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(71) Demandeur/Applicant:
CARGILL, INCORPORATED, US

(72) Inventeur/Inventor:
UNGER, ERNIE H., US

(74) Agent: SIM & MCBURNEY

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(54) Title: SHORTENINGS CONTAINING LITTLE OR NON TRANS FATTY ACIDS

(57) Abrégé/Abstract:

The present invention provides a shortening having little to no trans fatty acids.



ABSTRACT OF THE DISCLOSURE

The present invention provides a shortening having little to no *trans* fatty acids.

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SHORTENINGS CONTAINING LITTLE OR NO *TRANS* FATTY ACIDS

TECHNICAL FIELD

This invention relates to a shortening, and more particularly to a shortening
5 containing low or no *trans*-fatty acids.

BACKGROUND

Dietary consumption of foods high in *trans* fatty acids has been linked to increased serum cholesterol content. While some products containing no or low levels of *trans* fat have already been introduced, there are several factors that have limited the
10 introduction of low or no *trans* fat alternatives into the marketplace. For example, replacements of *trans* fat must provide at least comparable characteristics of the final food product (e.g., flavor, texture, flakiness). Many of these highly desirable food characteristics are best achieved through the use of *trans* fats or saturated fats. Because saturates are often associated with increased blood cholesterol levels, it is not in the best
15 interests of consumers or the food industry to increase saturates as a means to replace *trans* fats.

Some of the commonly used techniques to provide food products containing little or no *trans* fat include interesterification of unhydrogenated oils with high saturated fat base oils, the use of improved vegetable oils obtained by traditional plant breeding or
20 biotechnology, the use of jelling or texture building agents, use of antioxidants to increase oil stability, blending of vegetable oils with partially hydrogenated fats, or a combination of any of the above.

SUMMARY

The present invention describes blending fully hydrogenated hard fats having no
25 *trans* fat with unhydrogenated liquid oils having low saturated fats to thereby generate shortenings having little or no *trans* fat and low saturated fats. Blending a hard fat with a liquid oil produces a shortening that is plastic at room temperature and at initial baking

conditions. The present invention provides a shortening having little to no *trans* fatty acids and having low saturated fatty acids. The shortenings described herein have superior baking and frying attributes compared to commercially available shortenings.

In one aspect, the invention provides a shortening having about 11% to about 18%
5 by weight hard fat and about 82% to about 89% by weight liquid oil (e.g., about 12.5% by weight hard fat and about 87.5% by weight liquid oil; about 14% by weight hard fat and about 86% by weight liquid oil; about 16% by weight hard fat and about 84% by weight liquid oil; or about 18% by weight hard fat and about 82% by weight liquid oil); about 5% by weight hard fat and about 95% by weight liquid oil; or about 7% by weight
10 hard fat and about 93% by weight liquid oil. A liquid oil used in such a shortening can have from about 0.1% to about 7% α -linolenic acid based on total fatty acid content. In another aspect, the invention provides for shortenings having a solid fat content at 100°C of about 2.5% to about 13% and a *trans*-fatty acid content of about 0.5% to about 1.4%.

In another aspect, the invention provides for food products containing a
15 shortening of the invention. Representative non-limiting examples of food products include cake doughnut mix, raised yeast doughnut mix, sugar cookie mix, frozen biscuit mix, fresh biscuit mix, and machined pastry dough. The invention also provides for edible compositions made using a shortening of the invention such as a toaster pastry.

In an embodiment, a liquid oil used in a shortening of the invention has from
20 about 1.4% to about 4.0% α -linolenic acid. In some embodiments, a shortening of the invention can include an antioxidant. A shortening of the invention can exhibit a solid fat content at 92°F of about 4% to about 16% and/or a solid fat content at 104°F of about 3% to about 13%. By way of example, a shortening of the invention can have about 11% to about 25% by weight saturated fatty acids, about 50% to about 70% by weight
25 monounsaturated fatty acids; about 14% to about 23% by weight polyunsaturated fatty acids; less than about 5% *trans*-fatty acids (e.g., less than about 1.5% by weight *trans*-fatty acids, or about 0.5% to about 1.3% by weight *trans*-fatty acid isomers).

In yet another aspect, the invention provides for a fat product having an 18:1 content from about 40% to about 65%, an 18:2 content of about 7% to about 23%, an
30 18:3 content of about 0% to about 3.0%, and less than about 1.5% by weight *trans*-fatty acids, based upon total fatty acid content; a fat product having an 18:1 content from about

45% to about 75%, an 18:2 content of about 3% to about 10%, an 18:3 content of about 0% to about 3.0%, and less than about 1.5% by weight *trans*-fatty acids, based upon total fatty acid content; a fat product having an 18:1 content from about 50% to about 80%, an 18:2 content of about 0% to about 5%, an 18:3 content of about 0% to about 2.5%, and less than about 1.5% by weight *trans*-fatty acids, based upon total fatty acid content; or a fat product having a change in peroxide value (PV) of less than 5 meq/kg after 15 days of accelerated aging.

In another aspect, the invention provides for food products comprising such fat products. Representative non-limiting examples of food products include cake doughnut mix, raised yeast doughnut mix, sugar cookie mix, frozen biscuit mix, fresh biscuit mix, and machined pastry dough. The invention also provides for edible compositions made using a shortening of the invention such as a toaster pastry.

By way of example, a fat product of the invention can exhibit a solid fat content at 92° F of about 4.0 to about 13.0; and/or a solid fat content at 100° F of about 3.0 to about 12.0. A fat product of the invention also can have about 0.5% to about 1.3% by weight *trans*-fatty acid isomers; or an 18:0 content of about 5.0% to about 15.0% based on total fatty acid content.

Representative liquid oils that can be used in a shortening or fat product of the invention include, without limitation, canola oil, sunflower oil, safflower oil, and soybean oil. Representative hard fats that can be used in a shortening or fat product of the invention include, without limitation, fully-hydrogenated cottonseed oil, cottonseed oil stearine, fully-hydrogenated soybean oil, soybean oil stearine, fully-hydrogenated palm oil, palm oil stearine, fully-hydrogenated canola oil, and canola oil stearine.

In still another aspect, the invention provides for methods of making a shortening. Such methods generally include providing a blend comprising about 11% to about 18% by weight hard fat and about 82% to about 89% by weight liquid oil, the liquid oil having from about 0.1% to about 7% α -linolenic acid based on total fatty acid content; cooling the blend; and tempering the blend to make the shortening. For example, the cooling step can include cooling the blend to between about 65°F to about 82°F in a scraped surface heat exchanger for about 1.0 to about 1.8 minutes, and the tempering step can include tempering at a temperature of about 60°F to about 90°F for about 24 hours to about 72

hours. In some embodiments, nitrogen can introduced into the blend during the cooling step.

In yet another aspect, the invention provides methods of making a baked edible composition. Such methods generally include providing a food product made with a shortening or a fat product of the invention; and baking the food product.

In yet another aspect, the invention provides methods of making a fried edible composition. Such methods generally include providing a food product made with a shortening or fat product of the invention; and frying the food product. In an embodiment, the food product can be fried in a shortening or fat product of the invention.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention, suitable methods and materials are described below. In addition, the materials, methods, and examples are illustrative only and not intended to be limiting. All publications, patent applications, patents, and other references mentioned herein are incorporated by reference in their entirety. In case of conflict, the present specification, including definitions, will control.

The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the drawings and detailed description, and from the claims.

DETAILED DESCRIPTION

The present invention provides shortenings that are low in saturated fatty acids and in *trans* fatty acids, and that have superior baking and frying attributes when compared to commercially available vegetable and animal shortenings. The shortenings described herein have an oxidative stability equal to or better than the currently available partially hydrogenated vegetable and animal fat shortenings. The invention provides for a shortening that can be used to produce commercial and domestic baked and fried products with acceptable appearance, texture, shelf life, and other important properties.

Characterizing Shortenings

Double bonds in fatty acids in vegetable oils tend to be in the “*cis*” configuration. Hydrogenation of such oils results in the formation of fatty acids having double bonds in the “*trans*” configuration. Saturated fatty acids are fatty acids that lack a carbon-to-
 5 carbon double bond, and include myristic (C_{14:0}), palmitic (C_{16:0}), stearic (C_{18:0}), arachidic (C_{20:0}), and lignoceric (C_{24:0}) acids.

Trans fatty acids include any *trans* isomer of a C₁₄ through C₂₄ fatty acid, and can be detected using, for example, a method described by Madison, et al. (1982, *J. Amer. Oil*
 10 *Chem. Soc.*, 59:178-81). Free fatty acids are fatty acids that are not esterified. The amount of free fatty acids can be determined, for example, using American Oil Chemists’ Society (AOCS) method Ca 5a-40. Fatty acid composition can be determined, for example, using AOCS method Ce 1e-91.

Iodine value (IV) is a measure of the unsaturated linkages in a fat and is expressed
 15 by the number of grams of iodine equivalent to halogen adsorbed by a 100 gram sample of fat. IV is a laboratory test; commercial fats do not contain iodine. IV can be measured, for example, using AOCS Official Method Cd 1-25, also known as the Wijs method. IV also can be determined from the fatty acid composition using AOCS Method Cd 1c-85.

20 Peroxide value (PV) is a measurement of unsaturated fatty acids, which is the primary oxidation product in oils, relative to total fatty acids. PV generally is expressed as milli-equivalents of peroxide-oxygen combined per kilogram of fat (meq/kg). PV can be determined, for example, using AOCS method Cd 8b-90.

Oxidative stability relates to how easily components of an oil oxidize, which
 25 creates off-flavors in the oil. The Oil Stability Index (OSI) method is used to determine oils and fats’ resistance to rancidity. OSI results are expressed in hours at 110°C. OSI can be determined using an Oxidative Stability Instrument (Onion/Archer Daniels Midland, Decatur, Illinois). The Active Oxygen Method (AOM) is another rancidity test in which the fat to be tested is held at an elevated temperature (e.g., 98°C) and through
 30 which air is bubbled at a specified rate. A peroxide value is determined at intervals. The

endpoint is reported in hours required to reach a peroxide value of 100 meq/kg. AOM hours can be determined, for example, using AOCS method Cd 12b-92 or Cd 12-57.

