Carotenoid content in certain wild edible plants growing in the Lori Region of Armenia

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Abstract: The formation of pigments in plant tissues, including carotenoids, has been one of the most significant aromorphoses in the history of the origin of organic nature, a supreme result of chemical and then biological evolution. The carotenoids are synthesized in all photosynthetic organisms, some non-photosynthetic organisms. The scientific studies have shown that carotenoids contribute to the prevention of the development of various diseases in the human body. From both a scientific and practical perspective, studies that focus on determining the quantity of carotenoids in certain wild edible plants are highly valuable. It was conducted a study on the carotenoid in the leaves and stems of certain wild edible ten plants growing in the natural environment around the cities of Vanadzor and Stepanavan in the Lori region in Armenia. The differences content of carotenoid distribution between stems and leaves are likely influenced by environmental factots (for example- climate, soil conditions) in Vanadzor and Stepanavan. This analysis can guide both agricultural practices and health-oriented food production.

1 Introduction

Carotenoids are yellow and orange pigments that are synthesized in the cells of bacteria, fungi, and higher plants. They are the most widespread group of plant pigments. Their number exceeds 600. In the leaves of green plants, the most physiologically active components of this large group of chloroplast pigments are α- and β- carotenes, as well as their oxygen-containing derivatives, xanthophylls, which are also referred to as carotenoids. As additional pigments, they absorb and transfer light energy to chlorophyll a. According to studies by Manuel Rodriguez and others, carotenoids are synthesized in all photosynthetic organisms, some non-photosynthetic prokaryotes, and fungal organisms: In plant organisms, they are important for photoprotection from excess light and help in light harvesting, known as natural pigments in the yellow to red range. According to Tinahu Sun, carotenoids are important not only for photosynthesis and photoprotection, but also for the synthesis of pigments and phytohormones [1,2].

In the dark, the synthesis of carotenoids in plant tissues is more active, whereas under light it is suppressed. The literature reports that by 2018, ap to 850 types of carotenoids has been discovered in nature. According to the author, carotenoids play an important role in

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photosynthesis along with chlorophylls. In non-photosynthetic organs, carotenoids act as antioxidants and precursors of plant hormones, while in animals, they are not synthesized but are taken through food, where they act as precursors to vitamin A and contribute to enhancing immunity [2].

The physiologically most active components of this large group of chloroplast pigments in the leaves of green plants are α- and β- carotenes, as well as their oxigen-containing derivatives, xanthophylls. These pigments are soluble in fats and fat-soluble solvents. Their dilute solutions have light yellow, orange, or light red hues. Concentrated solutions range from orange to dark red [1,2].

According to the results of studies, carotenoids play a certain role during the flowering period of plants, with their quantity being relatively higher in the stigma of the pistil and in the pollen grains. During this period, the carotenoid content in the leaves partially decreases, while it increases in the anthers and petals. Carotenoids are also important for maintaining water balance in the human body. Consuming less than 6 mg of carotenoids per day nearly doubles the risk of developing cancerous diseases. Carotenoids possess antitumor, antitoxic, and immunomodulatory effects, and their use is recommended in clinics during the combined treatment of malignant formations as immunoregulators. Carotenoids are important for the prevention of chronic diseases, including cardiovascular diseases, age-related degeneration, certain types of cancer, cataracts, and viral illnesses such as COVID-19 [1]. According to Pasquale Crupi and colleagues, carotenoids have not only antioxidant and antitumor properties but also antidiabetic and antitumor effects on the human body [3].

The authors have also studied the preventive and therapeutic significance oflycopene for the human body and its application in cosmetics. In addition to fruits and vegetables, alternative sources of carotenoids may include microalgae and insects [3]. Research conducted by Frederick Khachik has shown that the inclusion of carotenoid supplements in the diet plays a significant role-in disease prevention [4]. According to Antonio J. Melendez-Martinez, compared to other bioactive substances, carotenoids can be converted into retinoids and exhibit vitamin A activity: The author notes that carotenoids are more versatile, not only as a source of vitamin A, but also as natural pigments, antioxidants, and compounds that promote health. Carotenoids are also of interest as natural cosmetic ingredients, providing cosmetic benefits when consumed internally [5].

According to in vitro and in vivo laboratory studies presented by A. Bendich, beta-carotene can protect phagocytic cells from auto-oxidative effects, stimulate the proliferation of T and B lymphocytes, enhance the tumor-killing abilities of effector T cells, macrophages, cytotoxic T cells, and natural killer cells, as well as increase the synthesis of certain interleukins [6]. Carotenoids also influence the regulation of cholesterol metabolism in cells. They exhibit antioxidant activity and affect cell membranes [7]. Additionally, carotenoids participate in the modification of protein structures in cell membranes and signal reception processes [8,9]. According to in vitro and in vivo laboratory studies by A. Bendich, beta-carotene can protect phagocytic cells from auto-oxidative damage, activate the proliferation of T and b lymphocytes, enhance the tumor-suppressing capabilities of effector T cells, macrophages, cytotoxic T cells, and natural killer cells, and increase the synthesis of certain interleukins [6]. Carotenoids also influence the regulation of cholesterol metabolism in cells, exhibit antioxidant activity, and affect cell membranes [7]. They participate in modifying protein structures in cell membranes and signal reception [8,9]. Carotenoids stimulate the immune system and inhibit tumor development. Through the activation of immune responses, carotenoids can suppress the development of fibrosarcoma [10]. In vitro studies have highlighted the inhibitory effects of lycopene and β-carotene on the growth of breast cancer [11].

