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(54) Title: REDUCED CALORIE FRENCH FRIES AND OTHER HIGH MOISTURE FAT-COATED FOODS HAVING REDUCED GREASINESS		
(57) Abstract <p>Reduced calorie french fries and other high moisture fat-coated foods having less greasiness are disclosed. Such products are typically obtained by applying to the surface of the french fry, or other food, reduced calorie fat compositions having particular fluid viscosity characteristics that correlate to reduced greasiness impressions. These reduced calorie fat compositions comprise a nondigestible fat, and optionally, a triglyceride fat or oil. The nondigestible fat in general comprises a liquid nondigestible oil and a sufficient amount of a nondigestible solid polyol polyester to control passive oil loss typically associated with the ingestion of liquid nondigestible oils.</p>		

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REDUCED CALORIE FRENCH FRIES AND OTHER HIGH MOISTURE
FAT-COATED FOODS HAVING REDUCED GREASINESS

5

TECHNICAL FIELD

10 The present invention relates to reduced calorie french fries and other high moisture fat-coated foods having reduced greasiness, and a method for preparing these foods.

BACKGROUND OF THE INVENTION

15 Deep-fried food such as chicken, fish, onion rings, and especially french fries are widely consumed. French fried potatoes are particularly popular due to their textural dichotomy, i.e., they have a crispy exterior and a fairly tender and moist interior. Deep frying is the preferred method for imparting textural dichotomy to french fried potatoes.

20 Cold or frozen uncooked or partially cooked (par-fried) potatoes pieces are typically deposited in a wire mesh basket which is immersed in a frying fat or oil heated to approximately 335° to 400°F (170° to 204°C). The potatoes are typically fried for about 120 to about 240 seconds. During frying, the potatoes absorb a substantial quantity of the frying fat or oil, typically from about 12 to about 20% by weight. Triglyceride frying fats or oils contribute a significant caloric content (about 9 calories per gram of oil) to the french fries.

25 Certain polyol fatty acid polyesters are known to be low calorie substitutes for frying fats and oils. For example, nonabsorbable, nondigestible sugar fatty acid polyesters or sugar alcohol polyesters having at least 4 ester groups of fatty acids having from 8 to 22 carbon atoms have been used as partial fat replacers in low calorie food compositions, including fried foods. (See Mattson et al; U.S. Patent 3,600,186; Issued
30 August 17, 1971.)

Unfortunately, regular ingestion of moderate to high levels of nondigestible polyol polyesters which are liquid at body temperature can result in undesirable passive oil loss, i.e., uncontrollable leakage of liquid polyesters through the anal sphincter. Solid nondigestible polyesters which have sufficiently high solids content at body
35 temperatures (i.e., 37°C) present no anal leakage problem, but they can taste waxy.

An alternative to completely liquid or completely solid nondigestible,

nonabsorbable polyol polyesters are intermediate melting polyol polyesters developed to provide passive oil loss control, while at the same time reducing waxiness impressions in the mouth. (See Bernhardt; European Patent Applications 236,288 and 233,856; Published September 9, 1987 and August 26, 1987, respectively.) These intermediate
5 melting materials exhibit a unique rheology at body temperatures by virtue of a matrix which involves a minimal level of solids (about 12% or lower) that binds the liquid portion. These intermediate melting polyol polyesters are sufficiently viscous and have a sufficiently high liquid/solid stability at body temperatures to provide passive oil loss control. An example are those obtained by substantially completely esterifying sucrose
10 with a 55:45 mixture of fully hydrogenated (hardstock) and partially hydrogenated soybean oil fatty acid methyl esters.

Intermediate melting polyol polyesters can be used as total or partial replacements for conventional triglyceride fats or oils in frying and cooking operations. Frying foods such as french fried potatoes in fats containing substantial levels (above
15 50%) of these intermediate melting polyol polyesters, can give a significantly increased greasiness impression compared to foods fried in triglyceride fats or oils. (In terms of physical characteristics, "greasiness" is, essentially, an unpleasant liquid viscosity effect in the mouth, as contrasted with "waxiness" which relates to a sensation that the fat composition has a relatively high level of solids and tastes or feels like wax. In terms of
20 organoleptic properties during french fry tasting, "greasiness" is described as a Vaseline-like coating in the mouth.)

In view of the foregoing, it would be desirable to identify reduced low calorie cooking or frying fats containing high levels of nondigestible polyol polyesters, especially intermediate melting polyol polyesters in excess of 50% by weight, which do
25 not provide excessive greasiness to french fried potatoes and other fried high moisture foods. It is an object of this invention to do so.

SUMMARY OF THE INVENTION

The present invention relates to high moisture cooked food products containing
30 a reduced calorie fat composition which do not have an undesirable greasiness taste. Such a product comprises an edible substrate with from about 3% to about 25% by weight of a reduced calorie fat composition. At least a portion of the fat composition is coated on the surface of the food product. The reduced calorie fat composition must contain a nondigestible fat component and, optionally, a conventional triglyceride
35 component.

In one embodiment, the nondigestible fat component comprises a blend of a liquid

nondigestible oil having a complete melting point below about 37°C and a nondigestible solid polyol fatty acid polyester having a complete melting point above about 37°C. The solid component is present in an amount sufficient to control passive oil loss of the liquid nondigestible oil. The nondigestible fat blend further has a Solid Fat Content profile slope between 70°F and 98.6°F of from 0 to about -0.75 % solids/°F. In this embodiment the nondigestible fat comprises from about 10% to 100% of the reduced calorie fat composition and the triglyceride fat or oil comprises from 0% to about 90% of the composition.

In an alternative embodiment, the nondigestible fat is a polyol fatty acid polyester of sugar and sugar alcohols having from 4 to 8 hydroxyl groups esterified with fatty acids having from 4 to 24 carbon atoms. These fats have a viscosity at 38.7°C of from about 5 to about 120 poise at a shear rate of 10 sec⁻¹; a liquid/solid stability at 38.7°C of at least about 30%, and a Solid Fat Content at 37°C of about 25% or less. In this embodiment the nondigestible polyol fatty acid polyester comprises from about 55% to about 85% of the reduced calorie fat composition and a conventional triglyceride comprises from about 15% to about 45%.

The reduced calorie fat composition must be formulated to have a fluid viscosity of from about 12 to about 105 centipoise at 60°C. The ratio of fluid viscosity of the fat composition to the percent fat in the cooked or prepared food product will typically range from about 2.5 to about 25.

The present invention also relates to a method for preparing high moisture cooked food products of reduced greasiness method comprising incorporating from about 3% to about 25% of these reduced calorie fat compositions into the food. It has been discovered through taste testing that there is a correlation between the fluid viscosity of the reduced calorie fat compositions used to prepare these high moisture food products and the greasiness impression exhibited by foods which have been coated with these fat compositions.

DETAILED DESCRIPTION OF THE INVENTION

A. Definitions

By "nondigestible" is meant that only about 70% or less of a fat or oil so characterized is digested by the body. Preferably, only about 20% or less of such fats or oils are digested.

By "digestible triglyceride fat or oil" is meant a triglyceride fat or oil that is substantially completely digested by the body. Typically, at least about 90% of such triglyceride fats or oils are digested.

By "polyol" is meant a polyhydric alcohol containing at least 4, preferably from 4 to 11, more preferably from 4 to 8, most preferably from 6 to 8, hydroxyl groups. Polyols include sugars (i.e., monosaccharides, disaccharides, and tri-saccharides), sugar alcohols (i.e., the reduction product of sugars), other sugar derivatives (i.e., alkyl glucosides), polyglycerols such as diglycerol and triglycerol, pentaerythritol and polyvinyl alcohols. Specific examples of suitable sugars, sugar alcohols and sugar derivatives include xylose, arabinose, ribose, xylitol, erythritol, glucose, methyl glycoside, mannose, galactose, fructose, sorbitol, maltose, lactose, sucrose, raffinose, trehalose and maltotriose. Preferred polyols include erythritol, xylitol, sorbitol, and glucose, with sucrose being especially preferred.

