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Influence of Linear Dimensions and Technological Preparation Parameters of Cotton Seeds on Hulling Efficiency and Reduction of Oil Losses

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Abstract: The article presents the results of a study of the influence of linear dimensions, lint content and moisture content of technical cotton seeds on the efficiency of the processes of hulling and subsequent separation. It has been established that the optimal kernel moisture content for seeds of grades I-III is 8.5-9.5 %, and for grade IV - 9.5-10.5 %, which ensures minimal oil losses with the husk. It is shown that when the lint content of seeds is less than 8 %, hulling units operate at 100 % of their rated capacity, whereas when this indicator is exceeded, it is advisable to reduce the load to 80-85 %.

Keywords: Cotton seeds; hulling; separation; linear dimensions; kernel moisture; lint content; residual hull; oil losses; technological optimization.

Introduction:

Processing of cotton seeds is one of the key branches of the oil and fat industry of the Republic of Uzbekistan, ensuring the production of edible and industrial oil, as well as high-quality cake for the feed industry. In recent decades, the growth in global demand for vegetable oils and related products creates the need to increase the efficiency of technological processing processes, reduce losses of oilseed raw materials and optimize the quality of the final product [1].

One of the critical stages of processing is the hulling of seeds, which ensures the separation of the shell from the kernel [2]. The efficiency of hulling determines the degree of preservation of the oil kernel, the reduction in the amount of fine fractions and the optimization of subsequent separation [3]. Insufficient separation of the shell increases the husk content in the kernel and contributes to a decrease in oil yield, while excessive mechanical impact leads to the formation of oil dust and increased technological losses [4, 5].

Modern varieties of cotton are characterized by a significant diversity of morphometric and physico-mechanical parameters, including linear dimensions, lint content and seed moisture [6]. These characteristics significantly influence the choice of hulling equipment design and its operating modes. The use of traditional disc or drum machines without taking into account the morphometric features of seeds can lead to a decrease in productivity, an increase in residual husk in the kernel and an increase in oil losses, which remains one of the unsolved problems in the technology of cotton seed processing [7].

The scientific problem also lies in the need for a quantitative assessment of the influence of these parameters on oil yield and kernel quality. Despite the existence of research on seed hulling and separation, most works are focused on standard varieties and do not take into account the variability of imported raw materials, their linear dimensions and degree of lint content [8]. This creates technological uncertainty in the large-scale processing of new cotton varieties.

In addition, an important aspect is the optimization of multi-stage separation, including the selection of sieve diameters and the sequence of their installation. Scientifically based regulation of these parameters allows minimizing losses of oilseed raw materials and improving the quality of the kernel, which directly affects the economic efficiency of production [9].

Thus, the urgent task is a comprehensive study of the relationship between the morphometric characteristics of seeds, moisture, lint content and parameters of technological preparation with indicators of the efficiency of hulling and separation. Solving this problem will allow developing scientifically based recommendations for optimizing the technological process, increasing oil yield and reducing production losses during the processing of cotton seeds of various varieties.

METHODS

The analysis of the cotton seed mixture (crushed seeds) was carried out according to the method of GOST 5947-68 [10]. A sample of the crushed seed mixture is taken automatically or manually - by intersecting the flow of material. The average sample is thoroughly mixed and reduced to 25 g by the diagonal division method. The selected sample is weighed on a technical balance, then sieved through a one-millimeter sieve. Oil dust is sifted off, and the remaining part is separated on glass with a feather into whole seeds, cutting (cutting is considered to be parts of the kernel whose size is less than half of it) and kernel. Whole seeds, cuttings and oil dust are weighed separately. The data of each weighing is multiplied by 100 and divided by the sample weight, which gives the percentage content of cuttings, oil dust and whole seeds in the crushed seed mixture.

The analysis of the cotton kernel was carried out according to the method of “Techno chemical control and production accounting ...” [11]. For analysis, about 25 g of kernel is taken and the sample is sieved through a one-millimeter sieve. From the fraction remaining on the sieve, free husk and whole seeds are isolated. From the passage through the sieve, husk particles visible to the naked eye are isolated.

To determine the percentage of total husk in the kernel, free husk, husk particles and whole seeds are weighed together. Whole seeds are determined by hulling the seeds after isolating the sample. The total husk content is expressed as a percentage of the weight of the taken sample.

