Polysaccharides of compass lettuce herb (Lactuca serriola L.) flora of the Central Black Earth RegionR.A.

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Polysaccarides of latuca serriola (Lactuca serriola L./Compass lettuce) herb of the flora of the central black soil region

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SUMMARY

The article provides data on the study of polysaccharides of compass lettuce herb. From the raw material of compass lettuce, polysaccharides were isolated by fractions: water-soluble polysaccharides, pectin complex, hemicellulose A and hemicellulose B. The monosaccharide composition of the isolated fractions was determined and their quantitative content was determined. The monosaccharide composition of the fractions is represented by galactose, glucose, arabinose, xylose, rhamnose, galacturonic and glucuronic acids. The IR spectra of the isolated fractions were determined, confirming their relation to polysaccharides. The sorption activity of the pectin complex in relation to methylene blue has been studied. The results obtained show the promise of using pectins from compass lettuce herb as a sorbent.

Keywords: compass lettuce, Lactuca serriola L., grass, polysaccharides, monosaccharide composition, pectin complex, sorption activity.

RESUME

The article presents the data on the study of polysaccharides of Lactuca Serriola herb. Polysaccharides have been isolated by fractions: water-soluble polysaccharides, pectin complex, hemicellulose A and hemicellulose B from the raw mass of Lactuca Serriola. The monosaccharide composition of the isolated fractions and their quantitative content have been determined. The monosaccharide composition of the fractions is represented by galactose, glucose, arabinose, xylose, rhamnose, galacturonic and glucuronic acids. The IR spectra of the selected fractions confirming their relationship to polysaccharides have been determined. The sorption activity of the pectin complex in relation to methylene blue has been studied. The result of its study is the prospect of using pectins from Lactuca Serriola herb as a sorbent.

Keywords: Compass lettuce, Lactuca Serriola, herb, polysaccharides, monosaccharide composition, pectin complex, sorption activity.

INTRODUCTION

Polysaccharides are substances of the primary biosynthesis of plants, their content can reach up to 80% of the extracted mass of dried raw materials [1].

Polysaccharides are of great importance for plants: starch and inulin are storage substances; pectin and hemicelluloses are part of the cell wall; gums and mucus are the energy reserve of plant cells [1, 2, 3].

Polysaccharides have a wide spectrum of pharmacological activity. Polysaccharides have anti-inflammatory [4, 5], anticoagulant [6], hepatoprotective [7], analgesic [8], anti-complementary [9], immunomodulatory activities [2, 3]. Polysaccharides also affect the rate of proliferation and maturation of osteoblastomas [10] and inhibit osteoporosis [11]. In addition, polysaccharides are used in medicine and pharmacy as food additives, sorbents, stabilizers, and gelling agents [12]. One of the important properties of pectin substances is their ability to form complexes, which may serve as a basis for their use as detoxifiers in case of poisoning with salts of heavy metals and radioactive isotopes [13].

A large number of various polysaccharides have been isolated from plants of the Astrov family (coltsfoot, medicinal dandelion, blue cornflower, autumnal sulbaba and rough-haired sulbaba, goatbeard, warthog, etc.). The aim of this work was to isolate and study polysaccharide complexes from compass lettuce herb (Lactuca serriola L.), growing in the regions of CentralChernozem region.

MATERIALS AND RESEARCH METHODS

As an object of research, we used compass lettuce grass (Fig. 1), harvested on the territory of the Kursk region in various habitats. The harvesting of raw materials was carried out by cutting the upper part of the plant to 20 cm, and the leaves below 20 cm were also cut off. The collected raw materials were dried, crushed to a particle size of 1 mm, and samples were taken for analysis by quartering [14].

