

DESCRIPTION

TITLE: BUTTER SHEET AND METHOD FOR ITS MANUFACTURE

The invention relates to the dairy industry and relates to the production of a butter sheet with a high content of butane-2,3-dione.

5 The butter is obtained from milk cream by churning, a mechanical operation involving vigorous agitation during which the cream fat is separated from the buttermilk and recovered in the form of agglomerated grains that are kneaded, optionally after being washed with water, to obtain a smooth texture. In Europe, the term «butter» refers to butter containing at least 82% milk fat, no more than 16%
10 water, and no more than 2% non-fat dry matter (essentially lactose, casein, and mineral salts) from cow's milk, the percentages being expressed by weight relative to the weight of the butter. This definition is established under Regulation (EC) No. 1234/2007, which more broadly governs yellow spreadable fats. In some countries, such as the United States, regulations (USDA, United States Department of
15 Agriculture) stipulate that butter must contain at least 80% milk fat.

Nonetheless, depending on the origin of the milk, in particular the animal's diet, the season in which the milk is collected, the cream used (for example, raw milk cream or pasteurized milk cream, low-fat cream, more or less matured cream), and also depending on the treatments applied to the butter, such as fractional
20 crystallization or salting, there are different types of butter, which do not all meet the same criteria.

The butter sheet, or tourage butter, or butter sheet for making pastry, or laminating butter, or roll-in butter, or dry butter, is a butter with a high fat content and low water content, giving it plasticizing properties that standard butter does not
25 possess. For these reasons, it's the butter used by pastry chefs to make puff pastry, where it is present in varying contents depending on the puff pastry product, whether raw or cooked, sweet or savory.

The technique for manufacturing puff pastry comprises preparing a dough based primarily on flour and water, the dough, then the lamination method, which
30 involves incorporating the butter in strips into the dough, without mixing them, to create a structure of alternating layers of dough and butter. This structure is then folded several times during a so-called rolling/sheeting method, then laminated to reduce the thickness to a few millimeters. To obtain a well-leavened and aerated puff pastry after baking, the choice of butter is crucial, it must remain in continuous and
35 homogeneous layers, and must not mix with the dough.

Thus, the butter sheet obtained by the fractionation method intended for this use is generally a butter with a fat content of at least 84% and a higher saturated fatty acid content than traditional butter to have a melting point of at least 30°C, and

up to 40°C. It is also advantageously obtained from cream that has undergone maturation through heat treatment, known as physical maturation, and/or through fermentation with the addition of lactic acid bacteria, known as biological maturation. During this/these maturation step(s), the cream will develop aromas and organoleptic and rheological qualities that will be found in the resulting butter sheet (in French: *beurre de tourage*).

The butter remains a highly regulated product, and during its manufacture, beta-carotene is the only permitted additive. Flavored butters have been available for several years, but these are primarily intended for direct consumption and cannot, either legally or technically, be used as butter sheet. For this reason, it is difficult to improve the flavor qualities of butter sheet, and even if they can be improved, they must withstand the conditions of puff pastry preparation in order to be present in the puff pastry product.

In the article by M. Kashaninejad et al., *International Journal of Dairy Technology*, vol. 70, No. 1 (2017), the authors studied the influence of several parameters in a butter manufacturing method comprising the following steps:

- milk pasteurization (78°C for 30 s) using a plate heat exchanger,
- skimming the pasteurized milk by centrifugation at 40°C to recover the milk cream,
- standardization of the cream to 40% fat content,
- pasteurization of the cream (88°C for 90 s),
- immediate cooling to 6°C,
- maturation of the pasteurized cream (18°C for 3 h),
- cooling and holding at 6°C,
- churning the matured cream to obtain butter grains,
- separation of the butter and buttermilk and washing the butter grains at 8°C,
- kneading the butter grains in the churn at low speed (15 min) then faster (1 min) to obtain the butter, and
- storage at 5°C for one week.

After one week, the butter is kept for 4 hours at different temperatures (5, 7, 10, 13, and 15°C) and then extruded under different conditions (shear rate: 500-1750 s⁻¹). After 15 days of storage at different temperatures (5, 7, 10, 13, and 15°C), analyses are performed.

