

Cottonseed oil: An oil for *trans*-free options

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Recent research has indicated that diets high in *trans* fatty acids may have unfavorable effects on both LDL (low-density lipoprotein or "bad cholesterol") and HDL (high-density lipoprotein or "good cholesterol") cholesterol. As a result of these findings professional health organizations have recommended that consumption of *trans* fatty acids be reduced.

The United States Departments of Health and Human Services (HHS) and Agriculture (USDA) jointly published revised Dietary Guidelines for Americans in January 2005 that recognized the importance of limiting both *trans* and saturated fatty acids, as well as cholesterol. The guidelines made these recommendations on fat consumption:

1. Consume less than 10% of calories from saturated fatty acids, less than 300 mg/day of cholesterol, and limit *trans* fatty acids to as low as possible;
2. Maintain fat intake between 20–35% of calories for adults, 25–35% for children 4 to 18 years old, and 30–35% for children 2 to 3 years old, with most fats composed primarily of poly- and monounsaturated fatty acids; and
3. Limit intake of fats and oils high in saturated and/or *trans* fatty acids.

U.S. regulations take effect soon

The U.S. Food and Drug Administration (FDA) is requiring the labeling of *trans* fatty acids on

packaged foods effective January 1, 2006. The amount of *trans* fatty acids must be listed on a separate line under saturated fat on the Nutrition Facts Panel for food products sold in the United States containing at least 0.5 g/serving *trans* fat; products containing <0.5 g/serving *trans* fat are required to express *trans* fat content as "0" (21 CFR 101). The labeling regulations are designed to improve consumer understanding of *trans* fatty acids and to influence industry to reduce *trans* fatty acid levels in food products.

Food processors face the difficult challenge of maintaining functionality, balancing nutrition and insuring adequate stability in replacement or reformulated food products, all at a reasonable cost. And to ensure consumer acceptance, replacement products or reformulated ingredients must meet taste, shelf life and price considerations.

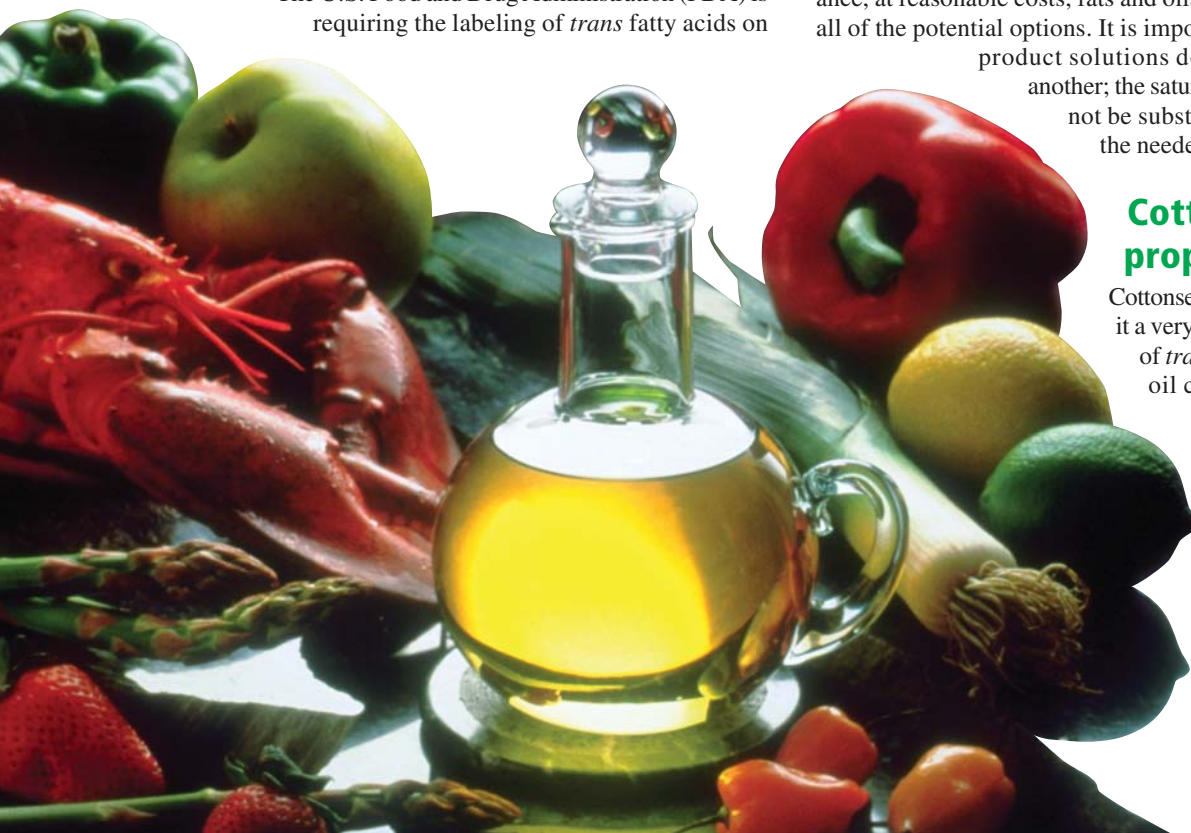
The hydrogenation process, responsible for a majority of the *trans* fatty acids in food products, has been the preferred process to achieve the desired functionality for fats and oils products.