By "polyol fatty acid polyester" is meant a polyol having at least 4 fatty acid ester groups. Polyol fatty acid esters that contain 3 or less fatty acid ester groups are generally digested in the manner of ordinary triglycerides, whereas those polyol fatty acid esters containing 4 or more fatty acid ester groups are substantially nondigestible. Not all of the hydroxyls of the polyol need be esterified, but it is preferable that disaccharide molecules contain no more than 3 unesterified hydroxyl groups, and more preferably no more than 2 unesterified hydroxyl groups. Typically, substantially all (e.g., at least about 85%, preferably at least about 95%) of the hydroxyl groups are esterified. In the case of sucrose polyesters, typically from about 7 to 8 of the hydroxyl groups are esterified.

By "fatty acid ester group" is meant a moiety formed from the reaction of a hydroxyl group with a fatty acid or fatty acid derivative which forms an ester that has fat-like properties. The fatty acid radicals have at least 4 carbon atoms and can contain up to 26 carbon atoms. The fatty acid radicals can be saturated or unsaturated, including positional or geometric isomers, e.g., cis- or trans- isomers, and can be naturally derived or synthetic.

As used herein "cooking" or "cooked" refers to a procedure wherein food products are treated with heat prior to their consumption, such as, for example, by frying, baking, broiling, microwaving, etc. Typically, the moisture content of the food is reduced during cooking.

As used herein, the term "comprising" means various components or steps can be conjointly employed in the compositions, foods, and methods of the present invention. Accordingly, the term "comprising" encompasses the more restrictive terms "consisting essentially of" and "consisting of".

All percentages and proportions used herein are by weight unless otherwise specified.

B. Reduced Calorie Fat Compositions

The food products herein are prepared by incorporating a reduced calorie fat composition comprising from about 10% to 100% of a non-digestible fat component and from 0% to about 90% of a triglyceride oil or fat. These reduced calorie fat compositions have specific theological characteristics as hereinafter described.

1. Nondigestible Fat Component

The reduced calorie fat compositions must contain a nondigestible fat component which can be a blend of a liquid nondigestible oil and a solid nondigestible polyol fatty acid polyesters having a relatively flat Solid Fat Content (SFC) profile slope across the range of temperatures between room temperature and body temperature or it can be an "intermediate melting" polyol polyester mixture which has certain viscosity characteristics and which exhibits defined SFC characteristics between room and body temperature.

a) Liquid/Solid Blends

i) Nondigestible Liquid Oil

A key component of the liquid/solid blend type of nondigestible fat component is a liquid nondigestible oil having a complete melting point above about 37°C. Suitable liquid nondigestible edible oils for use herein include liquid polyol fatty acid polyesters (see Jandacek; U.S. Patent 4,005,195; Issued January 25, 1977); liquid esters of tricarballic acids (see Hamm; U.S. Patent 4,508,746; Issued April 2, 1985); liquid diesters of dicarboxylic acids such as derivatives of malonic and succinic acid (see Fulcher; U.S. Patent 4,582,927; Issued April 15, 1986); liquid triglycerides of alpha-branched chain carboxylic acids (see Whyte; U.S. Patent 3,579,548; Issued May 18, 1971); liquid ethers and ether esters containing the neopentyl moiety (see Minich; U.S. Patent 2,962,419; Issued Nov. 29, 1960); liquid fatty polyesters of polyglycerol (See Hunter et al; U.S. Patent 3,932,532; Issued Jan. 13, 1976); liquid alkyl glycoside fatty acid polyesters (see Meyer et al; U.S. Patent 4,840,815; Issued June 20, 1989); liquid polyesters of two ether linked hydroxypolycarboxylic acids (e.g., citric or isocitric acid) (see Huhn et al; U.S. Patent 4,888,195; Issued December 19, 1988); liquid esters of epoxide-extended polyols (see White et al; U.S. Patent 4,861,613; Issued August 29, 1989); all of which are incorporated herein by reference, as well as liquid polydimethyl siloxanes (e.g., Fluid Silicones available from Dow Corning).

Preferred liquid nondigestible oils are liquid polyol fatty acid polyesters of sugar and sugar alcohols, and their mixtures. The preferred sugars and sugar alcohols include erythritol, xylitol, sorbitol, and glucose, with sucrose being especially preferred. The sugar or sugar alcohol are preferably esterified with fatty acids containing from 8 to 22

carbon atoms, and most preferably from 12 to 18 carbon atoms. Suitable naturally occurring sources of such fatty acids include corn oil, cottonseed oil, peanut oil, soybean oil, canola oil (i.e. low erucic acid rapeseed oil), sunflower seed oil, sesame seed oil, safflower oil, palm kernel oil, and coconut oil.

5 Liquid polyol fatty acid polyesters have minimal or no solids at body temperatures. Typical liquid polyesters contain a high proportion of C₁₂ or lower fatty acid groups or else a high proportion of C₁₈ or higher unsaturated fatty acid groups. Those liquid polyol polyesters having high proportions of unsaturated C₁₈ or higher fatty acid groups, have at least about half unsaturated fatty acids. Preferred unsaturated
10 fatty acids are oleic acid, linoleic acid, and mixtures thereof. Nonlimiting examples of suitable liquid polyol polyesters are sucrose tetraoleate, sucrose pentaoleate, sucrose hexaoleate, sucrose heptaoleate, sucrose octaoleate, sucrose hepta- and octaesters of unsaturated soybean oil fatty acids, canola oil fatty acids, cottonseed oil fatty acids, corn oil fatty acids, peanut oil fatty acids, palm kernel oil fatty acids, or coconut oil fatty
15 acids, glucose tetraoleate, the glucose tetraesters of coconut oil or unsaturated soybean oil fatty acids, the mannose tetraesters of mixed soybean oil fatty acids, the galactose tetraoleate, arabinose tetralinoleate, xylose tetralinoleate, galactose pentaoleate, sorbitol tetraoleate, sorbitol hexaesters of unsaturated soybean oil fatty acids, xylitol pentaoleate, and mixtures thereof.

20 Liquid polyol fatty acid polyesters can be prepared by a variety of methods known to those skilled in the art. These methods include: transesterification of the polyol (i.e. sugar or sugar alcohol) with methyl, ethyl or glycerol fatty acid esters using a variety of catalysts; acylation of the polyol with a fatty acid chloride or a fatty acid anhydride; and acylation of the polyol with a fatty acid, per se. See, for example, U.S.
25 Patent Nos. 2,831,854, 3,600,186, 3,963,699, 4,517,360 and 4,518,772, all of which are incorporated by reference. Specific, but nonlimiting, examples of the preparation of liquid polyol polyesters suitable for use in the practice of the present invention are disclosed in Young et al; World Patent Application US91-02394 (publication number WO91-15964); published October 31, 1991, which method is incorporated by reference.

30 ii) Solid Polyol Fatty Acid Polyesters

 Solid polyol fatty acid polyesters are solid at temperatures of about 37°C and higher, preferably are solid at temperatures of about 50°C and higher, and most preferably at temperatures of about 60°C or higher. These solid polyol polyesters have the ability to bind high levels of edible liquid nondigestible oils, when included at
35 appropriate levels. These solid polyol polyesters control or prevent the passive oil loss problem associated with the ingestion of such liquid oils.

Preferred solid polyol fatty acid polyesters of this type are selected from solid sugar fatty acid polyesters, solid sugar alcohol fatty acid polyesters and mixtures thereof. The preferred sugars and sugar alcohols include those previously defined for the liquid polyol polyesters, with sucrose being especially preferred.

5 x) Diversely Esterified Polyol Polyesters

One class of suitable solid polyol polyesters for use in the liquid/solid blend are those wherein the esters groups comprise a combination of (a) C₁₂ or higher unsaturated fatty acid radicals, C₄-C₁₂ fatty acid radicals or mixtures thereof, and (b) at least about 15% C₂₀ or higher saturated fatty acid radicals, preferably at least about 10 30%, more preferably at least about 50%, most preferably at least about 80%, long chain saturated fatty acid radicals.

