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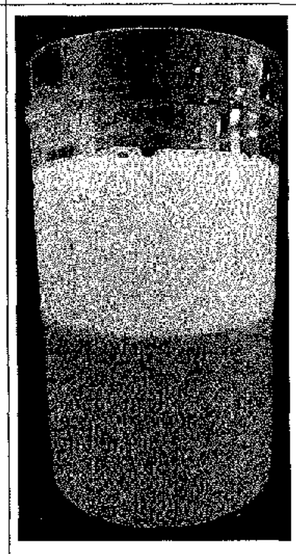
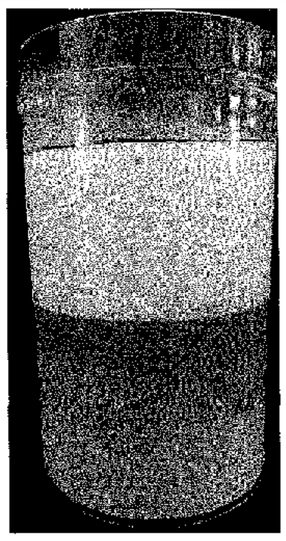
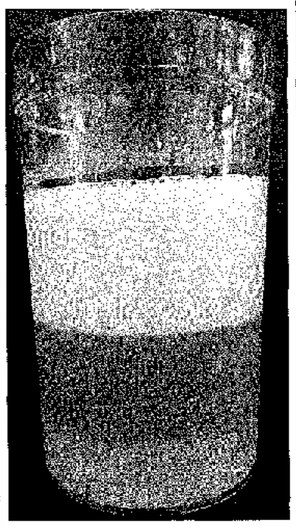
(54) Title: CYCLODEXTRINS IMPROVE FOAMING PROPERTIES IN FOOD PRODUCTS COMPRISING BARISTA MILK

Fig. 1: Characterization of layer formation of Barista-milk "low fat" of example 1 in coffee test

	Control (foamed milk with 1.5% fat in coffee test)	1.5% ACD (foamed milk with 1.5% fat and 1.5% ACD in coffee test)	3% ACD (foamed milk with 1.5% fat and 3% ACD in coffee test)
			
Evaluation of layer formation	-	+	++

(57) Abstract: The present invention relates to a food product comprising Barista milk and cyclodextrin wherein the Barista milk is selected from the group consisting of (1) liquid animal milk, (2) liquid plant milk and (3) animal or plant milk compositions in powder form comprising skim milk powder, whey protein powder, sodium caseinate, milk powder and fat powders based on dairy or plant fats, wherein it comprises less than 0.1 wt-% of thickening agent and wherein the food product in its liquid form has a fat content of at least 0.25 wt.-%, a temperature of at least 40°C and a pH value of not more than 6. Preferably, the Barista milk is used as topping for beverages like coffee and/or tea. Moreover, according to this invention, in a method of making this food product the cyclodextrin can directly be added to the Barista milk.

[Continued on next page]

WO 2021/104635 A1

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Cyclodextrins improve foaming properties in food products comprising Barista milk

The present invention relates to a food product comprising Barista milk and cyclodextrin wherein the Barista milk is selected from the group consisting of (1) liquid animal milk, (2) liquid plant milk and (3) animal or plant milk compositions in powder form comprising skim milk powder, whey protein powder, sodium caseinate, milk powder and fat powders based on dairy or plant fats, wherein it comprises less than 0.1 wt-% of thickening agent and wherein the food product in its liquid form has a fat content of at least 0.25 wt.-%, a temperature of at least 40 °C and a pH value of not more than 6. Preferably, the Barista milk is used as topping for beverages like coffee and/or tea. According to this invention, in a method of making this food product the cyclodextrin can directly be added to the Barista milk.

Cappuccino (espresso with milk foam) and latte macchiato (espresso with foamed milk and warm milk layers) are getting more and more popular for new life style products. The resulting coffee and tea-based beverages use aerated/ foamed toppings which must build up a fine and smooth foam with substantial volume and sufficient stability over time. These food products are made either fresh in food service restaurants, by the consumer at home as well as in vending machines; for nearly all types of these applications either liquids as well as powder-premixes are used. The stability against drainage, coarsening and collapsing of the foam pores is a major problem for such toppings as well as a creamy and smooth taste impression.

For ***dairy liquid systems*** milk with the requirement profile of specific foaming properties (Barista-milks) a lot of work has been realized with respect to protein content, denaturation rate of protein fractions and also the addition of protein to

the system (Norgaard *et al.* WO 2009/115090 A1) describes a specific milk protein concentration step by ultrafiltration to achieve a milk protein concentration of 3,0 to 4,8 percent. Even if these proteins act as emulsifier and surface active ingredients and therefore stabilize emulsions and foams the protein quality of Barista-milks is deeply influenced either by the raw material source (raw unprocessed milk) and their seasonal deviations (winter- versus summer milk) but also the usual heat treatment (pasteurization or UHT-treatment) leads to variable compositions. Despite this technical requirement profile (sufficient foam stability) the nutritional value and a good taste and texture profile could not always be achieved. Jin-M Jung *et al.* at NESTEC (WO 2013/087354 A1) worked on a specific protein aggregates-fibril-structure to increase foaming capacity; the main impacts come from the fibril structure which are expensive raw materials as they can only be achieved by a very specific heat treatment process (30 min to 48 h at 60°C to 120°C at pH below 2.5 and subsequent final pH-adjustment to 6-7). Beside the economic impact also the nutritional aspect (digestibility) of these fibrils is a concern and must be evaluated further in detail.

D.A. Kim (US 2007/0003681 A1) worked out that cyclodextrins improve the overrun (aeration) of oil-in-water-emulsions for whipped cream, cream cheese, mousse, yoghurt and ice cream for a specific recipe (0,5-5 % protein/ 2-6,5 % oil/ 80-97% water/ 2-15 % CD) whereat the ratio of cyclodextrin to oil (with unsaturated fatty acids) has a ratio of 0.65:1 (5:1 molar) particularly 0.9:1 (4:1) - these findings cannot be transferred to Barista-toppings as these applications are stored and consumed in a cold status (partly frozen) whereas the systems for Barista-applications has to be sufficient functional (foam stable) at high temperatures and partly acidic conditions (coffee). Therefore, there is still the demand for an easy foam optimization concept for dairy liquids (Barista-milks).

Within the ***dairy systems for Barista toppings*** there are various concepts worked out for ***powdered systems*** which have to be re-solubilized with hot water direct before consumption resp. aeration. These "dairy powder systems" have the advantage of better shelf-life (as dry ingredient) and higher flexibility in compounding with other dry ingredients but a major concern is the amount of foam (foaming capacity) as well as the foam stability.

There are various systems developed to improve the foaming properties - on the one side there are ***specific spray-drying processes*** in place to achieve a defined denaturation ratio of the whey proteins by selective heating the feed slurry (Zeller *et al.* at Kraft Foods, US 6,168,819) or to incorporate a gas within the skim milk before spray drying ("gasified skim milk" US 4,438,147) - the resulting low density foaming creamer releases its *encapsulated gas* to produce a foam when reconstituted in water. This type of "technical bound gas phase" is on the one side not sufficient to achieve a full Barista topping volume (only on a creamer level) and in addition by high heat treatment the casein fractions of the milk get more and more sensitive for acidic conditions like the pH-value of hot coffee - which leads to an unpleasant "curdling" of denaturated casein fractions in the final beverage.

