



(51) International Patent Classification:

A23C 9/13 (2006.01) A23L 33/10 (2016.01)
A23C 9/152 (2006.01)

(21) International Application Number:

PCT/US2017/044169

(22) International Filing Date:

27 July 2017 (27.07.2017)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/368,634 29 July 2016 (29.07.2016) US

(71) Applicant: KANSAS STATE UNIVERSITY
RESEARCH FOUNDATION [US/US]; 2005 Research
Park Circle, Suite 105, Manhattan, Kansas 66502 (US).

(72) Inventor: ARAMOUNI, Fadi; 3017 Jeanie Lane, Manhat-
tan, Kansas 66502 (US).

(74) Agent: SKOCH, Gregory J.; Hovey Williams, LLP,
10801 Mastin Blvd, Suite 1000, 84 Corporate Woods, Over-
land Park, Kansas 66210 (US).

(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,
HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP,
KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

(54) Title: YOGURT-BASED FOOD PRODUCT AND METHODS OF FORMING THE SAME

(57) Abstract: Yogurt-based food products, and methods of forming the same, are provided herein. The yogurt-based product provides a low-fat and low-calorie alternative to full-fat products yet has the desired texture and appearance of full fat products. The method of forming the inventive product comprises mixing non-fat strained yogurt, water, sugar, food grade gum, and condensed milk, and dehydrating the mixture at a low enough temperature so as to avoid killing the live and active yogurt cultures present in the product. The inventive product provides a ready-to-eat product that can be made to resemble the appearance, texture, and flavor of a number of high-fat or high-calorie food products but contains significantly fewer calories and fat per serving when compared to traditional products.



YOGURT-BASED FOOD PRODUCT AND METHODS OF FORMING THE SAME

5 BACKGROUND OF THE INVENTION

Field of the Invention

The invention is generally directed to a yogurt-based low-fat alternative food product having a similar desired texture and appearance of a full-fat product.

10 Description of the Prior Art

Consumers that are concerned with the adverse health effects of consuming full-fat foods desire food products with reduced caloric and fat content. Health and weight related problems such as obesity, type two diabetes, stroke, and heart disease are linked to higher consumption of full-fat foods. As cases of such problems continue to rise, consumers are looking for healthier, imitation products that mimic the current products that have higher amounts of calories and fat. According to data published by the Journal of American Medicine, it is estimated that more than one-third (34.9%) of U.S. adults are obese. Cold pack cheeses like American cheese typically have a fat content between 25-35% and must contain at least 23% milkfat by weight of the finished product according to federal regulations, which is why the typical American cheese contains high levels of calories and fat per serving.

U.S. Patent No. 4,719,113 describes a yogurt product resembling cheese produced by heating a liquid such as water and/or milk, gradually blending a dry mixture containing dehydrated yogurt powder, vegetable oil, and skim milk into the heated liquid, drying the liquid mixture to a viscous consistency, and then adding yogurt. The yogurt reduces the overall calories and fat of the product, while the liquid milk and water, dehydrated yogurt powder, and vegetable oil contribute to the overall flavor of the product. Although this method successfully reduces the overall calories and fat content of the product, the finished good is limited to cheese, and it is not able to provide the mouthfeel and texture of a full-fat product. What is needed is an alternative product to

full-fat products that has reduced calories and fat, without sacrificing palatability and without signs of syneresis.

SUMMARY OF THE INVENTION

5 In one embodiment of the present invention, there is provided a method of forming a solid food product. The method comprises mixing about 55% to about 90% by weight of non-fat strained yogurt, about 5% to about 40% by weight of added water, about 1% to 10% by weight of sugar, about 0.1% to about 5% by weight of food grade gum, and about 0.1% to about 3% by weight of condensed milk, and forming a
10 homogenous mixture. The homogenous mixture is dehydrated by heating the mixture at a temperature of about 70 °F to about 115 °F, thereby forming a solid yogurt formulation. The solid yogurt formulation is then cooled at a temperature of about 32 °F to about 50 °F.

Another embodiment of the present invention includes a solid yogurt-based food
15 product formed from the method described above.