Suitable unsaturated fatty acid radicals contain at least 12, preferably from 12 to 26, more preferably from 18 to 22, most preferably 18, carbon atoms. Suitable short chain saturated fatty acid radicals contain from 4 to 12, preferably from 6 to 12, and 15 most preferably from 8 to 12, carbon atoms. Suitable long chain saturated fatty acid radicals contain at least 20, preferably from 20 to 26, most preferably 22, carbon atoms. The fatty acid radicals can be used singly or in mixtures with each other, in all proportions. Straight chain fatty acid radicals are preferred. Examples of suitable long chain unsaturated fatty acid radicals are monounsaturated radicals such as lauroleate, 20 myristoleate, palmitoleate, oleate, elaidate, and erucate, and polyunsaturated radicals such as linoleate, arachidonate, linoleate, eicosapentaenoate, and docosahexaenoate. In terms of oxidative stability, the monounsaturated and diunsaturated fatty acid radicals are preferred. Examples of suitable short chain saturated fatty acid radicals are butyrate, hexanoate, octanoate, decanoate and dodecanoate. Examples of suitable long chain 25 saturated fatty acid radicals are eicosanoate (arachidate), docosanoate (behenate), tetracosanoate (lignocerate), and hexacosanoate (cerotate).

Mixed fatty acid radicals from oils which contain substantial amounts of the desired long chain unsaturated fatty acids, short chain saturated fatty acids, or long chain saturated fatty acids can be used as sources of fatty acid radicals in preparing the 30 solid polyol polyesters useful in the liquid/solid blend type of nondigestible fat component. The mixed fatty acids from such oils should preferably contain at least about 30% (more preferably at least about 50%, most preferably at least about 80%) of the desired long chain unsaturated, short chain saturated or long chain saturated fatty acids. For example, palm kernel oil provides a mixture of saturated fatty acids having 35 from 8 to 12 carbon atoms. Similarly, rapeseed oil or soybean oil provides a mixture of monounsaturated and polyunsaturated fatty acids having 12 to 26 carbon atoms, and

hardened (i.e., hydrogenated) high erucic rapeseed oil fatty acids can be as a source of long chain saturated fatty acids having from 20 to 26 carbon atoms. Preferably, the C₂₀ or higher saturated fatty acids (or their derivatives, e.g. methyl esters) are concentrated, for example, by distillation. An example of source oils for these solid polyol polyesters are high oleic sunflower oil and substantially completely hydrogenated high erucic rapeseed oil. When sucrose is substantially completely esterified with a 1:3 by weight blend of the methyl esters of these two oils, the resulting polyester has a molar ratio of unsaturated C₁₈ acid radicals to saturated C₂₀ or higher acid radicals of about 1:1, the saturated C₂₀ and C₂₂ acid radicals being about 28.6% of the total fatty acid radicals. The higher the proportion of the desired long chain unsaturated/short chain saturated and long chain saturated fatty acids in the source oils used in making the solid polyol polyesters, the more efficient the polyesters will be in their ability to bind the liquid nondigestible oils.

The molar ratio of (a) long chain unsaturated fatty acid radicals or short chain fatty acid radicals or mixtures thereof, to (b) long chain saturated fatty acid radicals, is from about 1:15 to about 1:1. Preferably, this molar ratio of (a) to (b) radicals is from about 1:7 to about 4:4, most preferably from about 1:7 to about 3:5.

Examples of solid polyol fatty acid polyesters containing mixtures of (a) and (b) radicals include sucrose tetrabehenate tetracaprylate, sucrose pentabehenate trilaurate, sucrose hexabehenate dicaprylate, sucrose hexabehenate dilaurate, the sorbitol hexaester of palmitoleic and arachidic fatty acid radicals in a 1:2 molar ratio, the raffinose octaester of linoleic and behenic fatty acid radicals in a 1:3 molar ratio, the maltose heptaester of a mixture of sunflower oil and lignoceric fatty acid radicals in a 3:4 molar ratio, the sucrose octaester of oleic and behenic fatty acid radicals in a 2:6 molar ratio, the sucrose octaester of lauric, linoleic and behenic fatty acid radicals in a 1:3:4 molar ratio, and the sucrose hepta- and octaesters of C₁₈ mono- and/or di-unsaturated fatty acid radicals and behenic fatty acid radicals in a molar ratio of unsaturated: behenic acid radicals of about 1:7 to 3:5.

y) Polyol Polyester Hardstocks

Other suitable solid polyol polyesters are described as "hardstocks". They contain ester groups which consist essentially of C₁₄-C₁₈ saturated fatty acid radicals used singly or in mixtures with each other. Typically these are straight chain fatty acid radicals. Mixed fatty acid radicals from completely or substantially completely hydrogenated vegetable oils containing substantial amounts of the saturated fatty acids can be used as sources of fatty acid radicals in preparing the solid polyol polyesters. Preferably such oils contain at least about 30% (more preferably at least about 50%,

most preferably at least about 80%) of the desired saturated fatty acids. Suitable source oils include completely or substantially completely hydrogenated soybean oil, cottonseed oil, palm oil, peanut oil, corn oil, safflower oil, sunflower oil, sesame oil, canola oil, and high erucic acid rapeseed oil. These oils are typically hydrogenated to an Iodine Value of about 12 or less, and preferably to an Iodine Value of about 8 or less.

z) Solid Polyol Fatty Acid Polyester Preparation

These solid polyol polyesters can be made according to prior known methods for preparing polyol polyesters. One method of preparation is reacting the acid chlorides or acid anhydrides of the respective fatty acids with sucrose. A sequential esterification process is preferably used when sucrose polyesters of mixed fatty acids are being prepared. In this sequential esterification process, sucrose is initially partially esterified with either the (a) long chain unsaturated or the short chain saturated acid chlorides, followed by complete or substantially complete esterification of this initial reaction product with the (b) long chain saturated fatty acid chlorides, in that order, or in the reverse order.

Another method for preparing these solid polyol polyesters is by reacting methyl esters of the respective fatty acids with sucrose in the presence of a fatty acid soap and a basic catalyst such as potassium carbonate. See, for example, Rizzi et al; U.S. Patent 3,963,699; Issued June 15, 1976, Volpenhein; U.S. Patent 4,518,772; Issued May 21, 1985, and Volpenhein; U.S. Patent 4,517,360; Issued May 14, 1985, all of which are incorporated by reference. See also Young et al.; World Patent Application US91-02394 (publication number WO91-15964); Published October 31, 1991, which is herein incorporated by reference.

iii) Formulation of Liquid/Solid Blends

The liquid/solid nondigestible fat blend can be formulated by mixing liquid nondigestible oil and a sufficient amount of the solid polyol polyester to control or prevent passive oil loss. What constitutes a "sufficient amount to control or prevent passive oil loss" with regard to the solid polyol polyester depends upon the particular solid polyol polyester involved, the particular passive oil loss control benefits desired, and the greasiness impressions desired for the nondigestible fat component.

For diversely esterified solid polyol polyesters, the nondigestible fat component usually comprises from about 80 to about 99% liquid nondigestible oil and from about 1 to about 20% solid polyol polyester. Preferably such blends comprise from about 85 to about 99% liquid nondigestible oil and from about 1 to about 15% solid polyol polyester. More preferably such blends comprise from about 91 to about 99% liquid nondigestible oil and from about 1% to about 9% solid polyol polyester.

For solid polyol polyesters hardstocks, the nondigestible fat component usually comprises from about 60 to about 90% liquid nondigestible oil and from about 10 to about 40% solid polyol polyester. Preferably such blends comprise from about 70 to about 90% liquid nondigestible oil and from about 10 to about 30 % solid polyol polyester. Most preferably such blends comprise from about 75 to about 85% liquid nondigestible oil and from about 15 to about 25% solid polyol polyester. Use of higher levels of liquid nondigestible oil can be desirable from the standpoint of reducing waxiness, but higher levels of solid polyol polyester are desirable from the standpoint of controlling or preventing passive oil loss associated with the liquid oils.