The Schall oven method of accelerated aging is used to measure the oxidative and flavor stability of a fat or a fat-containing food product. The Schaal oven method involves examining samples of an oil or food product held at an elevated temperature at regular intervals. Sometimes the oil or food product is held in the dark. Results are reported as the time elapsing until a rancid odor or flavor is detected. Under certain Schaal oven conditions, one day is approximately equivalent to one-month storage in the dark at ambient temperature.

Solid fat index (SFI) is an empirical measurement of the solid fat content of a sample over a defined temperature scale. SFI is a dilatometric procedure relying on volumetric changes occurring during melting and crystallization. See, for example, AOCS Official Method Cd 10-57 (re'vd 1989). Solid fat content (SFC) is the actual percent of solid fat at standard temperature points. SFC is typically measured by pulsed nuclear magnetic resonance (PNMR). See, for example, AOCS Official Method Cd 16b-93. See, also, *Bailey's Industrial Oil & Food Products*, 5th Ed., John Wiley & Sons, Inc., Vol. 4 (1996) for additional information on SFI and SFC.

The Mettler Drop Point (MDP) is the temperature at which a solid fat becomes fluid to flow. The MDP can be determined, for example, using AOCS Official Method Cc 18-80 (re'vd 1989).

The color of an oil can be determined using, for example, AOCS method Cc 13b-43, and using, for example, an American Oil Tintometer (e.g., Model AF715, The Tintometer LTD., Salisbury, England). Color of oils is evaluated using a series of red and yellow standardized glass slides as references. Oil color, therefore, is reported in values of yellow and red.

Fry stability relates to the resistance to degeneration of the oil during frying. "Fry life" is the time it takes for the flavor of a product fried in an oil to degrade to a set sensory score.

Shelf-life stability of an oil or a food product made using an oil can be determined by analyzing food samples made with or cooked in the oil, and then packaged and stored

in an oven at an elevated temperature to accelerate aging. “Shelf-life” is the time it takes for a food product to degrade to a set sensory score.

Flavor stability is the time it takes for the flavor of an oil to degrade to a set sensory score.

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Preparation of Shortenings

The term “shortening” refers to an oil (i.e., a fat product) that is plastic at room temperature. See, for example, Campbell et al., *Food Fats and Oils*, 8th Ed., Institute of Shortening and Edible Oils, Washington D.C. A shortening of the present invention is a
 10 combination of a hard fat (e.g., fully-hydrogenated cottonseed oil, cottonseed oil stearine, fully-hydrogenated soybean oil, soybean oil stearine, fully-hydrogenated palm oil, palm oil stearine, fully-hydrogenated canola oil, or canola oil stearine) and a liquid oil, preferably one low in saturated fats, such as canola oil, sunflower oil, safflower oil, or soybean oil. A shortening of the present invention possesses very little, if any, *trans*-fatty
 15 acids and possesses low levels of saturated fatty acids. Therefore, shortenings described herein are especially suitable for use in food products and/or for frying foods.

As indicated above, a number of different liquid oils can be used in a shortening of the invention. Although hydrogenated liquid oil can be used, liquid oil that has not been hydrogenated and has little or no *trans* fatty acids (e.g., contains less than 2% or less
 20 than 1% *trans* fatty acids) is preferred. Non-limiting examples of suitable liquid oils that can be used in a shortening of the invention include Clear Valley 65 (CV 65; Cargill, Minnetonka, MN), Clear Valley 75 (CV 75; Cargill, Minnetonka, MN), and Clear Valley 85 (CV 85; Cargill, Minnetonka, MN). CV 65, CV 75, and CV 85 are refined, bleached and deodorized oils produced from seeds of low I-linolenic acid *Brassica napus* plant
 25 lines. Table 1 shows the typical characteristics of CV 65, CV 75, and CV 85. Table 1 also includes the typical characteristics of a representative high oleic sunflower oil.

Table 1. Characteristics of CV 65, CV 75, and CV 85 Oils

	CV 65 [®] Oil	CV 75 [®] Oil	CV 85 [®] Oil	High Oleic Sunflower Oil
Oleic Acid, %	60-70	73-80	78-85	78-86
Linoleic Acid, %	15-25	8-15	3-8	6-12
Erucic Acid, %	<2	<2	<2	ND*
I-Linolenic Acid, %	2-5	2-5	1.5-3.5	<0.5
Total Sats, %	6-7.5	6-7.5	5-7	8-10
Trans Fatty acids, %	0.5-1.1	0.5-1.1	0.5-1.1	0
IV	<115	<95	<89	<87
AOM, hours	~30	~37	~65	>100

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*ND, not detectable

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The I-linolenic acid content in the CV 65 oil typically is from about 2.5% to about 4.5%. CV 65 oil has an oleic acid content of about 60% to about 75% by weight, a linoleic acid content of about 15% to about 25% by weight, and an erucic acid content of less than about 2% by weight. The CV 65, CV 75, and CV 85 oils have a trans-fatty acid content of about 0.5% to about 1.1%. CV 65 oil generally has an iodine value of less than about 115 and an AOM value of about 30 hours; CV 75 oil generally has an iodine value of less than about 95 and an AOM value of about 37 hours; CV 85 oil generally has an iodine value of less than about 89 and an AOM value of about 65 hours.

Liquid oils used in shortenings of the invention are generally refined, bleached and deodorized (RBD) oils. Refining refers to removing most if not all free fatty acids and other impurities such as phosphatides or protein substances from a crude oil. One common method of refining is done by treating an oil with a strong base, followed by extensive washings with water. Bleaching refers to a process that removes natural pigments (carotenoids, chlorophylls, and xanthophylls) and other impurities such as metal

cations (e.g., Fe, Cu, and Zn). Bleaching can be done by absorbing such pigments and/or cations on a natural bleaching earth or clay, which is usually added to an oil under vacuum and high temperature. Deodorizing refers to the removal of relatively volatile trace components (e.g., ketones, aldehydes, alcohols,) from an oil that contribute to
5 flavor, odor, and color. Deodorizing is usually done by injecting steam into an oil heated to high temperatures (e.g., 400-425°F) under high vacuum (e.g., <5 mm Hg).

A hard fat used in a shortening described herein contains few or no double bonds in fatty acyl moieties of the fat. In some embodiments, a fat having unsaturated bonds can be hydrogenated to form a hard fat suitable for use as described herein.

10 Hydrogenation can be done, for example, at a high temperature and under high pressure. Standard batch hydrogenation equipment featuring internal steam heating and water-cooling can be used. A nickel catalyst such as Nysosel SP7 (Engelhard, Cleveland, OH), or Pricat 9908 (Unichem, Emmerich, Germany) can be used during hydrogenation. See, for example, U.S. Patent Nos. 1,275,405; 1,390,687; 4,163,750; and 6,218,556. If a seed
15 oil is hydrogenated, it typically is hydrogenated to an Iodine Value (IV) to less than 5 meq (e.g., less than 3 meq), which, in the case of cottonseed hard fat, results in the presence of less than 2% *trans* fatty acids.

The hard fat used in a shortening of the invention also can be a stearine fraction. The stearine fraction primarily consists of stearic acid, a saturated 18-carbon fatty acid,
20 and palmitic acid, a saturated 16-carbon fatty acid. Fractionation methods using differences in melting point or volatility, for example, can be used to obtain a stearine fraction from, for example, cottonseed oil, soybean oil, palm oil, and canola oil.

The hard fat and the liquid oil are combined at a ratio of between 11% and 18% hard fat, and 82% and 89% liquid oil. Blending of the liquid oil and the hard fat requires
25 melting of the hard fat, which can be done prior to, during, or after addition of the liquid oil. Hard fats suitable for use in the invention typically melt at about 136°F to about 147°F. Antioxidants (see below) can be added to the blend.

The blend is then moved into one or more scraped-surface heat exchangers, which can utilize, for example, glycol, brine, freon, or liquid ammonia as a means to cool the
30 heat exchanger(s). The blend is pumped through the heat exchanger(s) and sufficient heat is removed by super cooling to cause crystallization (solidification) of the fat. The

solidified product exiting the votator is a homogeneous composition with homogeneous consistency. Votation followed by agitation in, for example, a "pin" unit, facilitates the formation of crystal structure such that the resulting shortening is smooth in appearance and firm in consistency. By varying the conditions of the votation process, products for
5 different applications (e.g., baking, creaming, or frying) can be produced. Votation is also known as plasticizing.

Nitrogen can be introduced into the blend at the time of entry into the scraped surface heat exchanger. The nitrogen provides for improved creaminess and a white appearance of the final shortening product.

10 Upon exiting of the blend from the votator, the crystals begin to matrix very rapidly and a firm shortening is formed. The liquid oil is interspersed with the crystals of the hard fat, forming a uniform shortening. The shortening can be tempered, for example, at 65°F to 90°F for 24 to 96 hours to allow the crystal structure to develop and stabilize.

15 The shortenings of the invention that contain a hard fat other than palm oil (e.g., cottonseed, soybean, safflower, and canola) have an average oxidative stability of about 25 to about 45 AOM hours in the absence of an antioxidant and generally exceeds about 60 AOM hours in the presence of an antioxidant. The MDP of the shortenings generally is about 100°F to about 140°F. The solid fat content (SFC) for a representative
20 shortening of the invention is as follows: at 50°F, about 5% to about 20%; at 70°F, about 4% to about 18%; at 80°F, about 3.5% to about 17%; at 92°F, about 3% to about 15%; at 100°F, about 2.5% to about 13%; and at 104°F, about 2% to about 12%. The shortenings of the invention can have an average IV of about 75 to about 105, and an average peroxide value of about 0.20 meq/kg to about 1.1 meg/kg. The shortenings of the
25 invention generally have the following fatty acid profiles: an average saturated fatty acid content of about 11% to about 25%; an average total *trans* fatty acid content of about 0% to about 2%; an average I-linolenic acid content of about 1.4% to about 4.0%; an average monounsaturated fatty acids of about 50% to about 70%; and an average polyunsaturated fatty acid content of about 14% to about 23%.

