11. Максимова Т.М., Белов В.Б., Лушкина Н.П., Королькова Т.А., Гаенок О.Н., Барабанова Н.А., Токуров Т.В., Роговина А.Г. Состояние здоровья, условия жизни и медицинское обеспечение детей в России. *Москва: ПЕР СЭ*. 2008;367. [Maksimova TM., Belov VB., Lushkina NP., Korol'kova TA., Gaenok ON., Barabanova NA., Tokurov TV., Rogovina AG. Health status, living conditions and medical care for children in Russia. *Moscow. Publishing house of "per-se"*. 2008;367. (In Russ.).].

12. Ткачук М.Г., Вадюхина С.В. Особенности физического развития детей, проживающих в условиях Крайнего Севера. *Учёные записки СПбГМУ им. акад. И.П. Павлова*. 2011;18(2):145-6. [Tkachuk MG., Vadjuhina SV. Features of the physical development of children living in the Far North. *The Scientific Notes of the I. P. Pavlov St. Petersburg State Medical University*. 2011;18(2):145-6. (In Russ.).].

13. Тутельян В.А., Батурин А.К., Конь И.Я. Распространённость ожирения и избыточной массы тела среди детского населения РФ: мультицентровое исследование. *Педиатрия*. 2014;93(5):28-31. [Tutel'jan VA., Baturin AK., Kon' IJa. The prevalence of obesity and overweight among the child population of the Russian Federation: a multicenter study. *Pediatia*. 2014; 93(5):28-31. (In Russ.).].

14. Крукович Е.В., Транковская Л.В., Осин А.Я., Бондарь Г.Н., Яценко А.К., Корнеева Е.А., Садова Н.Г. Физическое воспитание детей в организованных коллективах. *Здоровье. Медицинская экология. Наука*. 2015;63(5):43-50. [Krukovich EV., Trankovskaja LV., Osin AJa., Bondar' GN., Jacenko AK., Korneeva EA., Sadova NG. Physical education of children in organized groups. *Health. Medical ecology. The science*. 2015; 63(5):43-50. (In Russ.).].

15. Belisheva NK., Martynova AA., Pryanichnikov SV., Solov'evskaya NL., Mikhailov RE Age-dependent heart rate variability in preschool children living under the conditions of the European Arctic region. *Human Physiology*. 2016; 42(2):156-168. DOI:10.1134/S0362119716020031.

16. Shephard R.J., Rode A. The health consequences of "modernization": Evidence from circumpolar peoples. *Cambridge University Press, Cambridge*. 1996; 306.

17. Sullivan K.M., Gorstein J. ANTHRO software for calculating anthropometry. Version 1.02, Y2K Compliant. *WHO, Centres for Disease Control and Prevention*. 1999; 6.

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# INFLUENCE OF CEMENT PLANT EMISSIONS ON MEDICINAL PROPERTIES OF MEDICINAL PLANTS IN CENTRAL YAKUTIA

**ABSTRACT**

The work is devoted to the study of the influence of cement dust on the medicinal properties of plants, namely the content of flavonoids in plants of Central Yakutia. Flavonoids being evolutionarily adequate to the human body, cause antioxidant, angioprotective, hepatoprotective, choleretic, diuretic, neurotropic, anti-oncological and other important pharmacological properties. The plants were collected in areas of high and medium pollution with cement dust. The study found that the plants of each species collected in different environmental conditions, different levels of flavonoids. In the zone of severe pollution with cement dust (at a distance of 500 m from the plant), the most pronounced decrease in the content of flavonoids in plants than in other study areas was noted. From the above data it can be seen that the spectrum of the content of substances of secondary synthesis varies in plants growing in conditions of atmospheric pollution, depending on the zone of influence of cement dust emissions. All species we study collected in the technogenic zone produce fewer flavonoids than plants collected in the control area. That is connected, in all probability, with the need to develop adaptive systems to change the cement environment. This fact is a consequence of the response to stress factors of plant organisms.