The nondigestible liquid/solid blends should exhibit relatively flat SFC profile slopes across the range of temperature range of from typical room temperature to body temperature, i.e., from 70°F to 98.6°F. Typically, the SFC profile slope between these temperatures is from 0 to -0.75%solids/°F, preferably from 0 to -0.5%solids/°F, more preferably from 0 to -0.3%solids/°F, and most preferably from 0 to -0.1%solids/°F. The liquid/solid stability of these liquid/solid blends is typically at least about 30%, preferably at least about 50%, more preferably at least about 60%, and most preferably at least about 70%.

b) Intermediate Melting Nondigestible Fat Components

Nondigestible fat components can also be formulated other than by blending together liquid nondigestible oils and solid polyol polyesters. A nondigestible polyol fatty acid polyester mixture comprising sugars and sugar alcohols having from 4 to 8 hydroxyl groups esterified with fatty acid ester groups having from 4 to 24 carbon atoms. Such polyol polyester mixtures have, at 100°F (37.8°C), a viscosity of from about 5 to about 120 poise at a shear rate of 10-1 seconds, preferably from about 10 to about 75 poise, most preferably from about 15 to about 30 poise, and a liquid/solid stability (as defined in the Analytical Methods) of at least about 30%, preferably at least about 50%, more preferably at least about 60%, most preferably at least about 70%. These intermediate melting polyol polyesters have a high liquid/solid stability, i.e., the liquid portion of the mixture does not readily separate from the solid portion. The intermediate melting polyol polyester mixtures appear to be solid even though up to 95% or more of the polyester species therein are liquid.

Solid Fat Content (SFC) reasonably approximates the percent by weight solids of a fatty material at a given temperature. The intermediate melting polyol polyesters desirably have an SFC at 98.6°F (37°C) of about 25% or less, preferably in the range of from about 4 to about 18% and most preferably in the range of from about 4 to about 10%.

The polyol (e.g., sucrose) is preferably esterified with mixtures of fatty acids having from 8 to 22 carbon atoms. Most preferably, at least about 70% of the fatty acids are selected from the group consisting of lauric, myristic, palmitic, stearic, oleic, and elaidic (C_{18:1}), linoleic (C_{18:2}), and behenic acids and mixtures thereof. These intermediate melting polyol polyesters generally have an Iodine Value of from about 10 to about 70, preferably from about 15 to about 60. The preferred polyesters also have a fatty acid composition characterized by: (a) not more than about 0.6% fatty acids having 3 or more double bonds; (b) not more than about 20% fatty acids having 2 or more double bonds; and (c) not more than about 35% of the fatty acid double bonds are trans-double bonds. The number of trans double bonds is determined by infrared spectroscopy.

- Preferred fatty acid compositions for intermediate melting polyesters are:
- less than about 12% palmitic acid;
- from about 30 to about 70% stearic acid, preferably from about 40% to about 70%;
- from about 15 to about 60% oleic and elaidic acids, preferably from about 20% to about 50%;
- less than about 12% linoleic acid; and
- less than about 0.6% linolenic acid.

Highly preferred intermediate melting polyol polyesters are sucrose fatty acid polyesters wherein the majority of the hydroxyl groups esterified with fatty acids. Preferably at least about 85%, and most preferably at least about 95%, of the esters are octaesters, heptaesters, hexaesters, or mixtures thereof. Preferably, no more than about 40% of the esters are hexaesters or heptaesters, and at least about 60% of the esters are octaesters. Most preferably at least about 70% of the esters are octaesters and the penta- and lower esters are not more than 3% of the mixture.

These intermediate melting polyol polyesters can be prepared by a variety of methods including those mentioned above. See, for example, the preparation of intermediate melting sucrose polyesters according to European Patent Applications 233,856 and 236,288, to Bernhardt, published August 26 and September 9, 1987.

Preferred intermediate melting polyol polyesters described above having maximum levels of fatty acids with two or more double bonds, as well as trans-double bonds, can be prepared using two or three source oil streams. See U.S. application Serial No. 421,867, to Robert W. Johnston, Josephine L. Kong-Chan, Richard G. Schafermeyer and Paul Seiden, filed October 16, 1989 (herein incorporated by reference), which discloses these preferred intermediate melting polyol polyesters and

their preparation.

2. Conventional Triglyceride Oil or Fat Component

The fat compositions herein can optionally include a conventional digestible triglyceride fat or oil. When the nondigestible fat component comprises intermediate melting polyol polyesters, a digestible triglyceride fat or oil is required to provide fat compositions having the requisite fluid viscosity characteristics.

As used herein, the term "triglyceride oil" refers to those triglyceride compositions which are fluid or liquid above about 25°C. The triglyceride oils can include those which are fluid or liquid below 25°C. While these triglyceride oils consist primarily of triglyceride materials, they can also include residual levels of other components such as mono- and diglycerides. To remain fluid or liquid at temperatures below 25°C, the triglyceride oil contains a minimal amount of glycerides having melting points higher than about 25°C so as to limit the solids increase when the triglyceride oil is cooled. It is desirable that the triglyceride oil be chemically stable and resistant to oxidation.

Suitable triglyceride oils can be derived from naturally occurring liquid vegetable oils such as cottonseed oil, soybean oil, safflower oil, corn oil, olive oil, coconut oil, palm kernel oil, peanut oil, rapeseed oil, canola oil, sesame seed oil, sunflower seed oil, and mixtures thereof. Also suitable are liquid oil fractions obtained from palm oil, lard and tallow by, for example, graining or directed interesterification, followed by separation of the oils. Partially hydrogenated vegetable oils may also be used, e.g., refined and slightly hydrogenated soybean oil or refined cottonseed oil.

As used herein, the term "triglyceride fat" refers to those triglyceride compositions which are solid or plastic above about 25°C. Solid fats can be derived from plants or animals or can be edible synthetic fats or oils. Animal fats include lard, tallow, oleo oil, oleo stock, oleo stearin. Hydrogenated unsaturated vegetable oils which are crystallized or mixed with sufficient solid triglycerides to form a rigid interlocking crystalline structure which interferes with the free-flowing properties of the liquid oil can also be used. See U.S. Patent 3,355,302 to Purves et al, issued November 28, 1967, and U.S. Patent 3,867,556 to Darragh et al, issued February 18, 1975 (herein incorporated by reference), for further examples of solid fats. Addition of solid fats can cause adverse effects on the organoleptic properties, in particular waxiness and flavor display, of french fries or other high moisture foods. However, some level of solid fat is required in parfried foods as a freezing aid.

Triglyceride fats and oils include triglycerides in which one or more of the hydroxyls have been esterified with acetyl, propionyl, butyryl, caproyl, caprylyl, or

capryl radicals, and any remaining hydroxyl groups, if any, are esterified with acyl radicals of saturated or unsaturated fatty acids having from 12 to 24 carbon atoms.

Medium chain triglycerides (MCT's) can be added to the fat compositions, especially when the food is to be baked. Preferably the MCT's have the following fatty acid composition: from 0% to about 15% C_{6:0}, from about 40% to about 85% C_{8:0},
5 from about 15% to about 55% C_{10:0}, and from 0% to about 5% C_{12:0}. Most preferably, the MCT fatty acid composition is about 2-4% C_{6:0}, about 50-75% C_{8:0}, about 25-43% C_{10:0}, and about 0.5-2% C_{12:0}.

See European patent application 390,410 to Seiden, published March 10, 1990
10 which discloses reduced calorie fats comprising MLCT's useful in the present invention, and especially Examples 1 and 2 for methods for making same. See also U.S. 4,888,196 issued to Ehrmann et al.

The MLCT's comprise: (1) at least about 85%, preferably at least about 90%, and most preferably at least about 95% combined MLM, MML, LLM and LML
15 triglycerides.

For most fat materials used in the present invention, mono-long chain triglycerides (MLM and MML) are usually preferred over di-long chain triglycerides (LLM and LML), as well as the tri-long chain (LLL) and tri-medium chain (MMM) triglycerides. These preferred MLCT's comprise: (1) at least about 80%, preferably at
20 least about 90% and most preferably at least about 95% combined MLM and MML triglycerides; (2) no more than about 10%, preferably no more than about 5%, and most preferably no more than about 2% combined LLM and LML triglycerides; (3) no more than about 8%, preferably no more than about 4%, and most preferably no more than about 3% MMM triglycerides; and (4) no more than about 2%, preferably no more than
25 about 1%, and most preferably no more than about 0.5% LLL triglycerides.

The fatty acid composition of MLCT's preferably comprise from about 10 to about 70%, preferably from about 30 to 60%, and most preferably from about 40 to about 50% C₆ to C₁₀ saturated fatty acids. The C₈ and C₁₀ saturated fatty acids are most preferred. Preferably, the MLCT's contain not more than about 5%, and most
30 preferably no more than about 0.5% C₆ saturated fatty acid.

