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(71) Applicants: **AAK AB (PUBL)** [SE/SE]; Skrivaregatan 9, 215 32 MALMÖ (SE). **UNIVERSITY OF COPENHAGEN** [DK/DK]; Nørregade 10, 1165 COPENHAGEN (DK).

(72) Inventors: **BØGELUND MUNK, Merete**; Humlehaven 51B, 2500 VALBY (DK). **RISBO, Jens**; C.N. Petersensvej 23, 2000 FREDERIKSBERG (DK). **LEWERENTZ, Frida**; Fågelhundsvägen 53, 226 53 LUND (SE).

(74) Agent: **BERGENSTRÅHLE & PARTNERS STOCKHOLM AB**; Box 17704, 118 93 Stockholm (SE).

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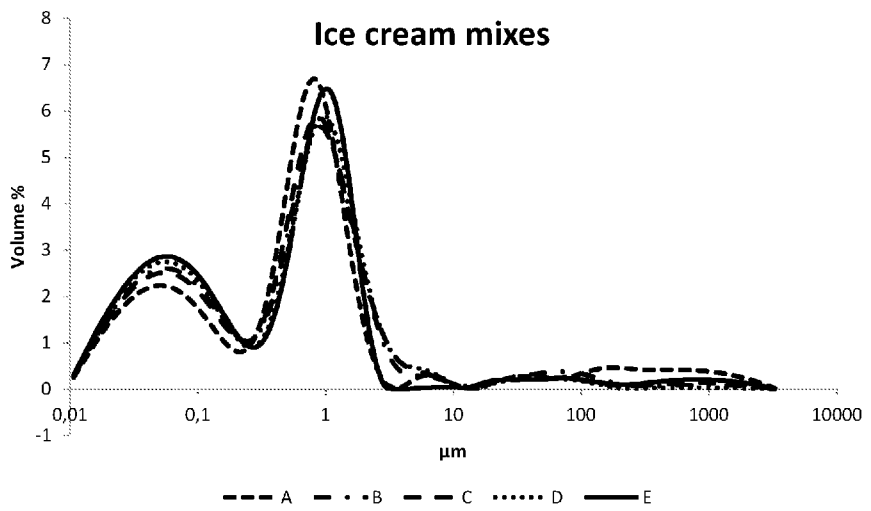
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(54) **Title:** AERATED FOOD PRODUCT COMPRISING SUNFLOWER WAX

Figure 1

A)



(57) **Abstract:** An aerated food product, such as a mousse, whipped topping, ice cream and frozen desserts, comprising a fat component and sunflower wax as a structuring agent is disclosed. Also disclosed is a method of producing an aerated food product that contains oils which have a low content of saturated fatty acids.

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AERATED FOOD PRODUCT COMPRISING SUNFLOWER WAX

FIELD OF INVENTION

The present invention relates to the field of aerated food products, such as mousse, whipped topping, ice cream and frozen desserts. In particular, it relates to aerated frozen food products that contain oils which have a low content of saturated fatty acids.

BACKGROUND OF THE INVENTION

Aerated food products rely on the incorporation and retention of air into the product to obtain the desired structure, texture and taste. One type of aerated food product is the aerated frozen food products.

Aerated frozen food products generally contain fat (dairy or non-dairy), milk solids-not-fat (the principal source of protein), sweeteners, stabilizers, emulsifiers, water and flavors. Aerated frozen food products are all consumed in the frozen state and rely on a concomitant freezing and whipping process to establish the desired structure and texture.

Saturated fats are conventionally used because they are mostly solid at the temperatures at which freezing and aeration take place in an ice cream freezer as well as the temperature of the subsequent storage and ingestion of the product. The presence of solid fat together with an emulsifier results in ice cream that can be aerated uniformly and consistently, holds its shape after extrusion and has good texture when eaten (see for example “Ice cream”, 6th edition, R.T. Marshall, H. D. Goff and R. W. Hartel, Kluwer Academic Press). Shape formation and retention is a critical factor in ice cream and thus such products cannot normally be produced with a low level of solid fat, because liquid fat is not able to form a fat network that provides structure to the product and stabilizes air bubbles. This results in uneven aeration and poor shaping properties.

Health-conscious consumers are looking for aerated food products which have all the properties of these traditional products but which are less unhealthy. Focus has thus been on substituting consumption of saturated fats to plant-derived unsaturated liquid oils. Another factor for this development is the increased awareness of sustainability in the food sector.

When using liquid oils instead of solid fats in the production of aerated frozen food products, means for supporting structure in the aerated frozen food product is needed. Oleogels has potential to be used in food production as an alternative to solid saturated fats. Oleogels are a common denotation for liquid oils structured into a solid-like material by components which function as structuring agents in low concentration without causing significant changes of the chemical composition. Such components are often denoted oleogellators.
It is known that oleogels may be formed using sunflower wax as structuring agent.

Yilmaz and Ögütcü, Food Func., 2015, 6, page 1194 describes the use of sunflower wax in an oleogel. The sunflower wax oleogel is used to prepare a cookie with good results. However, the document is completely silent regarding exchanging most or all solid fat of an aerated food product with liquid oil using sunflower wax as structuring agent and the method of production of aerated food products is also not disclosed.

Yilmaz and Ögütcü, RSC Adv., 2015, 5, page 50259 describes the use of sunflower wax in an oleogel. The sunflower wax oleogel is used to prepare a spreadable fat and butter alternative. However, the document is completely silent regarding exchanging most or all solid fat of an aerated food product with liquid oil using sunflower wax as structuring agent and the method of production of aerated food products is also not disclosed.

Hwang et al, J. Am. Oil Chem Soc, 2013, 90, page 1705 also describes the use of sunflower wax in an oleogel and the preparation of a margarine. Sunflower wax showed the greatest firmness for organogel and the margarine samples among the three plant waxes tested in this study. However, the document is completely silent regarding exchanging most or all solid fat of an aerated food product with liquid oil using sunflower wax as structuring agent and the method of production of aerated food products is also not disclosed.

Thus, several studies have evaluated the use of a sunflower wax oleogel, however none have produced an aerated food product using sunflower wax as a structuring agent.

Thus, there remains a need to provide an aerated food product being based mostly on liquid oil and containing low levels of saturated fats, which have good aeration and shaping properties.

SUMMARY

The invention relates to an aerated food product comprising a fat component and sunflower wax as a structuring agent.

According to an advantageous embodiment of the invention, the fat component is liquid fat.

In a further aspect of the invention the aerated food product also comprises an emulsifier.

The invention relates in a further aspect to an aerated food product with a low level of saturated fat present, such as a whipping cream or an ice cream.

The invention relates in an even further aspect to a non-dairy aerated food product.

FIGURES

Figure 1A Droplet size distribution in ice cream mixes differing in type of fat, type of emulsifier, or concentration of sunflower wax. A) coconut oil + PS217 (control), B) HOSO and 1 wt% SFW + DMG 0291, C) HOSO and 1 wt% SFW + PS217, D) HOSO and 0.6 wt% SFW + PS217, E) HOSO + PS217 (control).

Figure 1B Droplet size distributions in melted ice cream differing in type of fat, type of emulsifier, or concentration of sunflower wax. A) coconut oil + PS217 (control), B) HOSO and 1 wt% SFW + DMG 0291, C) HOSO and 1 wt% SFW + PS217, D) HOSO and 0.6 wt% SFW + PS217, E) HOSO + PS217 (control).

Figure 2 Serum separations over time of ice cream differing in type of fat, type of emulsifier, or concentration of sunflower wax. A) coconut oil + PS217 (control), B) HOSO and 1 wt% SFW + DMG 0291, C) HOSO and 1 wt% SFW + PS217, D) HOSO and 0.6 wt% SFW + PS217, E) HOSO + PS217 (control).

Figure 3A Droplet size distribution for ice cream mixes made with different concentrations of sunflower wax.

Figure 3B Droplet size distribution for ice creams made with different concentrations of sunflower wax.

Figure 4 Meltdown rates of ice creams containing different concentrations of sunflower wax

DETAILED DESCRIPTION

Definitions

As used herein, "%" or "percentage" all relates to weight percentage i.e. wt% or wt-% or w/w % or % by weight if nothing else is indicated.

As used herein, the singular forms "a", "an" and "the" include plural referents unless the context clearly dictates otherwise.

As used herein, "at least one" is intended to mean one or more, i.e. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, etc.

As used herein, the term "and/or" is intended to mean the combined ("and") and the exclusive ("or") use, i.e. "A and/or B" is intended to mean "A alone, or B alone, or A and B together". For example in the context "vegetable and/or non-vegetable origin" it is thus intended to mean "protein of vegetable origin", "protein of non-vegetable origin" or "protein of vegetable and non-vegetable origin".

As used herein, the term "fatty acid" encompasses fatty acid residues in triglycerides.

As used herein, the term "free fatty acid" is intended to mean fatty acids which are present in their acid or carboxylate form and not part of mono-, di- or triglycerides.

As used herein, the term "triglycerides" may be used interchangeably with the term 'triacylglycerols' and should be understood as an ester derived from glycerol and three fatty acids. "Triglycerides" may be abbreviated TG or TAG.

As used herein, "edible" is something that is suitable for use as food or as part of a food product. An edible fat is thus suitable for use as fat in food or food product and an edible composition is a composition suitable for use in food or a food product.

"Liquid oil" as used herein should be understood as an oil which is liquid at room temperature, i.e. around 20 degrees Celsius.

"Ice cream" and "aerated frozen dessert" is herein used interchangeable and should be understood as a food product comprising air, water, milk fat or non-dairy fat, sweeteners, stabilizers, emulsifiers, flavors and optionally protein from milk sources or vegetable source, which is consumed in a frozen state.

The term "aerated" is used to refer to a foam, in other words a dispersion of a gas in a solid or liquid medium. The gas may be any gas commonly used for foam generation such as CO_2, N_2 or N_2O, but typically the gas is atmospheric air.

