

COMPOSITIONS AND METHODS FOR FORMING FAT REPLACEMENT SUBSTANCE FOR FOOD PRODUCTS

CROSS REFERENCE TO RELATED APPLICATIONS

- 5 **[0001]** This application claims the priority to Singapore patent application No. 10202002148W, filed 9 March 2020, the contents of which are incorporated herein by reference.

FIELD

- 10 **[0002]** The present disclosure relates generally to compositions for fat replacement in food products, including fat replacement substances, methods of making or using the compositions or substances, emulsions and food products including the same.

BACKGROUND

- 15 **[0003]** The following discussion of the background to the invention is intended to facilitate an understanding of the present invention only. It should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was published, known or part of the common general knowledge of the person skilled in the art in any jurisdiction as at the priority date of the invention.

- 20 **[0004]** Most fat replacement technologies offered consist of microcrystalline cellulose (MCC) co-processed or blended with a hydrocolloid, namely carboxymethylcellulose sodium or xanthan gum. Products made with such compositions lack good mouthfeel as they often lose texture over time. Such fat replacement compositions result in products that are inferior with regard to taste and/or texture due to the loss of moistness and juiciness.
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- [0005]** Microcrystalline cellulose, also known as MCC or cellulose gel, is commonly used in the food industry for food products. For example, it has been used as a binder and stabilizer in food applications, including in beverages. It has also been used in pharmaceutical formulations, in industrial applications, in household products such as detergent and/or bleach tablets, in agricultural formulations, and in personal care products such as cosmetics.
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- [0006]** Hydrocolloids are often used as thickeners to enhance viscosity in a range of products including food products.

[0007] There exists a need to provide compositions and methods that alleviate at least one of the aforementioned problems.

SUMMARY

5 [0008] An improved composition for fat replacement in food products and methods of making or using the same is envisaged.

[0009] Accordingly, a first aspect of the invention relates to a composition for forming a fat replacement emulsion for food products comprising: 5 to 60 weight percent insoluble fibre; at least two hydrocolloid forming polysaccharides each having 0.2 to 10 weight percent; and 20 to 85 weight percent emulsifying agent, the weight percentages being based on the total composition.

[0010] According to another aspect of the invention relates to a fat replacement substance for food products comprising: the composition as described herein above, and an aqueous liquid combined under shear force.

15 [0011] According to another aspect of the invention relates to a food product comprising the composition as described herein above, or the fat replacement substance as described herein above.

[0012] According to another aspect of the invention relates to a method of manufacturing a fat replacement substance for food products comprising: (a) adding the composition as described herein above to an aqueous liquid; and (b) applying shear force until the fat replacement substance forms.

[0013] Other aspects and features of the present invention will become apparent to those of ordinary skill in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

25 BRIEF DESCRIPTION OF THE DRAWINGS

[0014] In the figures, which illustrate, by way of non-limiting examples only, embodiments of the present invention,

[0015] **Figure 1:** A schematic of the formation of composition and/or fat reducing substance for food products.

[0016] Figure 2: A photograph comparing vegetarian burgers made with (A) full fat and (B) 69% reduced fat with an embodiment of the invention.

[0017] Figure 3: Photographs of (A) an eggless low fat mayo made with an embodiment using exemplary composition 4 and (B) 50% low fat eggless mayo made with an embodiment using exemplary Composition 5.

[0018] Figure 4: Photographs of (A) 60% substituted vegetable oil – water emulsion (W/O emulsion) made with an embodiment using exemplary composition 6 and (B) 60% substituted butter – water-in-oil emulsion (W/O emulsion) made with an embodiment using exemplary composition 6.

[0019] Figure 5: Photographs of (A) and (B) mayonnaise made with non-substituted sunflower oil and (C) and (D) mayonnaise made with 18% of the sunflower oil substituted with a substance made with an embodiment using exemplary composition 6.

[0020] Figure 6: Photographs of (A) cake made with non-substituted oil and (B) cake made with 50% of the oil substituted with a substance made with an embodiment using exemplary composition 6.

[0021] Figure 7: Photographs of (A) cake made with non-substituted butter and (B) cake made with 60% of the butter substituted with a substance made with an embodiment using exemplary composition 6.

[0022] Figure 8: Photographs of (A) cookies made with non-substituted oil and (B) cookies made with 60% of the oil substituted with a substance made with an embodiment using exemplary composition 6.

[0023] Figure 9: Photographs of (A) cookies made with non-substituted butter and (B) cookies made with 40% of the butter substituted with a made with an embodiment using exemplary composition 6.

[0024] Figure 10: Photographs of (A) bechamel sauce made with non-substituted butter and (B) bechamel sauce made with 60% of the butter substituted with a substance made with an embodiment using exemplary composition 6. (C) Rheological results for the flow of bechamel sauce made with non-substituted butter compared to bechamel sauce made with 60% of the butter substituted with a substance made with an embodiment using exemplary composition 6.

5 **[0025]** **Figure 11:** Photographs of whole croissants, top row, and cross sections, bottom row, for (A) croissant made with non-substituted butter; (B) croissant baked for 35 minutes with 30% of the butter substituted with a substance made with an embodiment using exemplary composition 6; and (C) croissant baked for 40 minutes with 30% of the butter substituted with a substance made with an embodiment using exemplary composition 6.

DETAILED DESCRIPTION

10 **[0026]** Throughout this document, unless otherwise indicated to the contrary, the terms “comprising”, “consisting of”, “having” and the like, are to be construed as non-exhaustive, or in other words, as meaning “including, but not limited to”.

[0027] Furthermore, throughout the document, unless the context requires otherwise, the word “include” or variations such as “includes” or “including” will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

15 **[0028]** In various embodiments a composition for forming a fat replacement emulsion for food products comprising: about 5 to 60 weight percent insoluble fibre; at least two hydrocolloid forming polysaccharides each having independently about 0.2 to 10 weight percent; and about 20 to 85 weight percent emulsifying agent, the weight percentages being based on the total composition.

