Features of the accumulation of biologically active substances in the roots of burdock of the common synanthropic flora of the Voronezh region

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SUMMARY

Common burdock roots are used in medical and pharmaceutical practice mainly in the form of aqueous extracts, and the pharmacological effect is due to water-soluble compounds based on polysaccharides.

The aim of the study is to study the features of the accumulation of biologically active substances in the roots of common burdock harvested in various agro- and urban-biogeocenoses of the Voronezh region.

In 51 samples of burdock roots, the content of the sum of polysaccharides in terms of fructose, gravimetrically precipitated water-soluble polysaccharides and extractives extracted by water was determined. In terms of the content of extractive substances extracted by water, 8 samples of burdock roots do not meet the requirements of regulatory documents. The amount of extractive substances extracted by water has been reduced in samples harvested on agricultural land in Gribanovsky, Repyevsky, Ertilsky districts, under high-voltage power lines, near the chemical enterprises of OJSC Minudobreniya, OJSC Voronezhsintezkauchuk, along the M4 highway in the Ramonsky district, at a distance 100 m from the A144 highway in the Anninsky district. The correlation between the accumulation in the studied samples of the sum of polysaccharides in terms of fructose and the sum of gravimetrically determined water-soluble polysaccharides is characterized by a coefficient of 0.42, which indicates a positive moderate relationship. The correlation coefficient between the numerical values of the sum of polysaccharides in terms of fructose and the sum of extractives extracted by water from the roots of common burdock was 0.45, which also indicates a moderate positive relationship. A strong positive correlation was established for the numerical indicators of the content in the roots of common burdock of the sum of gravimetrically determined water-soluble polysaccharides and the sum of extractives extracted by water. The correlation coefficient between the numerical values of the sum of polysaccharides in terms of fructose and the sum of extractives extracted by water from the roots of common burdock was 0.45, which also indicates a moderate positive relationship. A strong positive correlation was established for the numerical indicators of the content in the roots of common burdock of the sum of gravimetrically determined water-soluble polysaccharides and the sum of extractives extracted by water. The correlation coefficient between the numerical values of the sum of polysaccharides in terms of fructose and the sum of extractives extracted by water from the roots of common burdock was 0.45, which also indicates a moderate positive relationship. A strong positive correlation was established for the numerical indicators of the content in the roots of common burdock of the sum of gravimetrically determined water-soluble polysaccharides and the sum of extractives extracted by water.

Keywords:Voronezh region, burdock ordinary, polysaccharides, extractive substances.

RESUME

The roots of the common burdock are used in medical and pharmaceutical practice mainly in the form of aqueous extracts, and pharmacological effect is due to water-soluble compounds based on polysaccharides, which causes research interest in identifying the features of the accumulation of this group of compounds.

The purpose of the study is to study the features of the accumulation of biologically active substances in the roots of ordinary burdock, prepared in various agricultural and urbobiogeocenoses of the Voronezh region. As part of the study, 51 samples of the roots of the common burdock we determined the content of the sum of polysaccharides in terms of fructose, gravimetrically precipitated water-soluble polysaccharides and extractive substances extracted by water. In terms of the content of extractive substances extracted by water, 8 samples of the roots of ordinary burdock do not meet the requirements of regulatory documentation. The amount of substances extracted by water was reduced in samples harvested on agricultural land in the Gribanovsky, Repyevsky, Ertilsky districts, under high-voltage

power lines, near the chemical enterprises of Minudobrenia OJSC, Voronezh Sintezkauchuk OJSC, along the M4 route in the Ramonsky district, at a distance of 100 m from the A144 route in the Anninsky The correlation between the accumulation in the studied samples of the sum of polysaccharides in terms of fructose and the sum of gravimetrically determined water-soluble polysaccharides is characterized by a coefficient of 0.42, which indicates a positive moderate relationship. The correlation coefficient between the numerical values of the sum of polysaccharides in terms of fructose and the sum of extractive substances extracted by water from the roots of ordinary burdock was 0.45, which also indicates a moderate positive relationship.