30 The shortenings of the invention containing, for example, palm oil or palm kernal oil (e.g., fully-hydrogenated or stearine fraction) as the hard fat can have an oxidative

stability of about 75 to 90 AOM hours (in the presence of an antioxidant). The MDP of shortenings containing palm oil generally is about 115°F to 130°F. Shortenings of the invention that contain palm oil typically have a solid fat content (SFC) as follows: at 50°F, about 25% to about 45%; at 70°F, about 15% to 35%; at 80°F, about 12% to about 28%; at 92°F, about 10% to about 20%; at 100°F, about 7% to about 17%; and at 104°F, about 6% to about 16%. The shortenings of the invention containing palm oil also can have an average IV of about 65 to about 80, and an average peroxide value of about 0 meq/kg to about 6 meg/kg. The shortenings of the invention containing palm oil as the hard fat generally have the following fatty acid profiles: an average saturated fatty acid content of about 25% to about 40%; an average total *trans* fatty acid content of about 0% to about 1.3%; an average I-linolenic acid content of about 0.8% to about 1.7%; an average monounsaturated fatty acids of about 45% to about 65%; and an average polyunsaturated fatty acid content of about 10% to about 20%.

Common additives can be added to the shortening of the present invention such as stabilizers, flavoring agents, emulsifiers, anti-spattering agents, colorants, or antioxidants. See, for example, Campbell et al., *Food Fats and Oils*, 8th Ed., Institute of Shortening and Edible Oils, Washington, D.C. for information on a variety of additives.

The above-described shortenings provide unique solid fat content profiles that are different from that of shortenings produced with hydrogenated oils or other blends of oils.

Food Products

The shortenings described herein can be incorporated into doughs or mixes to make food products such as donuts, pizzas, crusts (e.g., pie crusts), cookies, biscuits, pastries (e.g., toaster pastries), bread, or the cream in a cream-filled food product (e.g., Oreo[®] cookies). Since the shortenings described herein contain little to no *trans*-fatty acids, food products made with such shortenings contain reduced levels of or no *trans*-fatty acids per serving compared to the same food product made using many other known shortenings.

Nutrition Facts label serving sizes are based on the amount of food customarily eaten at one time (called the “reference amount”) as reported from nationwide food consumption surveys. (USDA & DHHS, 2000, *Nutrition and Your Health: Dietary*

Guidelines for Americans, Fifth Ed., Home and Garden Bulletin No.23). Serving sizes are based on reference amounts in one of three ways (FDA Center for Food Safety and Applied Nutrition, 2000, *Food Labeling and Nutrition*). For bulk products, such as cereals and flour, the Nutrition Facts labels use common household terms such as cup, 5 tablespoon, teaspoon, and fluid ounce at a quantity that is closest to the reference amount for that item. For products that are usually divided from consumption, such as cake or pizza, the serving size is a fractional amount of the product (e.g., “1/4 pizza”). Products that come in defined, discrete units— such as eggs and sliced products— are normally listed as the number of whole units that most closely approximates the reference amount. For 10 example, cookies have a reference amount of 30g. Thus, the serving size on a package of cookies weighing about 30 g each would be “1 cookie.”

A food product also can be made using shortening flakes. Flaked shortenings can be more evenly distributed in the food product during manufacturing, thereby reducing production time and energy costs. Flaked shortenings can result in a flakier crust or a 15 softer crumb depending on the food product, because, typically, they are not “released” until the food product is baked by a consumer. The shortenings described herein also can be used in an icing product, or as a coating on a food product.

A food product also or alternatively can be cooked (e.g., fried) in a shortening described herein. The normal temperature range for frying with a shortening of the 20 invention is 325°F to 375°F. Most foods cook rapidly in this range and develop a golden color, crisp texture and good flavor. Frying time is longer at lower temperatures, and results in lighter color, less flavor, and increased oil absorption.

Food products can be evaluated using mechanized procedures such as DIPIX® instrumentation (Ottawa, Canada). DIPIX® technology provides inspection systems for 25 food products. DIPIX® Inspection Systems can inspect the 3-dimensional features such as thickness, height, and end-to-end or center-to-end slope, the 2-dimensional features such as length, width, minimum diameter, maximum diameter, and ovality, and bake color features such as bake color of edges, background, and ridges and valleys. DIPIX® Inspection Systems also can inspect the optical density of a food product to detect holes 30 and/or uncooked portions of a food product. Additional information can be found at dipix.com on the World Wide Web.

A food product and the effect of a particular ingredient or process also can be evaluated by examining the sensory attributes of a food product. Sensory attributes include, for example, color, tenderness, amount of cracking, gumminess, chewiness, moistness, hardness, flavor quality, mouth coating, finger oiliness, and graininess.

5 Sensory attributes of food products are usually determined by a trained sensory panel. A sensory panel refers to those individuals involved in the sensory evaluation of the edible food product. Panelists are pre-screened to be able to detect the flavor differences in the particular product tested and are trained in sensory descriptions. A panel provides qualitative and quantitative scores for the sensory evaluation that are referenced against
10 calibrated standards.

Either or both the DIPIX® results and the sensory panel results can be analyzed for statistical significance. Statistical significance generally refers to a *p*-value of less than 0.05, *e.g.*, a *p*-value of less than 0.025 or a *p*-value of less than 0.01, using an appropriate parametric or non-parametric measurement, *e.g.*, a one-tailed two-sample *t*-
15 test. Standard deviation was also measured for many features.

The invention will be further described in the following examples, which do not limit the scope of the invention described in the claims.

20

EXAMPLES

Example 1—Making a shortening having little or no *trans* fatty acids

Liquid, low I-linolenic acid RBD canola oil (CV 65®) was combined with different amounts of fully hydrogenated cottonseed hard fat as indicated below in Tables 2, 3, 4, and 5. The processing conditions are shown in Table 2. The combination was
25 fully melted at approximately 130°F to produce a blend. If indicated, antioxidants were added to the blend before votation to increase the oxidative stability of the oils to greater than 70 hours AOM as measured by an OSI instrument.

The blend was votated through a scraped surface heat exchanger called a “C” unit. The heat exchanger was cooled with refrigerated liquids that include glycol, brine, or
30 freon. The blend was cooled through the “C” unit to 65°F to 82°F. The rapid cooling

through the scraped surface heat exchanger resulted in super-cooled oil crystals that remained fluid. Retention time in the "C" unit was typically 0.5 to 0.7 min.

Immediately after passing through the scraped surface heat exchanger, the cooled blend was passed through a pin unit. Some heat from crystallization was evident through the pin unit, where temperatures of the blend exiting the pin unit were typically 2°F to 5°F higher than the inlet temperature. The retention time in the pin unit was typically 0.5 to 1.0 min.

Table 2. Formulation and Processing Conditions

10	Formulation	Shortenings		
		<u>TE-3-70</u>	<u>TE-3-125</u>	<u>TE-3-50</u>
	CV 65 RBD, %	93.0	87.5	95.0
	Cottonseed Hard Fat (CSHF), %	7.0	12.5	5.0
	Process Conditions			
	Blend Tank Temp, °C	50-55	60	50-55
15	Votator Temp, 'C' Unit, °C	21-23	23-26	21-23
	Votator Temp, Pin Unit, °C	23-25	27-30	22-24

If indicated, nitrogen was introduced into the blend at the oil inlet flow of the scraped-surface heat exchangers. Upon exiting of the blend from the scraped-surface heat exchanges and the pin unit, the crystals began to matrix very rapidly and a shortening was formed. The shortening was tempered at 65°F to 90°F for about 48 hours to allow the crystal structure to develop and stabilize.

The shortenings remained in a stable crystal structure at room temperatures. As the amount of hard fat was increased to approximately 7%, the shortening could be stored at typical warehouse temperatures of 80°F for several months without separation of the liquid oil from the crystal matrix.

Tables 3, 4, and 5 show the analysis of the indicated shortenings and Table 6 shows the analysis of a commercial Progressive Baker All Purpose Shortening (Cargill, Minnetonka, MN). Table 7 shows the results of the Schaal Oven Tests to examine the stability of the shortenings. The Schaal oven test was performed according to AOCS Method Cg 5-97.

Table 3. Analysis of Shortenings

	TE-3-50	TE-3-70	TE-3-125
CV 65 RBD, %	95.0	93.0	87.5
Cottonseed Hard Fat (CSHF), %	5.0	7.0	12.5
Free Fatty Acids, %	0.04	0.05	0.05
Peroxide Value, meq/kg	0.45	0.80	0.90
Mettler Drop Point, °F	111.7	113.0	128.1
AOM, hours	34.60		37.12
Fatty Acid Profile, %			
C16:0	5.8	5.6	6.2
C16:1	0.3	0.3	0.3
C18:0	7.1	6.0	7.3
C18:1	62.1	62.8	61.6
C18:2	19.7	19.4	18.9
C18:3	1.9	2.0	2.0
C20:0	1.1	1.0	1.0
C20:1	1.2	1.3	1.2
C22:0	0.5	0.5	0.5
C22:1	0.2	0.2	0.2
C24:0	0.3	0.3	0.3
C24:1	0.1	0.4	0.3
Total Saturated FA, %	14.9	13.5	15.4
Total <i>trans</i> FA, %	1.1	1.1	1.1
Iodine Value	93.7	94.3	92.2
Solid Fat Content, %			
50°F	7.5	9.9	16.3
70°F	6.1	8.0	14.0
80°F	5.3	7.1	12.8
92°F	4.5	6.1	11.2
100°F	3.7	5.1	9.5
104°F	2.9	4.6	8.8
Additives	none	none	none

Table 4. Analysis of Shortenings

	TE-3-70	TE-3-125	TE-3-140	TE-4-350
CV 65 RBD, %	93.0	87.5	86.0	65.0
Cottonseed Hard Fat (CSHF), %	7.0	12.5	14.0	
Fractionated Palm Oil, %				35.0
Free Fatty Acids, %	0.04	0.04	0.04	0.04
Peroxide Value, meq/kg	0.57	0.42	0.32	3.80
Mettler Drop Point, °F	118.2	126.6	127.3	120.3
Color (5 ¼")	4.7Y;	5.1Y;	5.6Y;	
<u>Yellow</u> ; <u>Red</u>	0.5R	0.6R	0.6R	
AOM, hours	90.5	94.8	94.3	81.7
Fatty Acid Profile, %				
C16:0	5.9	7.1	7.3	27.6
C16:1	0.2	0.2	0.2	0.2
C18:0	7.7	11.7	12.5	3.2
C18:1	62.5	58.7	57.0	50.9

