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(54) Title: FOOD COMPOSITIONS INCORPORATING ADDITIONAL LONG CHAIN FATTY ACIDS

(57) Abstract: The present invention relates to the improvement of food items through the increased utilization of plant-derived stearidonic acid in a composition that also lowers linolenic acid content. Many long chain fatty acids have been classified as being Omega 3 and have been shown to provide several health benefits, including heart health. According to the current invention plant-derived stearidonic acid (18:4 ω 3) has been incorporated into a wide range of food products by using a low linolenic acid base composition to enhance stability and shelf life while reducing the need for hydrogenation. The product composition can be used either as an oil oil-based composition or a flour processed from soybeans with enhanced levels of stearidonic acid. These foods range from oil-based products (salad dressing, mayonnaise) to dairy products (milk, cheese) to prepared foods (entrees, side dishes). In addition to improved health benefits the current invention provides food rich in Omega-3 fatty acids that have enhanced storage and/or shelf life characteristics.



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FOOD COMPOSITIONS INCORPORATING ADDITIONAL LONG CHAIN FATTY ACIDS

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FIELD OF THE INVENTION

[001] The present invention relates to the utilization of transgenically derived stearidonic acid in the development of functional food products. More specifically it relates to an improvement in both the nutritional quality and shelf-life of food products through the use of transgenic plant-derived stearidonic acid.

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BACKGROUND OF THE INVENTION

[002] The present invention is directed to a method for improving foodstuffs through the utilization of novel partially transgenic plant-derived long-chain polyunsaturated fatty acid compositions ("LC-PUFA"), in particular those with the positive attributes of Omega-3 fatty acids and enhanced stability through the reduction of linolenic acid. Specifically, the inventor provides techniques and methods for the utilization of plant-derived LC-PUFA in foodstuffs that improves nutritional quality when combined with oil from conventionally improved breeds of oil-producing plants. In the past dietary fats have been thought of as valueless or even harmful dietary components. Many studies have made a physiological link between dietary fats and obesity and other pathologies such as atherosclerosis. Given this perception of low nutritional value, consumption of fats has been discouraged by many in the medical establishment.

[003] However, recent studies have determined that despite their relatively simple biological structures there are some types of fats that appear to improve body function in some ways and that may, in fact, be essential to certain physiological processes. The wider class of fat molecules includes fatty acids, isoprenols, steroids, other lipids and oil-soluble vitamins. Among these are the fatty acids. The fatty acids are carboxylic acids, which have from 2 to 26 carbons in their "backbone," with none, or various numbers of unsaturations in their carbohydrate structure. They generally have dissociation constants (pKa) of about 4.5 indicating that in normal body conditions (physiological pH of 7.4) the vast majority will be in a dissociated form.

[004] With the improvement in nutritional stature for fats and in particular fatty acids, many in the food industry have begun to focus on fatty acids and lipid technology as a new focus for food production. This focus has been particularly intense for the production and incorporation of Omega-3 fatty acids into the diet. Omega-3 fatty acids are long-chain polyunsaturated fatty acids (18-22 carbon atoms in chain length) with the first of the double bonds ("unsaturations") beginning with the third carbon atom. They are called "polyunsaturated" because their molecules have two or more double bonds "unsaturations" in their carbohydrate chain. They are termed "long-chain" fatty acids since their carbon backbone has at least 18 carbon atoms. The LC-PUFA family of oils for food compositions includes: alpha linolenic acid ("ALA"), stearidonic acid ("SDA"), gamma linolenic acid ("GLA"), linoleic acid ("LA"). ALA is the "base" omega-3 fatty acid, from which SDA is made in the body through a series of enzymatic reactions, but according to the current invention is reduced to provide a healthier oil composition. This synthesis processes from ALA are called "elongation" (the molecule becomes longer by incorporating new carbon atoms) and "desaturation" (new double bonds are created), respectively. In nature, ALA is primarily found in certain plant seeds (e.g., flax).

[005] In addition to difficulties with simply securing an appropriate supply of LC-PUFA's for societal consumption often the costs to process LC-PUFA's into food products is restrictive. These Omega-3 fatty acids, and some of the other LC-PUFA's can be quickly oxidized leading to undesirable odors and flavors. To reduce the rate of oxidation food processors must therefore either distribute the oil in a frozen condition or encapsulate the desirable fatty acids, each greatly increasing the cost of processing and consequent cost to the consumer. Despite this increased expense - food companies are interested in supplying Omega-3's and generally healthier food oils because they believe that health conscious consumers may be willing to pay a small premium for an improved diet if a reliable supply can be developed.

[006] Along with the movement of food companies to develop essential fats and oils as an important component in a healthy diet, governments have begun developing regulations pushing for the adoption of LC-PUFA's in the diet. The difficulty in supplying these needs has been the inability to develop a large enough supply of Omega-3 oil to align with growing marketplace demand. These limitations on supply, stability and sourcing greatly increase cost and correspondingly limit the availability of dietary Omega-3's. Accordingly, a need exists to

provide a large-scale stable supply of Omega-3's to include in food and feed formulations in a commercially acceptable way.

[007] In addition, soybean oil represents two-thirds of all food oil consumed in the United States. Food companies have used soybean oil because it is plentiful and relatively low cost. Soybean oil is typically low in harmful saturated fat and has a taste and texture desired by consumers. Currently, soybean oil accounts for roughly 80%, or 18.0 billion pounds, of the oil consumed in the US and is the most widely used oil in food production. However, to meet market expectations for shelf life, hydrogen must be added to soybean oil to increase its shelf-life and stability for use in processed foods such as fried foods, baked goods and snack products.

10 This hydrogenation process creates trans fats.

[008] Unfortunately, trans-fats have been linked to heart disease due to the findings that they have a negative impact on human cholesterol profiles. With this in mind the United States FDA has required food labels to include a trans fat content as from January 1, 2006. This has created a substantial demand for supplies of dietary oils that have lower levels of trans fats.

15 Accordingly, there is a market demand for a composition with lower trans fats with a profile that also includes other identifiable health benefits, such as Omega-3 fatty acids to meet federal guidelines and the demands of consumers for healthier food.

[009] The current invention provides an invention that answers both of the needs described above. It offers an alternative to fish or microbe supplied Omega-3 fatty acids and provides a soybean oil that has lower linolenic acid content, improving its taste profile and enhancing shelf-life without the production of trans fats through hydrogenation. The technology relied upon is both conventional plant breeding technology, oil processing technology and transgenically developed plants. The plant species that are specifically included within the group of those that could supply demand are: soybeans, corn, and canola, but also may include other plants as needed. Once produced the LC-PUFA's of the invention can be used to improve the health characteristics of a great variety of food products. This production can also be scaled-up as needed to both reduce the need to harvest wild fish stocks and to provide essential fatty acid components for aquaculture operations, each easing pressure on global fisheries.

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[0010] Surprisingly, the inventor has found that the concentration of LC-PUFA's from transgenic plant sources of the invention require a lower concentration in a given food or

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beverage product to be physiologically significant, these ranges are well within acceptable volume parameters for typical food products and can be used for a wider variety of foodstuffs.

SUMMARY OF THE INVENTION

5 [0011] The present invention encompasses production of oil from transgenic soybeans engineered to contain significant quantities of LC-PUFA's for use in food products to improve the health of an end consumer. Sufficient quantities of LC-PUFA enriched soybeans have been grown to allow the delivery of soybean oil with a substantial LC-PUFA component. This "LC-PUFA oil" provides an initial clean flavor, longer shelf-life stability and enhanced nutritional
10 quality relative to other sources of Omega-3 oils. The means to maintain oil quality during storage have also been developed. Several food products made from the LC-PUFA oil have been produced and found to have similar taste and sensory properties compared to products made from conventional oils, such as soybean oil.

 [0012] Also according to the current invention, shelf-life testing of food products has
15 also been conducted and the plant-derived LC-PUFA oil has substantially improved shelf-life characteristics relative to other Omega-3 containing products. Therefore, a preferred embodiment of the current invention is the usage of the LC-PUFA oil produced by transgenic plants in the production of food products for human consumption.

 [0013] Nutritional studies have shown that, compared to alpha-linolenic acid, SDA is
20 about 5 times more efficiently converted *in vivo* to EPA. Accordingly, in another embodiment of the current invention plant-derived LC-PUFA can be utilized as a nutraceutical supplement or dietary additive for certain pathological conditions with a lengthened shelf life due to a lower oxidation rate.

 [0014] According to another embodiment of the current invention a plant-derived LC-
25 PUFA composition can provide an oil reduced in trans-fats that can synergistically improve the health profile of the delivered oil by also delivering the health benefits of Omega-3 oil.

 [0015] Specifically, the current invention demonstrates that acceptable food products can be made with stearidonic acid, increasing their shelf-life beyond that of competitive PUFA oils.

 [0016] Moreover, the method of the current invention also provides for optimizing food
30 formulations to optimize health improvements in end consumers, in the form of an edible oil,

processing oil or oil composition, a whole bean extraction for use in a soymilk formulation or as a partial extraction flour-type composition.

[0017] In an additional embodiment of the current invention the LC-PUFA oils produced by transgenic plants can form the basis for the diet of aquaculture raised fish and/or products
5 from those fish.

[0018] In an additional embodiment of the current invention the LC-PUFA oils produced by transgenic plants can form the basis for the diet of beef cattle to improve the nutritional characteristics of beef and/or beef products. Additional embodiments of the current invention may also improve reproductive function.

10 [0019] In an additional embodiment of the current invention the LC-PUFA oils produced by transgenic plants can form the basis for the diet of pigs to improve the nutritional characteristics of pork and/or pork products. Additional embodiments of the current invention may also improve reproductive function.

[0020] In an additional embodiment of the current invention the LC-PUFA oils produced
15 by transgenic plants can form the basis for the diet of chickens to improve the nutritional characteristics of chicken and/or chicken products. Additional embodiments of the current invention may also improve reproductive function.

[0021] Other features and advantages of this invention will become apparent in the following detailed description of preferred embodiments of this invention, taken with reference
20 to the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

*Figures that reference "SDA + VistiveTM" also comprise the LC-PUFA oil of the invention.

[0022] Fig. 1 Shows The Biosynthetic Pathway Of PUFA Metabolism.

25 [0023] Fig. 2 Shows Time Point Testing For Sensory Information For Italian Dressing A-E.

[0024] Fig. 3 Shows Time Point Testing For Sensory Information For Ranch Dressing A-E.

[0025] Fig. 4 Shows Time Point Testing For Sensory Information For Mayonnaise A-D.

[0026] Fig. 5 Shows A Graphic Representing The Relative Bioactivity Of Omega-3 Fatty Acids.

[0027] Fig. 6 Shows A Process Flow Diagram For The Production Of Soymilk.

[0028] Fig. 7 Shows A Process Flow Diagram For The Production Of Vanilla Soymilk.

[0029] Fig. 8 Shows A Process Flow Diagram For The Production Of Margarine.

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DESCRIPTION OF THE PREFERRED EMBODIMENT

[0030] The following abbreviations have designated meanings in the specification:

Abbreviation Key:

	AA	Arachidonic Acid
	ALA	α – Linolenic Acid
10	DHA	Docosahexanoic Acid
	DNA	Deoxyribonucleic Acid
	EPA	Eicosapentanoic Acid
	GLA	γ - Linolenic Acid
	LA	Linoleic Acid
15	mRNA	messenger Ribonucleic Acid
	PUFA	Poly-Unsaturated Fatty Acids
	SDA	Stearidonic Acid

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Explanation of Terms:

25 Expression – The process of the transcription of a gene to produce the corresponding mRNA and translation of this mRNA to produce the corresponding gene product (i.e., a peptide, polypeptide, or protein).

Feed - Materials available for feeding animals which includes without limitation forage, fodder and concentrates.

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Food – Substances which are ingested by humans and contain nutrients which can be metabolized to produce energy.

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Gene – Chromosomal DNA, plasmid DNA, cDNA, synthetic DNA, or other DNA that encodes a peptide, polypeptide, protein, or RNA molecule.

Host or Host Organism – Bacteria cells, fungi, animals and animal cells, plants and plant cells, or any plant parts or tissues including protoplasts, calli, roots, tubers, seeds, stems, leaves, seedlings, embryos, and pollen.

5 Mouthfeel - Means how the substance feels in a human mouth. With regard to taste test profiles this refers to the viscosity, texture and smoothness of the substance being tested.

10 Nutritional Food Bar – As used herein, the term "Nutritional Food Bar" means a food bar designed to promote health.

Transformation – refers to the introduction of nucleic acid into a recipient host.

15 Transgene – Any piece of a nucleic acid molecule that is inserted by artifice into a cell, or an ancestor thereof, and becomes part of the genome of the plant or animal which develops from that cell. Such a transgene may include a gene which is partly or entirely exogenous (i.e., foreign) to the transgenic plant or animal, or may represent a gene having identity to an endogenous gene of the plant or animal.

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Transgenic – Any cell that includes a nucleic acid molecule that has been inserted by artifice into a cell, or an ancestor thereof, and becomes part of the genome of the plant or animal which develops from that cell.

25

DETAILED DESCRIPTION

30 [0031] The present invention relates to a system for an improved method of production of stearidonic acid and its incorporation into the diets of humans and livestock in an effort to improve human health. This production is through the utilization of transgenic plants engineered to produce LC-PUFA in high yield to allow commercial incorporation into food products. For the purposes of the current invention the acid and salt forms of fatty acids, for instance, butyric acid and butyrate, arachidonic acid and arachidonate, will be considered interchangeable
35 chemical forms.

[0032] The oil composition of the invention provides for a lower linolenic acid profile than known soybean compositions while providing the benefits of Omega-3 derived stearidonic

acid. The LC-PUFA composition of the invention contains soybean oil that has less than 3% linolenic acid, compared to 8% for traditional soybean oils. This results in a more stable soybean oil because with less linolenic acid the oil itself will oxidize more slowly resulting in superior shelf life. Also the flavor notes of linolenic acid are such that with a composition lower in this compound the oil will have a more palatable flavor profile. In addition soybeans with less linolenic acid require less or no partial hydrogenation. Therefore the production of undesirable trans fats in processed soybean oil can be reduced or eliminated and the corresponding oil will have a better cooking profile.

[0033] Turning to FIG. 1, all higher plants have the ability to synthesize the main 18 carbon PUFA's, LA and ALA, and in some cases SDA (C18:4n3, SDA), but few are able to further elongate and desaturate these to produce AA, EPA or DHA. Synthesis of EPA and/or DHA in higher plants therefore requires the introduction of several genes encoding all of the biosynthetic enzymes required to convert LA into AA, or ALA into EPA and DHA. Taking into account the importance of PUFAs in human health, the successful production of PUFAs (especially the n-3 class) in transgenic oilseeds, according to the current invention can then provide a sustainable source of these essential fatty acids for dietary use. The "conventional" aerobic pathway which operates in most PUFA-synthesising eukaryotic organisms, starts with $\Delta 6$ desaturation of both LA and ALA to yield γ -linolenic (GLA, 18:3n6) and SDA.

Establishing the Composition of Oils

[0034] Turning to Table 1a, it is important to provide a basis of what constitutes 'normal' ranges of oil composition vis-à-vis the oil compositions of the current invention. A significant source of data used to establish basic composition criteria for edible oils and fats of major importance has been the Ministry of Agriculture, Fisheries and Food (MAFF) and the Federation of Oils, Seeds and Fats Associations (FOSFA) at the Leatherhead Food Research Association facility in the United Kingdom. It must also be noted that figures that reference "SDA + VistiveTM" also comprise the LC-PUFA oil of the invention.

[0035] To establish meaningful standards data, it is essential that sufficient samples be collected from representative geographical origins and that the oils are pure relative to the compositions intended. In the MAFF/FOSFA work, over 600 authentic commercial samples of

vegetable oilseeds of known origin and history, generally of ten different geographical origins, were studied for each of 11 vegetable oils. The extracted oils were analyzed to determine their overall fatty acid composition ("FAC"). The FAC at the 2-position of the triglyceride, sterol and tocopherol composition, triglyceride carbon number and iodine value, protein values in the oil, melting point and solid fat content as appropriate are determined.

[0036] Prior to 1981, FAC data were not included in published standards because data of sufficient quality was not available. In 1981, standards were adopted that included FAC ranges as mandatory compositional criteria. The MAFF/FOSFA work provided the basis for later revisions to these ranges.

[0037] In general, as more data became available, it was possible to propose fatty acid ranges much narrower and consequently more specific than those adopted in 1981. Table 1a gives examples of FAC of oils that were adopted by the Codex Alimentarius Commission (CAC) in 1981 and ranges for the same oils proposed at the Codex Committee on Fats and Oils (CCFO) meeting held in 1993.

TABLE 1a - STANDARDS FOR FATTY ACID COMPOSITION OF OILS

Fatty acid	Soybean oil		Groundnut oil		Cottonseed oil		Sunflower-seed oil	
	1981	1993	1981	1993	1981	1993	1981	1993
C14:0	< 0.5	< 0.2	< 0.6	< 0.1	0.4-2	0.6-1	< 0.5	< 0.2
C16:0	7-14	8-13.3	6-16	8.3-14	17-31	21.4-26.4	3-10	5.6-7.6
C16:1	< 0.5	< 0.2	< 1	< 0.2	0.5-2	0-1.2	< 1	< 0.3
C18:0	1.4-5.5	2.4-5.4	1.3-6.5	1.9-4.4	1-4	2.1-3.3	1-10	2.7-6.5
C18:1	19-30	17.7-26.1	35-72	36.4-67.1	13-44	14.7-21.7	14-65	14-39.4
C18:2	44-62	49.8-57.1	13-45	14-43	33-59	46.7-58.2	20-75	48.3-74
C18:3	4-11	5.5-9.5	< 1	< 0.1	0.1-2.1	0-0.4	0-0.7	0-0.2
C20:0	<1	0.1-0.6	1-3	1.1-1.7	0-0.7	0.2-0.5	0-1.5	0.2-0.4
C20:1	<1	<0.3	0.5-2.1	0.7-1.7	0-0.5	0-0.1	0-0.5	0-0.2

C22:0	< 0.5	0.3-0.7	1-5	2.1-4.4	0-0.5	0-0.6	0-1	0.5-1.3
C22:1	-	< 0.3	< 2	< 0.3	0-0.5	0-0.3	0-0.5	0-0.2
C22:2	-	-	-	-	-	-	-	0-0.3
C24:0	-	< 0.4	0.5-3	1.1-2.2	0-0.5	0-0.1	0-0.5	0.2-0.3
C24:1	-	-	-	< 0.3	-	-	< 0.5	-

Sources: CODEX ALIMENTARIUS COMMISSION, 1983 and 1993.

[0038] Given the above and according to the current invention, the LC-PUFA rich oil produced in an recombinant oilseed plant, provides an oil composition not previously available for food manufacturers. It provides for the incorporation of an Omega-3 oil in food products that was not present in appreciable amounts in typical vegetable oils prior to the current invention. In addition the use of this Omega-3 oil is made possible without the traditional concerns with food sensory qualities, or shelf-life when such oils are delivered from a fish or algal source. After delivery of the oil it can be taken and utilized for the production of baked goods, dairy products, spreads, margarines, sports products, nutrition bars and infant formulas, feed, aquaculture, nutraceutical and medicinal uses. Each having enhanced nutritional content.

[0039] Turning to Table 1b, to illustrate the utility of the current invention a variety of food products have been/are being chosen representing a broad range of food categories, to determine the impact of LC-PUFA and other Omega-3 oils on product taste and shelf life.

