Study Of The Influence Of The Quantity Of Husk On The Extraction Process

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Abstract

This article examines the effect of the amount of husk (husk) in cottonseed shrot on the duration of the extraction process and the amount of oil yield in obtaining high-protein cottonseed shrot.

The study also examines the relationship between the degree of cottonseed shrot grinding, the concentration of miscella formed, and the duration of the extraction process during direct solvent extraction of cottonseed shrot.

Keywords: Degree of cottonseed grinding, gossypolization, extraction, high-protein shrot, solvent composition, solvent, protein content, food safety, technological process. [1,4,5].

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1. Introduction

The main products in the complete process cycle of vegetable oil production are purified vegetable oils, shells (husks, peels), and toasted shrot. The amount of shell added is also crucial when processing oil-containing raw materials in vegetable oil production technology. Regardless of the method of processing oil-containing raw materials, attention to and management of specific process parameters requires the technologist to possess significant theoretical and practical knowledge. [1, 20]

The following table presents the physicochemical properties of shrots obtained as a result of processing by various methods:

Table 3.7.

Physicochemical properties of shrots obtained as a result of processing oil-containing raw materials by various methods

No.	Name of indicators	Oil extraction method		
		Step pressing	Forpress extraction	Direct extraction
	Cottonseed shrot (toasted)			
1	Crude protein content in terms of dry matter, %, not less than	42	44	54
2	Residual oil content in terms of dry matter, %, no more than	7	1.5	1.5
3	Moisture and volatile matter content, %	10	11	10
4	Content of crude fiber in terms of dry matter, %, no more than	14	25	7
5	Content of free gossypol in terms of dry matter, % no more than	0.04	0.02	0.006
6	Amount of residual solvent, %, no more than	-	0.05	0.05
	Sunflower shrot (toasted)			
1	Crude protein content, %, not less than	34	36	39
2	Oil content in terms of dry matter, %, no more than	7	1.5	1.5
3	Moisture and volatile matter content, %	11	11	9
4	Content of crude fiber in terms of dry matter, %, no more than	23	25	21

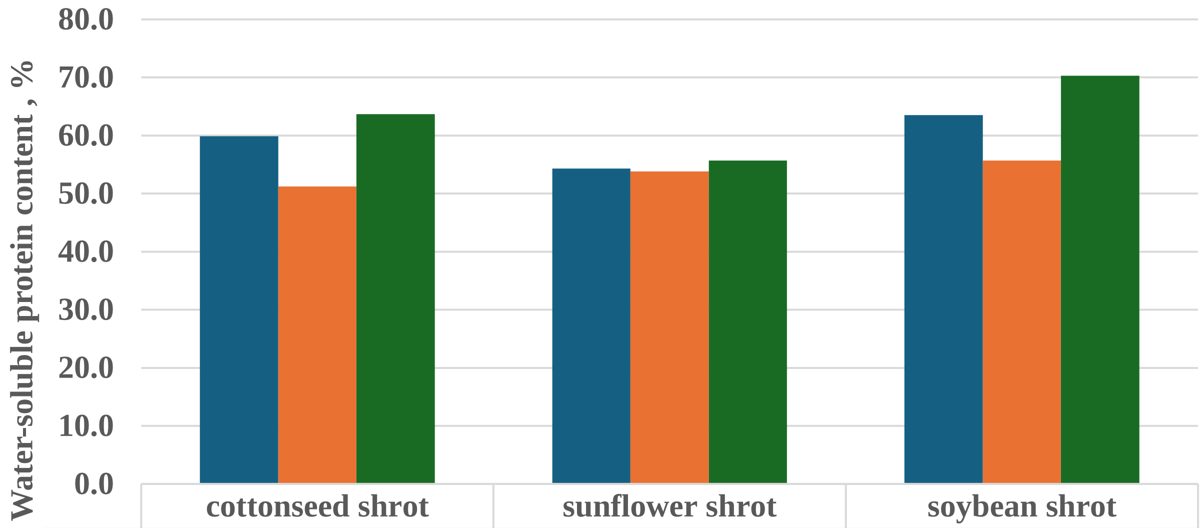
No.	Name of indicators	Oil extraction method		
		Step pressing	Forpress extraction	Direct extraction
5	Amount of residual solvent, %, no more than	-	0.08	0.05
	Soybean shrot (toasted)			
1	Crude protein content, %, not less than	38	46	47
2	Residual oil content in terms of dry matter, %, no more than	7	1.8	1.5
3	Moisture and volatile matter content, %	10	11	10
4	Content of crude fiber in terms of dry matter, %, no more than	7	7	7
5	Amount of residual solvent, %, no more than	-	0.1	0.1
6	Urease enzyme activity (pH after 30 minutes)	0.6	0.2	0.1