Keywords: Voronezh region, Arctium burdock, polysaccharides, extractive substances.

INTRODUCTION

Phytopreparations on the domestic pharmaceutical market have always been in significant demand, which is explained by their good therapeutic effect and relative harmlessness. Thus, according to the data of the Register of Medicines of Russia for July 2021, there are more than 2.1 thousand herbal medicines, and the number of biologically active additives based on medicinal plants exceeds 7.9 thousand [1]. At the same time, a large share of the procurement of medicinal plant materials falls on the European part of the Russian Federation, which is characterized by a significant population density, high economic activity, and the dynamic development of transport routes [2, 3]. In this regard, the threat of collecting plant materials in ecologically unfavorable areas increases,

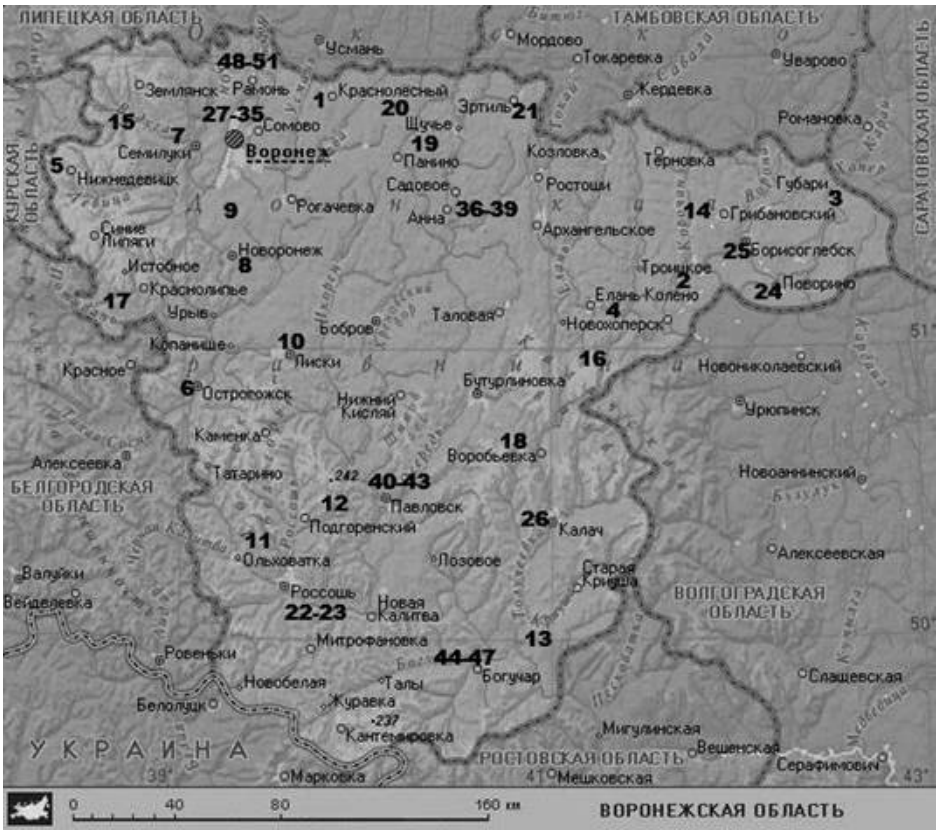
A ubiquitous species, the raw material of which is harvested from wild-growing individuals, is common burdock (Arctium lappa L.) - biennial, ubiquitous in the European part of Russia, in particular in the Voronezh region, a herbaceous plant up to 2.5-3 m high with a powerful taproot up to 1.5 m long. The roots of common burdock are traditionally used in folk medicine as choleretic, diaphoretic, diuretic, anti-inflammatory, wound-healing agent that improves metabolism. Widespread use is due to the rich chemical composition of this type of medicinal plant material, which is based on polysaccharides (up to 35-45% inulin), mucus, sesquiterpenoids, phytosterols, polyins (arctinal, etc.), fatty acids, lignans (arctin), essential oil, phenolic acids, organic acids, vitamins, macro- and microelements [4, 5]. Common burdock roots are used as a decoction. Thus,

The purpose of the study is to study the features of the accumulation of the sum of polysaccharides in terms ofon fructose, gravimetrically precipitated water-soluble polysaccharides and extractives extracted by water in the roots of common burdock harvested in various agro- and urban-biogeocenoses of the Voronezh region.

