FEATURES OF THE CONTENT AND ACCUMULATION OF BIOLOGICALLY ACTIVE SUBSTANCES IN THE LEAVES OF DANDELION DEPENDING ON THE GROWING CONDITIONS

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Abstract:
This paper discusses the features of the content and accumulation of some biologically active substances in the leaves of dandelion depending on the lighting conditions and climatic conditions.

Purpose of research is the establishment of the content of bioactive compounds in the leaves of the dandelion (Taraxacum officinale) to justify their use.

Key words: dandelion, pigments, phenolic compounds, flavonoids, riboflavin, thymol.

In 2017, the strategy "Science and technology: 2018-2040" was developed and adopted in the Republic of Belarus. One of the most important directions of this strategy in the field of bioindustry is the development of technologies for obtaining economically valuable products based on plant raw materials, as well as the development of therapeutic and prophylactic drugs, functional products, children's and herodietic nutrition. To implement these directions, the chemical composition of wild plants is studied, one of which is dandelion (Taraxacum officinale). This perennial herbaceous plant is distributed everywhere except for the Arctic and Alpine regions [1].

The Pharmacopoeia of many countries, including the State Pharmacopoeia of the Republic of Belarus, contains information about the roots of dandelion. This raw material is used for the preparation at home infusions used in the treatment of diseases of the gastrointestinal tract: esophagitis, colitis, gastric and duodenal ulcer. The roots of this plant have anti-inflammatory effect, promote rapid regeneration of damaged mucous membranes of internal organs. When harvesting dandelion roots, its aboveground part is discarded. In foreign medical practice, along with underground, widely used and aboveground part of the plant. In a number of countries it is used for the manufacture of anti-inflammatory drugs and immunomodulators. There is evidence of the use of the aerial part of dandelion in folk medicine in European countries. In some regions, dandelion leaves are used as a food, adding to soups and salads [2].

Previously, studies have been conducted, the results of which in the leaves of dandelion drug found the presence of biologically active compounds with different structures and effects on the human body. The analysis of literature sources shows that the information about the chemical composition of the above-ground part of the dandelion of the drug growing in the territory of the Republic of Belarus is very limited and not generalized. Full processing of all phytomass of this plant will promote its complex processing that corresponds to modern requirements of resource-saving and waste-free technologies. For these reasons, the study of biologically active substances contained in the leaves of Taraxacum officinale, is an important task [3].

The aim of this work is to establish the features of the content and accumulation of biologically active compounds of leaves of dandelion (Taraxacum officinale) to justify their use.

The object of the study served the leaves of dandelion, collected in the village Ulanovichi of Vitebsk region. Harvesting of raw materials was carried out at two sites: a mixed forest (shaded area) and a meadow along the shoreline of the Western Dvina river (a well-lit area). Methods for determining the chemical composition were generally accepted, with the exception of determining the pigment composition [4].

Determination of the quantitative content of photosynthetic pigments was carried out in alcohol extracts by spectrophotometric method [5].

The quantitative content of the sum of phenols and flavonoids was determined in alcohol extracts by spectrophotometric methods based on the formation of colored products of chemical reactions. Identification of the types of flavonoids was performed using the qualitative reactions from alcohol cure [5, 6].

Determination of the quantitative content of oxidized and reduced forms of Riboflavin was carried out by spectrophotometric method with preliminary heat treatment of plant material in an acidic medium. Riboflavin content was calculated according to the calibration schedule [7].

The quantitative content of thymol was determined spectrophotometrically, using the technique without prior isolation of essential oil [8].

The chemical composition of the above-ground part of the dandelion is represented by a wide range of biologically active compounds of different chemical structures and actions.

Pigments are chlorophylls a and b, carotenoids. The quantitative content of pigments can be used as an indicator of genetic and age-related changes in the plant. The functional purpose of chlorophylls is the absorption of light quanta and the implementation of photochemical reactions in the process of photosynthesis. Carotenoids are auxiliary pigments, they extend the spectrum of absorption of visible light by chlorophylls, protect them from active oxygen radicals that are formed during the light phase of photosynthesis [9].

The results of the determination of the number of photosynthetic pigments are given in table 1.