C18:2	18.5	17.3	17.0	14.2
C18:3	2.0	1.9	1.8	1.3
C20:0	0.8	0.8	0.8	0.6
C20:1	1.2	1.1	1.1	0.8
C22:0	0.4	0.5	0.5	0.2
C22:1	0.1	0.1	0.1	0.2
C24:0	0.3	0.5	0.8	0.2
C24:1	0.1	0.2	0.3	0.1
Total Saturated FA, %	15.2	20.4	22.4	32.4
Total <i>trans</i> FA, %	1.3	1.0	1.0	0.7
Iodine Value	92.2	86.6	84.4	72.6
Solid Fat Content, %				
50°F	8.4	14.3	15.8	33.3
70°F	7.3	12.8	14.1	23.8
80°F	6.6	11.8	13.0	19.1
92°F	5.2	10.1	11.1	15.0
100°F	4.7	8.7	9.8	12.3
104°F	4.0	8.4	8.8	11.1
Additives				
TBHQ, ppm	150	150	150	150
Nitrogen at Votation	yes	yes	yes	yes

Table 5. Analysis of Shortenings

	<u>TE-3-50</u>	<u>TE-3-160</u>
CV 65 RBD, %	95.0	84.0
Cottonseed Hard Fat (CSHF), %	5.0	16.0
Free Fatty Acids, %	0.03	0.03
Peroxide Value, meq/kg	0.55	0.62
Mettler Drop Point, °F	111.5	129.3
AOM, hours	80.3	91.3
Fatty Acid Profile, %		
C16:0	5.8	7.1
C16:1	0.3	0.3
C18:0	7.0	13.4
C18:1	62.4	59.9
C18:2	19.2	14.2
C18:3	1.9	2.0
C20:0	1.0	0.8
C20:1	1.3	1.1
C22:0	0.4	0.4
C22:1	0.2	0.1
C24:0	0.3	0.2
C24:1	0.2	0.2
Total Saturated FA, %	14.5	22.1
Total <i>trans</i> FA, %	0.7	0.7
Iodine Value	93.3	82.9
Solid Fat Content, %		
50°F	7.3	18.4

70°F	5.9	16.3
80°F	5.0	15.3
92°F	4.0	13.3
100°F	3.1	11.8
104°F	2.8	10.8

Additives		
TBHQ, ppm	150	150
Nitrogen at Votation	yes	yes

Table 6. Analysis of Control Shortening

Ingredients	All Purpose Shortening	
	Partially hydrogenated soybean oil; partially hydrogenated cottonseed oil	
Free Fatty Acids, %	0.05 max	
Peroxide Value, meq/kg	1.0 max	
Mettler Drop Point, °F	112 to 119	
AOM, hours	75 min	
Total Saturated FA, %	22 to 25	
Total <i>trans</i> FA, %	30 to 33	
Solid Fat Content, %		
50°F	27 to 33	
70°F	17 to 21	
80°F		
92°F	10 to 17	
100°F		
104°F	7 to 12	
Additives		
Nitrogen at Votation	yes	

Table 7. Shortening Stability Study - Schaal Oven Tests

	Crisco*	TE-3-50	TE-3-70	TE-3-125	TE-3-140	TE-3-160	TE-4-350
FAD (Day 0)							
14:0	0.19	0.07	0.09	0.13	0.14	0.15	0.55
16:0	14.88	5.75	5.46	6.57	6.89	7.05	29.41
16:1	0.20	0.30	0.30	0.28	0.30	0.27	0.34
18:0	12.24	7.04	7.06	11.16	11.82	13.42	3.37
18:1	37.16	62.36	63.33	59.65	58.45	59.94	49.20
18:2	31.38	19.24	18.97	17.62	17.66	14.22	13.87
18:3	2.76	1.88	2.04	1.90	1.86	2.03	1.25
20:0	0.39	0.97	0.70	0.69	0.76	0.82	0.55
20:1	0.23	1.28	1.22	1.15	1.14	1.14	0.77
20:2	0.02	0.06	0.05	0.05	0.05	0.04	0.03
22:0	0.32	0.44	0.36	0.35	0.37	0.40	0.22
22:1	0.04	0.17	0.05	0.05	0.13	0.09	0.18
24:0	0.11	0.28	0.20	0.19	0.21	0.22	0.14
24:1	0.06	0.16	0.18	0.21	0.21	0.21	0.12
Total Trans	10.5	0.7	0.7	0.6	0.7	0.7	0.5
Total Sats	28.14	14.54	13.86	19.09	20.19	22.05	34.23

Day 0							
PV	0.06	0.55	0.46	0.57	0.34	0.62	3.90
Odor	9	9	8	9	9	9	8
Color, red	0.5	0.6	0.7	0.7	0.7	0.7	2.0
Color, yellow	4.0	7.0	0.0	7.0	6.0	8.0	11.0
Flavor	9	8	8	8	9	8	8/7
FFA, %	0.04	0.03	0.03	0.03	0.03	0.03	0.04
AOM	34.47	80.26	84.67	87.41	87.46	91.34	79.59
Day 1							
PV	0.11	0.66	0.67	0.85	0.56	0.69	3.95
Odor	8	9	8/7	8	8	8	8/7
Color, red	0.7	1.0	0.7	0.7	0.7	1.0	2.0
Color, yellow	4.0	7.0	6.0	8.0	7.0	8.0	13.0
Flavor	8	8	8	8	8	8	7
Day 3							
PV	0.27	0.81	0.79	0.99	0.71	0.90	4.35
Odor	8	8/7	7	8	8	8	7/6
Color, red	1.0	1.1	1.1	1.1	1.0	1.2	2.5
Color, yellow	7.0	8.0	7.0	8.0	9.0	9.0	13.0
Flavor	8	7	7	7/8	7/8	8/7	7/6
Day 6							
PV	2.35	1.40	1.11	1.21	1.16	1.21	4.60
Odor	7/8	7	7/6	7	7	7	6
Color, red	1.2	1.3	1.3	1.3	1.3	1.3	2.0
Color, yellow	13.0	9.0	9.0	9.0	10.0	11.0	14.0
Flavor	7/8	7	7/6	7	7	7	7/6
Day 9							
PV	13.68	1.93	1.57	1.79	1.66	1.92	4.88
Odor	7/6	7/6	6	7/6	7	6	6/5
Color, red	1.2	1.5	1.5	1.5	1.5	1.5	2.5
Color, yellow	14.0	10.0	10.0	10.0	11.0	12.0	15.0
Flavor	6	6	6	6	6	6	6/5
Day 13							
PV	25.94	2.50	2.23	2.38	2.03	2.25	5.18
Odor	6/5	5	4/3	4/3	5	5	5/4
Color, red	1.2	1.5	2.0	1.5	1.5	1.6	2.5
Color, yellow	14.0	11.0	10.0	10.0	12.0	12.0	15.0
Flavor	5	5	3	4/3	5	5	4
Day 15							
PV	28.92	2.85	2.44	2.61	2.39	2.56	5.51
Odor	2	5/4	2	2	3	2	3/2
Color, red	1.5	2.0	2.0	2.0	1.5	1.7	2.5
Color, yellow	14.0	12.0	12.0	11.0	12.0	12.0	15.0
Flavor	1	4	1	2	2	2	2

* Crisco = partially hydrogenated soybean and cottonseed oils, mono- and di-glycerides.

Example 2—Preparation of shortenings

RBD CV 65 Canola oil and deodorized cottonseed stearine were combined in different amounts as indicated below. These blends were votated and then tempered. The results obtained are shown below.

Experiment 1 involved votating 227 kg of a blend of 93% CV 65 and 7% cottonseed stearine; 227 kg of a blend of 95% CV 65 and 5% cottonseed stearine; and 227 kg of a blend of 87.5% CV 65 and 12.5% cottonseed stearine.

Experiment 2 involved votating 1300 kg of a blend of 87.5% CV 65 and 12.5% cottonseed stearine; 650 kg of a blend of 86% CV 65 and 14% cottonseed stearine; and 550 kg of a blend of 93% CV 65 and 7% cottonseed stearine.

Experiment 3 involved votating 935 kg of a blend of 84% CV 65 and 16% cottonseed stearine; and 935 kg of a blend of 95% CV 65 and 5% cottonseed stearine.

The ingredients were combined in stainless steel jacketed tanks. The RBD CV 65 was added first and then the cottonseed stearine. The mixture was then heated to $70 \pm 5^\circ\text{C}$ and maintained at that temperature until all the stearine had dissolved. 150 ppm of an anti-oxidant (TBHQ; Eastman Chemical Co., Kingsport, TN) was added to the blend. The mixture was then cooled to $60 \pm 5^\circ\text{C}$ prior to votation.

The crystallization of blends by rapid heat removal using an externally cooled scraped surface heat exchanger results in the creation of small uniform 9-prime crystals in the shortening. The votator was set-up to run on glycol as a cooling medium and the scraped-surface heat exchangers were configured in series so that after the A unit, the partially-chilled blend passed to the C unit. From the C unit, the shortening passed to the agitated B unit or "pin" unit. In Experiment 1, nitrogen was not added during votation. In Experiments 2 and 3, 12-15% nitrogen was added to the discharge side of the votator pump. The shortening then passed through an extrusion valve that was placed after the B unit. The RPM of the A & C units was set at 400 rpm and the B unit was set at 100 RPM for all runs. The glycol temperature was set at -8°C for all the runs. The operating parameters for all runs are shown below in Table 8.

Table 8. Parameters for Making Shortenings

Experiment	Product RBD CV 65:CSHF	Feedrate (kg/hr)	A Unit Outlet ($^\circ\text{C}$)	C Unit Outlet ($^\circ\text{C}$)	B Unit Outlet ($^\circ\text{C}$)	N ₂ (%)	Extension Pressure (PSI)
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1	95:5	~100	31-32	22-23	23-24	0	0
1	93:7	~100	32-34	22-23	23-25	0	0
1	87.5:12.5	~100	33-34	25-26	28-29	0	0
2	93:7	100-105	26-28	22-23	23-24	12-15	50
2	87.5:12.5	100-120	29-32	22-24	27-30	12-15	65
2	86:14	120-130	NA	22-24	30-32	12-15	65
3	95:5	95-100	31-33	21-22	22-23	12-15	95-110
3	84:16	100-110	40-44	27-30	38-40	12-15	175-190

The following was used for votation: Scraped surface A unit with a 2 1/4" diameter concentric shaft (3" x 12" Model IC312A, Serial #81175VA; Chemtron Corp., Louisville, KY); agitated B unit (4" x 17 3/4" Model 201848, Serial #B668; Chemtron Corp., Louisville, KY); and scraped surface C unit with a 2 1/8" diameter eccentric shaft (3" x 12" Model IE312A, Serial #81175VA; Chemtron Corp., Louisville, KY). The votated product was packaged into 4-liter and 20-liter plastic pails.