20 **[0029]** Food products made by replacing or partially replacing the fats and oils used with the fat replacement substance formed from the composition, allow foods to have a good mouthfeel as the texture is maintained over time. Such fat replacement compositions result in products that experience little or no loss of moistness and juiciness.

25 **[0030]** In various embodiments food products comprise anything that can be eaten or consumed by an animal including a human. In various embodiments food products comprise consumables that contain or are meant to contain lipids such as fats or oils. In various embodiments food products comprise baked goods such as, bread, biscuits, cookies, brownies, muffins, pastries, pies or cakes; beverages such as
30 nut milks or other emulsions where an oil is added as an ingredient; sauces and condiments such as mayonnaise, bechamel sauce and tartar sauce; plant-based meat products such as plant-based minced meat substitutes, burger patties, sausages or

other formed products; dairy or meat based products.

5 **[0031]** In various embodiments, the weight percent of the insoluble fibre is in the range of about 5 to 60. In various embodiments, the weight percent of the insoluble fibre is in the range of about 5 to 50. In various embodiments, the weight percent of the insoluble fibre is in the range of about 5 to 40. In various embodiments, the weight percent of the insoluble fibre is in the range of about 5 to 30. In various embodiments, the weight percent of the insoluble fibre is in the range of about 5 to 20. In various
10 embodiments, the weight percent of the insoluble fibre is in the range of about 5 to 10. In various embodiments, the weight percent of the insoluble fibre is in the range of about 25 to 60. In various embodiments, the weight percent of the insoluble fibre is in the range of about 25 to 55. In various embodiments, the weight percent of the insoluble fibre is in the range of about 25 to 50. In various embodiments, the weight percent of the insoluble fibre is in the range of about 25 to 40. In various
15 embodiments, the weight percent of the insoluble fibre is in the range of about 30 to 40. In various embodiments, the weight percent of the insoluble fibre is in the range of about 30 to 35.

[0032] In various embodiments, the insoluble fibre is selected from cellulose fibres; and microcrystalline cellulose.

20 **[0033]** In various embodiments, the cellulose fibre may be purified cellulose fibre from various plant origins such as bamboo, wheat, oat, pea, sugar cane, or wood pulp.

[0034] In various embodiments, the microcrystalline cellulose is a partially hydrolyzed cellulose with degree of polymerization of 500 or fewer units.

25 **[0035]** There are various methods for producing microcrystalline cellulose such as treating a source of cellulose, preferably alpha cellulose in the form of pulp from fibrous plant materials, with a mineral acid to attack the less ordered regions of the cellulose polymer chain thereby liberating the crystalline sites which form crystallite aggregates which constitute the microcrystalline cellulose. These are then purified in various different ways. Any microcrystalline cellulose known in the art would be
30 suitable.

[0036] As microcrystalline cellulose is better at holding water than other insoluble fibres when it is used in combination with an emulsifying agent these components

allow both the water and fat or lipid components of the food stay within an emulsion and are not lost due to evaporation or syneresis. This permits food having reduced fat to remain moist and juicy and have taste and/or texture similar to the food with full fat content.

5 **[0037]** In various embodiments, the insoluble fibre is MCC (microcrystalline cellulose) co-processed with a hydrocolloid or gum to assist with absorbing water faster. In various embodiments the co-processed MCC comprises a microcrystalline cellulose in combination with a hydrocolloid, such as carboxymethylcellulose sodium or xanthan gum. In various embodiments the co-processed MCC comprises a
10 microcrystalline cellulose in combination with carboxymethylcellulose sodium. In various embodiments the co-processed MCC is in a powered form called "MCC Gel" as it has the ability to absorb water faster than microcrystalline cellulose on its own. Thus co-processing MCC with a hydrocolloid or gum makes it much easier to wet in water and form a gel like substance without the requirement of high shear conditions.
15 In various embodiments, the microcrystalline cellulose gel or MCC gel is a co-processed ingredient made up of roughly 88% microcrystalline cellulose with 12% carboxymethylcellulose sodium.

[0038] In various embodiments, the weight percent of the at least two
20 hydrocolloid forming polysaccharides are each independently in the range of about 0.5 to 10. In various embodiments, the weight percent of the at least two hydrocolloid forming polysaccharides are each independently in the range of about 1 to 10. In various embodiments, the weight percent of the at least two hydrocolloid forming polysaccharides are each independently in the range of about 1 to 8. In various
25 embodiments, the weight percent of the at least two hydrocolloid forming polysaccharides are each independently in the range of about 1 to 6. In various embodiments, the weight percent of the at least two hydrocolloid forming polysaccharides are each independently in the range of about 2 to 6. In various
30 embodiments, the weight percent of the at least two hydrocolloid forming polysaccharides are each independently in the range of about 1 to 4. In various embodiments, the weight percent of the at least two hydrocolloid forming polysaccharides are each independently in the range of about 2 to 4. In various
35 embodiments, the weight percent of the at least two hydrocolloid forming polysaccharides are each independently the same weight percent. In various embodiments, the weight percent of the at least two hydrocolloid forming polysaccharides are different from each other.

[0039] In various embodiments, the at least two hydrocolloid forming polysaccharides are a combination of two gums or hydrocolloids, where these may be natural, hydrolyzed or chemically derivatized celluloses. In various embodiments, the at least two hydrocolloid forming polysaccharides are a combination of three gums or hydrocolloids, where these may be natural, hydrolyzed or chemically derivatized celluloses.

[0040] In various embodiments, the hydrocolloid forming polysaccharide may comprise derivatized celluloses. In various embodiments, the derivatized celluloses comprise carboxymethylcellulose and its sodium salt, hydroxypropylcellulose, hydroxypropylmethylcellulose, or methylcellulose. In various embodiments the methylcellulose may be selected from any methylcellulose grades comprising A4C methylcellulose grade, A15C methylcellulose grade, A4M methylcellulose grade, A100M methylcellulose grade, MX methylcellulose grade or any other suitable methylcellulose grade derivatized cellulose. In various embodiments, the methylcellulose comprises A4C grade.

