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CARBOHYDRATES OF CULTIVATED VARIETIES OF *Althea rosea*

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The polysaccharides of three cultivated varieties of Althea rosea *have been investigated. The amounts of water-soluble polysaccharides and pectin substances in various organs of the plant have been determined. It has been shown that the maximum amount of water-soluble polysaccharides and pectin substances is present in the flowers. Their monosaccharide compositions have been studied. The physicochemical characteristics of the pectin substances are given.*

Hollyhock (*A. rosea*), family Malvaceae, is a valuable dye plant which is widely used in the food industry. It is a perennial herbaceous plant, but in Uzbekistan it is cultivated as a biannual summer-flowering plant. The varieties Rubinovyi makhrovyi (red double) and Naira (black double) have been isolated in the Institute of Botany of the Academy of Sciences of the Republic of Uzbekistan by individual-family selection from the red and black double forms of the hollyhock. The petals of the flowers of both varieties serve as the raw material for obtaining a natural food dye [1]. Considerable amounts of polysaccharides have been detected in the vegetative organs (roots, stems, leaves, flowers), and the present paper is devoted to a study of them. The water-soluble polysaccharides (WSPSs) and pectin substances (PcSs) of three cultivated varieties have been isolated and characterized. The amounts of the polysaccharides investigated in the various organs were different. In the red double variety the WSPSs and PcSs accumulated mainly in the flowers (4.75 and 17.3%, respectively) while in the hybrid variety they accumulated in the leaves (6.2 and 10%, respectively). The polysaccharides isolated consisted of amorphous powders with a pink tinge that possessed no reducing capacity and gave no color reaction with iodine, which showed the absence of starch.

To determine their qualitative and quantitative carbohydrate compositions, the polysaccharides were subjected to complete acid hydrolysis and the products were analyzed by PC and GLC in the form of aldononitrile acetates [2] (Table 2). The predominating monosaccharide components in the WSPSs and PcSs were rhamnose and arabinose. In addition to these, uronic acids and trace amounts of xylose, mannose, glucose, and galactose were detected. The ratio of the rhamnose and arabinose in the WSPSs of the flowers isolated from the red double and hybrid varieties was the same — 20:1, while in the PcSs it was 3:1.

There is information in the literature on the water-soluble polysaccharides [3] but the pectin substances have not been studied. We made a detailed study of the PcSs of *A. rosea*. They consisted of brown powders readily soluble in water forming viscous solutions. The greatest viscosity was possessed by solutions of the PcSs of the flowers, which had η_{rel} 5.0-6.41 (*c* 10; H_2O). All the PcSs had high positive specific rotations, which indicated the α- configuration of the glycosidic bond between the uronic acid residues (Table 3). The amount of uronic acids in the PcSs of the roots and stems was 52% [4].

The molecular mass of the PcSs, determined viscosimetrically [5] ranged from 8000 to 30,000. As can be seen from Table 3, with an increase in molecular mass the viscosity of the PcSs rose. The PcSs from flowers of the hybrid variety contained a larger amount of methoxy groups than the red double variety, which permits us to assign them to the high-methoxyl pectins. A jelly containing 2% of pectin from the flowers of the red double variety formed a mass of dense consistency which shows its good jelling capacity [6].

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TABLE 1. Amounts of the WSPSs and PcSs in Various Organs of the Cultivated Varieties of *A. rosea*

Plant organ	Red double		Black double		Hybrid variety	
	WSPSs	PcSs	WSPSs	PcSs	WSPSs	PcSs
Root	0,35	1,5	0,6	2,0	0,5	2,3
Stem	0,3	3,92	1,6	0,64	1,3	0,46
Leaves	1,5	9,0	2,15	10,8	6,2	10,0
Flowers	4,75	17,3	–	–	3,0	7,6

TABLE 2. Monosaccharide Compositions of the WSPSs and PcSs Isolated from Various Organs of Different Varieties of *A. rosea*

