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COMPREHENSIVE ASSESSMENT OF LINEAR DIMENSIONS, PHYSICAL-MECHANICAL AND CHEMICAL PROPERTIES OF COTTON SEEDS OF FOREIGN AND LOCAL VARIETIES

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Abstract: In this article, the oil content, linear dimensions, as well as the physical-mechanical and chemical properties of cotton seeds of foreign and local varieties were comprehensively studied. During the research, the geometric parameters, density, strength, and main chemical components of cotton seeds were analyzed. The obtained results are of great importance for evaluating raw material quality and improving oil extraction technologies. In addition, breeding efficiency was assessed based on the oil content indicators and technological characteristics of new varieties.

Keywords: cotton seeds, new variety, oil content, linear dimensions, physical-mechanical properties, chemical composition, raw material quality, breeding efficiency.

Introduction. Over the past 15 years, new cotton varieties have been bred in the Republic's cotton industry. At the same time, foreign cotton seeds have been imported and cultivated for the past two seasons. Among these, Chinese varieties are being developed using Xinjiang technology and producing high yields. Cotton is used to produce the main products: cotton fiber, seeds, and lint. While the resulting fiber and lint are processed as raw materials for textiles, cotton seeds are processed by oil and fat factories to produce oil [1].

In 2025, the country harvested 3.785 million tons of raw cotton, of which over 1 million tons was grown using imported cotton varieties. Oil and fat processing plants process industrial cottonseed based on a range of quality and physical-mechanical indicators, as well as determining process parameters. Particular attention is paid to such indicators as seed size (length, width, and height), 1,000-seed weight, and husk and kernel content [2].

From a technological standpoint, oilseeds consist of two parts: the kernel and the shell. Some oilseeds (cotton seeds, flax, castor beans) have only a shell, while others (sunflower, soybeans, etc.) have a shell and a thin seed film over the kernel. Regardless of the seed type, the outer shell of all oilseeds is called the husk, but the shell of cottonseeds is called the chaff. The constituent content of the shell and the kernel varies [3]. The shell of the seed is primarily high in fiber or cellulose, along with small amounts of high-molecular carbohydrates, wax-like substances, and even smaller amounts of protein and fat fractions [4].

The kernel contains essential nutrients: fats, proteins, phosphatides, vitamins, and many other fat-related substances. The shell contains very little oil, and this oil content is called botanical oil content. For example, the botanical oil content of cottonseed shells is 0.5–0.6%, while that of sunflower seed shells is approximately 0.2–0.3%. Meanwhile, the oil content of the kernels of the aforementioned seeds is 34–38% for cottonseed kernels and 60–65% for sunflower kernels [5].

These figures show that the oil in any oilseed is primarily found in the kernel, with only a negligible amount in the shell. If oilseeds are processed without separating the shell, the resulting vegetable oil will contain an increased content of high-molecular carbohydrates and wax-like substances found in the shell. This leads to a deterioration in the quality of the resulting vegetable oil, specifically an increase in acidity, darkening of the color, and a deterioration in the marketability of the oil [6].

Object and methods of research.

The study focused on industrial cotton seeds obtained from foreign cotton varieties. The physical and mechanical properties of industrial cotton seeds (dimensions: length, width, and height; 1000-seed weight; shell and kernel content, etc.) were analyzed using the following regulatory documents:

- O‘z DSt 597:2008: "Mass fraction of defective seeds" [7];
- O‘z DSt 598:2008: "Mass fraction of mineral and organic impurities" [8];
- O‘z DSt 600:2008: "Mass fraction of moisture" [9];
- O‘z DSt 601:2022: "Mass fraction of lint content" [10];
- O‘z DSt 602:2008 p. 6.2: "Actual oil content" [11].

Results and discussion.

At oil and fat processing plants, the oilseed raw material is received in warehouses, and the preparation department consists of cleaning, hulling/separation, and grinding sections, which result in the production of cottonseed meal. In the preparation department, the oilseed raw material is cleaned of various mineral, organic, and metallic impurities and sent for hulling to separate the kernel from the shell. Hulling (cleaning) of cottonseed produces cottonseed meal, consisting of a mixture of kernel, husk, and whole seeds. The cottonseed meal separation process is aimed at obtaining kernels with minimal husk content.

The percentage of whole seeds in the hulled cotton should not exceed 30% after the first hulling (cleaning), and 0.8% after the second. During the separation process, two fractions—the hull and the kernel—are separated. If significant amounts of unhulled whole seeds remain in the hull during separation, this leads to an increase in the oil content of the hull, which, in turn, reduces the oil yield from the raw material. Seeds of foreign Chinese varieties grown in the Republic differ from local varieties in that they are shorter and smaller. This requires changes to the hulling equipment parameters and special requirements for processing such seeds. For this purpose, we analyzed the linear dimensions and weight of 1,000 seeds of industrial cotton seeds of local and foreign varieties. The results are presented in Table 1.