[0040] Oxidative stability, as measured by accepted shelf-life sensory tests, is an important PUFA characteristic that determines the useful lifetime and flavor characteristics of fat and oils. Oxidative deterioration in fats and oils can be assessed by wet chemical methods such as peroxide value (PV, which measures peroxides resulting from primary oxidation), and p-anisidine value (AV, which principally measures 2-alkenals resulting from secondary oxidation), or in foods, can be assessed by sensory tasting tests. Selected food categories and products are as follows:

TABLE 1b

BEVERAGES	DAIRY PRODUCTS	BAKING	PREPARED FOODS	OIL BASED PRODUCTS	SNACK FOODS
Soy milks Smoothies Fruit Juices Dairy Drinks	Cheeses Cream Cheeses Sour Cream Yogurt Yogurt Drinks Non Dairy Creamers Dips	Breads Rolls Cakes Pastries Cookies Crackers Muffins	Entrees Side Dishes Soups Sauces Processed Meats Processed Fish Pet Foods	Salad Dressing Mayonnaise Margarine/ Spreads Shortening	Granola Cereals Snack/Nutritional Bars Confectionary

[0041] According to the current studies the development of food products

5 incorporating transgenic LC-PUFA provided several formulations and processes. Additional development and research has been conducted for flavor optimization and the enhancement of shelf-life characteristics. For example, food or beverages that can contain the LC-PUFA compositions of the current invention, include baked goods and baked good mixes (e.g., cakes, brownies, muffins, cookies, pastries, pies, and pie crusts), shortening and oil products (e.g.,
10 shortenings, margarines, frying oils, cooking and salad oils, popcorn oils, salad dressings, and mayonnaise), foods that are fried in oil (e.g., potato chips, corn chips, tortilla chips, other fried farinaceous snack foods, french fries, doughnuts, and fried chicken), dairy products and artificial dairy products (e.g., butter, ice cream and other fat-containing frozen desserts, yogurt, and cheeses, including natural cheeses, processed cheeses, cream cheese, cottage cheese, cheese
15 foods and cheese spread, milk, cream, sour cream, buttermilk, and coffee creamer), meat products (e.g., hamburgers, hot dogs, wieners, sausages, bologna and other luncheon meats, canned meats, including pasta/meat products, stews, sandwich spreads, and canned fish), meat analogs, tofu, and various kinds of protein spreads, sweet goods and confections (e.g., candies, chocolates, chocolate confections, frostings, and icings, syrups, cream fillings, and fruit fillings),
20 nut butters and various kinds of soups, dips, sauces and gravies. Each of the above examples comprise different embodiments of the current invention.

[0042] The current invention bases its formulations on target levels of Omega-3 oils for each food product. These levels were identified based on bio-equivalence of the LC-PUFA product. The following information in Table 2a, identifies the targeted Omega 3 levels on a per
25 serving basis:

TABLE 2a

Omega-3 Source	mg Omega-3 per serving
Stearidonic Acid (SDA) in the LC-PUFA Composition	375
EPA/DHA (fish/algal oil)	130
ALA (flax oil)	320

[0043] Based on this information, preferred formulations of the LC-PUFA of the current invention were developed with the appropriate level of oil to deliver the targeted levels on a per serving basis. The amount added varied between different applications due to the differences in serving size.

[0044] Below are Tables 2b-d reflecting the ranges of the LC-PUFA oil compositions of the current invention.

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TABLE 2b.LC-PUFA Oil Variant-1 (Produced by the Transgenic Plants of the Invention)

ANALYTICAL DATA OF SOYBEAN SEEDS AND OILS – CRUSH, (250 kilograms)									
	SEED			CRUDE OIL			RBD OIL		
Moisture (w/w %)	9.13	8.8	11.51	N/A	N/A	N/A	N/A	N/A	N/A
Oil content (%)	19.2	18.56	19.72	N/A	N/A	N/A	N/A	N/A	N/A
Peroxide value (PV, meq/kg)	N/A	N/A	N/A	0.46	0.00	0.06	0.03	0.0	0.0
Free fatty acids (FFA, %)	N/A	N/A	N/A	0.24	0.24	0.42	0.05	0.13	0.05
p-Anisidine value (AV)	N/A	N/A	N/A	0.43	0.31	0.22	0.3	0.63	0.83
Conjugated dienes (CD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Rancimat @110 C, hrs	N/A	N/A	N/A	N/A	N/A	N/A	4.6	1.89	1.85
Trans fatty acids (mg/g)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fatty acid composition (FAC, w/w%)									
C14:0 (Myristic)	0.11	0.1	0.1	0.09	0.09	0.08	0.09	0.08	0.08
C16:0 (Palmitic)	11.43	11.82	12.15	11.68	12.2	12	11.57	11.3	12.23
C16:1n7 (Palmitoleic)	0.1	0.09	0.09	0.1	0.12	0.14	0.1	0.09	0.14
C18:0 (Stearic)	4.26	4.28	4.31	4.26	4.41	4.24	4.24	4.4	4.26
C18:1n9 (Oleic)	21.09	19.44	18.54	20.88	19.28	18.6	21.16	19.3	18.74
C18:1 (Octadecenoic)	1.47	1.52	1.50	1.46	1.48	1.46	1.46	1.52	1.44
C18:2n6 (Linoleic)	51.75	24.82	24.56	52.14	25.48	24.06	51.88	25.38	24.1
C18:3n6 (Gamma linolenic)		5.28	6.17		5.23	6.15		5.27	6.21
C18:3n3 (Alpha linolenic)	8.47	10.00	10.14	8.22	10.6	10.03	8.23	10.72	10.15
C18:4n3 (Stearidonic)		20.40	20.90		19.40	21.16		20.16	21.10
C20:0 (Arachidic)	0.33	0.35	0.36	0.32	0.37	0.36	0.32	0.37	0.37
C20:1n9 (Eicosenoic)	0.16	0.17	0.18	0.15	0.24	0.24	0.15	0.18	0.22
C20:2n6 (Eicosadienoic)	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.03
C22:0 (Behenic)	0.31	0.30	0.31	0.32	0.31	0.31	0.32	0.32	0.3
C24:0 (Lignoceric)	0.1	0.06	0.06	0.1	0.08	0.07	0.1	0.06	0.07

Others	0.39	0.69	0.6	0.25	0.68	1.07	0.35	0.83	0.56
Total*	100.0	99.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Color (5.25")	N/A	N/A	N/A	70Y 3.2R (1")	70Y 3.6R (1")	70Y 3.8R (1")	2.8Y 0.1R	9Y 0.2R	3.3Y 0.0R
Chlorophyll (ppm)	N/A	N/A	N/A	0.007	0.004	0.011	0.02	0.028	0.013
Tocopherols (ppm)									
Alpha	N/A	N/A	N/A	98.5	106	101	99.4	103	95.3
Gamma	N/A	N/A	N/A	940	869	834	914	815	765
Delta	N/A	N/A	N/A	305	285	286	293	249	235
Total	N/A	N/A	N/A	1343.5	1260.0	1221.0	1306.4	1167.0	1095.3
Sterols (ppm)									
Campesterol	N/A	N/A	N/A	761	799	677	318	227	588
Stigmasterol	N/A	N/A	N/A	722	684	556	240	130	444
Beta-Sitosterol	N/A	N/A	N/A	1849	2196	1920	1071	1021	1747
Total	N/A	N/A	N/A	3332	3679	3153	1629	1378	2779
Metals (ppm)									
Phosphorus	N/A	N/A	N/A	473.6	451	58.5	N/A	N/A	N/A
Ca	N/A	N/A	N/A	1845	10.7	10.6	N/A	N/A	N/A
Mg	N/A	N/A	N/A	30.98	28.2	6.98	N/A	N/A	N/A
Fe	N/A	N/A	N/A	1.41	1.48	0.09	N/A	N/A	N/A
Cu	N/A	N/A	N/A	<0.05	<0.05	<0.05	N/A	N/A	N/A
Na	N/A	N/A	N/A	1.75	1.39	<0.20	N/A	N/A	N/A

TABLE 2c. LC-PUFA Oil Variant-1 (Produced by the Transgenic Plants of the Invention)

[illegible]

C14:0 (Myristic)	0.09	0.11	0.08	0.10	0.10	0.07	0.07	0.07	0.10	0.10	0.11
C16:0 (Palmitic)	11.14	12.14	10.65	12.07	12.54	10.49	10.48	10.49	12.07	12.06	12.03
C16:1 (<i>trans</i> -Hexadecanoic)**			0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C16:1n7 (Palmitoleic)	0.15	0.15	0.11	0.11	0.10	0.11	0.11	0.11	0.11	0.11	0.11
C17:0 (Margaric)	0.10	0.10	0.00	0.00	0.00	N/A	N/A	N/A	N/A	N/A	N/A
C18:0 (Stearic)	4.38	4.19	4.65	4.19	4.26	4.66	4.64	4.64	4.19	4.19	4.19
C18:1 (<i>trans</i> -Octadecenoic)			0.08	0.08	0.08	0.09	0.09	0.09	0.07	0.06	0.08
C18:1n9 (Oleic)	20.40	18.35	20.64	17.92	17.91	20.70	20.66	20.68	17.92	17.92	17.96
C18:1 (Octadecenoic)	1.29	1.27	1.47	1.47	1.49	1.49	1.50	1.48	1.46	1.47	1.46
C18:2 (<i>trans</i> -Octadecadienoic)			0.05	0.09	0.09	0.09	0.10	0.10	0.13	0.12	0.14
C18:2n6 (Linoleic)	53.51	35.07	53.10	35.22	35.34	53.07	53.07	53.07	35.21	35.26	35.47
C18:3 (<i>trans</i> -Octadecatrienoic)			0.04	0.18	0.20	0.13	0.10	0.11	0.40	0.42	0.36
C18:3n6 (Gamma linolenic)	0.00	4.92	0.00	4.95	4.82	N/A	N/A	N/A	4.91	4.90	4.83
C18:3n3 (Alpha linolenic)	7.34	10.31	7.63	10.27	10.18	7.58	7.63	7.62	10.13	10.11	10.09
C18:4 (<i>trans</i> -Octadecatetraenoic)			0.00	0.11	0.10	N/A	N/A	N/A	0.28	0.31	0.27
C18:4n3 (Stearidonic)	0.00	11.70	0.00	11.78	11.31	N/A	N/A	N/A	11.43	11.37	11.25
C20:0 (Arachidic)	0.38	0.39	0.39	0.42	0.41	0.38	0.39	0.39	0.41	0.41	0.41
C20:1n9 (Eicosenoic)	0.27	0.28	0.21	0.25	0.23	0.21	0.21	0.21	0.36	0.36	0.36
C20:2n6 (Eicosadienoic)	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C22:0 (Behenic)	0.38	0.33	0.40	0.33	0.34	0.41	0.40	0.40	0.35	0.35	0.36
C24:0 (Lignoceric)	0.16	0.14	0.14	0.13	0.13	0.14	0.14	0.14	0.13	0.13	0.13
Others	0.39	0.53	0.35	0.32	0.34	0.38	0.39	0.38	0.35	0.35	0.37
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Color (5.25")**	N/A	N/A	N/A	N/A	N/A	2.6Y 0.2R	1.2Y 0.0R	0.9Y 0.0R	1.4Y 0.0R	6.5Y 0.3R	3Y 0.4R
Chlorophyll, ppm	N/A	N/A	N/A	N/A	N/A	0.0	0.0	0.0	0.0	0.0	0.0
Citric acid, ppm	N/A	N/A	N/A	N/A	N/A	<10	<10	<10	<10	<10	<10
Tocopherols (ppm)											
Alpha	N/A	N/A	N/A	N/A	N/A	90.7	84.6	87.4	151	157	139
Gamma	N/A	N/A	N/A	N/A	N/A	727	725	689	683	721	650
Delta	N/A	N/A	N/A	N/A	N/A	159	171	162	102	104	105
Total	N/A	N/A	N/A	N/A	N/A	976.7	980.6	938.4	936	982	894
Sterols (ppm)											
campesterol	N/A	N/A	N/A	N/A	N/A	533	459	451	460	495	383
stigmasterol	N/A	N/A	N/A	N/A	N/A	569	453	448	465	519	364
B-sitosterol	N/A	N/A	N/A	N/A	N/A	1550	1410	1380	1620	1680	1

TABLE 2d. LC-PUFA Oil Variant-1 (Produced by the Transgenic Plants of the Invention)

ANALYTICAL DATA OF SOYBEAN SEEDS AND OILS – CRUSH,
(3 Metric Tonnes Control Soybeans, 5 Tonnes SDA soybeans)

	Control Seed			SDA Seed	Crude Oil		RBD Oil		
	RR1	A3525	MO591	SDA Comp	Control	Avg. SDA Values	Avg. Control Values	Lt Bleach SDA	Hvy Bleach-SDA
Moisture (w/w % or ppm*)	11.54	10.2	10.24				33.4*	38.6*	55.45*
Oil content (%)	18.90	19.59	19.28	19.08					
Peroxide value (PV, meq/kg)	0.3	0.46	0.5	0.5	0.21	0.26	0.0	0.0	0.0
Free fatty acids (FFA, %)	0.44	0.11	0.15	0.27	0.3	0.4	0.03	0.04	0.03
p-Anisidine value (AV)	N/A	N/A	N/A	N/A	0.34	1.63	1.07	2.35	2.05
Conjugated dienes (CD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Trans fatty acids (w/w %)	N/A	N/A	N/A	N/A	0.19	0.48	0.32	0.63	0.67
Fatty acid composition (FAC, w/w%)									
C14:0 (Myristic)	0.09	0.10	0.10	0.10	0.08	0.09	0.07	0.08	0.08
C16:0 (Palmitic)	10.94	11.41	11.71	12.68	11.11	12.59	10.99	12.42	12.42
C16:1 (Trans-Hexadecanoic)	N/A	N/A	N/A	0	0.01	0.01	0.01	0.01	0.01
C16:1n7 (Palmitoleic)	0.15	0.15	0.15	0.16	0.11	0.13	0.12	0.11	0.13
C17:0 (Margaric)	0.10	0.11	0.11	0.11	N/A	N/A	0	0	0
C18:0 (Stearic)	4.55	4.48	4.47	4.35	4.51	4.29	4.48	4.28	4.28
C18:1 (Trans-Octadecenoic)	N/A	N/A	N/A	0	0.08	0.08	0.08	0.07	0.06
C18:1n9 (Oleic)	21.70	20.90	20.51	18.47	20.77	17.76	20.82	17.83	17.85
C18:1 (Octadecenoic)	0.96	1.14	1.09	1.11	1.51	1.58	1.49	1.56	1.57
C18:2 (Trans-Octadecadienoic)	N/A	N/A	N/A	0	0.06	0.08	0.10	0.08	0.10
C18:2n6 (Linoleic)	51.76	52.25	52.52	31.25	52.00	31.39	52.08	31.31	31.32
C18:3 (Trans-Octadecatrenoic)	N/A	N/A	N/A	0	0.07	0.25	0.16	0.29	0.30
C18:3n6 (Gamma linolenic)	0	0.06	0	5.04	N/A	5.10	0	5.12	5.13
C18:3n3 (Alpha linolenic)	8.29	7.91	8.03	10.50	8.15	10.48	8.09	10.41	10.38
C18:4 (Trans Octadecatetraenoic)	N/A	N/A	N/A	0	N/A	0.13	0	0.21	0.24
C18:4n3 (Stearidonic)	N/A	0.16	N/A	14.59	N/A	14.64	0	14.77	14.68
C20:0 (Arachidic)	0.39	0.36	0.37	0.40	0.38	0.38	0.37	0.38	0.38
C20:1n9 (Eicosenoic)	0.26	0.25	0.24	0.29	0.24	0.26	0.22	0.27	0.28
C20:2n6 (Eicosadienoic)	0.04	0.04	0.04	0.03	0.04	0.03	0.04	0.04	0.05
C22:0 (Behenic)	0.41	0.34	0.34	0.33	0.38	0.32	0.37	0.34	0.34
C24:0 (Lignoceric)	0.14	0.13	0.12	0.11	0.13	0.09	0.13	0.10	0.10
Others	0.21	0.22	0.20	0.49	0.39	0.33	0.39	0.31	0.31
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Color (5.25")	N/A	N/A	N/A	N/A	70Y 2.9R (1")	70Y 3.7R (1")	5.2Y 0.4R	5.5Y 0.3R	4.3Y 0.3R

Chlorophyll (ppm)	N/A	N/A	N/A	N/A	0.156	0.033	0.0	0.0	0.0
Citric acid (ppm)	N/A	N/A	N/A	N/A	N/A	N/A	<10	<10	<10
Tocopherols (ppm)									
Alpha	N/A	N/A	N/A	N/A	96.1	111	87.6	106	94.9
Gamma	N/A	N/A	N/A	N/A	830	860	723	777	738
Delta	N/A	N/A	N/A	N/A	238	221	183	176	163
Total	N/A	N/A	N/A	N/A	1164.1	1192	993.6	1059	995.9
Sterols (ppm)									
Campesterol	N/A	N/A	N/A	N/A	778	668	674	532	498
Stigmasterol	N/A	N/A	N/A	N/A	773	673	656	512	476
Beta-Sitosterol	N/A	N/A	N/A	N/A	1860	1880	1700	1640	1570
Others	N/A	N/A	N/A	N/A	577	732	498	623	599
Total	N/A	N/A	N/A	N/A	3988	3953	3528	3307	3143
Metals (ppm)									
Phosphorus	N/A	N/A	N/A	N/A	330	756	N/A	N/A	N/A
Ca	N/A	N/A	N/A	N/A	18.6	52.8	N/A	N/A	N/A
Mg	N/A	N/A	N/A	N/A	23.6	47	N/A	N/A	N/A
Fe	N/A	N/A	N/A	N/A	0.67	0.59	N/A	N/A	N/A
Cu	N/A	N/A	N/A	N/A	<0.05	<0.05	N/A	N/A	N/A
Na	N/A	N/A	N/A	N/A	<0.20	<0.20	N/A	N/A	N/A

Table 2e Finished Base Oil Comparison

	SDA	<u>Vistive Oil</u>	<u>Standard Soybean Oil</u>
		w/o Transgenic oils	
Fatty Acid Composition, %			
C14:0 Myristic Acid	0.1	0.08	0.06
C16:0 Palmitic Acid	12.05	9.01	10.07
C16:1 Palmitoleic Acid	0.11	0.11	0.10
C18:0 Stearic Acid	4.19	4.20	4.35
C18:1 Oleic Acid	17.93	29.25	23.60
C18:2 Linoleic Acid	35.31	52.90	52.47
C18:3 Linolenic Acid	10.11	2.55	6.69
18:3 Gamma LA	4.88		
C18:4 Stearidonic Acid	11.35		
C20:0 Arachidic Acid	0.41	0.31	0.34
C20:1	0.36	0.31	0.27
C22:0 Behenic Acid	0.35	0.35	0.35
C24:0	0.13	0.10	0.10
% Total Trans Fatty Acid	0.89	1.15	16.53

*The LC-PUFA oil of the invention is a mixture of the transgenic oil "SDA" and Vistive Oil.

5 [0045] For the instant invention the primary source of stearidonic acid was oil extracted from transgenic soybeans which have been engineered to produce high levels of stearidonic acid. The soybeans were processed at an oil processing facility and oil was extracted consistent with the methods described in US Patent Applications 2006/0111578, and 2006/0111254.

10 [0046] To make the LC-PUFA composition of the invention, an amount of transgenically derived SDA oil was used and any liquid soybean oil was replaced with Vistive™ oil. This oil retained the benefits of an SDA rich Omega-3 oil with many of the consistency improvements otherwise found in Vistive™ oils.

