Technical News Features

Sunflower Oil Processing from Crude to Salad Oil[1]

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ABSTRACT

World-wide use of sunflower oil is second only to soybean oil. Interest in domestic use as a premium salad oil is very recent. The high ratio of polyunsaturated-to-saturated fatty acids makes sunflower oil a premium salad oil. Sunflower oil, however, contains a small amount of high melting wax which must be removed to avoid settling problems. It is possible to produce a brilliant, dewaxed, deodorized sunflower oil with over a 100-hr cold test at 0 C. This quality oil can be produced by conventional caustic refining, dewaxing, bleaching and deodorization. A quality finished oil may also be produced by dewaxing and steam refining. This paper reviews various methods for processing sunflower oil from the crude state through the finished, dewaxed, deodorized salad oil.

Sunflower seed oil, or more recently termed "sunflower oil," has been used as a commercial edible oil in Europe for many years. Only recently, however, has there been an interest in the processing of this oil for edible purposes in the United States.

Although the topic of this paper is the processing of sunflower oil from crude to salad oil, a brief historical background will aid in the study. Sunflowers had been an ornamental plant for many years, but the first commercial-type seeds were introduced into the United States in 1893 and were obtained from Russia (1). Considerable plantings were made in the United States and most of the seeds were of low-oil-type and suitable for bird feed. The present sunflower seeds, the high-oil-type, were introduced to the United States in 1964 and were the Russian variety, Peredovik (2). The earlier bird-feed-type seed contained only 29-30% oil, whereas the new Russian variety contained more than 40% oil. A brief note on the problems of seed genetics: V.S. Pustovoit, a Russian scientist, first began research work nearly 60 years ago on seed containing 28% oil (1). By 1927 he released a variety with an oil content of 36%. Within 30 years, based on his work and other Russian agronomists, the oil content of commercial seeds in Russia had increased to 51%. Present work indicates varieties available with oil content up to 59%.

As an indication of the growth in the United States, 30,000 metric tons were produced in 1966, and by 1970 this had only increased to 85,000 metric tons. This would hardly be sufficient to wet the storage tanks of a large commercial oil refiner. This small amount does not warrant extensive research into processing methods (3). However, the U.S. Department of Agriculture "Fats and Oils Situation" for February 1980 states that during the 1980s the United States will become the leading producer of sunflower seed, estimated at a record supply of 3.6 million metric tons, of which 2.9 million tons will be of the high oil seed (4).

It has been known for a long time that sunflower seed produced a highly desirable polyunsaturated oil for human consumption. The usual methods of processing were reported as caustic refining, bleaching, followed by hydrogenation and deodorization for shortening and margarine use. When used for salad oil, the refined oil was winterized for wax removal and then deodorized.

The early references to wax removal (5,6) were processes which resembled our winterizing. The oil was cooled to 5-6 C, held for 24 hr and then filtered. During filtration, filter aid was required to prevent blinding of the filter from the wax. This simple term "wax" has led to a misconception of the processing problems involved in wax removal.

Popov and Stefanov (7) reported on a method of isolating and analyzing the waxes from the oil. The waxes reported, far from a simple wax ester, consisted of many esters of long chain fatty acids and alcohols. The fatty acids range from C 16 to C 30, and 65% are in the C 20- C 22 group. The alcohols range from C 18 to C 34, and 60% are in the C 24-26 group (8,9). The melting point of these waxes ranges from 70-80 C (9).

As reported by Rac (10), the particle size of the wax crystals was in the range of 50-90 microns, and it was further shown that they were polar or hydrophilic at crystallizing temperatures. When lecithin was added to the wax-oil solution, the wax crystal particle size was reduced to the 20-30-micron range. This technical background on wax analysis as reported in foreign journals was invaluable when developing processes for wax removal.

Haraldsson (5) describes a process of basically caustic refining at temperatures in the range of 8-10 C and centrifugally separating the reaction products, principally soaps, phospholipids and waxes, from the oil. The waxes, being polar and hydrophilic, will concentrate at the surface between the oil and aqueous solution and will discharge from a centrifuge with the heavy or aqueous phase. Similar cold refining techniques were described by Rac (10) where polyphosphates were added to the caustic solution. Walker and Parkin (11) obtained a patent in 1947 entitled "Winterizing of Vegetable Oils" which described caustic refining in the 0-5 C range. More recently, a cold refining technique was patented by Young (12).

