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CHARACTERISTICS OF REFINING TECHNOLOGIES FOR VARIOUS VEGETABLE OILS

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Abstract
This article provides a detailed analysis of the specific characteristics and methods of the refining process for various oils. The article examines the main stages such as oil bleaching, deodorization, color alteration, and filtration. The results of this study are of significant importance for the production of high-quality products in the food and chemical industries, contributing to the provision of healthy and safe oils for consumers.

Keywords: Various oils, refining process, rapeseed oil, mustard oil, complex compounds, erucic acid, alkali content, glyceride composition, bleaching earths, fatty acids, sesamolin, sesame oil, hemp oil, whale oil.

Introduction

Oils are an essential component of the food industry, and their quality and safety directly affect consumer health. Refining is the process of converting crude oils into high-quality and edible products. This process involves chemical and physical methods and is carried out in accordance with the specific requirements of various types of oils. For vegetable oils such as rapeseed, safflower, sesame, flax, and soybean, there are specific requirements and methods for the refining process. Each

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type of oil has its own chemical composition and physical properties, which determine their refining process.

Refining rapeseed and mustard oils. Rapeseed and mustard oils are characterized by the presence of a large amount of unsaturated fatty acids, especially erucic acid. These oils also contain very complex, non-fat compounds, the presence of which complicates the oil purification process. The amount of erucic acid in these oils reaches 40-50%. Mustard and rapeseed seeds contain a complex of carbohydrates: pentoses, pectins, sucrose, and dextrins. Mustard glycosides are found in vegetable oils of the cruciferous family. These glycosides are compounds of glucose with isothiocyanate esters of unsaturated alcohols, which are hydrolyzed by enzymes in the presence of water. The glycoside sinigrin in black mustard is broken down by the enzyme myrosin into glucose, allyl isothiocyanate, and potassium bisulfate in the following order:

$$C_{10}H_{16}KS_2HO_9 + H_2O = C_3H_5NCS + C_6H_{12}O_6 + KHSO_4$$

When the gluconapin glucoside, which is present in rapeseed and structurally similar to sinigrin, breaks down, it separates into crotonyl mustard oil C_4H_7-NCS and glucose. White mustard contains the glucoside sinalbin, which, under the influence of the enzyme myrosinase and moisture, breaks down into glucose, sinalbin mustard oil, and sinapine bisulfate.

$$C_{20}H_{42}N_2S_2O_{15} + H_2O = C_6H_{12}O_6 + C_7H_7 - N = CS + C_{16}H_{24}NO_5 \cdot H_2SO_4$$

The hydrolysis of sinapine base results in the formation of sinapic acid and choline. The ash composition of mustard and rapeseed seeds indicates that the phosphorus in them is primarily present in the form of organophosphorus compounds. The presence of organic phosphorus and sulfur compounds in mustard and rapeseed oils leads to the poisoning of catalysts during the hydrogenation process. This complex of substances acts as a powerful emulsifying agent in the neutralization process. The purification of rapeseed and other oils belonging to the cruciferous family should include: decomposition of green pigments and removal of free fatty acids and the phosphatide-protein-glucoside complex. This can be achieved through two methods:

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• are hydrated, neutralized, and bleached separately;
• Chemical treatment is applied to the phosphatide-protein-glucoside and pigment complex, followed by neutralization. Purification of the phosphatide-protein-glucoside complex is achieved by processing it with a 0.1-1% solution of table salt as an active agent.

The second method involves chemically treating the phosphatide-protein-glucoside and pigment complex, followed by neutralization. In this process, a strong sulfuric acid is applied to the non-fat mixture and pigments, which are then separated and subsequently neutralized with alkali. Typically, only 0.1-0.2% of sulfuric acid is actively used, while the remaining acid must be neutralized with alkali. The refining process proceeds as follows: the oil is treated with sulfuric acid (0.8-1.5% of the oil mass) at a temperature of 25-280 °C. The amount of alkali should be sufficient to completely neutralize the free fatty acids and residual mineral acid. After neutralization, the oil is allowed to settle for 4-6 hours, after which it is separated from the soapstock. In factory practice, relatively satisfactory results in reducing the color of oils from cruciferous seeds, including rapeseed oil, are achieved through alkaline salt-water refining using the above-mentioned regime. Thus, the conditions for effective refining of oils obtained from the seeds of the cruciferous family mainly consist of the following: complete purification from non-fat impurities through neutralization with a weak solution of salt-water-based alkali and bleaching with activated clays.