As can be seen from the research results presented above, existing oil extraction methods preserve the high quality of the primary product—oil—but do not allow for effective control of the components and quality of the important by-product—shrot. Furthermore, the composition of the oil-containing raw material also changes according to processing methods. [1,2]

With step-press extraction of cottonseed shrot, the protein content is 42%, while with forepress extraction, this figure is higher than the other two methods, at 44%. Also, the highest free gossypol content is achieved with the first method (step-press extraction) at 0.04%, while with the third method (direct extraction), it is 0.006%. Increasing the protein content and decreasing the amount of free gossypol in cottonseed shrot contribute to its expanded range of uses. The physicochemical properties of sunflower and soybean shrots also vary proportionally to those of cottonseed shrot, demonstrating that direct extraction is one of the most optimal methods for using the shrot. [7,8,18]

Moreover, the fiber content of cottonseed shrot is important, creating the basis for producing high-protein cottonseed shrot by increasing the protein content. To expand the range of uses of cottonseed shrot, in addition to its high protein content, it is also important to increase the proportion of water-soluble proteins. Increasing the proportion of water-soluble proteins in the shrot, reducing the content of free gossypol, and increasing the crude protein content on a dry matter basis, based on the results of analysis using the selected methods, enables the shrot to be widely used in the feed industry. [1, 6, 17]

Figure 3.9 shows the results of the analysis of the proportion of water-soluble proteins in shrots using industrial methods.



	cottonseed shrot	sunflower shrot	soybean shrot
С.П	59.9	54.3	63.5
Ф.Э	51.2	53.8	55.7
П.Э	63.7	55.7	70.3

Fig. 3.9. The influence of production methods on the proportion of water-soluble proteins in shrots

As can be seen from Figure 3.9, the highest content of water-soluble proteins in cottonseed shrot is found in the direct extraction (DE) method and amounts to 63.7%, while in sunflower and soybean shrots the proportion of water-soluble proteins also increased accordingly. [17,18]

It was found that the lowest amount of water-soluble proteins is observed with the forepress extraction method (FE). When processing vegetable oils using forepress extraction, heat treatment for 50-70 minutes at 80-105°C, depending on the type of raw material, positively influences the yield of vegetable oils. However, this also leads to the formation of complex compounds of protein with other associated substances, as well as to the denaturation of proteins in the resulting shrot. [2,15,16]

Based on the conducted research, it was established that in order to minimize the content of free gossypol in cottonseed shrot (in terms of dry matter), compared to the currently widely used methods (SP) of step pressing and forepress extraction, the direct extraction method is more effective.

Study of the influence of husk on the extraction process

Based on the study's objective and ongoing research, it was established that the direct extraction method is the most effective for producing high-protein cottonseed shrot. The changes in extraction time and the concentration of the resulting miscella were studied depending on the amount of husk in the cottonseed shrot using the developed solvent compositions. [17, 18, 19]

For this purpose, cottonseed samples selected in section 3.3 of our study were used. For the step-pressing technology, a step-pressing "hot" technology was chosen. This was primarily because cold pressing technology is also used in vegetable oil production. However, using cold pressing specifically for cottonseed processing is not considered sufficiently cost-effective. This is because, with cold pressing, 20-22% of the oil from the oil-containing raw material remains in the defatted cake.

[1,20]

Currently, the methods used in industry are hot pressing, forepress extraction and direct extraction.