Studies by Pasquale Crupi and colleagues show that consuming carotenoid-rich foods reduces the risk of chronic diseases such as cardiovascular diseases, stress-related conditions, various types of cancer, and type 2 diabetes [3]. According to Alireza Milani and others, carotenoids and retinoids have similar biological activities, including antioxidant properties, inhibition of malignant tumor growth, and induction of apoptosis, while astaxanthin has neuroprotective properties. There is a direct link between the high intake of carotenoid-rich foods and reduced risks of breast, cervical, and ovarian cancers, as well as cardiovascular and eye diseases [12,13]. The authors recommend considering the type of disease and carotenoid content in foods before use [1211]. In the Republic of Armenia, research has also been conducted to study the quantitative and qualitative characteristics of carotenoids. Studies have examined the carotenoid content in certain tropical fruits and spice plants.

2 Materials and methods

A review of the literature reveals that many foreign and local researchers have studied the carotenoid content in wild edible plants and investigated their significance for human health [4, 5, 8, 9, 14]. According to Enrique Murillo and colleagues, tropical fruits serve as reservoirs of carotenoids and contribute to health promotion. The authors have also presented new data for the development of nutritional databases. Ewelina Kultys highlights the role of carotenoids in enhancing immune system resistance, promoting wound healing, and protecting against ultraviolet radiation. The authors propose green extraction methods for carotenoids from fruit and vegetable by-products. They suggest that extracting bioactive compounds from the by-products of fruit and vegetable processing can reduce food waste [15].

Colorless carotenoids such as phytoene and phytofluene, which are present in the skin, have the ability to absorb ultraviolet radiation [13].

We conducted a study on the carotenoid in the leaves and stems of certain wild edible plants growing in the natural environment around the cities of Vanadzor and Stepanavan in the Lori region. Thes plants are part of the diet of the region's residents and include: *Thymus serpyllum L., Teucrium polium L*., *Mentha viridis L., Asparagus officinalis L., Apium graveolens L*., *Chelidonium majus L., Urtica dioica L., Polygonatum odoratum (Mill) Druce, Heracleum sosnowskyi, Chaerophyllum bulbosum L.*

These plants were chosen due to their inclusion in the local diet, making them valuable for assessing their nutritional and health-related properties. In the Lori region, it is customary for the local population to include wild plants in their diet. This practice is particularly common in spring, during the period of intense growth and development of plats, when the frequency of their use significantly increases.

Therefore, the study of carotenoid content in wild edible plants growing in the Lori region is of great importance, as identifying the levels of theses plant pigments will be significant for evaluating their health benefits to the human body. Samples for the study were collected from the Gugark and Stepanavan areas of the natural environment surrounding the city of Vanadzor.

1. The Lori-Pambak region is the largest natural-historical area in northern Armenia. Its boundaries are defined by the following landmarks: to the north, the Virahayots Mountains; to the west, he Javakheti Plateau; to the east, the Gugark Mountain Range; and to the south, the Pambak Mountain Range. Within these boundaries lies the Debed River Basin, which is divided into two subregions: the Lori Depression and the Pambak Valley: These are separated by the Bazum Mountain Range. The Debed River forms at the confluence of its tributaries, the Dzoraget and the Pambak Rivers. The average altitude of

the Lori-Pambak region is 1600-1700 meters above sea level, with its highest point being Mount Achkasar (3196 meters) in the Javakheti Plateau and its lowest point being the Debedashen Plain at 375 meters. The physical-geographical region of Lori-Pambak spans from 41015' N latitude (6km northeast of the village of Metsavan) to 40041' N latitude (4km southeast of the Margahovit Pass in the Pambak Mountain Range) and from 43056' E longitude (upper reaches of the Chichkan River) to 44057' E longitude (the watershed section of the Gugark Mountain Rnage at the upper reaches of the Shnogh River) [Physical geography of the Armenian SSR. Erevan: 1971, 470p.].

