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IMPROVING THE TECHNOLOGY OF REFINING LOCAL RAW SOYBEAN OILS UNDER THE INFLUENCE OF AN ELECTROMAGNETIC FIELD

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Abstract
Methods of using the influence of an electromagnetic field in the refining process of vegetable oils obtained from local soybean seeds were studied. As a result of applying electromagnetic effects of various intensities, it was achieved to increase the quality indicators of refined soybean oils, as well as to improve their physicochemical characteristics.

Keywords. Local oily soybean seeds, vegetable oils, alkaline refining processes, oil quality indicators, physicochemical characteristics.

Introduction

Introduction. In our republic, special attention is paid to the cultivation of the soybean plant as an oilseed crop [1, 2]. Vegetable oils obtained from soybean seeds can be widely used in the production of various consumer products [3, 4]. Existing methods of refining vegetable oils extracted from soybean seeds have some drawbacks. Therefore, considerable attention is paid to using the influence of an electromagnetic field to accelerate the refining technology [5-7]. The use of electrophysical effects in the alkaline refining technology of vegetable oils extracted from local soybean seeds is of great importance.

The effect of the soda solution concentration on changes in the composition of the main chemical components of the resulting crude press oil during the moisture-heat treatment of soybean kernels was studied. For this purpose, studies were conducted with soybean seed batches with an average acid number ranging from 2.1 to 4.3 mg KOH/g.

In the studies, a soda lye solution activated in a 1.6 A/m EMF was used. The selection of such a power value was not accidental, since in most literature sources, this value of the EMF field strength made it possible to activate technological processes as much as possible. Partial processing of oil in the kernel in production conditions was carried out using a single pressing unit, by steaming and treating a moistening auger with a soda lye solution heated to 80 °C. Then, the resulting sodium soaps were converted into calcium salts by feeding a 15% solution of activated calcium chloride in the kernel to the first capacity of the roasting apparatus in production conditions.

The soda lye solution was supplied to the source until the moisture content of the kernel increased from 6.7% to 3.0...3.5%.

The effect of the soda solution concentration on reducing the acid number in the partial processing of kernel oil was studied. The batches of soybean seeds with the average oil acidity values of 1.0, 1.5, 2.0, 2.5, 3.0 and 4.0 mg KOH/g were studied. The studies were carried out under the conditions when the amount of the Na2CO3 soda solution was constant in all cases, and the concentration of soda in the solution was different. The results of the study on reducing the acid number of the kernel oil in the partial processing are shown in Figure 1.