In the methods of pressing and fore-press extraction, the introduction of husks is mentioned in the literature for the following purposes: creating internal pressure inside the pressing equipment, forming cracks in the cell walls of the oil-containing raw material, neutralizing the toxic substance gossypol (converting it from a free form to a bound form by forming a complex compound with amino acids and phosphatides in the core) during the processing of cotton seeds, facilitating the seepage of oil due to the uniform distribution of moisture over the entire surface of the material during heat treatment, swelling of the protein in the core and the subsequent formation of cracks in the cell walls and increasing the pressure. [1,2,21]

Current technology processes cottonseeds using a forepress extraction method with the addition of 20-25% husk. Increasing the amount of husk is one of the main factors that can degrade the quality of unrefined cottonseed oil (increased red and blue color units, increased acidity), create difficulties during the refining stage, and dramatically reduce the protein content of the shrot.

When processing oil-containing raw materials using direct extraction, 5-10% of husk is added to the oilseed shrot. Adding this amount of husk during the process reduces the processing time by improving solvent penetration into the material.

In our proposed method, the optimal choice of the amount of husk during direct extraction of cottonseed shrot affects the oil yield and protein content of the shrot.

The results of the study on the influence of the amount of husk in cottonseed shrot on the duration of the extraction process and the amount of oil yield in obtaining high-protein cottonseed shrot are presented in the following figures.

In this study, sample 1 contained 6% husk, sample 2 contained 8%, and sample 3 contained 10%.