[0041] In various embodiments, the hydrocolloid forming polysaccharide may comprise other components such as protein. In various embodiments the hydrocolloid forming polysaccharide may be gums that comprise polysaccharides and protein. In various embodiments the gums may be natural gums such as Gum Arabic, guar gum; locust bean gum; beta glucan; Dammar gum; Glucomannan; Psyllium seed gum; Konjac gum; gellan gum; Tara gum; Gum Ghatti; and xanthan gum or other natural gums known in the art. Some gums such as Gum Arabic and Gum Ghatti demonstrated slight emulsifying properties that resulted in superior fat replacement substance for emulsions for use in food products with reduced fat content that have similar taste and texture to food products made with natural fats and oils or with a higher fat content.

[0042] In various embodiments, the at least two hydrocolloid forming polysaccharides are each selected from carboxymethylcellulose sodium; methylcellulose; Gum Arabica; guar gum; locust bean gum; beta glucan; Dammar gum; Glucomannan; Psyllium seed gum; Konjac gum; gellan gum; Tara gum; Gum Ghatti; and xanthan gum.

[0043] In various embodiments, the at least two hydrocolloid forming polysaccharides are uncharged hydrocolloid forming polysaccharides. In various

embodiments, the two uncharged hydrocolloid forming polysaccharides are a combination of two gums or hydrocolloids, where these may be natural, hydrolyzed or chemically derivatized celluloses. In various embodiments, the two uncharged hydrocolloid forming polysaccharides are each selected from guar gum; locust bean gum; beta glucan; Dammar gum; Glucomannan; Psyllium seed gum; Tara gum; and xanthan gum. In various embodiments, the derivatized celluloses comprise hydroxypropylcellulose, hydroxypropylmethylcellulose, or methylcellulose.

In various embodiments, the two uncharged hydrocolloid forming polysaccharides are guar gum and xanthan gum. Guar gum is a galactomannan polysaccharide. Xanthan gum is a pentasaccharide. Any known guar gum and xanthan gum may be used.

[0044] In various embodiments, the at least two hydrocolloid forming polysaccharides are selected from carboxymethylcellulose sodium; methylcellulose; Gum Arabica; guar gum; and xanthan gum. In various embodiments, the at least two hydrocolloid forming polysaccharides are a combination of carboxymethylcellulose sodium; methylcellulose; and Gum Arabica. In various embodiments, the at least two hydrocolloid forming polysaccharides are a combination of guar gum and xanthan gum.

[0045] A combination of guar gum and xanthan gum has the advantage of acting synergistically to enhance viscosity and stabilize any emulsion formed from the composition.

[0046] In various embodiments, the weight percent of the emulsifying agent is in the range of about 20 to 80. In various embodiments, the weight percent of the emulsifying agent is in the range of about 30 to 85. In various embodiments, the weight percent of the emulsifying agent is in the range of about 40 to 85. In various embodiments, the weight percent of the emulsifying agent is in the range of about 50 to 85. In various embodiments, the weight percent of the emulsifying agent is in the range of about 60 to 85. In various embodiments, the weight percent of the emulsifying agent is in the range of about 70 to 85. In various embodiments, the weight percent of the emulsifying agent is in the range of about 80 to 85. In various embodiments, the weight percent of the emulsifying agent is in the range of about 20 to 60. In various embodiments, the weight percent of the emulsifying agent is in the range of about 20 to 65. In various embodiments, the weight percent of the emulsifying agent is in the range of about 30 to 60. In various embodiments, the weight percent of the emulsifying agent is in the range of about 40 to 60. In various embodiments, the weight percent of the emulsifying agent is in the range of about 50

to 60. In various embodiments, the weight percent of the emulsifying agent is in the range of about 55 to 60. In various embodiments, the weight percent of the emulsifying agent is in the range of about 50 to 55. In various embodiments, the weight percent of the emulsifying agent is in the range of about 55 to 60. In various
5 embodiments, the weight percent of the emulsifying agent is in the range of about 59 to 60.

[0047] In various embodiments, the emulsifying agent comprises one emulsifier. In various embodiments, the emulsifying agent comprises two emulsifiers.

[0048] In various embodiments, the emulsifying agent is selected from a sugar ester; a starch esterified with octenylsuccinic compound; a low Hydrophilic-Lipophilic Balance (HLB) emulsifier and acetylated starch. In various embodiments, the emulsifying agent comprises sodium starch octenylsuccinate which may be added in a dry form or a pregelatinized form. In various embodiments, the emulsifying agent comprises a low Hydrophilic-Lipophilic Balance (HLB) emulsifier. In various
10 embodiments, the low Hydrophilic-Lipophilic Balance (HLB) emulsifier comprises at least one of polyglycerol polyricinoleate, sucrose esters, mono-diglycerides or lecithins. In various embodiments, the emulsifying agent is a combination of a HLB emulsifier and sodium starch octenylsuccinate. The addition of a component with emulsifying or emulsion-stabilising properties, such as, sodium starch
15 octenylsuccinate, ensures both the water and fat or lipid components of the food stay within an emulsion and are not lost due to evaporation or syneresis. This permits food having reduced fat to remain moist and juicy and have taste and/or texture similar to the food produced with full fat content.

[0049] In various embodiments, the emulsifying agent is an esterified or an acetylated saccharide. In various embodiments, the esterified or the acetylated saccharide includes an esterified or an acetylated monosaccharide. In various other embodiments, the esterified or the acetylated saccharide includes an esterified or an acetylated polysaccharide. Advantageously, esterification or acetylation of saccharides increases the stability of the emulsifying agents emulsifying effect. The emulsifying agent makes the composition capable of interacting stably with fat
25 components of food products due to the lipophilic regions of the emulsifying agent at the molecular level. These features help or facilitate stability of the composition to maintain a stable emulsion which in turn helps to retain moisture in the fat replacement substance and in food products when the composition is used to form a
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fat replacement substance used in food products.

[0050] In various embodiments, the sugar ester comprises a sucrose ester or a glucose ester.