Various processing optimization took place to optimize either the right whey protein - casein ratio as well as the best rate of denaturation (EP 0 885 566 Nestle/ US 6,168,819 Kraft/ US 6,129,943 Kraft/ EP 0 813 815 Kraft) - all these formulations have still the disadvantage of high production control (additional processing step) and costs.

As alternative to increase the gas volume and therefore the foaming capacity the powder premix-systems were developed with "gasified carbohydrates" - B.L. Zeller at Kraft Foods Holding (EP 1 064 850 B1) developed 2005 a fractionated "gasification"

only of the carbohydrate fraction of a creamer to achieve a more sensitive heat treatment for the protein fractions. A technical disadvantage is the exact adjustment of the various dry ingredients with respect to the powder density to avoid particle size separation within storage and transport of the final creamer compositions - which is a main aspect within the application in vending equipments.

Alternative to encapsulated gas phase within the spray-drying the incorporation of chemically bound gas phase - mainly in the form of carbon dioxide carrier some formulations with "***chemically leavened***" creamer/ toppings have been developed; B.L. Zeller at Kraft Foods Holding developed (US 5,721,003 A/ WO 1996/008153 A1) different systems with Alkali bicarbonate and leavening acids like Glucono-delta-lacton to set free carbon dioxid by solubilization in water and reaction of bicarbonate with acid. Main disadvantage of that chemically leavened creamer topping is the stability of the foam and the taste of final beverage: in case of insufficient acidification of the carbon dioxide carrier or inhomogenous distribution within the powder the resulting beverage shows an alkaline soapy taste impact. Beside this disadvantage of the final beverages also the shelf life of the powder premix is limited - due to pre-reaction of the CO_2-carrier in the presence of humidity the final foaming capacity in the beverage is limited.

Beside the dairy based Barista toppings more and more **plant based alternative**s are required due to increased demand in vegan food intake. Traditionally such plant- based milk alternatives have their origin in Asia where legumes are part of the protein intake in the food basket.

In the meantime, the market for "dairy alternative milks" is also driven by milk allergy (allergenic proteins), lactose intolerance, absence of saturated fats and prevalence of hypercholesterolemia. Based on the raw material there are legume

based products (soy, pea, chickpea, lupin), cereal based (oat, rice, quinoa) and oil seeds or nut based (almond, nut, sesame, coconut).

These types of plant raw materials have totally different ingredient compositions and therefore other processing steps to produce "milk alternatives" are used.

Starting with a partly de-fatting step and an optional roasting step (in the case of almond, sesame and nuts) the raw material will be soaked, milled with water (colloid mill) and optionally separated from solids (decanter - filter centrifuge); in the case for cereal based milks intermediate enzymatic processes (f.e. alpha-amylase treatment of beta-Glucanases for oats) will be in between before final heat treatment (pasteurization or UHT-treatment), homogenization and packaging.

Main problems within the milk alternatives are either the grossy smell/ taste of soybean fraction; controlling the sterol fraction (Campesterol and stigmasterol) can be controlled by specific process (JP 2010-13395). For the production of oat milk L. Lindahl et al. 1997 (US 5,686,123) developed also a selective production process with alpha-amylase to get a milk-alternative with similar viscosity like cow milk. Also C.R. Mitchell et al 1988 (US 4,744,992) used an enzymatic treatment (Glucosidase and Beta-Amylase) for saccharifying the polysaccharide fraction for rice milk production to achieve a suitable viscosity. Nevertheless, the main focus was the production stability of pure milk - a further application of these products for aeration/ foaming could not be achieved.

J. Berger et. al 1997 (US 5,656,321) developed a production process for almond milk with grinding in water phase, UHT-treatment, homogenization during cooling and packaging to achieve a smooth mouthfeel without any sandy character - unfortunately the final product has limited foaming functionality and the usage for Barista-type toppings is not sufficient.

S. McCready 2011 worked on an alternative production process

(US 2011/0064862 A1) based on water and almond butter together with hydrocolloids (Gellan gum, guar gum, locust bean gum and Xanthan); also for this process final foaming properties of the almond resp. nut milk is not sufficient for Barista-toppings. A major concern for these plant based milks are seasonal deviations of raw materials (similar like dairy based but with higher deviations) and the "problem" of instability of foaming properties over storage time.

Object of the invention is to make available a food product with improved foaming properties even when used together with a hot and more acidic beverage like coffee. It should be cheap and make the manufacturing process more effective by saving costs, speeding it up and/or simplifying it.

This object is solved by this invention which discloses a food product comprising Barista milk and cyclodextrin wherein the Barista milk is selected from the group consisting of (1) liquid animal milk, (2) liquid plant milk and (3) animal or plant milk compositions in powder form comprising skim milk powder, whey protein powder, sodium caseinate, milk powder and fat powders based on dairy or plant fats, wherein it comprises less than 0.1 wt.-% thickening agent and wherein the food product in its liquid form has a fat content of at least 0.25 wt.-%, a temperature of at least 40 °C and a pH value of not more than 6.

The term *Barista milk* means either a liquid animal or plant milk that directly is foamable or a liquid animal or plant milk which has been produced by reconstitution of a milk powder in water and then is foamable.
This means that the food product of the invention comprising Barista milk in liquid form or as powder and cyclodextrin, itself can be in liquid or in powder form. Accordingly, the term

in its liquid form means that the food product directly is liquid or it has to be reconstituted from powder in water to give a liquid. According to the invention, the food product in its liquid form has a fat content of at least 0.25 wt.-%, a temperature of at least 40 °C and a pH value below 6.

Dairy powder systems for the reconstitution of Barista-milks are widely used and can be categorized according to their protein and fat content as well as fat type. Various ingredients, like skim milk powder, Na-caseinate, whey proteins, emulsifiers, stabilizers (phosphates and/or citrates), vegetable hardened fats as well as dairy fat are part of the spray-dried powder premixes.

The term *liquid* designates a substance or composition that contains at least 80 wt.-% of water.
The water content of the liquid preferably is at least 85 wt.-%, most preferably 90 wt.-%.

Preferably, the plant milk used in this invention is selected from the group consisting of dairy alternative milk products like soy milk, almond milk, oat milk, rice milk and pea milk in their liquid or powder form. Even more preferred the milk is an almond based milk alternative.

Plant milks can be produced based on partly de-fatted seed by milling with colloid mill and final adjustment of dry matter content with water. A combination of stabilizers like Gellan, locust bean gum, guar gum and/or carrageenan is added together with alpha cyclodextrin (ACD) before heat treatment (pasteurization/UHT-treatment) and homogenization.

Preferably, the animal milk used in this invention is selected from the group consisting of milk provided from cattle, water buffalo, goat, sheep, camel, donkey, horse, reindeer and yak in

their liquid or powder form. Even more preferred the milk is cow milk in its liquid or powder form, most preferably cow milk in its liquid form.