The comparison of the climatic indicators in the Vanadzor and Stepanavan cities of Lori region in Armenian is presented in the Table 1:

Table 1. The differences in the main climatic indicators in the Vanadzor and Stepanavan cities of Lori region in Armenian

Climatic indicators	Place	
	Vanadzor	**Stepanavan**
Absolute height above sea level (m)	1350	1397
Absolute maximum air temperature (°C)	36	35
Average annual air temperature (°C)	7.4	6.6
Number of days with wind speed of 15m/s and above	8	40
Sunshine Duration (hour)	2011	2003
Absolute minimum air temperature (°C)	-32	-34
Average annualprecipitaion (mm)	586	683
Annual average wind speed (m/s)	1.7	2.4

2. The content of pigments, including chlorophylls and carotenoids, was determined using optical density measurements. The chlorophylls and carotenoid content in plant samples was quantified by applying alcohol and acetone solutions, prepared followng methods commonly used in plant physiological studies. Optical density measurements were conducted using a UV-Vis spectrophotometer (UV-Vis SPECTROPHOTOMETER SL 150) at specific wavelenghts: 665 nm and 649 nm for chlorophyll, and 452.5 nm for carotenoids [Vorobev, V.H., i dr, Practical training in plant physiology. Kazan: 2013, 23-30 p.].

Spectrophotometric analysis is considered a relatively accurate quantitative method for determining pigments in leaves. The extract's optical density was measured the spectral range where maximum absorption occurs: the red region of the spectrum for chlorophylls (chlorophyll a and b), and the wavelength of maximum absorption for carotenoids. Pigment content is expressed in milligrams per gram of wet or dry plant material or as a percentage per unit area of leaf or stem surface. To determie the pigment concentration in the stems and leaves of the studied plants, fresh tissues weighing 0.3g were taken. Chlorophyll alcohol extracts were prepared using 96% ethanol. The pigment concentrations were calculated based on optical density readings using the following formula provided in the literature.

$$C_a = 13.70 \times D_{665} - 5.76 \times D_{649}$$

$$C_b = 25.8 \times D_{649} - 7.60 \times D_{665}$$

3. The sum of chlorophyll a (Ca) and chlorophill b (Cb) content was determined using Rebelein's formula [Vorobev, V.H., i dr, Practical training in plant physiology. Kazan: 2013, 23-30 p.].

$$C_a + C_b = 6.10 \times D_{665} + 20.04 \times D_{649}$$

The concentration of carotenoides was determined using Wettstein's formula:

$$C_{car} = 4.75 \times D_{452.5} - 0.226 \times C_a + C_b$$

For the concentration of pigments in plant tissue extracts, the content of carotenoids in the samples was calculated using the following formula:

$$A = \frac{V \cdot C}{P \cdot 1000},$$

Where:

C - is the concentration of carotenoids in mg/l,

V - is the volume of the extract in ml (4ml),

P - is the mass of the sample in grams (0.3g),

A - is the pigment content in the plant sampe in mg/g of wet weight[Vorobev, V.H., i dr, Practical training in plant physiology. Kazan: 2013, 23-30 p.]

The experiments were conducted at the Natural Science Complex Laboratory of Vanadzor State University and the laboratories of the Institute of Botany of the National Academy of Sciences of Armenia, with 7-8 repetitions. The obtained results were subjected to mathematical statistical analysis, and the mean values were determined.

4. The mathematical processing of the data was performed using the method of analysis of variance (ANOVA), with the determination of experimental error (SX, %) [Dospekhov, B.A., Methodology of field experiment.-Moscow: Publishing house “Agropromizdat”; 1985, 350 p.4].

3 Results

Samples were collected from two experimental sites–near Vanadzor and Stepanavan–from ten species of wild edible and aromatic plants: *Thymus serpyllum L., Teucrium polium L.*, *Mentha viridis L., Asparagus officinalis L., Apium graveolens L.*, *Chelidonium majus L., Urtica dioica L., Polygonatum odoratum (Mill.) Druce, Heracleum sosnowskyi, Chaerophyllum bulbosum L.*

3.1 The concentrations of pigments

The concentrations and content of pigments in the stem and leaf tissues of the collected plants were determined. The results for the concentration of pigments in the stems and leaves of plants collected from the vicinity of Vanadzor city are shown in Fig. 1.