5 **[0051]** In various embodiments, the starch esterified with octenylsuccinic compound is esterified with octenylsuccinic anhydride. In various embodiments, the starch esterified with octenylsuccinic compound comprises sodium starch octenylsuccinate or aluminium starch octenylsuccinate. In various embodiments, the starch esterified with octenylsuccinic compound is esterified or derivatized with
10 octenylsuccinic acid. The resulting modified starch is one that has both hydrophilic regions as well as lipophilic regions owing to the octenyl chains. In various embodiments, the emulsifying agent comprises sodium starch octenylsuccinate. In various embodiments, the sodium starch octenylsuccinate comprises food grade sodium starch octenylsuccinate E1450.

15 **[0052]** In various embodiments, the insoluble fibre is microcrystalline cellulose; the two hydrocolloid forming polysaccharides are guar gum and xanthan gum; and the emulsifying agent is sodium starch octenylsuccinate.

20 **[0053]** In various embodiments, the weight ratio of microcrystalline cellulose : xanthan gum : guar gum : sodium starch octenylsuccinate is 15.5 : 2 : 1 : 31.5. In various embodiments, the weight ratio of microcrystalline cellulose : xanthan gum : guar gum : sodium starch octenylsuccinate is 31:4:2:64.

25 **[0054]** In various embodiments, the insoluble fibre is microcrystalline cellulose; the at least two hydrocolloid forming polysaccharides are carboxymethylcellulose sodium, methylcellulose and Gum arabic; and the emulsifying agent is a combination of sodium starch octenylsuccinate and a low HLB emulsifier such as polyglycerol polyricinoleate.

[0055] In various embodiments, the weight ratio of microcrystalline cellulose : carboxymethylcellulose sodium : methylcellulose : Gum arabic : sodium starch octenylsuccinate : polyglycerol polyricinoleate is 42:6:12:24:383:33.

30 **[0056]** In various embodiments a fat replacement substance for food products comprises: the composition of any one of the composition embodiments described herein above, and an aqueous liquid combined under shear force.

[0057] Advantageously, the resultant emulsion is also more stable and does not separate as easily as the prior art when in use in food products.

[0058] In various embodiments, the aqueous liquid comprises water, juice, brine, soup or any other aqueous liquids suitable for cooking, baking or food products. In various embodiments, the aqueous liquid comprises a water based liquid comprising 50% or more water of the total volume of the liquid; 55% or more water of the total volume of the liquid; 60% or more water of the total volume of the liquid; 65% or more water of the total volume of the liquid; 70% or more water of the total volume of the liquid; 75% or more water of the total volume of the liquid; 80% or more water of the total volume of the liquid; 85% or more water of the total volume of the liquid; 90% or more water of the total volume of the liquid; 95% or more water of the total volume of the liquid; or 100% water of the total volume of the liquid. In various embodiments, the aqueous liquid may comprise a lipid component at a concentration less than the water component.

[0059] In various embodiments, the weight ratio of the composition to aqueous liquid is in the range of 1 : 19 to 1 : 4. In various embodiments, the composition is intended to be dosed with aqueous liquid in a weight ratio of 5-20% composition.

[0060] In various embodiments, the weight ratio of the composition to aqueous liquid is 1:6 to 1:7, 1 : 6.7 or 1:7. In various embodiments, the composition is intended to be dosed with aqueous liquid in a weight ratio of 12-13% composition.

[0061] In various embodiments, the fat replacement substance for food products may further comprise a lipid such as an oil or a fat. In various embodiments, the lipid is at a concentration less than the aqueous liquid.

[0062] In various embodiments the fat replacement substance may be used to replace the following:

- Animal source: butter, lard, tallow, ghee, clarified butter; or
- Plant source: vegetable oils (for example canola, soy, rice bran, sunflower, peanut, palm), hydrogenated vegetable oils, (for example: cocoa butter, palm kernel oil).

[0063] In various embodiments a food product comprising the composition of any one of the composition embodiments described herein above, or the fat replacement

substance of any one of the fat replacement substance embodiments described herein above.

5 **[0064]** In various embodiments food products comprise anything that can be eaten or consumed by an animal including a human. In various embodiments food products comprise consumables that contain or are meant to contain lipids such as fats or oils.

10 **[0065]** In various embodiments, the food product comprises baked goods. In various embodiments the baked goods comprise bakery products, selected from the group comprising or consisting of breads, cakes, cookies, brownies, muffins pastries and pies.

15 **[0066]** In various embodiments, the food product comprises plant-based meat substitutes. In various embodiments the plant-based meat substitutes are selected from the group comprising or consisting of plant-based minced meat substitutes, burger patties, sausages or other formed products. In various embodiments the plant-based meat substitutes may comprise fungal base meat substitutes.

[0067] In various embodiments, the food product comprises a meat composite.

20 **[0068]** In various embodiments, the food product comprises a sauce. In various embodiments, the food product comprises any sauce used with food including but not limited to mayonnaise, hollandaise sauce bechamel sauce or tartar sauce. In various embodiments the sauce comprises a condiment selected from the group comprising or consisting of mayonnaise, hollandaise sauce and tartar sauce.

[0069] In various embodiments, the food product comprises a drink. In various embodiments the drink is selected from the group comprising or consisting of nut milks and other emulsions where an oil is added as an ingredient

25 **[0070]** In various embodiments, a method of manufacturing a fat replacement substance for food products comprising: (a) adding the composition of any one of the composition embodiments described herein above to an aqueous liquid; and (b) applying shear force until the fat replacement substance forms.

30 **[0071]** In various embodiments, the aqueous liquid comprises water, juice, brine, soup or any other aqueous liquids suitable for cooking, baking or food products. In various embodiments, the aqueous liquid comprises a water based liquid comprising

50% or more water of the total volume of the liquid; 55% or more water of the total volume of the liquid; 60% or more water of the total volume of the liquid; 65% or more water of the total volume of the liquid; 70% or more water of the total volume of the liquid; 75% or more water of the total volume of the liquid; 80% or more water of the total volume of the liquid; 85% or more water of the total volume of the liquid; 90% or more water of the total volume of the liquid; 95% or more water of the total volume of the liquid; or 100% water of the total volume of the liquid. In various embodiments, the aqueous liquid may comprise a lipid component at a concentration less than the water component.

