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Prospects of Use in Medical Practice of Solidago caucasica Kem.-Nath.

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Abstract

The article summarizes the results of research unexplored plants – Goldenrod causacian (Solidago caucasica Kem.-Nath), fam. Asteraceae. S. caucasica is the endemic of the North Caucasus.

Materials and Methods: The objects of the study were herb and rhizomes with roots of the S. caucasica. The herb was collected in 5 region of the North Caucasus and cultivated. The rhizomes with roots was used from the cultivated plants. The analysis was carried out with use of methods by HPLC, liquid chromatography, chromatography – mass spectrometry, spectrophotometry, titrimetry, TLC, semi-quantitative spectral analysis.

Results: For the first time in Solidago caucasica herb revealed the presence of flavonoids (rutin, hesperidin, vicenin), coumarins (esculetin, umbelliferone, dihydrocoumarin), phenol carboxylic acids (chicory, gallic, caffeic and chlorogenic acid), organic acids (citric, malic and succinic acid), 15 amino acids, 5 macro- and 16 microelements. In the rhizomes with roots of the Solidago caucasica identified polyacetylene – matricaria ester. Content of flavonoids (herb – 1,57-1,95%); phenol carboxylic acids in terms of caffeic acid (herb – 0,88 ± 0,03%; rhizomes with roots – 1,35 ± 0,05%); tannins (herb – 9,50 ± 0,20%; rhizomes with roots – 7,27 ± 0,13%); organic acids (herb – 1,31 ± 0,03%); aglycone triterpene glycosides (herb – 1,01 ± 0,03%); carbohydrates (herb – 15.93%). It was found that the extract of Solidago caucasica herb has diuretic and antibacterial effects.

Conclusion: These researches testify to the value of Solidago caucasica and prospects of further studying for use in medical practice.

Key words: carbohydrates, flavonoids, organic acids, Solidago caucasica

INTRODUCTION

There is a lack of research data on Goldenrod causacian (*Solidago caucasica*), fam. Asteraceae, a plant that is widespread in the Caucasus (Figure 1). Still, the representatives of Solidago gen. are widely used in Europe and the USA. Solidago canadensis extract has significant diuretic, urate and oxalate lytic effect, it is included into the medications of “Marelin” and “Prostanorm”. Solidago virgaurea extract is included into “Fitodolor” medications, it has anti-inflammatory effect comparable with the effect of “Indomethacin”. Solidago root is contained in BAA “Man’s formula Prostata forte” and used in folk medicine as a wound-healing remedy[1].

In the literature there is only a taxonomy of the S. caucasica, a botanical characteristic and the growth in the Caucasus [2].

MATERIAL

The objects of the study were herb and rhizomes with roots of the S. caucasica. The herb was collected at the beginning of flowering by cutting the upper part 25-30 cm long without the coarse bases of the stems with discolored leaves in 2009-2016 in the North Caucasus: Karachay-Cherkess Republic, Karachaevsky district (Gum-Bashi Pass; Daut River Gorge, Uchkulan Pass; Daut River Gorge, Echik Pass), Kabardino-Balkar Republic, Chegem district (Mount Chegem) and Zolsky district (Tract of Gyly-Su), also the herb was used from the cultivated plants [3]. S. caucasica herb was air dried in shadow under cover and in well aerated facilities.

After the drying, stalks share, blackened leaves and impurities were sorted out. Roots with rhizomes were collected by manual uprooting of S. caucasica in early spring of 2014. Roots with rhizomes were cleaned from residues of overground parts and soil, rinsed and dried in a well aerated facility.

Figure 1. Solidago caucasica Kem.–Nath.

Table 1. Phenolic compounds identified in the Solidago caucasica herb by HPLC

Group of substances	Identified substances	Concentration,% of the amount phenolic compounds in extracting
Flavonoids	Rutin	4,77
	Vicenin	3,07
	Hesperidin	2,84
Coumarins	Umbelliferone	15,48
	Esculetin	1,85
	Dihydrocoumarin	2,18
Phenol carboxylic acids	Gallic acid	18,31
	Caffeic acid	6,27
	Chlorogenic acid	2,16
	Chicory acid	2,42

Table 2. The quantitative content of flavonoids in the Solidago caucasica herb

Series	Region					
	Mount Chegem of Kabardino-Balkar Republic	Tract of Gyly-Su of Kabardino-Balkar Republic	Gum-Bashi Pass of Karachay-Cherkess Republic	Daut River Gorge, Uchkulan Pass of Karachay-Cherkess Republic	Daut River Gorge, Echik Pass of Karachay-Cherkess Republic	Introducible S. caucasica
Series 1	1,83±0,05 ε = 2,82	1,68±0,04 ε = 2,54	1,76±0,04 ε = 2,37	1,82±0,04 ε = 1,98	1,85±0,03 ε = 1,53	1,88±0,04 ε = 2,09
Series 2	1,57±0,03 ε = 2,01	1,75±0,07 ε = 3,84	1,88±0,04 ε = 2,05	1,70±0,02 ε = 1,36	1,91±0,07 ε = 3,49	1,91±0,05 ε = 2,69
Series 3	1,72±0,06 ε = 3,68	1,60±0,02 ε = 1,35	1,81±0,06 ε = 3,32	1,86±0,06 ε = 3,04	1,82±0,04 ε = 2,00	1,95±0,05 ε = 2,81

Table 3. Carbohydrates from Solidago caucasica herb

Poly-saccharides	Content%	The ratio of monosaccharide residues					Content of uronic acids%
		Galactose	Glucose	Arabinose	Xylose	Rhamnose	
Water-soluble polysaccharides	3,08	4,7	1,2	1,2	1,4	-	25,3
Pectin	6,31	40,1	-	7,4	3,8	1,0	74,2
Hemicellulose	6,54	1,1	1,0	1,1	7,5	-	15,8

