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POLYSACCHARIDES FROM *Cichorium glandulosum* SEEDS

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The herb *Cichorium glandulosum* (chicory, Compositae) is used in Chinese folk medicine to treat liver diseases [1]. We isolated previously from this plant coumarins [2]. Herein we report results from a study of carbohydrates from *C. glandulosum* seeds. Low-molecular-weight and dye components were removed by defatting dried seeds (100 g) with $CHCl_3$ in a Soxhlet apparatus for 8 h. Then the residue was extracted with alcohol (80%). The remaining raw material was extracted three times with cold water to isolate water-soluble polysaccharides (WSPS-1). The resulting extracts were combined, centrifuged, and dried. The extract was purified of proteins by the literature method [3] and precipitated by alcohol in a 1:3 ratio. The resulting precipitate was separated, washed with alcohol, defatted with acetone, and dried in vacuo over P_2O_5. The yield of WSPS-1 was 1.06%. Then the residue was extracted with hot water at 80°C to afford WSPS-2 in 1.39% yield. Extracts WSPS-1 and WSPS-2 gave a negative reaction for starch.

WSPS-1 and WSPS-2 were light-brown powders that dissolved in water. Their hydrolysate (H_2SO_4, 2 N, 8 h, 100°C) contained acidic and neutral sugars in various ratios according to PC using BuOH:Py:H_2O (6:4:3) with development by anilinium acid phthalate. The quantitative monosaccharide composition of the hydrolysates was analyzed using GC with a PE-Turbomass aidosystem XI mass spectrometer, PESS quartz column (30 × 0.25 mm), 200°C, 35 mL/min, N_2 carrier gas. Sugar samples were analyzed as aldononitrile acetates [4, 5]. Table 1 gives the monosaccharide composition of the polysaccharides. WSPS-1 were a mixture of acidic and neutral polysaccharides. The dominant monosaccharides of WSPS-1 were rhamnose, xylose, and galactose; of WSPS-2, mainly mannose and galactose.

After removing WSPS, the remaining raw material was extracted twice with oxalic acid and ammonium oxalate solutions (0.5%, 1:1) for 2 h at 70°C. The extracts were combined, centrifuged, dialyzed, dried, and precipitated by alcohol (1:2). The precipitate was removed, washed with alcohol, and dried in vacuo over P_2O_5. The yield of pectinic substances (PS) was 2.28%.

PS were a white powder that was soluble in water. Its hydrolysate (H_2SO_4, 2 N, 42 h, 100°C) contained predominantly rhamnose, mannose, and galactose according to GC. The contents of free (C_f, 18.9%) and esterified carboxylic groups (C_e, 9.5%) were determined by titration. The degree of esterification (λ) was 33.5% [6]. Therefore, PS were low esterfied pectins.

Hemicellulose (HC) was isolated after removal of PS by extraction with base solution (5%) at room temperature. The extract was neutralized by acetic acid. The resulting precipitate was removed to afford HC-A in 0.92% yield. The supernatant solution was condensed and precipitated with alcohol. The resulting precipitate (4.28% yield) was designated HC-B. The predominant monosaccharides in the hydrolysates (H_2SO_4, 2 N, 72 h, 100°C) were mannose (HC-A) and arabinose and xylose (HC-B).

The biological activity was studied using inhibition by polysaccharides of nonenzymatic glycosylation of protein *in vitro* and antioxidant effects (ability to damage hydroxyl free radicals) [7]. Table 2 presents the results.

Table 2 shows that WSPS-1, WSPS-2, and PS had various biological activities. WSPS-1 were the best for inhibiting nonenzymatic glycosylation of protein; WSPS-2, for inhibiting peroxide oxidation of lipids.

PS were the best for destroying hydroxyl radicals.

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TABLE 1. Content and Monosaccharide Composition of Carbohydrates from *Cichorium glandulosum* Seeds

Polysaccharide	Yield, %	Monosaccharide composition, %						
		Rha	Xyl	Ara	Man	Glc	Gal	UAc
WSPS-1	1.06	20.2	10.88	7.90	4.23	1.88	21.29	0.98
WSPS-2	1.39	6.40	13.95	3.26	35.48	1.42	16.02	0.71
PS	2.28	27.83	0.87	3.49	22.81	3.06	18.51	2.72
HC-A	0.92	2.30	4.02	10.75	48.92	4.20	-	0.50
HC-B	4.28	2.91	4.47	18.98	2.29	2.42	-	-

TABLE 2. Screening for Biological Activity of Polysaccharides

Polysaccharide	Inhibition of nonenzymatic protein glycosylation, %	Peroxide oxidation of lipids, %	Ability to destroy hydroxyl radicals, %
WSPS-1	48	41	24
WSPS-2	15	48	34
PS	43	32	52

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