Ice cream is a frozen foam, the air being incorporated during the dynamic freezing process. Air quantity is calculated as "overrun", the percentage increase in volume that occurs as a result of the whipping when compared to the volume of the original mix. Overrun is calculated as:
% overrun = [(volume of product-volume of mix)/volume of mix] x 100
Overrun can also be calculated for individual containers by determining the portion of the mix displaced by air in the specific package as:
% overrun = [(mix weight-product weight)/product weight] x 100
Overrun is measured at atmospheric pressure.
Overrun can also be evaluated in connection with an aerated food product which is not frozen, e.g. a mousse or a whipped topping.

"Meltdown" as used herein is meant the rate at which the aerated frozen food product melts in a constant temperature environment, measured in terms of mass loss as function of time.

"Oleogel" as used herein to refer to liquid oils that have been transformed into solid-like materials by structuring agents in low concentration without causing significant changes of the chemical composition.

"Homogenization" as used herein refers to the process of dispersing one liquid into another liquid, when the two liquids are immiscible. This is achieved by turning one of the liquids into a state consisting of small particles or droplets distributed uniformly throughout the other liquid.

The invention relates to an aerated food product comprising a fat component and sunflower wax as a structuring agent.

According to one embodiment of the invention the aerated food product comprises a fat component in an amount of 5 to 40 % by weight, such as 5 to 15 % by weight, such as 8 to 12 % by weight of said aerated food product.

According to one embodiment of the invention, the aerated food product comprises a combination of solid fat and liquid oil.

According to an advantageous embodiment of the invention, the aerated food product comprises only liquid oil as the fat component.

One significant advantage of the invention is that in one embodiment the total amount of saturated fatty acids is less than 10 % by weight of the total fatty acid content.

According to a further embodiment of the invention, the sunflower wax is present in an amount of 1 to 40 % by weight, such as 1 to 15 % by weight, such as 1 to 10 % by weight, such as 5 to 15% by weight of the fat component.

In one embodiment of the invention the aerated food product also comprises an emulsifier.

According to an embodiment of the invention the aerated food product further comprises a protein source of either vegetable and/or non-vegetable origin.

According to a further advantageous embodiment of the invention, the aerated food product is a non-dairy product.

The present invention also relates to a method of producing an aerated frozen food product comprising the steps of:

a. mixing a fat component with sunflower wax and emulsifier, to obtain a fat phase mix,
b. heating said fat phase mix to 60-90 degrees Celsius,
c. mixing water with sweeteners, stabilizers, and optionally a protein source and/or an emulsifier to obtain a water phase mix,
d. optionally storing said water phase mix for 30 min – 3 hours,
e. mixing said fat phase mix and said water phase mix, to obtain a final mix,
f. pasteurizing and homogenizing said final mix,
g. optionally storing the final mix for 3 – 24 hours, and
h. aerating the final mix in an aeration step, wherein said aeration step is a whipping step

to obtain an aerated food product.

Aerated food products

The term "aerated food product" as used in this application means a food product comprising air usually incorporated by a process of whipping during production of the aerated food product. The aerated food product might be a fluid or liquid product in one state which before consumption is turned into an aerated product comprising air by whipping of the fluid or liquid product thereby incorporating air into the product. One example of such an aerated food product is whipping cream, which is fluid in one state (the cream state) and which is then subjected to whipping and thereafter turns into an aerated state (known as whipped cream). Another example of an aerated food product is a mousse and whipped toppings in general.

In one embodiment the aerated food product is an aerated frozen food product.

The term "aerated frozen food products" as used in this application means a food product intended for consumption in the frozen state. "Frozen" as used herein, denotes that the product is solidified under freezing conditions to a hardpack or pumpable semi-solid consistency which is not fluid or semi-fluid. The ice content of the aerated frozen food product should be between 30 and 65% ice, and more preferably between 40% and 60% ice when measured at -18 degrees Celsius.

In one embodiment of the present invention the aerated frozen food product is an ice cream. Ice cream is in some countries denoted an aerated frozen dessert. In the present invention "ice cream" also describes an aerated frozen dessert. I.e. the term "ice cream" is used herein to denote an aerated frozen food product which is similar to ice cream even if it would not meet the requirements for such, e.g. by level of milk fat, in all jurisdictions. Ice cream is normally comprised of a mixture of air, water, milk fat or non-dairy fat, protein such as for example milk solids-non-fat (MSNF), sweeteners, stabilizers, emulsifiers and flavors. An ice cream mix is the unfrozen blend of the ingredients used to supply these constituents, except air and flavoring materials. The ingredients of the ice cream mix can be combined in varying proportions within acceptable ranges. The person skilled in the art will know how to combine different ingredients. Both the percentage and the source of the constituent can affect the quality of the mix.

The amount of air incorporated in an ice cream is often given in the term of overrun. How to calculate overrun is described herein above under the definitions.

Preferably the aerated frozen food product has an overrun of at least 20%, such as at least 50%, such as at least 80%. It is preferable that the overrun does not exceed 200%, however, otherwise the food product does not exhibit the cold mouth-feel conventionally associated with aerated frozen food products. More preferably the overrun is less than 200%. In one embodiment the overrun is between 50-120%, such as between 80-120%.

Aerated food products according to the present invention are for example, but not limited to whipped topping, whipping cream and mousse.

Frozen aerated food products according to the present invention is for example, but not limited to, ice cream, gelato, frozen desserts, and sherbet. In a preferred embodiment the frozen aerated food product is an ice cream or a frozen dessert.

In one embodiment the frozen aerated food product of the present invention is a so-called non-dairy product, meaning in this context that the product does not contain any ingredients originating from dairy, i.e. milk ingredients. In this case the product is preferably made using only ingredients of vegetable origin.

Fat component

Fats are largely made up of triglycerides, together with minor amounts of other components such as phospholipids and diglycerides. Triglycerides are esters of glycerol with three fatty acids. Fatty acids which have no carbon-carbon double bonds are said to be saturated (herein abbreviated SAFA), whereas fatty acids that contain one or more carbon-carbon double bonds are said to be monounsaturated (MUFA) and polyunsaturated (PUFA), respectively. Fats that are liquid at ambient temperature (i.e. room temperature of app. 20 degrees Celsius) are often referred to as oils. In this application the term "fat" includes such oils.

The fat component of aerated food products influences the flavor, is a good carrier and synergist for added flavor components, produces a characteristic smooth texture, helps to give structure and aids in producing desirable melting properties.

For example, the fat component, i.e. the fat globules, play an essential role in the ice cream structure as they upon the freezing-whipping process of ice cream production create a partial coalesced network that stabilizes incorporated air bubbles as well as modifies the product texture and mouthfeel. Within the field of ice cream, the agglomeration of fat globules into a network is often referred to as so-called "fat destabilization". By capillary forces the fat globule network formed by fat destabilization also prevents phase separation between water and gas, which otherwise would result in a macroscopically phase separated system of foam and liquid upon thawing. It is the high melting fat crystals in the fat globules that retain the integrity of each fat globule against full coalescence and consequently only partially coalescence is promoted. In absence of fat crystals or other substances increasing elastic forces of the globules, full coalescence would occur limiting the structure in ice cream. This is the reason why a simple replacement of saturated fat with unsaturated oil in ice cream is not possible without significant loss of product quality.

In one embodiment of the present invention the aerated food product comprises a total amount of saturated fatty acids which is less than 10 % by weight of the total fatty acid content, such as 0-10% by weight, such as 2-10% by weight, such as 4-10% by weight, such as 6-10% by weight, such as 8-10% by weight of the total fatty acid content.

In another embodiment the total amount of saturated fatty acids is 0-8% by weight, such as 0-6% by weight, such as 0-4% by weight, such as 0-2% by weight of the total fatty acid content.

In one embodiment the fat component of the frozen aerated food product of the present invention is of vegetable origin. This is particularly the case when the frozen aerated food product is a so-called non-dairy product.

In another embodiment the non-dairy fat component may be mixed with a dairy fat component. In one embodiment of the present invention the fat component of the frozen aerated food product is liquid oil. In such an embodiment the liquid oil can be selected from the group consisting of, but not limited to: rapeseed oil, sunflower oil, high oleic sunflower oil, canola oil, high oleic soybean oil, soybean oil, flaxseed oil, grapeseed oil, olive oil, peanut oil, corn oil, and cottonseed oil.

In one embodiment of the present invention the liquid oil used as fat component in the aerated food product is a mixture of one or more of the liquid oils mentioned herein above.

In one embodiment the aerated food product of the invention comprises the fat component in an amount of 5-40% by weight of the aerated food product, such as 5-30%, such as 5-20%, such as 5-15% by weight of the aerated food product.

In another embodiment the aerated food product of the invention comprises the fat component in an amount of 8-20% by weight of the aerated food product, such as 8-15% by weight, such as 8-12% by weight of the aerated food product.

In one embodiment of the present invention the fat component of the frozen aerated food product is a mixture of solid and liquid fat. Such a mixture predominantly comprises liquid fat, such as at least 55% by weight of the total fat content, such as at least 60% by weight, such as at least 70% by weight, such as at least 80% by weight, such as at least 90% by weight, such as at least 95% by weight of the total fat content. In such an embodiment the solid fat can be selected from the list consisting of, but not limited to: Palm oil, palm kernel oil, coconut oil, cacao butter and shea butter.

Protein source

In order to aid in aeration during manufacture of the aerated food product it is preferable that the food product in one embodiment comprises a protein source. This protein source may be of either vegetable and/or non-vegetable origin.

In one embodiment mammalian milk protein is present in the aerated food product in an amount of at least 0.5% by weight of the aerated food product, more preferably at least 1%, more preferably at least 2%. In order to prevent the confection from exhibiting a chalky mouth-feel, however, it is also preferable that the protein content is less than 8%, more preferably less than 6% by weight of the aerated food product. In one embodiment of the present invention the protein content is 0.5-8% by weight, such as 0.5-6% by weight of the aerated food product. The dairy (i.e. non-vegetable) protein source can be selected from the group consisting of, but not limited to skim milk powder, sodium caseinate, or whey protein, whole milk, skim milk, condensed milk, evaporated milk, cream, and other milk solids non-fat.