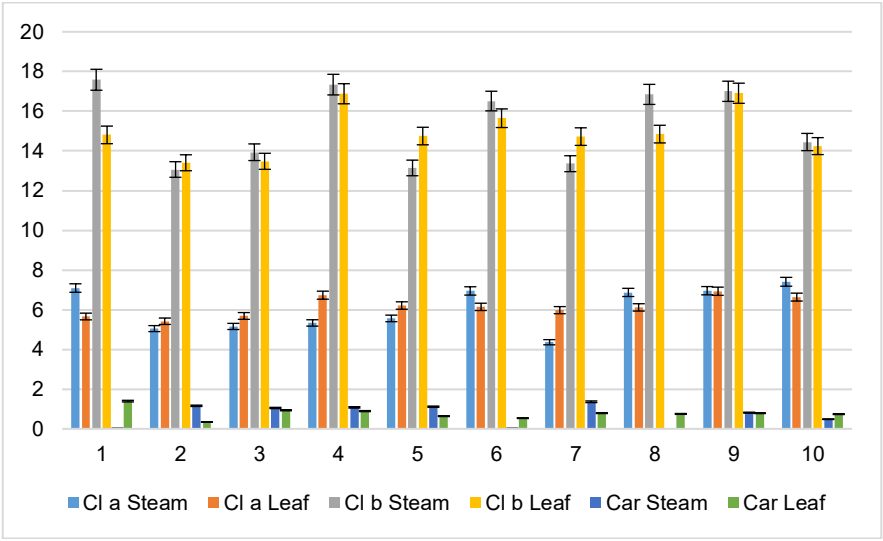

Fig. 1. Concentration of chlorophylls and carotenoids in the leaves and stems of the plants growing inVanadzor: *1. Thymus serpyllum L., 2. Teucrium polium L., 3. Asparagus officinalis L., 4. Mentha viridis L., 5. Apium graveolens L., 6. Chaerophyllum bulbosum L., 7. Urtica dioica L., 8. Chelidonium majus L., 9. Heracleum sosnowskyi, 10. Polygonatum odoratum (Mill.) Druce*

We also studied the concentration of chlorophyll a, b and carotenoids in the same plant samples growing in Stepanavan. The experimental results are showed in Fig. **2**.

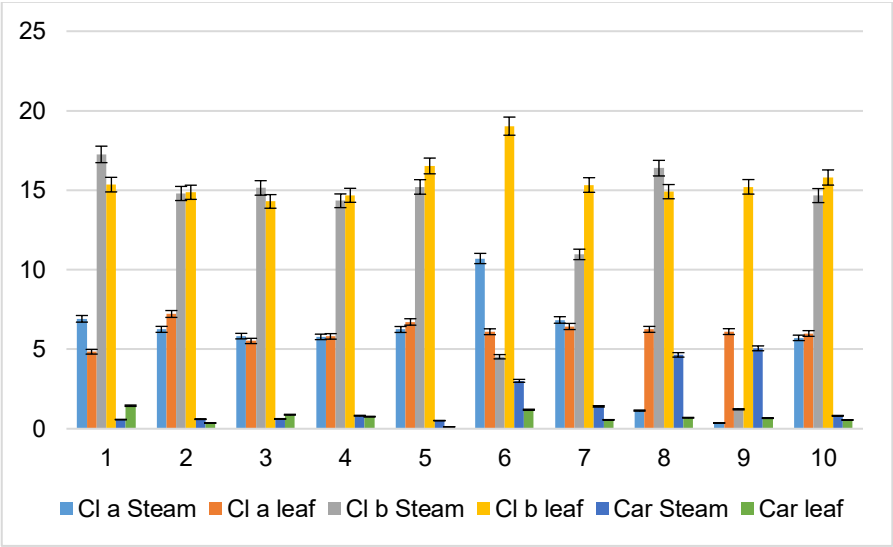

Fig. 2. Concentration of chlorophyll a, b and carotenoids in the leaves and stems of the plants growing in Stepanavan: *1. Thymus serpyllum L., 2. Teucrium polium L., 3. Asparagus officinalis L., 4. Mentha viridis L., 5. Apium graveolens L., 6. Chaerophyllum bulbosum L., 7. Urtica dioica L., 8. Chelidonium majus L., 9. Heracleum sosnowskyi, 10. Polygonatum odoratum (Mill.) Druce*

Based on the concentrations of chlorophylls and carotenoids, was determined the content of the chlorophyll a, b and carotenoids. The Table 2 including the data on the content of chlorophyll a, b and carotenoids of the plant samples growing in Vanadzor.

Table 2: The content of chlorophyll a, b and carotenoids of plant samples growing in Vanadzor