RESULTS AND DISCUSSION

The obtained results confirm that the moisture content of the cotton seed kernel is one of the key factors determining the efficiency of the hulling process and the amount of oil loss with the husk. It has been established that for cotton seeds of grades I-III, the optimal kernel moisture range is 8.5-9.5 %, whereas for grade IV seeds this indicator should be within 9.5-10.5 %. Compliance with these values ensures a reduction in the oil content of the husk and, accordingly, a decrease in oil losses at the hulling stage.

Deviation of seed moisture from optimal values leads to a deterioration in the conditions for separating the kernel and husk. With insufficient moisture, the shell becomes more brittle, which is accompanied by increased grinding of the kernel and an increase in the oil dust content in the husk. Under conditions of increased moisture, on the contrary, a deterioration in the opening of seeds and an increase in the proportion of incompletely hulled fractions are observed, which negatively affects the quality of the resulting kernel and complicates further processing stages.

Conducted studies have shown that conditioning seeds for moisture using saturated steam or a steam-water mixture allows for uniform moistening of the shell without significant overwetting of the kernel. In this case, the duration of seed stay in the humidification chamber should not exceed 30 minutes, and the treatment temperature should be in the range of 65-80 °C. Exceeding these parameters leads to the accumulation of surface moisture and the risk of thermal damage to the seeds, which affects the efficiency of hulling.

The stage of subsequent cooling of seeds in a vibrating chute using an aspiration device to a temperature not exceeding 45 °C plays an important role in stabilizing their physico-mechanical properties. Removing surface moisture before feeding the seeds into the hulling machine helps reduce particle adhesion and improves the conditions for component separation.

Special attention during the study was paid to the selection of the type of hulling equipment. It has been shown that disc hullers traditionally used in oil and fat enterprises do not provide the required hulling efficiency for imported varieties of cotton seeds widely cultivated at present. This is due to differences in their linear dimensions and geometric characteristics, which leads to an increase in the residual husk content in the kernel and an increase in the oil content of the waste.

A comparative analysis of various types of hulling machines showed that the design features of the equipment have a significant impact on the degree of husk separation and the amount of oil loss. The data presented in Table 1 indicate the possibility of reducing the residual husk content in the kernel and the oil content of the husk when using alternative hulling devices (drum hulling equipment) more adapted to processing seeds with altered linear dimensions.

This confirms the expediency of revising traditional technological solutions in the preparation shop of oil and fat enterprises, taking into account the varietal characteristics of the processed raw materials.

From the data presented in Table 1, it follows that when hulling cotton seeds of varieties 1-3 and 4, characterized by different linear dimensions, disc and drum hulling machines were used. It was found that when using a disc hulling device, the residual husk content in the cotton kernel exceeds the similar indicator obtained when using a drum huller by 3.8 % for seeds of grades I-III and by 3.3 % for grade IV seeds.

Table 1

Influence of the cotton seed hulling method on the residual husk content in the kernel and the oil content of the husk

Linear dimensions of cotton seeds (length/width/thickness), mm	Varieties of cotton seeds	Residual husk content in the kernel, %	Oil content of husk, %
With disc peeler			
8,1/4,9/4,4	I-III	10,5	1,16
7,8/4,7/4,3	IV	11,6	1,08

With drum peeler			
8,1/4,9/4,4	I-III	6,7	0,81
7,8/4,7/4,3	IV	8,3	0,74

A similar trend was also revealed for the indicator of oil dust in the husk composition. Thus, the difference in the oil dust content between the disc and drum hulling methods was 0.35 % for seeds of grades I-III and 0.34 % for grade IV seeds, which indicates higher oil losses when using disc hulling machines.

The analysis of the obtained data allows us to conclude that it is advisable to use drum hulling machines instead of traditional disc machines when preparing for processing technical cotton seeds obtained from imported varieties and differing in linear dimensions from local cotton varieties. The use of the drum hulling method ensures a significant reduction in the residual husk content in the kernel, as well as a decrease in the amount of oil dust in the husk, which ultimately contributes to an increase in the yield of cotton oil at subsequent processing stages.

The productivity of hulling machines is directly dependent on the degree of lint content of technical cotton seeds. It has been established that when the seed lint content is less than 8 %, the equipment is capable of operating within the approved rated productivity, achieving maximum load. When the lint content indicator increases above 8 %, it is technologically advisable to reduce the load to 80-85 % of the nominal power, due to the deterioration of the conditions for separating the shell and kernel, as well as an increase in the resistance of the material during processing.