The ingredients of typical dairy liquid Barista-milk is given in table 1, the ingredients of typical Barista-milk powders after reconstitution with the amount of water listed in table 2 is given in table 2.

Table 1: Typical dairy liquid Barista-milk

Ingredients	Type A: low fat milk	Type B: full fat milk
Proteins	3,0 - 3,2 %	3,1 - 3,3 %
Carbohydrates (Lactose)	4,8 - 5,0 %	4,7 - 4,9 %
Fat	1,4 - 1,6 %	3,4 - 3,6 %
Whey proteins	0,4 - 0,6 %	0,4 - 0,6 %
caseins	2,5 - 2,7 %	2,6 - 2,8 %

Table 2: Typical Barista-milk reconstituted from dairy powder

Powder-type	Category I "low fat"	Category II "medium fat"	Category III "high fat"
Typical ingredients	Skimmed milk powder, hardened plant fat, carbohydrates, emulsifiers, stabilizers	Skimmed milk powder, hardened plant fat, carbohydrates, emulsifiers, stabilizers	Skimmed milk powders, whey proteins, Sodium caseinates, hardened plant fat, carbohydrates,

			emulsifiers, stabilizers
Protein content	>18 %	>11 %	<3 %
carbohydrates	>70 %	>55 %	35 - 50 %
fat	<0,5 %	20-25 %	30-60 %
Reconstitution rate (powder/water)	3-7 % powder 93-97 % water	3-8 % powder 92-97 % water	3-7 % powder 93-97 % water

In an especially preferred embodiment of the invention, the Barista-milk is plant milk in liquid or powder form.

In the context of this invention foaming properties means foaming capacity (FC), foam stability (FS), foam firmness (FF), foam appearance, smooth and creamy mouthfeel and layer stability and is determined either of the food product in its liquid form alone as well as in the application in form of a coffee test (see below).

The cyclodextrins can be selected from alpha, beta or gamma cyclodextrin (abbreviated as ACD, BCD and GCD). Preferably, the food product comprises alpha cyclodextrin as cyclodextrin. It is even more preferred that Cavamax® W6 (Wacker Chemie AG) is used as alpha cyclodextrin. Advantageously the food product will be cheaper when comprising ACD instead of BCD and/or GCD.

Cyclodextrins in general are available as powder and can either be added to the desired liquid or be present as part of a powdered pre-mix. Preferably, the cyclodextrin content in the food product is in the range of 0.25 wt.-% to 5 wt.-%, even more preferred in the range of 0.5 wt.-% to 3.5 wt.-% and most preferred 3 wt.-%.

Surprisingly it has been found that cyclodextrins significantly improve the foaming properties like FC, FS and FF, which increase, of food products by simple addition of the ingredients in the system. Moreover, by addition of cyclodextrins a fine pore structure and smooth, creamy consistency and mouthfeel can be achieved.

It was especially surprising and not predictable from prior art that cyclodextrins improve foam stability over time in the presence of acidic (pH < 6) hot (temperature ≥ 40 °C) media measurable in a coffee test whereby at the same time improving foam firmness and sensory profile (reduction of cooking off-taste/ increase of smooth and creamy mouthfeel). Even more surprising is that this effect can be observed over a longer period of time (meaning a storage time of several days, e.g. see examples 9 or 10).

It was surprising and not predictable from prior art that cyclodextrins improve foam stability for all types of powdered premix systems (creamer, toppings, whiteners) and that especially the foam stability FS could be achieved at low dosage rates (0,25 % to 2 %).

Foaming properties can be determined either of the food product in its liquid form alone as well as in the application in form of a coffee test. The coffee test consists of the following steps:

- First the part of the food product in its liquid form consisting of the Barista milk and cyclodextrin is foamed (named milk part).
- Then FC, FS, and FF of the foamed milk part can be measured directly as described below.

Additionally, one to several parts of the foamed milk part of the food product and one to several parts of espresso manufactured according to the supplier are put into a beaker and then FC, FS and FF can be measured as described below.

- According to this invention FC means overrun and FC of the foamed product can be determined by the ratio of the volume of the generated foam versus the volume of un-foamed (liquid) according to Barac *et al.* (Int. J. Mol. Sci. 2010, p4973-4990): $FC\ [\%] = (V_{t1} - V_{t0})/(V_{t0}*100)$

with V_{t1} = volume after foaming and

V_{t0} = volume of suspension/ liquid before foaming.

- Foam stability can be measured as the change of foam volume over a specific time period (e.g. 0-30 min) according to Barac *et al.* (Int. J. Mol. Sci. 2011, p8372-8387):

$$FS\ [\%] = V_{Ftx*}/V_{Ft1}*100$$

with t_x = a chosen period e.g. after 15 min,

V_{Ft1} = foam volume directly after foaming and

V_{Ftx} = foam volume after t_x.

- Foam firmness can be measured with a Texture Analyzer where a probe device is pushed for a defined distance in the foam and the positive peak force [g] is determined.
- Moreover, foam structure and foam phase can be evaluated by visual control of foam appearance. It is considered as more advantageous the smaller the pore structure and the sharper the layer barrier between coffee and foam phase.
- In addition, the food product in its liquid form after foaming can be evaluated according to sensory characteristics (sensory profile):

1. The cooking-off-taste is the typical smell of sterilized milk with slightly burned characteristics.
2. Mouthfeel refers to the physical sensations in the mouth caused by food or drink, as distinct from taste. It is a fundamental sensory attribute which, along with taste and smell, determines the overall flavor of a food item. Mouthfeel is also sometimes referred to as texture. The

mouthfeel is considered as more advantageous when it is smoother and creamier.

Moreover, it was especially surprising that presence of cyclodextrins in the food product also increases sensory characteristics. The cooking-off taste can be reduced, and the layer formation can be improved (measurable in a coffee test, documented in examples 1 and 2). The mouthfeel is better when cyclodextrins are present in the food product that again can be determined in a coffee test. The foamed food product has a finer pore structure resulting in a creamier appearance as shown in examples 9 and 10.

According to the invention the food product comprises less than 0.1 wt-% of thickening agent. According to the invention the thickening agent preferably is xanthan and cellulose. The cellulose e.g. can be microcristalline cellulose and/or powdered cellulose. More preferably, the thickening agent is selected from the group consisting of xanthan and microcristalline cellulose and their mixtures. This more preferred embodiment means that the food product comprises less than 0.1 wt-% xanthan and comprises less than 0.1 wt-% microcristalline cellulose.
In an especially preferred embodiment, the food product does not comprise a thickening agent. In this embodiment it is preferred that the food product does not comprise microcristalline cellulose. It is furthermore preferred that the food product does not comprise xanthan. It is especially preferred that the food product does not comprise microcristalline cellulose and xanthan. This especially preferred embodiment means that the food product does not contain xanthan and does not contain microcristalline cellulose.

