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IMPROVEMENT OF SOYBEAN OIL HYDRATION PROCESS

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Abstract

This research focuses on optimizing the hydration process of local soybean oil; it demonstrates changes in the levels of hydratable and non-hydratable phospholipids in relation to the amount of water added, noting that the content of hydratable substances decreases exponentially as the level of non-hydratable phospholipids rises. Increasing the temperature of the soybean oil enhances the separation of hydratable phospholipids, with the highest yield of phospholipids observed upon the addition of 4% moisture and the lowest upon the addition of 2% moisture.

Keywords: *Soybean oil, phospholipids, hydratable and non-hydratable (fractions), alkali, water, moisture, acid and peroxide values*

Introduction

Soybean oil is a valuable source of nutrients, such as polyunsaturated fatty acids, vitamins, and antioxidants. Its composition can be modified during the hydration process, in which the addition of water to the oil causes the separation of its phospholipids – yielding a product with high physiological value.

Phospholipids are complex lipids – biologically active substances containing fatty acids, a phosphoric acid residue, and, in most cases, an additional nitrogen-containing group (Bokovikova T.N., 2000). Lecithin (specifically, phosphatidylcholine) constitutes the bulk of the phospholipids extracted from soybean oil; this product exhibits excellent surface activity and serves as a valuable source of emulsifiers (Kobzar M.V., 2005). Under traditional processing methods in Uzbekistan, soybean oil undergoes only partial hydration – or sometimes no hydration at all – resulting in the loss of this valuable raw material along with the soapstock during subsequent refining stages (Azimov Yu.Kh., Abdurakhimov S. A., Akhmedov A. N., 2020).

R. O'Brien, A. Kaufman, B. N. Markman, A. G. Sergeev, A. P. Nechaeva, N. S. Kornena, O. S. Abdurakhimov, A. I. Isabaev, A. N. Akhmedov, D. S. Salikhanova, A. T. Ruzibaev, D. S. Sagdullaeva, Yu. X. Azimov and others have conducted scientific and practical work. For this study, unrefined soybean oil obtained via pressing and extraction methods was selected. First and foremost, before hydrating the soybean oil, it is necessary to determine its physicochemical parameters.

The purpose of the work: The objective is to study and draw conclusions regarding the effect of moisture content on the separation of phospholipids from crude soybean oil obtained via pressing and extraction methods.

Materials and methods

Determination of the acid value of unrefined soybean oil. To determine the acid value of soybean oil, 3–5 g of the oil under study and 50 ml of a neutralized alcohol-ether mixture (in a 1:2 ratio – specifically, 96% ethyl alcohol and diethyl ether) are placed into a conical flask using a technical balance.

To prepare the neutralized alcohol-ether solution mixture, add a few drops of a 1% phenolphthalein indicator solution and titrate with an aqueous 0.1 N KOH solution for 30 seconds until the light red color disappears. The titration process is carried out under constant stirring. A microburette is suitable for determining the acid value of refined and bleached soybean oil.

The acid value is determined using the following formula (Kadyrov Yu. 2005):

$$A.V. = \frac{5{,}611 \cdot V \cdot K}{M}$$

where: V is the volume of 0.1 N KOH (in milliliters) used for titration;

K is the correction factor for the titer of the alkaline solution;

M is the mass of the oil being analyzed (in grams).

The final result is the arithmetic mean of two parallel determinations.

Determination of phospholipid composition

Thin-layer chromatography was used to study the phospholipid composition. Sorbfil plates were used for the analysis. The concentration of the standard sample was 5 mg/mL, and the plates were placed in a chamber saturated with eluent vapors. When the solvent front reached a point 1 cm from the top, the plates were removed and dried. A 5% alcoholic solution of phosphomolybdic acid and a 1% solution of ninhydrin were used for derivatization. A mixture of chloroform, methanol, acetic acid, and water in a 50:25:8:4 ratio served as the mobile phase. The results obtained were analyzed by comparison with data reported in the literature.

Results and Discussion

Unrefined soybean oil obtained via pressing and extraction methods was selected for the study. Before hydrating the soybean oil, it is essential to determine its physicochemical parameters. Table 3.5 below presents the physicochemical parameters of the unrefined soybean oil obtained through pressing and extraction.

Table 1. *Physicochemical characteristics of unrefined soybean oil obtained by pressing and extraction*

Name of indicators	Indications for the use of unrefined soybean oil	
	Obtained by pressing	Obtained by extraction
Acid value, mg KOH/g	2,8	4,3
Content of non-fat substances, %	0,08	0,12
Phospholipid content (calculated as stearo-oleo-lecithin), %	1,8	2,4
Moisture and volatile matter content, %	0,1	0,1
Peroxide value, mmol active oxygen/kg	4,8	5,3

As shown in Table 1 above, solvent-extracted unrefined soybean oil contains 0.6% more phospholipids (calculated as stearo-oleo-lecithin) than oil obtained by pressing, resulting in a higher yield of the extracted product. The primary reason for this is that the solvent dissolves not only the oil but also related components, including phospholipids.

Subsequently, unrefined soybean oil obtained via pressing and extraction was hydrated using a traditional method under laboratory conditions. The release of phospholipids was investigated by adding varying amounts of water to the soybean oil. The results obtained are presented in Table 2.

Table 2. *Effect of water content on phospholipid release in unrefined soybean oil obtained by pressing and extraction*

Amount of water supplied relative to the mass of oil, %	Hydration precipitates			
	amount relative to initial oil mass, %	moisture content, %	neutral oil content	phospholipid content (calculated as stearo-oleo-lecithin), %
Press oil				
0,5	1,51	30,2	32,4	36,6
1	2,47	36,5	34,8	28,0
2	4,31	41,4	38,2	19,5
3	5,71	46,5	36,6	16,3
4	6,98	49,1	36,4	13,7
Extraction oil				
0,5	1,58	28,7	31,8	38,7
1	2,61	34,3	33,4	31,6
2	4,59	38,6	37,4	23,1
3	6,11	43,1	35,5	20,8
4	7,45	45,7	36,1	17,4

As shown in Table 2 above, increasing the amount of water added to unrefined soybean oil reduces the mass fraction of phosphorus-containing substances in the resulting hydrated sludge. This increases the moisture content of the obtained phospholipid sludge and raises the energy consumption required for its subsequent processing. An analysis of the results indicates that adding 3% water (relative to the mass of the unrefined soybean oil) has a positive effect on the release of hydratable phospholipids; at higher water volumes, the yield decreases. Therefore, the optimal water addition level for this study can be established at 3%.

Conclusions

During the hydration of unrefined soybean oil obtained via pressing and extraction, the phospholipid content in the extraction-derived oil is high, and its hydration efficiency exceeds that of the pressed oil. This further confirms the high phospholipid content in oil obtained by the extraction method.

The results presented above indicate that the phospholipid sludge has a high oil and moisture content, yet a low phospholipid content, suggesting a need to improve the hydration process. Ultrasound has recently been employed in various industrial processes; its effectiveness could be evaluated by applying this method to the aforementioned process and conducting further research.

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