The shortenings containing 12.5% or 14% cottonseed stearine were tempered for 48 hours at a temperature between 23-26°C. The shortenings containing 5% or 7% cottonseed stearine were tempered for 48 hours at a temperature between 20-22°C. The shortening containing 16% cottonseed stearine was tempered for 48 hours at a temperature between 25-28°C.

The shortening was analyzed using the following methods:

Peroxide Value	AOCS Cd 8-53
Free Fatty Acids	AOCS Ca 5a-40
Color	Auto Tintometer Lovibond Colour, PFX 990
Mettler Drop Point	AOCS Cc 18-80

There were no anomalies noted in the votation of the different blends.

20 Example 3—Yeast Donuts

To test the efficacy and functionality of the shortenings described in Tables 3, 4, and 5, food products were made using such shortenings and compared to food products made using a commercially available hydrogenated vegetable oil and animal shortening.

An American Institute of Baking (AIB) formula was used to evaluate the shortenings in a yeast-leavened donut. The formulas and processes for screening are described below. The control baking formula included Master Chef® All-Purpose

Vegetable Shortening (non-emulsified; Cargill, Minnetonka, MN) in the dough and the control donuts were fried in Hi-Melt Donut Frying Shortening (Cargill, Minnetonka, MN). Each test shortening, e.g., TE-4-350, TE-3-125, or TE-3-70 was used in a dough and as the respective frying shortening.

5

<u>Yeast Donut Formula</u>		<u>grams</u>	<u>%</u>
Flour (bread)	(Pillsbury®)	60	40.00
Flour (cake)	(Softasilk®)	20	13.33
Sugar Retail	(C&H®)	5	3.33
10 Shortening		9	6.00
Non-Fat Dry Milk	(Fischer® low heat)	4.6	3.07
Salt	(Morton®)	1.4	0.93
Yeast	(Red Star Cake®)	5	3.33
Water		<u>45</u>	<u>30.00</u>
15		150	100.000

Each dough was mixed in a 300 g bowl farinograph mixer set to 25°C until peak development was reached. The dough was dried in the farinograph bowl for 1 minute. The yeast was then dispersed in water. The water/yeast slurry was added to the

20 farinograph bowl and mixed for 2 minutes on speed #2. The shortening was added and each dough was mixed to a peak Brabender Unit (BU; see below) (about 15 to 20 minutes total). Dough temperature was between 80°F and 85°F. The dough was rested in a mixing bowl covered with saran wrap for about 10 minutes, and sheeted to about 0.5 inches (setting #7). Light dusting flour was used during sheeting. The donuts were cut

25 with a cutter having a 3" outer cut and a 1" center cut. The dough was placed on Pam®-sprayed proofing screens on a small tray, and the trays were placed in the proofer (105°F dry, 100°F wet) for 30 minutes. The donuts were placed into frying oil (370°F) for 40 seconds on one side and 45 seconds on the other side. Donuts were fried in the following order: control 1, TE-3-125, TE-4-350, TE-3-70, and control 2. The donuts were removed

30 from the oil and placed on a rack for cooling. Duplicate control doughs were made to help distinguish potential processing effects from shortening effects.

The donuts were analyzed for volume, height, diameter and color using DIPIX® technology (Table 9). DIPIX® results are reported as an average of 5 donuts with the corresponding standard deviation (SD).

5 Finished donuts were held at ambient temperature for three to four hours before being served blind to the sensory panel. Sensory results were averaged and the means determined using ANOVA (Stat Soft®). Results from the sensory panel are shown in Table 10.

A single donut from each batch was also placed in the center of a paper towel for 24 hours to determine the amount of oil capable of being wicked from the donut.

10 *Physical attributes*

Mix Time

All doughs required about a 10-minute mix to achieve peak Brabender Unit (BU). Shortening type had no apparent effect on mix time. See Table 11.

Dough Brabender Unit (BU)

15 All doughs resulted in finished BU's in the range of 690 to 710. Shortening type had no apparent effect on dough BU. See Table 11.

Peak Height

The average height of donuts made using each of the test shortenings were within one standard deviation of the average height of control donuts. Shortening type had no
20 apparent effect on the average height of yeast donuts.

Diameter

The average diameter of donuts made using each of the test shortenings were within one standard deviation of the average diameter of control donuts. Shortening type had no apparent effect on the average diameter of yeast donuts.

25 Volume

The average volumes of donuts made using each of the test shortenings were within one standard deviation of the average volume of control donuts. Shortening type had no apparent effect on the volume of yeast donuts.

Color

The color scores of donuts made using each of the test shortenings were within one standard deviation of the color scores of control donuts. Shortening type had no apparent effect on yeast donut color.

5 Oil Absorption

The donuts made using each of the test shortenings wicked more oil onto a paper towel than the amount wicked by control donuts. Donuts made using the TE-3-70 test shortening appeared to wick more oil onto a paper towel than donuts made using the TE-3-125 or TE-4-350 test shortenings.

10 *Sensory attributes (significance = $p < 0.05$)*

Color

There were no significant differences in color between donuts made using each of the test shortenings and the control donuts.

Tenderness

15 The donuts made using TE-3-125 were significantly less tender than donuts made using the other test shortenings or the control donuts.

Gumminess

There were no significant differences in gumminess between donuts made using each of the test shortenings and the control donuts.

20 Moistness

There were no significant differences in moistness between donuts made using each of the test shortenings and the control donuts. Donuts made using TE-3-125 were directionally lower in moistness than donuts made using the other test shortenings or the control donuts.

25 Flavor Quality

There were no significant differences in flavor quality between donuts made using each of the test shortenings and the control donuts. The control donuts appeared to be directionally higher in flavor quality than the donuts made using each of the test shortenings.

Mouth Coating

There were no significant differences in mouth coating between donuts made using each of the test shortenings and the control donuts.

Finger Oiliness

5 There were no significant differences in finger oiliness between donuts made using each of the test shortenings and the control donuts.

Graininess

There were no significant differences in graininess between donuts made using each of the test shortenings and the control donuts.

10

Table 9. DIPIX® Results for Yeast Donuts

15

	Height (mm)	SD (mm)
Control 1	32.0	1.05
Control 2	33.1	0.85
TE-3-125	32.2	0.74
TE-3-70	32.8	0.61
TE-4-350	33.5	1.42

20

	Diameter (mm)	SD (mm)
Control 1	93.4	1.95
Control 2	94.8	-2.57
TE-3-125	93.6	1.13
TE-3-70	93.7	1.73
TE-4-350	93.0	2.01

25

	Volume (cm ³)	SD (cm ³)
Control 1	171.5	9.5
Control 2	181.6	10.5
TE-3-125	175.5	6.4
TE-3-70	178.3	9.2
TE-4-350	169.0	10.9

30

	Color	SD
Control 1	32.2	1.1
Control 2	36.3	1.24
TE-3-125	35.1	3.5
TE-3-70	34.0	3.1
TE-4-350	33.8	0.8

5

	Hole Area (mm ²)	SD (mm ²)
Control 1	93.4	1.95
Control 2	94.8	-2.57
TE-3-125	93.6	1.13
TE-3-70	93.7	1.73
TE-4-350	93.0	2.01

Table 10. Yeast Donut Sensory Panel Results

Panelist		Color	Tenderness	Gumminess	Moistness	Flavor Quality	Mouth Coat	Finger Oil	Graininess
1	Control 1	25	35	15	35	50	15	35	20
2	Control 1	38	46	12	46	40	29	14	10
3	Control 1	25	39	45	45	45	15	12	20
4	Control 1	30	45	40	40	40	20	25	25
5	Control 1	52	20	13	28	20	35-	35	36
6	Control 1	15	45	20	45	40	15	10	10
Mean		30.8	38.3	24.2	39.8	39.2	21.5	21.8	20.2
1	Control 2	25	35	15	35	50	15	25	25
2	Control 2	38	46	12	44	35	49	10	20
3	Control 2	25	40	45	45	45	15	12	20
4	Control 2	30	40	50	40	30	45	50	15
5	Control 2	40	30	25	45	25	43	42	15
6	Control 2	20	50	10	45	45	10	20	5
Mean		29.7	40.2	26.2	42.3	38.3	29.5	26.5	16.7
1	TE-4-350	30	40	15	35	55	25	35	20
2	TE-4-350	38	39	15	44	29	30	10	10
3	TE-4-350	30	35	45	45	45	15	13	20
4	TE-4-350	30	30	30	30	5	35	20	20
5	TE-4-350	33	38	20	40	30	31	28	20
6	TE-4-350	25	45	20	45	35	10	15	15
Mean		31.0	37.8	24.2	39.8	33.2	24.3	20.2	17.5

10

1	TE-3-70	35	35	15	35	55	15	35	15
2	TE-3-70	38	39	20	39	21	54	24	20
3	TE-3-70	25	40	45	45	45	15	12	20
4	TE-3-70	30	40	50	46	13	20	40	20
5	TE-3-70	33	25	9	30	20	40	37	27
6	TE-3-70	20	45	10	45	40	20	15	10
Mean		30.2	37.3	24.8	40.0	32.3	27.3	27.2	18.7

1	TE-3-125	25	30	15	30	50	20	35	20
2	TE-3-125	38	32	20	30	24	43	5	5
3	TE-3-125	25	39	45	45	45	15	13	20
4	TE-3-125	30	30	30	30	20	30	30	20
5	TE-3-125	52	15	18	39	20	30	31	21
6	TE-3-125	10	40	15	40	40	20	5	5
Mean		30.0	31.0	23.8	35.7	33.2	26.3	19.8	15.2

Table 11. Brabender Units of Doughs

	Control 1	TE-3-125	TE-4-350	TE-3-70	Control 2
BU	690	720	710	690	710
Mix time (min)	10.5	10.5	10.5	10.5	10

5

Sensory results were analyzed using Duncan's means testing (Stat Soft®) (Table 12).