In another embodiment the aerated food product is free of mammalian milk protein or a protein source from other non-vegetable source, i.e. the aerated food product only contains a non-dairy protein source. In this embodiment the source of proteins can be any vegetable source provided they function to help the creation of a good ice cream microstructure in the produced ice cream product. Types of vegetable protein which may be used in the present invention include, but are not limited to, the following and combinations thereof: pea protein, chickpea beans protein, soy protein, cotton seed protein, sunflower seed protein, lupin protein, oat protein, lentil protein, sesame seed protein, canola protein, broad been protein, horse bean protein, alfalfa protein, clover protein, rice protein, tapioca protein, potato protein, carob protein and corn protein.

In one embodiment the proteins source is soy protein, pea protein or lupin protein.

In one embodiment the vegetable protein is present in the aerated food product in an amount of at least 0.5% by weight of the aerated food product, more preferably at least 1%, more preferably at least 2%. In order to prevent the confection from exhibiting a chalky mouth-feel, however, it is also preferable that the protein content is less than 8%, more preferably less than 6% by weight of the aerated food product. In one embodiment of the present invention the protein content is 0.5-8% by weight, such as 0.5-6% by weight of the aerated food product.

The abovementioned non-dairy protein can in one embodiment be mixed with a dairy protein source, e.g. skim milk powder, sodium caseinate, whey protein, whole milk, skim milk, condensed milk, evaporated milk, cream, and milk solids non-fat.

In another embodiment the aerated food product does not contain protein.

Sweeteners

The aerated food product may contain sweeteners. Especially aerated frozen food products usually contain sweeteners. In order to provide the customary sweetness associated with aerated frozen food products and to avoid the food product to be overly hard, it is preferable that the aerated frozen food product comprises sweeteners in an amount of at least 5% by weight of the aerated frozen food product, more preferably at least 10%, most preferably at least 15%.

To avoid the aerated food product being too sweet, the amount of sweetener should be at most 35%, preferably at most 30%, most preferably at most 25% by weight of the aerated food product. In one embodiment the aerated food product comprises sweeteners in an amount of 5-35% by weight, such as 5-30% by weight, such as 5-25% by weight of the aerated frozen food product. In another embodiment the aerated food product comprises sweeteners in an amount of 10-35% by weight, such as 15-35% by weight of the aerated frozen food product.

In one embodiment one of the sweeteners are lactose, especially when added as part of the milk solids. In another embodiment the sweetener is of vegetable origin. The latter is especially relevant when the aerated food product is a non-dairy food product.

Generally, the aerated food product of the invention will be naturally sweetened and comprises one or more sugar compounds selected from the group consisting of monosaccharides, disaccharides, polysaccharides and oligosaccharides. Typical sugars include sucrose, fructose, glucose, maltose, galactose, dextrose, corn syrups, maltodextrin and lactose. The aerated food product may contain sugar alcohols alone or in combination with one or more sugar compounds selected from monosaccharides, disaccharides, polysaccharides and oligosaccharides. If present, the preferred sugar alcohols are erythritol, sorbitol, maltitol, lactitol, glycerol, and xylitol. Natural low- or non-caloric sweeteners such as stevia may be used. If it is desired to use artificial sweeteners, any of the artificial sweeteners known in the art may be used, such as

aspartame, saccharine, Alitame, acesulfame K, cyclamates, neotame, sucralose and the like, and mixtures thereof.

Emulsifiers

If desired, the aerated food product may include an emulsifying agent. The emulsifier may be present in the water phase and/or the fat phase of the aerated food product.

Emulsifiers lower the interfacial tension between fat and water, and aid destabilization of fat globules in the freezing process. Typical emulsifiers used include mono-di-glycerides of saturated fatty acids, mono-di-glycerides of partially unsaturated fatty acids, interesterified derivatives of monoglycerides, sorbitan esters, tween, polyglycerol polyricinoleate, egg yolk, fractions of egg yolk and lecithin. In one embodiment the emulsifier can be selected from the list consisting of: mono-di-glycerides or distilled monoglycerides of partially unsaturated fatty acids, or mono-di-glycerides or distilled monoglycerides of unsaturated fatty acids. In one embodiment the emulsifiers used is a combination of saturated and unsaturated fatty acids of mono-di-glycerides or distilled monoglycerides. The total concentration of emulsifier in the aerated frozen food product is between 0.05 and 1% by weight, more preferably between 0.1 and 0.5% by weight. In another embodiment the aerated frozen food product is essentially free of emulsifying agents.

Flavors

Flavorings may be included in the aerated food product of the present invention, preferably in amounts that will impart a mild, pleasant flavor. The flavoring may be any of the commercial flavors employed in for example ice cream, such as varying types of cocoa, pure vanilla or artificial flavors as vanillin, ethyl vanillin, chocolate, extracts, spices and the like. It will further be appreciated that many flavor variations may be obtained by combinations of the basic flavors.

Structuring agent

As discussed herein above the fat component of an aerated frozen food product usually aid to create structure and support inclusion of air. By exchanging some or all of the solid fat with liquid oil in an aerated frozen food product it is implied that an absence of fat crystals will occur, thus the structuring effect of the fat component is lost and an alternative structuring agent

is required. The present invention relates to the use of sunflower wax as a structuring agent. The term "structuring agent" as used herein means that sunflower wax is used to structure the fat component of the invention, and thereby the liquid oil becomes solid-like and structure is provided to the resulting aerated food product of the invention. By "structure" is meant that the aerated food product produced have the desired structure and form, and can be aerated uniformly and consistently during the manufacturing method (described herein below in the section "Manufacturing of aerated food products"), while still retain its shape after extrusion and has a good texture when eaten (see also the section herein below on "Sensory tests"). In one embodiment the fat component of the present invention is liquid oil. In one embodiment of the invention the sunflower wax is the only structuring agent present and is providing all the structure needed in the obtained aerated food product. In one embodiment the structuring agent provides structure by structuring another component than the fat component.

Sunflower wax is obtained after pressing of sunflower seed and separation of the sunflower wax from the sunflower oil. The INCI name of sunflower wax is Helianthus Annuus (Sunflower) Seed Wax. Sunflower wax has CAS no. 1286686-34-7.

The present invention describes a new and inventive method of using sunflower wax as a structuring agent in an aerated food product.

In one embodiment of the present invention the aerated food product comprises sunflower wax in an amount of 1-40% by weight of the fat phase, such as 1-30% by weight, such as 1-20% by weight, such as 1-10% by weight, such as 1-5% by weight, such as 5-15% by weight of the fat phase.

In another embodiment the aerated food product comprises sunflower wax in an amount of 1-15% by weight of the fat phase, such as 1-10% by weight, such as 1-5% by weight, such as 1-3% by weight, such as 1-2% by weight of the fat phase.

Manufacturing of aerated food products

The conventional manufacturing process for aerated food product, e.g. a mousse or a whipped cream, consists of a number of steps: (i) mixing the ingredients, (ii) pasteurization and high-pressure homogenization, (iii) ageing, (iv) aerating the mix under shear and (v) extrusion. When

making an aerated frozen food product, e.g. ice cream, the procedure is essentially the same with the addition of partially freezing of the mix in stage (iv) and an extra step after step (v) named (vi) hardening. Both these processes are well known by a person skilled in the art and is also described for example in "Ice cream", 6th edition, R.T. Marshall, H. D. Goff and R. W. Hartel, Kluwer Academic Press. The skilled person will know that the order of the steps in the method should be as outlined herein above as far as that is possible. It cannot be ruled out that certain steps can be performed in another order, but generally the order will remain the same in order to achieve an aerated food product.

In the ageing step, the mix is held at a low temperature, typically 4 degrees Celsius, for a period of time, typically a few hours, such as from 30 min – 24 hours. The ageing step is optional in the present invention. One purpose of the ageing step is to allow time for the fat (which is liquid at the pasteurization temperature) to crystallize before the mix is frozen and aerated. Traditionally, aerated frozen food products such as ice cream have been prepared with fats having a high proportion of saturated fat, for example dairy fat (60-70%) or coconut oil (>90%). High melting fatty acids in saturated fats crystallize during the aging step. It is due to the fat crystals that a structure giving fat network can be created during aeration. It is this fat network that allows the ice cream to retain its shape after extrusion and has a good texture when eaten.

Method of producing aerated food product

The present invention discloses a method of producing an aerated food product, said aerated food product comprising the steps of:

a. mixing a fat component with sunflower wax and emulsifier, to obtain a fat phase mix,
b. heating said fat phase mix to 60-90 degrees Celsius,
c. mixing water with sweeteners, stabilizers, and optionally a protein source and/or an emulsifier to obtain a water phase mix,
d. optionally storing said water phase mix for 30 min – 3 hours,
e. mixing said fat phase mix and said water phase mix, to obtain a final mix,
f. pasteurizing and homogenizing said final mix,
g. optionally storing the final mix for 3 – 24 hours, and

h. aerating the final mix in an aeration step, wherein said aeration step is a whipping step conducted by using a conventional mixer

to obtain an aerated food product.

The steps of the method are in a preferred embodiment to be performed in the order specified herein above starting this step a) and ending with step h), all the steps taken in alphabetical order.

The fat component of the invention is described in the section "fat component" herein above. The structuring agent is described in the section "structuring agent" herein above. In a preferred embodiment of the invention the fat component is liquid oil and sunflower wax is used as a structuring agent.

The emulsifier used in the invention is as described in the section "Emulsifiers" herein above.

In the method of the present invention the fat phase mix is heated to 60-90 °C in order to melt the sunflower wax. The fat phase mix is kept at the temperature for at least 20 minutes, such as 15 minutes, such as 10 minutes, such as or 8 minutes, such as for 6 minutes, such as for 4 minutes, such as for 2 minutes or until the entire fat phase is melted.