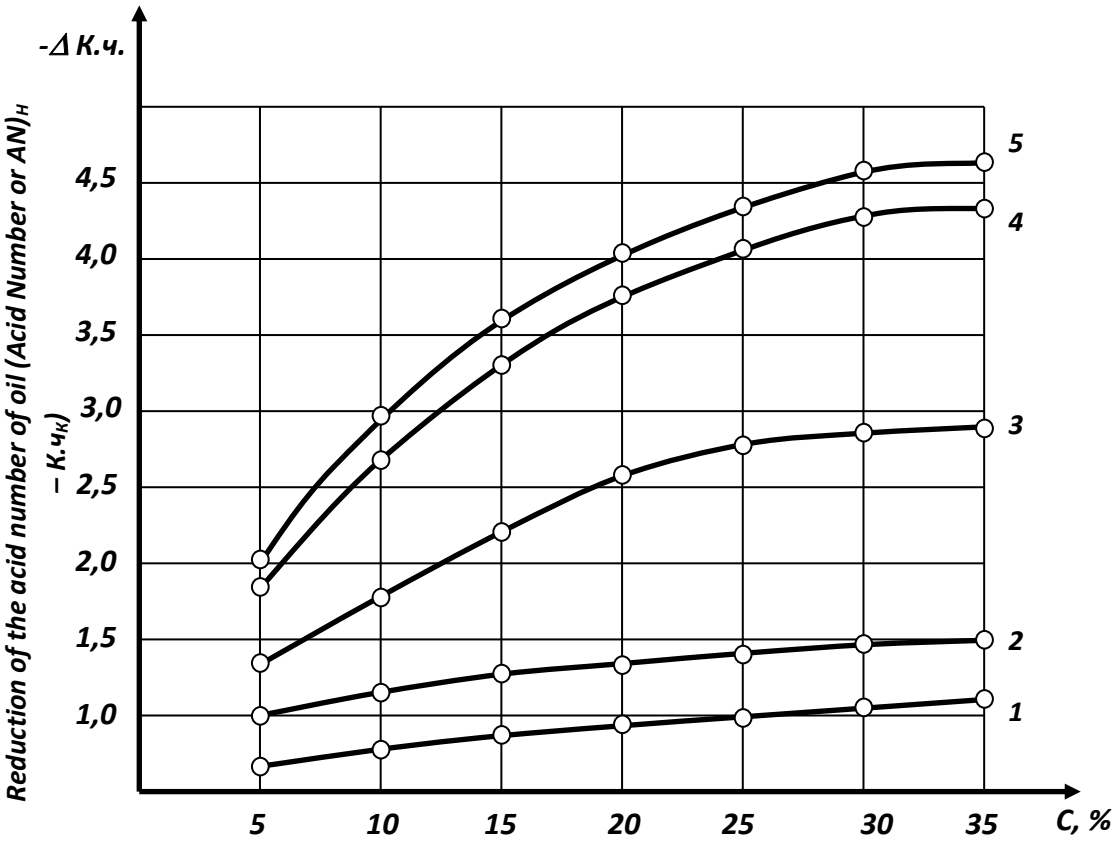

Figure 1. Effect of Soda Lye Concentration on Reducing the Acid Number of Kernel Oil During Partial Processing

Na_2CO_3 Initial acid number of the oil in the seeds:

1. Acid number = 1.0 mg KOH/g
2. Acid number = 1.5 mg KOH/g
3. Acid number = 2.5 mg KOH/g
4. Acid number = 3.5 mg KOH/g
5. Acid number = 4.5 mg KOH/g

From the data shown in Figure 1, it is evident that the acid number of the oil in the kernel decreases with an increase in the soda lye concentration. A strong decrease in the acid number was observed up to a soda solution concentration in the range of 5...15%.

Studies have shown that with an increase in the introduced soda lye concentration of more than 15%, the phenomenon of the acid number dropping to a minimum level was accompanied by the formation of soap that passed into the press oil, worsening the quality of the latter. For this reason, in the subsequent study and testing of the process of partial refining of the oil, the soda lye concentration did not exceed 15% in order to comply with the relevant technological conditions.

The largest decrease in the acid number in partially refined oil was observed at a 10% concentration of the soda solution in various samples of raw materials with different acid content. In this regard, the effect of the EMF intensity on reducing the acid number in partially refined oil was studied.

From the data in Figure 2, it is evident that the highest decrease in the acid number in partially refined oil was observed when treating the soda lye (concentration 10%) at an EMF field strength equal to 1.6 A/m. Taking this into account, further studies on the activation of the alkaline solution were carried out at an EMF voltage equal to 1.6 A/m.

Similar studies were carried out to obtain comparative data on the partial processing of oil in raw materials without the EMF method of processing the alkaline solution and without its application. Two oily samples of raw materials with different initial acid numbers in the kernel were studied. The research results are presented in Table 1.

Table 1 Comparative Results of Reducing the Acid Content in Partially Refined Oil Within the Raw Material *

"Magnetic field intensity in the EMF, A/m	"Acid number of the oil, mg KOH/g			
	Example- 1		Example- 2	
	"Before processing in the EMF	Processed in the EMF.	Before processing in the EMF	Processed in the EMF."
0	3,0	3,0	4,5	4,5
0,4	3,0	2,8	4,4	4,0
0,8	2,7	2,4	4,1	3,7
1,2	2,5	2,0	3,8	3,3
1,6	1,6	1,4	2,5	2,1
2,0	1,4	1,3	2,3	1,9
2,4	1,3	1,2	2,2	1,8

*The initial acid number of the oil in the studied samples:
1 – 3.0 mg KOH/g; 2 – 4.5 mg KOH/g.
The results of the study are shown in Figure 2.*

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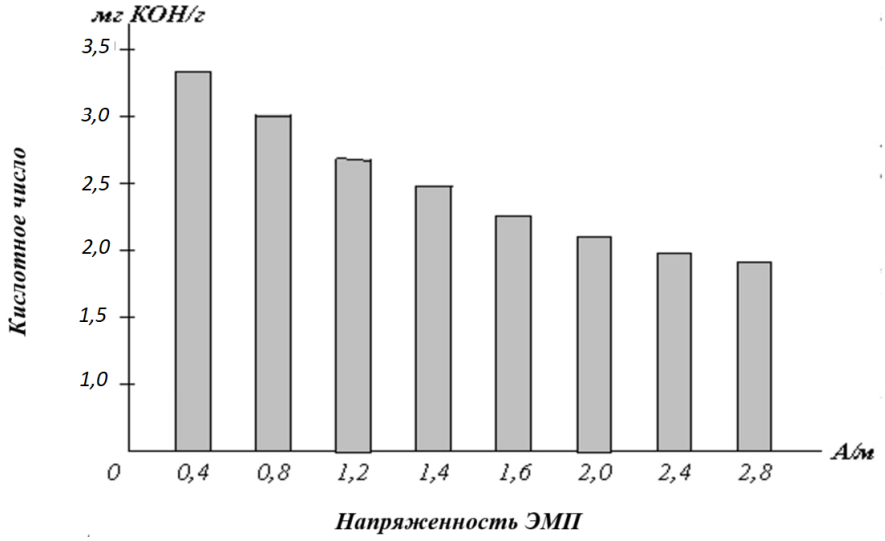

"Figure 2. Dependence of the decrease in the acid number of partially refined oil on the EMF intensity."

