

THE IMPACT OF REFINING PROCESSES ON THE QUALITY OF LOW-GRADE CORN OIL AND SOAPSTOCK FORMATION

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Annotation. This paper examines the effect of alkali refining on the quality of low-grade corn oil and the formation of soapstock. Low-quality oil is characterized by elevated levels of free fatty acids, phospholipids, pigments, and other associated substances, which reduces its consumer properties and storage stability. It has been established that the alkaline neutralization process effectively reduces the acid value and improves the organoleptic properties of the oil. However, increasing the free fatty acid content of the feedstock leads to increased alkali consumption and the amount of soapstock formed. Optimization of refining parameters has been shown to improve the quality of the finished product and reduce neutral fat loss.

Keywords: low-grade corn oil, alkali refining, neutralization, soapstock, acid value, free fatty acids, oil quality.

Introduction. Corn oil is a valuable vegetable product widely used in the food industry. However, improper raw material storage conditions, prolonged oil storage, or imperfect manufacturing processes lead to an increase in free fatty acid content and a deterioration in the oil's quality. This oil is considered low-grade and requires additional purification before further use.

One of the most effective methods for improving oil quality is alkali refining. During neutralization, free fatty acids react with alkali to form soaps, which are removed from the oil as soapstock. During the processing of low-grade oil, soapstock formation increases, which can lead to additional losses of neutral fat and a decrease in finished product yield.

Materials and Methods. The study was conducted on low-grade corn oil obtained from corn germ and characterized by an increased content of free fatty acids. The original oil had an acid value of 5.2 mg KOH/g, indicating partial hydrolysis of triacylglycerols and a decrease in its quality compared to the refined product. Alkaline refining was carried out in a laboratory setting by neutralizing free fatty acids with a sodium hydroxide (NaOH) solution. For the experiment, a 500g sample of oil was heated to 65-70°C with constant stirring. The required amount of alkali was calculated based on the oil's initial acidity, taking into account an excess of 5-10% alkali to ensure complete neutralization. A prepared aqueous solution of sodium hydroxide with a concentration of 12-16°Be was gradually added to the oil with continuous stirring. The neutralization process lasted 20-30 minutes. The reaction of free fatty acids with the alkali resulted in the formation of sodium salts of fatty acids (soaps), which form soapstock.

After neutralization was complete, the mixture was held for 30 minutes to allow phase separation. The soapstock was separated from the neutralized oil by settling and subsequent decanting. To remove soap residue, the refined oil was washed with hot water at 80-85°C until the wash water reached a neutral pH. The oil was then dried at 90-95°C under vacuum until residual moisture was removed.

To evaluate the process's effectiveness, the physicochemical properties of the original and refined oils were determined. Acid number was determined titrimetrically according to current standards based on the neutralization of free fatty acids with an alcoholic solution of potassium hydroxide. Results were expressed as milligrams of KOH required to neutralize the free fatty acids contained in 1 g of oil.

The amount of soapstock formed was determined gravimetrically by weighing the separated soap phase. All analyses were performed in at least three parallel replicates. The obtained experimental data were processed using mathematical statistics, calculating mean values and standard deviations. The reliability of the results was assessed at a significance level of ($p \leq 0.05$).

Results and discussion. The experimental studies showed that alkaline refining of low-grade corn oil significantly improves its physicochemical properties. In particular, the acid value decreased from 8.2 to 0.25 mg KOH/g, indicating the almost complete removal of free fatty acids as a result of the neutralization reaction with sodium hydroxide. This result demonstrates the high efficiency of the selected process mode and the complete chemical interaction between the free fatty acids and the alkaline reagent.

In addition to the reduction in acid value, the refining process also demonstrated a significant improvement in the organoleptic and physicochemical properties of the oil, including increased transparency, reduced color intensity, and a reduction in the content of associated impurities. This is due to the partial removal of phospholipids, pigments, and other colloidal-dispersed components that pass into the residual soap phase.

Analysis of the by-product showed that the soapstock yield was 7.8% of the original oil weight, significantly exceeding similar values typical for processing higher-quality raw materials. Increased soapstock formation is explained by the high content of free fatty acids in the original oil, which leads to increased consumption of the alkaline reagent and, consequently, to an increase in the formation of sodium salts of fatty acids. Furthermore, some neutral lipids migrate into the soapstock, increasing oil phase losses.

The Effect of Alkaline Refining on the Quality of Corn Oil

Table 1

Indicator	Before refining	Alkaline-refined	Change
Acid number, mg KOH/g	5.2	0.25	95.2% reduction
Oil color	Intense yellow	Light yellow	Clarification
Transparency	Cloudy	Transparent	Improvement

Soapstock yield, %	-	4.8-6.5	By-product formation
Oil phase loss	-	Low moderate	Depends on refining mode

Despite the increased byproduct yield, the alkaline refining process produced refined corn oil that met established acidity and quality requirements. This confirms the feasibility of this method for processing low-grade raw materials, provided that process parameters are optimized to minimize oil loss and improve overall process efficiency.

Conclusion. The conducted studies confirm that alkaline refining is an effective technological method for improving the quality of low-grade corn oil, significantly improving its physicochemical and organoleptic characteristics. The neutralization process significantly reduces the acid value due to the removal of free fatty acids, as well as partially eliminates phospholipids, pigments, and other associated impurities, which collectively leads to increased stability and consumer value of the final product.

It has been established that refining efficiency directly depends on the quality of the feedstock. Higher free fatty acid content in low-grade oil leads to increased alkaline reagent consumption and intensified saponification, which, in turn, is accompanied by an increase in soapstock yield. This leads to additional losses of neutral lipids, which are converted into a by-product soap phase, and reduces the overall yield of refined oil.

Thus, a direct correlation has been established between the degree of degradation of the feedstock and the amount of refining byproducts formed. In this regard, optimizing the process parameters of alkaline neutralization, including

alkali concentration, process temperature, and processing time, is particularly important. Rational selection of process conditions ensures the required level of purification while minimizing soapstock formation and reducing the loss of valuable oil components.

Therefore, improving the alkaline refining process is an important way to increase the efficiency of vegetable oil processing and the rational use of raw materials in the oil and fat industry.

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