Analysis of some groups of biologically active substances of rapeseed (Brassica napus l.), grown under chemical stress

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Analysis of some groups of biologically active substances of rape (Brassica napus L.) grown in conditions of chemical stress

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SUMMARY

The article deals with the influence of chemical stress on the content of biologically active substances in rapeseed grass. The quantitative content of tannins, flavonoids and polysaccharides was determined using known pharmacopoeial methods. As a result of the studies carried out, it was found that in rapeseed leaves under conditions of chemical stress, the amount of oxidizable compounds and polysaccharides increases, and the content of flavonoids practically does not change.

Key words: chemical stress, heavy metals, rape leaves,tannins, flavonoids, polysaccharides.

RESUME

The article deals with the effects of chemical stress on the content of biologically active substances in rapeseed leaves. The quantitative content of tannins, flavonoids and polysaccharides was determined using well-known pharmacopoeias techniques. As a result of the research, it was established that the amount of oxidizable compounds and polysaccharides in the leaves of rapeseed under chemical stress increases, while the content of flavonoids practically does not change.

Keywords: chemical stress, rapeseed leaves, tannins, flavonoids, polysaccharides.

RELEVANCE

Currently representatives of the cabbage family are promising sources to obtain drugs with antiulcer, hypoazotemic, choleretic and other types of action. Plants of this family contain unique natural compounds such as ascorbigen, sulforaphane, and dietary indoles, which have antitumor properties [14, 15, 16, 18].

Rape (Brassica napus L.) belongs to oilseeds and fodder crops from the cruciferous family and today remains one of the most demanded oilseeds both on the Russian and world markets [11]. Unlike many other cultivated plants, rape does not have a wild-growing ancestor. In culture, this plant was known 4 thousand years before

AD Rape came from the crossing of field cabbage or rape (Brassica campestris) with cabbage (Brassica oleracea) [eight]. Although rapeseed was cultivated in Russia at the beginning of the 19th century, most Russians know little about this crop.

Rape belongs to renewable energy sources and raw materials, which can and should occupy a significant place among the leading oilseeds produced in Russia. The expediency and prospects of its use in crop rotations have also been proved, since it improves the structure of the soil and fertilizes it due to its developed root system [9]. The economic importance of rapeseed by the end of the 20th century increased significantly due to the fact that this plant was actively used to obtain biodiesel [13]. The composition of rapeseed grass and rapeseed oil contains a large amount of unsaturated fatty acids, which play an important role in regulating fat metabolism, lowering cholesterol levels, the possibility of thrombus formation and a number of other diseases, including tumor ones. Therefore, the study of this plant is relevant not only for biology in general,

Rape is an annual herb of the cruciferous family.Brassicaceae. The root system is pivotal, powerfully developed. Stalk tall100-200 cm, strongly branched, erect, leafy, round in cross section, rather strong. The color is light green with an anthocyanin tint and a waxy coating. The upper leaves of rape are elongated-lanceolate with an extended base, covering half the stem. The lower leaves are petiolate, covered with bristly hairs along the petiole and edges. The leaves are covered with a waxy bloom of gray-green or bluish-purple in color. Inflorescence is a loose, elongated raceme, flowering from bottom to top (Fig. 1). Flowers are yellow, regular, bisexual. One plant forms up to 500 flowers. The fruit is a bent or straight pod 6–14 cm long; one plant contains from 200 to 300 pods. The pods are smooth or slightly lumpy [10].


Rice. 1. Canola (botanical illustration and inflorescence)

Chemically, common rape is rich in biologically active substances of various groups. Rape seeds contain up to 40–45% fat and up to 25–30% protein. Rapeseed oil has high nutritional value, and in terms of taste and fatty acid composition is close to olive oil. The composition of rapeseed contains a large amount of unsaturated fatty acids, which play an important role in regulating fat metabolism, lowering cholesterol levels, the possibility of blood clots and a number of other diseases. It also contains flavonoids, nitrogenous (indole derivatives), sulfur-containing compounds (glucosinolates), etc. [5, 6].

Unfavorable factors of the external environment or human activity can, to one degree or another, affect the accumulation of biologically active substances in plants. It was found that some pollutants, in particular heavy metals, can increase the synthesis of biologically active substances in plants. It has been shown, for example, an increase in the content of glucosinolates - the main BAS in plants of the family Brassicaceae [17].