Rice. 1. Compass lettuce (source:https://fishki.net/2056226-lekarstvennye-rastenija-rossii.html)

Polysaccharide complexes were isolated from a sample (50 g), for which the plant material was preliminarily extracted with chloroform to remove lipophilic substances, then with ethyl alcohol 70% to extract and remove phenolic compounds. Then, polysaccharides were isolated from the purified meal in fractions: a complex of water-soluble polysaccharides, a complex of pectin substances, hemicellulose A and hemicellulose B. purified water, the second and third extraction were carried out for 1 hour each and at the ratio of raw meal: extractant - 1:10 (in relation to the weight of raw material - 50 g). At the end of the extraction, the plant material was separated from the extraction by centrifugation, and the resulting extracts were combined and evaporated to obtain 1/5 of the recovery compared to the original volume. A threefold volume (in relation to the obtained extraction) of ethyl alcohol 96% was added to the one stripped off extract to precipitate water-soluble polysaccharides and left for 1 hour at room temperature. The resulting precipitate was washed with ethyl alcohol 70%, 96%, acetone, dried and weighed [15].

The meal of the raw material remaining after obtaining the water-soluble polysaccharide complex was used to isolate pectin substances. To do this, a mixture of oxalic acid (0.5% solution) and ammonium oxalate (0.5% solution) was added to it in a 1: 1 ratio and using a ratio of meal mass to volume of 1:20, and then the resulting mixture was heated in a water bath at 80–90 ° C for 2 hours. Re-extraction was carried out 2 more times. The acidic extracts were combined, concentrated under vacuum, and a threefold volume of ethyl alcohol 96% was added to them for precipitation. After precipitation, the resulting precipitate was separated by filtration, washed on the filter with 70% ethyl alcohol, and then with 96% alcohol. The resulting precipitate was dried and weighed [15].

The meal remaining after the isolation of pectin substances was used to isolate hemicellulose. At the first stage, cellulose from the meal was extracted with a 10% sodium hydroxide solution at room temperature, observing the mass to volume ratio of 1: 5. Then the extraction was filtered off, glacial acetic acid was added to the filter to form a precipitate of hemicellulose A. The formed precipitate of hemicellulose A was separated by filtration, washed with alcohol, purified water, dried, and weighed. Hemicellulose B was isolated from the filtrate by adding 96% ethyl alcohol (three volumes) to it, and a precipitate formed. The precipitate that formed was filtered off, washed with ethyl alcohol 96%, purified water, dried, and weighed [15].

In the isolated fractions of polysaccharides, their monosaccharide composition was studied by hydrolysis with sulfuric acid (2 N) at a temperature of 100–105 ° C. Hydrolyzed for various times: 6 hours - water-soluble polysaccharides, 20-24 hours - pectin substances and hemicelluloses A and B c

subsequent identification of monosaccharides by paper chromatography. The content of the monosaccharide composition was determined by densitometry after hydrolysis and thin layer chromatography [16].

IR spectra of the obtained polysaccharides were recorded on an Alpha Sample Compartment RT-DLa Tis HR 0.9 infrared spectrometer (Bruker) using a range from 400 to 4000 cm^{-1} [17].

The possibility of using a sorbent in medicine is characterized by its sorption activity, which is a relative value of the quantitative characteristics of the parameters of the sorbent and is determined by markers - model samples. We studied sorption activity by the ability to sorb methylene blue, which is traditionally used to determine the properties of enterosorbents and acts as a marker.

Determination of the sorption activity of the isolated pectin substances was studied by spectrophotometry. The reference drug was the enterosorbent "Polysorb" and activated carbon. To determine the sorption activity, a weighed portion of pectin substances (0.15 g) was placed in a 250 ml flask, a standard methylene blue solution (50 ml) was added and shaken on an electromagnetic stirrer for 20 minutes at a temperature of 36 ° C. Then the resulting solution was centrifuged for 15 minutes at 3000 rpm. The supernatant liquid (5 ml) was placed in a 50 ml volumetric flask, made up to the mark with purified water, and spectrophotometric at a wavelength of 396 nm. In parallel, the optical density of the methylene blue solution was determined [18].

CHARACTERISTIC OF THE OBJECT OF STUDY

Compass lettuce (Lactuca serriola L.) of the Asteraceae family - herbaceous plant,containing milky juice (latex). The stem is erect, furrowed, whitish or yellowish in color. Leaves are pinnate, semi-stemmed, oblong in shape with ears at the base, less often leaves are whole, their plates are arranged vertically. The underside of the stems and leaves is covered with very stiff yellowish bristles. Flowers are ligulate, yellow in baskets, forming a corymbose-paniculate inflorescence. The fruit is an achene [19].