Table 1

Quantitative content of pigments in 1 g of dry mass dandelion leaf, g *(M±m)*

Term	Place	Chlorophyll a	Chlorophyll b	Carotenoids
2017 year	Mixed forest	0,97±0,07	0,40±0,07	0,56±0,06
	The bank of the Western Dvina river	0,28±0,04[1]	0,12±0,01[1]	0,20±0,01[1]
2018 year	Mixed forest	1,08±0,06[3]	0,52±0,06[3]	0,66±0,05[3]
	The bank of the Western Dvina river	0,30±0,02[2,4]	0,15±0,02[2,4]	0,22±0,02[2,4]

Note: [1]P < 0,05 in comparison with the gathering place "mixed forest" in 2017; [2]P < 0,05 in comparison with the gathering place "mixed forest" in 2018; [3]P < 0.05 comparison with the gathering place "mixed forest in 2017"; [4]P < 0,05 in comparison with the gathering place, "the Bank of the river Western Dvina in 2017".

As can be seen from table 1, the content of chlorophyll a (2017) per 1g of raw material is significantly higher in dandelion leaves collected in a shaded area than in a well-lit 3.59 times. The content of chlorophyll b (2017) per 1g of raw material is also statistically higher in dandelion leaves collected in a shaded area, compared with a well-lit 3.42 times. The content of 1g of raw carotenoids (2017) is significantly higher in dandelion leaves collected in a shaded area than in a well-lit 2.95 times.

The content of chlorophyll a (2018) on 1g of raw materials is significantly higher in dandelion leaves collected in a shaded area, compared with a well-lit 3.6 times. The content of 1g of chlorophyll b (2018) is also statistically significantly higher in dandelion leaves collected in a shaded area than in a well-lit 3.46 times. The content of 1g of raw carotenoids (2018) is also significantly higher in dandelion leaves collected in a shaded area than in a well-lit 3 times.

The content of 1g of chlorophyll a is significantly higher in dandelion leaves collected in mixed forest in 2018 than in the same area in 2017 by 1.11 times. The content of chlorophyll b per 1g of raw material is also statistically higher in dandelion leaves collected in mixed forest in 2018 than in the same area in 2017 by 1.3 times. The content of 1g of raw carotenoids is significantly higher in dandelion leaves collected in a mixed forest in 2018 than in a similar area in 2017 by 1.18 times.

The content of chlorophyll a on 1g of raw materials is significantly higher in dandelion leaves collected on the river bank in 2018 than in the same area in 2017 by 1.07 times. The content of chlorophyll b per 1g of raw material is also statistically higher in dandelion leaves collected on the river bank in 2018 than in the same area in 2017 by 1.25 times. The content of 1g of raw carotenoids is significantly higher in dandelion leaves collected on the river bank in 2018 than in the same area in 2017 by 1.1 times.

Thus, it is proved that the content of 1g of raw pigments (chlorophylls a and b, carotenoids) is higher in the dandelion leaves collected in a shaded area than in a well-lit one, therefore, sunlight is one of the factors affecting the accumulation of pigments in the leaves.

In plants, phenolic compounds perform a number of physiologically important functions: they participate in the processes of respiration and photosynthesis, are regulators of growth, development and reproduction, and also perform a protective function. According to the literature, it is known that the secondary metabolites of dandelion leaves include taraxanthin, flavoxanthin, choline, lutein, carotene, triterpene alcohols [10].

The results of the study are shown in table 2.

Table 2

Quantitative content of the sum of phenolic compounds in dandelion leaves ,% *(M±m)*

Term	Place	The sum of phenolic compounds
2017 year	Mixed forest	8,36±0,98
	The bank of the Western Dvina river	15,01±1,40[1]
2018 year	Mixed forest	9,08±1,02[3]
	The bank of the Western Dvina river	16,45±1,46[2,4]

Note: [1]P < 0,05 in comparison with the gathering place "mixed forest" in 2017; [2]P < 0,05 in comparison with the gathering place "mixed forest" in 2018; [3]P < 0.05 comparison with the gathering place "mixed forest in 2017"; [4]P < 0,05 in comparison with the gathering place, "the Bank of the river Western Dvina in 2017".

Analysis of table 2 showed that the content of total phenolic compounds was significantly higher 1.80 times in the leaves of dandelion, collected on the banks of the river in 2017, and 1.81 times in the leaves of dandelion, collected on the banks of the river in 2018. The content of the sum of phenolic compounds is statistically significantly higher in dandelion leaves collected in the mixed forest in 2018 than in the same area in 2017 by 1.09 times. The content of the amount of phenolic compounds is significantly higher in the dandelion leaves collected on the river Bank in 2018 than in the same area in 2017 by 1.10 times.