It was surprising and in no way foreseeable that the smooth and creamy mouthfeel can be reached without addition of a thicken-

ing agent. Addition of thickening agent like xanthan and/or microcristalline cellulose until now was thought to be necessary to stabilize the pH value allowing a stable system. Advantageously, according to the invention it is not necessary to add a thickening agent like xanthan and/or microcristalline cellulose, thereby making more effective the manufacturing process e.g. by saving costs, speeding it up and simplifying it. In addition, it is an advantage that the requirement for products with less E-numbers (food additives to which the thickening agents belong) is fulfilled.

Preferably, the food product also comprises less than 0.1% whipped cream. It is even more preferred that the food product does not comprise whipped cream.

Surprisingly according to the invention, the smooth and creamy mouthfeel improves without adding whipped cream. Whereas on one hand it is a question of taste to leave off whipped cream on the other hand the manufacturing process would become more effective, the fewer additional substances are required.

It was surprising and in no way foreseeable that the effect of cyclodextrin in food products comprising milk on foaming is independent of the content of fat as far as the fat content is at least 0.25 wt-%. Preferably, the fat content is in the range of 0.25 wt-% to 60 wt-%, even more preferably in the range of 1.5 wt-% to 50 wt-%. Knowing the state of the art like US 2007/0003681 it is surprising that cyclodextrins significantly improve foaming properties even at a low dosage rate of 0.25 wt.-% to 3 wt.-% and especially surprising that this effect does not depend from a specific correlation ratio between cyclodextrin and fat content.

It is preferred that the Barista milk in its liquid form comprising cyclodextrin is aerated.

Barista milk *in its liquid form* means that the Barista milk directly is liquid or it has to be reconstituted from powder in water to give a liquid. The amount of water that has to be added to the Barista milk powder is given by the manufacturer of the Barista milk powder.

The Barista milk in its liquid form can be aerated (foamed) with an electrical milk frother (MF) or by steam injection with a coffee machine (CM).

Advantageously, by the invention the aeration step can easily be achieved at various steps in supply chain - either at food service restaurants as well as at consumer at home without any specific device which was not possible until now.

In another preferred embodiment the aerated Barista milk comprising cyclodextrin is used as topping

If the Barista milk in its liquid form comprising cyclodextrin is foamed it can be used as topping e.g. for hot beverages. The Barista milk in its liquid form comprising cyclodextrins can be pasteurized or UHT processed before foaming to achieve a shelf-life of up to 40 days or even longer.

Preferably, the foaming capacity of the food product in its liquid form determined by the ratio of the volume of the generated foam versus the volume of un-foamed liquid is at least 20% higher than that of an equally composed sample without the addition of cyclodextrin. The measurement of FC can be done either of the food product in its liquid form alone as well as in the application in form of a coffee test as described above.

To prove this inventive effect, in the examples, maltodextrin has been used and its effect compared to that of cyclodextrin

addition to Barista-milk. Maltodextrin like cyclodextrin consists of many carbohydrates joined together in a molecular chain that is used as a food additive. Maltodextrin is produced from vegetable starch by partial hydrolysis and is usually found as a white hygroscopic spray-dried powder. Maltodextrin is easily digestible, being absorbed as rapidly as glucose and may be either moderately sweet or almost flavorless. Therefore, maltodextrin is used as neutral substance without functional effect.

The examples show various product examples with recipe description, short processing procedure and improved foam properties in comparison to control (without addition of cyclodextrin or maltodextrin) and reference (without addition of cyclodextrin but with addition of maltodextrins). As measured e.g. in example 4 only addition of cyclodextrin to Barista-milk increased FC significantly whereas addition of maltodextrin did not show an effect on FC.

It was surprising that cyclodextrins significantly improve foaming capacity of the food product not only in its liquid form alone but also in the presence of acidic (pH < 6) hot (temperature ≥ 40 °C) media (in the application) measurable in a coffee test as described above.

pH values of the food product in its liquid form comprising espresso and the barista milk as well as cyclodextrin were measured with a pH electrode directly in three independent samples to be about 5.8 for cappuccino and about 6 for latte macchiato. The temperatures of the same samples were measured directly with a corresponding thermometer to be about 62°C and about 58 °C, respectively.

In further preferred embodiment the foam stability of the food product in its liquid form measured as the change of foam volume over 15 min is at least 25% higher than that of an equally

composed sample without the addition of cyclodextrin. The measurement of FS can be done either of the food product in its liquid form alone as well as in the application in form of a coffee test as described above.

If analyzing the same example 4, again addition of cyclodextrin to Barista-milk increased FS significantly whereas addition of maltodextrin did not show an effect on FS. Also at lower cyclodextrin dosages improvement of foaming capacity and at the same time foam stability could be observed.

It was even more surprising that cyclodextrins also significantly improve foam stability over time of the food product not only in its liquid form alone but also in the presence of acidic (pH < 6) hot (temperature ≥ 40 °C) media (in the application) measurable in a coffee test as described above.

Preferably, the foam firmness of the food product in its liquid form measured with a Texture Analyzer Stable Micro Systems is at least 25% higher than that of an equally composed sample without the addition of cyclodextrin. The measurement of FF can be done in a coffee test as described above.

FF has been determined e.g. in example 1 and was significantly higher if cyclodextrin was added.

It was especially surprising that cyclodextrins significantly improve foam firmness of the food product not only in its liquid form alone but also in the presence of acidic (pH < 6) hot (temperature ≥ 40 °C) media (in the application) measurable in a coffee test as described above.

It is, moreover, preferred that the food product comprises a preparation selected from the group consisting of coffee, herbal teas, green and black tea and cacao.

In another preferred embodiment the food product is in powder form. This means that the food product can be an instant composition comprising Barista milk and cyclodextrin.

In addition, it is preferred that the Barista milk has a fat content of not more than 5 wt.-%. It is even more preferred that the fat content is in the range of 0.5 wt.-% to 3.5 wt.-%. Plant fats can be hydrogenated vegetable fats.

A further object of the invention is a method of making the food product according to any of claims 1-11 wherein the cyclodextrin is directly added to the Barista milk. In this embodiment, the Barista milk can be in liquid or in powder form. This means that either the cyclodextrin can be added to the powder system before reconstitution or the cyclodextrin can be added to the Barista milk in its liquid form.

The invention is described in more detail below, without being limited to these examples.

Examples

Example 1:

Barista-milk was purchased under the name Weihenstephan (1,5 % fat). For this milk ingredients were calculated as given in table 3.

Table 3: Ingredients of dairy liquid Barista-milk "low fat"

Ingredients	**Type A: low fat milk**
Proteins	3.0 - 3.2 %
Carbohydrates (Lactose)	4.8 - 5.0 %
Fat	1.4 - 1.6 %
Whey proteins	0.4 - 0.6 %
caseins	2.5 - 2.7 %

Foaming

1. In a first experimental setup the Barista-milk was foamed with an electrical milk frother (abbreviated with MF; KYG Model MMF-006, 220-240V ~50/60Hz, 500 W, Dongguan Kai Yi Gou Electronic Commerce Co., Ltd) for 67 seconds while heating the product up to 63°C resulting in a foamed food product.
2. In a second experimental setup the Barista-milk was foamed by steam injection with coffee machine (abbreviated with CM; Jura J6, TYPE 740) for 24 seconds resulting in a foamed food product.