RESULTS AND DISCUSSION

The analysis of phenolic compounds, contained in S. caucasica herb, by HPLC showed that overall there are 24 compounds, from which have been identified flavonoids (rutin, hesperidin, vicenin), coumarins (esculetin, umbelliferone, dihydrocoumarin), phenol carboxylic acids (chicory, gallic, caffeic and chlorogenic acid) (Table 1) [4]. Analysis conditions: extraction with ethanol by 70%; high-performance liquid chromatograph firm "GILSTON", model 305, RHEODYNE 7125 USA; stationary phase: a metal column measuring 4.6 × 250 mm KROMASIL C18, particle size 5 microns; mobile phase: methanol-water-phosphoric acid (400: 600: 5); the flow rate of the eluent is 0.8 ml / min. UV detector "GILSTON" UV / VIS model 151, the wavelength of 254 nm and 360 nm.

Quantitative content of flavonoids, equivalent to the content of rutin in herb and estimated by the method of differential spectrophotometry (extraction by ethanol 70%, wavelength 410 ± 2 nm, the method is validated), started from 1,57±0,03% to 1,95±0,05% (Table 2) [5].

Quantitative determination of phenol carboxylic acids, equivalent to the content of caffeic acid, by the method of spectrophotometry (extraction by ethanol 40%, wavelength 329 ± 2 nm) in herb of S. caucasica was 0,88 ± 0,03%; in rhizomes with roots – 1,35 ± 0,05%.

The content of tannins, determined by the method of permanganatometric titration of water extraction, in the herb was 9,50 ± 0,20%, rhizomes with roots contained 7,27 ± 0,13%.

S. caucasica herb organic acids were analyzed by HPLC: Gilston; metal column 6.5 × 300 mm ALTECH OA-1000 Organic Acids; column temperature 60 ° C; mobile phase - sulfuric acid solution 0.005 M; the flow rate of the eluent is 3 ml / min. The results of water extraction assay, with detection at 190 nm wavelength, revealed citric, malic and succinic acid [6]. The content of organic acids, obtained by titrimetry of water extraction, was 1,31 ± 0,03%.

The content of the sum of aglycon triterpene glycosides by spectrophotometry [7] in S. caucasica herb in terms of oleanolic acid was 1,01 ± 0,03% [8].

In the rhizomes with the roots of S. caucasica, polyacetylene matricaria ester was identified by spectrophotometry. The matricaria ester was obtained by the method of two-dimensional TLC from petroleum ether extraction.

Carbohydrates from the herb of S. caucasica were isolated according to the method of N.K. Kochetkov [9] and M. Sinner [10]. The isolated water-soluble polysaccharides and pectin were assigned according to the amount of component monosaccharides as galactans; hemicellulose, xylans. The greatest amount of galactose was observed in

pectin fractions (Table 3). The yield of carbohydrates in S. caucasica herb was 15,93% [11].

Fatty acids were determined in S. caucasica herb by the method of gas-liquid chromatography mass-spectrometry (AT-5850/5973 Agillent Technologies, extraction of ethanol 50%, drying, addition of N, O-bis (trimethylsilyl) trifluoroacetamide): dihydroxypropionic acid, trihydroxybutyric acid, hydroxybutyric acid, palmitic acid, linoleic acid, linolenic acid, stearic acid), polyhydric alcohols and their derivatives (glycerol, xylitol, ribitol, inositol, myo-inositol, scyllo-inositol and etc.

The presence of 15 amino acids was found in S. caucasica herb: threonine, valine, methionine, leucine, isoleucine, phenylalanine, histidine, lysine, arginine, aspartic acid, serine, glutamic acid, glycine, alanine, tyrosine, of which the first 9 are essential amino acids. The analysis was carried out by liquid chromatography on an automatic amino acid analyzer [12].

Semi-quantitative spectral analysis was used for S. caucasica herb mineral composition and macroelements identification (Na, K, Mg, P, Ca) and microelements (Cr, Cu, Fe, Mn, Zn, Mo, Ag, Al, B, Ni, Si, V, Ba, Ti, Zr, Sr) [12].

S. caucasica herb extract can be classified as low toxic, which is proved by the acute toxicity evaluation test results.

In carrying out preliminary pharmacological studies, the diuretic and antibacterial effects of dry ethanol extract of S. caucasica herb [13] was studied. Evident diuresis rate increase by 64% was established in comparison with intact animals. Optimal dose of S. caucasica extract is 300 mg/kg, the dose increase leads to diuresis rate decrease [14].

Aqueous solution of a dry extract antibacterial effect studies showed that it has optimal effect in 20% concentration of the solution against Staphylococcus aureus (Makarov); S. aureus Type; S. epidermidis Wood–46; Bacillus subtilis L_2; Bac. anthracoides–96; Bac. anthracoides–1; Proteus vulgaris; – E. coli M–17; Pseudomonas aeruginosa [15].

Preliminary resource exploration studies showed that the total area of S. caucasica herb cover in the 5 explored regions of the North Caucasus was around 28 hectares with the annual resource potential stocking capacity of more than 1 ton [16]. Due to limited resource capacity and protection of wild growing endemic plant, the researchers made an attempt to cultivate S. caucasica. The cultivation experience of S. caucasica brought positive results. Rhizome sections reproduction was found to be the most effective, since the plant entered the generative phase within the first year with around 80% survival rate.

CONCLUSION

The results of the experiment confirmed that Solidago caucasica herb can be used as a source of biologically active substances and its effectiveness was proved pharmacologically. The obtained results can be applied in pharmaceutical industry. The completed studies can expand the register of Russian medications resources with further development of Solidago caucasica-based medications.

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