Elimination or reduction of *trans* fatty acids necessitates the identification of processes to replace hydrogenation and the development of suitable replacement products for the foodservice and food processor industries; unfortunately there is no all-purpose fat and oil ingredient suitable for all applications.

In order to provide products that deliver the desired performance, at reasonable costs, fats and oils developers need to consider all of the potential options. It is important that the *trans*-free food product solutions do not trade one problem for another; the saturated fatty acid content should not be substantially increased to provide the needed functionality and stability.

Cottonseed oil properties

Cottonseed oil has properties that make it a very desirable oil for development of *trans*-free products. Cottonseed oil contains sufficient saturated fatty acids (about 25–26%, consisting of: palmitic ~22%, stearic ~3%, myristic ~1%) to make it a relatively stable vegetable oil without partial hydrogenation as well as enough unsaturates (oleic ~22%, linoleic ~52%, and linolenic usually < 1%) to make it a heart healthy oil.



Palmitic acid is usually associated with the beta-prime crystal form of cottonseed oil, which is desirable in most solid shortening products because it promotes a smooth workable consistency, usually referred to as plasticity. Cottonseed oil is a good source of the essential fatty acid, linoleic, and like other vegetable oils it is essentially cholesterol-free.

More importantly, cottonseed oil is currently available in sufficient quantities to satisfy commercial food processing needs in a variety of applications (Table 1).

Fats and oils technologies

There are many significant technologies available for consideration for utilizing cottonseed oil.

Blends. Blends of *trans*-free liquid oils with *trans*-free solid or semi-solid fats can be made to achieve the desired melting and crystallization characteristics.

Interesterification. Interesterification modifies the melting and crystallization behavior of a fat and oil product by rearranging the fatty acids on the glycerol backbone; the fatty acid composition remains unchanged even though the physical characteristics are modified.

Fractionation. Physical separation of fats and oil can be made into fractions with different melting behaviors (i.e., olein, the

Table 1. Cottonseed Supply and Disappearance¹
[1,000 short tons]

Crop Year	Production	Crush	Oil	Whole Seed Feeding
2005-06	7,984	2,900	456	4,789
2004-05	8,242	2,923	468	4,788
2003-04	6,665	2,643	437	3,595
2002-03	6,184	2,515	385	3,424
2001-02	7,452	2,791	438	4,742

¹Source: National Agricultural Statistics Service, USDA; and Census Bureau, Dept. of Commerce, 2005

soft fraction, stearine, the hard fraction, or a calculated mid-fraction to provide specific functionalities).

Additives. Antioxidants, emulsifiers, antifoaming agents, metal chelating agents and other additives can be employed to provide the needed stability and reduce the amount of saturated fatty acids required to provide the desired functionality in many cases.

Modification of the hydrogenation process. Hydrogenation conditions (e.g., temperature, pressure, time, catalyst, and agitation) can be changed to decrease *trans* fatty acid production, but increase saturated fatty acid content. These techniques might be used to produce low or *trans*-free products but partial hydrogenation would still appear in the ingredient statement.

Using cottonseed oil

Edible fats and oils usage can be separated into four product categories with very distinctive differences which provide optimum performance for specific food products: liquid oils, shortenings, margarines, and specialty products. Cottonseed oil currently is used successfully in many applications, primarily as baking or frying fats or as salad or cooking oils, and has long been preferred by fried-snack makers.

Cottonseed oil can continue to function as the preferred oil in all of the categories, as explained here.