The MLCT's preferably comprise from about 30 to about 90%, preferably from about 40 to about 70%, and most preferably from about 40 to about 60% C₁₈ to C₂₄ saturated fatty acids. More preferably, the MLCT's comprise from about 20 to about 70%, and preferably from about 25 to about 50% C₂₀ to C₂₄ long chain saturated fatty
35 acids. Preferred MCT's have fatty acid compositions which comprise no more than about 12%, and most preferably no more than about 9% C₂₀ to C₂₄ saturated fatty

acids other than C₂₂ (behenic) saturated fatty acid. For MCT's containing stearic and behenic acid, the MLCT's preferably comprise from about 10 to about 30% C₁₈ (stearic) saturated fatty acid.

The MLCT's useful in the present invention can contain minor amounts of other fatty acids besides medium and long chain saturated fatty acids. For example, small amounts of C_{12:0}, C_{14:0}, C_{16:0}, C_{18:1}, C_{18:2} and C_{18:3} fatty acids can be present.

The MLCT's also typically comprise no more than about 6% fatty acids selected from C_{18:1}, C_{18:2} and C_{18:3} unsaturated fatty acids, and mixtures thereof, and most preferably no more than about 0.5%. Preferred MLCT's also comprise no more than about 3% lauric or myristic fatty acids, and mixtures thereof.

Preferred triglycerides comprise at least about 80% triglycerides having carbon number of from C₃₄ to C₃₈, from about 40 to about 50% C₈ to C₁₀ saturated fatty acids and from about 35 to about 50% stearic acid.

The MLCT's useful in the fat composition herein can be prepared by a wide variety of techniques such as:

- (a) random rearrangement of long chain and medium chain triglycerides;
- (b) esterification of glycerol with a blend of the corresponding fatty acids;
- (c) transesterification of a blend of medium and long chain fatty acid methyl esters with glycerol; and
- (d) transesterification of long chain fatty acid glycerol esters (e.g., glyceryl behenate) with medium chain triglycerides.

MCT's and MLCT's are preferred for use in the fat compositions of the present invention from a solvency and caloric density standpoint, whereas conventional triglycerides are preferred from a stability standpoint.

3) Formulation of Fat Compositions Used Herein

The fat compositions used in the present invention can be formulated by combining from 10% to about 100% of nondigestible fat components and from 0% to about 90% triglyceride fat or oil.

Fat compositions containing diversely esterified solid polyol polyesters preferably comprise from about 35% to 100% nondigestible fat and from 0 to about 65% triglyceride fat or oil, more preferably from about 55% to 100% nondigestible fat and from 0 to 45% triglyceride, and most preferably from about 55 to about 90% nondigestible fat and from about 10 to about 45% triglyceride fat or oil.

Fat composition containing solid polyol polyester hardstock preferably comprise from about 35 to about 85% nondigestible fat and from about 15 to about 65% triglyceride fat or oil, more preferably from about 45 to about 75% nondigestible fat and

from about 25 to about 55% triglyceride fat or oil.

Fat compositions wherein the nondigestible fat component contains intermediate melting polyol polyesters will generally comprise from about 55% to about 85% nondigestible fat and from about 15 to about 45% triglyceride fat or oil. Preferably such compositions comprise from about 55 to about 75% nondigestible fat and from about 25 to about 45% triglyceride fat or oil, and more preferably from about 55 to about 65% nondigestible fat and from about 35 to about 45% triglyceride fat or oil.

The fat compositions useful herein can be fortified with vitamins and minerals, particularly the fat-soluble vitamins. The fat-soluble vitamins include vitamin A, vitamin D, and vitamin E. See U.S. Patent 4,034,083 to Mattson (herein incorporated by reference) which discloses fat-soluble vitamins useful in fortifying polyol fatty acid polyesters. Various other ingredients typically present in frying fats can also be included in the compositions used in the present invention. These other ingredients include stabilizers to help protect against oxidative deterioration at high temperatures. Silicone oils, particularly methyl and ethyl silicone gels, are useful for this purpose and also function as anti-foaming agents. Methyl silicones have also proven effective in reducing the rate of oil polymerization during frying. Other additives typically included in frying fat such as minor amounts of optional flavorings, emulsifiers, anti-spattering agents, anti-sticking agents, antioxidants or the like can also be present.

4) Viscosity Characteristics of the Fat Compositions Used Herein

Fluid viscosity is a measure of the internal friction between layers of liquid molecules in the fat and directly impacts both the lubriciousness and greasiness impression of fats. In fried food applications, lubriciousness makes the food more palatable. The fat compositions herein generally exceed a certain minimum fluid viscosity to achieve lubriciousness. During mastication, shear forces cause a thinning and dispersal of the fat phase so that a thin film is formed on particles of food. Such a thin film dispersed with the food particles imparts lubriciousness to the masticated food and enhances the overall taste by reducing dryness and transporting fat soluble flavors. However, sometimes the fluid fat phase is not completely dispersed with the food, but rather forms a separate coating on the oral surfaces. This separate coating is perceived in the mouth as greasiness. Greasiness is an undesirable sensory effect in fried foods.

It is therefore important for fat compositions used to coat cooked food to have fluid viscosities which are above a certain minimum to achieve lubriciousness, but below a critical maximum to avoid greasiness. In general, a fluid viscosity of from about 12 to about 105 centipoise for the fat composition gives an acceptable greasiness impression and sensory benefits for french fried potatoes and other high moisture foods containing

these fat compositions. Indeed, the greasiness impression of the french fried potatoes of the present invention can be minimized to parity with that of french fried potatoes fried in a 100% triglyceride frying fat by using fat compositions which provide these particular fluid viscosity characteristics.

5 The viscosity values used to characterize the fat compositions are determined at the temperature of the food when it is consumed. The temperature of 140°F (60°C) was selected for measuring the minimum and maximum fluid viscosity values since it is essentially the temperature at which french fried potatoes and other high moisture fat-coated foods are typically consumed. It has surprisingly been found that the fluid
10 viscosity of the fat compositions at this temperature is correlatable to the greasiness impression left by french fried potatoes and other high moisture foods coated with these compositions, as determined by organoleptic testing.

 The maximum fluid viscosity can vary somewhat depending on the fat content of the fried food. In the case of "high fat" foods (i.e., fat content greater than about 16%),
15 the fluid viscosity of the fat composition should generally be about 70 centipoise or less, preferably 60 centipoise or less, and most preferably 50 centipoise or less. In the case of "medium fat" foods (i.e., fat content of from about 13% to about 16%), the fluid viscosity of the fat composition should be 85 centipoise or less, preferably 75 centipoise or less, and most preferably 65 centipoise or less. In the case of "low fat" foods (i.e., fat
20 content less than about 13%) the fluid viscosity should be about 105 centipoise or less, preferably about 95 centipoise or less, and most preferably about 85 centipoise or less. In general, the fluid viscosity can be increased as the fat content decreases and still provide reduced greasiness impressions in french fried potatoes or other high-moisture fried foods. Thus, for fried foods it has been found that a range for the ratio of fluid
25 viscosity of the fat composition to percent total fat in the product can be specified. Generally this ratio will vary from 2.5 to 25, more preferably from about 2.5 to about 9.

 There are a number of factors or variables which can affect the fluid viscosity of fat compositions. By controlling these variables, it is possible to formulate fat compositions of the foregoing type which will have the requisite fluid viscosity
30 characteristics so as to reduce greasiness of cooked foods prepared therewith.

 One factor is the molecular weight of the fat components. Small differences in molecular weight can have a large impact on the fluid viscosity of a particular fat composition. In general, the fluid viscosity of the fat composition increases as the molecular weight increases. Because triglycerides generally have lower molecular
35 weights than nondigestible fats, increasing the proportion of the triglyceride component can lower the fluid viscosity of the fat composition. While increased proportions of

nondigestible fat component maximizes caloric reduction, this increase must be balanced against the increase in fluid viscosity, and, hence, the added greasiness impression. As noted the fat compositions comprise from about 10 to 100% nondigestible fat and from 0 to about 90% triglyceride fat or oil. In lower fat fried foods (i.e., <16%), it is possible
5 to make products with acceptable greasiness impressions using 100% nondigestible fat. In higher fat fried foods (i.e., >16%), the nondigestible fat may have to be blended with triglycerides to achieve the desired fluid viscosity.