10 **[0072]** In various embodiments applying shear force may be affected by means of a high shear cutter, granulator, planetary mixer, food processor, mortar and pestle or any equipment capable of generating strong shearing forces.

15 **[0073]** In various embodiments, the composition is added to the aqueous liquid at a weight ratio in the range of 1 : 19 to 1 : 4. In various embodiments, the composition is intended to be dosed with aqueous liquid in a weight ratio of 5-20% composition.

[0074] In various embodiments, the composition is added to the aqueous liquid at a weight ratio of 1 : 6, 1 : 6.7, 1:7 or 1:6 to 1:7. In various embodiments, the composition is intended to be dosed with aqueous liquid in a weight ratio of 12 -13% composition.

20 **[0075]** In various embodiments, the method further comprises adding a lipid to the fat replacement substance such as an oil or a fat to the fat replacement substance either before or during applying shear force to form a fat replacement emulsion.

25 **[0076]** This will allow the fat reducing emulsion to be used as the total substitute for the lipid used in the original recipe. For example, where 100 grams of vegetable oil is called for and a 50% reduction of the oil is required, water and oil can be added in equal parts to the composition either before or during applying shear force. The required amount of 100 grams of the resulting fat reducing emulsion can then be used as a complete replacement of the vegetable oil used in the original recipe.

30 **[0077]** Advantageously, the composition is able to emulsify with the remaining fat/oil to form a stable, flowable emulsion that can evoke the mouthfeel of an oily substance or the creaminess of a fat.

[0078] Alternatively, in various embodiments, the fat reducing emulsion may be made with the aqueous liquid. Then where 100 grams of vegetable oil is called for and a 50% reduction of the oil is required, 50 grams of the fat reducing emulsion and 50 grams of the vegetable oil may be used in making the food product added in the same way the vegetable oil is instructed to be added.

[0079] It should be further appreciated by the person skilled in the art that variations and combinations of features described above, not being alternatives or substitutes, may be combined to form yet further embodiments falling within the intended scope of the invention.

[0080] As would be understood by a person skilled in the art, each embodiment, may be used in combination with other embodiment or several embodiments.

Examples

[0081] Example 1: baked goods

[0082] Composition 1

Component	Specific component used	% by weight
Insoluble fiber (partially soluble fibre)	high polymerisation inulin	100%

[0083] Composition 1 was used in bakery products, when a banana bread (dense banana cake) recipe was successfully altered to reduce oil added by 30%, using 10g composition 1 and a mix of 30g vegetable oil and 20g erythritol, a low-calorie sweetener was subjected to high shear and used as a replacement for vegetable oil. This was done concurrently with sugar reduction to create a banana bread that was lower in calories, fat and sugar than the original.

[0084] Composition 2

Component	Specific component used	% by weight
Insoluble fibre (partially soluble fibre)	high polymerisation inulin	75%
soluble fibre	Low polymerisation inulin	25%

[0085] 20g of Composition 2 and a mix of 70g butter and subjected to high shear was used to substitute 30% of fat (butter and shortening) to good effect in chocolate chip cookies. The products were presented at a food conference and tasters were

impressed that they could not tell that these had been reduced in fat and/or sugar.

[0086] While this was somewhat successful at retaining moisture and mouth feel it required too much inulin. Alternatives that retain moisture and mouth feel are needed.

5 **[0087]** Example 2: Plant-based meat products

[0088] As plant-based burgers are known to be high in fat, comparable to conventional meat burgers, it made sense to explore ways of reducing the fat content. For this project, the goal was to cut fat by more than 50% while still retaining the moistness and juiciness of a burger patty. Variations of the composition were
10 used to explore ways to retain moistness without affecting taste.

[0089] The currently used fat replacement solutions were compared to fat replacement substances that were formed with compositions that included an emulsifying ingredient. It was hypothesised that an emulsifying ingredient, would be instrumental in retaining water and maintaining a good texture and mouthfeel. An
15 emulsifying ingredient that can be co-processed with fat or at least emulsifiable with fat was chosen and compared.

[0090] Composition 3

Component	Specific component used	% by weight
Insoluble fiber	a finely milled (30um) insoluble cellulose fibre	85%
Gum/hydrocolloid 1	carboxymethylcellulose sodium (CMCNa)	15%

[0091] Composition 4

Component	Specific component used	% by weight
Insoluble fiber	Microcrystalline cellulose	31%
Gum/hydrocolloid 1	Xanthan gum	4%
Gum/hydrocolloid 2	Guar gum	2%
Emulsifier	Sodium starch octenylsuccinate	63%

[0092] Composition 3 was sheared in a weight ratio of 4.6% composition 3 with
20 95.4% water and subjected to high shear to create a gel-like substance that works as the fat replacement substance.

[0093] Composition 4 was sheared in a weight ratio of 12.75% composition 4 with 87.25% water and subjected to high shear to create a gel-like substance that works as the fat replacement substance.

[0094] Composition 3 and 4 were each employed in plant-based burger patty, replacing 60% and 69% of the original oils used in the original formulation. These patties were assessed to be generally moist and juicy, with the 69% replacement version made with composition 3 coming across as less moist than the original. It was also observed to dry up faster on cooling (See table 1). In comparison where composition 4 was used in 69% fat reduction in plant-based burger patties it was able to produce a well-received prototype that stayed moist on cooling.

Figure 2 depicts two types of vegetarian patties. The one on the left (Figure 2 (a)) is a full fat version. The one on the right (Figure 2 (b)) is made with Composition 4 with 69% fat reduction. No observable visual differences were noted.

