Chemistry of Natural Compounds, Vol. 48, No. 3, July, 2012 [Russian original No. 3, May-June, 2012]

BRIEF COMMUNICATIONS

CARBOHYDRATES OF *Nigella sativa* AND *N. damascena*

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UDC 615.322:582.675.1:[547.917.06:543]

Annual herbaceous plants of the family Ranunculaceae, e.g., *Nigella damascena* L. and *N. sativa* L., are used worldwide as food and medicinal plants. Information on the widespread medicinal use of these plants has been published [1].

Herein we communicate results on the isolation and general characterization of carbohydrates of seeds from two *Nigella* species. We studied air-dried ground seeds of plants cultivated in Stavropol Territory (Russia).

Ground raw material (100 g) was treated with $CHCl_3$ to remove colored substances and non-carbohydrate components. The remaining raw material was extracted (×2) with refluxing EtOH (82°). The raw material was dried. The EtOH extracts were combined, evaporated, and chromatographed on Filtrak FN 7 and 12 paper (PC). The sugars soluble in alcohol (SSA) of both species contained according to PC galactose, glucose, and an unidentified oligosaccharide. Then, water-soluble polysaccharides were isolated by fractions by extraction with cold water (WSPS-C), hot water (WSPS-H), a mixture of oxalic acid and ammonium oxalate solutions (0.5%) (pectinic substances, PS), and base solution (5%) (hemicellulose, HMC).

The carbohydrates were hydrolyzed by acid in order to establish the monosaccharide composition [2]. The qualitative and quantitative monosaccharide composition was determined by PC (*n*-BuOH:Py:H_2O, 6:4:3; detection by anilinium biphthalate) and GC.

GC analysis was carried out on a Chrom-5 chromatograph with a flame-ionization detector, glass column (1.5 m × 0.3 m, 5% Silicone XE-60 on Chromaton NAW, 0.200–0.250 mesh), 210°C, He carrier gas at 30 mL/min, as the aldononitrile acetates [3].

Table 1 presents the content and monosaccharide composition of the carbohydrates in *N. sativa* seeds. It can be seen that acidic and base-soluble polysaccharides were the principal ones with yields of 3.18 and 3.24%, respectively. Arabinose dominated in all fractions.

Seeds of *N. damascena* were dominated by HMC consisting primarily of xylose and mannose. The WSPS fractions included arabinose, glucose, and galactose; the WSPS-H, arabinose and galactose (Table 1).

The WSPS of *N. sativa* were a friable dark-brown powder with a greenish tint; of *N. damascena*, a gray powder that was soluble in H_2O. They formed a slightly cloudy solution. An aqueous solution of the polysaccharides gave a positive reaction with I_2. This suggested the presence of glucan-type polysaccharides.

The PS were a gray powder that dissolved with heating in H_2O to form viscous solutions that gave a positive reaction for starch with I_2. The PS hydrolysate contained the neutral monosaccharides shown in Table 1. PC identified uronic acid.

Titration [4] determined the content in PS of *N. sativa* and *N. damascena* of free (Cf) 14.4/10.2% and esterified (Ce) 4.5/3.4%, respectively, carboxylic groups. The degrees of esterification (λ) were 23.8 and 25.0%, respectively. Therefore, the PS were considered low-esterified PS.

HMC was a friable brown powder that dissolved in base. Aqueous solutions also gave a reaction for starch with I_2.

IR spectra of the analyzed carbohydrate fractions contained characteristic absorption bands that showed the presence of galacturonic acid in the pyranose form in polysaccharides existing in the $^4C_1$-α-conformation. IR spectra were taken in KBr pellets on a Perkin–Elmer Model 2000 spectrometer. Uronic acids were associated through intramolecular H-bonds involving primary and secondary alcohol hydroxyls. Carboxylic groups were found primarily in the ionized form and partially esterified by MeOH. A significant amount of galacturonides was noted according to the absorption band intensity in the WSPS-H and acidic fractions [5, 6].

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 0009-3130/12/4803-0460

TABLE 1. Content and Monosaccharide Composition of Polysaccharides of *Nigella sativa* and *N. damascena*

Polysaccharid	PS yield, %	Ratio of monosaccharide units						
		Rha	Xyl	Ara	Man	Glc	Gal	UAc
				Nigella sativa				
WSPS-C	1.07	–	Tr.	9.1	–	1.0	3.3	–
WSPS-H	1.34	–	Tr.	3.3	–	1.0	2.2	–
PS	3.18	–	Tr.	2.9	–	1.0	Tr.	+
HMC	3.24	–	Tr.	0.6	–	Tr.	1.0	Tr.
				N. damascena				
WSPS-C	0.47	Tr.	3.56	17.48	–	34.8	32.5	Tr.
WSPS-H	0.46	Tr.	6.14	43.87	–	6.11	31.0	Tr.
PS	0.45	Tr.	10.5	21.87	–	25.82	Tr.	+
HMC	2.17	6.14	43.87	2.45	31.1	+	Tr.	Tr.

Spectrophotometry using the reaction of galacturonides with carbazole in H_2SO_4 solution was used for the analysis [7]. The contents of polygalacturonic acid in seeds from *N. sativa* and *N. damascena* were 29.3 ± 1.5% and 5.85 ± 1.1%, respectively.

Thus, the contents of polysaccharides in seeds from two *Nigella* species were found. The qualitative and quantitative monosaccharide compositions and their physicochemical properties were studied.

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