Determination of Foaming capacity (FC)

The foaming capacity (identical to overrun) of the foamed product was determined by the ratio of the volume of the generated

foam versus the volume of un-foamed (liquid) according to Barac *et al*. (Int. J. Mol. Sci. 2010, p4973-4990).

The amount of the liquid was placed in a defined plastic beaker (e.g. 300 ml) and the volume was measured (= V_{t0}). After foaming the product was placed into the same beaker and again the total product volume was evaluated (= V_{t1}). Out of these two values the foaming capacity was calculated according to the following formula:

$$\mathbf{FC\ [\%] = (V_{t1} - V_{t0})/(V_{t0}*100)}$$

V_{t1} = volume of suspension/ liquid and foam after foaming

V_{t0} = volume of suspension/ liquid before foaming

Determination of Foam stability (FS)

The foam stability was measured as the change of foam volume over a specific period (e.g. 0-30 min) according to Barac *et al*. (Int. J. Mol. Sci. 2011, p8372-8387).

For this purpose, in defined intervals (e.g. every 3 min) the foam volume (= V_F) was measured. Out of these data the foam stability after a certain period was calculated by the following formula:

$$\mathbf{FS\ [\%] = V_{Ftx*}/V_{Ft1}*100}$$

$*t_x$ = a chosen period e.g. after 15 min

V_{Ft1} = foam volume directly after foaming

V_{Ftx} = foam volume after a certain time of period

Determination of Foam firmness (FF)

The foam firmness was measured by Texture Analysis with a Texture Analyzer from Stable Micro Systems. 100 g of the foamed product was placed in a defined beaker (300 ml) and rested for defined time (30 seconds); the Stable Micro System Cream Probe device P/CR (spheric circle modul) was pushed for a defined distance (50 mm) to set an initial trigger force of 0,5 g into the foam - the foam firmness was measured as the positive peak force (g).

Coffee test

125 ml of the foamed product and 45 ml of espresso (Dallmayr Crema d'Oro) were put into a beaker. Foam stability, foam structure and foam phase (foam-coffee) were evaluated by visual control of foam appearance, pore structure and layer barrier between coffee and foam phase.

Analytical data determined after foaming of a sample of 100 g and 60-63 °C with MF and 125 g and 65-66 °C with CM of the liquid Barista-milk "low fat" described in this example are given in table 4.

Table 4: Characteristic data of dairy liquid Barista-milk "low fat" after foaming

	control	**„low fat" milk with 1.5% ACD**	**„low fat" milk with 3% ACD**
low fat milk [%]	100	98.5	97
ACD[5]	-	1.5	3
FF [g]	29.3 (100 %)	38.8 132 %)	46.0 (156 %)
FC [%][1]	177	176	173
FS [%] after 15 min[1]	65	68	67
FS [%] after 30 min[1]	59	59	60
FC [%][2]	79	85	84
FS [%] after 15 min[2]	74	72	76
sensory evaluation: detection of cooking-off-taste[3]	3	1	1
improved layer formation in coffee test[4]	-	+	++

[1] foam preparation with milk frother (MF)

foam preparation with coffee machine (CM)
sensory evaluation selective to identify presence (ranking 3) or absence (ranking 1) of cooking-off-taste
coffee test check whether improved (+), significantly improved (++) or insufficient (-), layer stability for latte macchiato, for reference see figure 1
ACD = alpha Cyclodextrin = CAVAMAX® W6 Food grade, Wacker Chemie AG

Example 2:

Barista-milk was purchased under the name Weihenstephan (3,5 % fat). For this milk ingredients were calculated as given in table 5.

Table 5: Ingredients of dairy liquid Barista-milk "high fat"

Ingredients	**Type A: high fat milk**
Proteins	3.1- 3.3 %
Carbohydrates (Lactose)	4.7 - 4.9 %
Fat	3.4 - 3.6 %
Whey proteins	0.4 - 0.6 %
caseins	2.6 - 2.8 %

Foaming, determination of FC, FS and FF as well as Coffee Test were executed as described in example 1 and data given in table 6.

Table 6: Characteristic data of dairy liquid Barista-milk "high fat" after foaming

	control	**„high fat" milk with 1.5% ACD**	**„high fat" milk with 3% ACD**

low fat milk [%]	100	98.5	97
ACD[5]	-	1.5	3
FF [g]	21.7 (100 %)	31.0 (142 %)	33.6 154 %)
FC [%][1]	182	180	177
FS [%] after 15 min[1]	64	66	62
FS [%] after 30 min[1]	56	62	56
FC [%][2]	79	79	75
FS [%] after 15 min[2]	72	71	74
sensory evaluation: detection of cooking-off-taste[3]	3	1	1
improved layer for-mation in coffee test[4]	-	+	++

[1] foam preparation with milk frother (MF)

[2] foam preparation with coffee machine (CM)

[3] sensory evaluation selective to identify presence (ranking 3) or absence (ranking 1) of cooking-off-taste

[4] coffee test check whether improved (+), significantly improved (++) or insufficient (-) layer stability for latte macchiato, for characterization see figure 2

[5] ACD = alpha Cyclodextrin = CAVAMAX® W6 Food grade, Wacker Chemie AG

Example 3:

Barista-milk powder was purchased under the name MPC85 from Meggle. This powder was supplemented with Milk protein, silica and ACD and then reconstituted in water as given in table 7. The resulting liquid milk was composed as given in table 7.

Foaming (with milk frother) and determination of FC were executed as described in example 1 and data given in table 7.

Table 7: Ingredients of dairy Barista-milk "low fat" (<0.5%) reconstituted from powder and FC determined after foaming

Ingredient	Control	Example Dairy powder "low fat" category I A	Example Dairy powder "low fat" category I B
Skimmed milk powder MPC85 (Meggle)[1]	3.40%	3.36%	3.30%
Lactose (not added separately)	0.20%	0.20%	0.19%
Milk protein[2]	0.16%	0.16%	0.16%
Silica (E551)[3]	0.04%	0.04%	0.04%
ACD[4]	0%	1.4%	2.8%
Water	96.2%	94.8%	93.5%
FC [%]	84 (100 %)	105 (125 %)	163 (194 %)

[1] Skim milk powder MPC 85 - Meggle (fat content 1 %/ protein content 81 %/ Lactose 5.5 %)

[2] Milk protein Sodium caseinate Emulac NA - Meggle (fat content 0,8 %/ protein content 91 %/ Lactose < 0,1 %)

[3] Silica HDK - Wacker Chemie AG

[4] ACD = alpha Cyclodextrin = CAVAMAX® W6 Food grade, Wacker Chemie AG

Example 4:

Grubon Topping 60 was purchased from Uelzena EG. This powder was supplemented with Maltodextrin or ACD and then reconstituted in water as given in table 8.

Foaming (with milk frother) and determination of FC and FS were executed as described in example 1 and data given in table 8.