In another embodiment, there is provided a solid yogurt food product. The product comprises from about 1% to about 20% by weight of one or more carbohydrates, wherein about 25% to about 75% by weight of said one or more carbohydrates is derived from a strained yogurt, and wherein about 25% to about 75% by weight of said one or
20 more carbohydrates is derived from added sugar. The product further comprises from about 25% to about 75% by weight of total water, less than about 5% by weight of fat, and from about 10% to about 50% by weight protein. The food product contains live and active yogurt cultures and has a density of from about 0.6 to about 1 g/cm³.

25 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention is directed to a nutritious, palatable, ready-to-eat solid yogurt product that is lower in calories and fat per serving than conventional full-fat products, and methods of producing the same. The inventive food product is a yogurt-based alternative to high calorie- and fat-containing products, without sacrificing the
30 mouth feel and pleasure experienced when consuming a full-fat product.

In certain embodiments, the inventive food product is formed from a homogenous mixture of ingredient components. As the inventive food product is a yogurt-based product, the homogenous mixture comprises non-fat yogurt. In preferred embodiments, the non-fat yogurt is non-fat strained yogurt (i.e., “Greek” yogurt). As used herein, strained or Greek yogurt is yogurt that has been strained to remove at least a portion of its whey (i.e., the watery portion remaining after milk curdles), resulting in a thicker consistency than unstrained yogurt. In preferred embodiments, the non-fat strained yogurt comprises less than about 5% by weight of whey, preferably less than about 3% by weight of whey, and more preferably less than about 1% by weight of whey, based on the total weight of the non-fat strained yogurt taken as 100% by weight. The strained yogurt may be prepared from milk that has been enriched by boiling off some of its water content, and/or by adding extra butterfat and powdered milk, although the strained yogurt may be supplied from any number of commercial strained yogurt suppliers. The strained yogurt generally comprises at least about 10% by weight of protein. In preferred embodiments, the yogurt comprises live and active yogurt cultures. As used herein, the term “live and active yogurt cultures” refers to living organisms, such as *Lactobacillus bulgaricus* and *Streptococcus thermophilus*, which convert pasteurized milk to yogurt during fermentation. The presence of such organisms in live and active yogurt cultures has been shown to provide a number of health benefits to consumers, such as improved digestive and immune system health.

Other components of the homogenous mixture comprise added water, sugar (or mixture of sugars), a food grade gum (or blend), and condensed milk. As used herein, “added water” refers to water that is added as a separate component and not innately present in another ingredient. “Sugar” refers to sweet, short-chain, soluble carbohydrates, such as monosaccharides, disaccharides, and oligosaccharides, and includes mixtures of different saccharide varieties. Preferred sugars include granulated sucrose (i.e., table sugar), although other sugars may also be used including, but not limited to, glucose, fructose, galactose, maltose, and lactose. Food grade gums are polysaccharides, similar to sugars but with many sugar units making up a large molecule, which can be used as thickening agents and/or stabilizers. Food grade gums that may be

used in embodiments of the present invention include vegetable gums, such as alginin, guar gum, locust bean gum, xanthan gum, and the like. In preferred embodiments, the food grade gum is selected from the group consisting of xanthan gum, locust bean gum, and mixtures thereof. In particularly preferred embodiments, the food grade gum is a blend of xanthan gum and locust bean gum. As used herein, “condensed milk” is cow’s milk from which water has been removed. The condensed milk may be provided as sweetened (i.e., with sugar added as a preservative) or unsweetened condensed milk.