Compass lettuce grows throughout Russia with the exception of the Far North. In central Russia, it grows in wastelands, weedy places, in kitchen gardens, orchards, on roadsides, along river banks [20].

Compass lettuce has been known since ancient times [19]. Its medicinal properties were described by Hippocrates (430 BC). Also, the properties of lettuce were assessed by Aristotle (356 BC). Certain types of lettuce were described by Theophrastus (322 BC) and Dioscorides (60 AD). The Arab physicians Altabri in Firdausul HiKmat, Razi in Alhawi, Abu Ali Ibn-Sina in Alqanoon and Majuzi in Kamil-us-Sana described the pharmacological properties and uses of lettuce seeds [19]. A Yunnan physician described in detail the pharmacological action of the plant. Based on the ancient texts of Yunani, wild lettuce was used mainly as an analgesic, sedative, diuretic and cooling agent, its components were recommended for the treatment of headaches, insomnia, nervousness, fever, palpitations, painful urination [19].

In domestic folk medicine, compass lettuce is known as an antipyretic, analgesic, anti-inflammatory, antitumor, blood purifier [19]. The use of compass lettuce improves appetite, cures headaches, coughs, jaundice, leprosy, insomnia. Boiled lettuce is a good remedy for chest organs and for increasing milk production. Externally, the leaves are used in the form of medicinal dressings for stretching the ligaments [19].

Based on these historical data, lettuce is attracting the attention of modern scientists to study its pharmacological activity. Experimental studies have shown that extracts obtained by various extractants have antioxidant activity, which is based on the reaction of free radicals with 1,1-diphenyl-2-dipicrylhydrazyl (DPPH). The most pronounced effect was shown by the ethyl acetate fraction [21].

A methanol extract from compass lettuce herb in the experiment had an antispasmodic, broncho- and vasodilator effect, and also showed analgesic activity [22]. Alcoholic extracts from lettuce herb showed high cytotoxic activity against breast cancer, hexane extract - moderate cytotoxic activity against liver cancer [23].

Compass lettuce herb has antibacterial activity. Experimental studies have also shown that ingestion of lettuce leaves prevents cardiomyocytes from being damaged in diabetes mellitus [19]. The listed pharmacological effects of a plant can be due to the presence in it of various classes of biologically active substances: phenolic compounds, monoterpenes, sesquiterpenes,

triterpenoids and others [19].

Clinical studies of lettuce herb have shown that lettuce lowers blood glucose and has antidiabetic properties, stimulates hematopoiesis [19], and is effective in chronic gastritis, gastric ulcer and duodenal ulcer.

The chemical composition of the plant has not been studied enough to date, and mainly by foreign scientists. All parts of lettuce contain sesquiterpene lactones, triterpene compounds were found in leaves and stems, flavonoids were found in leaves, aerial parts contain steroid compounds, and seeds contain fatty oil [24]. At the same time, we have not found information on the content of other biologically active substances in lettuce herb in the literature. In this regard, it was of interest for us to study the polysaccharides of lettuce and identify new directions for its use in medicine.

RESULTS AND DISCUSSION

From the raw material of compass lettuce, we fractionally isolated the following polysaccharides: water-soluble fraction of polysaccharides, pectin complex, hemicelluloses A and B. The total content of polysaccharides from the raw material (dry) compass lettuce was 23.2% (Table 1).

It was shown that the monosaccharide composition of the isolated polysaccharide complexes is represented by 7 monosaccharides (Table 1). The main monosaccharides of the water-soluble complex are arabinose (14.67%) and galactose (11.05%). The basis of pectins is galacturonic acid (83.74%). In addition to it, pectins include galactose, arabinose, and rhamnose. The qualitative monosaccharide composition of hemicellulose A and B is represented by galactose, glucose, arabinose, xylose and rhamnose, among which the maximum value was noted for xylose (7.87% and 8.17%, respectively).