Table 12. Yeast Donut Sensory

Cell	Duncan test; Variable Tenderness					
	Approximate Probabilities for Post Hoc Tests					
	Error: Between MS = 23.003, Degrees of Freedom (df) = 20.000					
	Sample	(1) 37.333	(2) 38.333	(3) 40.167	(4) 37.833	(5) 31.000
1	TE-3-70		0.737264	0.360220	0.858648	0.033345
2	Control 1	0.737264		0.515629	0.858648	0.023145
3	Control 2	0.360220	0.515629		0.435736	0.006509
4	TE-4-350	0.858648	0.858648	0.435736		0.028821
5	TE-3-125	0.033345	0.023145	0.006509	0.028821	

5

10 Example 4—Cake Donuts

 An AIB formula was used to evaluate the shortenings in a cake donut. The formulas and processes are described below. The control formula included Master Chef® All-Purpose Vegetable Shortening (non-emulsified) in the dough. The control dough was fried in Hi-Melt® Donut Frying Shortening. The indicated test shortenings were used in the donut doughs and as the frying shortening. Duplicate control doughs were made to help separate potential process effects from shortening effects.

<u>Cake Donut Formula</u>			<u>AIB Formula</u>	
			<u>(g)</u>	<u>(%)</u>
20	Cake Flour	(Softasilk®)	373.3	29.28
	Bread Flour	(Pillsbury®)	160	12.55
	Granulated Sucrose	(C&H®)	231.3	18.14
	Dextrose		10.7	0.84
	NFDM	(Fischer® low heat)	38.7	3.04
25	Salt	(Morton®)	12	0.94
	Baking Soda	(Arm & Hammer®)	8	0.63
	SAPP 40	(FMC®)	11	0.86

	Nutmeg	(McCormick®)	0.65	0.05
	Mace	(McCormick®)	0.4	0.03
	Liquid Egg Yolk		100	7.84
	Shortening		33.3	2.61
5	Vanilla	(McCormick®)	2.7	0.21
	Water		<u>292.7</u>	<u>22.96</u>
			1274.75	100.0

The dry ingredients were mixed on low speed in a Kitchenaid® 5 qt mixer. The liquids and shortening were added and mixed for 1 minute on low and 2 minutes on medium. The donut maker was set to setting #3, and the donuts were fried at 370°F for 45 seconds on the first side and 35 seconds on the second side.

The donuts were analyzed on the DIPIX® machine for volume, height, diameter, and color. DIPIX® results are reported as an average of 9 donuts with the corresponding standard deviation (SD) (Table 13).

Finished donuts were held at ambient temperature for three to four hours before being served blind to the sensory panel. Sensory results were averaged (Table 14) and the means were tested using ANOVA and Duncan's means testing (Stat Soft®).

A single donut from each batch was also placed in the center of a paper towel for 24 hours to determine the amount of oil capable of being wicked from the donut.

Physical attributes

Height

The average height of donuts made using each of the test shortenings were within one standard deviation of the average height of control donuts. Shortening type had no apparent effect on the average height of cake donuts.

Diameter

The average diameter of donuts made using each of the test shortenings were within one standard deviation of the average diameter of control donuts. Shortening type had no apparent effect on the diameter of cake donuts.

Volume

The average volumes of donuts made using each of the test shortenings were within one standard deviation of the average volume of control donuts. Shortening type had no apparent effect on the volume of cake donuts.

Color

The color scores of donuts made using each of the test shortenings were within one standard deviation of the color score of control donuts. Shortening type had no apparent effect on the color of cake donuts.

5 Oil absorption

The donuts made using each of the test shortenings wicked more oil onto a paper towel than the amount wicked by control donuts. Donuts made using the TE-3-70 test shortening appeared to wick more oil onto a paper towel than those made using the TE-3-125 and TE-4-350 test shortenings.

10 *Sensory attributes (significance = $p < 0.05$)*Color

There were no significant differences in color between donuts made using each of the test shortenings and the control donuts.

Tenderness

15 There were no significant differences in tenderness between donuts made using each of the test shortenings and the control donuts.

Gumminess

There were no significant differences in gumminess between donuts made using each of the test shortenings and the control donuts.

20 Moistness

There were no significant differences in moistness between donuts made using each of the test shortenings and the control donuts.

Flavor Quality

25 The donuts made using the TE-4-350 test shortening had significantly less flavor quality than the donuts made using the other test shortenings or the control donuts.

Mouth Coating

There were no significant differences in mouth coating between donuts made using each of the test shortenings and the control donuts.

Finger Oiliness

30 Donuts made using the TE-3-70 and the TE-3-125 test shortenings were judged as having significantly higher finger oiliness than the control donuts. Donuts made using

the TE-3-70 shortening were judged as having the highest finger oiliness. Donuts made using the TE-4-350 shortening appeared to be directionally higher in finger oiliness compared to control donuts.

Graininess

- 5 Donuts made using the TE-3-70 test shortening had significantly finer graininess than the control donuts and donuts made using the TE-4-350 test shortening.

Table 13. DIPIX® Results for Cake Donuts

	Height (mm)	SD (mm)
Control 1	25.9	1.4
Control 2	30.3	1.6
TE-3-125	28.9	1.6
TE-3-70	28.7	1.8
TE-4-350	28.2	1.3

	Diameter (mm)	SD (mm)
Control 1	71.3	3.3
Control 2	68.6	2.6
TE-3-125	70.1	2.2
TE-3-70	69.5	3.1
TE-4-350	70.9	3.2

	Volume (cm ³)	SD (cm ³)
Control 1	98.1	3.9
Control 2	110.9	3.7
TE-3-125	109.1	4.7
TE-3-70	105.5	5.7
TE-4-350	107.9	4.9

	Color*	SD
Control 1	17.0	2.45
Control 2	14.4	0.98
TE-3-125	13.2	1.94
TE-3-70	13.9	1.2
TE-4-350	15.1	2.1

*higher number = lighter

5

	Hole area (mm ²)	SD (mm ²)
Control 1	204.9	110.2
Control 2	37.5	36.6
TE-3-125	79.7	80.1
TE-3-70	113.7	94.7
TE-4-350	113.1	100.8

Table 14. Cake Donut Sensory

Panelist		Color	Tender- ness	Gummi- ness	Moist ness	Flavor Quality	Mouth Coat	Finger Oiliness	Grain- iness
1	Control 1	30	40	10	40	50	25	30	35
2	Control 1	22	35	10	30	40	12	13	44
3	Control 1	25	37	30	30	47	12	15	29
4	Control 1	32	20	29	50	30	15	15	42
5	Control 1	30	40	40	40	40	10	20	10
6	Control 1	35	45	10	35	35	20	5	40
Mean		29	36.2	21.5	37.5	40.3	15.7	14.7	33.3

Panelist		Color	Tender- ness	Gummi- ness	Moist-ness	Flavor Quality	Mouth Coat	Finger Oiliness	Grain- iness
1	TE-3-125	30	30	10	40	50	20	25	40
2	TE-3-125	31	35	13	40	45	13	13	22
3	TE-3-125	33	32	30	28	42	12	19	29
4	TE-3-125	33	28	6	46	40	16	20	33
5	TE-3-125	40	40	50	40	30	30	30	25
6	TE-3-125	30	50	20	40	35	20	6	16
Mean		32.8	35.8	21.5	39.0	40.3	18.5	18.8	27.5

Panelist		Color	Tender- ness	Gummi- ness	Moist-ness	Flavor Quality	Mouth Coat	Finger Oiliness	Grain- iness
1	TE-3-70	30	30	10	40	50	15	25	30
2	TE-3-70	30	40	10	31	44	12	13	28
3	TE-3-70	31	33	30	28	42	12	23	21
4	TE-3-70	33	28	6	46	40	10	14	26
5	TE-3-70	40	40	40	40	24	22	30	10
6	TE-3-70	30	45	10	34	30	26	15	10
Mean		32.3	36.0	17.7	36.5	38.3	16.2	20.0	20.8

Panelist		Color	Tender- ness	Gummi- ness	Moist-ness	Flavor Quality	Mouth Coat	Finger Oiliness	Grain- iness
1	TE-4-350	30	30	10	35	45	15	25	40
2	TE-4-350	22	40	10	30	44	12	13	28
3	TE-4-350	27	32	30	30	42	12	19	29
4	TE-4-350	33	38	20	40	10	25	15	42
5	TE-4-350	40	40	40	40	5	15	30	15
6	TE-4-350	30	50	10	35	35	25	6	26
Mean		30.3	38.3	20.0	35.0	30.2	17.3	18.0	30.0

Panelist		Color	Tender-ness	Gummi-ness	Moist-ness	Flavor Quality	Mouth Coat	Finger Oiliness	Graininess
1	Control 2	30	40	10	45	45	20	20	35
2	Control 2	31	40	13	40	40	12	13	28
3	Control 2	23	39	24	34	46	12	14	38
4	Control 2	33	20	20	50	30	15	5	25
5	Control 2	30	40	50	50	40	10	30	20
6	Control 2	40	50	10	34	40	15	6	40
Mean		31.2	38.2	21.2	42.2	40.2	14.0	14.7	31.0

The volume of donuts from each batch was evaluated using a displacement test. The results for six donuts from each batch were averaged, and indicated that the volume of the donuts made using the test shortenings was similar to the volume of control donuts.

Example 6—Biscuits

The biscuit recipe shown below was used to evaluate the effects of the test shortenings in biscuits. The control biscuits included Master Chef® All-Purpose Vegetable Shortening (non-emulsified) in the dough. All biscuit doughs were mixed and kneaded by hand.

<u>Biscuit Formula</u>			
		g	%
15	Sugar (C&H®)	30	2.33
	Shortening	210	16.30
	Salt (Morton®)	12	0.93
	Baking Powder (Calument®)	36	2.80
	Whole milk	400	31.06
20	Cake flour (Softasilk®)	300	23.29
	Bread flour (Pillsbury®)	300	23.29
		1288	100.00

Biscuits were made as follows. Dry ingredients were sifted into a bowl. Refrigerated shortening was cut into the dry ingredients until the consistency was coarse. The liquids were combined and added to the dry ingredients. The dough was hand mixed until soft, and kneaded lightly 10 to 20 times for about 30 seconds. The dough was rolled between 0.5" metal rails to achieve a 0.5"-thick sheeted dough. Seven cm diameter biscuits were cut out, placed in ZipLock® freezer bags, and frozen at -10°F. The biscuits

were thawed at room temperature for 30 minutes, and baked at 425°F for 15 to 20 minutes.

The donuts were analyzed on a DIPIX® machine for volume, height, diameter, and color. DIPIX® results are shown below in Table 15 and are reported as an average
5 of 6 biscuits with the corresponding standard deviation (SD).