The plant sample	The organ of plant	The content of pigments (mg/g) in wet weight			Chlorophyll a + b
		Chlorophyll a	Chlorophyll b	Carotenoid	
Thymus serpyllum L.	stem	0.0945 ± 0.2	0.2345 ± 0.12	0.0003 ± 0.02	24.6778
	leaf	0.0754 ± 0.3	0.1974 ± 0.11	0.0186 ± 0.11	20.4684
Teucrium polium L.	stem	0.0673 ± 0.3	0.1742 ± 0.02	0.0154 ± 0.3	18.8068
	leaf	0.0723 ± 0.4	0.1787 ± 0.12	0.0046 ± 0.02	18.8251
Asparagus officinalis L.	stem	0.0688 ± 0.14	0.1857 ± 0.13	0.0140 ± 0.01	19.0926
	leaf	0.0758± 0.2	0.1796 ± 0.04	0.0125 ± 0.03	19.6215
Mentha viridis L.	stem	0.0711 ± 0.20	0.2312 ± 0.12	0.0144 ± 0.11	22.6746
	leaf	0.0898 ± 0.3	0.2250 ± 0.5	0.0119 ± 0.1	23.614
Apium graveolens L.	stem	0.0742 ± 0.4	0.1752 ± 0.2	0.0148 ± 0.22	18.7075
	leaf	0.0828 ± 0.13	0.1966 ± 0.03	0.0085 ± 0.05	20.9634
Chaerophyllum bulbosum L.	stem	0.0926± 0.21	0.2201 ± 0.1	0.00003 ± 0.02	24.4606
	leaf	0.0819 ± 0.03	0.2086 ± 0.4	0.0072 ± 0.12	21.792
Urtica dioica L.	stem	0.0582 ± 0.03	0.1781 ± 0.13	0.01816 ± 0.11	17.7211
	leaf	0.0797 ± 0.23	0.1963 ± 0.02	0.0106 ± 0.2	20.7011
Chelidonium majus L.	stem	0.0916 ± 0.3	0.2246 ± 0.4	0.000086 ±0.14	23.7212
	leaf	0.0816 ± 0.14	0.1979 ± 0.4	0.01003 ± 0.5	20.9669
Heracleum sosnowskyi	stem	0.0928 ± 0.02	0.2267 ± 0.21	0.0108 ± 0.05	23.9625
	leaf	0.0924 ± 0.11	0.2254 ± 0.13	0.0105 ± 0.12	23.8379
Polygonatum odoratum (Mill.) Druce	stem	0.0988 ± 0.3	0.1926 ± 0.06	0.0064 ± 0.3	21.8574
	leaf	0.0885 ± 0.4	0.1899 ± 0.03	0.0099 ± 0.2	20.8815

3.2 Comparison of Chlorophyll a Content in stems and leaves of plant growing in Vanadzor

In the same samples of the studied plants, the chlorophyll *a* content in the stems and leaves was compared. The findings are as follows: In *Thymus serpyllum L.*the chlorophyll a content in the stem is 1.253 times higher than in the leaves; in *Teucrium polium L.* It is 1.074 times higher in the leaves; in *Asparagus officinalis L.* It is 1.102 times higher in the leaves; in *Mentha viridis L.* It is 1.263 times higher in the leaves; in *Apium graveolens L.* It is 1.116 times higher in the leaves; in *Chaerophyllum bulbosum L.* the stem content is 1.131 times higher; in *Urtica dioica L.*the leaves contain 1.369 times more chlorophyll *a*; in *Chelidonium majus L.* the stem content is 1.122 times higher; *Heracleum sosnowskyi*the stem content is 1.004 times higher; in *Polygonatum odoratum (Mill.)Druce* the stem content is 1.116 times higher.

In the five species of plants growing in Vanadzor-*Thymus serpyllum L., Chaerophyllum bulbosum L., Chelidonium majus L., Heracleum sosnowskyi*, *Polygonatum odoratum (Mill.)Druce the content of* chlorophyll *a* is higher in the stems and in the other five species *Teucrium polium L.,Asparagus officinalis L.Mentha viridis L.*, *Apium graveolens L.*, *Urtica dioica L. the content of* chlorophyll *a* is higher in the leaves.

3.3 Comparison of Chlorophyll b Content in stems and leaves of plant growing in Vanadzor

The chlorophyll *b* content in the same samples of the studied plants in the stems and leaves was compared. The results are as follows: in *Thymus serpyllum L.*the chlorophyll *b* content in the stem is 1.187 times higher than in the leaves; in *Teucrium polium L.* it is 1.025 times higher in the leaves; in *Asparagus officinalis L.*it is 1.034 times higher in the stem; in *Mentha viridis L.* it is 1.027 times higher in the stem; in *Apium graveolens L.* it is 1.122 times higher in the leaves; in *Chaerophyllum bulbosum L.* the stem content is 1.055 times higher; in *Urtica dioica L.* the leaves contain 1.102 times more chlorophyll *b*; in *Chelidonium majus L.* the stem content is 1.135 times higher; in *Heracleum sosnowskyi* the stem content is 1.006 times higher; in *Polygonatum odoratum (Mill.)Druce*1.014 times higher in stem.

Among the studied plants in Vanadzor in seven species -*Thymus serpyllum L., Asparagus officinalis L., Mentha viridis L., Chaerophyllum bulbosum L., Chelidonium majus L., Heracleum sosnowskyi*, *Polygonatum odoratum (Mill.)Druce*the content of chlorophyll *b* is higher in the stems and in three species- *Teucrium polium L.*, *Apium graveolens L.*, *Urtica dioica L.* the content of chlorophyll *b* is higher in the leaves.