15 [0047] In addition to oil, flour was made from the transgenic and control soybeans typical of industry practices in processing full-fatted soy flour. One example of a food formulation utilizing the LC-PUFA of the invention is found in Table 3a-3c, and Figures 2a-2e below. General attributes of Italian style dressings according to preferred embodiments of the current invention are provided in Tables 4a-4c.

Table 3a Italian Salad Dressing – Shelf Life Attributes -

	Soybean Oil (reference)							
		95°F	95°F	95°F	95°F	73°F	73°F	73°F
	Initial	1 mo	2 mo	3 mo	4 mo	2 mo	4 mo	6 mo
APPEARANCE								
Opacity	5	5	5	5	5	5	5	5
Color	5	5	6	6	6	5	5	5
AROMA		55						
Total Aroma	7.5	7.5	7.5	8	8.5	7.5	7.5	7.5
Vinegar	6	6	5.5	6	5.5	6	6	5.5
Pungent	5	5	5	5.5	5.5	5	4.5	5
Total Onion/ Garlic/Herb	4	4.5	3.5	3.5	3	4.5	4	4
Total Oil	2	2.5	3	3.5	3.5	2.5	2.5	2.5
Total Off	0	0	2	2.5	3	0.5	1	1.5
Oxidized Oil	0	0	1.5	2	2.5	0.5	0.5	1.5
FLAVOR								
Total Flavor	8.5	8	8.5	9	9	8.5	8.5	8
Vinegar	6	6	6	6.5	6	6	6	5.5
Pungent	6	6	6	6.5	6	6	6	5.5
Total Onion/ Garlic/Herb	5	5	4.5	4	3.5	5.5	4.5	4.5
Sour	6	6	6	6.5	7	6.5	6.5	6
Salty	6.5	7	6.5	6.5	7	6.5	7	7
Total Oil	3	3	4	4	4	3.5	3.5	3
Total Off	0	0	2	2.5	3.5	0.5	1	2
Oxidized Oil	0	0	2	2	2.5	0.5	0.5	2
TEXTURE								
Viscosity by Mouth	4	4	4.5	4.5	4	4	4	4
Oily Mouthfeel (after 5 seconds)	7	7	7.5	7.5	7.5	7	7.5	7
Comments:		very similar to control	slight cardboard, slight pondy, slight painty	oxidized oil, old herb, slightly waxy	oxidized oil, cardboard cooked oil	very slight oxidized oil	slightly oxidized oil, slightly cardboard	
Scale range = 0 to 15								

Table 3a cont'd Italian Salad Dressing – Shelf Life Attributes –

TABLE 6b cont'd

LC-PUFA
GOLDEN ITALIAN DRESSINGS
PROFILES

	LC-PUFA Composition			
		95°F	95°F	73°F
	Ini	1 mo	2 mo	2 mo
APPEARANCE				
Opacity	7.5	7.0	7.5	7.0
Color	5.0	5.0	5.5	5.0
AROMA				
Total Aroma	7.0	7.0	7.5	7.5
Vinegar	5.5	5.5	6.0	6.0
Pungent	5.0	5.0	5.5	5.0
Total Onion/ Garlic/Herb	3.0	3.5	3.0	3.5
Total Oil	3.0	3.0	3.0	3.0
Total Off	1.0	1.5	2.5	1.5
Oxidized Oil	1.0	1.5	2.0	1.0
FLAVOR				
Total Flavor	7.5	8.0	8.5	8.5
Vinegar	5.5	5.5	6.0	6.5
Pungent	5.5	5.5	6.0	6.5
Total Onion/ Garlic/Herb	4.0	4.0	4.0	5.5
Sour	6.0	6.0	6.0	6.0
Salty	7.0	6.5	6.5	6.5
Total Oil	3.5	3.5	3.5	3.5
Total Off	1.0	2.0	2.5	1.5
Oxidized Oil	1.0	2.0	2.0	1.0
TEXTURE				
Viscosity by Mouth	5.0	5.0	4.5	4.5
Oily Mouthfeel (after 5 seconds)	8.0	7.5	7.0	7.0
Comments:	slight oxidized oil	slight oxidized oil, very slight beany	slight oxidized oil, slight reheated oil, slight cardboard	slight oxidized oil, slight beany, slight cardboard

Scale range = 0 to 15

Table 3b Italian Salad Dressing – Shelf Life Attributes

	Fish Oil							
		95°F	95°F	95°F	95°F	73°F	73°F	73°F
	Ini	1 mo	2 mo	3 mo	4 mo	2 mo	4 mo	6 mo
APPEARANCE								
Opacity	6.5	5	5	5	5	6	6	6
Color	5	5	5.5	6	7.5	5	5	5
AROMA								
Total Aroma	6.5	7.5	8.5	9	9	7	7	7
Vinegar	5.5	6	5.5	5.5	5	5.5	5.5	5.5
Pungent	4.5	4.5	5	4.5	5	4.5	4.5	5
Onion/ Garlic/Herb	3.5	3	3.5	3	3	3.5	3.5	3.5
Total Oil	3	3	3.5	5	6	2.5	2.5	3
Total Off	0.5	1	3.5	5	6	1	2	3
Oxidized Oil	0.5	1	3	4.5	5.5	0.5	1.5	3
FLAVOR								
Total Flavor	7.5	7.5	9	9.5	10	8	8.5	8.5
Vinegar	5.5	6	6	5.5	5	6	6.5	6
Pungent	5	6	6	6	5	6	6.5	5.5
Total Onion/ Garlic/Herb	4.5	4.5	4	3.5	3.5	5.5	4	4
Sour	5.5	6	6	6	7	6	6.5	6
Salty	6.5	6.5	7	6.5	7	7	6.5	7
Total Oil	4	3.5	4	5	6.5	3.5	4	3.5
Total Off	0.5	1.5	3	4.5	6.5	1	2.5	3.5
Oxidized Oil	0.5	1	3	4	6	0.5	2	3.5
TEXTURE								
Viscosity by Mouth	5	4.5	4.5	4.5	4	4.5	4	4
Oily Mouthfeel (after 5 seconds)	8	8	7.5	7.5	7.5	8	7	7
Comments:	very slight oxidized oil aroma and flavor	slight oxidized oil, slight beany	pondy, cardboard, heavy oil, slight painty	distinctly fishy	strong fishy	very slight oxidized oil	slightly fishy, slightly pondy, slightly motor oil	waxy, cardboard

Table 3b cont'd Italian Salad Dressing – Shelf Life Attributes -

	Algal Oil							
	Ini	95°F 1 mo	95°F 2 mo	95°F 3 mo	95°F 4 mo	73°F 2 mo	73°F 4 mo	73°F 6 mo
APPEARANCE								
Opacity	5.5	5	5	5	5.5	5.5	5.5	6
Color	5	5	5.5	6	7	5	5	4.5
AROMA								
Total Aroma	7	7.5	7.5	8	8	7	7.5	7
Vinegar	5.5	6	5.5	6	5	5.5	5.5	5.5
Pungent	5	5.5	4.5	5	4.5	5	5	4.5
Onion/ Garlic/Herb	3.5	3.5	3.5	3	3	3.5	3.5	3.5
Total Oil	3	2.5	3	3	3.5	2.5	3	2.5
Total Off	1	1	2	2	3	1	2	2
Oxidized Oil	1	1	1.5	1.5	2.5	1	1.5	2
FLAVOR								
Total Flavor	7.5	7.5	8.5	8.5	9	8	8.5	8
Vinegar	5.5	6	6	6	6	6	6.5	5.5
Pungent	5.5	6	6	6	6	6	6	5.5
Onion/ Garlic/Herb	4.5	4.5	4.5	4	3	4.5	4.5	4.5
Sour	6	6	6	6.5	7	6	6.5	5.5
Salty	6.5	6.5	6.5	6.5	7	6.5	7	6.5
Total Oil	4	3.5	3.5	4	4	3.5	3.5	3.5
Total Off	1	1	2	2.5	3	1	2	2.5
Oxidized Oil	1	1	1.5	2	2.5	0.5	2	2.5
TEXTURE								
Viscosity by Mouth	5	4	4	4	4	4.5	4	4.5
Oily Mouthfeel (after 5 seconds)	7.5	7	7	7	7	7.5	7	7
Comments:	slight oxidized oil aroma and flavor, very slight pondy	slight oxidized oil, slight card- board	slight cardboard, slight oxidized oil	pondy, heavy oil, reheated oil	pondy, slightly rubbery, oxidized heavy oil	slight oxidized oil, slight cardboard, slight heated oil	slightly oxidized oil, slightly reheated heavy oil	slightly cardboard slightly painty

5 Table 3c Italian Salad Dressing – Shelf Life Attributes

	Flax Oil							
	Ini	95°F 1 mo	95°F 2 mo	95°F 3 mo	95°F 4 mo	73°F 2 mo	73°F 4 mo	73°F 6 mo
APPEARANCE								
Opacity	5.5	5	5	6	5.5	5.5	5	5.5

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Color	5	5	5.5	6	7	5	5	5
AROMA								
Total Aroma	7	7	7.5	8	8	7	7	7
Vinegar	5.5	6	6	6	6	6	5.5	5.5
Pungent	5	5	5	5.5	5.5	4.5	4	5
Total Onion/ Garlic/Herb	3.5	4	3.5	3	3	3.5	4	3.5
Total Oil	3.5	3	3	3	3.5	3	3	3
Total Off	2	1.5	2.5	2.5	3	1.5	2.5	2.5
Oxidized Oil	1.5	1	2.5	2	2.5	1	1.5	2
FLAVOR								
Total Flavor	8	8	8.5	9	9	8	9	8.5
Vinegar	6	5.5	6	6.5	6	6	6	5.5
Pungent	5.5	5.5	6	6	6	6	6	5.5
Total Onion/ Garlic/Herb	4	5	4.5	4	3.5	5	5	4.5
Sour	6	5.5	6	6.5	6.5	5.5	6.5	5.5
Salty	6.5	6.5	6.5	6.5	7	6.5	7	6.5
Total Oil	4	4	4	3.5	4	4	4	3.5
Total Off	3	1.5	2.5	2	3.5	1.5	3	2.5
Oxidized Oil	2	0.5	2	2	2.5	1.5	2	2.5
TEXTURE								
Viscosity by Mouth	5	4.5	4.5	4	4	5	4.5	4
Oily Mouthfeel (after 5 seconds)	8	7.5	7.5	7.5	7	7.5	7.5	7

Table 4a: ITALIAN SALAD DRESSING

LC-PUFA SALAD DRESSING FORMULATIONS - ITALIAN						
Variant	Control	LC-PUFA	SDA	Fish Oil	Algal Oil	Flax Oil
Formula Number	50-RA-325-000	50-RA-691-000	50-RA-326-000	50-RA-328-000	50-RA-330-000	50-RA-327-000
INGREDIENT	%					
Liquid Soybean Oil	44.5000	33.17	33.1700	43.0700	43.2700	42.9700
Omega 3 Oil		11.33	11.33	1.43	1.23	1.53
Water	39.3530	39.3530	39.3530	39.3530	39.3530	39.3530
Egg Yolk, Liquid, 10% Salt	2.9000	2.9000	2.9000	2.9000	2.9000	2.9000
Viegar, White Distilled, 120 gr	2.8500	2.8500	2.8500	2.8500	2.8500	2.8500
Sugar, White, Fine Granulated	2.5000	2.5000	2.5000	2.5000	2.5000	2.5000
Buttermilk Powder, Cultured LOL#20631	2.1000	2.1000	2.1000	2.1000	2.1000	2.1000
Salt, Regular, Non Iodized	1.7000	1.7000	1.7000	1.7000	1.7000	1.7000
Flavor, Cultured Buttermilk, Cargill#24521	1.5000	1.5000	1.5000	1.5000	1.5000	1.5000
Garlic, Dehydrated, Granular	0.4500	0.4500	0.4500	0.4500	0.4500	0.4500
Onion, Dehydrated, Granular	0.4400	0.4400	0.4400	0.4400	0.4400	0.4400
Mustard Flour, Wisconsin Spice SP448	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000
Acid, Phosphoric, 75%	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000
Gum, Xanthan, 60 mesh, Regular	0.2750	0.2750	0.2750	0.2750	0.2750	0.2750

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Preservative, Potassium Sorbate	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
Monosodium Glutamate (MSG)	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
Preservative, Sodium Benzoate, Granular	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
Pepper, Black, 30-60 mesh	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
Parsley, Dehydrated, Granular - 10 +30	0.0250	0.0250	0.0250	0.0250	0.0250	0.0250
Preservative, EDTA, Calcium Disodium	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070
TOTAL	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000

Table 4b: ITALIAN SALAD DRESSING

Italian Salad Dressing Production Process:	
1. Check that the mixer is in good working condition, free and clear of dust & dirt, sealed tight, mill set correctly.	
2. Set mix tank speed to 25 hz.	
3. Meter in water to mix tank.	
4. Add preservatives (Benzoate, Sorbate, EDTA) into mix tank.	
5. Make gum slurry (Xanthan Gum + 400g soybean oil)	
6. Add to Dixie tank, mix for 3 minutes	
7. Add the rest of the dry ingredients to the Dixie mill.	
8. Adjust mix tank speed to 45 hz.	
9. Add HFCS, caramel color, and Yellow No. 6 to the Dixie tank	
10. Slowly add remainder of soybean oil and if appropriate, Omega 3 oil	
11. Add distilled vinegar, mix for 30 seconds	
12. Open mix tank valve, and set pump speed to 30 hz.	
13. Turn on pump to pack; colloid mill is off.	
14. Pack into bulk or individual containers, cap.	

5

Table 4c: ITALIAN SALAD DRESSING

SHELF LIFE PRODUCTION
ANALYTICAL/MICRO RESULTS

ITALIAN DRESSING

	Control	LC-PUFA	SDA	Fish Oil	Algal Oil	Flax Oil
	50-RA-252-000	50-RA-690-000	50-RA-248-000	50-RA-264-000	50-RA-266-000	50-RA-265-000
pH	3.51	3.52	3.52	3.53	3.52	3.51
Total Acidity	1.01	1.02	1.02	1.00	1.01	1.02
Total Solids	2.56	2.56	2.51	2.50	2.52	2.53
Bostwick (viscosity)	18.9 cm	19.25 cm	19.1 cm	19.25 cm	19.0 cm	18.9 cm
Total Plate Count	<10	<10	<10	<10	<10	<10
Lactics	<10	<10	<10	<10	<10	<10
Yeast	<10	<10	<10	<10	<10	<10
Mold	<10	<10	<10	<10	<10	<10

10

[0048] According to the methods of the current invention samples of various salad dressings were submitted to a contracting food laboratory for confirmatory studies and analysis of various embodiments of the invention.. The general approach to the shelf-life testing is for 5

attribute panelists to taste the dressings and come to consensus regarding the attributes and intensity (on a 15 pt scale – 0 being absent, 15 being extreme) for each dressing. The lists of attributes identified by the panelists are in the attached documents. Additional attributes are identified as warranted. The characteristics of attribute testing are provided below, Table 5,
5 along with the data from sensory testing at various time points, Table 6.

[0049] The underlying VISTIVE soybean oil, developed through conventional breeding, contains less than three percent linolenic acid as compared to the typical eight percent level found in traditional soybeans. The result is a more stable soybean oil, with less need for hydrogenation. Because soybeans with a lower linolenic acid level reduce the need for partial
10 hydrogenation, their application in processed soybean oils will reduce the presence of trans fats in processed soybean oil. In a synergistic combination with the transgenic SDA of the invention a LC-PUFA oil composition has been developed that satisfies both government regulatory needs and commercial needs for dietary oils with a healthier profile. It maintains the lower level of linolenic acid while providing the benefits of Omega-3 oil and enhanced tocopherol levels.

15

**TABLE 5. LC-PUFA DRESSING DEFINITIONS OF SENSORY ATTRIBUTES
APPEARANCE**

20 Yellow Color The intensity of the yellow color in the sample, from light to dark yellow.

AROMA/FLAVOR

25 Total Aroma The total aroma intensity of the sample.

Total Flavor The total flavor intensity of the sample, including the basic tastes.

30 Total Oil The intensity of aroma/flavor of any type of oil, including oxidized oil.

Oxidized Oil The intensity of aroma/flavor of oxidized oil, described as old oil that has undergone oxidation, characterized as cardboard, beany, painty, or fishy.

35 Total Off Aroma/Flavor The intensity of aroma/flavor of believed to not intended in the product, includes oxidized oil and other off notes. The nature of the off note is to be described.

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	Mayonnaise/Dairy	The intensity of the aroma/flavor associated with mayonnaise or dairy product.
5	Vinegar	The intensity of the aroma/flavor of white vinegar or acetic acid.
	Onion/Garlic/Herb	The intensity of aroma/flavor associated with onion, garlic, and all dried and fresh green herbs.
10	Sour	One of the four basic tastes, perceived primarily on the sides of the tongue; common to acids.
	Salty	One of the four basic tastes, perceived primarily on the sides of the tongue; common to sodium chloride (table salt).

15

FEELING FACTORS

20	Pungent	The amount of burning or irritation of the nasal cavity produced by smelling the sample, such as with horseradish.
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TEXTURE

25	Viscosity by Mouth	The degree of thickness of the sample as perceived when manipulated in the mouth.
	Oily Mouthcoating	The amount of coating perceived on the soft tissues of the mouth

30 **AFTERTASTE**

	Total Aftertaste	The total aftertaste intensity of the sample.
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35

EXAMPLE 1
Salad Dressing

40 [0050] The tables above represent the data developed for a preferred embodiment of the current invention. Please also see Figures 2a-2e for graphical representation of the data out to four months. According to the data provided herein, the samples containing LC-PUFA are significantly less off-flavored than corresponding fish and algal Omega-3 oil formulations, providing the benefit of the presence of an omega-3 formulation without the substantially shortened shelf-life and limited stability. Due to pungent flavors and extremely unpleasant odors

the fish and algal derived oils simply could not be tested and were removed from the 3 months accelerated evaluation period whereas the LC-PUFA composition of the invention was not. Overall the LC-PUFA compositions of the invention demonstrate improved stability, reduced degradation and consequent enhanced shelf-life for commercial utilization in conjunction with the delivery of beneficial Omega-3's into the diet.

[0051] With regard to specific salad dressing embodiments the LC-PUFA compositions of the invention developed utilized for enhanced Ranch Dressings maintained their flavor profile longer than the fish and algal oils after 6 months room temperature storage. For Italian dressings, the more complex flavor system does do some masking, but the LC-PUFA containing dressings of the current invention are again less off flavored than comparable based fish/algal dressings.

Italian Salad Dressings:

[0052] According to the current invention the shelf-life studies, at room temperature and accelerated studies, were completed through 4 months. Each sample has been evaluated by the trained attribute panel in a food laboratory at 0, 2 and 4 months at room temperature and at 1 and 2 months accelerated temperature (95°F). For Ranch Dressings, the fish and algal oil samples were only smelled at 3 months due to high off flavor and character at the two month point and were untestable after that point. All other samples, including those containing the LC-PUFA oil of the invention, were evaluated at 2 months. This is typical for accelerated shelf life evaluations.

[0053] According to the methods of the current invention the Italian dressings have demonstrated significant stability in terms of flavor relative to other omega-3 containing test subjects. Accelerated testing has been completed through four months testing at 95°F. At this point, all of the products exhibited off flavors, with the fish oils demonstrating the highest in off notes. Significantly, the LC-PUFA formulations of the invention were very similar to the soybean oil reference with the improvements in composition and health profile in place.