Finished biscuits were held at ambient temperature for 15 minutes before being served blind to the sensory panel. Sensory results were averaged (Table 16) and means tested using ANOVA and Duncan's means testing (Stat Soft®) (Tables 17 and 18).

Physical attributes

10 Average Height

The average height of biscuits made using test shortening TE-3-125 was slightly higher than that of biscuits made using the other test shortenings or of the control biscuits.

Diameter

15 The average diameters of biscuits made using each of the test shortenings were within one standard deviation of the average diameter of control biscuits. Shortening type had no apparent effect on the average diameter of biscuits.

Volume

20 The volume of biscuits made using TE-4-350 appeared to be slightly lower than the volume of biscuits made using the other test shortenings or the volume of control biscuits.

Color

25 The color of biscuits made using TE-3-70 appeared slightly lighter than the color of control biscuits and biscuits made using TE-3-125. The color differences, however, may be due to the location of a biscuit in a bake pan and/or the location of a biscuit in an oven. Biscuits placed on the edge of a pan tended to be darker than those in the center of a pan.

Sensory attributes (significance = $p < 0.05$)

Color

30 The color of biscuits made using TE-3-70 appear lighter in color than the color of biscuits made using the other test shortenings or the control biscuits. The color

differences, however, may be due to location of a biscuit in a bake pan and/or the location of a biscuit in an oven. Biscuits placed on the edge of a pan tended to be darker than those in the center of a pan.

Tenderness

5 There were no significant differences in tenderness between biscuits made using each of the test shortenings and the control biscuits.

Gumminess

There were no significant differences in gumminess between biscuits made using each of the test shortenings and the control biscuits.

10 Moistness

There were no significant differences in moistness between biscuits made using each of the test shortenings and the control biscuits.

Flavor Quality

15 There were no significant differences in flavor quality between biscuits made using each of the test shortenings and control biscuits.

Mouth Coating

There were no significant differences in mouth coating between biscuits made using each of the test shortenings and control biscuits.

Finger Oiliness

20 There were no significant differences in finger oiliness between biscuits made using each of the test shortenings and control biscuits.

Graininess

There were no significant differences in graininess between biscuits made using each of the test shortenings and control biscuits.

25

Table 15. DIPIX® Results for Biscuits

	Average Height (mm)	SD (mm)
Control 1	27.3	1.32
TE-3-125	29.7	0.82
TE-3-70	26.4	0.53
TE-4-350	26.1	0.6

30

	Diameter (mm)	SD (mm)
Control 1	69.2	0.93
TE-3-125	68.2	0.73
TE-3-70	68.9	0.94
TE-4-350	68.3	0.62

5

	Volume (cm ³)	SD (cm ³)
Control 1	103	5.5
TE-3-125	102.1	4.7
TE-3-70	98.9	3.3
TE-4-350	95.8	2.1

10

	Color	SD
Control 1	39.3	7.05
TE-3-125	36.5	1.85
TE-3-70	47.3	5.06
TE-4-350	43.6	4.76

15

Table 16. Biscuit Sensory

Panelist		Color	Tender- ness	Gummi- ness	Moistness	Flavor Quality	Mouth Coat	Finger Oiliness	Grain- iness
1	Control 1	27	35	15	30	55	10	20	45
2	Control 1	30	38	10	15	35	5	5	38
3	Control 1	35	25	20	20	50	10	10	20
4	Control 1	28	29	15	26	29	14	7	23
5	Control 1	24	40	40	30	30	30	30	30
6	Control 1	30	30	15	35	40	25	2	20
Mean		29.0	32.8	19.2	26.0	39.8	15.7	12.3	29.3

Panelist		Color	Tender- ness	Gummi- ness	Moistness	Flavor Quality	Mouth Coat	Finger Oiliness	Grain- iness
1	TE-3-125	35	35	20	30	50	10	15	45
2	TE-3-125	40	28	5	15	35	8	5	44
3	TE-3-125	40	20	34	6	50	30	16	26
4	TE-3-125	35	34	22	17	40	14	7	23
5	TE-3-125	35	40	40	30	30	30	30	30
6	TE-3-125	40	50	15	40	40	20	5	15
Mean		37.5	34.5	22.7	23.0	40.8	18.7	13.0	30.5

Panelist		Color	Tender- ness	Gummi- ness	Moistness	Flavor Quality	Mouth Coat	Finger Oiliness	Grain- iness
1	TE-3-70	20	30	25	35	45	10	15	40
2	TE-3-70	30	19	3	15	35	10	5	30
3	TE-3-70	10	15	30	10	40	50	30	30
4	TE-3-70	24	39	12	27	20	30	5	36
5	TE-3-70	30	40	45	38	30	30	30	35
6	TE-3-70	20	45	10	35	30	15	5	20
Mean		22.3	31.3	20.8	26.7	33.3	24.2	15.0	31.8

Panelist		Color	Tender- ness	Gummi- ness	Moistness	Flavor Quality	Mouth Coat	Finger Oiliness	Grain- iness
1	TE-4-350	27	30	30	40	40	10	20	40
2	TE-4-350	30	28	8	15	35	10	5	40
3	TE-4-350	35	24	34	10	50	35	30	25
4	TE-4-350	24	48	20	38	30	21	6	19
5	TE-4-350	25	40	40	30	30	30	30	25
6	TE-4-350	26	45	20	40	35	15	5	25
Mean		27.8	35.8	25.3	28.8	36.7	20.2	16.0	29.0

Panelist		Color	Tender- ness	Gummi- ness	Moistness	Flavor Quality	Mouth Coat	Finger Oiliness	Grain- iness
1	Control 2	40	35	15	35	50	10	20	45
2	Control2	40	23	3	15	35	10	10	30
3	Control 2	45	20	22	30	50	20	30	38
4	Control 2	30	23	30	20	11	15	9	13
5	Control 2	50	40	50	45	30	30	45	35
6	Control 2	45	50	10	45	40	20	5	15
Mean		41.7	31.8	21.7	31.7	36.0	17.5	19.8	29.3

5

Table 17. Biscuit Sensory—Color

Cell	Duncan test; Variable Color					
	Approximate Probabilities for Post Hoc Tests					
	Error: Between MS = 29.177, Degrees of Freedom (df) = 20.000					
	Sample	(1) 22.333	(2) 29.000	(3) 41.667	(4) 27.833	(5) 37.500
1	TE-3-70		0.055288	0.000041	0.093211	0.000215
2	Control 1	0.055288		0.000902	0.712392	0.013173
3	Control 2	0.000041	0.000902		0.000489	0.196657
4	TE-4-350	0.093211	0.712392	0.000489		0.007539
5	TE-3-125	0.000215	0.013173	0.196657	0.007539	

10

Table 18. Biscuit Sensory—Finger Oil

Cell No.	Duncan test; Variable Finger Oil					
	Approximate Probabilities for Post Hoc Tests					
	Error: Between MS = 19.980, Degrees of Freedom (df) = 20.000					
	Sample	(1) 15.000	(2) 12.333	(3) 19.833	(4) 16.000	(5) 13.000
1	TE-3-70		0.340605	0.090392	0.702616	0.447577
2	Control 1	0.340605		0.015256	0.207180	0.798908
3	Control 2	0.090392	0.014256		0.153183	0.023165
4	TE-4-350	0.702616	0.207180	0.153183		0.284807
5	TE-3-125	0.447577	0.798908	0.023165	0.284807	

Example 7—Sugar Cookies

5 The recipe shown below was used to evaluate the test shortenings in sugar cookies. The control formula included Master Chef® All-Purpose Vegetable Shortening (non-emulsified) in the dough.

	<u>Sugar Cookies</u>	<u>Grams</u>	<u>%</u>
10	Sugar (C&H®)	374	31.17
	Shortening	226	18.83
	Salt (Morton®)	7	0.58
	Sodium Bicarbonate (Arm & Hammer®)	4	0.33
	Vanilla (McCormick®)	2	0.17
15	Whole eggs	75	6.25
	Whole milk	61	5.08
	Cake flour (Softasilk®)	225.5	18.79
	Bread flour (Pillsbury®)	225.5	18.79
		1200	100.00

20

25 The sugar, shortening, salt, sodium bicarbonate and vanilla were mixed in a KitchenAid® 5 quart mixer on low speed (1) for 3 min. The eggs were added and mixed on low speed for 3 min. The milk was added and mixed on low speed for 1 min. The flours were sifted and added to the mixture. The mixture was mixed on low speed for 1 min. The cookie dough was deposited on a sheet pan liner using an ice cream scoop. The dough was baked at 400°F for 12 min, and the cookies were placed on a rack to cool.

The cookies were weighed (Table 19), and analyzed on a DIPIX® machine for volume, height, diameter, and color. DIPIX® results are reported as an average of 9 sugar cookies with the corresponding standard deviation (SD) (Table 20).

Finished cookies were held at ambient temperature for 15 days before being served blind to the sensory panel. Sensory results were averaged (Table 21) and means tested using ANOVA and Duncan's means testing (Stat Soft®) (Table 22).

Physical attributes

Average Height

The average height of cookies made using each of the test shortenings were within one standard deviation of the average height of control cookies. Shortening type had no apparent effect on the average height of cookies.

Diameter

The diameter of cookies made using TE-3-125 appeared to be slightly larger than the diameter of cookies made using the other test shortenings or the control cookies.

Volume

The volume of cookies made using TE-3-125 appeared to be slightly larger than the volume of cookies made using the other test shortenings or the control cookies.

Color

The color of cookies made using TE-3-125 and TE-3-70 appeared to be slightly darker than cookies made using TE-4-350 or control cookies.

Sensory attributes (significance = $p < 0.05$)

Color

Cookies made using TE-3-125 and TE-3-70 were significantly darker than cookies made using TE-4-350 or control cookies.

Cracking

There were no significant differences in cracking between cookies made using each of the test shortenings and the control cookies.

Hardness

There were no significant differences in hardness between cookies made using each of the test shortenings and the control cookies.

Chewiness

There were no significant differences in chewiness between cookies made using each of the test shortenings and the control cookies.

Moistness

5 Cookies made using TE-4-350 were significantly more moist than cookies made using TE-3-70 or TE-3-125, or control cookies.

Flavor Quality

There were no significant differences in flavor between cookies made using each of the test shortenings and control cookies.

10 Mouth Coating

There were no significant differences in mouth coating between cookies made using each of the test shortenings and control cookies.