Other factors or features which affect the fluid viscosity of the fat compositions relate to the nature of the nondigestible fat compositions. For example, the level of
10 solids in the nondigestible fat component while necessary to control passive oil loss typically associated with the ingestion of liquid nondigestible oils, can affect the viscosity. The presence of high levels of solids may also lead to rapid crystallization of the fat composition which in turn can lead to an increased fluid viscosity of the fat composition. Such increases in viscosity can be especially troublesome during cooling
15 of cooked foods. It is thus desirable for the solids levels to be set so that the food experiences minimal crystallization and viscosity increase during cooling from the serving temperature of 140°F. Crystallization is determined by the presence of exothermic peaks measured by DSC (differential scanning calorimetry) as described in the Analytical Methods section. Preferably, no crystallization is measured during the
20 first 5 minutes, more preferably no crystallization is measured during the first 10 minutes, and most preferably no crystallization is measured for the full 20 minutes of the cooling profile.

Another factor which can affect fluid viscosity is the level of saturated fatty acids present in the nondigestible fat. The frictional interaction and flow properties of the fat
25 are influenced by the intermolecular bonding and packing that occurs between the fatty acid chains. Saturated fatty acid chains are more viscous at room temperature. Decreasing the level of saturated fatty acids of the nondigestible fat reduces its fluid viscosity, but it also reduces the oxidative stability. A balance between viscosity and oxidative stability and fry-life must met. The saturated fatty acids typically comprise
30 from about 7 to about 60%, preferably from about 10 to 40%, most preferably from about 15 to about 35% of the ester groups of the solid component of the nondigestible fat component.

C. Preparation of Foods Cooked with Reduced Fat Compositions

The present invention also relates to preparation of french fried potatoes and
35 other high moisture foods cooked with the fat compositions described above. As used herein, the term "high moisture food" refers to a food having a moisture content of

about 10% or more, preferably about 15% or more, more preferably about 25% or more, and most preferably from about 35% to about 70%. These foods typically have a fairly crisp exterior and a fairly moist or tender interior. This end product moisture content can be achieved before or after treatment with the fat composition.

5 The fat compositions are applied to the exterior surface of high moisture foods, but they may also be incorporated into the interior thereof. The food products of the present invention comprise an edible substrate having incorporated therein from about 3% to about 25%, more preferably from about 10% to 20% of the reduced calorie fat compositions described herein. At least a portion of the fat composition is coated on
10 the surface of the resulting food product.

 The present invention particularly relates to french fries and other high moisture foods that are coated with these reduced calorie fat compositions. As used herein, the term "fat-coated foods" refers to foods having all or a portion of the fat on its surface. The fat compositions can be applied to edible substrate by a variety of means including
15 immersing, dipping, soaking, spraying, blowing, pouring, pan coating, tumble coating, brushing, applying with a roller, falling film methods, enrobing and curtain coating. The fat composition can be heated during application to the food substrate, such as in the case of frying. If desired, the fat compositions of the present invention can be applied to the surface of the food before cooking or baking. The fat composition can also be
20 applied to the surface of a fat containing food. This surface fat is usually absorbed to some extent by the food.

 The method for frying french fried potatoes and other high moisture foods comprises immersing these foods into a heated fat composition of the present invention for an appropriate period of time. The particular temperatures and times for frying
25 depend on the particular food, the desired final moisture content, product appearance and texture desired, as well as the final fat content.

 In the case of french fried potatoes, cold or frozen uncooked or partially cooked (parfried) french fried potatoes are deposited in a wire mesh basket which is immersed in a fat composition at from about 335° to about 400°F (from about 168°C to about 204°
30 C) for from about 120 to about 240 seconds, preferably for 190 seconds at 171°F-177° C. It is believed that cooking the french fried potatoes or other high moisture food at higher temperatures for a shorter period of time may improve the greasiness impression of the french fried potatoes or other high moisture food.

 It has also been found that when french fried potatoes are made using the fat
35 composition herein, the final product can have a gelatinous texture in the interior of the fry. This typically produces a waxy, moist ("limp") texture even if the fries are

overcooked by normal standards. This can be avoided if the parfried potato pieces are prepared as follows:

- a) blanch in water for 6 to 20 minutes at temperatures of from 140°F (60°C) to 210°F (99°C), preferably 20 minutes at 140°F (60°C);
 - 5 b) dip in 1% aqueous sodium acid pyrophosphate solution;
 - c) dry for 6 to 30 minutes at 140°F (60°C) to 210°F (99°C), preferably 30 minutes at 140°F (60°C); and
 - d) parfry for 30 to 90 seconds at 300°F (148°C) to 390°F (199°C), preferably for about 30-60 seconds at 365°F (185°C) to 390°F (199°C).
- 10 Higher temperature frying for shorter times is preferred.

This combination of steps is believed to promote and set starch gelatinization prior to frying and to minimize frying oil uptake during frying.

In addition to french fried potatoes, other high moisture fried or baked foods such as cottage fries, hash browns, "tater tots", onion rings, chicken, fish, doughnuts, or fried pies (i.e., turnovers) can be made. The food substrate may be in whole pieces, or slices, or diced, or shredded, or ground into flour and used by them selves, or with a variety of other food ingredients, e.g., flavors, seasonings, sweeteners (including artificial sweeteners), gels, emulsifiers, carbohydrates, bulking agents, liquid crystals, cheeses, vitamins, fibers, browning agents, etc. The foods may be made from dough's that are extruded or sheeted/cut; pieces may be agglomerated; pieces or whole entities may be coated; pieces or whole entities may be layered between other materials such as crackers, wafers, etc. These may be further fried, dried (including freeze dried), baked, microwaved, etc., into their final food product form.

D. Analytical Test Methods

25 A number of parameters used to characterize elements of the present invention are quantified by particular experimental analytical procedures. Each of these procedures is described as follows:

1. Fluid Viscosity of Fat Composition

a) Preparation of the Sample

30 A 250 to 300 gram sample of the fat composition is placed in a 400 ml beaker and heated to 140°F (60°C) using a water bath.

b) Measurement

35 The fluid viscosity of the fat composition is measured with a Brookfield Model RV 1/2 viscometer using spindle number 1. The viscometer is set on a shear rate of 10 revolutions per minute. The viscometer spindle is placed in the 140°F (60°C) fat composition until the fat composition just covers the spindle immersion line. Sufficient

space (i.e., about 1 inch) is left between all sides of the container and the spindle to prevent accidental rubbing. The viscometer spindle is allowed to revolve for several minutes in the fat composition at 10 RPM to ensure uniform mixing and temperature at 140°F (60°C). The shear stress is read from the viscometer dial. The viscosity is calculated by multiplying the measured shear stress by the shear rate factor provided by the manufacturer for a given spindle and shear rate combination. For spindle number 1 at 10 RPM, the shear rate factor is 5.0.

2. Ester Distribution of Sucrose Polyesters

10 The relative distribution of the individual octa-, hepta-, hexa- and penta- esters of sucrose can be determined by the method described in U.S. 4,919,964 beginning at col. 9, line 59 to col. 10, line 5 (incorporated herein by reference.)

3. Slope of Solid Fat Content (SFC) of Polyol Polyesters

15 The method for determining this slope is described in U.S. 5,085,884 at col.21, lines 41 to 64 (herein incorporated by reference).

4. Complete Melting Point of Solid Polyol Polyesters by Differential Scanning Calorimetry (DSC)

20 The complete melting point of the solid polyol polyesters can be determined by DSC as follows:

Equipment:

Perkin-Elmer 7 Series Thermal Analysis System, Model DSC7, manufactured by Perkin-Elmer, Norwalk, CT.

25 Procedure:

- a. Sample of solid polyol polyesters is heated to at least 10°C above the complete melt point and mixed thoroughly.
- b. 10 ± 2 mg of sample is weighed into sample pan.
- c. A scan is performed from about 10°C above the temperature at which all visible solids are gone to -60°C at 5°C per minute.
- 30 d. The temperature of the sample is maintained at -60°C for 3 minutes and scanned from -60°C to the original starting temperature at 5°C per minute (i.e., from about 10°C above the temperature at which all visible solids are gone).
- e. The complete melt point is the temperature at the intersection of the base line (i.e. specific heat line) with the line tangent to the trailing edge of the endothermic peak.
- 35

5. Intermediate Melting Polyol Polyester Viscosity Measurement

The sample is prepared and the measurement conducted on a Ferranti-Shirley viscometer as described in U.S. 4,880,657 at col. 11, lines 34-56 (incorporated herein by reference)

5

6. Polyol Polyester Liquid/Solid Stability Measurement

This method is described in U.S. 4,880,657 at col.11., line 61 to col. 12, line 17 (herein incorporated by reference.)