MATERIALS AND RESEARCH METHODS

The choice of territories for the selection of samples of plant raw materials is conditioned by the peculiarities of anthropogenic impact (Fig. 1, Table 1): chemical industrial enterprises (Fig. 1: 23, 24, 28); combined heat and power plant (CHP) (Fig. 1: 27); nuclear power plant (NPP) (Fig. 1: 8); international airport. Peter I (Fig. 1:30); street of Voronezh (Dimitrov street) (fig. 1: 31); high-voltage power lines (VLE) (Fig. 1: 9); Voronezh reservoir (Fig. 1: 29); regional centers (Borisoglebsk (Fig. 1: 25), Kalach (Fig. 1: 26)); deposit area

nickel ores (Fig. 1: 4); areas located in the zone of radioactive contamination after the accident at the Chernobyl nuclear power plant (Fig. 1: 5–7); agricultural land with the active use of chemicalization (Fig. 1: 10-22); background (for comparison) - protected areas (Fig. 1: 1, 2, 3)). Also, samples were taken along and at a distance of 100 m, 200 m, 300 m from roads of varying degrees of congestion: forest zone (Fig. 1: 32–35) - M4 highway, forest-steppe zone (Fig. 1: 36–39)) - A144 highway, steppe zone (Fig. 1: 40–43) - M4 highway, low-speed (country) motor road with low traffic (Fig. 1: 44–47) and railroad (Fig. 1: 48–51) ...



Rice. 1. Map of sampling of medicinal plant materials (transcript in the text)

The procurement of raw materials was carried out in early autumn (September) in 2016. The roots of annual burdock individuals were dug up, cleaned of thin roots, leaves, stems, washed from the ground, cut into pieces, and dried by the shade method to the permissible moisture content of the raw material (no more than 14%) [5].

Determination of the content of the sum of polysaccharides in terms of fructose, as well as extractives extracted by water, was carried out according to the standard pharmacopoeial method [6, 7]. The accumulation of gravimetrically determined water-soluble polysaccharides was studied using an express validated and patented method of ultrasonic extraction using an ultrasonic bath Grad 40–35 [4]. Each determination was carried out three times. The data obtained in the course of the research were statistically processed using the Microsoft Excel program.

RESULTS AND ITS DISCUSSION

The determined indicators of the content of biologically active substances (BAS) in the roots of common burdock are given in table. 1.

It was found that all the studied samples of burdock roots meet the pharmacopoeial requirements for the content of the sum of polysaccharides in terms of fructose. At

The concentration of this group of biologically active substances in the studied samples of raw materials varied greatly depending on the place of its collection. The content of the sum of polysaccharides in terms of fructose in the samples harvested in the control areas took numerical values from 14.72% to 15.75%. For raw materials collected in agrobiocenoses, the accumulation of this group of biologically active substances in the range of 10.31-13.67% is characteristic. The roots of common burdock growing in urbanized areas are characterized by the accumulation of the sum of polysaccharides in terms of fructose from 8.46% to 14.38%. The lowest concentration of the sum of polysaccharides in terms of fructose was noted for samples harvested near the chemical enterprises of LLC Bormash in the Povorinsky region, JSC Minudobreniya in the Rossosh region, near the international airport, along and at a distance of 100 m from the A144 highway in the Anninsky region, along and at a distance of 200 m from the railway, under high-voltage power lines. Thus, it can be assumed that there is a significant negative effect of anthropogenic load on the accumulation of this group of biologically active substances in burdock roots.

Table 1

The content of biologically active substances in samples of common burdock roots (Arctium lappa L.)

