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DEVELOPMENT OF A METHOD FOR DETERMINING THE ADHESION FORCE OF COTTON FIBER TO THE SEED

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Abstract: in this article, experimental work was carried out to develop a method for determining the adhesion force of fiber to the seed for various breeding varieties. For this purpose, samples of 100 g, 150 g, 200 g, 250 g and 300 g were taken; the seeds in each sample were separated out and combed first with a coarse-toothed comb and then with a fine-toothed comb. Fiber bundles were formed from the chalaza, lateral and micropyle parts of the seed, and the adhesion force of the sample fiber to the seed was determined on a DSH-3M tensile-testing device. The distance between the clamps was 3 mm. The number of fibers was counted using an MBI-6 biological microscope.

Keywords: chalaza, lateral and micropyle parts of the seed, "barky" (husk-adhering) fiber, adhesion force of the fiber bundle, number of fibers in the bundle

The world's largest cotton-producing countries are China, the USA, India, Pakistan, Uzbekistan, Brazil, Turkey, Egypt and Mexico, which together account for more than 80% of the world's total cotton output.

Cotton is one of the most widely cultivated crops in world agriculture. The leading cotton-producing countries — India (6.1 million tons), China (5.5 million tons), the USA (4.1 million tons), Brazil (1.9 million tons) and Pakistan (1.7 million tons) — together account for 75% of the world's cotton crop. Cotton is of major importance as a key component of agricultural exports.

In our country, cotton growing is a principal branch of agriculture, and the nation's economic development is directly linked to this sector. The importance of cotton in the national economy is immense. There is virtually no branch of the economy that does not, to one degree or another, use products made from the cotton plant or its fiber.

In recent times, demand for cotton products has been growing steadily. At the same time, the limited area of irrigated farmland, climate change, water scarcity, increasing soil salinization and unfavorable weather conditions are creating major difficulties in obtaining high and high-quality yields of agricultural crops. It is well known that, in any soil and climate conditions, it remains a pressing task to grow cotton that is resistant to external factors, resistant to disease and pests, early-maturing, high-yielding and of good quality.

In processing different breeding varieties at cotton-ginning enterprises, various defects and waste products arise: that is, under the influence of the technological processes, tangled and complex-tangled fiber, broken or damaged seeds, "barky" (husk-adhering) fiber, neps, and fine and coarse impurities are formed.

Two defects in cotton fiber are considered harmful, namely "barky" fiber and neps. Eliminating these during spinning is a complex process. The first main reason for the formation of "barky" fiber is that, when cotton is dried at high temperature, pores form in the surface layer of the seed; as a result, moisture in the inner layers of the seed cannot escape during the drying process, which gives rise to this defect. The second main reason is that, during the process of separating fiber from the seed at cotton-

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ginning enterprises, the adhesion force of the fiber to the seed differs among different breeding varieties, and the seed's structure, geometric properties and firmness also vary depending on the breeding variety.

At cotton-ginning enterprises, when processing different breeding varieties — particularly during ginning — the fiber is separated from the seed under the same applied force for all varieties. This leads to an increase in the amount of "barky" fiber and to a deterioration in the quality of the finished product obtained.

At cotton-ginning enterprises, a separate optimal ginning regime should be developed for each breeding variety during the ginning process. Experimental work was carried out to develop a method for determining the adhesion force of fiber to the seed for various breeding varieties. For this purpose, samples of 100 g, 150 g, 200 g, 250 g and 300 g were taken; the seeds in each sample were separated out and combed first with a coarse-toothed comb and then with a fine-toothed comb. Fiber bundles were formed from the chalaza, lateral and micropyle parts of the seed, and the adhesion force of the sample fiber to the seed was determined on a DSH-3M tensile-testing device. The distance between the clamps was 3 mm. The number of fibers was counted using an MBI-6 biological microscope.

The test results obtained from determining the adhesion force of fiber to the seed for various breeding varieties are presented in Table 1.

Table 1

Indicators for determining the adhesion force of fiber to the seed for various breeding varieties

No.	Sample mass, g	Average mass of fibrous seeds, m, mg	Adhesion force of the fiber bundle, cN	Number of fibers in bundle, n	Adhesion force of a single fiber	"Barky" (husk-adhering) fiber content, n	Absolute error, mg	Relative error, %
Andijon-36 variety								
Chalaza part of the seed								
1.	100	125.4	630	786	0.80	5.0	7.6	5.80
2.	150	120.6	660	799	0.83	6.0	6.8	5.64
3.	200	120.8	640	765	0.84	8.0	7.0	5.79
4.	250	127.2	638	788	0.81	7.0	6.5	5.11
5.	300	139.8	648	802	0.81	6.0	6.3	4.51
	Average	**122.2**	**643**	**788**	**0.82**	**7.0**	**6.8**	**5.37**
Lateral part of the seed								
1.	100	128.9	721	826	0.87	2.0	7.2	5.59
2.	150	125.4	739	808	0.91	3.0	7.0	5.58
3.	200	130.3	746	836	0.89	3.0	7.3	5.60
4.	250	125.6	757	812	0.93	1.0	6.7	5.33
5.	300	127.6	761	800	0.95	1.0	6.1	4.78
	Average	**119.8**	**745**	**816**	**0.91**	**2.0**	**6.9**	**5.38**