This study demonstrates the effect of the above parameters on the butter's acidity index, color, and rheological properties, but without suggesting any specificity for the production of a butter sheet.

According to the invention, a method for the continuous manufacturing of butter sheet has been developed, which, thanks to the implemented steps, makes it

possible to obtain a butter that has retained the diacetyl content of the original matured cream.

The diacetyl, or butane-2,3-dione, or butanedione, the flavoring of butter, is a byproduct of cream fermentation, which is used as a food ingredient to impart a buttery flavor to a food or enhance the buttery flavor of a food.

Thanks to the cold-processed method of the invention, the diacetyl content in the butter sheet is higher than that of conventional butter sheet, without any exogenous addition of diacetyl. This presence amplifies the perception of the buttery flavor, which is fully present in the puff pastry product made from said butter.

By «exogenous addition of diacetyl», is meant the addition of diacetyl as an ingredient, as opposed to diacetyl, which results solely from the biological maturation of the cream, or endogenous diacetyl.

Furthermore, it has been discovered that the butter sheet thus produced has improved plasticizing properties compared to known butter sheet, facilitating the roll-in / sheeting method and making it possible to obtain a dough with superior flakiness.

Thus, the invention provides a butter sheet with a high content of butane-2,3-dione, meeting the following characteristics:

it has a content of butane-2,3-dione (or diacetyl) originating solely from the biological maturation of the cream, which ranges from 0.5 ppm to 3 ppm, preferably from 0.8 ppm to 3 ppm, better still from 1 ppm to 3 ppm, and

it has a ductility such that, in a 3-point bending test performed on a sample of said butter, said butter having been kept for 15 days at 4°C and said sample itself having been kept for 24 hours at 4°C and having a dimension of 17 cm in length by 2 cm in width and 1.8 cm in height, by the application of a compression cylinder with a diameter of 10 mm and a length of 93 mm, with a 5 kg 5 g load cell at a rate of 2 mm/s between 2 fixed points 5 cm apart over a distance of 30 mm, no complete fracture is visually detectable.

As mentioned above, diacetyl is an ingredient that could be added to enhance the flavor of the butter and that of the puff pastry product made from this butter. However, according to a preferred embodiment of the invention, the butter sheet does not contain exogenous butane-2,3-dione, i.e., any butter that does not result from the biological maturation of the cream. Under these conditions, this butter sheet can meet the characteristics of a PDO (Protected Designation of Origin) butter as defined in the Decree of November 5, 2020, relating to the amendment of the specifications of the protected designation of origin «Beurre de Charentes-Poitou»/«Beurre des Charentes»/«Beurre des Deux-Sèvres».

Advantageously, a butter of the invention also meets the following properties: fat content of at least 82% (w/w),

water content of at most 16% (w/w), and
 protein fraction content of at most 2% (w/w),
 the percentages being given relative to the butter.

And even better, it further meets at least one, or even both of the following
 5 characteristics:

density of at least 0.95, and
 strength of at least 8 N at 8°C after 15 days at 4°C.

In a preferred form, the solids are in the form of an organized crystalline
 network, comprising few or no nodular crystals. Indeed, these can be an obstacle to
 10 achieving good dough during the manufacture of puff pastry. Thus, preferably, a
 butter of the invention is free of nodular crystals.

The invention also concerns a method for manufacturing a butter sheet from
 cow's milk, said method comprising the following steps:

15 pasteurization of the milk,
 skimming of pasteurized milk to recover the milk cream,
 pasteurization of the cream,
 maturation of the pasteurized cream comprising at least one biological
 maturation,
 churning of the matured cream to obtain butter grains,
 20 kneading of the butter grains to obtain butter,
 said method implementing the following steps following the kneading,
 at least one cycle, preferably at least two cycles, of butter treatment, identical
 or different, the cycle(s) comprising a step of mechanical shearing of said butter for
 500 s⁻¹ to 3000 s⁻¹; and cooling of the butter by at least 12°C with kinetics ranging
 25 from -7.0°C/min to -45°C/min; and
 a crystallization of the butter thus sheared and cooled.

The mechanical shearing of the above butter at 500 s⁻¹ to 3000 s⁻¹ (also called
 shear rate) provides it with an energy content comprised between 14 kJ/kg and 42
 kJ/kg.