No. p / p	Collection area	Content sums polysaccharides in terms of for fructose,%	Content water soluble polysaccharides, %	Sum extractive substances recoverable water
1	Voronezh State Natural Biosphere reserve them. V.M. Peskova	15.75 ± 0.07	37.82 ± 0.53	47.84 ± 0.31
2	Khopersky natural biosphere reserve (Novokhopersky district)	14.72 ± 0.06	28.58 ± 0.43	40.16 ± 0.27
3	Khopersky natural biosphere reserve (Gribanovsky district)	15.29 ± 0.05	38.94 ± 0.30	50.10 ± 0.41
4	with. Elan-Koleno	13.53 ± 0.05	31.85 ± 0.61	42.90 ± 0.19
5	Nizhnedevitsky district	13.59 ± 0.06	28.60 ± 0.43	39.46 ± 0.34
6	Ostrogozhsky district	11.54 ± 0.06	34.64 ± 0.55	41.98 ± 0.26
7	Semiluksky district	12.84 ± 0.08	24.19 ± 0.70	36.78 ± 0.18
eight	Novovoronezh	12.08 ± 0.08	27.54 ± 0.44	44.00 ± 0.20
nine	VLE (Kashirsky district)	10.24 ± 0.06	21.17 ± 0.28	29.64 ± 0.34
ten	Agricultural fields of Liskinsky district	12.29 ± 0.05	25.82 ± 0.63	38.27 ± 0.028
eleven	Agricultural fields of Olkhovatsky district	11.03 ± 0.07	32.75 ± 0.51	40.26 ± 0.30
12	Agricultural fields of Podgorensky district	11.25 ± 0.06	35.18 ± 0.47	43.09 ± 0.35
13	Agricultural fields of Petropavlovsk district	14.56 ± 0.05	30.63 ± 0.53	42.99 ± 0.21
fourteen	Agricultural fields of Gribanovsky district	10.67 ± 0.06	22.53 ± .58	31.50 ± 0.29
15	Agricultural fields of the Khokholsky district	11.80 ± 0.07	31.85 ± 0.49	42.43 ± 0.35
16	Agricultural fields of Novokhopersky district	12.89 ± 0.04	26.80 ± 0.29	38.89 ± 0.39

