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PLANT POLYSACCHARIDES. IV. CHEMICAL COMPOSITION OF POLYSACCHARIDES AND THEIR REGULATORY PROPERTIES

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The search for plant growth stimulators among plant carbohydrates is a matter of interest. Regulatory properties of oligo- and polysaccharides have been reported in [1-4]. Continuing investigations in this direction, we have studied the properties of polysaccharides isolated from the flora of Central Asia [5]. The sources of isolation and the compositions of the polysaccharides are given in Table 1.

The polysaccharides differed in chemical composition and molecular mass. Of them, a pectin is represented by the serial No. (1). A glucofructan (2) and a fructan (4) consist mainly of *D*-fructose (90-95%) and *D*-glucose (5-10%), the fructofuranoses in the chains of these polymers being linked by β-2→1 and β-2→6 glycosidic bonds. A mannan (3) is a linear polymer with β-1→4 glycosidic bonds between *D*-mannopyranose residues. A mucilaginous polysaccharide (5) consists of acid and neutral sugars, as shown previously [6].

The primary screening of the polysaccharides for growth-stimulating activity was conducted under laboratory conditions. An experiment with a cotton plant of the variety S-4880 under field conditions was carried out in the Tinchlik kolkhoz [collective farm], Tashkentskaya Oblast.

In order to reveal biological activity, substances (1)-(5) were investigated with solutions having concentrations of from 0.01 to 0.5%. Seeds of the S-4880 cotton plant were used as the biotest [7]. The biological activities of the polysaccharides were determined from the energy of germination, the germinative capacity of the seeds, and the change in the length of the seedling radical. The results of the investigation showed that substances (1)-(5) exerted different effects on the growth of the cotton seeds. In a concentration of 0.1%, substance (1) was capable of increasing the energy of germination by 6%, the germinating capacity of the seeds by 10%, and the elongation of the seedling radicle by 9.6 mm. Substances (2)-(4) and (5) accelerated germination by 10, 9, 12, and 15% and raised the germinating capacity by 12, 14, 16, and 20%, respectively. At the same time the length of the seedling radicles increased to 18 mm.

Among the substances tested under field condition, the best results were shown by the mucilaginous polysaccharide. The positive effect of the mucilaginous polysaccharide was shown in an acceleration of the rate of development of the cotton plants: the flowering phase set in 2-3 days earlier and the shedding of the fruit organs decreased by 14%. The increase in yield of raw cotton in comparison with the control averaged 350 kg/ha.

To determine the cause-and-effect changes in growth and development and also in the productivity of a cottonplant after the action of the mucilaginous polysaccharide it was necessary to follow the activity and directivity of the enzymatic processes taking place in the leaves and regulating the carbohydrate metabolism, and for this we used Kursanov's method [12]. Therefore, by creating a vacuum, a mixture of glucose and fructose was infiltrated into leaves of the experimental and control plants. After 6, 12, 24, and 48 h, the amounts of monosaccharides and the total amount of sugars were determined, and the synthesis or hydrolysis of the infiltrated sugars was judged by comparing them with the control variant (Table 2).

A high synthetic activity of the enzymes of the carbohydrate metabolism was detected in the cottonplant leaves from the experimental variant with the mucilaginous polysaccharide (0.5% solution). The amount of sucrose synthesized from the infiltrated monosaccharides (glucose and fructose) was 32%, as compared with 23% in the control.

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TABLE 1. Sources of Isolation and Compositions of the Polysaccharides

Substance	Source of the polysaccharides	OCH_3, %	Cal, %	Mol. mass	Ratio of the monosaccharides						
					Gal	Glc	Man	Ara	Xyl	Rham	Fr
1	Ungernia sewerzowii [8]	3.4	52.4	40–50000	23.2	2.0	–	2.2	1.0	3.2	–
2	Polygonatum sewerzowii [9]	–	–	2000-2500	–	+	–	–	–	–	+
3	Ungernia ferganica [10]	–	–	10000-35000	–	3.1	96.0	1.0	–	–	–
4	Allium suworowii [11]	–	–	13000	–	+	–	–	–	–	+
5	Gydonia oblonga [6]	–	–	–	6.3	4.9	1.0	2.4	14.2	–	–

TABLE 2. Influence of the Mucilaginous Polysaccharide on the Synthesis of Sugars in Isolated Cottonplant Leaves

Variant	Time of exposure, h	Amount of infiltrated monosacch., %	Carbohydrates, %		Sugars, %
			mono	di	
Control	6	100	67.0	24.0	9.0
	12	100	60.0	22.0	18.0
	24	100	54.6	22.4	23.0
	48	100	54.2	22.8	23.0
Mucilaginous polysaccharide	6	100	62.0	19.4	18.6
	12	100	58.0	18.2	23.0
	24	100	60.0	16.0	24.0
	48	100	42.0	26.0	32.0

Thus, under the influence of the mucilaginous polysaccharide the activity of the enzyme of carbohydrate metabolism in cottonplant leaves is raised, and this determines the nature of the regulatory action of the preparation.

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