On the other hand, one of the factors that reduce the area of land suitable for agriculture is its pollution with high concentrations of heavy metals (HM) due to vigorous industrial activities of humans (Ilyin, 1991; Schuetzenduebel et al., 2002). Different types of plants have different resistance to heavy metals. This is ensured by the functioning of specialized mechanisms at various levels of the organization. The main task of all these mechanisms is to isolate toxic concentrations of metals from metabolically active cell compartments (Radionov, 2008).

The use of plants to restore heavy metal contaminated soils is called phytoremediation (Chaney et al., 1997). Her main the disadvantage is the relatively low biomass of most plants - hyperaccumulators and low growth rates. Therefore, it is of particular interest to study such plant species as, for example, rapeseed, which are capable of forming a significant biomass and accumulating heavy metals in high concentrations.

The development of industry, energy, transport and human activities negatively affects the ecological state of the environment and the accumulation of biologically active substances. At the same time, it was found that heavy metals contribute to an increase in the synthesis of biologically active substances in plants. An example is representatives of plants of the familyBrassicaceae, uwhich, under the influence of chemical stress, the content of glucosinolates, the main biologically active substance, increases [11]. Therefore, interest in the determination of biologically active substances in the leaves of rapeseed collected in clean and contaminated areas has increased.

MATERIALS AND METHODS

The objects of the study were samples of rapeseed raw materials (Brassica napus) threevarieties (Builder (Bu), Brander (Br), Highlight (H), grown in 2018 on soils selected in the zone of influence of the following enterprises: CJSC Karabashmed (at a distance of 1.5 km from the enterprise), JSC Satkinsky iron-smelting plant "(at a distance of 2 km from the enterprise) and OJSC" Uchalinskiy ore mining and processing plant "(at a distance of 1.2 km from the enterprise). variants of the experiment (including background) mineral fertilizers were applied in the form of nitroammofoska at the rate of N120P120K120.The samples were grown in three variants of the experiment: in contaminated soils (Uchaly Bu, Br and H; Karabash Bu, Br and H; Satka Bu, Br and H) and in the background soil (background Bu, Br and H).In soils after acid decomposition by the atomic absorption method, the content of bulk forms of heavy metals was determined: Mn, Fe, Cd, Cu, Zn.

The following groups of biologically active substances were quantitatively determined in rapeseed leaves: tannins, flavonoids, and polysaccharides. The quantitative determination of tannins was carried out by the titrimetric method - permanganatometry, according to the State Pharmacopoeia of the XIII edition of the OFS.1.5.3.0008.15 [4]. Determination of the quantitative content of flavonoids was carried out by differential spectrophotometry at a wavelength of 410 nm [2]. The quantitative content of polysaccharides was determined by the gravimetric method, according to the State Pharmacopoeia of the XIII edition of FS.2.5.0032.15 "Large plantain leaves".

RESULTS AND ITS DISCUSSION

The degree of soil contamination was calculated in relation to the regional geochemical background (RGF) [1] and to indicators of tentatively permissible concentrations (APC) of chemical substances in the soil (for Fe - to the clarke value in the earth's crust) [3] (Table 1).

Table 1

Gross concentrations of heavy metals in the studied soil samples before growing rapeseed and standards, mg / kg

A place selection soil	Fe	Zn	Cu	Mn
Background	22484,00	29,60	23.59	590,00
Uchaly	32188,00	125,80	365.00	895,00
Karabash	15375,00	1565,00	1204,00	965.00
Satka	12063,00	13.40	34.20	523,00
UEC	25,000.00 *	55,00	33.00	1500.00
RGF	37100,00	223.00	49,00	1060,00

Table 1, the background indicates the excess of the UEC. It can be seen that the content of heavy metals in the background sample for all indicators does not exceed the OEC of gross forms.

The content of gross forms of heavy metals in the studied soils can be ranked in decreasing order as follows: iron, manganese, copper, zinc.

Thus, the concentration of manganese does not exceed the established standards in all studied soils. The greatest excess of the APC of all metals is observed for the soil from Karabash: Zn - 28.5 APC; Cu - 36.5 ODK. In the soil from Uchalov: Fe - 1.3 APC; Zn - 2.3 ODK; Cu - 11 ODK. The smallest excess of the standards was found in the samples from Satka: Cu - 1.04 APC.