10

7. Polyol Polyester Fatty Acid Composition and Trans Fatty Acids

The fatty acid composition (FAC) of the polyesters is determined by gas chromatography, using a Hewlett-Packard Model S712A gas chromatograph equipped with a thermal conductivity detector and a Hewlett-Packard Model 7671A automatic sampler. The chromatographic method used is described in Official Methods and Recommended Practices of the American Oil Chemists Society, 3rd Ed., 1984, Procedure Ce 1-62.

15

The percentage of trans fatty acids in the polyester sample is determined by infrared spectrophotometry (IR). The IR method used is described in Madison et al, "Accurate Determination of trans Isomers in Shortenings and Edible Oils by Infrared Spectrophotometry." J. Am. Oil Chem., Vol. 59, No. 4 (1982), pp. 178-81. The trans value obtained by IR, together with the total number of double bonds based on the FAC of the polyester sample, is used to calculate the percentage of trans double bonds.

20

8. Crystallization of Solids in Fried Foods under Ambient Conditions Using DSC

25

A Differential Scanning Calorimeter (Perkin-Elmer Series 7 Thermal Analysis System) is programmed to simulate the ambient cooling of a plate containing about 1/2 pound of french fried potatoes or other end-use product which has just removed from the fryer. The cooling profile lasts 20 minutes.

30

5-7 milligrams of a sample of a nondigestible fat material is heated to about 195° F (90.5°C) in the DSC. The sample is then cooled at a rate of 12.4°F (6.9°C) per minute for 4 minutes. The sample is then cooled at a rate of 5.2°F (2.9°C) per minute for 8 minutes. Lastly, the sample is cooled at a rate of 1.6°F (0.9°C) per minute for 12 minutes. Heat flow peaks measured below the baseline are a measure of crystallization.

35

E. Specific Examples

Several reduced calorie fat compositions are prepared and then used in the

following Examples 1-4 to prepare french fried potatoes. All of these fat compositions contain a nondigestible fat component. All but one of these fat compositions also contain a "conventional" triglyceride component. The nondigestible fat component of these compositions comprises either a) a blend of a liquid and solid sucrose polyesters (SPEs) or b) an intermediate melting fat (IMF) sucrose polyester (SPE).

The components of the nondigestible fat are optionally added to refined, bleached and deodorized soybean oil or medium chain triglycerides and heated until all solids are dissolved to provide the fat compositions of Table I.

TABLE I

<u>FAT</u>	<u>COMPOSITION</u>	<u>COMPONENT</u>	
A		Liquid SPE I	95.0
		Solid SPE I	5.0
B		Liquid SPE I	85.5
		Solid SPE I	4.5
		Soybean Oil	10.0
C		Liquid SPE I	76.0
		Solid SPE I	4.0
		Medium Chain Triglyceride	20.0
D		Liquid SPE I	66.5
		Solid SPE I	3.5
		Soybean Oil	30.0
E		Liquid SPE II	85.5
		Solid SPE I	4.5
		Medium Chain Triglyceride	10.0
F		Liquid SPE I	75.0
		Soybean Oil	25.0
G		IMF SPE I	55.0
		Soybean Oil	45.0

The intermediate melting fat sucrose polyester (IMF SPE), solid sucrose polyester (solid SPE) and liquid sucrose polyesters (liquid SPE) used to make these fat compositions have the at tributes set forth in the following Table II.

TABLE II

FATTY ACID				
<u>COMPOSITION</u>	<u>IMF SPE I</u>	<u>Solid SPE I</u>	<u>Liquid SPE I</u>	<u>Liquid SPE II</u>
% C8	0.0	0.0	0.0	100.0
% C12	0.0	0.0	0.0	0.0
% C14	0.0	0.0	0.4	0.0
% C16	9.5	2.9	21.3	0.0
% C18	54.7	1.0	4.4	0.0
% C18-1	19.9	4.4	32.1	0.0
% C18-2	13.6	4.5	40.8	0.0
% C18-3	1.0	0.0	0.2	0.0
% C20	0.7	2.0	0.4	0.0
% C22	0.0	83.4	0.1	0.0
% C24	0.0	1.8	0.0	0.0
% Other	0.6	0.0	0.3	0.0

ESTER

<u>DISTRIBUTION</u>	<u>IMF SPE I</u>	<u>Solid SPE I</u>	<u>Liquid SPE I</u>	<u>Liquid SPE II</u>
% OCTA	92.9	74.0	76.0	100.0
% HEPTA	7.1	25.3	23.2	<0.1
% HEXA	<0.1	0.3	0.4	<0.1
% PENTA	<0.1	0.4	0.4	<0.1
% LOWER	<0.1	<0.1	<0.1	<0.1

5

Example 1

Russett Burbank potatoes at about a 20% potato solids content are cut into 1/4" x 3 1/2" potato strips to make shoestring style french fried potatoes. The potato strips are blanched in hot water (87°C) for about 10 minutes then allowed to equilibrate for about 10 minutes under ambient conditions. The potato strips are fried in each of two fat compositions to doneness using a food service type kettle ratio of fryer at a fryer oil mass to potato strip mass of about 15:1. Fat compositions and characteristics of the

10

fried products are set forth in Table III:

TABLE III

<u>Fat Composition</u>	<u>Frying Temperature</u>	<u>Frying Time</u>	Fluid Viscosity at 60°C (centipoise)	% <u>Fat</u>	% <u>Moisture</u>
C	176.7°C	6.0 min.	45	15.2	45.08
D	176.7°F	6.0 min.	53	19.9	35.44

5 Both of these french fry samples are not unacceptably greasy tasting even though they contain relatively high levels of nondigestible fat materials.

Example 2

10 Russett Burbank potatoes at about 20% potato solids content are cut into 1/4" x 3 1/2" potato strips to make shoestring style french fried potatoes. The potato strips are blanched in 140°F water for 5 minutes. The blanched potato strips are allowed to equilibrate at ambient conditions for 5 minutes followed by drying in an oven set at 175°
 15 F and 90% relative humidity for 10 minutes. The dried potato strips are then fried in the fat compositions of Table IV for 90 seconds at 375°F followed by rapid freezing to make frozen par fries. The par fries are finished fried in the same fat composition at about 15:1 loading ratio of frying fat to par fry mass.

Table IV

<u>Fat Composition</u>	<u>Finished Frying Temperature</u>	<u>Finished Fry Time</u>	Fluid Viscosity at 60°C (centipoise)	% <u>Fat</u>	% <u>Moisture</u>
F	204°C	4.0 min.	65	14.4	33.1
G	177°C	3.7 min.	48	16.2	41.0

20 Both of these french fry samples are not unacceptably greasy tasting even though they contain relatively high levels of nondigestible fat materials.

Example 3

Russett Burbank potatoes at about 20% potato solids content are cut into 1" x 4" wedges to made steak fry style french fried potatoes. The potato wedges are blanched

for 15 minutes in 87°C water and allowed to equilibrate for 10 minutes at ambient conditions. The potato wedges are then par fried in a frying pan containing about 1/2" - 1" depth of the fat compositions described in Table V.

5

TABLE V

Fat Composition	Frying Temperature	Frying Time	Fluid Viscosity at 60° C (centipoise)	% Fat	% Moisture
A	176°C	7.0 min.	95	11.2	71.8
B	176°C	7.0 min.	78	3.2	71.7
E	176°C	15.0 min.	58	7.4	74.7

All three of these french fry samples are not unacceptably greasy tasting even though they contain relatively high levels of nondigestible fat materials.