[0095] Table 1: comparison plant-based burger patty (n=15)

Fat type used N= 10	Moistness					Bounciness				
	1	2	3	4	5	1	2	3	4	5
100% original fat				X				X		
60% fat replacement with comp 3 40% original fat				X			X			
69% fat replacement with comp 3 31% original fat		X						X		
69% fat replacement with comp 4 31% original fat				X					x	

[0096] Example 3: Sauces & Condiments

[0097] Composition 5

Component	Specific component used	% by weight
Insoluble fiber	a finely milled (30um) insoluble cellulose fibre	40%
Gum/hydrocolloid 1	Guar gum	2%
Gum/hydrocolloid 2	Xanthan gum	4%

Emulsifier	sodium starch octenylsuccinate (E1450)	54%
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[0098] Composition 4 and 5 were employed in mayonnaise. Each composition was dosed with water in a weight-based ratio of 15.3% composition 4 or 5 and 84.7% water. Each mixture was subjected to high shear to create a gel-like substance that works as the fat replacement substance. 50% of the original oil content of the mayonnaise was replaced with fat replacement substances formed with composition 4 or 5. Both the resulting mayonnaises were assessed favorably by testers. The mayonnaise formed with fat replacement substance formed with composition 4 remained stable on storage at 4°C for more than 1 month. The mayonnaise formed with fat replacement substance formed with composition 5 exhibited some syneresis, where water separated from the mayonnaise and collected on top. Without being bound to any theory it is hypothesised that microcrystalline cellulose (MCC)'s better ability to hold water prevented water loss through evaporation or syneresis. Composition 4 also produced a mayonnaise with higher viscosity and closer texture to that of a typical fatted mayonnaise. This can be seen in Figure 3A.

[0099] Example 4

[00100] Composition 6

Component	Specific component used	% by weight
Insoluble fiber	Microcrystalline cellulose	8.4%
Gum/hydrocolloid 1	Carboxymethylcellulose sodium	1.2%
Gum/hydrocolloid 2	Methylcellulose	2.4%
Gum/hydrocolloid 3	Gum Arabic	4.8%
Emulsifier 1	sodium starch octenylsuccinate (E1450)	76.6%
Emulsifier 2	Polyglycerol polyricinoleate	6.6%

[00101] Roughly 88% of microcrystalline cellulose was co-processed with 12% carboxymethylcellulose sodium and formed into a powder called microcrystalline cellulose gel or MCC gel. The powdered co-processed microcrystalline cellulose carboxymethylcellulose sodium MCC gel the emulsifier 1, sodium starch octenylsuccinate, and the other components were first dry blended as they are all powders, with the exception of polyglycerol polyricinoleate. The latter is added to the dry mix and triturated under shear using a pestle and a mortar to achieve a slightly

clumpy powder.

[00102] The composition 6 was dosed with water in a weight-based ratio of 10.5% composition 6 and 89.5% water. Each mixture was subjected to high shear to create a gel-like substance that works as the fat replacement substance. This ratio was maintained whether the substitution of fat/oil was carried out at 50, 60 or 70% substitution. The exact ratios are as follows:

% Substitution	% fat/oil	% Composition 6	% water
50	50	5.225	44.775
60	40	6.270	53.730
70	30	7.315	62.685

[00103] As a general rule an amount of composition 6 was used that corresponds to one-tenth the amount of substitution required. Therefore, should 60 % reduction of fat be desired, the amount of composition 6 can be regarded as 6g per 100g of original fat or oil. Amount of water would be 60g-6g = 54g per 100g of original fat or oil.

[00104] The procedure for liquid oils substitutions:

1. Disperse Composition 6 in the oil;
2. Transfer the mixture into a food processor;
3. Add water gradually while operating the food processor or blender; and
4. A homogenous emulsion with a smooth glossy surface should form.

[00105] See Figure 4A for an example of a 60% substituted vegetable oil – water emulsion (W/O emulsion).

[00106] The procedure for solid lipid substitutions:

1. Microwave the solid lipid (fat or oil) until liquid;
2. Dissolve Composition 6 in the liquefied oil/fat
3. Transfer the mixture to a food processor;

4. Add water gradually while operating the food processor; and

5. A homogenous whipped butter-like solid should form

[00107] See Figure 4B for an example of a 60% substituted butter – water emulsion (W/O emulsion).

5 **[00108]** Composition 6 has the advantage of being able to create W/O emulsions even in the presence of more water than oil. This is hypothesised to be due to the use of at least two emulsifiers to extend the functionalities of oil even with substantial substitution. Composition 6 was used to make Mayonnaise, cakes, cookies, bechamel sauce and flaky pastries.

10 **[00109]** Mayonnaise

[00110] Mayonnaise was made with composition 6 by substituting 18% of vegetable oil with a substance formed with composition 6 or with non-substituted oil. The mayonnaise recipe required 70% oil. Both mayonnaises were oil-in-water emulsions as is typical of mayonnaise. The normal mayonnaise made with non-substituted sunflower oil is depicted in Figures 5A and 5B and the mayonnaise made with 18% of the vegetable oil substituted with a substance formed with composition 6 is depicted in Figure 5C and 5D. The mayonnaise formed with 18% of the vegetable oil substituted with a substance formed from composition 6 could not be discerned from the mayonnaise made with non-substituted oil by 3 testers amongst a panel of 8 (37.5%) based on taste and textural differences. Similarly, 4 tasters amongst a panel of 8 (50%) preferred the lower fat mayonnaise (see Table 2).

[00111] **Table 2:** comparison of Mayonnaises (n=8)

	18 % oil substituted mayonnaise vs normal mayonnaise
Similar texture to normal mayonnaise	3
Preferred over normal mayonnaise	4

[00112] Cakes

25 **[00113]** Cakes made with 50% of oil in a cake recipe substituted with a substance formed with composition 6. The resulting cake had a texture is close to the

cake made with non-substituted oil. The cake made with 50% of oil in a cake recipe substituted with a substance formed with composition 6 required a longer baking duration. The normal cake made with non-substituted oil is depicted in Figures 6A and the cake made with 50% of the oil substituted with a substance formed with composition 6 is depicted in Figure 6B. Firmness of the cakes were similar as assessed by a TA.XT plus texture analyzer (see Table 3).

[00114] **Table 3:** Firmness of the cakes were assessed by a TA.XT plus texture analyser.