Water is mixed with sweeteners, stabilizers, optionally protein to obtain a water phase mix. Optionally the water phase mix is stored for 30 min – 3 hours to hydrate the protein source. The protein source of the present invention is described herein above in the section "protein source". The sweetener of the present invention is described herein above in the section "sweetener".

Stabilizers used in the present invention may be selected from the group consisting of, but not limited to guar gum, cellulose gum (CMC), locust bean gum (LBG), xanthan, carrageenan, and pectin.

The water phase mix is heated to a temperature equivalent to the temperature of the fat phase mix and the two phases are mixed together to obtain the final mix. This final mix is then subjected to pasteurization. Pasteurization is a process known by the person skilled in the art and commonly used in the production of food products.

After the pasteurization of the final mix said final mix is subjected to homogenizing. This homogenization can be any form of homogenization, e.g. homogenization in a high-speed blender or another shredding device, and/or high-pressure homogenization.

In one embodiment of the invention the step of homogenization is repeated more than one time.

In one embodiment of the invention the homogenization is repeated at least 2 times, such as at least 4 times, such as at least 6 times, such as at least 8 times, such as at least 10 times.

Homogenization is known in the art as being the process of disrupting one liquid into small droplets and disperses them into a continuous phase of another liquid when the two liquids are immiscible. This mixture is the definition of an emulsion.

In the present invention an emulsion suitable for the purpose is suggested to be achieved when the droplet size of the mixture is D(4.3) < 30 micron, D(3.2) < 5 micron, which is the volume mean diameter (D(4.3)) and surface area mean diameter (D(3.2)) of droplets respectively. The person skilled in the art will know how to evaluate when a mixture is homogenized.

Once the final homogenized mixture is obtained an aerated food product may be produced using conventional methods of production.

Before the production of the aerated food product the final mix may be stored for 3 – 24 hours in order for another step of ageing to occur. This allows the sunflower wax and any saturated fatty acids if present to crystallize. Furthermore, proteins might be displaced from the fat droplet interface by emulsifiers which aid destabilization of fat droplets, thus creating a structural network.

It is well within the skills of the skilled person within the art of food products to produce aerated food products, such as aerated frozen food products. Before aerating the final mix into the aerated food product one may optionally cool the final mix to approximately 4 degrees Celsius.

The aim in the production of the aerated frozen food product is to achieve a structural network. This structural network, which is commonly generated by partial coalesced fat droplets, is also needed in aerated food products in general and it is thus not only needed when the product is an aerated frozen food product.

Several parameters are involved and need to be controlled to achieve a space-filling fat network that structures and stabilizes ice cream. The total amount of fat influences the fat network formation, where low fat products exhibit less structure formation, whereas high fat products are more prone to generate visible fat granules. The size distribution of the fat droplets and the number of fat droplets also influence the character of the network. The solid fat content which is a function of fat type (i.e. solid fat content (SFC)) and aging time also plays a major role. Also, the minor components of the aerated food product influence the formation of fat network, such as the protein type, and the quantity and type of emulsifier.

Thus, it is clear for the person skilled in the art that to obtain fat network is a critical but delicate task with many factors involved.

Too much solid fat leads to insufficient contact between globules, as the liquid component is thought to hold globules together when they collide (partial coalescence), but too much liquid oil will result in full coalescence rather than partial coalescence. Thus, producing an aerated food product using liquid oil as the main fat component brings about an inherent challenge in relation to obtaining the needed structural lipid network. The present invention has solved this problem by utilizing sunflower wax as a structuring agent to make liquid oil more solid-like as also demonstrated here in the examples section.

Sensory analysis

One way of evaluating a food product is by sensory analysis. This is a well-known and recognized way to evaluate and there are several different tests that can be performed. The sensory analysis is usually performed using a panel of trained sensory assessors using a panel of parameters useful for the product being evaluated.

When evaluating an aerated frozen food product such as an ice cream there is a consideration to be taken in relation to the temperature control.

The parameters typically investigated when performing a sensory analysis on an aerated frozen food product are iciness, creaminess, sweetness and off-taste. The skilled person will

know that a modified panel can be used if the food product to be evaluated is an aerated food product instead. The panelist performing the sensory analysis are asked to estimate the parameters according to the scale presented in table A, and described in more detail herein below.

Table A

Iciness*	**Creaminess**	**Sweetness**	**Off-taste**
Very small	Weak	Low	Yes
Small	Medium	Medium	No
Medium	Creamy	High	
Large			
Very large			

*perceived size of ice crystals

Following the tasting of each ice cream the panelists will discuss on the grading and the group of panelists will agree to a weighed grade for each parameter.

The iciness parameter is an important parameter relating to the texture of the aerated frozen food product. Texture refers to the grain or to the finer structure of the product, and depends upon the size, shape and arrangement of the small particles. The common texture defects are called coarse, icy, fluffy, sandy, and buttery. Coarse or icy texture indicates that the ice crystals are large or not uniform in size, or that the air cells are too large. This is the most common texture defect in aerated frozen food products and is affected by many factors. “Coarse and icy” also includes the presence of ice pellets, which are caused by droplets of water getting into the ice cream, frequently from the retailer´s scoops.

Iciness is evaluated the following way. The panelists are instructed to take a half spoon of the aerated frozen food product and put it in their mouth. They are then instructed to bite through the sample. If the ice crystals are tangible, they can be crushed and then the aerated frozen food product is judged as very icy.

The results of the iciness evaluation will be expressed by using the words “very small”, “medium”, “large”, “very large” as parameters of range according to the following definition:
Very small = negligible.
Small = acceptable.
Medium = disturbs the mouthfeel.
Large = results in a poor ice cream.
Very large = unacceptable.

The creaminess parameter relates to the "Body" of the aerated frozen food product, whether it feels pleasantly smooth or soft in the mouth, free from harshness while processing the sample, thus it refers to consistency (“chewiness”) or firmness and to the melting character of aerated frozen food product. Defects in the creaminess parameter are commonly described as crumbly, soggy and weak.

The results of the creaminess evaluation will be expressed by using the words “weak”, “medium creamy”, “creamy” as parameters of range according to the following definition:
“Weak”: Melts rapidly in the mouth to watery texture. A “weak” body lack firmness or chewiness and is invariably accompanied by rapid melting. It should not be confused with “fluffy” or “snowy” texture and excessive overrun. A weak body is particularly undesirable from the consumer´s viewpoint and should receive a very low score.
“Medium creamy”: melts at an acceptable rate, with acceptable firmness and chewiness.
“Creamy”: Mouth feeling like ice cream. Ice cream having an ideal texture will be very smooth, the solid particles being too small to be detected in the mouth.

The sweetness parameter relates to the taste of the aerated frozen food product. The objective is to assess the intensity of the sweetness, or whether the sample has a bad fat taste (generally old or stale flavor). The results of the sweetness evaluation will be expressed using the words “low”, “medium” or “high” as parameters of range according to the following definition:
“Low”: flat or bland taste.
“Medium”: normal, standard sweetness.
“High”: Very sweet.

The Off-taste parameter relates to whether the sample has a bad fat taste (generally old or stale flavor). The results of the off-taste evaluation will be expressed using the words "yes" or "no". If sample is assessed to be with off-taste (answered "yes"), the panelist includes a short description of how it tastes bad, i.e. whether it tastes oxidized, old, unnatural flavor, rancid, salty, etc.

The result of the combined results from the sensory analysis will provide the skilled person with knowledge about whether or not the tested aerated food product fulfills the desired requirements.

EXAMPLES

Example 1

The ice creams in the following examples were formulated and produced as described herein below. The skilled person will know this is one way of producing an aerated frozen food product such as ice cream and that other methods might be possible.

Mixing - all dry water soluble ingredients (sweeteners, skim milk powder and stabilizers) were first dry-blended and then added to a vessel with water preheated to 60°C under continuous stirring of an overhead high shear mixer. The mix was left to hydrate for 30 min at said temperature.

Pre- homogenization – oil was mixed with emulsifiers and, where intended, sunflower wax which was melted using a microwave until fully dissolved (~80°C). The water phase mix was heated to 75°C where after the fat phase mix was added under continuous stirring of an overhead high shear mixer for 5 minutes.

Homogenization - the mix is heated to 75°C in a heat exchanger and then homogenized in a 1-stage homogenizer at 130 bar.

Pasteurization - the mix is pasteurized at 85°C for 15 seconds and then rapidly cooled down to 2-4°C.

Ageing - the mix was held at 4°C for 12-20 hours.

Freezing – vanilla flavor was added to the mix, which then was aerated and frozen using a Technohoy MF 50 ice cream pilot with a closed dasher. The target was to deliver a desired overrun of 100%. The products were extruded at -5°C.