3.4 Comparison of Carotenoid Content in stems and leaves of plant growing in Vanadzor

In the analyzed plant samples, the carotenoid content in stems and leaves was compared. The results revealed significant variations between the two plant parts across the studied species:The content of carotenoid in leaves of *Thymus serpyllum L.* are exceeded stems by 62.0 times. The content of carotenoid in *Teucrium polium L.* was higher in stems by 3.347 times; in *Asparagus officinalis L.* was higher in stems by 1.12 times; in *Mentha viridis L.* was higher in stems by 1.21 times; in *Apium graveolens L.* in leaves exceeded stems by 1.741 times; in *Chaerophyllum bulbosum L.* in leaves exceeded stems by 240.0 times; in *Urtica dioica L.* was higher in stems by 1.713 times; in *Chelidonium majus L.* in leaves exceeded stems by 116.62 times; in *Heracleum sosnowskyi* in leaves exceeded stems by 1.028 times; in *Polygonatum odoratum (Mill.) Druce* in leaves exceeded stems by 1.547 times.

In Vanadzor, in most species, the leaves contain more carotenoids than the stems, with striking differences observed in *Chaerophyllum bulbosum L.* and *Chelidonium majus L.*, where the carotenoid content in the leaves exceeded that in the stems by over 100 and 200 times, respectively. In *Teucrium polium L., Asparagus officinalis L.,* and *Mentha viridis L.*, the stems showed higher carotenoid content, albeit by smaller margins. *Thymus serpyllum L.* displayed the highest leaf-to-stem ratio among the plants studied.

The based on the concentrations of chlorophylls and carotenoids, the content of pigments has been determined in plant samples growing in Stepanavan. The results are presented in Table 3.

Table 3: The content of pigments of plant growing in Stepanavan

The type of plant	The organ of plant	The content of pigments (mg/g) in wet weight			Chlorophyll a + b
		Chlorophyll *a*	Chlorophyll *b*	Carotenoid	
Thymus serpyllum L.	stem	0.0922 ± 0.2	0.2300 ± 0.11	0.0076 ± 0.03	24.169
	leaf	0.0645±0.01	0.2046 ± 0.12	0.0193 ± 0.20	20.1941
Teucrium polium	stem	0.0833 ± 0.11	0.1972 ± 0.03	0.0080 ± 0.02	21.0479

The type of plant	The organ of plant	The content of pigments (mg/g) in wet weight			Chlorophyll a + b
		Chlorophyll *a*	Chlorophyll *b*	Carotenoid	
L.	leaf	0.0962 ± 0.16	0.1982 ± 0.04	0.0048 ± 0.11	20.0892
Asparagus officinalis L.	stem	0.0776 ± 0.12	0.2019 ± 0.2	0.0082 ± 0.13	20.9712
	leaf	0.0736 ± 0.04	0.1906 ± 0.03	0.1178 ± 0.21	19.8193
Mentha viridis L.	stem	0.0770 ± 0.15	0.1911 ± 0.12	0.0109 ± 0.11	20.1138
	leaf	0.0774 ± 0.2	0.1957 ± 0.11	0.0101 ± 0.12	20.4894
Apium graveolens L.	stem	0.0832 ± 0.04	0.2027 ± 0.13	0.0068 ± 0.03	21.4513
	leaf	0.0895 ± 0.02	0.2203 ± 0.14	0.0015 ± 0.3	23.2445
Chaerophyllum bulbosum L.	stem	0.1343 ± 0.2	0.0604 ± 0.12	0.0403 ± 0.3	10.708
	leaf	0.0813 ± 0.11	0.2537 ± 0.04	0.0159 ± 0.13	18.9947
Urtica dioica L.	stem	0.0912 ± 0.12	0.1462 ± 0.04	0.0188 ± 0.03	17.8075
	leaf	0.0857 ± 0.11	0.2044 ± 0.02	0.0074 ± 0.2	21.7615
Chelidonium majus	stem	0.0152 ± 0.3	0.2184 ± 0.16	0.0619 ± 0.21	3.5021
	leaf	0.0833 ± 0.13	0.1988 ± 01.2	0.00926 ± 0.02	21.1603
Heracleum sosnowskyi	stem	0.0048 ± 0.2	0.0163 ± 0.3	0.0674 ± 0.02	1.5858
	leaf	0.0814 ± 0.03	0.2028 ± 0.11	0.0088 ± 0.12	21.3241
Polygonatum odoratum (Mill.) Druce	stem	0.0762 ± 0.2	0.1955 ± 0.12	0.0108 ± 0.02	20.3804
	leaf	0.0798 ± 0.3	0.2106 ± 0.11	0.0073 ± 0.2	21.7911

3.5 Comparison of Chlorophyll a Content in stems and leaves of plant growing in Stepanavan

In the same samples of the studied plants, the chlorophyll *a* content in the stems and leaves was compared. The distribution is as follows: in *Thymus serpyllum L*. the chlorophyll a content in the stem exceeds that in the leaves by 1.429 times; in *Teucrium polium L.* it is higher in the leaves by 1.154 times; in Asparagus officinalis L. the stem content is 1.054 times higher; in *Mentha viridis L.* it is slightly higher in the leaves by 1.005 times; in *Apium graveolens L*. it is higher in the leaves by 1.075 times; in *Chaerophyllum bulbosum L*. the stem content is 1.651 times higher; *Urtica dioica L*. the stem content is 1.064 times higher; in *Chelidonium majus L.* the content is significantly higher in the leaves by 5.480 times; in *Heracleum sosnowskyi*, it is much higher in the leaves by 16.958 times; in *Polygonatum odoratum (Mill.) Druce*, the chlorophyll a content is higher in the leaves by 1.047 times.