Table 1. Linear dimensions and 1000-seed weight of local and foreign cotton varieties

Cotton Seed Variety Name	Linear dimensions, mm			Weight of 1000 seeds, g
	Length	Width	Thickness	
Local Varieties				
Andijon-35	9,0	5,0	4,2	112,0
Sulton	9,6	5,2	4,6	112,1
S-6524	8,4	5,2	4,6	109,6
Foreign varieties				
Xin Lu Zao-52	7,8	4,7	4,3	80,4
Xin Lu Zao-78	7,9	4,9	4,3	88,4
Xin Lu Zao-57	8,1	4,9	4,4	90,6

Table 1 shows that the seeds of local varieties are superior to foreign varieties in terms of linear dimensions and 1,000-seed weight. The significant difference in kernel and shell content indicates the need to use specific parameters when processing this oilseed. Failure to adjust the process parameters during seed hulling will result in increased levels of oil dust and whole seeds in the husk.

Cottonseed consists of a shell (husk) and a kernel, separated from the shell by an air gap. The husk is primarily composed of fiber, while the kernel consists primarily of oil and protein. There are two types of cotton: fine-staple and medium-staple. Fine-staple cotton seeds differ from medium-staple cotton seeds by a lower degree of pubescence and a slightly higher oil and gossypol content.

A characteristic feature of cottonseed is the presence of a yellow pigment called gossypol in the kernel tissue. Its quantity in the seeds varies widely and depends on many factors, including growing conditions, cultivation, varietal characteristics, and others. The wall of the nuclear node, where gossypol and its derivatives are located, consists of cellulose rich in pectin, hemicellulose, and unidentified substances. Gossypol is a poison and causes disruption of the cardiovascular and nervous systems. The color and toxicity of gossypol determine the nutritional or feed value of processed products (oil, cake, meal). These factors are completely altered during seed processing. In addition to gossypol, cottonseeds contain proteins, phosphatides, nitrogen-free extractives, carbohydrates, and other components.

In our subsequent studies, we analyzed the chemical composition and physical and mechanical properties of the local variety "Sulton" and the imported variety "Xin Lu Zao – 78." The results are presented in Tables 2 and 3.

Table 2. Chemical composition of "Sulton" and "Xin Lu Zao – 78" varieties

№	Name of indicators	Units of measurement	Sulton variety	Xin Lu Zao – 78
1	Seed composition:			
	core	%	45,12	43,15
	shell	%	54,88	56,85
2	Fatty oil content:			
	in seeds	%	19,78	13,71
	in the core	%	36,03	31,25
	in the shell	%	0,52	0,61
3	Crude protein content	%	19,8	21,2
4	Total content of P_2O_5	%	0,89	0,88
5	Content of P_2O_5 in phosphatides	%	0,11	0,11
6	Fiber content	%	15,3	17,6
7	Mineral content (ash content)	%	3,2	3,1
8	Content of nitrogen-free extractive substances	%	27,8	26,1
9	Gossypol relative to dry kernel mass:	%	1,155	1,211
	free	%	0,855	0,811
	connected	%	0,3	0,4
10	Tannins	%	8,5	8,5
11	Carbohydrate content	%	27,0	27,6
12	B_2 (riboflavin)	%	0,19	0,19
13	B_5 (pantothenic acid)	%	0,91	0,88
14	PP-B_5 (nicotinic acid)	%	1,12	1,22

An analysis of the data in Table 2 reveals that the chemical composition of the local "Sulton" variety and the imported "Xin Lu Zao-78" variety differs significantly only in the oil content of the seeds. The physical and mechanical properties of cottonseed are essential for the design of warehouses, bins, transport vehicles, preparatory plant equipment, and, in some cases, for establishing equipment operating modes.

Table 3. Physico-mechanical indicators of "Sulton" and "Xin Lu Zao – 78" varieties

№	Name of indicators	Units of measurement	Sulton variety	Xin Lu Zao – 78
1	Seed density, kg/m³:			
	crushable	kg/m³	1,05	1,05
	true	kg/m³	1,13	1,15
2	Density of the nucleus, true	kg/m³	1,03	1,04
3	Husk density, true	kg/m³	1,34	1,38
4	Bulk density of seeds with 7.7% pubescence:			
	minimal	kg/m³	350,0	320,0
	maximum	kg/m³	363,0	333,0
	average	kg/m³	356,0	326,5
5	The angle of natural repose with a pubescence of 7.7%	degree angle	51	52

6	Coefficient of internal friction	kt	0,81	0,81
7	Adhesive force	kg/sm²	0,125	0,125

Table 3 shows that when analyzing the physical and mechanical properties of industrial cottonseed, the main values do not differ significantly. However, when comparing the bulk density of seeds with 7.7% pubescence, it was found that for the local variety "Sulton" it was 350–363 kg/m³, while for the foreign variety "Xin Lu Zao – 78" it ranged from 320 to 333 kg/m³. This indicates the need to process the foreign variety according to certain parameters.

Conclusion. Given the above, while the introduction of foreign varieties of industrial cottonseed into our country's cotton industry allows for increased yields, improving the process of preparing the cottonseed for oil extraction, taking into account its linear dimensions, physical and mechanical properties, and chemical composition, is a pressing issue. This requires replacing knife seed hullers with other types or changing the screen sizes during separation compared to traditional ones. Otherwise, this will lead to exceeding the standard for whole seeds in the hull and increased carryover of oilseed dust into the husk.

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