Other additives may also be included in the homogenous mixture. Such additives comprise preservatives, desiccants, and flavorings. For example, in particularly preferred embodiments, the homogenous mixture comprises an acidulant or flavoring, such as citric acid. The citric acid may be included in the mixture in the acid form or as a citrate salt. In the same or other preferred embodiments, the homogenous mixture comprises cultured dextrose. Cultured dextrose is a food additive, generally consisting of an undefined mixture of fermentation metabolites, including butyric, propionic, and lactic acids and small peptides, that may be used to inhibit the growth of undesirable bacteria and mold in the inventive food product. Cultured dextrose is generally considered to be a more natural and safe preservative than others used in the industry, as it is prepared by the fermentation of milk or sugar powders by the probiotic bacteria *Propionibacterium freudenreichii* and *Lactococcus lactis*, both of which are often used in the production of cheese and other dairy products. Exemplary cultured dextrose can be provided as an off-white powder sold as MicroGARD® available from Danisco. In the same or other preferred embodiments, the homogenous mixture comprises calcium chloride. Calcium chloride is a class of inorganic compounds with the chemical formula $\text{CaCl}_2(\text{H}_2\text{O})_x$, where $x = 0, 1, 2, 4, \text{ and } 6$. Calcium chloride salts are highly soluble in water, although the anhydrous salts are hygroscopic, which makes the salts useful as desiccants.

Additional components may be included in the homogenous mixture or subsequently added to the inventive product later during formulation (e.g., during or after the dehydration step). Such components include natural and/or artificial flavor(s), seasoning(s), color(s), regular and/or dehydrated fruit and/or vegetable pieces, and the like. For example, when the inventive product is being used as a cheese slice alternative,

cheese flavorings may be used. In such embodiments, the inventive yogurt-based slice provides the same mouthfeel texture and appearance of a traditional full fat cheese slice without the increased fat and caloric content. Other exemplary flavor varieties include, but are not limited to, barbeque, ranch, and maple bacon. It should be understood that a number of additional flavorings, additives, or other components commonly used in the food industry may be included in the homogenous mixture of later during formulation within the scope of the present invention.

In certain embodiments, the homogenous mixture is prepared by combining the components in the approximate amounts shown in Table 1, below.

Table 1. Homogenous mixture components for yogurt-based product.

Component	Broad range (wt%)	Preferred Range (wt%)	More Preferred Range (wt%)
Strained yogurt	55 – 90	65 – 85	70 – 80
Added Water	5 – 40	10 – 30	15 – 20
Sugar	0.5 – 10	1 – 8	2 – 5
Food grade gum	0.1 – 5	0.2 – 3	0.5 – 2
Condensed milk	0.1 – 3	0.2 – 1	0.25 – 0.5
Citric acid	0.1 – 3	0.2 – 1	0.25 – 0.5
Cultured dextrose	0.1 – 3	0.2 – 1	0.25 – 0.5
Calcium chloride	0.1 – 5	0.3 – 3	0.5 – 1.5
Other additives/flavorings	0 – 10	0.1 – 5	0.5 – 2

Methods of forming the inventive yogurt product comprise mixing some or all of the above-described components to form a homogeneous mixture. The components may be mixed using any number of mixing techniques and equipment known in the art, including but not limited to, aerators, agitators, conical blenders, gas mixers, homogenizers, in line mixers, ribbon mixers, high viscosity mixers, and the like. The

homogenous mixture formed by the mixing step is generally a liquid or semiliquid (e.g., paste-like) mixture.

The homogenous mixture is then dehydrated in order to form a solid yogurt-based formulation. The mixture is dehydrated by heating the mixture at a temperature high enough to effectively evaporate a substantial portion of the moisture content and low enough so as to not kill the live yogurt cultures present in the mixture. In certain embodiments, the homogenous mixture is dehydrated by heating the mixture at a temperature of about 70 °F to about 115 °F, preferably about 80 °F to about 110 °F, and more preferably about 90 °F to about 105 °F. Dehydrating the homogenous mixture reduces the moisture content and forms a solid yogurt formulation. The solid yogurt formulation is then cooled at a temperature of about 32 °F to about 50 °F, preferably about 35 °F to about 45 °F, which forms a solid food product. The solid yogurt formulation may also be shaped or cut as desired, either before or after the cooling step. Various molding or cutting techniques can be used to achieve the desired shape and texture of the product.