After the hulling stage, the separation of the obtained mixture (crushed seeds) is carried out during the separation process. At oil and fat enterprises, this process is implemented in bitter separator units. Structurally, the equipment provides two-stage separation, at which each stage involves sequential separation of the mixture into shell (husk) and kernel fractions.

The bitter separator is equipped with two drum sieves, each divided into five sections with hole diameters in the range of 4-8 mm. The efficiency of separation is determined by the correspondence of the sizes of the sieve holes to the linear dimensions of the processed seeds, as well as the ratio of kernel to husk. In this regard, the correct selection and sequence of placement of sieves with different hole diameters, ensuring optimal fractionation of the material, is of particular importance.

Table 2 shows the recommended parameters for the arrangement of sieves in the bitter separator. It was found that at the first stage of separation, it is advisable to use a sequence of sieves with hole diameters from 4 to 8 mm, which ensures efficient primary separation of the mixture. At the second stage, it is rational to use sieves with hole diameters from 4 to 6 mm, which allows increasing the degree of kernel cleaning and reducing the content of shell impurities in the final fraction.

Table 2

Parameters of mixture fractionation during two-stage separation in a bitter separator

Number of sieve sheets along the product flow	Diameter of sieve holes, mm	
	first peeling	second peeling
1	4	4

2	5	4
3	6	5
4	7	5
5	8	6

The data presented in Table 2 confirm that correct adjustment of separation parameters, taking into account the linear dimensions of technical cotton seeds, is an important factor in increasing the efficiency of the technological process and reducing losses of oilseed raw materials.

CONCLUSIONS

The conducted studies confirmed that the efficiency of hulling and subsequent separation of cotton seeds is largely determined by their linear dimensions, moisture content and degree of lint content, as well as the design features of the equipment used. It has been established that the use of drum hulling machines provides a better quality of shell separation compared to disc machines, which is expressed in a decrease in the residual husk content in the kernel by 3.3-3.8 % and a reduction in oil losses with the husk due to a decrease in oil dust by 0.34-0.35 %. An additional technological effect is achieved with optimal adjustment of two-stage separation with a rational selection of sieve diameters. The combination of the proposed solutions makes it possible to increase the degree of kernel cleaning, reduce technological losses and ensure a higher yield of cotton oil when processing seeds of various varieties.

REFERENCES

1. Kandel, S., Holguin, F.O., Idowu, J. et al. Importance of cottonseed oil and improvement of its quality and quantity through different breeding strategies. Journal of Cotton Research, 2026. DOI:10.1186/s42397-025-00252-y.
2. Preethi, M., Eevera, T., Rajanbabu, V. et al. Cotton seed management: traditional and emerging treatment approaches for enhanced productivity. Journal of Cotton Research, 2025.
3. Harvesting and post-harvest management approaches for preserving cottonseed quality. Industrial Crops and Products, 2020.
4. Frontiers | Compressive mechanical properties of cottonseed. Zheng Y. et al., Frontiers in Materials, 2023.
5. Обоснование технологических и конструктивных параметров оборудования для обрушивания семян хлопчатника. Методические материалы / сборники научных работ.
6. Изучение исходных показателей качества местных и зарубежных семян хлопчатника… Намазов Ш.Э., Тиллаев А.М. Актуальные исследования, 2026.
7. Changes in cottonseed meal quality during post-harvest processing of cottonseed. Journal of Stored Products Research, 2024.
8. Абдурахимов А.А., Серкаев К.П., Кадиров Ю.К. Системный анализ технологической линии рафинации хлопковой мисцеллы // Журнал “Химия и химическая технология” - Ташкент. - 2013. - №2. - С.66-69.
9. А.А. Абдурахимов, Ю.К. Кадиров, К.П. Серкаев Развитие технологической линии рафинации хлопковой мисцеллы с использованием процессов гидратации и электромагнитной обработки // М.: Масложировая промышленность - 2014, №4, 16-19 стр.
10. ГОСТ 5947-68 Семена Хлопчатника технические. Технические условия.
11. Технохимический контроль и учет производства в маслодобывающей и жироперерабатывающей промышленности // Том II, Специальные методы анализа сырья, полуфабрикатов и готовой продукции Под общей редакцией канд. техн. наук А.Г. Сергеева и ст. научн. сотр. В.П. Ржехина. Пищепромиздат, Москва 1959 г.