Let us estimate the intensity of metal contamination of the humus horizon of soils using the concentration coefficient K_C (coefficient of abnormality according to V.V. Dobrovolsky [7]) of each of the elements relative to the background: $K_C = C_i / C_{fi}$,

where C_{fi} and C_i - background (regional geochemical background) and actual content of the i-th element in the soil.

The results are shown in table. 2.

table 2

Concentration coefficient Kci and its ranking according to V.V. Dobrovolsky

Place of selection soil	Fe	Zn	Cu	Mn
Uchaly	0.87	0.56	7, 45	0.84
Karabash	0.41	7.02	24.57	0.91
Satka	0.33	0.06	0.70	0.49
RGF	37100	223	49	1060

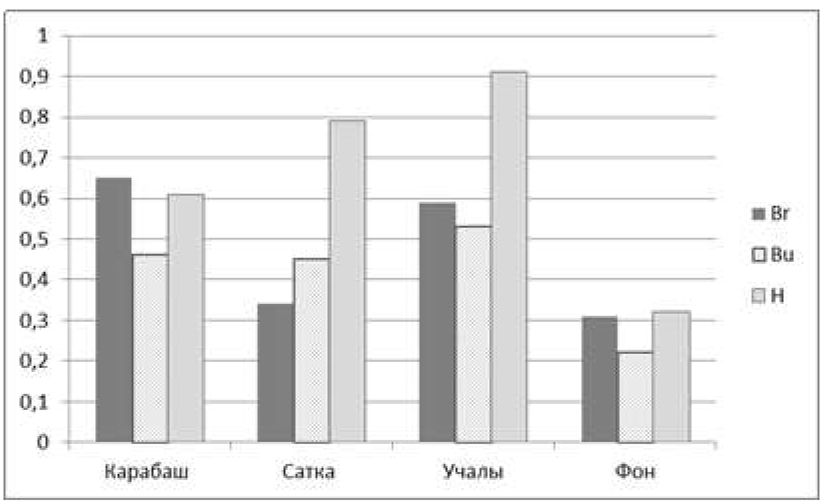
Legend:		
		Natural fluctuation (Kc <5)
		Weak pollution (5 <Kc <10)
		Moderate pollution (10 <Kc <30)
	xxx	Strong pollution (Kc> 30)

The ratio of the content of gross forms of HM to their regional background shows that in the studied soils, within the limits of natural fluctuations, there is the gross amount of most metals. Weak level of soil pollution with copper (Uchaly) and zinc (Karabash), moderate pollution with copper (Karabash).

Thus, according to the degree of contamination with heavy metals, the soils can be ranked in decreasing order as follows: Karabash, Uchaly, Satka.

Next, the content of biologically active substances in rape leaves was determined.

The quantitative content of tannins was carried out by the titrimetric method. The results obtained are presented in the diagram (Fig. 2).



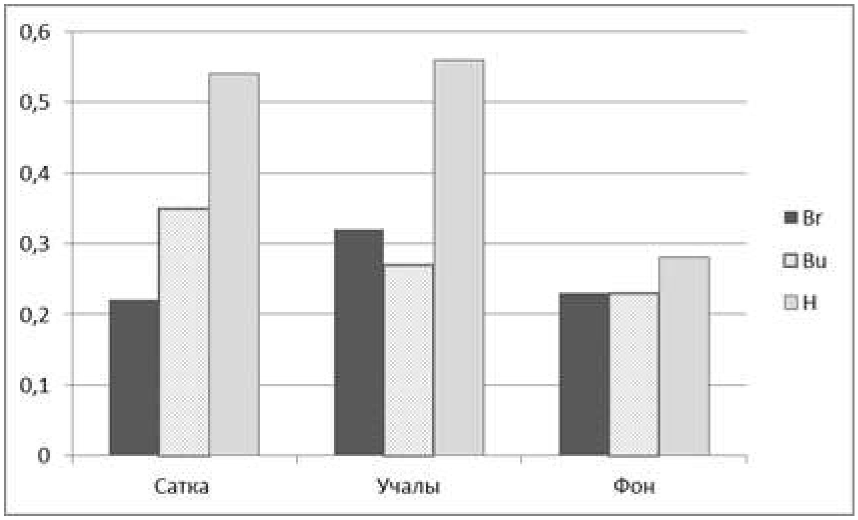
Rice. 2. Diagram of the quantitative content of tannins in rape leaves,%

The results obtained indicate that the content of tannins in the studied samples of rape leaves ranged from 0.22 ± 0.01 to 0.91 ± 0.04.