17	Agricultural fields of Repyevsky district	11.57 ± 0.04	23.74 ± 0.64	30.79 ± 0.21
eighteen	Agricultural fields of the Vorobievsky district	14.05 ± 0.08	35.44 ± 0.37	48.43 ± 0.22
19	Agricultural fields of Paninsky district	13.67 ± 0.08	36.73 ± 0.56	53.72 ± 0.28
twenty	Agricultural fields of the Verkhnekhavsky district	10.46 ± 0.05	25.85 ± 0.44	37.09 ± 0.30
21	Agricultural fields of Ertilskiy district	13.27 ± 0.05	22.05 ± 0.48	33.59 ± 0.17
22	Agricultural fields of Rossoshansk district	10.31 ± 0.03	25.10 ± 0.52	36.97 ± 0.41
23	500 m from JSC "Minudobreniya"	9.57 ± 0.08	24.08 ± 0.50	32.65 ± 0.33
24	500 m from LLC "Bormash"	8.46 ± 0.06	25.98 ± 0.73	38.90 ± 0.28
25	Borisoglebsk city	13.93 ± 0.03	30.17 ± 0.62	44.32 ± 0.31
26	Kalach city	14.42 ± 0.07	34.26 ± 0.24	42.89 ± 0.23
27	500 m from CHP VOGRES (Voronezh)	12.74 ± 0.06	23.85 ± 0.37	37.22 ± 0.36
28	500 m from OOO Sibur (Voronezh)	10.64 ± 0.06	23.13 ± 0.49	34.17 ± 0.38
29	Coast of the Voronezh Reservoir.	14.64 ± 0.07	32.61 ± 0.72	45.27 ± 0.26
thirty	Near the Voronezh airport. Peter I	9.35 ± 0.05	27.53 ± 0.70	35.87 ± 0.29
31	Voronezh street (Leningradskaya street)	11.16 ± 0.07	26.42 ± 0.57	37.50 ± 0.31
32	Along the M4 highway (in the Ramon district)	11.89 ± 0.07	25.75 ± 0.55	33.38 ± 0.29
33	100 m from the M4 (in the Ramonsky district)	11.44 ± 0.06	24.15 ± 0.53	35.60 ± 0.44
34	200 m from the M4 (in the Ramonsky district)	12.53 ± 0.06	26.64 ± 0.47	39.61 ± 0.17
35	300 m from the M4 (in the Ramonsky district)	12.28 ± 0.07	26.02 ± 0.45	38.58 ± 0.27
36	Along the A144 highway (in the Anninsky district)	10.45 ± 0.05	27.60 ± 0.46	38.01 ± 0.31
37	100 m from A144 (in Anninsky district)	10.07 ± 0.08	24.24 ± 0.51	33.19 ± 9.20
38	200 m from A144 (in Anninsky district)	11.27 ± 0.04	25.74 ± 0.39	39.90 ± 0.33
39	300 m from A144 (in Anninsky district)	11.65 ± 0.03	27.19 ± 0.46	42.85 ± 0.31
40	Along the M4 highway (in Pavlovsky district)	12.36 ± 0.05	34.70 ± 0.45	41.85 ± 0.28
41	100 m from M4 (in Pavlovsky district)	11.56 ± 0.07	32.50 ± 0.75	43.69 ± 0.32
42	200 m from M4 (in Pavlovsky district)	13.08 ± 0.08	34.68 ± 0.34	42.90 ± 0.29
43	300 m from M4 (in Pavlovsky district)	13.99 ± 0.07	33.81 ± 0.51	52.84 ± 0.18
44	Along the non-speed road	13.52 ± 0.06	29.64 ± 0.74	43.64 ± 0.24
45	100 m from the non-speed road	14.25 ± 0.08	30.52 ± 0.27	46.31 ± 0.31
46	200 m from the non-speed road	14.38 ± 0.08	28.16 ± 0.39	39.03 ± 0.28
47	300 m non-speed road	14.00 ± 0.05	29.28 ± 0.38	41.07 ± 0.35
48	Along the railroad	10.57 ± 0.06	34.93 ± 0.42	46.05 ± 0.42
49	100 m from the railway	9.47 ± 0.08	31.74 ± 0.47	44.48 ± 0.40
50	200 m from the railway	9.03 ± 0.07	32.28 ± 0.53	47.95 ± 0.18
51	300 m from the railway	11.75 ± 0.07	33.30 ± 0.42	51.38 ± 0.23
Numerical indicator for FS		Not less than 8	-	Not less than 35

Content of gravimetrically determined water-soluble polysaccharides in roots

common burdock is characterized by numerical values from 21.17 to 38.94%. In the samples harvested in the control territories, the amount of gravimetrically determined water-soluble polysaccharides varies from 28.58 to 38.94%. For the roots of common burdock growing in agrobiocenoses, the accumulation of this group of biologically active substances is somewhat lower than for the samples of the control territories, and is characterized by values in the range of 22.05–36.73%. When analyzing the roots of common burdock growing under the conditions of urbanbiocenoses, the lowest level of water-soluble polysaccharides was found for the sample harvested under high-voltage power lines (21.17%), which presumably may indicate the suppression of biosynthetic processes in the plant under the influence of an electromagnetic field.

Analyzing the data obtained, we can conclude that there is no noticeable anthropogenic effect on the accumulation of this group of compounds: the samples collected in ecologically favorable zones differ little in the quantitative content of gravimetrically determined water-soluble polysaccharides from the samples harvested under agro- and urbanbiocenoses.