15 Table 19. Average Weight of Sugar Cookies

Shortening	Weight (g)
Control	10.7
TE-3-125	11.3
TE-3-70	10.4
TE-4-350	11.1

20

Table 20. DIPIX® Results for Sugar Cookies

	Average Height (mm)	SD (mm)
Control 1	12.0	0.28
TE-3-125	11.9	0.18
TE-3-70	12.4	0.51
TE-4-350	12.5	0.57

25

	Diameter (mm)	SD (mm)
Control 1	51.1	0.71
TE-3-125	53.2	0.33
TE-3-70	50.0	0.64
TE-4-350	51.1	0.96

30

	Volume (cm ³)	SD (cm ³)
Control 1	24.0	0.92
TE-3-125	26.5	0.18
TE-3-70	24.5	1.29
TE-4-350	25.7	1.03

	Color	SD
Control 1	29.5	1.70
TE-3-125	24.8	1.09
TE-3-70	23.7	1.34
TE-4-350	30.4	1.77

Table 21. Sugar Cookie Sensory

Panelist		Color	Cracking	Hardness	Chew	Moistness	Flavor Quality	Mouth Coat
1	Control	25	35	25	5	10	50	20
2	Control	30	30	30	0	10	20	10
3	Control	35	33	42	3	12	40	10
4	Control	25	42	20	3	33	50	17
5	Control	28	32	30	20	20	39	11
6	Control	15	35	20	0	15	40	10
Mean		26.3	34.5	27.8	5.2	16.7	39.8	13.0

Panelist		Color	Cracking	Hardness	Chew	Moistness	Flavor Quality	Mouth Coat
1	TE-3-125	35	30	25	5	10	55	10
2	TE-3-125	40	20	30	0	10	30	10
3	TE-3-125	40	40	42	3	10	40	10
4	TE-3-125	33	42	27	7	33	50	17
5	TE-3-125	33	29	28	20	17	39	11
6	TE-3-125	25	40	30	0	10	40	10
Mean		34.3	33.5	30.3	5.8	15.0	42.3	11.3

Panelist		Color	Cracking	Hardness	Chew	Moistness	Flavor Quality	Mouth Coat
1	TE-4-350	25	40	30	5	10	45	20
2	TE-4-350	30	30	30	0	10	40	10
3	TE-4-350	25	28	49	3	12	40	12
4	TE-4-350	24	42	20	7	40	50	5
5	TE-4-350	30	35	33	19	22	39	11
6	TE-4-350	15	30	25	0	15	45	10
Mean		24.8	34.2	31.2	5.7	18.2	43.2	11.3

Panelist		Color	Cracking	Hardness	Chew	Moistness	Flavor Quality	Mouth Coat
1	TE-3-70	25	35	20	5	10	45	15
2	TE-3-70	50	40	30	0	10	35	10
3	TE-3-70	40	33	42	3	10	40	12
4	TE-3-70	40	42	27	3	33	50	17
5	TE-3-70	33	32	22	15	19	39	18
6	TE-3-70	30	20	15	0	10	40	10
Mean		36.3	33.7	26.0	4.3	15.3	41.5	13.7

Panelist		Color	Cracking	Hardness	Chew	Moistness	Flavor Quality	Mouth Coat
1	Control 2	30	35	25	5	10	45	20
2	Control 2	35	10	30	0	10	45	10
3	Control 2	35	24	49	3	12	40	15
4	Control 2	24	35	20	7	40	50	5
5	Control 2	28	27	37	19	17	39	18
6	Control 2	25	35	20	0	15	45	10
Mean		29.5	27.7	30.2	5.7	17.3	44.0	13.0

Table 22. Sugar Cookie Sensory—Color

Cell No.	Duncan test; Variable Color					
	Approximate Probabilities for Post Hoc Tests					
	Error: Between MS = 16.223, Degrees of Freedom (df) = 20.00					
	Sample	(1) 36.33	(2) 29.500	(3) 24.833	(4) 26.333	(5) 34.333
1	TE-3-70		<i>0.010704</i>	<i>0.000194</i>	<i>0.000650</i>	0.400138
2	Control 2	<i>0.010704</i>		0.070765	0.188556	0.050881
3	TE-4-350	<i>0.000194</i>	0.070765		0.526381	<i>0.001032</i>
4	Control 1	<i>0.000650</i>	0.188556	0.526381		<i>0.003550</i>
5	TE-3-125	0.400138	0.050881	<i>0.001032</i>	<i>0.003550</i>	

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OTHER EMBODIMENTS

It is to be understood that while the invention has been described in conjunction with the detailed description thereof, the foregoing description is intended to illustrate and not limit the scope of the invention, which is defined by the scope of the appended claims. Other aspects, advantages, and modifications are within the scope of the following claims.

WHAT IS CLAIMED IS:

1. A shortening comprising about 11% to about 18% by weight hard fat and about 82% to about 89% by weight liquid oil, said liquid oil having from about 0.1% to
5 about 7% α -linolenic acid based on total fatty acid content.
2. The shortening of claim 1, wherein said liquid oil is selected from the group consisting of canola oil, sunflower oil, safflower oil, and soybean oil.
- 10 3. The shortening of claim 1, wherein said hard fat is selected from the group consisting of fully-hydrogenated cottonseed oil, cottonseed oil stearine, fully-hydrogenated soybean oil, soybean oil stearine, fully-hydrogenated palm oil, palm oil stearine, fully-hydrogenated canola oil, and canola oil stearine.
- 15 4. The shortening of claim 1, said liquid oil having from about 1.4% to about 4.0% α -linolenic acid.
5. The shortening of claim 1, further comprising an antioxidant.
- 20 6. The shortening of claim 1, said shortening comprising about 12.5% by weight hard fat and about 87.5% by weight liquid oil.
7. The shortening of claim 1, said shortening comprising about 14% by weight hard fat and about 86% by weight liquid oil.
- 25 8. The shortening of claim 1, said shortening comprising about 16% by weight hard fat and about 84% by weight liquid oil.
9. The shortening of claim 1, said shortening comprising about 18% by
30 weight hard fat and about 82% by weight liquid oil.

10. The shortening of claim 1, said shortening exhibiting a solid fat content at 92°F of about 4% to about 16%.

11. The shortening of claim 1, said shortening exhibiting a solid fat content at
5 104°F of about 3% to about 13%.

12. The shortening of claim 1, said shortening having about 11% to about 25% by weight saturated fatty acids.

10 13. The shortening of claim 12, said shortening having about 50% to about 70% by weight monounsaturated fatty acids.

14. The shortening of claim 13, said shortening having about 14% to about 23% by weight polyunsaturated fatty acids.

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15. The shortening of claim 14, wherein said shortening has less than about 5% *trans*-fatty acids.

16. The shortening of claim 1, said shortening having less than about 1.5% by
20 weight *trans*-fatty acids.

17. The shortening of claim 16, said shortening having about 0.5% to about 1.3% by weight *trans*-fatty acid isomers.

25 18. A shortening having a solid fat content at 100°C of about 2.5% to about 13% and a *trans*-fatty acid content of about 0.5% to about 1.4%.

19. A food product comprising the shortening of claim 1.

20. The food product of claim 19, wherein said product is selected from the group consisting of cake doughnut mix, raised yeast doughnut mix, sugar cookie mix, frozen biscuit mix, fresh biscuit mix, and machined pastry dough.

5 21. An edible composition comprising the shortening of claim 1.

22. The edible composition of claim 21, wherein said edible composition is a toaster pastry.

10 23. A fat product having an 18:1 content from about 40% to about 65%, an 18:2 content of about 7% to about 23%, an 18:3 content of about 0% to about 3.0%, and less than about 1.5% by weight *trans*-fatty acids, based upon total fatty acid content.

15 24. The fat product of claim 23, said fat product having about 0.5% to about 1.3% by weight *trans*-fatty acid isomers.

25. The fat product of claim 23, said fat product exhibiting a solid fat content at 92° F of about 4.0 to about 13.0.

20 26. The fat product of claim 23, said fat product exhibiting a solid fat content at 100° F of about 3.0 to about 12.0.

27. The fat product of claim 23, said fat product having an 18:0 content of about 5.0% to about 15.0% based on total fatty acid content.

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28. A fat product having a change in peroxide value (PV) of less than 5 meq/kg after 15 days of accelerated aging.

29. A food product comprising the fat product of claim 23.

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30. The food product of claim 29, wherein said product is selected from the group consisting of cake doughnut mix, raised yeast doughnut mix, sugar cookie mix, frozen biscuit mix, fresh biscuit mix, and machined pastry dough.

5 31. An edible composition, comprising a food fried in the fat product of claim 23.

32. A method of making a shortening comprising the steps of:

- 10 a) providing a blend comprising about 11% to about 18% by weight hard fat and about 82% to about 89% by weight liquid oil, said liquid oil having from about 0.1% to about 7% α -linolenic acid based on total fatty acid content;
- b) cooling said blend; and
- c) tempering said blend to make said shortening.

15 33. The method of claim 32, wherein said cooling step comprises cooling said blend to between about 65°F to about 82°F in a scraped surface heat exchanger for about 1.0 to about 1.8 minutes.

20 34. The method of claim 32, wherein said tempering step comprises tempering at a temperature of about 60°F to about 90°F.

35. The method of claim 34, wherein said tempering is for about 24 hours to about 72 hours.

25 36. The method of claim 32, wherein nitrogen is introduced into said blend during said cooling step.

37. A method of making a baked edible composition, comprising the steps of:

- 30 a) providing a food product comprising the shortening of claim 1; and
- b) baking said food product.

38. A method of making a fried edible composition, comprising the steps of:
- a) providing a food product comprising the shortening of claim 1; and
 - b) frying said food product.

5 39. The method of claim 38, wherein said food product is fried in the shortening of claim 1.

40. A shortening comprising about 5% by weight hard fat and about 95% by weight liquid oil.

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41. A shortening comprising about 7% by weight hard fat and about 93% by weight liquid oil.

42. A fat product having an 18:1 content from about 45% to about 75%, an
15 18:2 content of about 3% to about 10%, an 18:3 content of about 0% to about 3.0%, and less than about 1.5% by weight *trans*-fatty acids, based upon total fatty acid content.

43. A fat product having an 18:1 content from about 50% to about 80%, an
18:2 content of about 0% to about 5%, an 18:3 content of about 0% to about 2.5%, and
20 less than about 1.5% by weight *trans*-fatty acids, based upon total fatty acid content.

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