The following ingredients were used in the present examples (Table 1):

Ingredient	Class	Supplier	Details
Sucrose	sugar	Südsucker	
Skim milk powder	protein	Fayrefield foodtec A/S	
High Oleic Sunflower Oil	fat	AAK Sweden AB	Fritex HOSO
Coconut fat	fat	AAK Sweden AB	Kristal, MP* 25°C
Glucose fructose syrup	sugar	Lantmännen Reppe	Reppos 40 L, DE 38 – 42, TS 80
Sunflower wax	wax	KahlWax	Kahlwax 6607L
Distilled monoglycerides (Blended with Fully hydrogenated vegetable fat)	emulsifier	DuPont	GRINDSTED PS 217, IV** 26-34 I2/100g, MP 64°C
Distilled monoglycerides	emulsifier	Paalsgaard	Palsgard DMG 0291, Iodine value 60-70 I2/100g, MP 52°C
Guar gum	stabilizer	DuPont	GRINDSTED® GUAR 250
Locust bean gum	stabilizer	DuPont	GRINDSTED® LBG 246
Carrageenan	stabilizer	CP Kelco	Carrageenan K 100
Vanilla flavor	aroma	Einar Willumsen	01372 Vanilla bourbon extract

Table 1

*MP= melting point

** IV = iodine value

The products obtained in the examples were analyzed using the following methods.

a. Fat droplet size

The lipid droplet size of ice cream mix and ice creams was determined by light scattering using a Mastersizer 3000 (Malvern Instruments, Malvern, UK). Absorption index was set to 0.0, refractive indices for lipid and water was set to 1.47 and 1.33 respectively.

b. Viscosity

The viscosity of ice cream mixes was determined using a Standard ISO Viscosity Cup (Gardco Paul N. Gardner) according to the instructions from the manufacturer.

c. Solvent extractable fat

25 g of frozen ice cream weighed up in a 100 mL cylinder glass. The ice cream was thawed at room temperature and 30 mL of heptane was added to each cylinder glass. The cylinder glasses were rotated 15 times at 30 rpm, allowed to set for 10 minutes and then rotated again 15 times at 30 rpm after which they were left for 60 min. The heptane layer was pour into conical flasks which then were let to temper in a sand bath at 275°C for 30 min. The heptane in the flasks was evaporated in a sand bath. The heptane extraction procedure was repeated 2 more times and then the flasks were incubated at 105°C for 4 hours. The fat which remained after evaporating the heptane is the solvent extractable fat (SEF). The SEF is expressed as the ratio of solvent extractable fat per total fat content.

c. Meltdown/serum separation test of ice cream

Tests were performed on a stainless steel wire mesh grid having a size of 25x25 cm, with 3 mm diameter squares, 1 mm thick wire. Underneath the grid was a collecting vessel of large enough volume to collect the entire sample tested of the product volume and balances for weighing the material collected in the vessel. The balances were connected to a data logging system to record the mass collected. The grids were placed in a meltdown cabinet capable of holding up to 6 of these grids simultaneously. Before placement in the cabinet the ice cream samples were equilibrated in a freezer at -25°C, and then weighed on a zeroed balance. They were then placed on the mesh grid and the data logging system measured the amount of collected material every minute over a 120 minute time period.

d. Air bubble size

12,5 mg of ice cream was left to melt under a cover glass in one of the cavities on a microscopy cavity slide. The ice cream slide was then examined using a light microscope (Nicon Eclipse Ci) and pictures were taken in a predetermined pattern on 9 positions on the slide using the x10 objective. The microscopy software (NIS Elements BR 4.60.00) was used to measure the diameter of the air bubbles in the sample. The number weighted average diameter was then calculated.

e. Microstructure analysis by confocal laser scanning microscopy

The microstructure of the ice creams were investigated by confocal laser scanning microscopy, where the lipid phase was stained using a 1 ppm Bodipy 493/503 (4,4-Difluoro-1,3,5,7,8-Pentamethyl-4-Bora-3a,4a-Diaza-*s*-Indacene;Invitrogen, Carlsbad, CA, USA) dissolved in dimethyl sulfoxide. Excitation wavelength was 488 nm and emission bandwidth was 500-570 nm.

Example 2

Ice creams with varying type of emulsifiers and sunflower wax concentrations

5 different ice creams were produced and analyzed according to the methods above with the formulations in table 2. Sample A and E were controls with no wax and with coconut oil and HOSO constituting the fat source in respectively mix.

	A	B	C	D	E
Water	60,9	60,9	60,9	60,9	60,9
Sugar	12	12	12	12	12
Skim milk powder	11	11	11	11	11
Coconut oil	10				
HOSO		9	9	9,4	10
Fructose-glucose syrup	5,35	5,35	5,35	5,35	5,35
Sunflower wax		1	1	0,6	
Emulsifier PS 217	0,3		0,3	0,3	0,3
Emulsifier DMG 0291		0,3			

guar gum	0,1	0,1	0,1	0,1	0,1
Locust Bean Gum (LBG)	0,1	0,1	0,1	0,1	0,1
Carrageenan	0,05	0,05	0,05	0,05	0,05
Vanilla flavor	0,2	0,2	0,2	0,2	0,2

Table 2

Ice cream mix analyses

The viscosity of the ice cream mix had an effect on the ice cream making process and also the melting properties of the ice cream (Table 3). Neither of the ice cream mixes differed much from the reference ice cream made with coconut fat (A). The solvent extractable fat was low in all mixes as would be expected in fine dispersed emulsions. The size distributions of all ice cream mixes are rather similar (figure 1A).

	Viscosity, cSt	**SEF_{mix}, %**
A	559	1,60
B	351	1,20
C	493	0,40
D	505	0,00
E	444	2,40

Table 3

Ice cream analyses

The goal was to produce ice creams with an overrun (OR) of 100%. As can be observed in table 4 below it was not possible to reach as high OR in the produced mixes with HOSO (samples B-E) as with coconut fat (sample A). The average air bubble size was larger in the ice cream made with HOSO (E) than in the reference sample made with coconut fat (A). In the ice creams with wax sample B stands out as the air bubble size was larger than in all the other samples and OR was low. Sample C and D had an air bubble size in between samples A and E where D, with the highest OR, was closer to A and D was closer to E. This shows that the addition of wax to HOSO influenced the air bubble size.

The heptane extraction showed that the ice cream samples B and D had similar SEF to the ice cream sample made without wax and HOSO (Table 4). However, in sample C SEF was much lower. The lower SEF in sample C can be explained by the increased stability due to the higher wax content (1%). Sample B also contain 1% wax but in turn it has a less stabile emulsifier (DMG0291) and hence this increases SEF. Compared to the reference ice cream (A), samples B, D and E had a higher and C had a lower SEF.

	OR, %	**Air bubble size**	**SEF*$_{IC}$, %**
A	106%	28,8	29,6
B	77%	41,6	38,8
C	86%	32,1	20,6
D	92%	29,1	46,1
E	82%	33,7	44,4

*Solvent extractable fat content

Table 4

When the mixes are processed into ice creams, the droplet sizes increase (Figures 1A-B) which indicates agglomeration, e.g. partial coalescence or full coalescence. Especially for ice creams made either with coconut fat (sample A) or 1% SFW, DMG291 (sample B) the size increase is extensive (see figure 1B). Sample C seems to have less larger droplets/aggregates than the other ice creams which agrees with the lower SEF value.

The serum separation test showed that none of the ice creams was comparable to the reference with coconut fat regarding melting resistance and serum separation (see figure 2). There are indications that the ice cream made with only HOSO melts faster than the ice cream with 0,6% wax and the same emulsifier. The ice cream with 1% wax and DMG0261 melts even slower. It should be noted that the reference with coconut oil melts very slowly because of an extensive fat agglomeration. Ice creams made with coconut oil, with less fat agglomeration, has previously been shown to melt similarly to the B and C samples.

All ice creams were subjected to an informal sensory test. It was found that the ice creams with wax had an acceptable sense of iciness and sweetness but with a bit lower creaminess than the reference ice cream. In two of the three ice creams containing wax no off-taste was noticed

from the wax. The general conclusion was that the wax ice cream was acceptable regarding sensory properties.

Neither the heptane extraction nor the droplet size distribution analysis can distinguish partial coalescence from full coalescence. Molten ice cream samples were analyzed using CLSM which revealed that ice cream made solely with HOSO and no wax (sample E) differentiated from the other samples by containing very large irregular oil fractions in the size range above 50 µm. These oil fractions were entirely fused together, unlike the large aggregates in the other samples where individual droplets were still detectable. For the ice creams made with either coconut fat (sample A) or wax+HOSO (sample B-D) internal crystals inside the lipid droplets were visible. Concerning wax ice creams, the extent of agglomeration seems to be affected by the concentration of wax (1 %w/w restricted coalescence more than 0.6 %w/w).

The addition of sunflower wax to HOSO when making ice cream stabilized the fat globules against full coalescence and contributed to a partially coalesced fat network similar to what is found in an ice cream made with fat containing solid fat crystals such as coconut oil.

Example 3

Ice creams with varying sunflower wax concentrations

The correlation between ice cream quality and concentration of sunflower wax in the oil phase has been investigated. For the experimental design the lipid phase (oil + wax) was kept constant at 10 wt% whereas the ratio of oil:wax differentiated as follows; 99:1, 90:10, and 60:40.

Recipe: Ice cream mix	**Specified ingredients**	**1 wt% WAX***	**10 wt% WAX***	**40 wt% WAX***
		wt%	wt%	wt%
Oil	HOSO	9.9	9	6
Sunflower wax	Kahlwax 6607L	0.1	1	4
Protein	NaCas	1	1	1
Sugars	Sucrose	12	12	12
	Lactose	5	5	5

	Maltodextrin DE15	5	5	5
Stabilizers	Guar gum	0.15	0.15	0.15
	Kappa Carrageenan	0.02	0.02	0.02
Emulsifiers	LACTEM (Grindsted P22)	0.2	0.2	0.2
	Unsat. monoglyceride (Dimodan MO 90)	0.1	0.1	0.1
Water		66.53	66.53	66.53
Total		100	100	100
	Dry matter	**33.47**	**33.47**	**33.47**
	Outlet temp.	24.3	27.5	29.5

*Refers to the concentration of wax in the lipid phase, whereas the concentration of wax in the ice creams constituted 0.1 wt%, 1 wt%, and 4 wt% respectively.

Table 7

Method: The ice cream mixes were prepared by hydrating protein, sugars, and stabilizers for 2 h at room temperature, followed by heating the water phase to 80°C in a water bath. The fat phase consisting of oil, wax and emulsifiers was likewise heated to 80°C in a water bath, and subsequently the two phases (fat and water) were mixed. Pre-homogenization of the mix was carried out with a heavy-duty laboratory mixer (Silverson L4RT, Silverson Machines, Bucks, UK) for approximately 1 min at 7000 rpm. The final mix was then homogenized using a two-stage high-pressure valve homogenizer (Panda Plus 2000, GEA Niro Soavi, Parma, Italy) at 150/50 bar. A water bath was connected to the heating jacket of the feed hopper to maintain a temperature of 75°C to avoid crystallization of the wax during the emulsification process. Two cooling tubes were connected to the homogenizer, and ice water was pumped through. Inlet temperature of pre-homogenized mix: 75-80°C. Outlet temperature of ice cream mix: 24-29°C.

