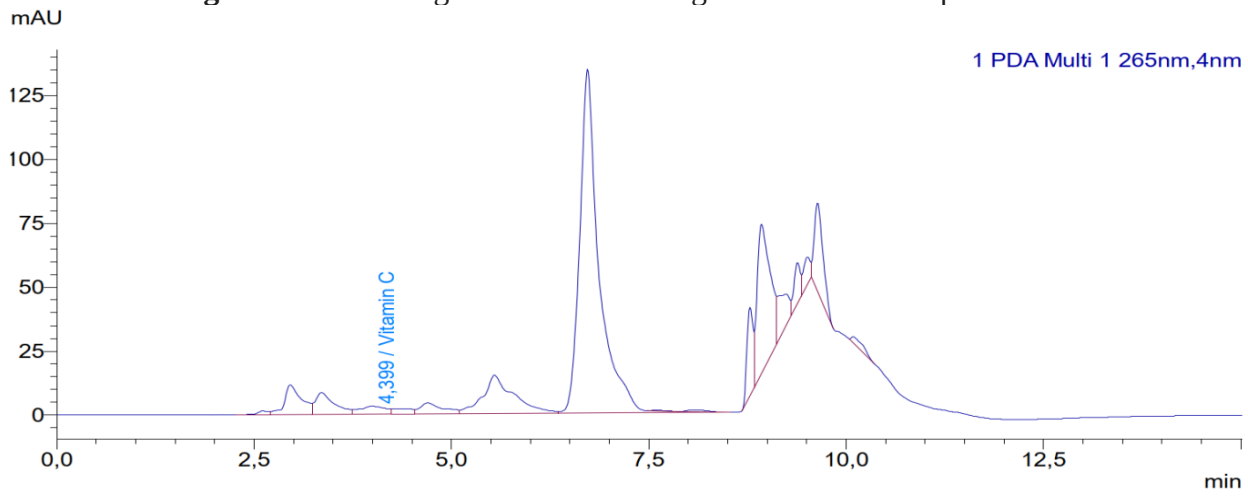


Figure 4. Chromatogram for determining the amount of vitamin C in sample extract.

Table 3. Amount and retention time of vitamins in the extract.

Vitamin	Catch time, sec	Concentration, mg/l	Amount per 100 g sample, mg
Vitamin **B_1**	2,953	5,865	14,663
Vitamin **B_3**	5,55	11	27,500
Vitamin **PP**	7,592	0,12	0,300
Vitamin **B_9**	17,036	1,033	2,583
Vitamin **B_2**	18,745	1,441	3,603
Vitamin **B_6**	6,714	11,841	29,603
Vitamin **B_{12}**	Not detected	0	0,000
Vitamin **C**	4,399	1,619	4,048

Chromatographic Analysis of Vitamins in the Aerial Part Extract of Marshmallow (Althaea officinalis)

The chromatograms of the extract from the aerial part of Althaea officinalis (shown in Figures 2 and 3) revealed the presence of vitamins B1, B2, B3, B6, and B9. However, vitamin B12 was not detected, indicating its absence in the extract composition.

According to the data (Table 3), the content of the studied vitamins per 1 g of dry matter was as follows: Vitamin B1 – 14.663 mg, Vitamin B2 – 3.603 mg, Vitamin B3 – 27.500 mg, Vitamin B6 – 29.603 mg, Vitamin B9 – 2.583 mg, Vitamin PP – 0.3 mg, Vitamin C – 4.048 mg.

The high content of vitamins B1, B3, B6, and C in Althaea officinalis makes it beneficial for strengthening children's immune systems and ensuring the normal functioning of the nervous system.

Functions of the detected vitamins: Vitamin B1 (Thiamine) protects skin cells from the effects of solar radiation, helps prevent certain types of skin cancer, and participates in the metabolism of carbohydrates, proteins, and fats, aiding in the conversion of food into energy. It also plays a crucial role in nerve impulse transmission, increases resistance to infections, and strengthens the immune system.

Vitamin B3 (Niacin) supports skin health, the nervous system, and the digestive tract. It plays a role in skin cell renewal, regulates pigmentation, and helps lower cholesterol levels, benefiting the cardiovascular system.

Vitamin B6 (Pyridoxine) improves metabolism in brain tissues, ensures the even distribution of glucose, enhances mental and physical performance, regulates the production of pituitary hormones, reduces the risk of cardiovascular diseases, and participates in serotonin synthesis, which regulates sleep, appetite, and mood.

Vitamin C has antioxidant properties, reduces stress levels, improves iron absorption, supports eye, heart, and dental health, accelerates wound healing, and stimulates collagen production.

Thus, the medicinal marshmallow (Althaea officinalis) is a valuable source of water-soluble vitamins and can be used in both traditional and scientific medicine as a biologically active supplement or medicinal infusion.

Conclusion. Marshmallow (Althaea officinalis) is rich in water-soluble vitamins. B vitamins support metabolism, maintain the nervous system, promote growth and development, and improve brain function, memory, and mood. Additionally, considering its effectiveness in treating skin and nervous disorders such as dermatitis and vitiligo, this plant can be used as a medicinal dietary supplement.

Vitamin C found in marshmallow is an effective remedy for preventing inflammatory and cold-related diseases such as scurvy, pharyngitis, laryngitis, rhinitis, and flu. It also has a beneficial effect on the respiratory and digestive systems.

Due to these properties, marshmallow can be used in both traditional and scientific medicine as a dietary supplement or infusion. Its use is not only beneficial and effective but also economically advantageous, as synthetic drugs may negatively impact the digestive system, particularly the liver, leaving side effects behind.

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