[0054] According to the methods of the current invention the Ranch-style dressings demonstrated significant improvements according to sensory parameters relative to Fish Oil and Algal Oil formulations containing other Omega-3's. Also according to the invention, accelerated testing has been completed. High intensity off flavors developed in the fish and algal samples at two months whereas the LC-PUFA oil of the invention and the reference soybean oil

could be evaluated according to sensory parameters at 3 months. The reference and flax samples exhibited more characteristic flavors and less off flavor than the LC-PUFA oil of the invention.

The LC-PUFA oil of the invention exhibited more characteristic flavors and less off flavors than the fish and algal samples. This demonstrates that LC-PUFA has improved shelf life vs. fish and

5 algal oils. In addition, room temperature testing was completed for the formulations according to the current invention through 4 months. Results indicate that the LC-PUFA samples of the invention indicate that the LC-PUFA product of the invention has a significantly lower profile for off flavors and unpleasant odors relative to other omega-3 sources, including fish and algal oils.

10 [0055] The data for both Italian and Ranch type dressings and charts that demonstrate the characteristics for the evaluation are attached in Tables 1-11 and figures 2 and 3.

EXAMPLE 2

RANCH SALAD DRESSING

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Table 6a - Ranch Salad Dressing Shelf Life Attributes

	Soybean Oil (reference)						SDA Oil					
	Ini	95°F 1 mo	95°F 2 mo	95°F 3 mo	73°F 2 mo	73°F 4 mo	Ini	95°F 1 mo	95°F 2 mo	95°F 3 mo	73°F 2 mo	73°F 4 mo
APPEARANCE												
Yellow Color	4	5	5	6	4	4	4	4.5	5	6	4	4
AROMA												
Total Aroma	6.5	6.5	6.5	7.5	6.5	7	6.5	7	8	8.5	6.5	7
Mayonnaise	4	4	3.5	3	4	3.5	4	4	2.5	1.5	4	3
Dairy/Cultured Dairy	2.5	2.5	2	1.5	2	2	2.5	2	1.5	1	2.5	1.5
Vinegar	4	4	3.5	3	3.5	3.5	3.5	3.5	2.5	2.5	3.5	3
Pungent	4	4	4	3.5	3.5	4	3.5	3.5	5	4.5	4	4
Total Onion/Garlic/Herb	3	3	2	2	2.5	2.5	2.5	2.5	1.5	1	2.5	2
Total Oil	2.5	2.5	4	4.5	3	3	3	3	5.5	6	3	3.5
Total Off	1	1	4	4.5	2	2	1.5	3	5.5	6.5	1.5	3
Oxidized Oil	1	1	3.5	4	1.5	1.5	1	3	5.5	6	1	3
FLAVOR												
Total Flavor	7	7.5	8	8.5	7.5	7.5	7	7.5	8.5	9	7.5	8
Mayonnaise	5	5.5	3.5	3.5	5	4	5	5	3	2.5	4.5	3.5
Dairy/Cultured Dairy	3	3	2	2	2.5	2.5	3	2	1.5	1.5	2.5	2
Vinegar	4	4	3.5	3.5	3.5	4	3.5	4	2.5	3.5	4	3.5
Pungent	4	4	4.5	4	4	4	3.5	4	5	5	4	4.5
Total Onion/ Garlic/Herb	4	4	2.5	2	3	3.5	3.5	3	2	2	3.5	3
Sour	4.5	4.5	5	5	4.5	4.5	4	4	5	5.5	4.5	5
Total Oil	3.5	3.5	5	4.5	4.5	3.5	4	4	7	6.5	4	4.5
Total Off	1.5	2	5	5	2	2.5	2	3.5	7	7	2	4
Oxidized Oil	1.5	2	5	4.5	1.5	2	1.5	3	7	6.5	1.5	4
TEXTURE												
Viscosity by Mouth	6	6	6	6	6	6	6	6.5	6	6	6	6
Oily Mouthfeel (after 5 sec)	5	5.5	5	5	5	5	5.5	6	5	5	5	5
Comments:		very slight oxidized oil	cardboard, slight oxidized oil	oxidized oil, musty (sweat socks)	slight oxidized oil, slight cardboard	slightly oxidized oil	slight oxidized, slight beany	pondy, fishy	primarily pondy, fishy, linseed oil	fishy, pondy, oxidized oil-painty	slight oxidized oil	fishy, painty, SO2

Scale = 0 to 15

Note: color indicates variance from reference soy oil at initial timepoint; yellow=+/-1.0, orange=+/-1.5 to 2.0, red=+/-2.5

**Table 6a - Ranch Salad
Dressing Shelf Life Attributes**

	Fish Oil						Algal Oil					
	Ini	95°F 1 mo	95°F 2 mo	95°F 3 mo	73°F 2 mo	73°F 4 mo	Ini	95°F 1 mo	95°F 2 mo	95°F 3 mo	73°F 2 mo	73°F 4 mo
APPEARANCE												
Yellow Color	4	4.5	5	6.5	4	4	5	5.5	5.5	6	5	4.5
AROMA												
Total Aroma	6.5	8.5	9	10.5	8	8.5	6.5	7.5	8.5	10	6	8
Mayonnaise	4	2	2	0.5	3.5	2	4	3	2.5	0.5	3.5	2
Dairy/Cultured Dairy	2.5	1	1	0.5	2	1.5	2	2	1	0.5	2	1.5
Vinegar	4	2	2	2	3	2.5	3.5	3	2	2	3	2.5
Pungent	4	2.5	5.5	5.5	4	4.5	3.5	3	5	5	3.5	4.5
Total Onion/Garlic/Herb	3	1.5	1	0.5	2	1.5	3	2	1	1	2	1.5
Total Oil	2.5	6	6.5	8.5	4	5.5	2.5	5	6	7.5	3.5	4.5
Total Off	1	6.5	7	9.5	4	5	1	4	6	8.5	2	4.5
Oxidized Oil	1	6.5	6.5	8.5	3.5	5	1	4	6	7.5	1.5	4.5
FLAVOR												
Total Flavor	7	9	9.5		8.5	9.5	7	8	9		7.5	9
Mayonnaise	5	2	2.5		4.5	2	5	3.5	2.5		4.5	2
Dairy/Cultured Dairy	3	1.5	1		2	1	3	2	1.5		2	1.5
Vinegar	4	2	2		3.5	2.5	3.5	3.5	2		3.5	3
Pungent	4	2.5	6		4	5	4	3.5	6		3.5	4.5
Total Onion/ Garlic/Herb	4	1	1.5		2.5	1.5	3.5	3	1.5		2.5	1.5
Sour	4.5	3.5	5.5		5	5	4	3.5	5.5		4	5
Total Oil	4	7	7.5		5	7.5	3.5	5.5	7.5		4.5	6.5
Total Off	2	7	8		4.5	7	1.5	5	7.5		2	6.5
Oxidized Oil	2	7	8		4	7	1.5	5	7.5		1.5	6.5
TEXTURE												
Viscosity by Mouth	6	6	6		6	6	6.5	6.5	6.5		6	6
Oily Mouthfeel (after 5 sec)	5.5	5	5		5	5	5	6	5		5.5	5
Comments:	slight beany, slight oxidized oil	strong fishy, slight pondy	strong fishy	fishy	fishy, pondy, old vegetabl es	strong fish	very slight oxidized oil	fishy	strong fishy, pondy	fishy, pondy	oxidized oil, slight pondy, slight cardboard	fishy, pondy

Scale = 0 to 15

Note: color indicates variance from reference soy oil at initial timepoint; yellow=+/-1.0, orange=+/-1.5 to 2.0, red=+/-2.5

**5 Table 6b Composition of the Invention – Comparison with LC-PUFA-based Mayonnaise
RANCH DRESSINGS PROFILES**

	LC-PUFA			
			95°F	73°F
	Ini	1 mo	2 mo	2 mo
APPEARANCE				
Yellow Color	4.0	5.0	6.0	4.5

AROMA				
Total Aroma	6.0	6.5	7.0	7.0
Mayonnaise	4.0	5.0	3.0	3.5
Dairy/Cultured Dairy	2.5	2.5	1.5	1.5
Vinegar	3.5	3.0	3.5	3.5
Pungent	3.5	3.0	4.5	4.0
Total Onion/Garlic/Herb	2.0	2.0	2.0	2.0
Total Oil	3.0	3.5	5.0	3.5
Total Off	1.5	2.5	5.0	3.0
Oxidized Oil	1.5	2.0	5.0	2.5
FLAVOR				
Total Flavor	7.0	7.0	8.0	8.0
Mayonnaise	5.0	6.0	3.5	4.0
Dairy/Cultured Dairy	2.5	2.0	2.0	2.0
Vinegar	3.5	4.0	3.0	3.5
Pungent	4.0	4.0	4.0	4.0
Total Onion/ Garlic/Herb	3.5	3.0	2.0	3.5
Sour	4.5	4.5	5.0	5.0
Total Oil	4.0	4.5	6.0	5.0
Total Off	2.0	3.0	5.5	3.0
Oxidized Oil	2.0	2.5	5.5	2.5
TEXTURE				
Viscosity by Mouth	6.0	6.0	6.0	6.0
Oily Mouthfeel (after 5 seconds)	5.5	5.5	5.0	5.5
Comments:	slight oxidized oil, slight pondy	oxidized oil, musty, vegetative, pondy, beany	painty, old parmesan cheese, cardboard	painty, cardboard, old parmesan cheese

Scale = 0 to 15

**Table 6b - Ranch Salad
Dressing Shelf Life Attributes**

	Flax Oil					
		95°F	95°F	95°F	73°F	73°F
	Ini	1 mo	2 mo	3 mo	2 mo	4 mo
APPEARANCE						
Yellow Color	4.5	5	5.5	6	5	4.5
AROMA						
Total Aroma	6	7	6.5	8	6.5	6
Mayonnaise	3.5	4.5	3.5	3	4	3
Dairy/Cultured Dairy	3	2.5	1.5	1.5	2	2
Vinegar	3.5	4	3	3	3	3.5
Pungent	3.5	4	4	3.5	3.5	3.5
Total Onion/Garlic/Herb	3	3	1.5	2	2.5	2
Total Oil	3	3	4	4	3	3
Total Off	2	2	3.5	4.5	2	2
Oxidized Oil	1.5	1.5	3.5	4	1.5	2
FLAVOR						
Total Flavor	7	7	7.5	8.5	8	7
Mayonnaise	4.5	5	3.5	3.5	5	4
Dairy/Cultured Dairy	3	3	2	2	2.5	2.5
Vinegar	3.5	4	3	3.5	3.5	4
Pungent	4	3.5	4.5	4	4	4.5
Total Onion/ Garlic/Herb	3.5	3.5	2.5	2.5	3	2.5
Sour	4.5	4	5	5	5	5
Total Oil	4	4	4.5	5	4.5	4
Total Off	3	2.5	4	5	3.5	3
Oxidized Oil	2	2.5	3.5	4.5	2.5	2.5
TEXTURE						
Viscosity by Mouth	6.5	6.5	6	6	6	6
Oily Mouthfeel (after 5 sec)	6	5.5	5	5	5.5	5
Comments:	slight fishy	slight oxidized oil, slight fishy	pondy, beany, oxidized oil	musty (sweat socks), oxidized oil, slightly fishy, pondy	pondy, slightly sour milk	cardboard, slightly old parmesean, slightly pondy

Scale = 0 to 15

Note: color indicates variance from reference soy oil at initial timepoint; yellow=+/-1.0, or

**Table 7a
LC-PUFA SALAD DRESSING FORMULATIONS
- RANCH**

Variant	Control	LC-PUFA	SDA	Fish Oil	Algal Oil	Flax Oil
Formula Number	50-RA-325-000	50-RA-691-000	50-RA-326-000	50-RA-328-000	50-RA-330-000	50-RA-327-000
INGREDIENT	%					
Liquid Soybean Oil	44.5000	33.17	33.1700	43.0700	43.2700	42.9700
Omega 3 Oil		11.33	11.33	1.43	1.23	1.53

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Water	39.3530	39.3530	39.3530	39.3530	39.3530	39.3530
Egg Yolk, Liquid, 10% Salt	2.9000	2.9000	2.9000	2.9000	2.9000	2.9000
Vinegar, White Distilled, 120 gr	2.8500	2.8500	2.8500	2.8500	2.8500	2.8500
Sugar, White, Fine Granulated	2.5000	2.5000	2.5000	2.5000	2.5000	2.5000
Buttermilk Powder, Cultured LOL#20631	2.1000	2.1000	2.1000	2.1000	2.1000	2.1000
Salt, Regular, Non Iodized	1.7000	1.7000	1.7000	1.7000	1.7000	1.7000
Flavor, Cultured Buttermilk, Cargill#24521	1.5000	1.5000	1.5000	1.5000	1.5000	1.5000
Garlic, Dehydrated, Granular	0.4500	0.4500	0.4500	0.4500	0.4500	0.4500
Onion, Dehydrated, Granular	0.4400	0.4400	0.4400	0.4400	0.4400	0.4400
Mustard Flour, Wisconsin Spice SP448	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000
Acid, Phosphoric, 75%	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000
Gum, Xanthan, 60 mesh, Regular	0.2750	0.2750	0.2750	0.2750	0.2750	0.2750
Preservative, Potassium Sorbate	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
Monosodium Glutamate (MSG)	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
Preservative, Sodium Benzoate, Granular	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
Pepper, Black, 30-60 mesh	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
Parsley, Dehydrated, Granular -10 +30	0.0250	0.0250	0.0250	0.0250	0.0250	0.0250
Preservative, EDTA, Calcium Disodium	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070
TOTAL	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000

Table 7b

Ranch Dressing Production Process

1. Check that the Mixer is in good working condition, free and clear of any dirt or dust, sealed tight.
2. Set colloid mill at 0.45"
3. Set mix tank speed at 45 hz.
4. Meter water into the mix tank.
5. Add in preservatives (Benzoate, Sorbate, EDTA) into the mix tank.
6. Make gum slurry (Xanthan gum + 700g soybean oil)
7. Add slurry to dixie tank, allow to mix for 3 minutes
8. Increase tank speed to 35 hz.
9. Add remaining dry ingredients slowly to the mix tank.
10. Add Egg Yolk and Cultured Milk Powder
11. Increase tank speed to 45 hz.
12. Slowly add the remaining soybean oil, and if appropriate, the Omega 3 oil.
13. Add slowly, the vinegar and phosphoric acid.
14. All to mix until all ingredients are incorporated and mixed (approx 30 sec)
15. Open mix tank valve, and set pump speed to 30 hz.

5

Table 7c

SHELF LIFE PRODUCTION
ANALYTICAL/MICRO RESULTS

RANCH DRESSING

	Control	SDA	Fish Oil	Algal Oil	Flax Oil
	50-RA-325-000	50-RA-326-000	50-RA-328-000	50-RA-330-000	50-RA-327-000
pH	3.80	3.79	3.79	3.79	3.80
Total Acidity	0.82	0.83	0.82	0.84	0.84
Total Solids	2.17	2.15	2.15	2.14	2.17
Bostwick (viscosity)	8.3 CM	8.5 cm	8.8 cm	8.5 cm	8.8 cm
Total Plate Count	30	50	110	30	20
Lactics	<10	<10	<10	<10	<10
Yeast	<10	<10	<10	<10	<10
Mold	<10	<10	<10	<10	<10

[0056] The general approach to the shelf life testing is for 5 trained attribute panelists to taste the dressings and come to consensus regarding the attributes and intensity (on a 15 pt scale – 0 being absent, 15 being extreme) for each dressing. The lists of attributes identified by the panelists are in the attached documents. Additional attributes would be identified as warranted.

Creamy Ranch Dressing-Initial Time Point

Compared to the reference soybean oil:

10

The SDA Oil sample did not differ by 1.0 or more for any attribute. Panelists commented that this sample had a slight oxidized, slight beany note.

15

The LC-PUFA sample was slightly lower in total Onion/Garlic/Herb Aroma. Panelists commented that this sample had a slight oxidized oil, slight pondy note.

20

The Fish Oil sample did not differ by 1.0 or more for any attribute. Panelists commented that this sample had a slight beany, slight oxidized oil note.

The Algal Oil sample was slightly higher in yellow color. Panelists commented that this sample had a very slight oxidized oil note.

The Flax Oil sample was higher in Total Off Flavor, and slightly Higher in Total Off Aroma and Oily Mouthfeel. Panelists commented that this sample had a slight fishy flavor

5 [0057] For the current example the tables above provide significant data on flavor and consistency. In the case of Ranch Dressing, because of its more sensitive flavor, the differences between the dressings made with LC-PUFA and the competitive counterparts are more obvious. The tables above represent the data developed for a preferred embodiment of the current invention. Please also see Figures 3a-3h for graphical representation of the data with Ranch
10 Dressing. According to the data provided herein the samples containing LC-PUFA are significantly less off-flavored than those containing the fish and algal oils. Due to pungent flavors and extremely unpleasant odor the fish and algal derived oils were simply removed from the 3 months accelerated evaluation period whereas LC-PUFA was not. Demonstrating improved stability, reduced degradation and consequent enhanced shelf-life.

15

EXAMPLE 3 MAYONNAISE

[0058] According to the current invention, a mayonnaise was prepared and tested with
20 the omega-3 containing oil of the invention, the data provided applies for all mayonnaise and spoonable salad dressing variants, produced in a variety of ways (colloid mill, frying mill, etc).