This is probably also due to the different lighting mode. Thus, the total content of phenolic compounds can reveal a connection with a certain environmental environment, depending on moisture and light.

Phenolic compounds contained in the leaves of dandelion have antimicrobial and anti-inflammatory effects.

Flavonoids are active metabolites of plant cells. One of their most important functions is participation in oxidation and reduction processes, many of them are antioxidants [6].

The total content of flavonoids in dandelion leaves from different growing conditions is shown in table 3.

Table 3

Quantitative content of the sum of flavonoids in dandelion leaves ,% *(M±m)*

Term	Place	The sum of flavonoids
2017 year	Mixed forest	0,64±0,09
	The bank of the Western Dvina river	2,49±0,25[1]
2018 year	Mixed forest	0,69±0,11[3]
	The bank of the Western Dvina river	2,78±0,39[2,4]

Note: [1]P < 0,05 in comparison with the gathering place "mixed forest" in 2017; [2]P < 0,05 in comparison with the gathering place "mixed forest" in 2018; [3]P < 0.05 comparison with the gathering place "mixed forest in 2017"; [4]P < 0,05 in comparison with the gathering place, "the bank of the river Western Dvina in 2017".

According to the results presented in table 3, it can be seen that the content of the amount of flavonoids is significantly higher by 3.89 times in the dandelion leaves collected on the river bank in 2017, and 4 times in the dandelion leaves collected on the river bank in 2018. The content of the amount of phenolic compounds is significantly higher in the dandelion leaves collected in the mixed forest in 2018 than in the same area in 2017 by 1.07 times. The content of the amount of phenolic compounds is significantly higher in the dandelion leaves collected on the river Bank in 2018 than in the same area in 2017 by 1.11 times.

Qualitative chemical reactions were carried out with the obtained extracts [6].

After the cyanidin test, pink staining appeared, therefore, in the extracts there are closed-cycle flavonoids. After the reaction with ammonia, yellow staining was observed, which is typical for closed-cycle flavonoids. After completing boric-citric reaction, watched the bright yellow staining that indicates the presence in the extracts of flavonoids containing two hydroxy groups. After performing the reaction with aluminum chloride was observed yellow staining that confirms the presence in the extracts of flavonoids containing two hydroxy groups.

Therefore, on the basis of the obtained results it can be concluded that extracts from dandelion leaves regardless of the climate and lighting conditions contain all the studied types of flavonoids.

In plants, riboflavin plays an important role: part of coenzymes of flavinadeninnukleotid (FMN) and flavinadeninnukleotid (FAD) respiratory enzymes [7]

The results of the study are shown in table 4.

Table 4

Quantitative content of riboflavin in dandelion leaves, mkg *(M±m)*

Term	Place	Oxidized riboflavin	Recycled riboflavin
2017 year	Mixed forest	5,50±0,28	2,93±0,25
	The bank of the Western Dvina river	3,78±0,49[1]	2,20±0,27[1]
2018 year	Mixed forest	5,58±0,30	2,96±0,27
	The bank of the Western Dvina river	3,80±0,50[2]	2,25±0,30[2]

Note: [1]P < 0,05 in comparison with the gathering place "mixed forest" in 2017; [2]P < 0,05 in comparison with the gathering place "mixed forest" in 2018.

According to the results presented in table 4, the content of the oxidized form of Riboflavin is significantly higher by 1.5 times, and reduced by 1.3 times in the dandelion leaves collected in the mixed forest compared to the dandelion leaves collected along the coastline in 2017.

The content of oxidized riboflavin is significantly higher by 1.46 times, and recycled by 1.31 times in raw materials collected in a mixed forest compared to dandelion leaves collected along the coastline in 2018. The content of the oxidized form of riboflavin in the raw material from the shaded zone of the 2018 is 1.01 times higher than in the raw material of the 2017. The content of the oxidized form of riboflavin in the raw material from the well-lit zone of the 2018 is also 1.01 times higher than in the raw material of the 2017.

The content of recycled riboflavin in the leaves from the shaded zone of the 2018 is 1.01 times higher than in the raw material of the 2017. The content of recycled riboflavin in the leaves from the well-lit zone of the 2018 is 1.02 times higher than in the raw material of the 2017.

This is due to the different lighting conditions (sunlight is one of the factors affecting the accumulation of vitamins in the leaves) and the peculiarities of the climatic regime in 2017 and 2018.

According to the results of the study, it can be concluded that the accumulation of riboflavin is influenced only by lighting features; climatic features practically do not affect the accumulation of this biologically active substance.