Liquid Oils

Three major types of oils, i.e., cooking, salad, and high stability, have been developed based on the different degrees of clarity and/or oxidative stability at and below room temperature.

Cooking oils are typically used for pan frying, deep fat frying, sauces, gravies, marinades, and other non-refrigerated food preparations where a clear liquid oil has application. Refined, bleached, and deodorized cottonseed oil (RBD-CSO) is naturally an excellent cooking oil due its fatty acid profile which contributes a flavor and frying stability equal to or better than most brush (partial) hydrogenated vegetable oils.

Salad capable of remaining clear and brilliant at 32°F (0°C) for a minimum of 5 1/2 hours is the standard used to determine if an oil is suitable for the production of emulsion products with high oil levels that require refrigeration. Cottonseed oil must be winterized (removal of a portion of the solid component through chilling, crystallization and filtration) or fractionated to produce olein and stearine fractions to meet the salad oil standards. The olein fraction from

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cottonseed oil is the standard for salad oils for the production of mayonnaise, spoonable salad dressing, and other high oil emulsions.

High stability oils remain clear at room temperature and possess an exceptional oxidative and flavor stability. High stability oils can be produced from natural cottonseed oils by selective fractionation to obtain an olein fraction with the desired characteristics. The high stability oils have found application as frying oils, spray oils, pan release agents, food-grade lubricants, and as carriers for vitamins, color, spices and other ingredients.

Shortenings

Shortenings consist of crystalline solid triglycerides suspended in liquid triglycerides. The ratio of these two phases determines the consistency of a shortening as it relates to firmness, softness, and spreadability.

Plastic consistency shortenings designated as “all-purpose” consist of 10 to 25% crystalline solid triglycerides suspended in liquid oil. The stearine fraction from the cottonseed oil high stability oil fractionation would perform more than adequately as the solid triglyceride or hard stock. Liquid cottonseed oil as the liquid triglyceride component would provide more than adequate flavor stability.

The basic all-purpose shortening is the building block for many different general and specialized shortenings. Specialized shortening development can involve a change in the ratio of soft components or the addition of an additive. Additives (e.g., emulsifiers, antifoaming agents, antioxidants, and chelating agents) can dramatically change the performance of a shortening but the choice, level, and type must be evaluated carefully to ensure that its use does not produce an undesirable effect in the finished products.

Sharp melting point shortenings are preferred for specific frying situations, non-dairy systems, cookie fillers, confectionery fats and others requiring an eating character and flavor stability not possible with blends of liquid oils and hard fats. An alternative process to hydrogenation to produce these characteristics is the interesterification of blends of crystalline solid triglycerides suspended in liquid oil.

Cottonseed oil blends similar to those suggested for all-purpose shortenings above could be changed from a plastic consistency with a melting point above body temperature to one that is firm below body temperature but melts rapidly above body temperature.

Liquid shortenings allow the food processors to merchandise their products with “all-vegetable” and “polyunsaturated” labeling; today another nutritional and merchandising benefit can be added—*no trans*—when the liquid oil used has not been hydrogenated. RBD-CSO blended with a cottonseed oil hardstock produced using a fractionated stearine, directed interesterification, or an oil hydrogenated completely to saturation would provide adequate flavor stability and the necessary solids dispersion for liquid shortenings suitable for use as cake, bread, frying, and non-dairy production with the additives suitable for each application.

Margarines and spreads

Intesterification and cottonseed oil formulation strategies identified for the sharp melting point shortenings can be used to produce the desirable characteristics for margarines and spreads.

Specialty Products

Major changes are continually occurring in the markets for fats and oils where cottonseed oil may be the preferred source oil, because it performs as desired.

Background reading

To learn more about cottonseed oil properties and the available technologies for consideration for cottonseed oil, consult:

- O'Brien, R.D., Lynn A. Jones, C. Clay King, Phillip J. Wakelyn, and Peter J. Wan, Cottonseed Oil, Vol. 2, Chap. 5, *Bailey's Industrial Oil & Fat Products, Sixth edition*, F. Shahidi, ed., John Wiley & Sons, Inc. Hoboken, New Jersey, 2005, p.173–279.
- Hunter, J. Edward, *inform 15:510–512*, 2004
- O'Brien, R.D, *Fats and Oils: Formulating and Processing for Applications, Second Edition*, CRC Press, Boca Raton, Florida, 2004, p16–18 and 265–266.

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