It can be noted that the content of tannins in the leaves of various rapeseed samples grown on the soil of the background territory ranges from 0.22% to 0.32%, and in the rapeseed raw materials grown on the soils of territories contaminated with heavy metals - from 0 , 34% to 0.91%.

Quantitative content of flavonoids carried out method differential spectrophotometry and calculated their content in terms of on the routine. Samples of rapeseed grown in Karabash were not examined, because the plants were severely suppressed, and the dry matter of the plants was insufficient for analysis. The research results in Fig. 3.

The results obtained indicate that the content of flavonoids in the studied samples of rape leaves ranged from 0.22 ± 0.01 to 0.56 ± 0.02.

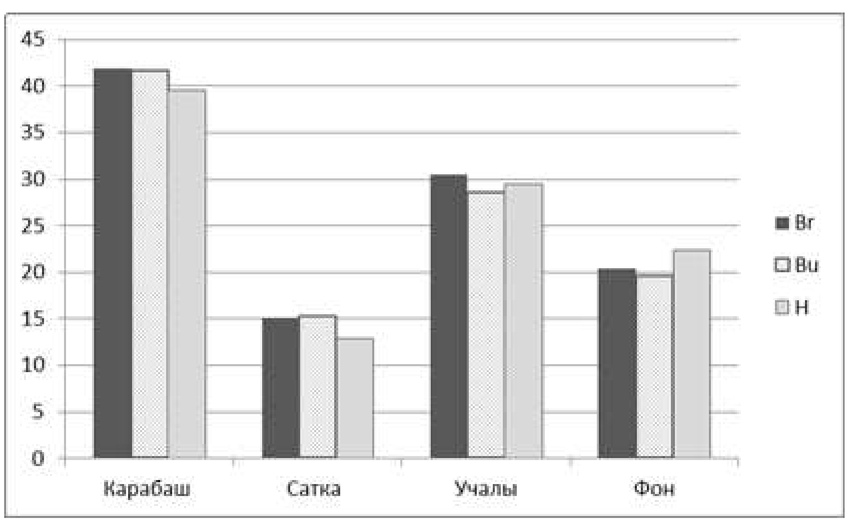


Rice. 3. Diagram of the quantitative content of flavonoids in rape leaves,%

It can be noted that the content of flavonoids in the leaves of various rapeseed samples grown on the soil of the background territory is from 0.23% to 0.28%, and in the raw rapeseed grown on the soils of territories contaminated with heavy metals - from 0, 22% to 0.56%.

Analysis of the data obtained shows that chemical stress has an insignificant effect on the content of flavonoids in rape leaves.

The quantitative content of polysaccharides was carried out by the gravimetric method. The research results are shown in Fig. 4.



Rice. 4. Diagram of the quantitative content of polysaccharides in rape leaves,%

The results obtained indicate that the content of polysaccharides in the studied samples of rape leaves ranged from 12.27 ± 1.64 to 41.89 ± 1.64.

It can be noted that the content of polysaccharides in the leaves of various rapeseed samples grown on the soil of the background territory ranges from 19.49% to 22.38%, and in the raw rapeseed grown on the soils of territories contaminated with heavy metals - from 12, 27% to 41.89%.

Analysis of the data obtained shows that chemical stress affects the content of polysaccharides in rapeseed leaves mostly towards an increase in the content of the latter.

CONCLUSION

V the result pilot research It was it was found that under conditions of chemical stress in rape leaves there is an increase in the amount of oxidizable compounds and polysaccharides. At the same time, chemical stress insignificantly affects the content of flavonoids in rape leaves. No correlation was found between the degree of soil pollution and the amount of biological substances in rape leaves.

CONCLUSIONS

1. A comparative phytochemical study of rape leaves was carried out, grown on the background soil and under conditions of chemical stress, for the content of tannins, flavonoids and polysaccharides.
2. Chemical stress affects the content of tannins and polysaccharides in rapeseed leaves are mostly in the direction of increasing the content of the latter.
3. Chemical stress has little effect on content flavonoids in rapeseed leaves.
4. The studies carried out have shown the feasibility of further phytochemical study of rapeseed as a source of biologically active compounds for the creation of domestic drugs with different pharmacological activity.

This work was supported by the RFBR grant No. 17-44-020574.

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