Cold refining, i.e., reacting sodium hydroxide or similar agents with the oil at 5-10 C and separating at these temperatures, will produce a well refined and thoroughly dewaxed oil. The disadvantages can be a reduced capacity through the centrifugal separator and possibly higher refining losses resulting from emulsification at high viscosity.

A more recent refining, dewaxing process has been commercially introduced in the European market which claims higher oil yields while still producing a dewaxed oil with a cold test of more than 24 hr at 0 C (13).

In this process, the oil is conventionally caustic-refined and centrifugally separated. The refined oil is then cooled to 5-10 C, mixed with 2-5% water along with a small amount of sodium hydroxide, and mildly agitated for 4-5 hr. The waxes, now hydrophilic at these temperatures, are wetted by the water and trace soap present. The waxes are therefore transferred from the oil phase to the water phase where they form a suspension of crystals in the water-soap mixture.

After completion of crystallization and phase transfer, the mixture is fed to a second centrifugal separator. The

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TABLE I

Influence of Degumming on the Phosphorus, Calcium, Magnesium and Iron Contents of Different Sunflower Oils

Treatment	P ppm	Ca ppm	Mg ppm	Fe ppm
Mill 1				
Crude	237	77	60	6
Degummed	55	48	18	1
Mill 2				
Crude	21	9	6	22
Degummed	14	8	4	10
Canadian mill				
Crude	77	18	18	1
Degummed	15	10	7	1

stability was 150 hr at 0 C.

While we could not correlate higher phosphorus content in crude oil to a reduced cold test stability, it became apparent that crude oils which had a normal reduction in phosphorus by degumming would dewax more readily. The oil with high iron responded to dewaxing in a similar fashion to oils with high phosphorus. Work is continuing in an attempt to correlate these factors to dewaxing efficiency.

The only other effect that we could observe without undergoing long-age testing for stability was the need to increase the amount of bleach clay in the dark-colored crude oils to obtain finished oil color in the range of 6Y-0.6R.

The results of our laboratory and pilot plant studies have shown a process for dewaxing either well degummed sunflower oil in preparation for steam refining or caustic-refined oil in preparation for bleaching and deodorization which will produce a finished oil with cold stabilities in excess of 70 hr at 0 C.

Furthermore, we observed that the steam refining of sunflower oils was following along the same trend which was earlier observed for soybean oils. The crude oils must meet the following criteria: (a) the oils must fully water degum to 50 ppm phosphorus or less; (b) the water-degummed oil must bleach when using a maximum of 1.0% acid activated clay to an oil containing 15 ppm phosphorus or less, and contain not more than 0.1 ppm iron (Fe).

It may be observed that we have not referred to the wax content in the crude oils nor the finished products. The literature reports wax contents in crude oil varying from 0.02-0.35% (19). The waxes in crude sunflower oil are difficult to measure accurately because of their low concentration. The analytical methods are involved and time-consuming (9,14,20).

A rapid method for determining wax content in refined or finished sunflower oil has recently been published by Brimberg (21). This procedure was based on adding known amounts of purified wax to a thoroughly dewaxed oil, holding for a short period of time at 0 C and making turbidity measurements.

In conclusion, we feel that the analysis of the crude oil from our more recent tests indicates a need for closer control at the mills producing the crude oils. Krasil'nilov (9) presented information showing that ca. 83% of the wax was in the hull, whereas the membrane of the seed contained less than 17%. The oil in the kernel contained only traces of wax.

Kurucz (22) reported on results from a prepress-solvent extraction plant using Krasnodar-type seed whereby the same seed could produce a light-colored crude oil, or a brownish-colored crude oil, or even a dark-colored oil, depending on the seed handling in storage.

Sunflower oil is highly unsaturated, but when processed properly from seed through deodorization will produce an excellent edible oil. Fortunately linolenic acid is not a problem as in soybean oil, but again, iron cannot be tolerated in either oil (23,24).

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Additional technical references can be found in Ref. 1, which contains a good bibliography.

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