Consequently, it can be assumed that the content and accumulation of flavonoids depends on the presence and concentration of anthropogenic impurities in the atmosphere. According to the literature data, it was found that at a distance of 20 m from the plant there was the excess of biogenic elements B, Zn, Cu. Their high concentration in the soil is manifested in inhibition of growth, increase of lipid peroxidation and permeability of plant membranes.

**Keywords:** flavonoids, dietary supplement, cement dust.

**Introduction.** One of the directions of development of the pharmaceutical industry is to increase the range of new medicines, which include medicinal plant materials and products dietary supplemented on it. Currently, out of hundreds of thousands of medicines used in world medical practice, medicinal preparations from plants make up over 30%.

It has been established that with increasing extremes of climatic growing conditions in the tissues of a number of plant species, a greater number of biologically active substances (DIETARY SUPPLEMENT) are synthesized [5, 7].

Intensive industrial development of natural resources has a negative impact on natural ecosystems. Due to emissions of solid particles, especially ash, soot, cement dust into the atmospheric air, dust layers are formed, which slow down the processes of photosynthesis. Cement dust, penetrating through the stomata during the gas exchange of leaves into plants, affects not only the surface, but also the cells inside the plant. The more available moisture reserves from the soil are consumed, the earlier the plants experience a water deficit [3]. Photosynthetic activity decreases with an increase in leaf temperature and the onset of water deficiency [6].

“Yakutcement” is the largest cement plant of republican significance in Yakutia. The plant is located in the village of Mokhsogollokh Khangalassky district. Currently, the plant produces up to 300 thousand tons of cement per year, over 500 thousand tons of crushed stone.

Aerial emissions from this plant, along with oxides and nitrogen dioxide, sulfur dioxide, carbon dioxide and organic combustion products, contain a significant amount of cement, slurry and clinker dust, which is capable of alkalizing the environment [8].

We have conducted a study of plants collected in the zones of influence of cement dust and motor vehicle exhaust gases on the accumulation of flavonoids in them. A comparative phytochemical analysis of vegetation growing on technologically polluted sites is of great importance in terms of studying the mechanisms of plant adaptation to the negative effects of a polluted environment. Therefore, phytochemical studies are an essential part of the study of the biological resources of Yakutia.

**Material and research methods.**We studied 8 plants growing in Central Yakutia as the object of study: ordinary tansy *Tanacetum vulgare* L. (leaves, flowers), fireweed angustifolia *Chamaenerion angustifolium* (L.) Holub. (leaves, flowers), lanka astalavista *Linaria acutiloba* Fisch. ex. Reichenb. (leaves), Mongolian wormwood *Artemisia mongolica* (Bess.) Fisch. ex. Nakai (leaves), yakut wormwood *Artemisia jacutica* Drob. (leaves), elecampane British *Inula britannica* L. (leaves), dandelion horned *Taraxacum ceratophorum* (Ledeb.) DC. (leaves), yarrow ordinary *Achillea millefolium* L. (leaves), growing in Central Yakutia.

Plant samples were collected from communities in the vicinity of the "Yakutcement" plant in Moksogollokh, Khangalassky district, at a distance of 500 m, 1000 m and 2000 m in a linear, northeastern direction. In total, 4 areas were selected for collecting plants.

**Area number 1** is located on an artificial sand dump 500 meters from the "Yakutcement" cement plant. There are 14 species in the community, of which *Tanacetum vulgare* L., *Chamaenerion angustifolium* (L.) Holub., *Artemisia mongolica* (Bess.) Fisch. ex. Nakai., *Linaria acutiloba* Fisch. ex. Reichenb., *Taraxacum ceratophorum* (Ledeb.) DC. dominate. The total projective vegetation (TPV) cover is 30%.

**Area number 2** is located 1000 meters from the cement plant "Yakutcement", adjacent to the highway. The objects of study are located in the larch-forbury-cranberry forest with birches and willows. The stumps from the felling of trees is marked in the forest and there is an undergrowth of larch. *Larix dahurica* Turcz. ex. Trautv., *Betula pendula* Roth., *Salix bebbiana* Sarg. are noted in the tree layer. The closeness of tree crowns is 5%. In the shrub layer, there are *Rosa acicularis* Lindl., *Vaccinium vitis-idaea* L., *V. uliginosum* (L.) In the grassy layer, there are 16 plant species, dominated by *Tanacetum vulgare* L., *Chamaenerion angustifolium* (L.) Holub., *Linaria acutiloba* Fisch. ex. Reichenb., *Vicia amoena* Fisch., *Inula Britannica* (L.). The TPV cover is 40%.