Refining Soybean Oil. The glyceride composition of soybean oil is not constant but depends on the seed variety and its growing conditions. Soybean oil typically contains glycerides of the following acids: palmitic (2.4-6.8%), oleic (32-35.6%), linoleic (52.5-57%), and linolenic (2-3%). The total content of saturated fatty acids ranges from 8% to 12%. In terms of glyceride composition, soybean oil is similar to sunflower oil; therefore, the refining processes and technological conditions should not differ from those used for refining sunflower oil. Soybean oil contains large amounts of phosphatides, unsaponifiable matter, and coloring substances. The main objectives of soybean oil refining are complete removal of phosphatides through hydration and oil bleaching using activated bleaching earths. The conditions for hydration, salt-water neutralization, and bleaching processes are similar to those applied to sunflower oil.

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Cleaning sesame oil. The color of sesame oil can vary depending on the extraction method and seed variety. Sesame oil contains the following fatty acids: oleic (37.5-48%), linoleic (36-46%), palmitic (7.7%), stearic (4.6%), and other non-saponifiable substances. Additionally, it contains 0.8-1.73% sterols, sesamin, sesamol, and sesamolins. Sesame oil obtained from white seeds is easy to purify using the salt-water neutralization method. However, the presence of sesamol and a large amount of pigments in the oil causes its color to darken when exposed to air. Therefore, sesame oil is treated with sulfuric acid before alkaline neutralization. Sesamolin is converted to sesamol under the influence of acids or acidic adsorbents. Thus, high-quality oil with good color can be obtained by pre-treating the oil with acid, deodorizing or adsorption purification from impurities, as well as protecting hot oil or salomas from air exposure.

Refining of flax and hemp oils. Due to the presence of a large amount of highly unsaturated linoleic (15-30%), linolenic (44-61%), and isolinoleic acids in their composition, these are considered drying oils. The oils contain sterols, phosphatides, and carbohydrates, and are also rich in pigments, especially chlorophylls. The acids in these highly unsaturated oils, upon neutralization, form thin, mobile soap films with a micellar layer. This complicates the formation of soapstock pieces characteristic of sunflower and cottonseed oil soapstocks. The resulting soap systems are balanced by hydrophilic complexes - phosphatides and carbohydrates. Soap films formed during the refining of flax and hemp oils practically do not adsorb pigments. Therefore, even with the use of an excess amount and high concentration of alkali solution, the color of the oil changes minimally.

Easily soluble soap films of highly unsaturated fatty acids often lead to the formation of an emulsion. Thus, the refining process of linseed and hemp oils should be aimed at maximally purifying the carbohydrate complex and phosphatides, breaking down and separating chlorophyll and carotenoids, and removing free fatty acids. The technological regime is determined based on the intended use of the obtained oil. Refining of hydrogenated vegetable oils and animal fats: Refining salomas derived from most vegetable oils is usually straightforward. However, hydrogenated whale oil, rapeseed oil, and some other fats behave differently compared to non-hydrogenated fats. For example, raw whale oil is easily refined without forming an emulsion.

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Hydrogenated fat, on the contrary, deviates from the usual structure of soap formation and acquires high emulsifying properties. Even some hydrogenated oils form soap structures that differ from those obtained during the refining of initial oils. During selective hydrogenation of linoleic and linolenic acids, they easily isomerize, leading to the accumulation of isooleic acid in the salomas up to 20%, and in some cases up to 40-45%. The conversion of unsaturated fatty acids to saturated fatty acids leads to the formation of dense (concentrated) soap films and simultaneously increases their viscosity. The presence of isooleic acids ensures emulsification due to the retention of the second hydrophilic group. Products obtained from refining sunflower oil or whale oil and salomas have different viscosities and water solubility properties.
During the hydrogenation of fats, the saturation of the unsaturated bonds of carotene and carotenoids with hydrogen results in various color changes, i.e., partial or complete loss of color. Chlorophyll and its derivatives decompose significantly. Thus, during the refining of salomas, we encounter deeply altered coloring agents; therefore, for their separation and further bleaching of the salomas, neither high-concentration alkaline solutions nor processing with activated bleaching earths are effective.

Conclusion

Refining processes for oils, including vegetable oils such as rapeseed, mustard, sesame, flax, hemp, and soybean, as well as hydrogenated vegetable oils and animal fats, are crucial for purification, quality improvement, and preparation for consumption. These processes comprise several stages, including acid treatment, alkaline neutralization, settling, and bleaching, which help remove undesirable substances while preserving beneficial properties. Specific conditions and technologies must be applied for each type of oil, as the composition and characteristics of each oil differ. Consequently, these processes serve to provide consumers with safe and high-quality food products.

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