Table 8a LC-PUFA – Mayonnaise, Formulation

MAYONNAISE SHELF LIFE ATTRIBUTES										
n=5										
	Soybean Oil (reference)					SDA Oil				
		95°F	95°F	73°F	73°F		95°F	95°F	73°F	73°F
	Ini	1 mo	2 mo	2 mo	4 mo	Ini	1 mo	2 mo	2 mo	4 mo
APPEARANCE										
Color	4	4.5	5	4	4	4	4.5	5	4	4
AROMA										
Total Aroma	6	6.5	7	6	6	6	7	8.5	6.5	6.5
Eggy Aroma	3.5	3.5	3	3.5	3	3.5	3.5	2	3.5	2.5
Vinegar Aroma	3	3.5	2.5	3	3	3	2.5	2.5	3	2.5

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Pungent	4	4.5	4	4	4.5	3.5	4	4.5	3.5	4.5
Total Oil	1.5	2.5	3.5	2	2.5	1.5	2.5	5	2	3.5
Total Off	0.5	2	3.5	1.5	2.5	0.5	3	6.5	2	4.5
Oxidized Oil	0.5	2	3.5	1.5	2	0.5	2.5	5	2	3.5
FLAVOR										
Total Flavor	6.5	7	7	7	7	6.5	8.5	9	7	8
Eggy Flavor	4	4	3	4	3.5	4	4.5	2.5	4	3
Vinegar Flavor	2.5	3	2.5	3	2.5	2.5	2.5	2.5	2.5	2.5
Sweet	3.5	3.5	3.5	3.5	3	3.5	5	3.5	3	3
Sour	2.5	2.5	3	3	3	2.5	3.5	3	2.5	3
Salty	3	3	3	3.5	3.5	3.5	3.5	3	3.5	4
Total Oil	3	3.5	4	3.5	3.5	3.5	4	5.5	3.5	4.5
Total Off	1.5	3	4.5	2	3.5	1	5	6.5	2.5	5.5
Oxidized Oil	1.5	2.5	4	2	3	0.5	4	5.5	2	4.5
TEXTURE										
Viscosity by Mouth	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	9
Oily Mouthfeel (after 5 seconds)	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	9
Comments:		old oil, beany, slightly waxy	painty, cardboard	slightly oxidized, cardboard	reheated oil, slightly beany			slight sulfur, oxidized oil, slightly beany	Slight sulfur, pondy, slightly melted plastic	

Table 8b Composition of the Invention – Comparison with Fish Oil-based Mayonnaise

n=5					
	Fish Oil				
		95°F	95°F	73°F	73°F
	Ini	1 mo	2 mo	2 mo	4 mo
APPEARANCE					
Color	4	4.5	5	4	4
AROMA					
Total Aroma	6	6.5	7.5	6.5	6.5
Eggy Aroma	3.5	3.5	3	3.5	3
Vinegar Aroma	3	3	3	3	3
Pungent	3.5	4	4.5	4	4.5
Total Oil	1.5	2	4	2.5	3
Total Off	0.5	2	4.5	2	3.5
Oxidized Oil	0.5	1.5	4	2	3

FLAVOR					
Total Flavor	6.5	7.5	8	7.5	8
Eggy Flavor	4	4	2.5	4	3
Vinegar Flavor	2.5	2.5	2.5	2.5	2.5
Sweet	3.5	3.5	3.5	3.5	3
Sour	2.5	3.5	3.5	3	3
Salty	3	3.5	4	3.5	4
Total Oil	3	3.5	5	4	5
Total Off	1	3	6	3.5	5.5
Oxidized Oil	0.5	2.5	5	3.5	5
TEXTURE					
Viscosity by Mouth	8.5	9	8.5	8.5	9
Oily Mouthfeel (after 5 seconds)	8.5	9	8.5	8.5	9.5
Comments:		fishy, musty, painty	strong fishy	oxidized oil, painty, old mayo, fish	fishy

Table 8c Composition of the Invention – Comparison with Algal Oil-based Mayonnaise

	Algal Oil				
		95°F	95°F	73°F	73°F
	Ini	1 mo	2 mo	2 mo	4 mo
APPEARANCE					
Color	5.5	7	6.5	6	5.5
AROMA					
Total Aroma	6	8	9	7	8
Eggy Aroma	4	2.5	2	3	2
Vinegar Aroma	3	3	2.5	3	2
Pungent	3.5	4.5	5	4	5.5
Total Oil	1.5	4	6	2.5	5
Total Off	0.5	4.5	6.5	2	5.5
Oxidized Oil	0.5	4.5	6	2	5
FLAVOR					
Total Flavor	6.5	9	9.5	8	9
Eggy Flavor	5	2.5	2	3	2
Vinegar Flavor	2.5	2.5	2	2.5	1.5

Sweet	4	2.5	3.5	3	3
Sour	2.5	3.5	3.5	3	3.5
Salty	3.5	3.5	3.5	3.5	4
Total Oil	3	6	7	5	6.5
Total Off	1.5	6.5	7.5	4.5	7.5
Oxidized Oil	1	6	7	4.5	6.5
TEXTURE					
Viscosity by Mouth	8.5	8.5	8.5	8.5	9
Oily Mouthfeel (after 5 seconds)	8.5	9	8.5	8.5	8.5
Comments:		fishy, pondy	Strong fishy	Oxidized oil, painty old mayo, fishy	Fishy, pondy, beany, cardboard

5 8d Composition of the Invention – Comparison with Flax Oil-based Mayonnaise

	Flax Oil				
		95°F	95°F	73°F	73°F
	Initial	1 mo	2 mo	2 mo	4 mo
APPEARANCE					
Color	4.5	5.5	5.5	5	5
AROMA					
Total Aroma	6	6.5	7.5	6.5	6.5
Eggy Aroma	3.5	4	2	3.5	2.5
Vinegar Aroma	3	3	2.5	3.5	2.5
Pungent	3.5	4	5	4.5	4
Total Oil	1.5	2.5	4.5	2	3
Total Off	1.5	2	5	1.5	3.5
Oxidized Oil	1	2	4.5	1.5	3
FLAVOR					
Total Flavor	7	7	8	7.5	7.5
Eggy Flavor	3.5	4	2.5	3.5	3
Vinegar Flavor	2.5	2.5	2	3	2.5
Sweet	3	3.5	3.5	3.5	3.5
Sour	2.5	3	3	3	3
Salty	3.5	3.5	3.5	3.5	4
Total Oil	3	3.5	5	4	4.5

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Total Off	3.5	2.5	5.5	3	4.5
Oxidized Oil	3	2.5	5	3	4.5
TEXTURE					
Viscosity by Mouth	8.5	9	8.5	8	8.5
Oily Mouthfeel (after 5 seconds)	8.5	9	8.5	8.5	8.5
Comments:		Old oil, reheated oil, beany, waxy	Fishy, cardboard, reheated oil	Fishy, pondy	Strong fishy

8e Composition of the Invention – Comparison with PUFA-based Mayonnaise

	<u>Soybean Oil (reference)</u>	<u>SDA Oil</u>	<u>LC-PUFA</u>	<u>Fish Oil</u>	<u>Algal Oil</u>	<u>Flax Oil</u>
	Ini	Ini	Ini	Ini	Ini	Ini
APPEARANCE						
Color	4.0	4.0	3.5	4.0	5.5	4.5
AROMA						
Total Aroma	6.0	6.0	5.5	6.0	6.0	6.0
Eggy Aroma	3.5	3.5	3.0	3.5	4.0	3.5
Vinegar Aroma	3.0	3.0	3.0	3.0	3.0	3.0
Pungent	4.0	3.5	3.5	3.5	3.5	3.5
Total Oil	1.5	1.5	1.5	1.5	1.5	1.5
Total Off	0.5	0.5	0.5	0.5	0.5	1.5
Oxidized Oil	0.5	0.5	0.5	0.5	0.5	1.0
FLAVOR						
Total Flavor	6.5	6.5	6.5	6.5	6.5	7.0
Eggy Flavor	4.0	4.0	4.0	4.0	5.0	3.5
Vinegar Flavor	2.5	2.5	2.5	2.5	2.5	2.5
Sweet	3.5	3.5	3.5	3.5	4.0	3.0
Sour	2.5	2.5	2.5	2.5	2.5	2.5
Salty	3.0	3.5	3.5	3.0	3.5	3.5
Total Oil	3.0	3.5	3.0	3.0	3.0	3.0
Total Off	1.5	1.0	1.0	1.0	1.5	3.5
Oxidized Oil	1.5	0.5	1.0	0.5	1.0	3.0
TEXTURE						
Viscosity by Mouth	8.5	8.5	8.5	8.5	8.5	8.5
Oily Mouthfeel (after 5 seconds)	8.5	8.5	9.0	8.5	8.5	8.5
Comments:	slight cardboard, slight beany	slight oxidized oil	very slight oil based paint	very slight oxidized oil	slight oxidized oil, slight plastic-like	fishy, pondy, oxidized oil, reheated oil

Scale range = 0 to 15

Note: color indicates variance from Soybean reference; yellow= \pm 1.0, orange= \pm 1.5 to 2.0, red= \leq 2.5

Table 9a.

LC-PUFA MAYONNAISE FORMULATIONS AND PROCESS

Generic Formula	Typical	Range	Control	w/LC-PUFA Oil	w/ Fish Oil	w/Algal oil	w/Flax Oil
Control Soybean Oil	79	65-84	79.000	54.650	75.900	76.350	75.730
LC-PUFA Oil				24.350	3.100	2.650	3.270
Water	5.093	to 100%	5.093	5.093	5.093	5.093	5.093
Egg Yolk (10% Salted)	7	5.0-13.0	7.000	7.000	7.000	7.000	7.000
White Distilled Vinegar 120 gr	3.5	2.0-9.0	3.500	3.500	3.500	3.500	3.500
Sugar	3.5	1.0-5.0	3.500	3.500	3.500	3.500	3.500
Salt	1.4	0.5-1.8	1.400	1.400	1.400	1.400	1.400
Mustard Flour	0.5	0.3-1.0	0.500	0.500	0.500	0.500	0.500
Calcium Disodium EDTA	0.007	0-0.007	0.007	0.007	0.007	0.007	0.007
Total	100		100.00	100.00	100.00	100.00	100.00

Notes:

Potassium sorbate, lemon juice concentrate, flavorings are optional ingredients.

Light and reduced fat versions can be made by reducing fat level and the addition of starch and gum.

HFCS and other sweeteners may be used in place of sugar.

Public Sources:

21CFR160.10 Standard of Identity for Mayonnasie

Product Literature: EGGSolutions, American Egg Board

Product Literature: G.S. Dunn Ltd, Full Egg Mayonnaise

Process: From G. S. Dunn Ltd Product Literature and known industry practice

1. Hydrate mustard flour in water for 5 min
 2. Add vinegar, lemon juice (alt. ingredient), salt, sugar to the mixture
 3. Add egg yolk.
- Mix.
4. Add EDTA to the oil
 5. Slowly add the oil to the mix, increasing agitation speed as it is added.
 6. Blend and homogenize, utilizing a colloid mill or alternative.

Table 9b

Mayonnaise Process - Pilot Plant

2. Set the colloid mill at 30.
3. Add the water first, then mix in the EDTA.

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4. Add the egg yolk, mix for 3 min.
5. Pre-mix the mustard flour, sugar, and salt. Add the premix slowly until dissolved and evenly dispersed.
6. Add in the oils mix for 3 minutes, set Dixie mix tank speed at 35hz.
7. Slowly add in the vinegar
8. Mix until all ingredients are dispersed. Shut off Dixie Mixer agitation, allow air to escape.
9. Start up the Collid Mill. Open mix tank, valve, set pump speed to 30hz.
10. Pack into individual packages.

[0059] According to the current invention. The general approach to the shelf life testing is for 5 trained attribute panelists to taste the dressings and come to consensus regarding the attributes and intensity (on a 15 pt scale – 0 being absent, 15 being extreme) for each dressing. The lists of attributes identified by the panelists are in the attached documents. Additional attributes would be identified as warranted.

Table 9c.

	<u>VALUE</u>	SCALE REFERENCE
<u>APPEARANCE</u>		
Color	0.0	White (paper)
	7.5	Manila Folder
<u>AROMA\FLAVOR</u>		
Eggy	8.0/6.0	Chopped Hard Boiled Eggs
Vinegar Aroma	6.5	100% Heinz Distilled Vinegar solution
Vinegar Flavor	4.0	2% Heinz Distilled Vinegar solution
Total Off	3.5	Edamame, raw soybeans
Oxidized Dairy/Oil (aroma and flavor)	4.0	Canola Oil (opened 9/05)
	5.0	Wesson Vegetable Oil (opened 11/22/04)
	8.0	Kraft Parmesan Cheese (2001 expiration date)
Sweet	2.0	2.0% Sucrose in Water
	5.0	5.0% Sucrose in Water
Sour	2.0	0.025% Citric Acid in Water
	5.0	0.04% Citric Acid in Water
Salty	2.0	0.2% Sodium Chloride in Water
	5.0	0.5% Sodium Chloride in Water

MOUTHFEEL FACTORS

Pungent (aroma)	8.0	100% Heinz Distilled Vinegar solution
-----------------	-----	---------------------------------------

TEXTURE

Viscosity by Mouth	8.0	50:50 mix of Lucerne Heavy Cream and Kraft Mayonnaise
	11.0	Kraft Mayonnaise

Oily Mouthfeel	8.0	Kraft Mayonnaise
----------------	-----	------------------

[0060] According to the current invention the following data was developed after initial evaluations. Similar to the Salad Dressings example, the initial flavor of LC-PUFA containing mayonnaise was similar to the control. The flax sample was most different from the others

5 compared

[0061] According to the methods of the current invention, the shelf-life studies two month studies at both room temperature and accelerated storage conditions were completed. All samples in the accelerated temperature study had noticeable off flavor with the algal oil sample containing the highest off notes. LC-PUFA performed better than the other omega-3 containing

10 oil sources. For the room temperature study, Algal oil exhibited much higher levels of off flavors than the LC-PUFA oil of the invention. See the above data in tables 12-14 and Figures 4a-4e.

15

EXAMPLE 4 SOY MILK

[0062] According to the current invention, Soymilk can be prepared in two different ways. In the first, LC-PUFA enriched soybeans are de-hulled, flaked and then made into full

20 fatted soy flour. The soymilk is formulated by first dissolving the soy flour into water, mixing, and processing to inactivate the enzymes. The soy base is filtered to remove additional solids and degassed. The remaining ingredients are added, mixed, the product is then homogenized in a two stage homogenizer, then processed through a Ultra High Temperature (UHT) thermal processing unit. The resulting product is packed and refrigerated with a typical shelf life of 12 weeks. Following is a formulation as provided in Table 10, see also FIG. 6 for a process flow

25 diagram.

Table 10.

Vanilla Soymilk	%
Water	88.122
LC-PUFA Enriched Soy Flour	6.786
Full Fat Soymilk.	0.600
Sucrose	3.400
Carageenan	0.022
Cellulose Gum	0.350
Salt	0.040
Calcium Carbonate	0.350
Natural and Artificial Flavors	0.330
TOTAL	100.000

5 [0063] The example used can also be applied to different types of homogenization and thermal processing units (direct steam, indirect steam, etc.). Different soymilk flavors, including plain, chocolate, apple, orange, berry, etc. can be prepared in the same manner.

 [0064] The resulting product was found to have acceptable flavor and mouth "feel" properties in comparison to soymilk made from flour processed the same way but without the
10 LC-PUFA enhancement of the current invention. According to the data developed in pursuit of the current invention after 9 months shelf life, only slight differences in taste exist between the embodiments of the current invention enhanced with a transgenic LC-PUFA composition versus a control composition with non-transgenic soybean oil containing no Omega-3 fatty acids. This was done for both the soymilk and fruit smoothies. Note these are kept refrigerated and only
15 have a 3 month shelf life in most commercial settings.

 [0065] The second approach to this example is to use isolated soy protein, and to add LC-PUFA enriched soy oil to achieve a new product composition. Following is a formulation as provided in Table 11 with a corresponding flow diagram in FIG 7.

Table 11.

Vanilla Soymilk	%
Water	88.058
Sucrose	3.500
Isolated Soy Protein	2.700
Maltodextrin	3.500
11% LC-PUFA Soybean Oil	1.500
Carageenan	0.022
Cellulose gum	0.350
Salt	0.040

Natural & Artificial Flavors	0.330
TOTAL	100.000

[0066] According to the current invention the example provided above used can also be applied to different types of homogenization and thermal processing units (direct steam, indirect steam, etc.). Different soymilk flavors, including plain, chocolate, apple, orange, berry, etc. can be prepared in the same manner. The resulting product was found to have acceptable flavor and mouthfeel properties in comparison to soymilk made with refined, bleached and deodorized soybean oil.

EXAMPLE 5 FRUIT SMOOTHIES

[0067] According to a preferred embodiment of the current invention, fruit smoothies, developed from soymilk. Other sources of LC-PUFA oil could be used for the development of fruit smoothies as well, in alternative embodiments. Also according to the current invention the processes developed for the production of the fruit smoothies takes into account the unique properties of the LC-PUFA oil for enhancing health and nutrition. Two smoothie type products have been developed, and both products have been determine to have extended shelf life properties. During a process that involves the utilization of ultra high pasteurization, stored refrigerated, with a 12 week shelf life typical of other refrigerated drinks. Although a mixed berry prototype is described herein, other flavors can be developed including strawberry, grape, cranberry, orange, lemon, apple, pineapple, mango, strawberry- banana and any other fruit flavor combination.

[0068] In the first approach, soymilk is prepared as described in the first part of Example 4, utilizing LC-PUFA enriched soy flour. Additional ingredients including stabilizers, flavorings and fruit are added prior to homogenization. The following is a formulation used for the product:

Table 12.
MIXED BERRY FRUIT SMOOTHIE - SOY BASED

	%
Water	77.774
LC-PUFA Enriched Soy Flour	6.773
Pectin	0.300
Cellulose gel/pectin mix	0.400
Sucrose	9.300

Citric Acid, anhydrous	0.450
Potassium Citrate, granular	0.060
Soy lecithin	0.060
Salt	0.070
Frozen Strawberry Puree	4.000
Frozen Blackberry Puree	0.500
Red Grape Juice Concentrate	0.123
Natural Flavor	0.020
Natural Flavor	0.060
Natural Berry Flavor	0.050
Natural and Artificial Mixed Berry Flavor	0.040
Natural and Artificial Blueberry Flavor	0.020
Total	100.000

[0069] The soybase portion was prepared according to the process described in Example

4. The processing for the remainder of the product is described below:

5 Table 13.

Preparation Procedures:

1. Pre-weigh all dry ingredients
2. **Stabilizer portion:** Add prescribed water for stabilizer portion into mixing vessel and begin agitation.
3. Heat water to 110 to 120°F.
4. Mix the pectin and Avicel with a portion of the dry sugar and add slowly to the water with high shear mixing. Allow 5 minutes for hydration.
5. Add the citric acid.
6. **Soy milk portion:**
7. Add the potassium citrate, soy lecithin and salt.
8. **Combine the stabilizer portion and soymilk portion into larger, steam jacketed mixing vessel.**
9. Add the purees, color, and flavorings and mix until uniform.
10. Check pH. Expected pH 4.2 ± 0.2 .
11. Heat to 160°F and homogenize d/s 2500+500 psi. (3000 psi total)
12. UHT process in the Microthermics unit. Target process is 224°F for 19 seconds.
13. Cool in Microthermics cooling sections and fill directly into containers.
14. Apply closure and place bottles into chilled water bath. Cool to $\leq 50^\circ\text{F}$.
15. Take count of bottles, apply labels, and refrigerate (PD Warehouse walk-in refrigerator).

[0070] A second approach developed by the current invention is where an LC-PUFA enriched oil is added to a formulation containing Isolated Soy Protein. In this embodiment, a mixed berry product was developed, but can be extended to additional flavors as described above. Following is the basic formulation used in an embodiment of the current invention:

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Table 14

MIXED BERRY FRUIT SMOOTHIE - SOY BASED

	%
Water	81.077
Pectin	0.300
Cellulose gel/pectin mix	0.400
Sucrose	8.700
Citric Acid, anhydrous	0.310
11% LC-PUFA Soybean Oil	1.500
Isolated Soy Protein	2.700
Potassium Citrate, granular	0.060
Soy lecithin	0.080
Salt	0.060
Frozen Strawberry Puree	4.000
Frozen Blackberry Puree	0.500
Red Grape Juice Concentrate	0.123
Natural Flavor	0.020
Natural Flavor	0.060
Natural Berry Flavor	0.050
Natural and Artificial Mixed Berry Flavor	0.040
Natural and Artificial Blueberry Flavor	0.020
Total	100.000

5 The product was developed according to the methods of the invention and has the following formulation:

Table 15.

Preparation Procedures:

1. Pre-weigh all dry ingredients
2. **Stabilizer portion:** Add prescribed water for stabilizer portion into mixing vessel and begin agitation.
3. Heat water to 110 to 120°F.
4. Mix the pectin and Avicel with a portion of the dry sugar and add slowly to the water with high shear mixing. Allow 5 minutes for hydration.
5. Add the citric acid.
6. **Soy milk portion:** Add the prescribed water for the soymilk portion into a separate mixing vessel and begin agitation.
7. Heat the water to 100 to 110°F
8. Add the soy protein isolate. Mix well to disperse.
9. Add the potassium citrate, soy lecithin, salt and oil.
10. **Combine the stabilizer portion and soymilk portion into larger, steam jacketed mixing vessel.**
11. Add the frozen strawberry puree, color, and flavorings and mix until uniform.
10. Check pH. Expected pH 4.2 ± 0.2 .