**Area number 3** is located 2000 meters from the plant "Yakutcement" and 50 meters from the road. In the steppe grassy meadow, 15 plant species are noted, of which Poaangustifolia L., Taraxacumceratophorum, ChamaenerionangustifoliumHolub.,Tanacetum vulgare L., Hordeumjubatum L., LinariaacutilobaFisch. exReichenb., Artemisia mongolica dominate. The TPV cover is 40%.

**Area number 4** (control area) is located 67 km from the "Yakutcement" in the district of the village of Tabaga. The meadow is periodically trampled and eaten by cattle. The community includes 12 plant species dominated by *Geranium pratense* L., *Elytrigia repens* (L.) Nevski, *Acetosa thysiflora* (Finger.) A. Love et D. Love, *Tanacetum vulgare* L., *Chamaenerion angustifolium* (L.) Holub., *Potentilla bifurca* L., *Linaria acutiloba* Fisch. ex. Reichenb. The TPV cover is 90%.

**Research methods.** Geobotanical descriptions of communities are made according to the generally accepted method [4].

Quantitative determination of flavonoids was made using the standard method Shelyuto [9]. The dietary supplementis of this method is the ability of flavonoids to complex with aluminum chloride, with measurement of the optical density of the complexes in the visible region at a blue light filter, at a wavelength of 410 nm. In this case, we used cells with a layer thickness of 0.75 mm. The study was conducted using a spectrophotometer Specord - 40. Measurements were performed at a multiplicity of 3 times, 70% ethyl alcohol was used as an extractant. The calculation of the number of flavonoids was carried out according to a calibration schedule built according to the routine.

The plant material was collected in dry weather, during flowering, during the greatest accumulation of biologically active substances, namely in the first decade of July. Preparation of raw materials was carried out in a dark, ventilated area. The loss of raw material mass during drying was about 90%.

Statistic analysis of the data was performed using by Statistica 19 software. Standard methods of variation statistics were used: the calculation of mean values, standard errors, 95% confidence interval. The data in the tables are presented in the form M ± m, where M is the average, m is the average error. To assess the statistically significant differences in the data obtained, non-parametric methods, Student criterion, Spearman correlation analysis were used. The probability of the validity of the null hypothesis was taken at $p < 0.05$.

**The discussion of the results.** Near the plant, the area is subject to anthropogenic impact, which affects the density of the projective cover of vegetation. Plant communities are found in dry disturbed habitats covered with mud and cement dust. Currently, the vegetation in the village and its surroundings is mainly represented by anthropogenic ruderal communities. Birch disturbed highlighted by the presence and dominance in the community such synanthropic species as: ordinary tansy, wormwood Yakut, fireweed angustifolia, quack grass, lankaastalavista, dandelion ergonomy, melilotus officinalis, etc.

According to the Pokrovskaya Hydrometeorological Service of the Republic of Sakha (Yakutia), northeast winds prevail in the study area [8]. This is due to the fact that the village is located on the open and high banks of the Lena River. Winds from the river side (south-west), as a rule, carry air masses in the northeast direction. Therefore, we chose the northeast direction from the cement plant as a place to gather plants.

The study found that plants of each species, collected in different environmental conditions, differ in the content of flavonoids.

Thus, a statistically significant decrease in the content of flavonoids was observed in flowers (Table 2) of plants. The most pronounced decrease in 2.5 times in the leaves and 2.2 times in the flowers was noted in *Tanacetum vulgare* L., and the smallest in the flowers of *Chamaenerion angustifolium* (L.) Holub.(1.13 times).

