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POLYSACCHARIDES FROM THE WASTES OF SOME FRUIT AND BERRY,
VEGETABLE, AND TECHNICAL CROPS

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The fractional isolation of water-soluble polysaccharides and pectin substances has been carried out from the wastes of fruit and berry and vegetable crops: apples, quinces, grapes, and tomatoes, and also the valves of cotton bolls. The qualitative and quantitative monosaccharide compositions of the carbohydrates isolated have been determined, and the characteristics of the pectin substances are given.

In the processing of fruit and berry and vegetable crops in the preserving factories of Uzbekistan — apples (*Malus domestica*, *M. pumila*), quinces (*Cydonia oblonga*), grapes (*Vitis vinifera*), and tomatoes (*Lycopersicum esculentum*) — a large amount of wastes is formed, and during the working of the heap cleaners, the valves of the bolls of the cotton plant (*Gossypium hirsutum*) accumulate.

One of the possible methods for their utilization is the isolation from them of valuable polymers and, in particular, pectin substances. Interest is shown in them in pharmacy as stabilizers for suspensions and emulsifying agents [1, 2] and in the food industry as gel-forming agents [3].

We successively extracted the polysaccharides from one sample of air-dry raw material: first the water-soluble polysaccharide (WSPSs) and then the pectin substances (PSs). To determine their monosaccharide compositions, samples of the polysaccharide fractions were subjected to complete acid hydrolysis. The hydrolysates were analyzed by the PC and GLC methods. The results obtained are given in Table 1.

As can be seen from Table 1, the amounts of WSPSs in the sample investigated ranged between 1 and 4.2%. The polysaccharides isolated consisted of white powders with a creamy tinge readily soluble in water. Rhamnose, arabinose, xylose, mannose, glucose, and galactose were detected in the hydrolysis products. The pectin substances, which were obtained with yields of 1.2-15.2%, were characterized in greater detail. The pectins did not contain starch, as was shown by the negative reaction with iodine. The PSs obtained consisted of odorless white powders with a creamy tinge readily soluble in water and precipitated from their aqueous solutions by aluminum sulfate.

In the products of the complete acid hydrolysis of the PSs, in addition to the monosaccharides given in Table 1, we found a considerable amount of galacturonic acid, which was identified by PC and electrophoresis with markers. The quantitative characteristics obtained by the titrimetric method [4] are given below (%):

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TABLE 1. Amounts of Polysaccharides and Their Monosaccharide Compositions

Object of investigation	Type of polysaccharide	Yield of polysaccharide, %	Ratio of monosaccharides					
			Rham	Ara	Xyl	Gal	Glc	Man
<i>Malus domestica</i> <i>M. pumila</i> (mixture)	WSPs	3,9						
	PSs	15,2	9,2	1	Tr.	Tr.	Tr..	Tr..
<i>Cydonia oblonga</i>	WSPs	1,2	6,8	11	5,4	5,3	4,6	1
	PSs	7,6	1	1	1,3	2,2	1,5	Tr.
<i>Gossypium hirsutum</i>	WSPs	2,9	8,3	5,8	1,6	1	9	3,1
	PSs	7,0	2,3	4,1	4,1	2	1	Tr.
<i>Lycopersicum esculentum</i>	WSPs	4,2	1,6	1,7	1	2,5	2,5	1,6
	PSs	2,9	2	2	3	1,3	1	1,7
<i>Vitis vinifera</i>	WSPs	1,4	1,7	6	1	3,2	2,4	4,6
	PSs	1,2	2,6	3,3	1	4,2	1,3	5,8

Pectin	K_f	K_e	λ	OCH_3
<i>M. domestica, M. pumila</i>	3,3	7,6	69	5,0
<i>C. oblonga</i>	5,8	6,7	53	4,4
<i>G. hirsutum</i>	2,1	5,1	70	3,4
<i>L. esculentum</i>	5,0	1,3	20,4	1
<i>V. vinifera</i>	1,2	3,3	72,6	2,2

K_f represent the free carboxy groups; K_e the methoxylated carboxy groups; and λ the degree of methoxylation.

The gel-forming capacity of the pectins depends on the viscosity of their solutions. We studied the viscosity of the PSs from the wastes containing them in the largest amount (excluding *V. vinifera*). The results on the relative, specific, and reduced viscosities (η_{rel} , η_{sp} , and η_{red}) as functions of the concentration of the solutions are given below:

Pectin	Concentration of the pectin solution, %	η_{rel}	η_{sp}	η_{red}
<i>M. domestica, M. pumila</i>	0,12	1,8	0,78	6,2
	0,25	2,7	1,7	6,8
	0,5	6,0	4,7	9,4
<i>C. oblonga</i>	0,12	2,4	1,4	11,2
	0,25	4,0	3,0	12,0
	0,5	10,0	9,0	18,0
<i>G. hirsutum</i>	0,12	2,4	1,4	11,0
	0,25	4,0	3,0	11,9
	0,5	9,0	8	16,0

As we see, solutions of the pectins studied possessed high viscosities. The relative and specific viscosities rose rapidly with an increase in concentration. Thus, the relative viscosity of a 0.5% solution of pectins was 3.5-4.0 times greater than that of a 0.12% solution.

Jellies containing 1% of the PSs from quinces, apples, and cotton boll valves consisted of dense masses, which indicate their good jelling properties. A mixture of 0.3 g of a pectin with 25 g of sugar formed a jelly of good strength, which was determined by a standard method [5].

Thus, the fairly high concentration and good jelling properties of the PSs from apple and quince press residues, and also from cotton boll valves, makes them promising material for use in medicine, pharmacy, and the food industry.

EXPERIMENTAL

Descending paper chromatography was performed on Filtrak FN-11,14 paper in the 1-butanol-pyridine-water (6:4:3) system. Monosaccharides were detected with aniline hydrogen

phthalate in water-saturated butanol at 110°C. For analysis, the monosaccharides were converted into the corresponding aldonitrile acetates, and GLC was performed on Tsvet-101 instrument with a flame-ionization detector. Steel column (200 × 0.3 cm) filled with 5% of XE-60 on Chromaton N-AW (0.200-0.250 mm), with a rate of flow of helium of 60 ml/min, a thermostat temperature of 210°C and a evaporator temperature of 270°C. The relative amounts of sugars were determined from peak areas.

Paper electrophoresis was performed in a horizontal instrument at 1100 V, 7 mA, in 1% acetic acid on FN-7 paper for 4 h.

Viscosities were measured in a Ostwald viscometer with a capillary having a diameter of 0.73 mm at 20°C.

Isolation of the Polysaccharides. The WSPs and PSs were extracted successively from 100 g of air-dry raw material as described in [6].

The acid hydrolysis of the polysaccharides was carried out with 2 N H₂SO₄ at 100°C, for 8 h in the case of the WSPs and for 48 h in the case of the PSs. The neutralized and purified hydrolysates were analyzed by PC and GLC.

SUMMARY

The fractional isolation of the water-soluble polysaccharides and pectin substances from the wastes of fruit and berry and vegetable crops — apples, quinces, grapes, and tomatoes — and also from cotton boll valves has been performed. The qualitative and quantitative monosaccharide compositions of the carbohydrates isolated have been determined, and the characteristics of the pectin substances are given.

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