10 [0071] The resulting products from both approaches in this example were typical of a fruit flavored smoothie embodiment of the invention with a refrigerated shelf life of 12 months as developed for the current invention.

[0072] The data and techniques above demonstrate the production of a mixed berry smoothie from soymilk according to the methods of the invention. According to an embodiment

of the invention the LC-PUFA oil of the invention provides substantial differences relative to other omega-3 containing samples.

EXAMPLE 6 MARGARINE TYPE SPREADS

Table 16

70% Fat Margarine Type Spread

	Control	SDA	LC- PUFA	Fish	Algal	Flax
Ingredient	%	%	%	%	%	%
Soy Salad Oil	35.00	10.65	10.65	31.90	32.35	31.73
Partially Hydrogenated Soy Bean Oil *	35.00	35.00	35.00	35.00	35.00	35.00
Omega 3 Oil		24.35	24.35	3.10	2.65	3.27
Water	27.60	27.60	27.60	27.60	27.60	27.60
Salt	2.00	2.00	2.00	2.00	2.00	2.00
Lecithin, Soy Based **	0.14	0.14	0.14	0.14	0.14	0.14
Sodium Benzoate	0.09	0.09	0.09	0.09	0.09	0.09
52% Plastic Mono & Diglyceride ***	0.15	0.15	0.15	0.15	0.15	0.15
Vitamin A / Beta Carotene Blend ****	0.01	0.01	0.01	0.01	0.01	0.01
Natural & Artificial Butter Flavor	0.01	0.01	0.01	0.01	0.01	0.01
Total	100.00	100.00	100.00	100.00	100.00	100.00

[0073] According to a preferred embodiment of the current invention, a typical margarine process, is, the water, salt, sodium benzoate, and butter flavor are mixed as an aqueous phase. Turning to FIG. 7 a milk ingredient, such as whey powder, sodium caseinate or milk powder may be added to the aqueous phase. The oils, lecithin, mono and diglycerides, vitamins, and flavorings are mixed, and combined with the aqueous phase and mixed. The mixed emulsion is passed through a series of scraped surface heat exchangers, pin mixers and resting tubes (A, B and C units respectively) to achieve a desired fill temperature and consistency.

EXAMPLE 7 COOKIE DOUGH

[0074] According to the invention the LC-PUFA oil of the invention can also be developed into food products including cookies. Below is provided one recipe for such utilization.

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Table 17

Ingredient	%
Flour	49.20
Baker's Sugar	16.00
Hardened soybean oil (Mpt 36-38°)	17.40
20% LC-PUFA Oil	7.5
Liquid soya oil	4.1
Salt	0.80
Water	5.00
Total	100.00

Recombinant Plant Production

[0075] One method to recombinantly produce a protein of interest a nucleic acid encoding a transgenic protein can be introduced into a host cell. The recombinant host cells can be used to produce the transgenic protein, including a desirable fatty acid such as LC-PUFA that can be secreted or held in the seed, seed pod or other portion of a target plant. A nucleic acid encoding a transgenic protein can be introduced into a host cell, e.g., by homologous recombination. In most cases, a nucleic acid encoding the transgenic protein of interest is incorporated into a recombinant expression vector.

[0076] In particular the current invention is also directed to transgenic plants and transformed host cells which comprise, in a 5' to 3' orientation, a promoter operably linked to a heterologous structural nucleic acid sequence. Additional nucleic acid sequences may also be introduced into the plant or host cell along with the promoter and structural nucleic acid sequence. These additional sequences may include 3' transcriptional terminators, 3' polyadenylation signals, other untranslated nucleic acid sequences, transit or targeting sequences, selectable markers, enhancers, and operators.

[0077] Preferred nucleic acid sequences of the present invention, including recombinant vectors, structural nucleic acid sequences, promoters, and other regulatory elements, are described above. The means for preparing such recombinant vectors are well known in the art.

For example, methods for making recombinant vectors particularly suited to plant transformation are described in U.S. Pat. Nos. 4,940,835 and 4,757,011.

[0078] Typical vectors useful for expression of nucleic acids in cells and higher plants are well known in the art and include vectors derived from the tumor-inducing (Ti) plasmid of *Agrobacterium tumefaciens*. Other recombinant vectors useful for plant transformation, have also been described in the literature.

[0079] The transformed host cell may generally be any cell which is compatible with the present invention. The transformed host cell may be prokaryotic, more preferably a bacterial cell, even more preferably an *Agrobacterium*, *Bacillus*, *Escherichia*, *Pseudomonas* cell, and most preferably is an *Escherichia coli* cell. Alternatively, the transformed host cell is preferably eukaryotic, and more preferably a plant, yeast, or fungal cell. The yeast cell preferably is a *Saccharomyces cerevisiae*, *Schizosaccharomyces pombe*, or *Pichia pastoris*. The plant cell preferably is an alfalfa, apple, banana, barley, bean, broccoli, cabbage, canola, carrot, cassava, celery, citrus, clover, coconut, coffee, corn, cotton, cucumber, garlic, grape, linseed, melon, oat, olive, onion, palm, pea, peanut, pepper, potato, radish, rapeseed (non-canola), rice, rye, sorghum, soybean, spinach, strawberry, sugarbeet, sugarcane, sunflower, tobacco, tomato, or wheat cell. The transformed host cell is more preferably a canola, maize, or soybean cell; and most preferably a soybean cell. The soybean cell is preferably an elite soybean cell line. An "elite line" is any line that has resulted from breeding and selection for superior agronomic performance.

[0080] The transgenic plant of the invention is preferably an alfalfa, apple, banana, barley, bean, broccoli, cabbage, canola, carrot, cassava, celery, citrus, clover, coconut, coffee, corn, cotton, cucumber, garlic, grape, linseed, melon, oat, olive, onion, palm, pea, peanut, pepper, potato, radish, rapeseed (non-canola), rice, rye, safflower, sorghum, soybean, spinach, strawberry, sugarbeet, sugarcane, sunflower, tobacco, tomato, or wheat plant. The transformed host plant is most preferably a canola, maize, or soybean cell; and of these most preferably a soybean plant.

30 Method for Preparing Transgenic Plants

[0081] The invention is further directed to a method for preparing transgenic plants capable of producing a substantial amount of LC-PUFA comprising, in a 5' to 3' direction, a

promoter operably linked to a heterologous structural nucleic acid sequence. The nucleic acid sequence comprising the sequence of LC-PUFA when translated and transcribed into amino acid form. Other structural nucleic acid sequences may also be introduced into the plant along with the promoter and structural nucleic acid sequence. These other structural nucleic acid sequences may include 3' transcriptional terminators, 3' polyadenylation signals, other untranslated nucleic acid sequences, transit or targeting sequences, selectable markers, enhancers, and operators.

[0082] The method generally comprises selecting a suitable plant cell, transforming the plant cell with a recombinant vector, obtaining the transformed host cell, and culturing the transformed host cell under conditions effective to produce a plant.

[0083] The transgenic plant of the invention may generally be any type of plant, preferably is one with agronomic, horticultural, ornamental, economic, or commercial value, and more preferably is an alfalfa, apple, banana, barley, bean, broccoli, cabbage, canola, carrot, castorbean, celery, citrus, clover, coconut, coffee, corn, cotton, cucumber, Douglas fir, Eucalyptus, garlic, grape, Loblolly pine, linseed, melon, oat, olive, onion, palm, parsnip, pea, peanut, pepper, poplar, potato, radish, *Radiata* pine, rapeseed (non-canola), rice, rye, safflower, sorghum, Southern pine, soybean, spinach, strawberry, sugarbeet, sugarcane, sunflower, Sweetgum, tea, tobacco, tomato, turf, or wheat plant. The transformed plant is more preferably a canola, maize, or soybean cell; and most preferably a soybean plant. The soybean plant is preferably an elite soybean plant. An elite plant is any plant from an elite line. Elite lines are described above.

[0084] The regeneration, development, and cultivation of plants from transformed plant protoplast or explants is well taught in the art (Gelvin et al., **PLANT MOLECULAR BIOLOGY MANUAL**, (1990); and, Weissbach and Weissbach, **METHODS FOR PLANT MOLECULAR BIOLOGY** (1989)). In this method, transformants are generally cultured in the presence of a selective media which selects for the successfully transformed cells and induces the regeneration of the desired plant shoots. These shoots are typically obtained within two to four months.

[0085] The shoots are then transferred to an appropriate root-inducing medium containing the selective agent and an antibiotic to prevent bacterial growth. Many of the shoots will develop roots. These are then transplanted to soil or other media to allow the continued development of roots. The method, as outlined, will generally vary depending on the particular plant strain employed.

[0086] Preferably, the regenerated transgenic plants are self-pollinated to provide homozygous transgenic plants. Alternatively, pollen obtained from the regenerated transgenic plants may be crossed with non-transgenic plants, preferably inbred lines of economically important species. Conversely, pollen from non-transgenic plants may be used to pollinate the regenerated transgenic plants.

[0087] The transgenic plant may pass along the nucleic acid sequence encoding the protein of interest to its progeny. The transgenic plant is preferably homozygous for the nucleic acid encoding the protein of interest protein and transmits that sequence to all its offspring upon as a result of sexual reproduction. Progeny may be grown from seeds produced by the transgenic plant. These additional plants may then be self-pollinated to generate a true breeding line of plants.

[0088] The progeny from these plants are evaluated, among other things, for gene expression. The gene expression may be detected by several common methods (e.g., western blotting, immunoprecipitation, and ELISA).

[0089] Regulatory sequences include those that direct constitutive expression of a nucleotide sequence in many types of host cells, those that direct expression of the nucleotide sequence only in certain host cells (e.g., tissue-specific regulatory sequences) and those that direct expression in a regulatable manner (e.g., only in the presence of an inducing agent). It will be appreciated by those skilled in the art that the design of the expression vector may depend on such factors as the choice of the host cell to be transformed, the level of expression of transgenic protein desired, and the like. The transgenic protein expression vectors can be introduced into host cells to thereby produce transgenic proteins encoded by nucleic acids.

[0090] As used herein, the terms "transformation" and "transfection" refer to a variety of art-recognized techniques for introducing foreign nucleic acid (e.g., DNA) into a host cell, including calcium phosphate or calcium chloride co-precipitation, DEAE-dextran-mediated transfection, lipofection, electroporation, microinjection and viral-mediated transfection. Suitable methods for transforming or transfecting host cells can be found in Sambrook et al. (**Molecular Cloning: A Laboratory Manual**, 2nd Edition, Cold Spring Harbor Laboratory press (1989)), and other laboratory manuals.

[0091] One skilled in the art can refer to general reference texts for detailed descriptions of known techniques discussed herein or equivalent techniques. These texts include: Ausubel, et

al., **CURRENT PROTOCOLS IN MOLECULAR BIOLOGY** (eds., John Wiley & Sons, N.Y. (1989)); Birren et al., **GENOME ANALYSIS: A LABORATORY MANUAL 1: ANALYZING DNA**, (Cold Spring Harbor Press, Cold Spring Harbor, N.Y. (1997)); Clark, **PLANT MOLECULAR BIOLOGY: A LABORATORY MANUAL**, (Clark, Springer-Verlag, Berlin, (1997)); and, Maliga et al., **METHODS IN PLANT MOLECULAR BIOLOGY**, (Cold Spring Harbor Press, Cold Spring Harbor, N.Y. (1995)). These texts can, of course, also be referred to in making or using an aspect of the invention. It is understood that any of the agents of the invention can be substantially purified and/or be biologically active and/or recombinant.

[0092]

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Reduction of Linoleic Acid

[0093] It is known that Omega-3 and Omega-6 fatty acids are fatty acids that are required in human nutrition. Omega-6 fatty acids include linoleic acid and its derivatives. These oils are considered essential to human nutrition because these fatty acids must be consumed in the diet because humans cannot manufacture them from other dietary fats or nutrients, and they cannot be stored in the body. Fatty Acids of this sort provide energy and are also components of nerve cells, cellular membranes, and are converted to hormone-like substances known as prostaglandins.

[0094] Looking at Fig. 1, linoleic acid is an 18-carbon long polyunsaturated fatty acid containing two double bonds. Its first double bond occurs at the sixth carbon from the omega end, classifying it as an omega-6 oil. As linoleic acid is absorbed and metabolized in the human body, it is converted into a derivative fatty acid, gamma linoleic acid (GLA), which is converted into di-homo-gamma linoleic acid (DGLA) and arachidonic acid (AA). The DGLA and AA are then converted into two types of prostaglandins by adding two carbon molecules and removing hydrogen molecules. There are three families of prostaglandins, PGE1, PGE2, and PGE3. DGLA is converted to PGE1, while AA is converted into PGE2. PGE3 is made by the conversion of omega-3 fatty acids.

[0095] In humans the over consumption of omega-6 oils in relation to consumption of omega-3 oils can lead to an overproduction of inflammation-producing prostaglandins (PGE2) and a scarcity of anti-inflammatory prostaglandins (PGE1 and PGE2). This in turn can lead to a variety of other health problems. Going further, the daily consumption of omega-6 fatty acids by

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consumers may be excessive, due to the presence of omega-6 fatty acids in common cooking vegetable oils and processed foods currently on the market. The ratio of omega-6 to omega-3 fatty acid consumption can often reach 20:1 in western diets. To achieve a more desirable ratio, an embodiment of the current invention provides for the increased production of LC-PUFA while reducing the production of LA in a transgenic oilseed plant. The resulting oil contains lower levels of LA while providing for the production of significant quantities of LC-PUFA and can be used in a variety of roles in the food industry from cooking oil to food ingredient.

Raising Tocopherol Levels

[0096] Tocopherols are natural antioxidants and essential nutrients in the diet found in plant oils. These antioxidants protect cell membranes and other fat-soluble parts of the body, such as low-density lipoprotein (LDL) cholesterol from damage. It also appears to protect the body against cardiovascular disease and certain forms of cancer and has demonstrated immuno-enhancing effects. According to the current invention enhancements in the presence of tocopherols in the oil of transgenic seed oil plants will be beneficial to consumers of the oil. Relative to the purposes of the current invention enhanced concentrations of tocopherols present in various embodiments of the current will be beneficial as a part of an oil product and may also reduce the oxidation of LC-PUFA

[0097] Although the foregoing invention has been described in some detail by way of illustration and example for purposes of understanding, it will be apparent to those skilled in the art that certain changes and modifications may be practiced. Therefore, the description and examples should not be construed as limiting the scope of the invention, which is delineated by the appended claims.

[0098] Accordingly, it is to be understood that the embodiments of the invention herein providing for an improved source of LC-PUFA for utilization in food products should not be limited to the specific examples. These examples are illustrative of the general applicability of the current invention to a vast range of food items. With the inclusion of LC-PUFA these items can be made with the same or better sensory qualities while significantly enhancing the nutritionally quality of the food produced for human consumption.

[0099] Moreover, the examples provided herein are merely illustrative of the application of the principles of the invention. It will be evident from the foregoing description that changes in the form, methods of use, and applications of the elements of the disclosed plant-derived could be used for applications not directly related to human consumption. Included in this field is the use of plant-derived LC-PUFA for the development of nutritionally enhanced feed for use in animal production industries generally including but not limited to: beef production; poultry production; pork production; and or, aquaculture. These variant uses may be resorted to without departing from the spirit of the invention, or the scope of the appended claims.

[0100] A reference herein to a patent document or other matter which is given as prior art is not taken as an admission that that document or prior art was part of common general knowledge at the priority date of any of the claims.

[0101] With reference to the use of the word(s) "comprise" or "comprises" or "comprising" in the foregoing description and/or in the following claims, unless the context requires otherwise, those words are used on the basis and clear understanding that they are to be interpreted inclusively, rather than exclusively, and that each of those words is to be so interpreted in construing the foregoing description and/or the following claims.

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The claims defining the invention are as follows:

1. A food product comprising from 0.1 wt.% to 80 wt.% stearidonic acid and exhibiting at least 5% longer shelf-life against flavor degradation than an otherwise identical food product having eicosapentanoic acid rather than stearidonic acid and wherein said food product comprises an oil from a transgenic plant comprising at least 10% by weight stearidonic acid based on the total weight of fatty acids in the oil and further comprises a soybean oil having less than 3% by weight alpha-linolenic acid (ALA) based on the total weight of fatty acids in the soybean oil.
2. An animal feed product comprising from 0.1 wt.% to 80 wt.% stearidonic acid and exhibiting at least 5% longer shelf-life against flavor degradation than an otherwise identical animal feed product having eicosapentanoic acid rather than stearidonic acid and wherein said animal feed product can be used as animal feed for livestock or aquaculture and said animal feed product comprises an oil from a transgenic plant comprising at least 10% by weight stearidonic acid based on the total weight of fatty acids in the oil and further comprises a soybean oil having less than 3% by weight alpha-linolenic acid (ALA) based on the total weight of fatty acids in the soybean oil.
3. A nutraceutical product containing from 0.1 wt.% to 80 wt.% stearidonic acid and exhibiting at least 5% longer shelf-life against flavor degradation than an otherwise identical nutraceutical product having eicosapentanoic acid rather than stearidonic acid and wherein said nutraceutical product comprises an oil from a transgenic plant comprising at least 10% by weight stearidonic acid based on the total weight of fatty acids in the oil and further comprises a soybean oil having less than 3% by weight alpha-linolenic acid (ALA) based on the total weight of fatty acids in the soybean oil.
4. The food product, animal feed product, or nutraceutical product of any one of claims 1 to 3 wherein said shelf-life is at least about 15% longer.
5. The food product, animal feed product, or nutraceutical product of any one of claims 1 to 3 further comprising tocopherols.

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6. The food product, animal feed product, or nutraceutical product of any one of claims 1 to 3 further comprising soy protein.
7. The food product, animal feed product, or nutraceutical product of any one of claims 1 to 3 wherein said product comprises less than about 40 wt.% linoleic acid (LA).
8. The food product of claim 1 wherein said product further comprises transgenic soybean oil comprised of at least 10 wt.% stearidonic acid and at most about 35 wt.% linoleic acid (LA) based on the total weight of fatty acids or derivatives thereof in the food product, and wherein said soybean oil comprises at least about 400 ppm tocopherols.
9. The food product of claim 1, wherein the food product is selected from the group consisting of soybean meal; soyflour; defatted soyflour; soymilk; spray-dried soymilk; soy protein concentrate; texturized soy protein concentrate; hydrolyzed soy protein; soy protein isolate; and spray-dried tofu.
10. The food product of claim 1, further comprising a moisture containing ingredient; and a sufficient amount of stabilizer to form an emulsion, such that said food product is a stable emulsion.
11. The food product of claim 10, wherein said moisture containing ingredient is a dairy component.
12. The food product of claim 1 wherein said transgenic plant is an oilseed plant.
13. The food product of claim 1 wherein said transgenic plant is selected from the group consisting of canola, corn, flax, and soybean.
14. The food product of claim 1 wherein said food product is selected from the group consisting of baked goods, dairy products, spreads, margarines, sports products, nutrition bars and infant formulas.

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15. The animal feed product of claim 2 wherein said livestock is cattle, swine, or poultry.

16. The animal feed product of claim 2 wherein said aquaculture is salmon, trout, catfish, tilapia, crustacean, or mackerel.

17. A method of making the food product of claim 1 comprising mixing an oil composition comprising stearidonic acid with a food to increase the amount of stearidonic acid in the food relative to the level of other fatty acids and decrease the amount of alpha-linolenic acid (ALA) in the food relative to the level of other fatty acids.

