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WATER-SOLUBLE PROTEINS OF THE SEEDS OF SOME VARIETIES OF CASTOR-OIL PLANT

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The water-soluble proteins of twelve varieties of castor-oil plant have been studied by electrophoresis. The high hemagglutinating activities of proteins of the seeds is connected with the presence of an electrophoretic component having R_f 0.042.

The castor-oil plant is widely used in many sectors of industry and medicine [1]. An investigation of the fatty acid composition of castor oil has shown that the level of ricinoleic (12-hydroxyoleic) acid in various subspecies of the castor-oil plant ranges from 83.6 to 90%, while palmitic, stearic, oleic, and linoleic acids are present in small amounts [2].

The seeds of the castor-oil plant (castor beans) contain a considerable amount of protein, but the presence of certain toxic groups of proteins called phytohemagglutins greatly decreases their fodder value [3].

At the present time, work is being done on the creation of new varieties of castor-oil plant with a decreased amount of toxic substances [4]. The aim of our investigation was an electrophoretic study of the water-soluble proteins of different varieties of castor-oil plant and their hemagglutinating activity, which is of great interest for domestic selection.

The seeds were ground and their oil [5] and protein [6] contents and hemagglutination titers [7] were determined. The results of the analyses are given in Table 1. The varieties differed considerably with respect to their oil and protein contents and agglutination titers. The oil content of the seeds of the individual varieties ranged from 43.1 to 52.7%, the protein content from 20.1 to 32.2%, and the agglutination titer from 1:64 to 1:1024. The lowest agglutination titers were found in samples 1, 2, 3, and 9, the protein contents of which were high.

The results of the electrophoretic investigation of the protein spectrum of the water-soluble fractions of individual seeds are shown in Table 2 in the form of the relative

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TABLE 1. Oil and Protein Contents and Hemagglutination Activities of 12 Varieties of Castor-Oil Plant

Sample No.	Variety or hybrid	VIR* catalog number	Amount, %		Hemagglutination titer
			oil	protein	
1	Kubanskaya-12	—	49,8	22,45	1:64
2	VNIIMK-165	1188	51,7	29,20	1:128
3	Donskaya krupnokistnaya	1288	52,3	28,34	1:64
4	Krasnodarskii-3	1325	52,3	27,30	1:512
5	Donskaya-7	1350	50,9	32,2	1:256
6	Kubanskaya-15	1331	52,7	20,15	1:512
7	Nebraska-145/4	1266	47,5	24,50	1:1024
8	Gibrid ranni [hybrid early]	896	49,2	20,31	1:1024
9	VNIIMK-18	1351	51,1	23,03	1:64
10	Kubanskaya-10	1330	49,8	25,19	1:1024
11	Donskaya rannyaya	1356	52,7	20,03	1:1024
12	Donskaya-7 × LZ-81-686-6	—	43,1	28,34	1:2048

TABLE 2. Relative Mobilities of the Electrophoretic Components of the Water-Soluble Proteins of 12 Varieties of Castor-Oil Plant

Relative mobility, R_f	Variety of hybrid											
	Kubanskaya-12	BNIIMK-165	Donskaya krupnokistnaya	Krasnodarskii-3	Donskaya-7	Kubanskaya-15	Nebraska-145/4	Gibrid rannii	VNIIMK-18	Kubanskaya-10	Donskaya rannyaya	Donskaya-7 × LZ-81-686-6
0,042	—	+	+	+	—	+	+	+	—	+	+	+
0,072	+	+	—	—	+	+	+	+	+	+	+	+
0,092	—	+	+	+	+	+	+	—	+	+	—	+
0,110	+	+	+	+	+	+	+	+	+	+	+	+
0,150	+	+	+	+	+	+	+	+	+	+	+	+
0,260	+	+	+	+	+	+	+	+	+	+	+	+
0,350	+	+	+	+	+	+	+	+	+	+	+	+
0,420	—	+	+	—	—	+	+	+	—	+	+	+
0,440	—	+	+	—	+	—	+	—	—	—	+	+
0,500	—	—	—	—	—	—	+	—	—	—	—	+
0,520	—	—	—	—	—	+	+	—	—	—	—	+

mobilities of the components. Intervariety differences were found in the upper and lower parts of the electrophoretograms — R_f 0.042 and 0.420-0.520. The electrophoretic components with R_f 0.420-0.520 were proteins with molecular masses of 40-20 kDa possessing no hemagglutinating activity. Consequently, the high agglutination titer detected in samples 4, 6, 7, 8, 10, 11, and 12 was due to the presence of the component with R_f 0.042. These results agree well with those that we obtained previously in relation to the amount of hemagglutinating components with R_f 0.04 and 0.11 in castor bean meal [8].

The absence of a correlation between the amount of protein and hemagglutinating activity permits the assumption of the possibility of selecting castor-oil plant varieties with a high protein content and a low toxicity. There is no doubt that the capacity for synthesizing group-specific lectins (hemagglutinating proteins) is under genetic control [9]. Therefore, one of the most important ways of obtaining information on the genotype may be the investigation of the protein spectrum and the finding of polymorphic systems of reserve plant proteins [10]. The characteristic proteins found in the samples of castor oil plant may have great value for further genetic investigations and the development of more effective methods of selecting the parental forms for crossing and the identification of varieties.

Thus, an electrophoretic study of the polymorphism of the reserve proteins of this valuable crop is necessary for solving cardinal questions of the selection of the castor-oil plant.

EXPERIMENTAL

The seeds of 12 varieties of castor-oil plant supplied by the Kuban experimental station of VIR [N. I. Vavilov All-Union Scientific-Research Plant Breeding Institute] were used.

Preparation of the Flour. Castor beans freed from husks were ground and extracted with cooled petroleum ether and were washed with this reagent until the oil had been eliminated completely. The residue was dried in the air.

The isolation of the water-soluble proteins of the castor bean was carried out by extracting the flour obtained from a single bean with distilled water in a ratio of 1:10 at 10°C for 2 h. The extract was centrifuged and the precipitate was discarded. The supernatant liquid was used for electrophoretic separation.

Electrophoresis was carried out in 7.5% PAAG in a basic buffer (pH 8.9) in vertical plates with dimensions of 1 × 115 × 115 mm. An AVGÉ apparatus for vertical gel electrophoresis was used, with Tris-glycine buffer at U = 250 and I = mA per plate for 2.5 h.

The fixation and staining of the gels and densitometry were performed as we have described previously [8].

SUMMARY

Twelve varieties of the castor-oil plant have been investigated and among them have been found promising varieties with high protein contents and low hemagglutinating activity.

The spectra of the water-soluble proteins of the castor-oil plant have been investigated by electrophoresis, and intervariety differences have been found.

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