10 Example 4

Russett Burbank potatoes of about 20% potato solids content are cut into 1/4" x 3 1/2" potato strips to make shoestring type french fried potatoes. The potato strips are then blanched in 165°F water for 10 minutes. The blanched potato strips were then twice par fried by first frying at 360°F for 50 seconds followed by freezing and then
15 frying at 360°F for 180 seconds. The twice par fried potato's are then frozen. The final french fried potatoes are prepared by baking in a convection oven at 425°F for 4 1/2 minutes. Results are set forth in Table VI.

20

TABLE VI

Fat Composition	Fluid Viscosity at 60°C	% Fat	% Moisture
A	95	18.9	29.3

Such french fries are not unacceptably greasy tasting even though they contain relatively high levels of nondigestible fat materials.

What is claimed is:

1. A high moisture, cooked food product of reduced greasiness, which product comprises an edible substrate and from 3% to 25%, preferably 10% to 20%, of a reduced calorie fat composition, at least a portion of which fat composition is coated on the surface of said food product; wherein
 - A) said reduced calorie fat composition comprises:
 - i) from 10% to 100%, preferably from 35% to 100% of a nondigestible fat component comprising:
 - (a) a liquid nondigestible oil having a complete melting point below 37°C; and
 - (b) nondigestible solid polyol fatty acid polyester which has a complete melting point above 37°C and which is present in an amount sufficient to control passive oil loss;
said nondigestible fat component having a Solid Fat Content profile slope between 21.1°C and 37°C of from 0 to -1.26 %solids/°C (0 to -0.75 %solids/°F); and
 - ii) from 0% to 90%, preferably from 0% to 65% of a triglyceride fat or oil; and
 - B) said reduced calorie fat composition is formulated to have a fluid viscosity of from 12 to 105 centipoise, preferably from 12 to 85 centipoise, at 60°C.
2. A food product according to Claim 1 wherein
 - A. the ratio of fluid viscosity of said fat composition to percent fat in said product ranges from 2.5 to 25; and
 - B. the nondigestible fat component exhibits substantially no crystallization during the first 5 minutes of cooling from a temperature of 90.5°C.
3. A food product according to Claim 2 wherein the nondigestible fat component comprises:
 - A) from 80% to 99% of the nondigestible fat component of a liquid polyol fatty acid polyester; and

- B) from 1% to 20% of the nondigestible fat component of a solid polyol fatty acid polyester having the ester groups which comprise a combination of:
- (1) C₁₂ or higher unsaturated fatty acid radicals, C₄-C₁₂ saturated fatty acid radicals or mixtures thereof, and
 - (2) C₂₀ or higher saturated fatty acid radicals which comprise at least about 15% of the total ester-forming radicals in the polyol polyester,
- wherein the molar ratio of (1):(2) radicals is from 1:15 to 2:1.
4. A food product according to Claim 2 wherein the nondigestible fat comprises:
- A) from 60% to 90% of the nondigestible fat components of an oil; and
 - B) from 10% to 40% of the nondigestible fat component of a solid polyol fatty acid polyester having ester groups comprising C₁₄-C₁₈ saturated fatty acid radicals.
5. A high moisture, cooked food product of reduced greasiness, which product comprises an edible substrate and from 3% to 25% of a reduced calorie fat composition, at least a portion of which fat composition is coated on the surface of said food product; wherein
- A. the reduced calorie fat composition comprises:
 - i) from 55% to 85% of a nondigestible polyol fatty acid polyester component comprising polyols selected from the group consisting of sugars and sugar alcohols having from 4 to 8 hydroxyl groups, which polyol contains fatty acid ester groups having from 4 to 24 carbon atoms, said polyol polyester component further having
 - a) a viscosity at 37.8°C of from 5 to 120, preferably from 10 to 75, poise at a shear rate of 10 seconds⁻¹;
 - b) a liquid/solid stability at 37.8°C of at least 30%, preferably at least 50%; and

- c) a Solid Fat Content at 37°C of 25% or less; and
 - ii) from 15% to 45% of a triglyceride fat or oil;
 - B. said reduced calorie fat composition is formulated to have a fluid viscosity of from 12 to 105 centipoise at 60°C;
 - and
 - C. the ratio of fluid viscosity of said fat composition to percent fat in said product ranges from 2.5 to 25.
- 6. A food product according to Claim 4 or Claim 5 wherein the edible substrate comprises potato material and the food product is fried.
- 7. A method for preparing a high moisture, cooked food product of reduced greasiness, which method comprises incorporating into an edible substrate from 3% to 25%, preferably from 10% to 20%, of a reduced calorie fat composition, at least a portion of which fat composition remains coated on the surface of said food product after cooking; wherein
 - A) said reduced calorie fat composition comprises:
 - i) from 10% to 100%, preferably from 35% to 100%, of a nondigestible fat component comprising:
 - a) a liquid nondigestible oil having a complete melting point below 37°C; and
 - b) a nondigestible solid polyol fatty acid polyester having a complete melting point above 37°C to which is present in amount sufficient to control passive oil loss;
said nondigestible fat component having a Solid Fat Content profile slope between 21.1°C and 37°C of from 0 to -1.26 %solids/°C (0 to -0.75 %solids/°F); and
 - ii) from 0% to 90%, preferably from 0% to 65%, of a triglyceride fat or oil; and
 - B) said reduced calorie fat composition is formulated to have a fluid viscosity of from 12 to 105, preferably from 12 to 85, centipoise at 60°C.
- 8. A method according to Claim 7 wherein

- A. the ratio of fluid viscosity of said fat composition to percent fat in said product ranges from 2.5 to 25; and
 - B. the nondigestible fat component exhibits substantially no crystallization during the first 5 minutes of cooling from a temperature of 90.5°C.
9. A method according to Claim 8 wherein the nondigestible fat component comprises:
- A) from 80% to 99% of the nondigestible fat component of a liquid polyol fatty acid polyester; and
 - B) from 1% to 20% of the nondigestible fat of a solid polyol fatty acid polyesters having the ester groups which comprise a combination of:
 - (1) C₁₂ or higher unsaturated fatty acid radicals, C₄-C₁₂ saturated fatty acid radicals or mixtures thereof, and
 - (2) C₂₀ or higher saturated fatty acid radicals which comprise at least 15% of the total ester-forming radicals in the polyol polyester,wherein the molar ratio of (1):(2) radicals ranges from 1:15 to 2:1.
10. A method for preparing a high moisture, cooked food product of reduced greasiness, which method comprises incorporating into an edible substrate from 3% to 25% of a reduced calorie fat composition, at least a portion of which fat composition remains coated on the surface of said food product after cooking; wherein
- A) said reduced calorie composition comprises:
 - i) from 55% to 85% of a nondigestible polyol fatty acid polyester compound comprising a polyol selected from the group consisting of sugars and sugar alcohols having from 4 to 8 hydroxyl groups, and fatty acid ester groups having from 4 to 24 carbon atoms, said polyol polyester component further having
 - a) a viscosity at 37.8°C from 5 to 120, preferably from 10 to 75, poise at a shear rate of 10 seconds⁻¹;

- b) liquid/solid stability at 37.8°C of at least 30%, preferably at least 50%; and
 - c) a Solid Fat Content profile slope of 25% or less at 37°C; and
- ii) from 15% to 45% triglycerides;
- B) said reduced calorie fat composition is formulated to have a fluid viscosity of from 12 to 105 centipoise; and
 - C) the ratio of fluid viscosity of said composition to percent fat present in said product ranges from 2.5 to 25.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 93/07911

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 A23L1/217 A23D9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 5 A23L A23D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 390 410 (THE PROCTOR & GAMBLE COMPANY) 3 October 1990 cited in the application see page 8, line 29 - line 31 see page 9, line 37 - line 47 see page 10, line 41 - line 47 see page 24, line 1 - line 11 see claims 1,7,8	1,7
X	EP,A,0 424 067 (THE PROCTOR & GAMBLE COMPANY) 24 April 1991 cited in the application see page 6, line 36 - page 7, line 7 see claims 1-7	5,6,10

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents :

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- *E* earlier document but published on or after the international filing date
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INTERNATIONAL SEARCH REPORT

Intern: 1 Application No
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P,X	WO,A,92 20237 (THE PROCTOR & GAMBLE COMPANY) 26 November 1992 see page 15, line 24 - line 32 see page 16, line 3 - line 20 see examples 1,2,8 see claims 1-9 ---	1-4,6-9
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