Thymol delays the reproduction of microorganisms on the surface of the skin and mucous membranes, therefore, extracts from such inexpensive and affordable raw materials can be used externally as a healing agent (lotions, compresses, General and local baths), as well as be part of cosmetics, such as lotions and toothpastes [8].

The results of the quantitative determination of thymol content are shown in table 5.

Table 5

Quantitative content of thymol in dandelion leaves, % *(M±m)*

Срок сбора	Place	Thymol
2017 year	Mixed forest	0,91±0,01
	The bank of the Western Dvina river	1,09±0,03[1]
2018 year	Mixed forest	0,93±0,02
	The bank of the Western Dvina river	1,12±0,04[2]

Note: [1]P < 0,05 in comparison with the gathering place "mixed forest" in 2017; [2]P < 0,05 in comparison with the gathering place "mixed forest" in 2018.

According to the results presented in table 5, it can be seen that the content of thymol is significantly higher by 1.2 times in the dandelion leaves collected on the river Bank in 2017, and by the same number of times in the dandelion leaves collected on the river bank in 2018. The content of thymol is higher in the dandelion leaves collected in the mixed forest in 2018 than in the same area in 2017 by 1.02 times. The content of thymol is higher in the dandelion leaves collected on the river bank in 2018 than in the same area in 2017 by 1.03 times.

According to the data obtained, it can be concluded that the accumulation of thymol is influenced only by the peculiarities of lighting; climatic features practically do not affect the accumulation of this biologically active substance.

The content of all investigated biologically active substances, except Riboflavin and thymol, in raw materials collected in 2018 is higher than in 2017. This is due to the influence of hydrometeorological conditions, as may 2017. in the Republic of Belarus was characterized by unstable temperature regime, frequent frosts and precipitation in the form of wet snow. The average temperature was +12,08 C. May 2018. marked by high temperatures and precipitation deficit. The average monthly temperature was +16.14 C [6].

The studied biologically active substances contained in the aerial part of the dandelion have a number of beneficial effects on the skin and mucous membranes, therefore, can be widely used in dentistry and dermatology. Pigments have a local antibacterial effect, which will allow the use of such extracts in the creation of dermatological and dental ointments. Phenolic compounds have anti-inflammatory effect. Spectrum of action of various flavonoids: anti-inflammatory, antibacterial, antioxidant. Flavonoids help to improve the structure of the vascular walls, blood supply and contribute to the rapid healing of small inflammations. Riboflavin also has a positive effect on the skin, accelerates its metabolism.

Thus, the result of these studies identified some chemical constituents of leaves of dandelion, possessing biological activity. It was found that the content of photosynthetic pigments (chlorophylls a and b, carotenoids) and Riboflavin on 1g of raw materials is higher in dandelion leaves collected in a shaded area, compared with well-lit. The content of the sum of phenolic compounds and flavonoids, thymol is higher in dandelion leaves collected in the open area, compared with shaded. In addition, the content of biologically active substances in raw materials collected in 2018 is higher than in 2017 (except riboflavin and thymol). The accumulation of Riboflavin and thymol is influenced only by lighting features, and climatic features practically do not affect the accumulation of these biologically active substances. The qualitative composition of flavonoids under the influence of sunlight and climatic conditions does not change.

Extracts obtained from the leaves of Taraxacum officinale are inexpensive and affordable, they are convenient to use not only to create medicines, but also in the cosmetic industry, for example, to enter into the composition of lotions. This type of cosmetic products is convenient and easy to use, combining several functions: removing makeup, cleansing of dirt and excess sebum, healing minor skin lesions. This product is most convenient for oily and combination skin types. Such skin is not recommended to overload with cosmetics, therefore, a minimum of care products with combined action is necessary. These cosmetics will be especially in demand among adolescents, pregnant and lactating women, as well as those undergoing long-term hormonal therapy, as due to the rearrangements in the endocrine system, these categories of people may experience certain dermatological problems. In addition, extracts obtained from the leaves of dandelion medicinal, can be administered in shampoos designed to care for hair and scalp prone to high fat content. Extracts from such affordable and feature-rich raw materials can be included in the composition of balms for care of lip skin that is prone to frequent cracks. Also, these extracts can be introduced into the composition of toothpastes, due to the fact that the leaves of the dandelion drug have an anti-inflammatory effect not only on the skin but also on the mucous membranes, which is especially important in the tendency of the gums to constant bleeding.

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