Among the plant samples studied in Stepanavan the chlorophyll *a* content in the stems was higher than in the leaves in four species: *Thymus serpyllum L*., Asparagus officinalis L., *Chaerophyllum bulbosum L*., *Urtica dioica L*. In contrast, the chlorophyll *a* contentwas higher in the leaves than in the stems in six species: *Teucrium polium L., Mentha viridis L., Apium graveolens L*., *Chelidonium majus L*., *Heracleum sosnowskyi*, *Polygonatum odoratum (Mill.)Druce.*

3.6 Comparison of Chlorophyll b Content in stems and leaves of plant growing in Stepanavan

In the same samples of the studied plants, the chlorophyll *b* content in stems and leaves was compared, and the results are as follows: in *Thymus serpyllum L*. the chlorophyll *b* content

in the stems exceeds that in the leaves by 1.124 times. In *Teucrium polium L.* it is slightly higher in the leaves by 1.009 times. In *Asparagus officinalis L.* the stem content exceeds the leaves by 1.059 times. In *Mentha viridis L.* it is slightly higher in the leaves by 1.024 times.In *Apium graveolens L*. the content is higher in the leaves by 1.086 times. In *Chaerophyllum bulbosum L*. the content in the leaves is significantly higher by 4.2 times. In *Urtica dioica L*. the leaves contain 1.398 times more chlorophyll *b* than the stems. In *Chelidonium majus L*. the chlorophyll *b* content in the stem is higher by 1.098 times. In *Heracleum sosnowskyi* the content is much higher in the leaves by 12.44 times, In *Polygonatum odoratum (Mill.)Druce* the content is higher in the leaves by 1.077 times.

Among the studied plants, the chlorophyll *b* content is higher in the stems of three species: *Thymus serpyllum L*., *Asparagus officinalis L.*, *Chelidonium majus L*.. In contrast, the chlorophyll *b* content is higher in the leaves of seven species: *Teucrium polium L.*, *Mentha viridis L.*, *Apium graveolens L*., *Chaerophyllum bulbosum L*., *Urtica dioica L.*, *Heracleum sosnowskyi*, *Polygonatum odoratum (Mill.)Druce.*

3.7 Comparison of Carotenoid Content in stems and leaves of plant growing in Stepanavan

This comparison shows *Asparagus officinalis L*. as having the highest carotenoid content in its leaves. In the studied plants, the carotenoid content in the leaves was compared to that in the stems. The results are as follows: *Thymus serpyllum L*.: the carotenoid content in the leaves exceeds that in the stem by 2.539 times; *Teucrium polium L.*: the carotenoid content is higher in the stem by 1.66 times; *Apium graveolens L*.: the carotenoid content in the leaves exceeds that in the stem by 14.365 times; *Mentha viridis L.*: the carotenoid content is higher in the stem by 1.079 times; *Apium graveolens L*.: the carotenoid content higher in the stem by 4.533 times; *Chaerophyllum bulbosum L*.: the carotenoid content higher in the stem by 2.534 times; *Urtica dioica L*.: the carotenoid content higher in the stem by 2.540 times; *Chelidonium majus L*.: the carotenoid content higher in the stem by 6.684 times; *Heracleum sosnowskyi*: the carotenoid content in the leaves exceeds that in the stem by 7.659 times; *Polygonatumodoratum (Mill.)Druce:* the carotenoid content higher in the stem by 1.479 times.

This comparison shows that, for most plants, the carotenoid content is higher in the leaves, except for a few where the stem has a higher concentration. In seven plants the carotenoid content is higher in the stem, such as: *Teucrium polium L.*, *Mentha viridis L.*, *Apium graveolens L*., *Chaerophyllum bulbosum L*., *Urtica dioica L*., *Chelidonium majus L*. and *Polygonatum odoratum (Mill.)Druce.* In the three plants the carotenoid content is higher in the leaves: *Thymus serpyllum L*., *Heracleum sosnowskyi* and *Asparagus officinalis L.*

3.8 Comparison the carotenoid content between the samples from Vanadzor and Stepanavan

The carotenoid content in stems and leaves of the studied plants was compared between the samples from Vanadzor and Stepanavan, as shown in Figure 3.

