

De-Oiling of Soybean Seeds and Analysis of Quality Indicators of The Resulting Meal

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Abstract

This article analyzes the technological process of de-oiling soybean seeds and the quality indicators of the meal obtained as a result of this process. The study explored methods for extracting oil from soybean seeds, the efficiency of the de-oiling process, and its impact on the composition of the meal. Moisture content, protein share, residual oil, ash content, and other important physicochemical indicators of the resulting meal were determined, and its nutritional value was evaluated. The results indicate that soybean meal is of significant importance as a high-protein feed for livestock and poultry.

Keywords: Soybean, extraction, hydrodynamics, meal, oil, hexane, diffusion, residual oil, fraction, desolventization.

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1. Introduction

The process of extracting prepared soybean meal is one of the primary stages in the industrial separation of vegetable oils, based on the laws of diffusion and mass transfer. This process is typically carried out using organic solvents, primarily hexane, and its efficiency is determined by numerous technological parameters. The essence of extraction is that the solvent penetrates the meal particles, dissolves the remaining oil within the

cells, and carries it out to the external environment. Therefore, the intensity of the process directly depends on the contact surface between the solvent and the solid phase, temperature, time, and hydrodynamic conditions.

At the preparation stage, properly crushed, flaked meal with optimal moisture ensures high efficiency in the extraction process. The extraction process is usually conducted in continuous apparatuses, such as belt or carousel extractors. In these units, the meal moves in a layer, and the solvent treatment occurs based on the

counter-current principle. The counter-current regime ensures maximum saturation of the solvent at the outlet and minimal residual oil content.

In a well-organized practical process, the residual oil content in the de-oiled meal is approximately 0.5–1.5%. If technological parameters are not chosen optimally, this figure increases, leading to economic losses. Temperature is one of the most critical factors affecting

the process. For solvents like hexane, the optimal temperature is usually in the range of 50–60 °C. As temperature increases, oil solubility rises, diffusion accelerates, and the process intensifies. However, excessively high temperatures increase solvent evaporation, negatively impact safety, and can lead to the denaturation of the protein within the meal. Thus, temperature control is essential for maintaining extraction efficiency and product quality.

Table 1. The effect of temperature on the extraction process of soybean grist

Temperature, °C	Oil Yield, %	Meal Yield, %	Oil in Meal, %	Protein in Meal, %
40	72	82	4.5	46
50	82	79	3.2	46.5
60	90	77	1.8	47.5
70	94	75	1.2	48
80	95	74	1.0	47

The duration of the process is also a vital parameter. When the extraction time is insufficient, the oil is not fully separated, resulting in high residual oil content in the meal. Conversely, excessively long extraction increases energy consumption and reduces technological efficiency. In practice, the optimal time is usually between 45–90 minutes, depending on the particle size of the meal and the type of equipment.

Particle size and shape significantly influence the mass transfer rate during extraction. Fine particles have a large surface area and saturate quickly with the solvent, but an overly fine fraction complicates filtration and slows the solvent flow. In very large particles, it is difficult for the solvent to reach the inner layers. Therefore, it is advisable for the optimal thickness of the flaked meal to be around 0.25–0.35 mm. Solvent consumption and its circulation speed are also key factors; in industry, the ratio of solvent to raw material is typically chosen in the range of 1:1.5 – 1:2.

After the extraction process, a certain amount of solvent remains in the de-oiled meal. To remove it, a desolventization stage is applied. In this process, the solvent is evaporated via steam treatment and condensed

for reuse. It is crucial to correctly manage temperature and moisture during desolventization, as the functional properties of the protein are formed at this stage. Excessive heat reduces protein solubility, which leads to negative results in subsequent isolate production. To obtain high-quality soybean protein isolate, it is important to preserve the protein structure by choosing mild technological regimes: moderate temperature, optimal time, and minimal mechanical damage.

2. Conclusion

The extraction of prepared soybean meal is a complex physicochemical process influenced by several important technological parameters. During extraction, oil moves from the internal structure of soybean particles into the solvent through diffusion and dissolution. The efficiency of this process depends on temperature, extraction time, particle size, solvent consumption, and hydrodynamic conditions.

Temperature plays a major role because it reduces oil viscosity and increases the rate of mass transfer. As temperature rises, the solvent penetrates the soybean particles more easily, improving oil separation. However, excessively high temperatures may damage protein

quality and increase solvent losses.

Extraction time is also important. If the process is too short, part of the oil remains in the meal. If it is too long, energy consumption increases and productivity decreases. Therefore, selecting the optimum extraction time is necessary for efficient industrial operation.

Scientific optimization of these parameters makes it possible to increase oil recovery, reduce residual oil in the meal, and preserve the protein quality of the defatted product. As a result, optimized extraction not only improves the economic efficiency of soybean processing but also creates favorable conditions for producing high-quality soybean protein concentrates and isolates.

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