The Role of Safflower Oil in Edible Oil Applications

JOHN E. BLUM, Durkee Famous Foods, Berkeley, California

Abstract

Safflower oil has been used as an edible oil in numerous countries for many years. In the US, commercial use of safflower oil as an edible product was noted in the 1950's and the use continues at progressively higher levels each year.

One use of safflower oil in "dressing" type products is related to the natural cold resistance of the oil. Other applications include oil, margarine and some imitation dairy products. Additional development work has been done on other food products so that the scope of usage could be broadened if there should be increased demands for safflower oil.

The susceptibility of safflower oil to oxidation has been minimized by improved processing and packaging.

Further use of safflower oil appears to be dependent upon availability, pricing, good cold resistance and the role of polyunsaturates in the diet.

Introduction

SIGNIFICANT USE of safflower oil for edible purposes in this country was not made until the 1950's; since that time, however, increasing use of safflower oil has now classified the oil as a minor but significant edible oil source.

Analytical

The use of safflower oil as an edible oil raw material is related to the chemical and physical properties of the oil. The high linoleic acid content of safflower oil is a significant factor where high levels of linoleic acid are desired. A comparison of published data, which may still be subject to minor corrections (3,11), definitely indicates safflower oil has the highest linoleic acid content with correspondingly low levels of saturated acids and monounsaturated acids as compared with other domestic oils. Exact comparison data are dependent upon analytical methods used and source of oil samples; however, the same pattern holds true for both GLC or spectrophotometric analysis.

Liquid Safflower Oil Properties

The high iodine value and high linoleic acid content of safflower oil indicate the oil is susceptible to oxidation. This is accentuated by the relatively low content of gamma tocopherol, the most significant natural antioxidant present in the safflower oil. In an unstabilized condition, safflower oil appears to oxidize more rapidly than other domestic liquid oils.

Much of the early edible use of safflower oil was associated with rapid oxidation and subsequent loss of desirable edible properties. Based upon these problems of rapid oxidation, it has been established on a practical basis that proper packaging in sealed containers or nitrogen-blanketed tanks or containers can limit the degree of oxidation. Practical shelf life beyond 6 months has been demonstrated. Proper packaging has also been supplemented with the use of one or more antioxidants: propyl gallate, butylated hydroxy anisole, butylated hydroxy toluene, sequestered with citric or phosphoric acid. Actual samples of edible safflower oil with antioxidants in sealed containers have been acceptable after one-year storage at ambient temperatures.

TABLE I

Estimates of US Edible Safflower Oil Consumption

	Year	Millions of pounds		Year	Millions of pounds
(2)	1958	0.4	(17)	1962	38.0[a]
	1959	1.5		1963	50.5
	1960	2.0		1964	38.3
	1961	45.0		1965 Jan.–July	17.1

[a] Extrapolated data. Figure appears abnormally low.

TABLE II

Typical Selected Analytical Values Deodorized Safflower Oil, 1963 Crop

Color, Lovibond	5Y.5R	Saponification value	191
FFA, as oleic	0.03%	Unsaponifiable[a]	0.5%
R.I. @ 25C	1.4744	Cloud point	OF
Iodine value	145		

[a] The Unsaponifiable Content contains 0.04 to 0.07% total tocopherols which are approx. 85% alpha and 15% gamma (14). Average figure of 0.037% total tocopherols of which 90% is alpha and 10% is gamma on a broad series of samples have been determined (8).

The effects of light upon the shelf life of safflower oil are to lower the acceptable life significantly. In a recent series of tests (13) with daylight fluorescent tubes, it is shown that safflower oil is significantly more light-stable than cottonseed or soybean oil. However, on a practical basis the use of brown bottles or tins is significantly advantageous.

Flavor of edible safflower oil stored at ambient temperatures is generally acceptable even at moderate levels of oxidation. An illustration of flavor stability is apparent from a comparison of flavor scores versus peroxide values (PV). In one typical test of commercial oils in our laboratory, it was established that edible safflower oil at PV of 4 me/kg had an acceptable (fair) rating of 7.0 on the basis of a 10-point flavor scoring system. Correspondingly, soybean salad oil with a flavor rating of 7.0 had a PV of 1.5 me/kg and cottonseed salad oil with a flavor rating of 7.0 had a PV of 2.5 me/kg. In some of our own observations, occasional samples of safflower oil with a PV of 8 were still considered in the same fair category with a flavor rating of 6. There are variations in oil source, processing and handling, each contributing to the flavor evaluation but the general pattern of good flavor stability is considered typical. Similar results were noted by others (1,5,14).

The exact basis for the good flavor stability has not been established; however, the lack of linolenic acid is a major consideration (7,9,12). A second factor is in the improved handling of safflower oil. In particular, careful handling of safflower oil to minimize oxidation prior to deodorization does produce a good flavored oil with good flavor stability. A practical upper limit for the degree of oxidation has been determined to be 10 me/kg.