In the second section, there was a significant increase in the level of flavonoids compared with the first section of the study, but it remaining lower than in the control section. The greatest accumulation of flavonoids in 1.9 times was observed in Tanacetum vulgare L. It should be noted that an increase in their content in the leaves and flowers in this area occurred identically.

In the third study area, there was a decrease in the content of flavonoids in comparison with the second area. Per-

**Content of flavonoids in the leaves (upper digits) and flowers (lower digits) of plants growing in different distances from the cement plant "Yakutcement"**

| Typeofplant | 500 m | 1000 m | 2000 m | Controlarea |
|---|---|---|---|---|
| Ordinary tansy *Tanacetum vulgare* L. | 0.2821±0.0006* 0.2254±0.0006* | 0.5397±0.0001*+ 0.4356±0.0001*+ | 0.4779±0.0001*++ 0.3947±0.0004*++ | 0.7105±0.0073 0.4001±0.0001 |
| Fireweed angustifolia *Chamaenerion angustifolium* (L.) Holub. | 0.5258±0.0003* 0.2417±0.0003* | 0.788±0.0009*+ 0.3568±0.0001*+ | 0.6340±0.0006*++ 0.3223±0.0211*++ | 1.0614±0.0006 0.2754±0.0001 |
| Lanka astalavista *Linaria acutiloba* Fisch. ex. Reichenb. | 0.2974±0.0001* 0.3425±0.0003* | 0.3786±0.0004*+ 0.4125±0.0003*+ | 0.3389±0.0006*++ 0.2138±0.0006*++ | 0.4878±0.0028 0.5628±0.0009 |

* - significance of differences $p<0.05$ in comparison with the control area;

*+ - significance of differences $p<0.05$, compared to the MCP at a distance of 500 m;

*++ - significance of differences $p<0.05$,compared to the MCP at a distance of 1000 m.

haps this decrease is due to the fact that at a distance of 2000 meters from the Yakut Cement plant, plants are less susceptible to the effects of cement dust, as evidenced by their higher content than in the first section. At the same time, this site is located in the immediate vicinity of the highway (50 meters) and, most likely, vehicle exhaust emissions are also likely to contribute to this accumulation.

The data show that the spectrum of the content of substances of secondary synthesis varies in plants growing under conditions of atmospheric pollution, depending on the zone of influence of emissions of cement dust. All species studied by us collected in the technogenic zone produce less flavonoids than plants collected in the control plot. This is due, in all likelihood, to the need to develop adaptation systems to change the cement environment.Therefore, it can be assumed that the content and accumulation of flavonoids depends on the presence and concentration of man-made impurities in the atmosphere. The reduced production and accumulation of flavonoids are a consequence of the response of plant organisms to the presence of emissions of the cement plant (MCP) in the atmosphere.

In the process of technogenic impact on the soil cover in the area of the cement plant there are significant changes in the chemical composition of soils, increases their alkalinity and increases the accumulation of heavy metals, which subsequently affect the growth and development of plants [2].

It should be noted that the soil cover is one of the contributors to pollutants. The level of anthropogenic accumulation of chemical elements in soils is explained by their concentration, volumes and duration of emissions into the atmosphere. The study of the chemical composition of cement dust and its comparison with the quantitative chemical composition in the control sod-carbonate soil in the impact zone of emissions from the “Yakutcement” plant were carried out by M.M. Shashurin. As a result of the studies, the excess of cement dust content was found in comparison with the soil: Sr – 700 mg/kg in cement dust (in the control soil 200 mg/kg); Ti – 2000 against 1250 mg/kg; Pb – 30 against 20 mg/kg; Zn – 400 against 100 mg/kg; Cu – 50 against 8.5 mg/kg in the control soil [8, 11].

The high concentration of these elements in the soil is manifested in inhibition of growth, increase of lipid peroxidation and permeability of plant membranes [3, 6]. In visual assessment, the main symptoms of poisoning plants with the above substances are: yellow tops of leaves, necrosis of plant tissues (begins with the edges of the leaves) [6, 15].

Any biotic or abiotic stress (exposure to pathogenic fungi, bacteria, viruses, temperature changes, mechanical damage, bright light, ultraviolet radiation, imbalance of mineral components in the soil, drought, salinity, exposure to ozone, herbicides, heavy metal salts) can lead to intensification of flavonoid biosynthesis in various anatomical parts of the plant [9, 13].