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No.	Sample mass, g	Average mass of fibrous seeds, m, mg	Adhesion force of the fiber bundle, cN	Number of fibers in bundle, n	Adhesion force of a single fiber	"Barky" (husk-adhering) fiber content, n	Absolute error, mg	Relative error, %
Micropyle part of the seed								
1.	100	118.7	891	900	0.99	1.0	7.7	6.49
2.	150	123.6	921	904	1.02	-	7.6	6.15
3.	200	126.3	919	916	1.00	-	7.2	5.70
4.	250	127.3	913	908	1.00	-	7.0	5.50
5.	300	125.3	930	910	1.02	-	6.1	4.87
	Average	**123.2**	**915**	**908**	**1.01**	**-**	**7.1**	**5.74**
52-4 variety								
Chalaza part of the seed								
1.	100	122.4	621	798	0.78	7.0	7.8	6.37
2.	150	125.6	616	786	0.78	8.0	7.3	5.81
3.	200	127.8	610	789	0.77	9.0	7.0	5.48
4.	250	122.8	609	743	0.82	8.0	6.6	5.37
5.	300	126.5	612	745	0.82	9.0	6.3	4.98
	Average	**122.3**	**614**	**772**	**0.79**	**8.0**	**7.0**	**5.60**
Lateral part of the seed								
1.	100	115.6	746	820	0.91	2.0	7.2	6.23
2.	150	118.7	769	810	0.95	2.0	7.0	5.90
3.	200	127.8	780	808	0.97	2.0	6.9	5.40
4.	250	125.6	760	836	0.91	3.0	6.5	5.18
5.	300	126.8	744	822	0.90	4.0	6.3	4.97
	Average	**123.9**	**760**	**820**	**0.93**	**3.0**	**6.8**	**5.54**
Micropyle part of the seed								
1.	100	112.8	941	910	1.03	-	7.6	6.74
2.	150	115.5	961	929	1.03	-	7.4	6.41
3.	200	114.9	951	910	1.04	-	7.2	6.27
4.	250	126.7	939	930	1.01	-	7.0	5.52
5.	300	125.8	946	920	1.03	-	6.2	4.93
	Average	**122.1**	**948**	**919.8**	**1.03**	**-**	**7.1**	**5.97**

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No.	Sample mass, g	Average mass of fibrous seeds, m, mg	Adhesion force of the fiber bundle, cN	Number of fibers in bundle, n	Adhesion force of a single fiber	"Barky" (husk-adhering) fiber content, n	Absolute error, mg	Relative error, %
Xitoy-31 variety								
Chalaza part of the seed								
1.	100	120.7	628	756	0.83	8.0	8.5	7.04
2.	150	120.4	631	780	0.81	9.0	8.0	6.64
3.	200	123.5	609	782	0.79	9.0	7.8	6.32
4.	250	125.2	613	763	0.80	8.0	7.5	5.99
5.	300	130.4	606	767	0.79	7.0	6.5	4.98
	Average	**123.2**	**617**	**770**	**0.80**	**8.0**	**7.7**	**6.19**
Lateral part of the seed								
1.	100	120.6	706	806	0.88	2.0	7.8	6.47
2.	150	116.9	713	816	0.87	2.0	7.5	6.41
3.	200	128.8	720	822	0.88	3.0	6.9	5.36
4.	250	120.5	719	816	0.88	1.0	6.2	5.15
5.	300	123.4	721	810	0.89	2.0	6.0	4.86
	Average	**120.0**	**716**	**814**	**0.88**	**2.0**	**6.9**	**5.65**
Micropyle part of the seed								
1.	100	123.5	930	905	1.03	-	7.2	5.83
2.	150	126.6	928	912	1.02	-	7.4	5.84
3.	200	127.8	939	920	1.02	-	7.1	5.56
4.	250	126.4	920	890	1.03	-	7.0	5.53
5.	300	128.9	916	900	1.02	-	6.5	4.96
	Average	**123.4**	**927**	**905**	**1.02**	**-**	**7.0**	**5.54**
Xitoy-29 variety								
Chalaza part of the seed								
1.	100	120.3	624	768	0.81	8.0	7.1	5.90
2.	150	125.6	606	788	0.77	8.0	6.4	5.09
3.	200	127.8	612	798	0.77	7.0	6.6	5.16
4.	250	120.5	638	767	0.83	9.0	6.1	5.06