Hydrogenated Safflower Oil Properties

Safflower oil is readily hydrogenated in conventional processing equipment. The hydrogenated saf-

TABLE III

Gross Fatty Acid Composition of American Oils (3,11)

	Safflower oil	Corn oil	Soybean oil	Cottonseed oil	Peanut oil	Olive oil
Polyunsaturates	73–79	56–58	55–69	50–55	24–25	8–15
Monounsaturates	10–19	28–32	14–35	14–24	53–56	68–76
Saturates	8–11	12–14	10–17	26–31	20–22	16–17

flower oil has improved oxidative stability over the liquid oil and, by proper handling and blending, can be used in products such as margarine or shortening. The oxidative stability of hydrogenated safflower oil is significantly below similar products such as hydrogenated cottonseed oil, soybean oil or corn oil when both are hardened to the same degree. It is difficult to produce a plastic hydrogenated safflower oil product having an AOM stability of 100 hr (16) by conventional processing. This comparatively low stability of hydrogenated safflower oil may be related to the relative proportions of tocopherol isomers mentioned previously.

Plasticized hydrogenated safflower oil products such as margarine or shortenings may evidence physical crystal changes, or polymorphism. These changes are noted visually and the products can be described as sandy or oily. Microscopic examinations under polarized light confirm the presence of large needle-like crystals. X-ray diffraction classifies these large crystals as beta form. It is believed that this behavior is related to the high percentage of C-18 symmetrical type glycerides formed during the course of hydrogenation.

From a practical standpoint, the tendency to crystal change can be minimized by careful blending of hydrogenated stocks of dissimilar type glycerides but most conveniently by blends of hydrogenated safflower oils with other types of hydrogenated oils such as cottonseed oil. With proper formulation, crystal change or polymorphism is a minor problem.

The hydrogenation of safflower oil rapidly decreases the linoleic acid content and, where a high linoleic acid content is desired, hydrogenation does defeat this goal. One most practical method to preserve high linoleic acid levels in hardened products is to blend selected hydrogenated oil stocks with liquid safflower oil to the desired hardness.

In general, then, hydrogenated safflower oil products have found little application in industry. Some of the noneconomic reasons relate to lack of crystal stability, comparatively low oxidative stability and lower linoleic acid levels.

Applications

Safflower oil products are now commonly found on many store shelves. Basic products for home use include bottled oil, margarine and occasionally canned shortening. Other processed foods containing safflower oil are mayonnaise, salad dressing, french dressing, nonstandard dressings, frozen desserts (10) and bread. Products such as filled milk, imitation cream, imitation sour cream, imitation dried eggs and others have been test-marketed and could become routinely available.

Many of these safflower oil products indicate the relatively high polyunsaturate content of the foods. In the recent National Diet-Heart Study sponsored by the National Institute of Health, a number of products such as cake mixes, cheese products and meat products were manufactured with safflower oil as the filling agent. Safflower oil has been used in a number of these D-H items because manufacturers thought it was the most appropriate way to meet D-H specifications for desired levels of linoleic acid (15).

Safflower oil is particularly suited for use in a number of these food products due to the high natural cold test and good flavor stability at low levels of oxidation. Safflower oil has been experimentally evaluated in frozen salad dressing (6) where it has been found that the dressings are stable under freezing conditions of 10–20F and markedly superior to other oils in this temperature range.

"Compounded" industrial products or blends of liquid safflower oil with hydrogenated vegetable oils such as soya, cotton, corn, peanut, safflower or imported lauric types are or have been produced. "Compounded" products include margarine oil, all-purpose shortening, emulsified cake shortening (both plastic and fluid types) and emulsified bread shortening. These special products are functionally equivalent to standard commercial counterparts.

The natural cold resistance of safflower oil has a functional effect in "compounded" products in that these products remain plastic over long temperature ranges. These plastic compounded products can be designed to have a maximum amount of linoleic acid for a given consistency. This is a major factor where a high content of linoleic acid is desired. One derived product, a distilled safflower monoglyceride, is commercially available. It is an edible product suitable for use as an emulsifier in icing shortening, water-in-oil emulsifier, a foam suppressor or related applications.

Future Trends

There are many factors that can be considered in reference to the future use of safflower oil in edible food products.

Price and availablility will play a major part when relating safflower oil to other major economic oils such as soya, cotton, corn and peanut. In addition to price, the physical-chemical properties of safflower oil should also be considered in special applications. Here the extremely high cold resistance, relatively good flavor stability and low color values would tend to increase usage while low resistance to oxidation and polymorphic tendencies of the hydrogenated stocks may tend to decrease use.

Probably the largest single factor will be in the nutritional field (3). If the results of nutritional studies prove that a high polyunsaturated diet is desirable or required, this would be a significant factor in increasing future use of safflower oil. Effects of recent statements (4) of the American Heart Association, recommending increased polyunsaturate fat intake whenever possible as one point of an 8-point program of dietary control, may have an influence on increasing safflower oil usage. Conversely, if the high polyunsaturated diet is not proven to be required, the future use will probably continue at relatively low levels.

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