Probably, the data obtained on the variation in the studied samples of burdock roots in the numerical values of the content of the sum of polysaccharides in terms of fructose and the sum of gravimetrically determined water-soluble polysaccharides differ significantly due to the method of quantitative determination of polysaccharides. It is a well-known fact that heavy metals accumulated in medicinal plant raw materials bind into strong complexes with hydroxy groups of condensed hexoses and pentoses [8]. In gravimetric determination, heavy metals bound to polysaccharides are well precipitated together with the determined group of BAS, while in spectrophotometric determination, complexes of mono- and polysaccharides with ecotoxicants, due to their lower solubility, interfere with the formation of specific complexes with the complexing agent used in the procedure.

The amount of extractives extracted by water from the roots of common burdock ranged from 29.64% to 53.72%. In eight studied samples, this indicator turned out to be below the minimum numerical value established by the pharmacopoeial monograph (35%): in the roots of common burdock harvested in agricultural fields in Gribanovsky, Repyevsky, Ertilsky districts, under high-voltage power lines, near the chemical enterprises of OAO Minudobreniya, Voronezhsintezkauchuk OJSC, along the M4 highway in the Ramonsky district, at a distance of 100 m from the A144 highway in the Anninsky district. In samples that do not meet the requirements of the State Pharmacopoeia in terms of "the sum of extractives extracted by water", the content of the sum of polysaccharides in terms of fructose,

To analyze the relationship between the content of polysaccharides in burdock roots in terms of fructose, the amount of gravimetrically determined water-soluble polysaccharides, as well as the amount of extractives extracted by water, Pearson's correlation coefficients were calculated [9]. The correlation between the accumulation in the studied samples of the sum of polysaccharides in terms of fructose and the sum of gravimetrically determined water-soluble polysaccharides is characterized by a coefficient of 0.42, which, according to the Chaddock scale [9], indicates a positive moderate relationship.

Correlation coefficient between the numerical values of the sum of polysaccharides in terms of fructose and the sum of extractives extracted from burdock roots by water

ordinary, was 0.45, which also indicates a moderate positive relationship. A strong positive correlation (Pearson's correlation coefficient of 0.86) was established for the numerical indicators of the content in the roots of common burdock of the sum of gravimetrically determined water-soluble polysaccharides and the sum of extractives extracted by water.

This relationship of numerical indicators can be explained by the fact that when extracting water-soluble polysaccharides and for extracting the amount of extractives from a given type of medicinal plant material, the same solvent is used - water. In this case, water-soluble polysaccharides constitute the main group of substances extracted by water from the roots of common burdock.

CONCLUSIONS

1. 51 samples of roots of common burdock growing in various agro- and urban-biogeocenoses of the Voronezh region. The samples determined the content of the sum of polysaccharides in terms of fructose, gravimetrically precipitated water-soluble polysaccharides and extractives extracted by water.

2. Correlation between the accumulation in the studied samples of the sum of polysaccharides in terms of for fructose and the amount of gravimetrically determined water-soluble polysaccharides is characterized by a coefficient of 0.42, which indicates a positive moderate relationship.

3. Coefficient of correlation between the numerical values of the sum of polysaccharides in in terms of fructose and the amount of extractives extracted from the roots of burdock by water, was 0.45, which also indicates a moderate positive relationship.

4. Strong positive correlation (Pearson correlation coefficient 0.86) established for the numerical indicators of the content in the roots of common burdock, the sum of gravimetrically determined water-soluble polysaccharides and the sum of extractives extracted by water.

5. It was revealed that the lowest concentration of the sum of polysaccharides in terms of fructose was noted for samples harvested in places experiencing a strong anthropogenic load. The roots of common burdock, collected in ecologically favorable zones, differ little in the quantitative content of gravimetrically determined water-soluble polysaccharides from the samples harvested under conditions of agro- and urbobiocenoses. Probably, the obtained data differ due to the method of quantitative determination of polysaccharides. The content of the sum of extractives extracted from the roots of burdock by water turned out to be below the minimum numerical value in 8 studied samples, while this raw material also revealed relatively low values of the concentration of the sum of polysaccharides in terms of fructose, as well as the sum of gravimetrically determined water-soluble polysaccharides.

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