Table 1

Content and composition of polysaccharides in the raw mass of compass lettuce (Lactuca serriola L.),%

Fractions polis-charid	Containing nie	Monosaccharide composition						
		Galak-tose	Glucose	Arabinose	Xylose	Ramnose	Galactu-ron acid	Glucuro-new acid
Water soluble poly-saccharides	8.61 ± 0.27	11.05 ± 0.45	0.71 ± 0.03	14.67 ± 0.40	0.91 ± 0.04	1.11 ± 0.05	1.30 ± 0.06	2.81 ± 0.12
Pectin complex	5.03 ± 0.14	3.23 ± 0.11	-	4.64 ± 0.14	-	1.62 ± 0.06	83.74 ± 2.54	-
Hemicel-lulose A	6.51 ± 0.27	6.45 ± 0.17	5.82 ± 0.13	2.33 ± 0.10	7.87 ± 019	1.14 ± 0.04	-	-
Hemicel-lulose B	3.05 ± 0.15	5.90 ± 0.13	6.37 ± 0.19	1.82 ± 0.09	8.17 ± 022	0.95 ± 0.04	-	-
Sum	23.20							

The IR spectrum of the water-soluble polysaccharide complex contains absorption bands: 1730, 1610, 1415, 1320, 1240, 1140, 1020 cm^{-1}, typical for functional groups of polysaccharides, such as: C = O, $COO,^{-}COO,^{-}$–OH, – OH, C – O – C, C – OH. The IR spectrum of pectin substances has absorption bands in the range: 1720, 1610, 1430, 1320, 1240, 1140, 1020 cm^{-1}corresponding to functional groups: C = O, $COO,^{-}COO,^{-}$ - OH, - OH, C – O – C, C – OH, characteristic of polysaccharides. Absorption bands in the region of 1730-1720 cm^{-1}, 1610 cm^{-1} in polysaccharides and pectin substances correspond to C = O, COO groups and characterize the presence of galacturonic acid, which corresponds to the data obtained in the study of the monosaccharide composition [25].

The obtained spectra of hemicellulose A and hemicellulose B contain absorption bands in the range of 1476-1480, 1341-1348, 1185-1187, 908-910 cm^{-1}corresponding to functional groups: C – H, - OH, C – O – C, C – OH, typical for hemicelluloses. The difference between the IR spectrum of hemicellulose A and hemicellulose B was established, in the IR spectrum of hemicellulose A there is an additional absorption band in the region of 1042 cm^{-1}, which is most likely associated with different chemical bonds of the studied groups [25].

Pectin substances are characterized by pronounced sorption properties. An important aspect of the use of sorbents is enterosorption, which is used in medical practice to remove endo- and exotoxins [26]. Therefore, the expansion of the raw material base of sorbents is gaining more and more

meaning. The results of the study of the sorption capacity of pectins obtained from compass lettuce herb in relation to methylene blue showed its rather high sorption activity (Table 2).

table 2

Sorption activity of pectin substances from compass lettuce herb (Lactuca serriola L.)

Sorbent name	Metrological characteristics				
	NS	S_2	S	ΔX	E rel.,%
Polysorb	709.17	10.1933	3.1927	8.88	1.25
Activated carbon	430.13	3.4357	1.8536	5.15	1.20
Pectin from compass lettuce herb	533.54	46.4743	6.8172	18.95	3.55

The study made it possible to establish that the sorption activity of the pectin fraction of compass lettuce is somewhat lower than that of the reference preparation "Polysorb", but higher than that of activated carbon.

CONCLUSIONS

1. Isolation of polysaccharides from compass lettuce herb has been carried out and the following fractions have been obtained: water-soluble polysaccharide complex, pectin substances, hemicelluloses A and B. The belonging of the isolated fractions to the class of polysaccharides was proved using the IR spectra of the isolated polysaccharide complexes.

2. The monosaccharide composition of the isolated polysaccharide complexes.

3. It has been shown that the pectin substances of the compass lettuce herb exhibit a high sorption activity in relation to methylene blue, superior in activity to activated carbon. The results obtained indicate the possibility of using the studied pectins as enterosorbents.

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