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New approaches in deacidification of edible oils—a review

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Abstract

In the fats and oils industry, deacidification of oils is important not only for consumer acceptance, but also because it has the maximum economic impact on production. Chemical, physical, and miscella deacidification methods have been used in the industry. There are several drawbacks associated with these conventional deacidification processes. Some new approaches that may be tried out—as alternatives to current industrial practices—are biological deacidification, reesterification, solvent extraction, supercritical fluid extraction and membrane technology. These new approaches—independently, or in combination with current technology—may be useful to overcome major drawbacks. Besides being eco-friendly, they could also lead to savings in energy and reduction in oil losses. Some of these approaches could very well replace the existing technology in the years to come.

Keywords: Biorefining; Chemical, physical and miscella deacidification; Chemical reesterification; Membrane technology; Solvent extraction; Supercritical fluid extraction

1. Introduction

Food is mainly composed of water, carbohydrates, proteins, and fat. Fat is regarded as an important component of the diet, because it is an important source of energy, as well as of essential fatty acids, and of fat-soluble vitamins such as vitamins A, D, E and K (Hay et al., 1980). Commercial sources of edible oils and fats include oilseeds, fruit pulp, animals and fish. Oilseeds are the major source for the production of edible oils. The total world production of major oilseeds in 2002 was 326.3 million metric tons (www.soystats.com). [1]

The method chosen for oil extraction depends on the nature of the raw material, as well as on the capacity of the industrial plant. Pressing followed by solvent extraction is the method most widely employed for handling a wide variety of oilseeds (Young et al., 1994), which contribute nearly 50% of the total vegetable oil produced in the world. The crude oil that is extracted from the oilseeds is a mixture of FFA, mono-, di-, and triglycerides, phosphatides, pigments, sterols and tocopherols. Trace amounts of metals, flavonoids, tannins, and glycolipids may also be present (Cheryan, 1998). Refining usually refers to the removal of nontriglyceride fatty materials. But, in the United States, the term 'refining' is applied to the operations of pretreatment and deacidification or neutralization. In most other countries it means the complete series of treatments, including also bleaching and deodorization, to make the fat suitable for edible use (Anderson, 1953). Industrially the two most commonly used methods for refining are chemical and physical refining. A typical scheme of oil processing is presented in Fig. 1. The different impurities removed (or partially removed) at different stages of chemical and physical refining are listed elsewhere (Young et al., 1994).

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[1] www.soystats.com/2003/Default-frames.htm.

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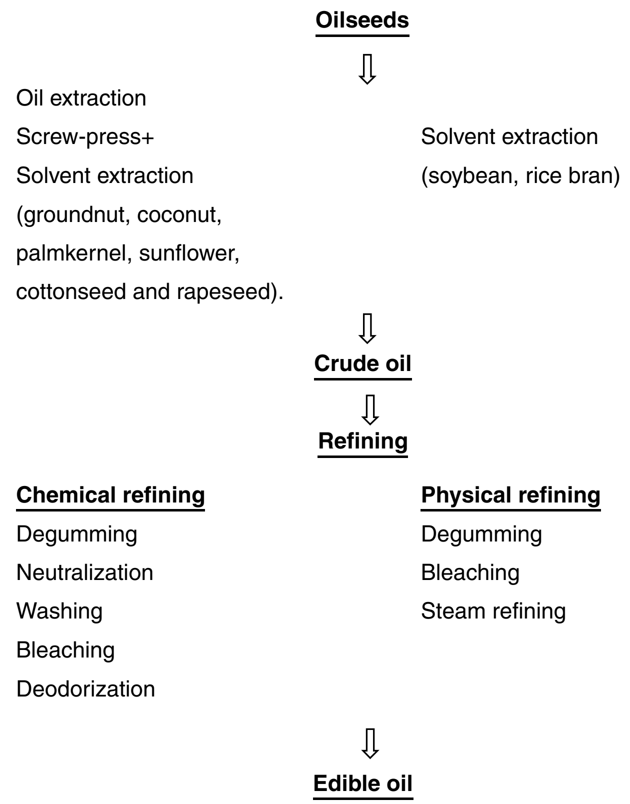

Fig. 1. Scheme of conventional oil processing.

1.1. Deacidification

Crude fats and oils consist of some quantity of FFA, along with triglycerides. FFA are virtually absent in fats/oils of living tissue. They can be formed, however, by enzyme (lipase) action, after the oilseed has been harvested, or the animal has been slaughtered. Hydrolysis of ester bonds in lipids (lipolysis) resulting in the liberation of FFA, may be caused by enzyme action or by heat and moisture (Nawar, 1996). The release of short-chain fatty acids by hydrolysis is responsible for the development of an undesirable rancid flavor (hydrolytic rancidity). Furthermore, FFA are more susceptible to oxidation than the glycerol esters of these fatty acids; and this lipid oxidation, leads to oxidative rancidity in edible oils and fat-containing foods. Therefore, any increase in the acidity of the oil must be absolutely avoided.

The deacidification process has the maximum economic impact on oil production. Any inefficiency in this process has a great bearing on the subsequent process operations. The removal of FFA from crude oil represents the most delicate and difficult stage in the refining cycle, since it determines the quality of the final product. Chemical, physical, and miscella deacidification methods have been used industrially for deacidification. These conventional methods are well documented; nevertheless, they are briefly discussed in this review, and their relative features and limitations are summarized in Table 1.

2. Conventional methods of deacidification

2.1. Chemical deacidification

Industrially the most commonly used method for deacidification is chemical deacidification. The purpose of deacidification in the conventional chemical process

Table 1
Industrial methods of deacidification

S. no.	Features	Limitations
1	*Chemical deacidification*	
	Versatile—produces acceptable quality oil from all types of crude oil	Excessive loss of neutral oil with high-FFA crude oil (occlusion) Soapstock—low commercial value
	Multiple effects—purifying, degumming, neutralizing and partially decolourizing the oils	Neutral oil loss due to hydrolysis
2	*Physical deacidification*	
	Suitable for high-FFA oil	Pretreatments are very stringent
	Low capital and operating costs—less steam and power consumption	Not suitable for heat sensitive oil—e.g., cottonseed oil Chances of thermal polymerization
	Greater oil yield	Controlled rate of removal of FFA
	Elimination of soapstock as well as reduced effluent quantity	
	Improved quality FFA	
3	*Miscella deacidification*	
	Lower strength of caustic solution	Higher investment—totally enclosed and explosion-proof equipment
	Increased efficiency of separation	Solvent loss—requires careful operation and greater maintenance
	Minimum oil occlusion in soapstock	More suitable for integrated extraction and refining plant
	Superior colour of final product	Cost intensive—homogenization necessary for effective neutralization and decolourization
	Water washing eliminated	
		For efficient operation oil conc. in miscella should be ~50% (two-stage solvent removal)