	Original cake made with non-substituted oil	cake made with 50% of oil in a cake recipe substituted with a substance formed with composition 6
Average firmness value (g)	229.95	192.05
Standard deviation	27.86	27.07

[00115] A panel of 5 testers regarded cake made with 50% of oil in a cake recipe substituted with a substance formed with composition 6 favourably, with most agreeing that it could easily pass off as a typical full-fat cake (see Table 4).

[00116] **Table 4:** Comparison of cakes (n=5)

	50 % oil substituted oil cake vs cake with non-substituted oil
Similar texture	5
Similar taste	4
Could pass off as a typical full-fat cake	5

[00117] A butter cake recipe was also attempted. Cakes made with 60% of butter in a butter cake recipe substituted with a substance formed with composition 6. There was no change in baking conditions this time round. However, the lower fat cake had a reduced degree of rise, despite its firmness remaining comparable to the original cake (see table 5). The normal cake made with non-substituted butter is depicted in Figures 7A and the cake made with 60% of the butter substituted with a substance formed with composition 6 is depicted in Figure 7B.

[00118] **Table 5:** Physical parameters of the cake including rise height and

Firmness of the cakes were assessed by a TA.XT

	Original butter cake	Absolute 60 % butter substituted butter cake
Tallest height (mm)	62.3	55.9
Average firmness (g)	207.84	219.16
Standard deviation	18.91	15.66

[00119] A panel of 5 testers regarded the butter cake indistinguishable from the control in terms of texture and taste, regardless of the difference in appearance between the cakes (see table 6).

5 [00120] **Table 6:** Comparison of cakes (n=5)

	60 % butter substituted oil cake vs cake with non-substituted butter
Similar texture	5
Similar taste	5
Could pass off as a typical full-fat cake	5

[00121] Cookies

[00122] A model cookie recipe using oil was used to investigate the effects of fat substitution in cookies/biscuits that use oil as the main fat component. Here, cookies made with 60% of oil in a cookie recipe substituted with a substance formed with composition 6 was achieved with a slightly extended baking time. Cookies made with 50% of oil in a cookie recipe substituted with a substance formed with composition 6 required the same baking time as cookies made with unsubstituted oil. The normal cookies made with non-substituted oil is depicted in Figures 8A and the cookies made with 60% of the oil substituted with a substance formed with composition 6 is depicted in Figure 8B. The lower fat cookies were found to be slightly harder than the original recipe as analysed by a TA.XT texture analyser (see Table 7).

[00123] **Table 7:** Firmness of the cookies were assessed by a TA.XT plus texture analyser.

	Original oil cookies	60 % oil substituted oil cookies
Average hardness value (g)	1430.23	1637.26
Standard deviation	144.48	58.81

[00124] Nevertheless, a panel of 5 testers, found the lower fat cookies to also judged favourably against the control (see Table 8).

[00125] **Table 8:** Comparison of cookies (n=5).

	60 % oil substituted oil cookies vs cookies with non-substituted oil
Similar texture	3
Similar taste	3
Could pass off as a typical full-fat cookie	5

[00126] Similar substitution was achieved for butter cookies, where cookies made with up to 40% of butter in a butter cookie recipe substituted with a substance formed with composition 6. Successful fat reduction of up to 40% was achieved for the butter cookies. The normal cookies made with non-substituted butter is depicted in Figures 9A and the cookies made with 40% of the butter substituted with a substance formed with composition 6 is depicted in Figure 9B. This reduced fat butter cookies also required a slightly extended baking time. They also had slightly increased hardness (see Table 9).

[00127] **Table 9:** Firmness of the cookies were assessed by a TA.XT plus texture analyser.

	Original butter cookies	40 % substituted butter cookies
Average hardness value (g)	749.40	896.29
Standard deviation	39.85	50.08

[00128] The texture of the cookies was found to be comparable to the control (non-substituted butter cookie), albeit with some detractions with regard to taste (see Table 10).

[00129] **Table 10:** comparison of butter cookies (n=5)

	40 % butter substituted butter cookies vs non-substituted butter cookies
Similar texture	5
Similar taste	0 (Less buttery)
Could pass off as a typical full-fat cookie	5

[00130] Sauce

[00131] Bechamel sauce is a butter-based sauce commonly used in several dishes. Successful butter substitution of 60% was achieved without large deviations from the original texture. Bechamel sauce was made with 60% of butter in a bechamel sauce recipe substituted with a substance formed with composition 6. The normal bechamel sauce made with non-substituted butter is depicted in Figures 10A and the bechamel sauce made with 60% of the butter substituted with a substance formed with composition 6 is depicted in Figure 10B. Referring to figure 10C, rheologically, the original sauce with no substitution and the lower fat sauce made with 60% of the butter substituted with a substance formed with composition 6 performed similarly. This demonstrates the effectiveness of a substance formed with composition 6 in replicating the flow properties of fat. Consequently, on a panel of 10 testers, almost all preferred the lower fat bechamel sauce citing superior taste and texture (see Table 11).

[00132] **Table 11:** Comparison of bechamel sauce (n=10).

	60 % butter substituted bechamel sauce vs non-substituted bechamel sauce
Similar texture	4
Similar taste	10
Preferred	8

[00133] Croissants and other flaky pastries

[00134] One of the most difficult applications to replicate for butter is its use in folded, flaky pastries, including but not limited to croissants, danishes, filo, and puff pastry. Here, croissants were made with 30% of butter in a croissant recipe substituted with a substance formed with composition 6. The normal croissant made with non-substituted butter is depicted in Figures 11A. Croissants made with 30% of the butter substituted with a substance formed with composition 6 is depicted in Figure 11B, which was baked for the same time, and Figure 11C, which was baked for an additional 5 minutes. Although the texture deviated from the control croissant,

the lower fat versions were still similar in appearance and in taste (see Table 12).