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No.	Sample mass, g	Average mass of fibrous seeds, m, mg	Adhesion force of the fiber bundle, cN	Number of fibers in bundle, n	Adhesion force of a single fiber	"Barky" (husk-adhering) fiber content, n	Absolute error, mg	Relative error, %
5.	300	119.6	620	756	0.82	8.0	5.9	4.93
	Average	**123.8**	**620**	**775**	**0.80**	**8.0**	**6.3**	**5.23**
Lateral part of the seed								
1.	100	120.6	745	822	0.91	3.0	6.8	5.64
2.	150	126.2	723	818	0.88	4.0	6.6	5.23
3.	200	125.1	721	829	0.87	3.0	6.3	5.04
4.	250	120.1	712	826	0.86	2.0	6.2	5.16
5.	300	122.0	759	838	0.91	3.0	6.1	5.00
	Average	**122.8**	**732**	**827**	**0.89**	**3.0**	**6.4**	**5.21**
Micropyle part of the seed								
1.	100	125.6	930	904	1.03	-	7.3	5.81
2.	150	123.4	918	912	1.01	-	7.2	5.83
3.	200	120.9	922	905	1.02	-	6.8	5.62
4.	250	124.5	934	922	1.01	-	6.6	5.30
5.	300	126.7	905	916	0.99	-	6.3	4.97
	Average	**124.2**	**922**	**912**	**1.01**	**-**	**6.8**	**5.51**
52-4 variety								
Chalaza part of the seed								
1.	100	119.6	616	705	0.87	7.0	7.6	6.35
2.	150	122.0	608	722	0.84	8.0	7.1	5.82
3.	200	125.6	612	734	0.83	8.0	6.8	5.41
4.	250	126.8	614	721	0.85	9.0	6.4	5.04
5.	300	128.9	620	720	0.86	7.0	6.1	4.73
	Average	**124.6**	**614**	**720**	**0.85**	**8.0**	**6.8**	**5.47**
Lateral part of the seed								
1.	100	120.6	765	802	0.95	3.0	8.3	6.88
2.	150	122.2	734	831	0.88	2.0	7.8	6.38
3.	200	126.1	757	803	0.94	3.0	7.6	6.03
4.	250	127.2	740	808	0.91	4.0	7.3	5.74

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No.	Sample mass, g	Average mass of fibrous seeds, m, mg	Adhesion force of the fiber bundle, cN	Number of fibers in bundle, n	Adhesion force of a single fiber	"Barky" (husk-adhering) fiber content, n	Absolute error, mg	Relative error, %
5.	300	128.0	760	814	0.93	2.0	6.3	4.92
	Average	**123.1**	**751**	**812**	**0.92**	**3.0**	**7.5**	**5.99**
Micropyle part of the seed								
1.	100	120.5	910	902	1.01	-	7.0	5.81
2.	150	124.6	918	906	1.01	-	7.2	5.78
3.	200	126.2	922	908	1.02	-	6.9	5.47
4.	250	119.8	930	899	1.03	-	6.8	5.68
5.	300	126.1	924	896	1.03	-	6.3	4.99
	Average	**122.6**	**921**	**902**	**1.02**	**-**	**6.8**	**5.55**

The results of the research carried out on determining the adhesion force of fiber to the seed show, first of all, that when the parts of the seed are compared, the adhesion force of the fiber to the seed in the micropyle part is twice as high as in the chalaza part. This is because, in the chalaza part of the seed, the cavity relative to the seed kernel is larger than in the micropyle and lateral parts.

Secondly, our research shows that the formation of "barky" fiber occurs specifically more often in the chalaza part of the seed.

Analyzing the adhesion force of cotton fiber to the seed, for the Andijon-36 variety the adhesion force of the lateral part increased by 13.7% and the adhesion force of the micropyle part increased by 29.3% relative to the chalaza part; for the 52-4 variety, the lateral part increased by 19.2% and the micropyle part by 35.2%; for the Xitoy-31 variety, the lateral part increased by 13.8% and the micropyle part by 33.4%; for the Xitoy-29 variety, the lateral part increased by 15.3% and the micropyle part by 32.8%; and for the 52-4 (second) variety, the lateral part increased by 18.2% and the micropyle part by 33.3%, relative to the chalaza part.

Comparing the breeding varieties, for the Andijon-36 variety, relative to the cotton-fiber indicators obtained from the 100 g sample, the 150 g sample seed showed [the corresponding] "barky" fiber content, absolute error and relative error.

The results of the analysis showed that a sample mass of 300 g was adopted for all breeding varieties, and the relative error was found to range from 4.3% to 4.9%.

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