After 24 h of aging, the ice cream mixes (3 L) were frozen in a soft serve freezer (Model 152, Taylor Company, Rockton, IL, USA) with a draw temperature of -7°C. The ice creams were collected in 100 mm x 50 mm x 75 mm laminated cardboard boxes and hardened at -23°C for at least 48 h.

Results: The lipid droplet size of ice cream mixes and melted ice creams was determined by light scattering using a Mastersizer 3000 (Malvern Instruments, Malvern, UK). Absorption index was set to 0.0, refractive indices for lipid and water was set to 1.47 and 1.33 respectively.

For ice cream mixes the droplet size distributions are almost identical regardless of wax concentration. However, there is a slight tendency that droplet size decreases with increasing amount of wax (see figure 3A).

When the mixes are processed into ice creams, the size distributions become broad and large aggregates are formed for all three samples. Especially 1% followed by 40% has a large quantity of large aggregates (see figure 3B).

The size and morphology of oil droplets in ice cream mixes and ice creams were also investigated by confocal laser scanning microscopy (CLSM). The lipid phase was stained with 1 ppm Bodipy 493/503 (4,4-Difluoro-1,3,5,7,8-Pentamethyl-4-Bora-3a,4a-Diaza-*s*-Indacene;Invitrogen, Carlsbad, CA, USA) dissolved in dimethyl sulfoxide. Excitation wavelength was 488 nm and emission bandwidth was 500-570 nm.

For all three mixes the lipid phase consisted of small droplets of comparable size, which corresponded with the measurements of light scattering. Concerning the melted ice creams, the morphology of the lipid in the 1% wax sample contained both small individual droplets and large coalesced segments. The 10% wax sample had a comparable structure, although the very large coalesced oil segments were lacking. For both 1% and 10% samples, the structure of the 2D picture changed a lot depending on where in the sample (z direction) it was taken (whether it was near a surface of an air bubble or not). The ice creams with 40% wax were more homogeneous: no large differences were observed between images captured at the surface of an air bubble and in the continuous aqueous phase absent from air bubbles. The morphology of lipid droplets composed by 60:40 oil and wax respectively had the appearance of fluffy clouds/flakes. The microscopic study clearly shows that the wax concentration is correlated to resistance towards full coalescence of oil droplets. When the oil is structured by 40% wax the droplets become hard/elastic and no coalescence emerges. With 1% wax in the oil phase the droplets are considerably more prone towards full coalescence, and finally 10% wax in the oil phase is somewhere in between.

For the evaluation of meltdown rate, ice cream samples of similar weight (165 g ± 15 g) were placed on a stainless steel mesh (wire size 0.56 mm, mesh size 2.0 x 2.0 mm) and allowed to stand at temperature controlled conditions at 20°C in a climatized room. The weight of the melt that passed through the mesh was collected and recorded every 10 min for a total of 130 min.

The ice cream containing 40% wax in the lipid phase maintained the shape during the entire melting experiment: The shape just gradually diminished. The melted fraction was white, which indicates that the lipid continued being emulsified. On the other hand, for ice creams containing 10% and 1% wax in the lipid phase, the structure collapsed during meltdown and the melted fraction constituted primarily the aqueous phase of ice creams. This could be observed visually as the melted fractions were rather transparent.

Since the meltdown rate is based on weight % dripping through the mesh, it appears that sample 40% melts faster compared to sample 1% and 10%, where the lipid fraction (or parts of the lipid fraction) is retained on the mesh. After 130 minutes 84% of 40% sample had been dripping through the mesh, whereas it was only 57% and 53% for the 1% and 10% samples, respectively (see figure 4). That the lipid constituents did not drip through the mesh despite thawing of ice crystals indicates that the ice creams have become de-emulsified and that oil droplets somehow create network. In this case the meltdown curves indicate that the lipid fraction in sample 1% and 10% is somehow attached, either as agglomerates or network, and therefore they remain as thawed fluffy foams on top of the mesh while the aqueous phase is draining off.

Brief conclusion: With the amount of wax in the oil phase, the extent of droplet aggregation can be controlled. High concentrations of wax create stable emulsions with absence of full coalescence. Samples with 1% and 10% wax were very alike, but it is hypothesized that besides wax concentration, the characteristics of emulsions can also be modified by the choice of emulsifiers and stabilizers.

Example 4

Distribution of wax in oil-in-water emulsions

Melting and crystallization temperatures have been determined by differential scanning calometry (DSC) for bulk sunflower wax, oleogels structured by 10% sunflower wax, and

finally oleogel-in-water emulsions with oleogel concentration of 5, 10, or 15 wt%. In the emulsions the ratio between oil:wax was kept constant at 9:1. The aim was to establish that sunflower wax is dispersed in the oil phase of the emulsions and that it has not been separated from the oil phase during homogenization.

The table display onset temperature for crystallization and melting for bulk sunflower wax, sunflower wax oleogel, and oleogel emulsions with different concentrations of oleogels.

Sample	$Crys_{onset}$ Wax	$Crys_{onset}$ Oil	$Crys_{onset}$ H_2O	**$Melt_{onset}$ Wax**	$Melt_{onset}$ Oil	$Melt_{onset}$ H_2O
Bulk SFW	74 °C			**67 °C**		
SFW oleogel	63 °C	-36 °C		**44 °C**	-20 °C	
5% emulsions	29-17 °C	-33 °C	-17 °C	**51 °C**	[b]	-11 °C
10% emulsions	28-19 °C	-33 °C	-17 °C	**48 °C**	[b]	-11 °C
15% emulsions	28-17 °C	-33 °C	-19 °C	**48 °C**	[b]	-13 °C

[b] Exotermic peak for oil is not detectable as it is overlayed by the exotermic peak for water!

Table 8

When the wax is dispersed in the oil phase, as seen for the oleogel in the above table 8, the melting temperature will be decreased compared to bulk wax. In table 8 it is shown that bulk SFW starts melting at 67°C, whereas the dispersed wax in oleogels melts at 44°C. This is due to supercooling. Also for the emulsions the melting temperature of the wax has decreased, from 67°C for bulk SFW to approx. 50°C in emulsions. This shows that sunflower wax remains in the oil phase when the oleogel is dispersed into an aqueous phase.

CLAIMS

1. An aerated food product comprising a fat component and sunflower wax as a structuring agent.
2. The aerated food product of claim 1, wherein said aerated food product comprises a fat component in an amount of 5 to 40 % by weight of said aerated food product.
3. The aerated food product of claims 1-2, wherein said aerated food product comprises a fat component in an amount of 5 to 15 % by weight of said aerated food product.
4. The aerated food product of claims 1-3, wherein said aerated food product comprises a fat component in an amount of 8 to 12 % by weight of said aerated food product.
5. The aerated food product of claims 2-4, wherein said fat component present in said aerated food product is a combination of solid fat and liquid oil.
6. The aerated food product of claims 2-4, wherein said fat component present in said aerated food product consists of liquid oil.
7. The aerated food product of claim 5, wherein said solid fat is selected from the group consisting of palm oil, palm kernel oil, coconut oil, cacao butter and shea butter.
8. The aerated food product of claims 5-6, wherein said liquid oil is selected from the group consisting of: rapeseed oil, sunflower oil, high oleic sunflower oil, canola oil, high oleic soybean oil, soybean oil, flaxseed oil, grapeseed oil, olive oil, peanut oil, corn oil, groundnut oil, and cottonseed oil.
9. The aerated food product of claims 1-8, wherein the total amount of saturated fatty acids is less than 10 % by weight of the total fatty acid content.
10. The aerated food product of claims 1-9, wherein said aerated food product comprises sunflower wax in an amount of 1 to 40 % by weight of the fat component.
11. The aerated food product of claims 1-10, wherein said aerated food product comprises sunflower wax in an amount of 1 to 15 % by weight of the fat component.
12. The aerated food product of claims 1-11, wherein said aerated food product comprises sunflower wax in an amount of 1 to 10 % by weight of the fat component.
13. The aerated food product of claims 1-12, wherein said aerated food product comprises sunflower wax in an amount of 5 to 15% by weight of the fat component.
14. The aerated food product of claims 1-13, wherein said aerated food product further comprises an emulsifier.

15. The aerated food product of claim 14, wherein said emulsifier is selected from the group consisting of mono-di-glycerides of saturated fatty acids, mono-di-glycerides of unsaturated fatty acids, mono-di-glycerides of partially unsaturated fatty acids, distilled monoglycerides, esterified derivatives of monoglycerides, sorbitan esters, polyglycerol polyricinoleate, egg yolk, fractions of egg yolk and lecithin.

16. The aerated food product of claims 14-15, wherein said emulsifier is mono-di-glycerides of partially unsaturated fatty acids, distilled monoglycerides of partially unsaturated fatty acids, mono-di-glycerides of unsaturated fatty acids or distilled monoglycerides of unsaturated fatty acids.

17. The aerated food product of claims 1-16, wherein said aerated food product further comprises a protein source of either vegetable and/or non-vegetable origin.

18. The aerated food product of claim 17, wherein the protein source is selected from the group consisting of pea protein, chickpea beans protein, soy protein, cotton seed protein, sunflower seed protein, lupin protein, oat protein, lentil protein, sesame seed protein, canola protein, broad been protein, horse bean protein, alfalfa protein, clover protein, rice protein, tapioca protein, potato protein, carob protein and corn protein.

19. The aerated food product of claim 17, wherein the protein source is selected from the group consisting of skim milk powder, sodium caseinate, whey protein, whole milk, skim milk, condensed milk, evaporated milk, cream, whey, and other milk solids non-fat.