Table 8: Ingredients of dairy Barista-milk "medium fat" (20-25%) reconstituted in water from dairy powder (DP) and FC and FS determined after foaming

Ingredient	**Control**	**Example DP II 1A**	**Example DP II 1B**	**Example DP II 1C**	**Example DP II 1D, reference**	**Example DP II 1E, reference**
Grubon Topping 60[1]	3.8%	3.8%	3.8%	3.7%	3.8%	3.8%
ACD[2]	0%	0.5%	1.4%	2.8%	0%	0%
Maltodextrin (Glucidex IT 12, Roquette)	0%	0%	0%	0%	0.5%	1.4%
Water	96%	95.7%	94.8%	93.5%	95.7%	94.8%
FC [%]	63 (100 %)	87 (138 %)	105 (166 %)	121 (192 %)	58 (92 %)	71 112 %)
FS [%] (a 3 min)	27	64	55	66	24	31

[1] Grubon Topping 60 - Uelzena EG (ingredients: glucose syrup, skimmed-milk powder (32%), fully hydrogenated coconut fat, lactose, milk protein, stabilizers: potassium phosphate (E 340), anti-caking agent: calcium phosphate (E 341), emulsifier: citric acid esters of mono- and diglycerides of fatty acids (E 472c), mono- and diglycerides of fatty acids (E

471), colour: carotine (E 160a)/ fat content: 23,4 %; protein content 11,9 %; carbohydrates 57,1%)

[2] ACD = alpha Cyclodextrin = CAVAMAX® W6 Food grade, Wacker Chemie AG

Example 5:

Foamer M35 was purchased from Meggle. This powder was supplemented with ACD and then reconstituted in water as given in table 9.

Foaming (with coffee machine) and determination of FC and FS were executed as described in example 1 and data given in table 9.

Table 9: Ingredients of dairy Barista-milk "medium fat" (20-25%) reconstituted in water from dairy powder (DP) and FC and FS determined after foaming

Ingredient	**Control**	**Example DP II 2A**
Foamer M35 (Meggle)[1]	3.8%	3.8%
ACD[2]	0%	1.4%
Water	96.2%	94.8%
FS [%] (after 15 min.)	32	67

[1] Foamer M35 – spray-dried Capucchino foamer – Meggle (Ingredients: glucose syrup, skimmed-milk powder, fully hydrogenated coconut fat, milk protein, stabilizer: dipotassium phosphate (E 340ii)/ fat content 23 %; protein content 14 %; carbohydrates 56 %)

[2] ACD = alpha Cyclodextrin = CAVAMAX® W6 Food grade, Wacker Chemie AG

Example 6

Grubon Creamer Topping was purchased from Uelzena EG. This powder was supplemented with Maltodextrin or ACD and then reconstituted in water as given in table 10.

Foaming (with milk frother or coffee machine as listed in the table) and determination of FC and FS were executed as described in example 1 and data given in table 10.

Evaluation of Half-life-time (HLT):

The half-life-time (in minutes) can be determined based on the foam stability data: The half-life-time indicates the moment at which the original foam amount has been reduced to the half of the original volume.

Table 10: Ingredients of dairy Barista-milk "high fat" reconstituted in water from dairy powder (DP) and FC and FS determined after foaming

Ingredient	**Control**	**Example DP III 1A**	**Example DP III 1B**	**Example DP III 1C, reference**
Grubon Creamer Topping (Uelzena EG)[1]	3.8%	3.8%	3.8%	3.8%
ACD[2]	0%	0.5%	1.0%	0%
Maltodextrin (Glucidex IT 12, Roquette)	0%	0%	0%	1.0%

Water	96.2%	95.7%	95.2%	95.2%
FC [%][3]	62 (100 %)	82 (132 %)	81 (131 %)	72 (116 %)
FC [%][4]	161	159	168	182
FS [%] (after 3 min)[5]	4	51	54	4
HLT [min][6]	1.4	5.0	>15	1.4

[1] Grubon creamer topping powder based on hydrogenated plant fat - Uelzena EG (ingredients: fully hydrogenated coconut fat, glucose syrup, stabilizers: polyphosphate (E 452), potassium phosphate (E 340), milk protein, emulsifier: sodium stearoyl-2-lactylate (E 481), anti-caking agent: silica (E 551); fat content 49,7 %; protein content 4,3 %; carbohydrates 39,2 %)

[2] ACD = alpha Cyclodextrin = CAVAMAX® W6 Food grade, Wacker Chemie AG

[3] Foaming capacity FC for foams made of re-constituted milk aerated with coffee machine

[4] Foaming capacity FC for foams made of re-constituted milk aerated with milk frother

[5] Foam stability FS for foams made of re-constituted milk aerated with milk frother

[6] HLT = half life time

Example 7

ICS Creamy topping was purchased from Pelican rouge Coffee roasters B.V. This powder was supplemented with Maltodextrin or ACD and then reconstituted in water as given in table 11.

Foaming (with milk frother) and determination of FC and FS were executed as described in example 1 and data given in table 11.

Table 11: Ingredients of dairy Barista-milk "high fat" (30-60%) reconstituted in water from dairy powder (DP) and FC and FS determined after foaming

Ingredient	**Control**	**Example DP III 2A**	**Example DP III 2B, reference**
ICS Creamy Topping (Pelican Rouge Coffee Roasters B.V.)[1]	3.8%	3.8%	3.8%
ACD[2]	0%	1.4%	0%
Maltodextrin (Glucidex IT 12, Roquette)	0%	0%	1,4%
Water	96.2%	94.8%	94.8%
FC [%]	73 (100 %)	122 (167 %)	114 (156 %)
FS [%] (after 6 min)	0	56	0

[1] ICS Creamy topping - Pelican rouge Coffee roasters B.V. (ingredients: fully hydrogenated coconut fat, glucose syrup, lactose, whey permeate, milk protein, stabilizers: polyphosphate (E 452), potassium phosphate (E 340), emulsifier: sodium stearoyl-2-lactylate (E 481), anti-caking agent: silica (E 551)/ fat content 29,8 %; protein content 2,8 %; carbohydrates 60,9 %)

[2] ACD = alpha Cyclodextrin = CAVAMAX® W6 Food grade, Wacker Chemie AG

Example 8

Megglite 35-08 was purchased from Meggle. This powder was supplemented with ACD and then reconstituted in water as given in table 12.

Foaming (with coffee machine) and determination of FC and FS were executed as described in example 1, determination of HLT executed as described in example 6 and data given in table 12.

Table 12: Ingredients of dairy Barista-milk "high fat" reconstituted in water from dairy powder (DP) and FC and FS determined after foaming

Ingredient	**Control**	**Example DP III 3A**
Megglite 35-08 (Meggle) 1)	3.8%	3.8%
ACD[2]	0%	1.4%
Water	96.2%	94.8%
FC [%]	73	64
FS [%] (after 15 min)	29	69
HLT[3] [min]	9	>15

[1] Megglite 35-08 spray-dried coffee whitener powder based on hydrogenated vegetable fat - Meggle (ingredients: glucose syrup, fully hydrogenated coconut fat, milk protein, stabilizier: potassium phosphate (E 340), emulsifier: mono- and diglycerides of fatty acids (E 471), polysorbate 80 (E 433), anti-caking agent: silica (E 551), colour: carotin (E 160a); fat content 36 %; protein content 2,3 %; carbohydrates 58 %)

[2] ACD = alpha Cyclodextrin = CAVAMAX® W6 Food grade, Wacker Chemie AG

[3] HLT = half life time

Example 9

Almonds of the brand name Gut&Günstig were purchased from EDEKA (for details see footnote[1]) and milled in Thermomix with tap water. After filtration stabilizer blend and ACD were added as listed in table 13. The resulting solution was homogenized with Silverson LSM at 8000 rpm for 10 min, pasteurized at 70°C for 5 min (as known by the skilled person), filled into packaging and stored in refrigerator.