Results of extraction experiments

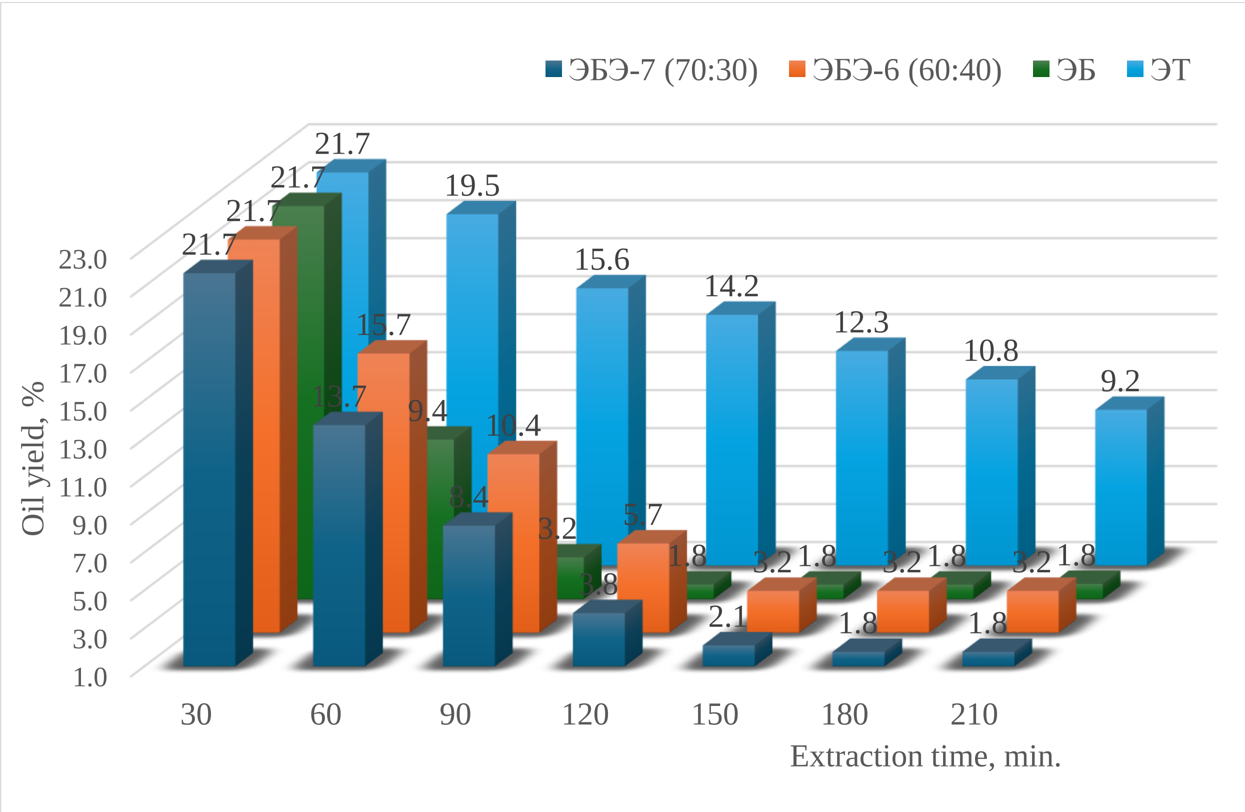
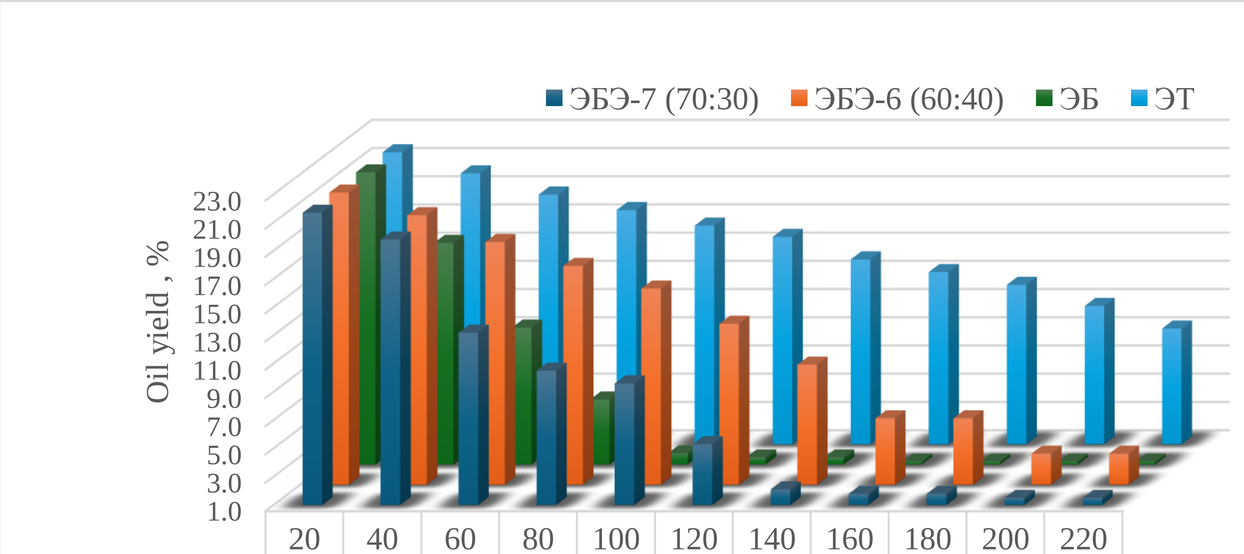


Fig. 3.10. Extraction time as a function of solvent type for Sample 1

The study revealed that the initial oil content of the selected cotton seeds was 21.7%. With a 6% husk content in the shrot

: With the solvent composition (extraction gasoline + ethanol) EBE -7: the extraction process lasted 180 minutes, the oil content of the shrot decreased to a constant value of 1.8%. With the solvent EBE-6: after 150 minutes, the oil content of the shrot did not fall below a constant value of 3.2%. With pure (EB) extraction gasoline: the extraction time was 120 minutes. With (ET) ethanol: the oil content of the shrot after 210 minutes was 9.2%.