20. The aerated food product of claims 1-16, wherein said aerated food product does not comprise a protein source.

21. The aerated food product of claims 1-20, wherein said aerated food product is a non-dairy product.

22. The aerated food product of claims 1-21, wherein said aerated food product is selected from the list comprising: whipped topping, mousse, ice cream, gelato, frozen desserts, and sherbet.

23. An aerated food product comprising:

- a fat component in an amount of 5-15% by weight of the total aerated food product,
- sunflower wax in an amount of 0.05-6% by weight of the total aerated food product,
- protein in an amount of 0-10% by weight of the total aerated food product,
- sweeteners in an amount of 10-30% by weight of the total aerated food product,
- stabilizers in an amount of 0.01-1% by weight of the total aerated food product,

- and emulsifiers in an amount of 0.01-1% by weight of the total aerated food product.

24. The aerated food product according to claim 23, wherein said sweetener is a sugar compound, such as a monosaccharide, disaccharide, polysaccharide and/or oligosaccharide.

25. The aerated food product according to claim 23, wherein said stabilizer is selected from the group consisting of guar gum, cellulose gum (CMC), locust bean gum (LBG), xanthan, carrageenan, and pectin.

26. A method of producing an aerated food product comprising the steps of:

a. mixing a fat component with sunflower wax and emulsifier, to obtain a fat phase mix,

b. heating said fat phase mix to 60-90 degrees Celsius,

c. mixing water with sweeteners, stabilizers, and optionally a protein source and/or an emulsifier to obtain a water phase mix,

d. optionally storing said water phase mix for 30 min – 3 hours,

e. mixing said fat phase mix and said water phase mix, to obtain a final mix,

f. pasteurizing and homogenizing said final mix,

g. optionally storing the final mix for 3 – 24 hours, and

h. aerating the final mix in an aeration step, wherein said aeration step is a whipping step

to obtain an aerated food product.

27. The method of claim 26, wherein step e is performed at 60-90 degrees Celsius.

28. The method of claims 26-27, wherein said fat component comprises less than 10% by weight of saturated fatty acids.

29. The method of claims 26-28, wherein said emulsifier is selected from the group consisting of mono-di-glycerides of saturated fatty acids, mono-di-glycerides of unsaturated fatty acids, mono-di-glycerides of partially unsaturated fatty acids, distilled monoglycerides, esterified derivatives of monoglycerides, sorbitan esters, polyglycerol polyricinoleate, egg yolk, fractions of egg yolk and lecithin.

30. The method of claims 26-28, wherein said emulsifier is mono-di-glycerides of partially unsaturated fatty acids, distilled monoglycerides of partially unsaturated fatty acids, mono-di-glycerides of unsaturated fatty acids or distilled monoglycerides of unsaturated fatty acids.

31. The method of claims 26-30, wherein said protein source is of either vegetable and/or non-vegetable origin.

32. The method of claims 26-30, wherein said protein source is selected from the group consisting of pea protein, chickpea beans protein, soy protein, cotton seed protein, sunflower seed protein, lupin protein, oat protein, lentil protein, sesame seed protein, canola protein, broad been protein, horse bean protein, alfalfa protein, clover protein, rice protein, tapioca protein, potato protein, carob protein and corn protein

33. The method of claims 26-30, wherein said protein source is selected from the group consisting of skim milk powder, sodium caseinate, whey protein, whole milk, skim milk, condensed milk, evaporated milk, cream, whey, and other milk solids non-fat.

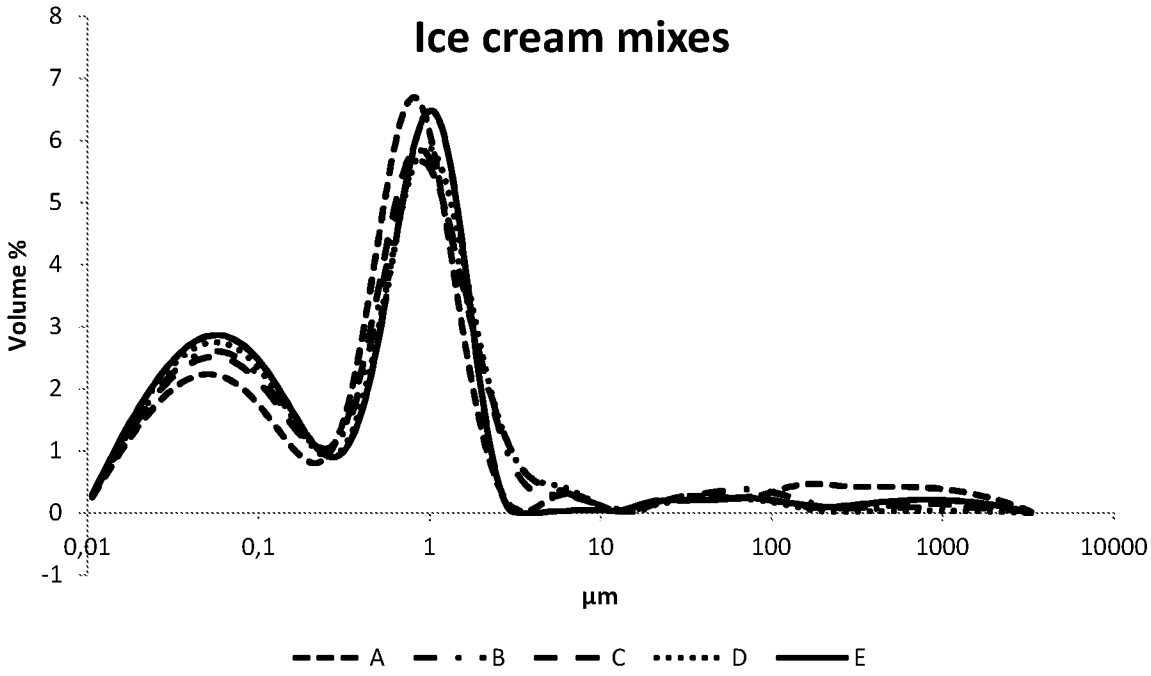
34. The method of claims 26-30, wherein the aerated food product does not comprise a protein source.

35. The method of claims 26-34, wherein said stabilizer is selected from the group consisting of guar gum, cellulose gum (CMC), locust bean gum (LBG), xanthan, carrageenan, and pectin.

36. The method of claims 26-35, wherein said sweetener is a sugar compound, such as a monosaccharide, disaccharide, polysaccharide and/or oligosaccharide.

Figure 1

A)


Ice cream mixes
Volume %
8
7
6
5
4
3
2
1
0
-1
0,01
0,1
1
10
100
1000
10000
µm
A
B
C
D
E

B)

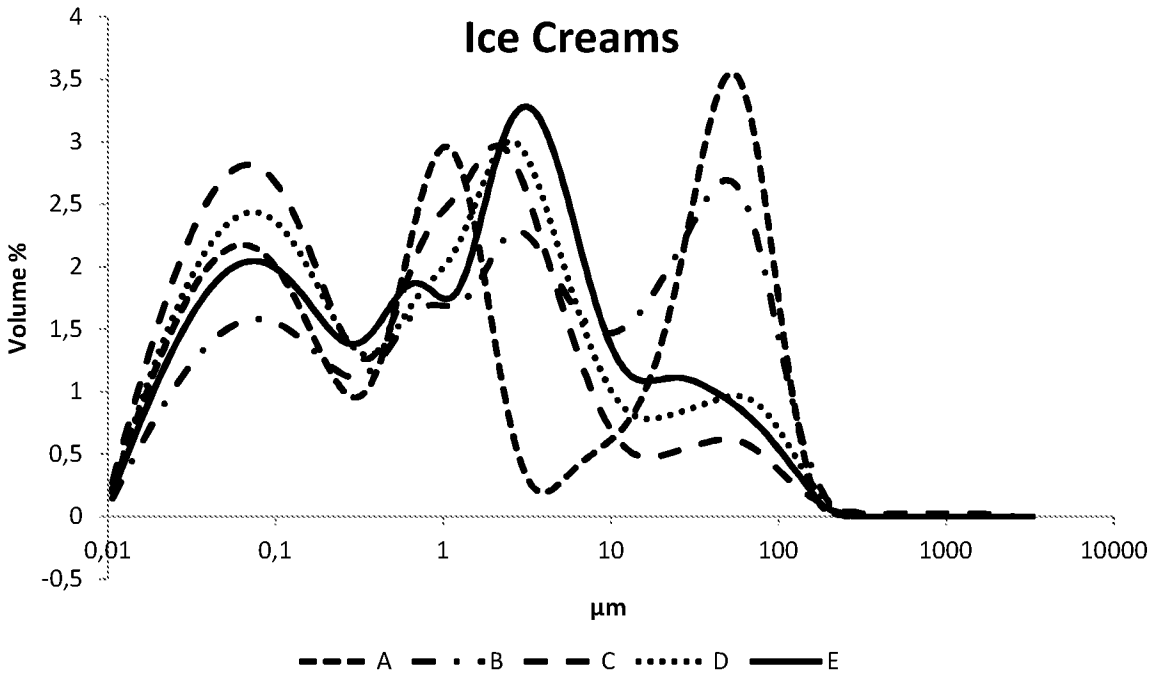

Ice Creams
Volume %
4
3,5
3
2,5
2
1,5
1
0,5
0
-0,5
0,01
0,1
1
10
100
1000
10000
µm
A
B
C
D
E