18. A method of making an animal feed product of claim 2 comprising mixing an oil composition comprising stearidonic acid derived from a transgenic plant with feed nutrients and said feed product further comprises an oil having less than 3% by weight of alpha-linolenic acid (ALA).

19. A method of making the nutraceutical product of claim 3 comprising adding an oil composition comprising stearidonic acid from a transgenic plant to a food.

20. The method of any of any one of claims 17 to 19 further comprising adding soy protein to the product.

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Pathways of PUFA Metabolism

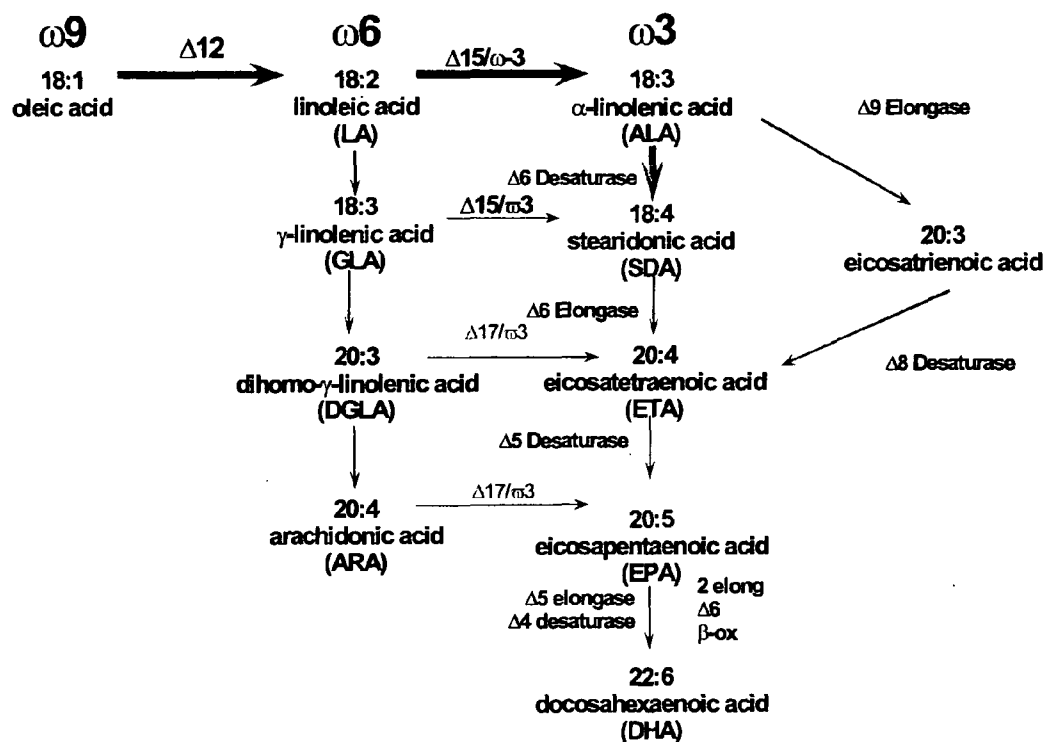
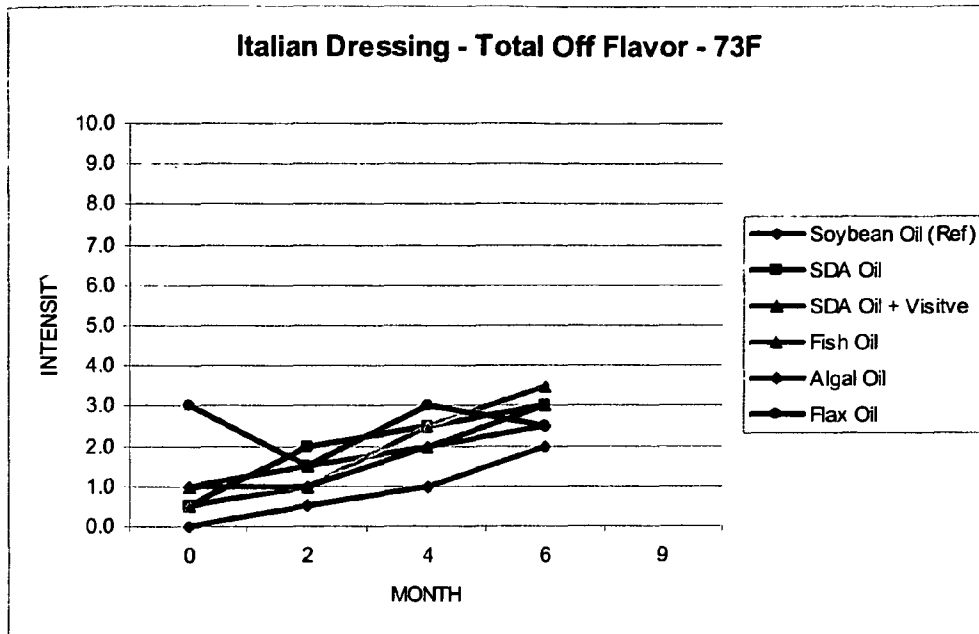


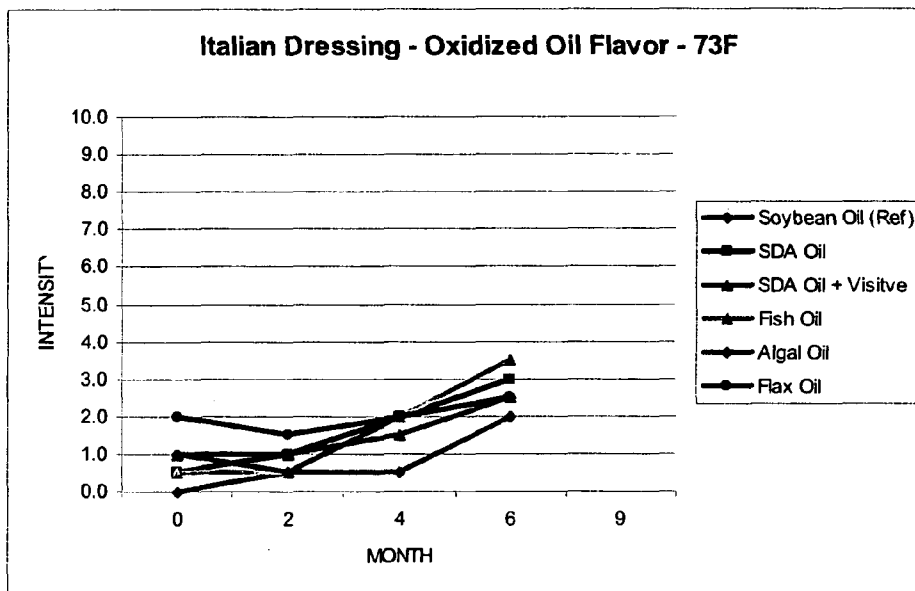
FIG. 1

FIG. 2a



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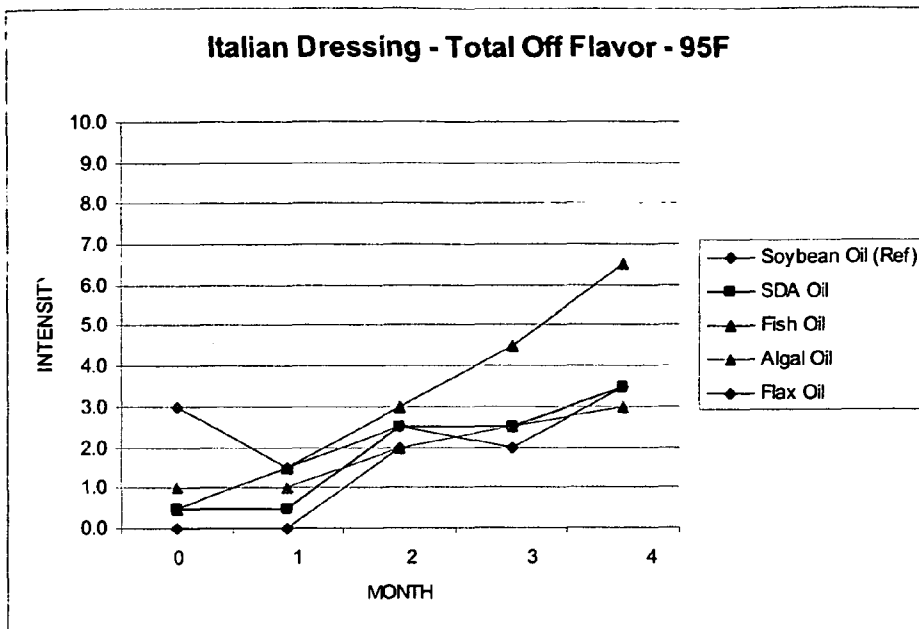
FIG. 2b



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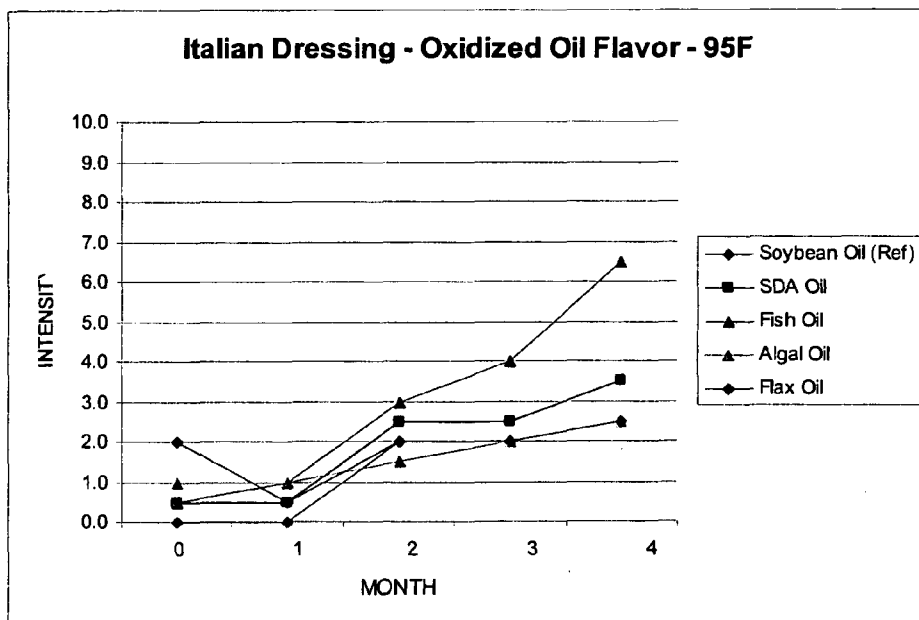
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FIG 2c



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FIG. 2d



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5 FIG 2e

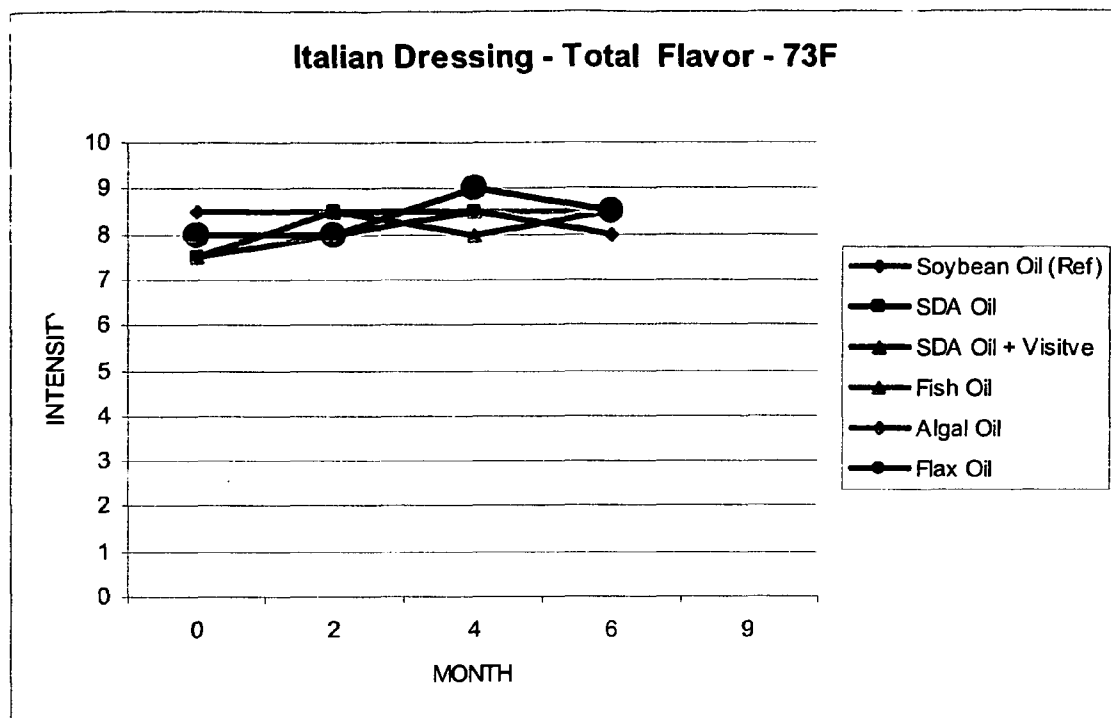
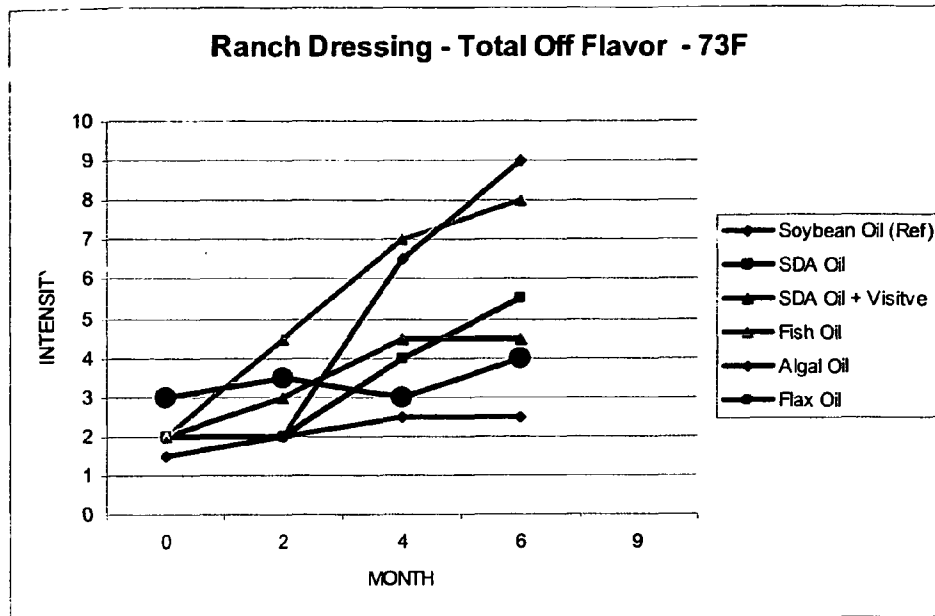
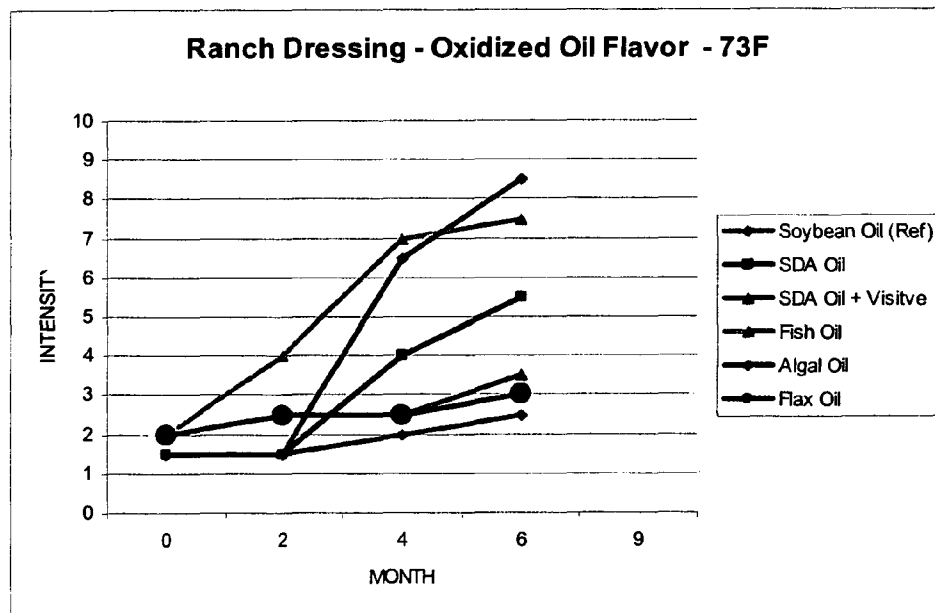


FIG. 3a



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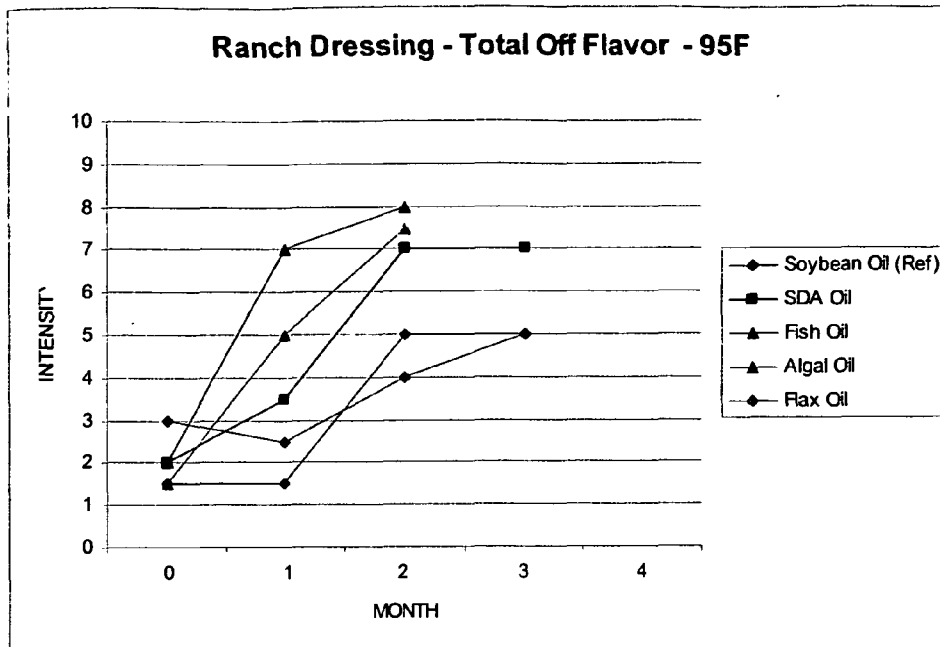
FIG. 3b