Foaming (with milk frother) and determination of FC were executed as described in example 1 and data given in table 13.

Table 13: Components of plant-based Barista-milk alternative with 2.5% almonds and characterization

Ingredient	**Control**	**Almond milk Example A**	**Almond milk Example B**
Almonds[1]	2.5%	2.49%	2.47%
Stabilizer/Thickener[2]	0.03%	0.03%	0.03%
ACD[3]	0%	0.5%	1.0%
Water	97.5%	97.0%	96.5%
FC [%]	43 (100 %)	142 (330 %)	152 (353 %)
FC [%] after 2 days	7 (16 %)	151 (351 %)	144 (334 %)
Sensory / Appearance		foam with finer pore structure and creamier appearance	

[1] almonds: bleached almonds de-skinned (fat content 54,1 %; protein content 18,7 %; carbohydrates 3,7 %)

[2] Stabilizers: Gellan A2 (Danisco); Carrageenan CL 110 (Danisco); Locust bean gum Vidogum L150/300 (Unipektin), Guar Gum 200 (DuPont)

[3] ACD = alpha Cyclodextrin = CAVAMAX® W6 Food grade, Wacker Chemie AG

Example 10

Almonds of the brand name Gut&Günstig were purchased from EDEKA (for details see footnote[1]) and milled in Thermomix with tap water. After filtration stabilizer blend and ACD were added as listed in table 14. The resulting solution was homogenized with Silverson LSM at 8000 rpm for 10 min, pasteurized at 70°C for 5 min (for reference see above), filled into packaging and stored in refrigerator.

Foaming (with milk frother) and determination of FC were executed as described in example 1 and data given in table 14.

Table 14: Components of plant-based Barista-milk alternative with 2.9% almonds and characterization

Ingredient	**Control**	**Almond milk - high almond content Example A**
Almonds[1]	2.90%	2.87%
Stabilizer/Thickener[2]	0.03%	0.03%
ACD[3]	0%	1.0%
Water	97.1%	96.1%
FC [%]	86 (100 %)	150 (174 %)
FC [%] after 2 days	14 (16 %)	142 (165 %)

Sensory / Appearance		foam with tremendous improved fine pore structure and cream-ier appearance

[1] almonds: bleached almonds de-skinned (fat content 54,1 %; protein content 18,7 %; carbohydrates 3,7 %)

[2] Stabilizers: Gellan A2 (Danisco); Carrageenan CL 110 (Danisco); Locust bean gum Vidogum L150/300 (Unipektin), Guar Gum 200 (DuPont)

[3] ACD = alpha Cyclodextrin = CAVAMAX® W6 Food grade, Wacker Chemie AG

What is claimed is:

1. A food product comprising Barista milk and cyclodextrin wherein the Barista milk is selected from the group consisting of (1) liquid animal milk, (2) liquid plant milk and (3) animal or plant milk compositions in powder form comprising skim milk powder, whey protein powder, sodium caseinate, milk powder and fat powders based on dairy or plant fats,
wherein it comprises less than 0.1 wt-% thickening agent and wherein the food product in its liquid form has a fat content of at least 0.25 wt.-%, a temperature of at least 40 °C and a pH value below 6.

2. The food product according to claim 1 wherein the thickening agent is selected from the group consisting of xanthan and microcristalline cellulose and their mixtures.

3. The food product according to any of claims 1 or 2 wherein the Barista milk in its liquid form comprising cyclodextrin is aerated.

4. The food product according to claim 3 wherein the Barista milk is used as topping.

5. The food product according to any of claims 1 to 4 wherein alpha cyclodextrin is used as cyclodextrin.

6. The food product according to any of claims 1 to 5 wherein the content of cyclodextrin is in the range of 0.25 wt.-% to 5 wt.-%.

7. The food product according to any of claims 1 to 6 wherein the foaming capacity of the food product in its liquid form determined by the ratio of the volume of the generated foam

versus the volume of un-foamed liquid is at least 20% higher than that of an equally composed sample without the addition of cyclodextrin.

8. The food product according to any of claims 1 to 7 wherein the foam stability of the food product in its liquid form measured as the change of foam volume over 15 min is at least 25% higher than that of an equally composed sample without the addition of cyclodextrin.

9. The food product according to any of claims 1 to 8 wherein the foam firmness of the food product in its liquid form measured with a Texture Analyzer Stable Micro Systems is at least 25% higher than that of an equally composed sample without the addition of cyclodextrin.

10. The food product according to any of claims 1 to 9 wherein it comprises a preparation selected from the group consisting of coffee, herbal teas, green and black tea and cacao.

11. The food product according to any of claims 1 to 10 wherein it is in powder form.

12. The food product according to any of claims 1 to 11 wherein the Barista milk is animal milk or plant milk and has a fat content of not more than 5 wt.-%.

13. A method of making the food product according to any of claims 1-12 wherein the cyclodextrin is directly added to the Barista milk.

Fig. 1: Characterization of layer formation of Barista-milk "low fat" of example 1 in coffee test