In the implementation of the stress-protective effect lie the antioxidant properties of these compounds. Any abiotic stress causes hyperproduction of hydrogen peroxide in chloroplasts, mitochondria and peroxisomes of the plant cell, along with the release of peroxidase and catalase by these organelles [10]. Significant amounts of $H_2O_2$ diffuse into vacuoles - the main location of flavonoids [12], which are able to effectively neutralize $H_2O_2$ and other active oxygen forms [14]. Their protective function is also carried out through the formation of barriers to infection or mechanical damage (tannins, lignins) and inherent antibiotic activity in many of them.

A number of authors suggest that flavone compounds increase the tolerance ofplants to adverse environmental conditions [1, 9]. It is known that in non-typical habitats its flavonoid complex, reflecting a specific type of secondary exchange, varies significantly and does not coincide with similar profiles characteristic of the species in this region [1, 13]. In addition, the objectives of the study included the study of the flavonoid complex for the analysis of ecological and cenotic number of communities growing in the territory of the Mokhsogollokh Cement plant. All the above mentioned factors of plant growth in Yakutia undoubtedly affect the accumulation of dietary supplement.

**Conclusion**. The therapeutic properties of medicinal, pharmacopoeia plants studied by us in Central Yakutia are greatly reduced in the areas of strong and medium pollution with cement dust, as evidenced by the small accumulation of flavonoids in these areas than in the control area. At the same time, in these two areas, tansy ordinary *Tanacetum vulgare* L. can serve as an indicator of pollution, since the content of flavonoids in it is most significantly reduced than in other plants. Man-made loads on the natural environment around industrial enterprises depend on many factors. This should take into account, first of all, the volume of emissions into the air and discharges into surface and groundwater of substances that pollute the environment, the area of direct mechanical destruction of soil and vegetation cover in the area of industrial enterprises, local industries, the duration of man-made load, natural conditions.

As the distance from the cement plant for a distance of up to 2 km, the General condition of the vegetation improves, the plant organs have no external signs of damage or weakening. It can be as-

sumed that the content and accumulation of flavonoids depends on the presence and concentration of anthropogenic impurities in the atmosphere. Reduced production and accumulation of them are a consequence of the response of plant organisms to the presence in the atmosphere – the emission of MCP. Collection of medicinal plants near cement plants is not recommended, as the medicinal properties of medicinal plants, grown in such conditions, are reduced. Since there is an accumulation of carcinogenic substances, carbonates, which can harm human health and the environment as a whole.

## References


1. Олешко Г.И., Зеленина М.В., Вотинова Т.И. [и др.]. Влияние условий обитания на накопление флавоноидов некоторыми видами рода вероника и брусника региона Урала. *Материалы юбилейной научно-практической конференции посвященной 60-летию Пермской Государственной фармацевтической академии.* Пермь: ПГФА, 1997: 15-16. [Oleshko GI, Zelenina MV, Votinova TI [et al.]. Influence of habitat conditions on the accumulation of flavonoids by some species of the genus Veronica and lingonberry in the Ural region. *Materials of the anniversary scientific-practical conference dedicated to the 60th anniversary of the Perm State Pharmaceutical Academy*. Perm: PSFA. 1997; 15-16. (In Russ.).]

2. Ковальский В.В. Геохимическая экология. М.: Наука, 1974; 298:123-125. [Kovalsky VV. Geochemical ecology. Moscow: Science. 1974; 298:123-125. (In Russ.).]

3. Краева Е.В. Влияние промышленных выбросов предприятия «Мальцевский портландцемент» на устойчивость сосны. *Биологическое разнообразие лесных экосистем: материалы всероссийского совещания.* М.: 1995; 340:269-271. [Kraeva EV. Influence of industrial emissions of the Maltsevsky Portlandcement enterprise on the stability of pine. Biological diversity of forest ecosystems: materials of the All-Russian meeting. Moscow. 1995; 340:269-271. (In Russ.).]