	20	40	60	80	100	120	140	160	180	200	220
ЭБЭ-7 (70:30)	21.7	19.8	13.2	10.5	9.6	5.3	2.1	1.8	1.8	1.5	1.5
ЭБЭ-6 (60:40)	21.7	20.1	18.2	16.5	14.9	12.4	9.5	5.7	5.7	3.2	3.2
ЭБ	21.7	16.7	10.7	5.6	1.8	1.5	1.5	1.2	1.2	1.2	1.2
ЭТ	21.7	20.2	18.7	17.6	16.5	15.7	14.1	13.2	12.3	10.8	9.2

Fig. 3.11. Extraction time as a function of solvent type for Sample 2

The results showed that increasing the amount of husk by 2% affects the course of extraction time. At 8% husk content: With pure extraction gasoline (EB) : After 100 minutes, the oil content of the oilseed shrot was 1.8%. After 200 minutes, it decreased by 0.6%, amounting to 1.2%. With EBE-7 : After 160 minutes, the oil content of the oilseed shrot decreased to 1.8%. After 220 minutes, this figure decreased by 0.3%. With EBE-6: the oil content of the oilseed shrot did not fall below 3.2%. With ethanol: no figure below 9.2% was recorded. It was established that changing the amount of husk in the oilseed shrot affects the extraction process, as in Sample 1.

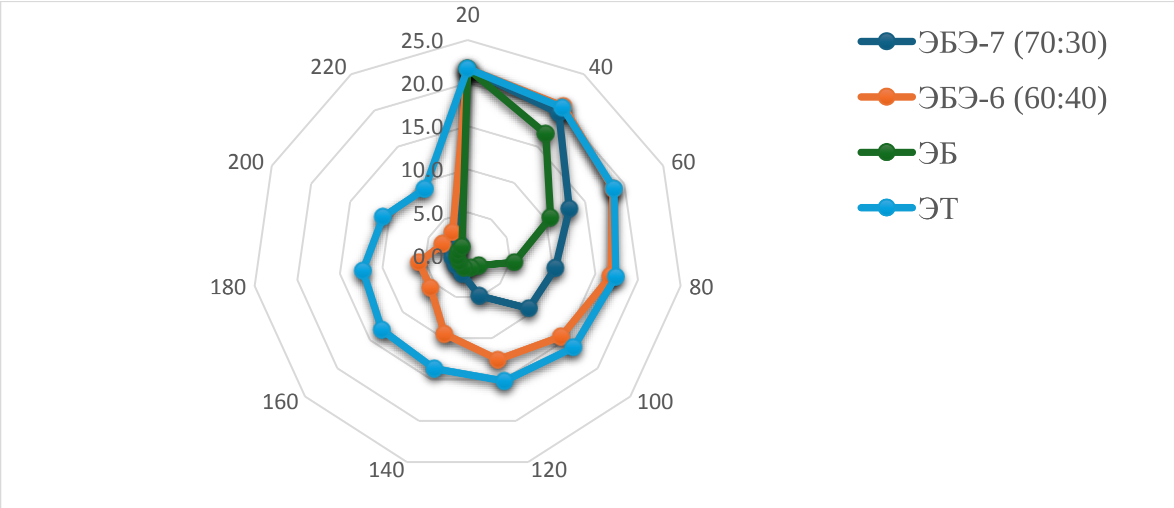


Fig. 3.12. Extraction time as a function of solvent type for Sample 3

It was found that the increase in the amount of husk in Sample 3 is close to the values of Sample 2 and has virtually no effect on the oil yield.

Based on the above, it can be said that despite the existence of technologies for the neutralization of gossypol and its conversion into oil, they are not widely used in industry due to their high economic cost.

To extract biologically active substances from cottonseeds and other oil-containing raw materials, as well as to increase the mass fraction of protein substances, it is possible to control the structural composition and quality indicators of the resulting product during the extraction process by modifying existing fundamental approaches and applying unconventional technological solutions.

2. Conclusions

It has been established that the optimal amount of husk in cottonseed shrot for direct extraction is 8%. This amount is sufficient for extraction for 120-130 minutes, which is close to the extraction time with traditional extraction gasoline. It has been proven that increasing the amount of husk does not significantly affect the extraction process, but an amount above 10% can have the opposite effect. It has been found that increasing the amount of husk negatively affects the protein content of the resulting cottonseed shrot. The proportion of total protein and water-soluble proteins in toasted shrots of oil-containing raw materials depends on the method of their extraction. Direct extraction has been found to be the most optimal method for obtaining high-protein shrot. [17,18,19]

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