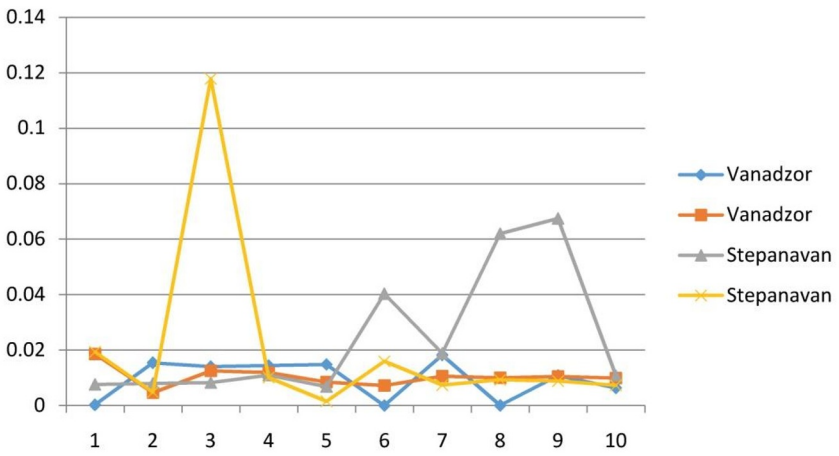

Fig. 3. Comparison of the carotenoid content in the stems and leaves of the studied plants growing in Vanadzor and Stepanavan: 1. Thymus serpyllum L., 2. Teucrium polium L., 3. Asparagus officinalis L., 4. Mentha viridis L., 5. Apium graveolens L., 6. Chaerophyllum bulbosum L., 7. Urtica dioica L., 8. Chelidonium majus L., 9. Heracleum sosnowskyi, 10. Polygonatum odoratum (Mill.) Druce

From Figure 3 it is evident that in two of the studied plants, *Thymus serpyllum L.*and *Heracleum sosnowskyi*, the carotenoid content in the leaves surpasses that in the stems in both growth locations. In the case of three plants *Teucrium polium L.*, *Mentha viridis L.* and *Urtica dioica L.* the carotenoid content is higher in the stems.

For the other studied plants, the distribution varies: in *Asparagus officinalis L.*, the carotenoid content is higher in the stems of samples grown in Vanadzor, whereas in the leaves, it is higher in samples from Stepanavan. In *Chelidonium majus L., Apium graveolens L.*, *Chaerophyllum bulbosum L.*and *Polygonatum odoratum (Mill.) Druce*, the carotenoid content is higher in the leaves of samples from Vanadzor but higher in the stems of samples from Stepanavan.

Among the studied plants, *Chaerophyllum bulbosum L.* ranks first in terms of its health benefits. In samples grown in Vanadzor, the carotenoid content in the leaves exceeds that in the stems by 240 times, while in samples from Stepanavan, the leaf carotenoid content is 2.534 times higher than that in the stems.

Second place is held by *Chelidonium majus L.* In samples grown in Vanadzor, the carotenoid content in the leaves exceeds that in the stems by 116.62 times, whereas in Stepanavan samples, the carotenoid content in the stems surpasses that in the leaves by 6.684 times.

In third place is *Asparagus officinalis L.* in samples from Vanadzor, the carotenoid content in the stems is 1.12 times higher than in the leaves, whereas in Stepanavan samples, the carotenoid content in the leaves exceeds that in the stems by 14.365 times.

In *Apium graveolens L.*, the carotenoid content in the stems of Stepanavan samples is 4.533 times higher than in the leaves, while in Vanadzor samples, the carotenoid content in the leaves is 1.741 times higher than in the stems.

This comparison provides insights into how environmental factors may influence the carotenoid concentration in different plant parts across these two locations.

4 Conclusions

The comparing of the content of carotenoids in the plants growing in Vanadzor and Stepanavan, showed that the plants have more significance for health.

The steams and leaf of the *Chaerophyllum bulbosum L.* used by the population in cooked and pickled form in food. The steam and leaf of the *Chelidonium majus L.* are used in the folk medicine.The steams and leaf of the plant of *Thymus serpyllum L.* are used in the tea, its lowers the blood pressureand raises the immune boosting properties.

Considering the antioxidant and immune boosting properties of carotenoids [2], we believe that the use of these plants can be quite beneficial for human health.

The Geographic Influence are: The differences content of carotenoid distribution between stems and leaves are likely influenced by environmental factots (for example-climate, soil conditions) in Vanadzor and Stepanavan. In the plants growing in Vanadzor, leaves generally exhibit a higher carotenoid content, while in the plants growing in Stepanavan, the stems of some plants tend to contain more carotenoids. The nutritional and Medicinal Implications are: Carotenoids are essential antioxidants linked to eye health, immune support, and reducing the risk of chronic diseases. The findings suggest specific plants and their parts (stems or leaves) could be targeted for functional foods or medicinal uses, depending on the location and plant type. The patterns of Carotenoid Distribution are: The plants such as *Chaerophyllum bulbosum L.* and *Chelidonium majus L.* show marked contrast in carotenoid distribution between regions, highlighting the need for localized agricultural strategies to maximize nutritional content. The Research Implications are: The study provides a foundation for further research into how environmental factors affect phytochemical accumulation in plants. It underscores the importance of regional cultivation strategies for optimizing health-related compounds in plants.

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