4. Лавренко М.Е., Корчагина А.А. Полевая геоботаника. М.; Л.: Наука, 1964: Т. (3); 530:263-264. [Lavrenko ME, Korchagina AA. Field geobotanics. Moscow; L.: Nauka. 1964; V. (3); 530:263-264. (In Russ.).]

5. Макаров А.А. Лекарственные растения Якутии и перспективы их освоения. Новосибирск: СО РАН, 2002; 264:113-115. [Makarov AA. Medicinal plants of Yakutia and the prospects for their development. Novosibirsk: SO RAN. 2002; 264:113-115. (In Russ.).]

6. Опекунова М.Г. Биоиндикация загрязнений: *учеб. Пособие*. СПб.: С.-Петерб. Университета. 2016; 300:278. [Opekunova MG. Bioindication of pollution: studies. manual. SPb.: Un-ta. 2016; 300:278. (In Russ.).]

7. Стогний В.В. Эколого-климатические особенности функционирования защитных антиоксидантных систем в тканях дикорастущих растений. *Радиоэкология.* 1999; Т. 39(1):79-83. [Stogny VV. Zhuravskaya AN, Kershengolts BM. Ecological and climatic features of the functioning of protective antioxidant systems in the tissues of wild plants. *Radioekologiya*. 1999; V. 39(1):79-83. (In Russ.).]

8. Писаренко И.А. Отчет о геоэкологических исследованиях на территории Покровского промышленного узла (Немюгюнцы – Покровск – Мохсоголлох – Верхний Бестях). Верхнебестяхское ЛГРЭ. 1995; 45:30. [Pisarenko IA. Report on geoecological studies on the territory of the Pokrovsky industrial hub (Nemyugunts - Pokrovsk - Mokhsogollokh - Verkhniy Bestyakh). Verkhnebestyakhskoe LGRE. 1995; 45:30. (In Russ.).]

9. В.П. Георгиевский, А.И. Рыбаченко [и др.]. Физико-химические и аналитические характеристики флавоноидных соединений. Ростов на/Д.: Ростовск. ун-та. 1988; 143:98. [Georgievsky VP, Rybachenko AI. [et al.]. Physico-chemical and analytical characteristics of flavonoid compounds. Rostov na / D.: Rostov. Un-ty. 1988; 143:98. (In Russ.).]

10. Флавоноиды Achillea glabella Kar. Et Kir. *Материалы международного совещ., посв-го памяти Минаевой В.Г. «Физиолого-биохимические аспекты изучения лекарственных растений".* Новосибирск: 1998; 56:27. [Kenzhebaeva ST, Kulmagambetova EA, Pribytkova LN. [et al.]. Flavonoids Achillea glabella Kar. Et Kir. *Materials of the international meeting devoted to the memory of V.G. Minayeva. "Physiological and biochemical aspects of the study of medicinal plants".* Novosibirsk. 1998; 56:27. (In Russ.).]

11. Шашурин М.М. Влияние хронического действия экотоксикатов на физиолого-биохимические свойства и стрессоустойчивость растений, ферментный потенциал почв Центральной и Южной Якутии: *автореф. дис… канд. биол. наук*. Якутск, 2006; 18:9. [Shashurin MM. The influence of the chronic action of ecotoxicates on the physiological and biochemical properties and resistance of plants to plants, the enzymatic potential of the soils of Central and South Yakutia. *avtoref. dis… kand. biol. nauk*. Yakutsk. 2006; 18:9. (In Russ.).]

12. Andersen Q, Markham K. Flavonoids: Chemistry, biochemistry and Applications. CRC press Taylor &Group. 2006; 1197.

13. Bould C, Hewitt E, Needham P. Diagnosis of mineral disorders in plants: Principles. Vol. No I. London: Her Majestry's Stationery Office. 1983; 174.

14. Ooman B.D. Marra G. Flavonoids and antioxidative activities in buckwheat. *Food Chemistry.* 1996; Vol. 44. 1746-175.

15. Marschner H. Mineral plant nutrition of higher plants. London: Acad. Press. 1997; 889.


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