The yogurt-based solid food product of the present invention is a low-fat alternative to full fat products. Although the inventive product comprises considerably less fat than full fat food products, the inventive product still provides the mouth feel and satisfaction of eating a full fat product. The inventive food product generally has a density of about 0.6 to about 1 g/mL, preferably about 0.7 to about 0.9 g/mL, and more preferably about 0.75 to about 0.85 g/mL. Although the homogenous mixture used to form the final product is generally liquid or semiliquid, the dehydration step removes a substantial amount of the moisture, thereby forming a solid food product. In preferred embodiments, the inventive food product has a shelf life of at least about 10 days, preferably at least about 14 days, more preferably at least about 30 days, and more preferably at least about 60 days. As used herein, the term “shelf life” means that the food product maintains its texture, appearance, and nutritional properties for a specified period of time. The shelf life may be increased by the use of additional preservatives. Without being bound by any theory, it is believed that the presence of the food grade

gums improves stability of the inventive product so as to inhibit syneresis (i.e., the separation of liquid from the yogurt product).

In certain embodiments, the inventive food product comprises certain nutritional components in the approximate amounts shown in Table 2, below.

Table 2. Nutritional components for yogurt-based product.

Component	Broad range (wt%)	Preferred Range (wt%)	More Preferred Range (wt%)
Carbohydrates	1 – 20	5 – 15	10 – 12
Carbohydrate source			
yogurt	25 – 75	35 – 70	45 – 60
added sugar*	25 – 75	30 – 65	40 – 55
Total Water	25 – 75	40 – 60	45 – 50
Fat	< 5	< 3	< 1
Protein	10 – 50	20 – 40	25 – 35
-Ratio casein : whey	20:1 – 1:1	15:1 – 2:1	10:1 – 3:1
Calcium	0.1 - 3	0.2 - 2	0.5 - 1

*Denotes sugar that is added separately and not a constituent of another component.

Advantageously, the low temperatures used in the dehydration step of the production process avoids killing the live and active yogurt cultures present in the yogurt. Therefore, the inventive food product contains live and active cultures that have been shown to provide significant health benefits to consumers. Additionally, the inventive product provides a ready-to-eat product that can be made to resemble the appearance and texture of a number of high-fat or high-calorie food products, such as cheese slices, fruit leathers, salad toppings, cheese crumbles, solid snacks fillings, spreads, dips, process fillings, and the like, and contains significantly less calories and fat per serving when

compared to traditional similar products. By varying the dehydration and the shaping processes, the inventive product can also be made in different shapes, consistencies and textures for a variety of other applications. In certain embodiments, for example, the food product is capable of being sliced, rolled, and/or molded without cracking the outer surface of the food product. The inventive yogurt-based product provides consumers the option to consume products with lower calories and fat without having to sacrifice flavor.

EXAMPLE

The following example sets forth a method of forming a yogurt-based food product according to one embodiment of the present invention. It is to be understood, however, that this example is provided by way of illustration and nothing therein should be taken as a limitation upon the overall scope of the invention.

Formulation:

In one embodiment of this invention, the product is made by combining 70-80% non-fat Greek style yogurt, 15-20% water, 2.5-5.0% sugar, 0.5-2.0% mixture of food grade gum (xanthan and locust bean), 0.25-0.50% condensed milk, 0.25-0.50% citric acid, 0.25-0.50% cultured dextrose, and 0.5-1.5% calcium chloride. This mixture is combined until the food grade gum is homogeneously mixed into the liquid ingredients. Once the mixture is homogeneous, it is dehydrated at a low temperature (90-105 °F) to maintain the activity of live cultures in the yogurt. The total dehydration time and temperature can be varied, depending on the size, shape, and texture of the flavor variety. After dehydrating, the product should be cut into various shapes, cooled to an ambient temperature then stored at refrigerated temperature (35-45 °F). Alternatively, the cutting and shaping can be performed after cooling.

Characteristics:

For every 19 gram serving of the above formulation, there are 35 calories, 0 grams fat, 2 grams carbohydrate, 6 grams protein, and 15% of the daily value for calcium. These values take into account the percent moisture of the yogurt slice, which amounts to 46% with a range of 40-60%. In addition, the density of this product is 0.814 g/mL, and it has the hardness and elasticity similar to that of cheese. Regarding the shelf

life, it was determined that the yogurt slices maintain ideal properties for 14-16 days without any added preservatives and up to 60 days with preservatives. In addition, it was confirmed that live active cultures do survive the mild dehydration process.