[00135] **Table 12:** physical features and comparison of butter croissants

	Original non-substituted butter croissant (35 min bake time)	Butter 30% substituted butter croissant (35 min bake time)	Butter 30% substituted butter croissant (40 min bake time)
Colour	Golden brown	Slightly browner	Slightly browner
Taste	Buttery, sweet, slightly salty, toasted	Less buttery, sweet, slightly salty, more toasted	Less buttery, sweet, slightly salty, more toasted
Texture (surface)	Crispy and flaky	Hard and crispy	Hard and crispy
Texture (inner body)	Layered, aerated with big pore size,	Less layered, moist centre, dense and tough	Less layered, moist centre, dense and tough
Taste by tasters (n=4)	same as a croissant - 4 different - 0	same as a croissant - 3 different - 1	same as a croissant - 3 different - 1

[00136] In the foregoing manner, various embodiments of the disclosure are described for addressing at least one of the foregoing disadvantages. Such embodiments are intended to be encompassed by the following claims, and are not to be limited to specific forms or arrangements of parts so described and it will be apparent to one skilled in the art in view of this disclosure that numerous changes and/or modification can be made, which are also intended to be encompassed by the following claims.

Claims

1. A composition for forming a fat replacement emulsion for food products comprising: 5 to 60 weight percent insoluble fibre; at least two hydrocolloid forming polysaccharides each having 0.2 to 10 weight percent; and 20 to 85 weight percent emulsifying agent, the weight percentages being based on the total composition.
5
2. The composition according to claim 1, wherein the insoluble fibre is selected from cellulose fibres; and microcrystalline cellulose.
10
3. The composition according to claim 1 or 2, wherein the at least two hydrocolloid forming polysaccharides are selected from carboxymethylcellulose sodium; methylcellulose; Gum Arabica; guar gum; locust bean gum; beta glucan; Dammar gum; Glucomannan; Psyllium seed gum; Konjac gum; gellan gum; Tara gum; Gum Ghatti; and xanthan gum.
15
4. The composition according to any one of claims 1-3, wherein the at least two hydrocolloid forming polysaccharides comprise a combination of carboxymethylcellulose sodium; methylcellulose; and Gum Arabica
20
5. The composition according to any one of claims 1-3, wherein the at least two hydrocolloid forming polysaccharides are each uncharged hydrocolloid forming polysaccharides.
- 25 6. The composition according to claim 5, wherein the uncharged hydrocolloid forming polysaccharides are each selected from guar gum; locust bean gum; beta glucan; Dammar gum; Glucomannan; Psyllium seed gum; Tara gum; and xanthan gum.
- 30 7. The composition according to any one of claims 5, wherein the uncharged hydrocolloid forming polysaccharides are guar gum and xanthan gum.

8. The composition according to any one of claims 1 to 8, wherein the emulsifying agent is selected from a sugar ester; a starch esterified with octenylsuccinic compound; a low Hydrophilic-Lipophilic Balance (HLB) emulsifier and acetylated starch.
- 5
9. The composition according to claim 8, wherein the sugar ester comprises a sucrose ester or a glucose ester.
- 10
10. The composition according to claim 8, wherein the starch esterified with octenylsuccinic compound comprises sodium starch octenylsuccinate or aluminium starch octenylsuccinate.
- 15
11. The composition according to claim 8, wherein the low Hydrophilic-Lipophilic Balance (HLB) emulsifier is selected from Polyglycerol polyricinoleate, sucrose esters, mono-diglycerides and lecithins.
- 20
12. The composition according to claim 8, wherein the low Hydrophilic-Lipophilic Balance (HLB) emulsifier comprises Polyglycerol polyricinoleate.
- 25
13. The composition according to claim 1, wherein
- the insoluble fibre is microcrystalline cellulose;
- the at least two hydrocolloid forming polysaccharides are guar gum and xanthan gum; and
- the emulsifying agent is sodium starch octenylsuccinate.
- 30
14. The composition according to claim 13, wherein the weight ratio of microcrystalline cellulose : xanthan gum : guar gum : sodium starch octenylsuccinate is 31 : 4 : 2 : 63.

15. The composition according to claim 1, wherein:
the insoluble fibre is microcrystalline cellulose;
the at least two hydrocolloid forming polysaccharides are carboxymethylcellulose sodium, methylcellulose and gum Arabic ; and
5 the emulsifying agent is sodium starch octenylsuccinate and polyglycerol polyricinoleate.
16. The composition according to claim 15, wherein the weight ratio of
microcrystalline cellulose : carboxymethylcellulose sodium : methylcellulose : gum
10 Arabic : sodium starch octenylsuccinate : polyglycerol polyricinoleate is 42 : 6 : 12 : 24 : 383 : 33.
17. A fat replacement substance for food products comprising: the composition
according to any one of claims 1 to 16, and an aqueous liquid combined under
15 shear force.
18. The fat replacement substance according to claim 17, wherein the weight ratio of
the composition to aqueous liquid is in the range of 1 : 19 to 1 : 4.
- 20 19. The fat replacement substance according to claim 17, wherein the weight ratio of
the composition to aqueous liquid is 1 : 6 to 1 : 7.
20. The fat replacement substance according to any one of claims 17 to 19, further
comprising a lipid.
25
21. A food product comprising the composition according to any one of claims 1 to
16, or the fat replacement substance according to any one of claims 17 to 20.
22. The food product according to claim 21, comprising baked goods.
30

23. The food product according to claim 21, comprising plant based meat substitutes.
24. The food product according to claim 21, comprising a meat composite.
- 5 25. The food product according to claim 21, comprising a sauce.
26. The food product according to claim 21, comprising a drink.
- 10 27. A method of manufacturing a fat replacement substance for food products comprising:
a. adding the composition of any one of claims 1 to 16 to an aqueous liquid; and
b. applying shear force until the fat replacement emulsion forms.
- 15 28. The method according to claim 27, wherein the composition is added to the aqueous liquid at a ratio in the range of 1 : 19 to 1 : 4.
29. The method according to claim 27, wherein the composition is added to the aqueous liquid at a ratio of 1 : 6 to 1 : 7.
- 20 30. The method according to any one of claims 27 to 29, further comprising adding a lipid to the fat replacement substance either before or during applying shear force.