Figure 2

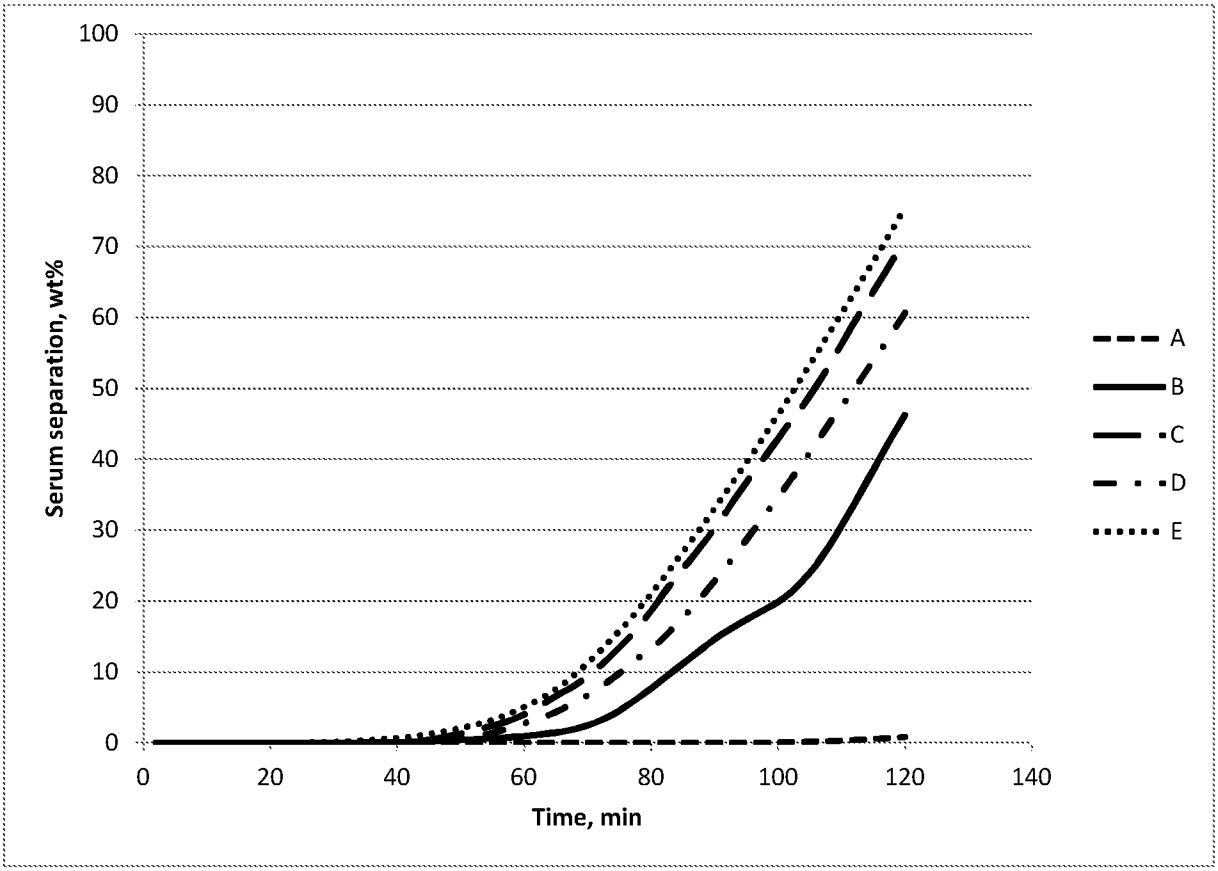
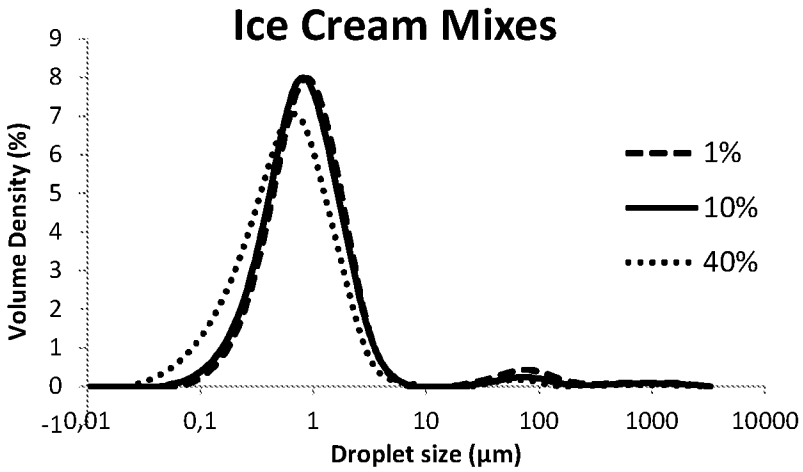

Serum separation, wt%
100
90
80
70
60
50
40
30
20
10
0
0
20
40
60
80
100
120
140
Time, min
A
B
C
D
E

Figure 3

A)


Ice Cream Mixes
Volume Density (%)
9
8
7
6
5
4
3
2
1
0
-1
0,01
0,1
1
10
100
1000
10000
Droplet size (µm)
1%
10%
40%

B)

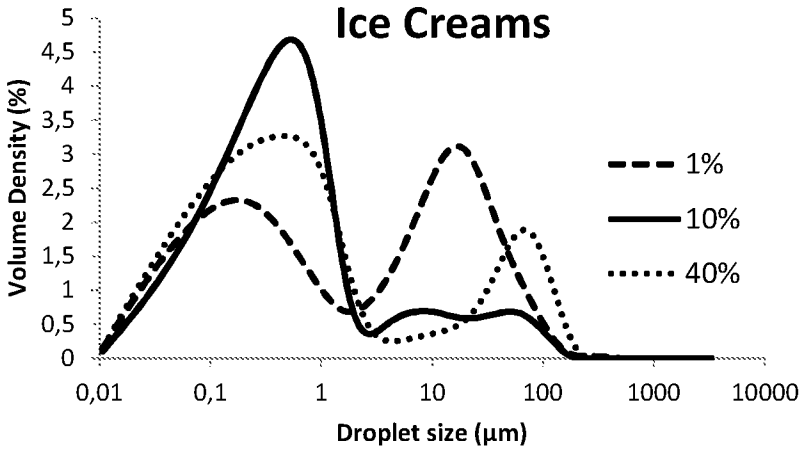
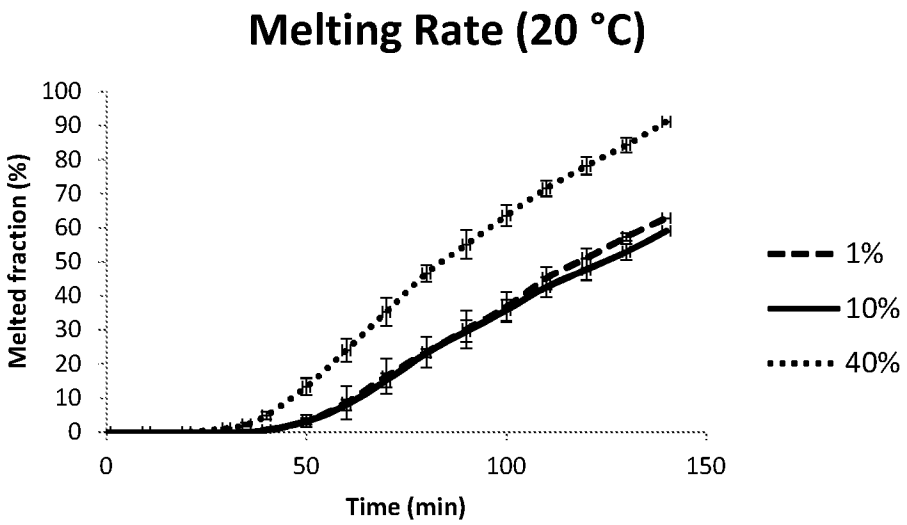

Ice Creams
Volume Density (%)
5
4,5
4
3,5
3
2,5
2
1,5
1
0,5
0
0,01
0,1
1
10
100
1000
10000
Droplet size (µm)
1%
10%
40%

Figure 4


Melting Rate (20 °C)
Melted fraction (%)
100
90
80
70
60
50
40
30
20
10
0
0
50
100
150
Time (min)
1%
10%
40%

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2019/050749

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: A23D, A23G

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

SE, DK, FI, NO classes as above

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

EPO-Internal, PAJ, WPI data, BIOSIS, CHEM ABS Data, COMPENDEX, EMBASE, INSPEC, MEDLINE, Mintel

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Zulim Botega D.C. et al. (2013): "Development of formulations and processes to incorporate wax oleogels in ice cream" Journal of Food Science vol 78, nr 12, pp C1845-C1851.; whole document; see especially abstract, materials and methods --	1-36
Y	Doan C.D. et al (2018) "Internal and external factors affecting the crystallisation, gelation and applicability of wax-based oleogels in food industry" Innovative Food Science and Engineering Technologies vol 45, pp 42-52.; whole document --	1-36

☒ 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

"D" document cited by the applicant in the international application

"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	Date of mailing of the international search report
25-09-2019	26-09-2019

Name and mailing address of the ISA/SE
Patent- och registreringsverket
Box 5055
S-102 42 STOCKHOLM
Facsimile No. + 46 8 666 02 86

Authorized officer
Elias Pershagen
Telephone No. + 46 8 782 28 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2019/050749

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Zulim Botega D.C. et al. (2013): "The potential application of rice bran wax oleogel to replace solid fat and enhance unsaturated fat content in ice cream" Journal of Food Science vol 78, nr 9, pp C1334-C1339.; materials and methods --	1-36
A	Singh, A. et al. (2017) "Advances inedible oleogel technologies - a decade in review" Food Research International, vol 97, 307-317.; whole document --	1-36
A	CN 105010575 A (HANGZHOU HENGHUA FOOD CO LTD), 4 November 2015 (2015-11-04); whole document --	1-36
A	CN 106561966 A (UNIV JIANGNAN), 19 April 2017 (2017-04-19); whole document -- --------	1-36

International application No.
PCT/SE2019/050749

Continuation of: second sheet

International Patent Classification (IPC)

A23G 9/46 (2006.01)
A23D 7/015 (2006.01)
A23G 9/32 (2006.01)

CN	105010575	A	04/11/2015	NONE
CN	106561966	A	19/04/2017	NONE