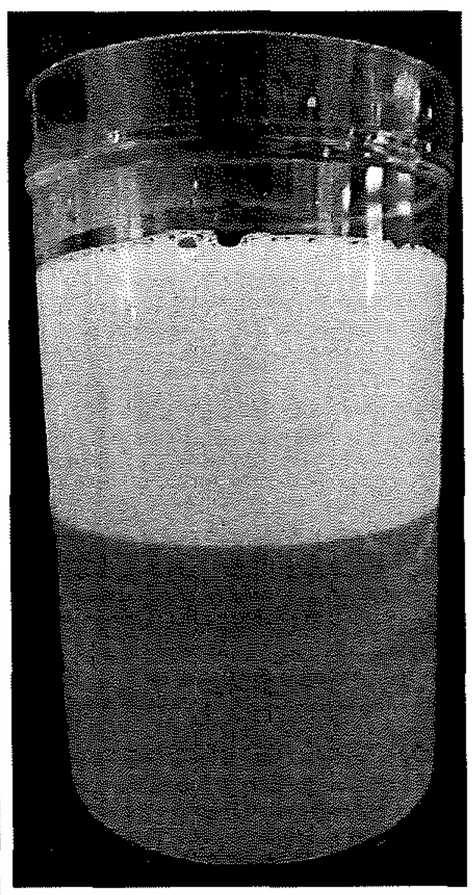
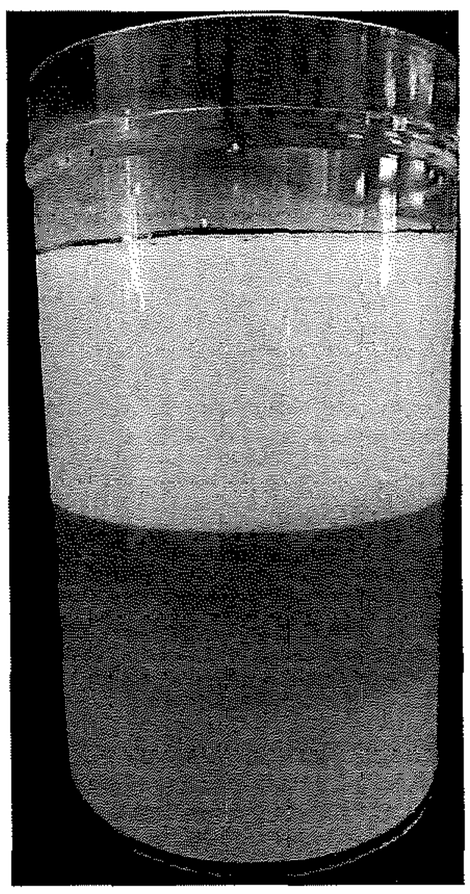
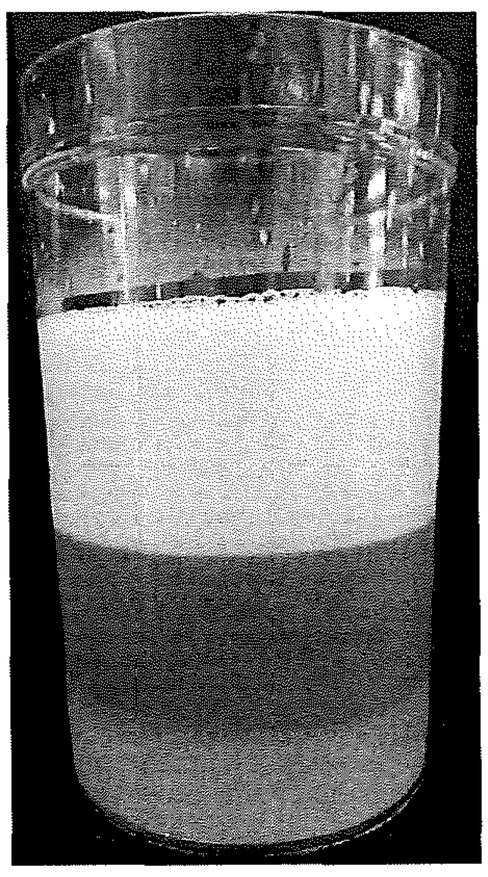
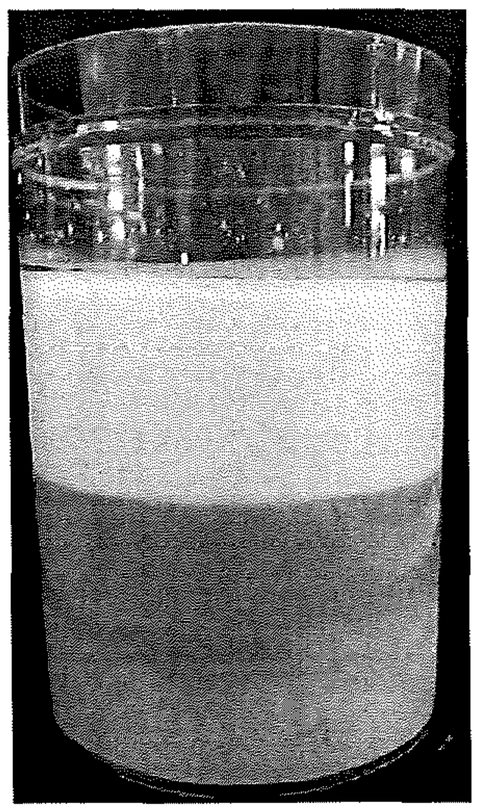
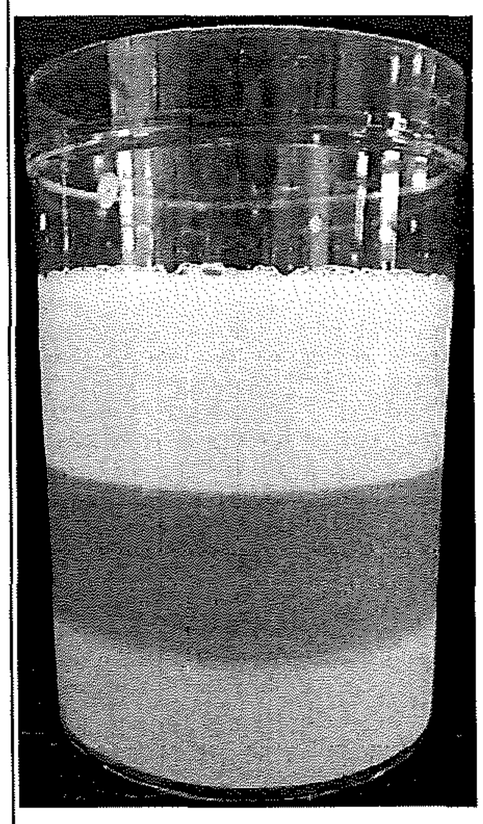
	Control (foamed milk with 1.5% fat in coffee test)	**1.5% ACD** (foamed milk with 1.5% fat and 1.5% ACD in coffee test)	**3% ACD** (foamed milk with 1.5% fat and 3% ACD in coffee test)
			
Evaluation of layer formation	-	+	++

Fig. 2: Characterization of layer formation of Barista-milk "high fat" of example 2 in coffee test

	Control (foamed milk with 3.5% fat in coffee test)	**1.5% ACD** (foamed milk with 3.5% fat and 1.5% ACD in coffee test)	**3% ACD** (foamed milk with 3.5% fat and 3% ACD in coffee test)
			
Evaluation of layer formation	-	+	++

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/082971

A. CLASSIFICATION OF SUBJECT MATTER
INV. A23C9/152 A23C9/154 A23C11/02 A23F5/40 A23C11/10
ADD.

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)
A23C A23F

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, BIOSIS, EMBASE, FSTA, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 109 645 126 A (BRIGHT DAIRY & FOOD CO LTD) 19 April 2019 (2019-04-19) page 1, paragraph 6 page 2, paragraph 13 page 6, paragraph 108 -----	1-13
X	US 2007/003681 A1 (KIM DENNIS A [US]) 4 January 2007 (2007-01-04) paragraphs [0019], [0039] - [0040] -----	1-13
X	JP 2015 047117 A (INA FOOD IND CO LTD) 16 March 2015 (2015-03-16) paragraphs [0034] - [0039]; examples 1-10 -----	1-13
X	US 2008/069924 A1 (ZELLER BARY LYN [US] ET AL) 20 March 2008 (2008-03-20) example 9 -----	1-13

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
14 May 2020	28/05/2020

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1

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/082971

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 109 662 147 A (BRIGHT DAIRY & FOOD CO LTD) 23 April 2019 (2019-04-23) example 2 -----	1-13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2019/082971

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