Variety	Type of polysaccharide	Amounts of the monosaccharides					
		Rha	Ara	Xyl	Man	Glc	Gal
Red double	WSPS-S	17,6	2,0	Tr.	Tr.	1,0	2,8
	WSPS-L	27,5	Tr.	4,0	—	1,75	1,0
	WSPS-F	22,0	1,0	—	Tr.	1,0	Tr.
	PcS-S	4,33	1,0	—	—	4,5	—
	PcS-L	7,5	3,0	1,8	Tr.	Tr.	1,0
	PcS-F	3,3	1,0	—	—	—	1,0
	PcS-R	18,3	3,0	Tr.	Tr.	Tr.	1,0
Black double	WSPS-S	22,0	1,5	Tr.	—	1,0	1,0
	WSPS-L	22,0	4,0	Tr.	Tr.	2,0	1,0
	PcS-S	27,5	5,0	Tr.	—	1,0	1,0
	PcS-L	0,25	3,25	1,0	Tr.	1,0	1,2
	PCS-R	52,5	7,5	5,0	—	1,5	1,0
Hybrid variety	WSPS-S	22,0	1,25	Tr.	—	Tr.	1,0
	WSPS-L	11,0	1,5	Tr.	Tr.	1,0	1,5
	WSPS-F	22,0	1,0	—	Tr.	—	—
	PcS-S	22,0	2,0	Tr.	Tr.	1,0	1,3
	PcS-L	27,5	7,5	—	—	Tr.	1,0
	PcS-F	52,5	17,5	Tr.	Tr.	Tr.	1,0
	PcS-R	4,0	3,2	1,0	—	—	—

*S) stem; L) leaves; F) flowers; R) roots.

Thus, in contrast to wild types [7-10], in cultivated varieties of *A. rosea* the WSPSs and PcSs accumulate to a greater extent in the flowers than in the stems and consist mainly of pentoses. The polysaccharides of *A. rosea* deserve further study with the aim of revealing the possibility of their use in medical practice and in the food industry.

EXPERIMENTAL

The descending PC of the sugars was carried out in the butan-1-ol–pyridine–water (6:4:3) system on FN-11 paper. GLC was conducted on a Chrom-5 chromatograph. Aldononitrile peracetates were analyzed under the following conditions: glass column (0.3 × 200 cm), 5% of Silicone XE-60 on Chromaton N-AW-DMCS 0.160-0.200 mm, 210°C; carrier gas helium, rate of flow of gas 60 ml/min [2].

TABLE 3. Physicochemical Properties of the PcSs

Variety	Type of polysaccharide	$[\alpha]_D^{20}$, deg (c 1,0; H_2O)	MM	η_{rel} (c 1,0; H_2O)	O-CH3,%	Uronic acid, %
Red double	PcS-R	+176	8000	2,15	2,36	27,3
	PcS-S	+180	12000	2,36	3,51	40,0
	PcS-L	+161	18000	4,62	3,72	47,0
	PcS-F	+182	30000	6,41	3,85	50,0
Black double	PcS-R	+178	8000	2,32	2,67	29,0
	PcS-S	+175	13000	2,22	3,95	43,0
	PcS-L	+164	15000	4,28	4,32	52,0
Hybrid	PcS-R	+160	12000	2,49	2,79	22,0
	PcS-S	+173	9000	2,72	3,54	47,0
	PCs-L	+163	11000	3,20	3,87	45,0
	PcS-F	+187	26000	5,20	6,98	48,0

The complete acid hydrolysis of the WSPSs was achieved with 2 N H_2SO_4 at 100°C for 8 h, while the PcSs were hydrolyzed for 48 h.

The uronic acids were determined by the carbazole method [4]. The viscosity of the PcSs was determined as in [5]. The specific rotations of the substances were measured on a Zeiss polarimeter in a tube 1 dm long with a volume of 10 ml at 20°C.

Isolation of the WSPSs. The air-dry raw material (20 g for each organ, separately) was treated with chloroform (1:5) and with 82% alcohol (1:5). The residual raw material was extracted twice with water (1:10) at room temperature for 3-4 h. The extract was separated off, centrifuged, and evaporated to 1/2 volume. After treatment with alcohol, (1:2) the resultant precipitate was separated off and was washed with alcohol and acetone and dried in vacuum over P_2O_5. The yields of WSPSs are given in Table 1.

Isolation of the PcSs. After the isolation of the WSPSs, the residual raw material was extracted twice with 0.5% solutions of oxalic acid and ammonium oxalate (1:1) at 70°C for 3 h. The extracts were combined, dialyzed against mains water, and precipitated with methanol (1:3). The precipitate was separated off, dehydrated with acetone, and dried in vacuum over P_2O_5. The yields are given in Table 1.

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