From the data in Table 1, it is evident that a reduction in the acid number was observed in the partially refined oil in both cases. At the same time, the use of EMF (Electromagnetic Field) on the soda solution accelerates the process and increases the degree of reduction in the acid number of the raw material. The best positive results were achieved at an EMF intensity of 1.6 A/m. In raw materials with a relatively high oil acidity, an almost twofold decrease in the acid number is observed in the partially refined oil. This is of great importance in organizing the technology of partial processing of oil in the kernel in press factories industrially.

The process of reducing the acid number in partially refined oil is influenced by the heating temperature of the soda solution, along with its concentration. Therefore, we investigated the effect of the temperature (60...95°C) of a 10% concentration of activated soda solution on reducing the acid content of partially refined soybean seed oils with an initial acid number of the oil in the raw material of 3.0...4.5 mg KOH/g. The studies were conducted in laboratory and production conditions.

The selection of the specified temperature range (60...95°C) is related to the less intensive progress of the reaction at low soda solution temperatures (below 60°C), which leads to a smaller reduction in the acid number. Increasing the soda solution temperature to 95°C accelerated the process of protein substances in the kernel.

Data on the effect of temperature on reducing the acid number of the oil in the raw material are presented in Table 2.

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Table 2 Effect of the temperature of the activated alkaline solution on the reduction of the acid number of partially refined oil."

№ т/р	Temperature of the alkaline solution. °C	Acid number in crude oil, mg KOH/g.			
		3,0		4,5	
		Acid number in partially refined oil.	Difference, Δ A.n..	Acid number in partially refined oil	Difference, Δ A.n.
1	60	2,9	0,1	4,3	0,2
2	65	2,4	0,6	3,9	0,6
3	70	2,1	0,9	3,5	1,0
4	75	1,7	1,3	3,1	1,4
5	80	1,6	1,4	2,6	1,9
6	85	1,5	1,5	2,1	2,4
7	90	1,3	1,7	1,7	2,8
8	95	1,2	1,8	1,6	2,9

It is evident from the data in Table 2 that increasing the temperature of the soda solution to 70-90°C has a positive effect on reducing the acid number of the oil in the kernel.

A series of studies were conducted to investigate the effect of reducing the acid content of the oil in the kernel during the processing of various soybean seeds, differing in terms of the key indicators of the activated soda solution concentration (the average acid number of the oil in the raw material ranging from 3.0 to 4.5 mg KOH/g).

The data presented indicate that the effect of the activated caustic soda solution on the raw material during moisture-thermal processing leads to a reduction in the acid number of the oil in the kernel. The most significant reduction in the acid number of the oil in the raw material was observed during the processing of seeds with relatively high initial oil and acid numbers. For example, when treating with an active soda solution with a concentration ranging from 5 to 15%, the reduction in the acid number of the oil in the raw material ranges from 1.8 to 2.4 mg KOH/g. When processing soybean seeds with an average initial oil acidity of 3.8 mg KOH/g, the decrease in the acid number does not exceed 2.1 to 2.7 mg KOH/g from the initial value of this indicator.

The effect of the duration of the reaction of the alkaline aqueous solution (concentration 10%, temperature 25°C) with the kernel on reducing the acid content of the oil was studied. The studies were carried out in laboratory conditions by mixing the kernel with an activated soda solution for 2, 4, 6, ... 16 minutes, followed by treating the raw material with an activated solution of calcium chloride. The data are presented in Table 3.

Table 3 Effect of the concentration of the alkaline solution on the reduction of the acid number of partially refined oil in the raw material..

№ т/р	Temperature of the alkaline solution °C	Хом мойдаги кислота сони, мг КОН/г			
		3,0		4,5	
		Acid number in partially refined oil	Difference, Δ A.n	Acid number in partially refined oil	Difference, Δ Acid number..
1	2	2,8	0,2	4,4	0,1
2	4	2,6	0,4	4,1	0,4
3	6	2,3	0,7	3,6	0,9
4	8	1,8	1,2	3,1	1,4
5	10	1,3	1,7	2,6	1,9
6	12	1,0	2,0	2,0	2,5
7	14	0,9	2,1	1,6	2,9
8	16	0,8	2,2	1,2	3,3

It is evident from the data in Table 3 that the duration of the solution's reaction with the raw material is also a significant technological factor influencing the reduction of the acid content in the oil extracted from the kernel. An intensive reduction in the acid number is not practically observed within the 2-4 minute range. The highest reduction in the acid number is observed with a contact duration of 12 minutes, and a further increase in the contact time leads to a slight decrease in the acid number. Therefore, subsequent studies were conducted using an interaction time of more than 12 minutes between the raw material's free fatty acids and the soda lye solution.

Conclusion: In the alkaline refining processes of crude vegetable oils obtained from local soybean seeds, it was achieved to improve the quality indicators and enhance the physicochemical characteristics of the finished products as a result of treating the solutions with an electromagnetic field.

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