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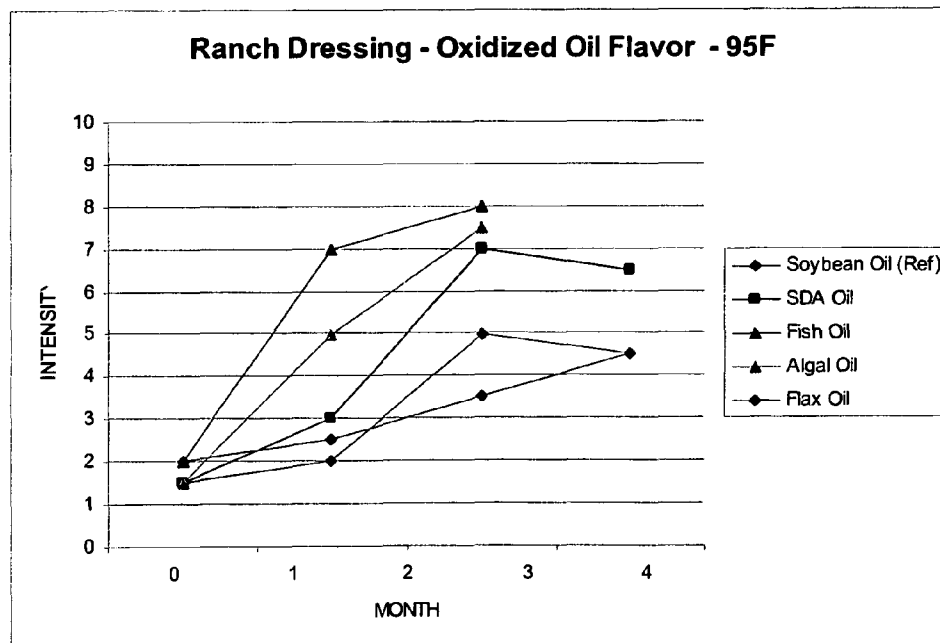
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FIG. 3c



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FIG. 3d



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FIG. 3e

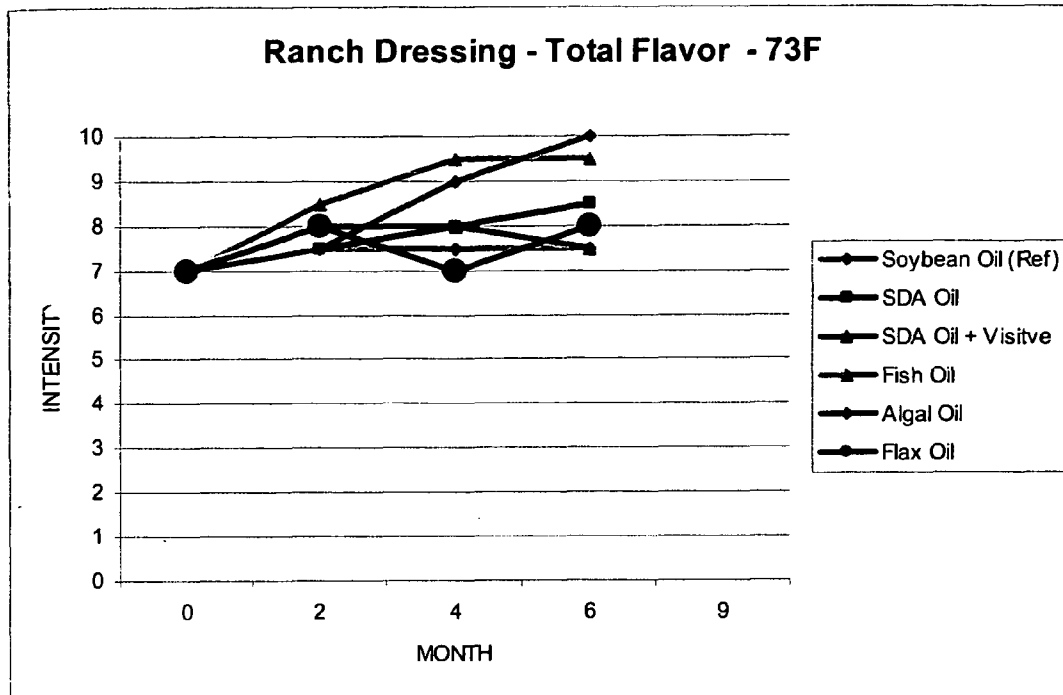
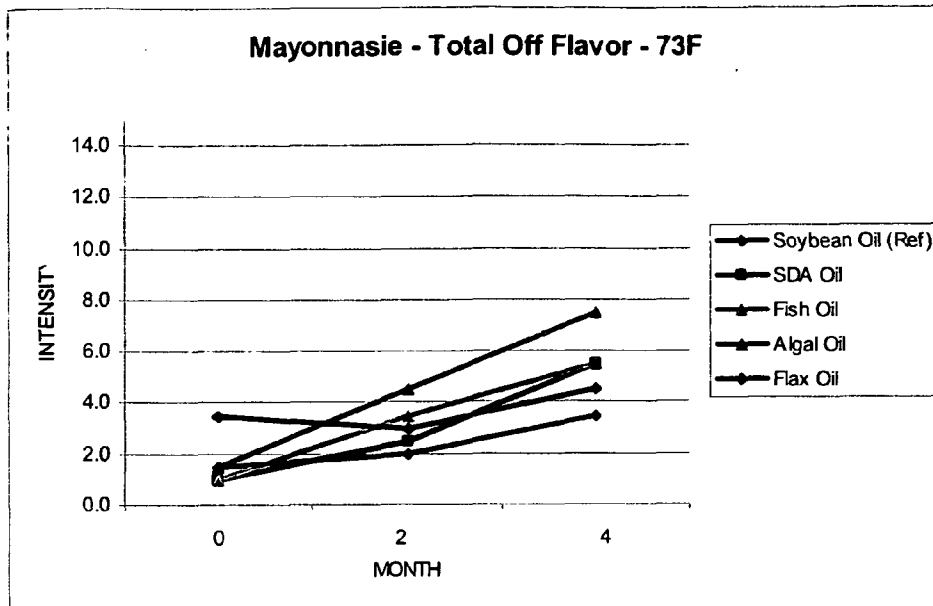
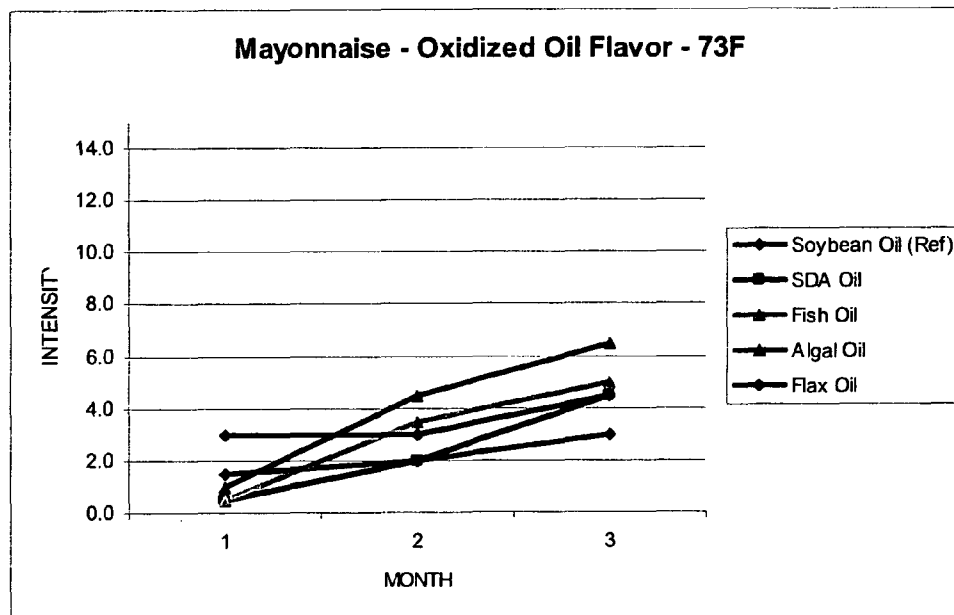


FIG. 4a



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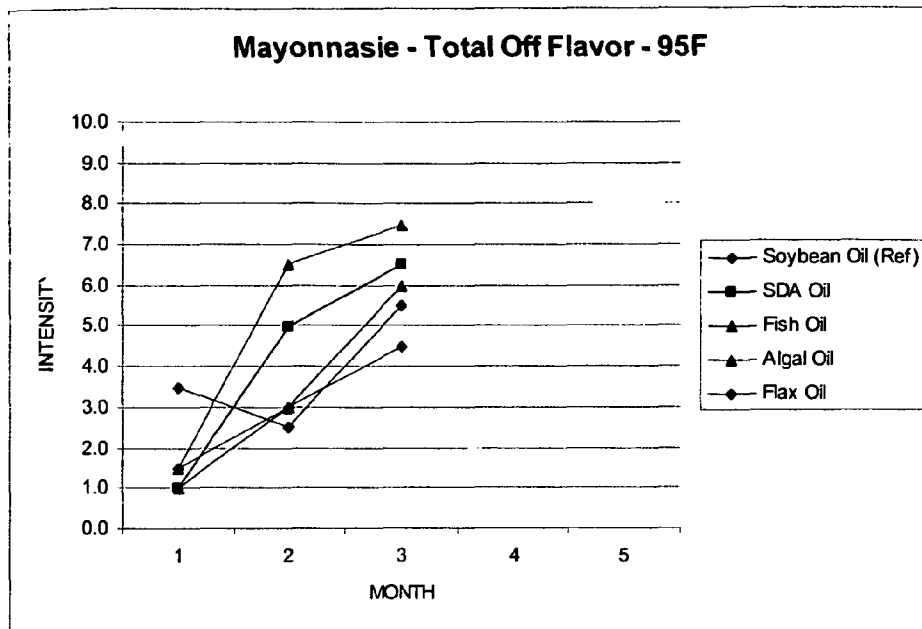
FIG. 4b



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FIG. 4c



5 FIG. 4d

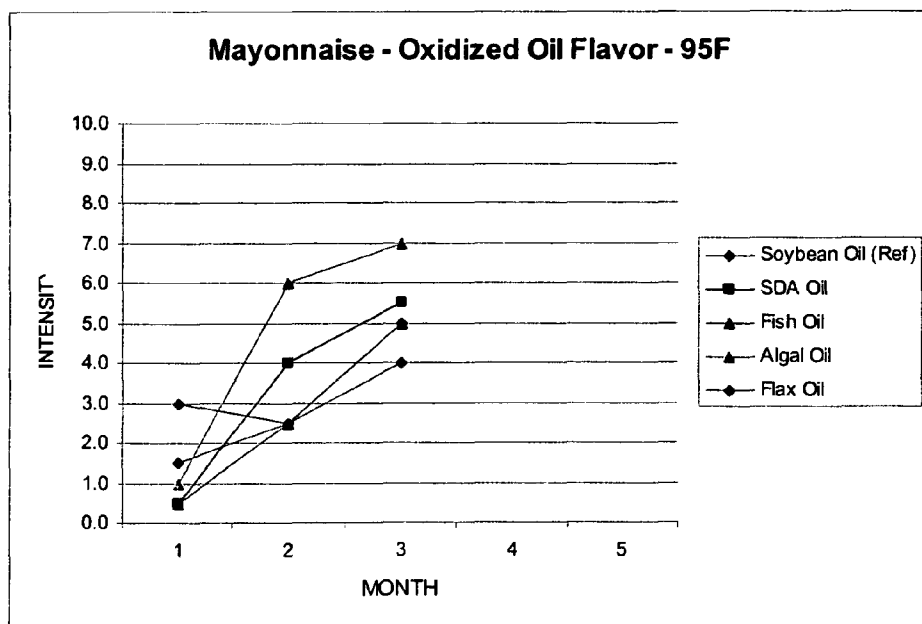
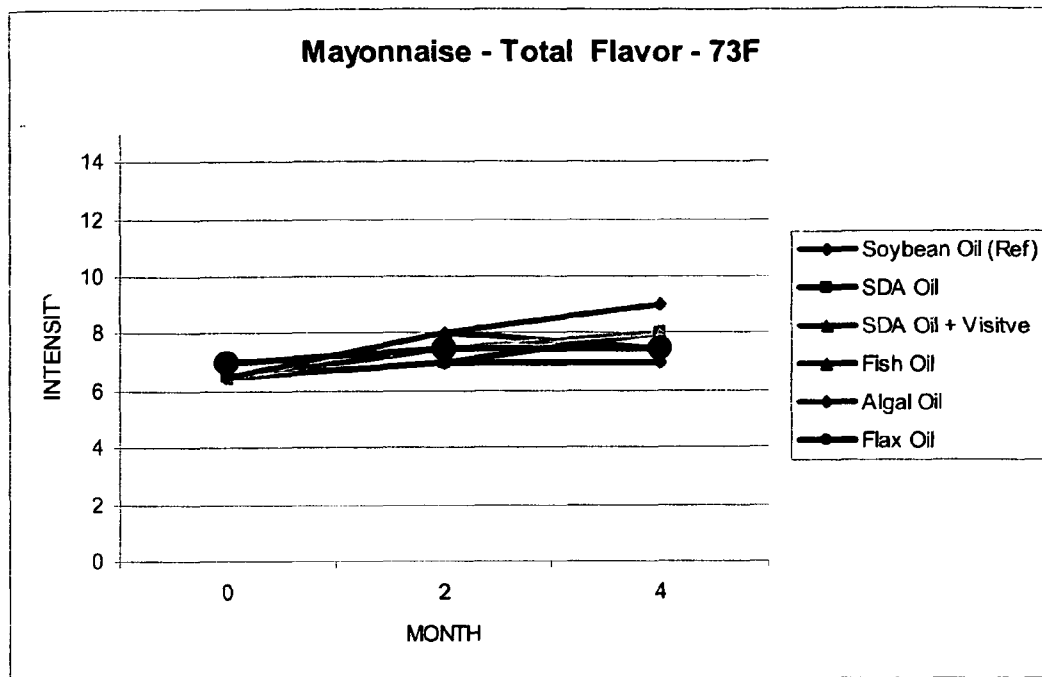


Fig. 4e



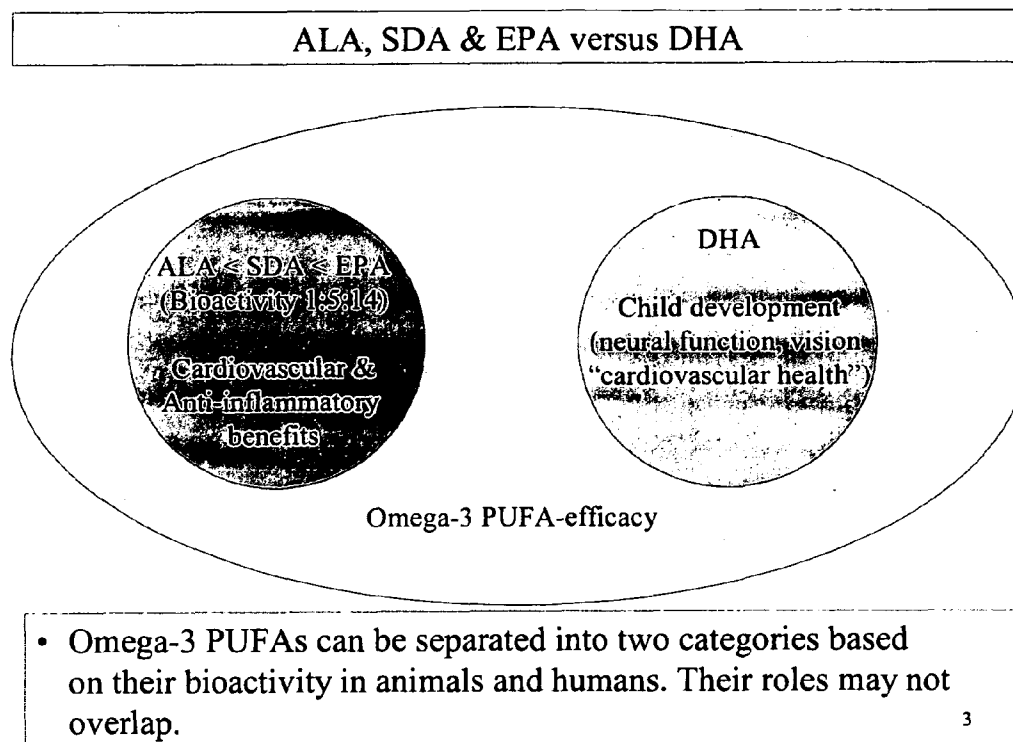


FIG. 5

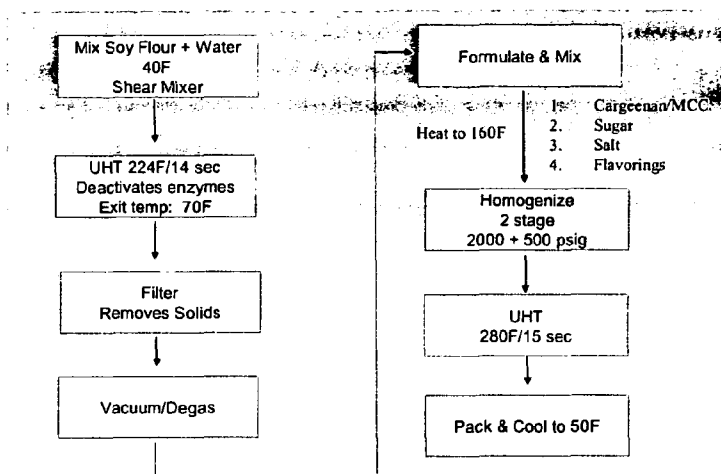


FIG. 6

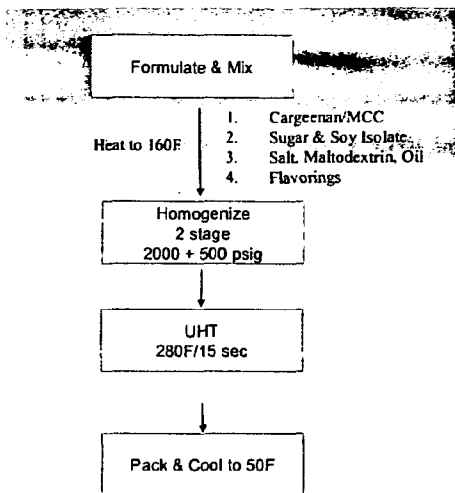
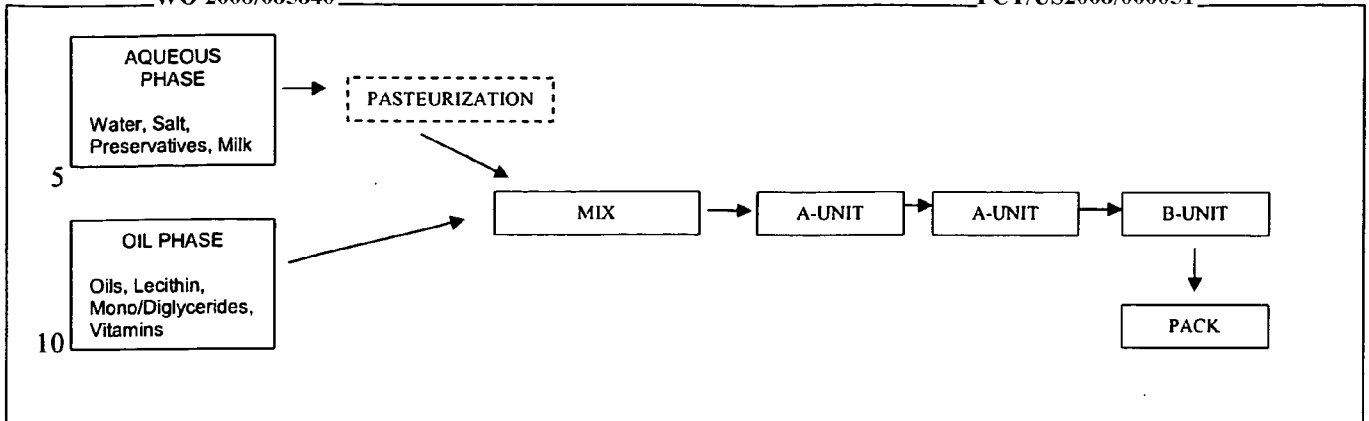


FIG. 7



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FIG. 8

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