Claims :

1. A method of forming a solid food product comprising
mixing about 55% to about 90% by weight of non-fat strained yogurt, about 5%
to about 40% by weight of added water, about 1% to 10% by weight of
5 sugar, about 0.1% to about 5% by weight of food grade gum, and about
0.1% to about 3% by weight of condensed milk, and forming a
homogenous mixture;

dehydrating said homogenous mixture by heating the mixture at a temperature of
about 70 °F to about 115 °F, thereby forming a solid yogurt formulation;
10 and

cooling said solid yogurt formulation at a temperature of about 32 °F to about 50
°F.

2. The method of claim 1, further comprising the steps of forming
15 said solid yogurt formulation into body and cutting said body to form slices of said solid
yogurt formulation.

3. The method of claim 2, wherein said cutting step is performed
before said cooling step.

20 4. The method of claim 2, wherein said cutting step is performed after
said cooling step.

25 5. The method of claim 1, wherein said homogenous mixture further
comprises about 0.1% to about 3% by weight of citric acid.

6. The method of claim 1, wherein said homogenous mixture further
comprises about 0.1% to about 3% by weight of cultured dextrose.

30 7. The method of claim 1, wherein said homogenous mixture further
comprises about 0.1% to about 5% by weight of calcium chloride.

8. The method of claim 1, wherein said non-fat strained yogurt comprises less than about 5% by weight of whey, based on the total weight of yogurt taken as 100% by weight.

9. The method of claim 1, wherein said dehydrating step results in said homogenous mixture having a moisture content of from about 25% to about 75% by weight.

10. A solid yogurt food product formed by the method of claim 1.

11. The food product of claim 10, said food product having a shelf-life of at least about 10 days.

12. The food product of claim 10, said food product comprising less than about 5% by weight of fat.

13. The food product of claim 10, said food product having a moisture content of about 25% to about 75% by weight.

14. The food product of claim 10, said food product having a protein content of about 10% to about 50% by weight.

15. The food product of claim 10, said food product having a density of about 0.6 to about 1 g/mL.

16. The food product of claim 10, said food product comprising live active yogurt cultures.

17. A solid yogurt food product comprising:
from about 1% to about 20% by weight of one or more carbohydrates, wherein
about 25% to about 75% by weight of said one or more carbohydrates is

derived from a strained yogurt, wherein about 25% to about 75% by weight of said one or more carbohydrates is derived from added sugar; from about 25% to about 75% by weight of total water; less than about 5% by weight of fat; and
5 from about 10% to about 50% by weight protein;
wherein said food product contains live and active yogurt cultures,
wherein said food product has a density of from about 0.6 to about 1 g/cm³.

10 18. The food product of claim 17, wherein said food product comprises from about 0.1% to about 3% by weight of calcium.

15 19. The food product of claim 17, wherein said protein comprises casein and whey protein, wherein the ratio of casein to whey protein is about 20:1 to about 1:1.

20 20. The food product of claim 17, said food product having a shelf-life of at least about 10 days.

25 21. The food product of claim 17, wherein said food product is capable of being sliced, rolled, and/or molded without cracking the outer surface of said food product.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2017/044169

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A23C 9/13; A23C 9/152; A23C 9/154; A23L 33/10 (2017.01)

CPC - A23C 9/1307; A23C 9/137; A23C 9/152, A23C 9/154; A23L 33/10 (2017.08)

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History document

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

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

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2015/0320064 A1 (LYLE et al) 12 November 2015 (12.11.2015) entire document	1-21
A	US 4,874,627 A (GREIG et al) 17 October 1989 (17.10.1989) entire document	1-21
A	US 2010/0278994 A1 (KLEMASZEWSKI) 04 November 2010 (04.11.2010) entire document	1-21
A	US 2014/0287126 A1 (THE QUAKER OATS COMPANY) 25 September 2014 (25.09.2014) entire document	1-21

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

18 September 2017

Date of mailing of the international search report

12 OCT 2017

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, VA 22313-1450

Facsimile No. 571-273-8300

Authorized officer

Blaine R. Copenheaver

PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774