30 According to the invention, the aforementioned steps are carried out under the
 following conditions, considered alone and preferably in combination.

The cooling cycle(s) of the sheared butter is preferably carried out using a
 scraped surface heat exchanger.

According to one variant, the butter is cooled to at least 12°C with kinetics
 35 ranging from -7.0°C/min to -40°C/min.

The crystallization of the sheared and cooled butter is carried out by a resting
 time of at least 5 minutes, preferably 5-15 minutes, and more preferably 9-13

minutes, at a temperature of 5-16°C. It is advantageously carried out in a resting tube.

A method of the invention can optimize the quality of the butter sheet produced by biologically maturing pasteurized cream before the churning by adding lactic ferments and maintaining it at a temperature of 7-21°C for 16-48 hours. These are known mesophilic aromatic and acidifying culture ferments. Ideally, the biological maturation is carried out until the pH of the pasteurized cream reaches a value of 6.2 to 5.6, preferably 5.8 to 5.6.

In an even more advantageous implementation, the biological maturation of the cream is supplemented by physical maturation. It may comprise one or more heat treatment cycles, identical or different, each including a temperature increase to a value of 6-21°C; holding at this temperature for 10-30 minutes; and a temperature decrease to a value of 21-4°C.

The method of the invention may further involve a washing, generally with water, the butter grains resulting from churning the cream.

The method of the invention and its advantages are illustrated in the examples below.

Example 1: Production of a butter sheet according to the invention

A cow's milk from a PDO region is pasteurized and then skimmed at 75°C for 20 seconds. The cream resulting from this skimming is pasteurized at 92°C in a plate heat exchanger for 10 seconds and then cooled to 9°C, preferably 8°C.

It then undergoes physical maturation in a double-jacketed tank. To this end, the cream is heated to 18°C with a hot water loop at 55°C for 15 minutes, to a value comprised between 6 and 21°C for 10 to 30 minutes, then cooled to 14.5°C with an iced water loop between 1°C and 2°C, to a value comprised between 21°C and the inoculation temperature around 12-15°C. The used ferments are Flora Danica mesophilic ferments (acidifying and flavoring) from NOVONESIS for biological maturation. This is followed by an acidification step of the cream as well as an aromatic development during which diacetyl is produced. When the pH reaches 6.0, the cream is then cooled to between 6 and 4°C. The resulting pH is then 5.8 to 5.6.

Once the cream has cooled, the churning can begin. The churning is carried out on a butyrator with a flow rate of 2000 L/h. The cream is heated by a plate exchanger to a temperature comprised between 8.5 °C and 10.5 °C. Once the phase inversion has been carried out, the grains obtained are kneaded in a first body at a speed of 21 revolutions/minute then kneaded in a second body at a speed of 25 revolutions/minute. The obtained butter has a fat content of 82% (w/w) and a

humidity of less than 16% (w/w) and a non-fat content of 1.6% (w/w) and a density of 0.95.

At the outlet of the butyrator, the butter, which is at a temperature of 12-14°C, is stored in a silo for a maximum of 2 hours. The butter is drawn from this silo at 15-16°C and then transferred to a high-shear mixer (SPX BMX type, 0.6 L, 100 mm long, 90 mm diameter). The shear rate between the static axis and the upper rotating axis is 1265 s⁻¹.

Then the butter is cooled by a scraped-surface heat exchanger (SPX-0.049 m², 0.3 L, 271 mm long, 11 mm annular space) at a speed of 750 revolutions/minute and a temperature of 14°C. It is cooled again by a scraped-surface heat exchanger at a speed of 500 revolutions/minute and a temperature of 9°C.

The butter is then sheared again at a speed of at least 50 revolutions/minute with a shear force of 1575 s⁻¹. It is finally cooled by another scraped-surface heat exchanger at a speed of 250 revolutions/minute and a temperature of 6°C.

The butter crystallizes in a resting tube for 11 minutes.

The summer butter thus obtained has no nodules, its strength is 8 N at 8°C after 15 days at 4°C (measured using a TAXT), and its diacetyl content is 1.4 ppm.

The butter strength is tested by penetration on a texturometer (TA.XT plus C from Stable Micro Systems) equipped with Exponent connect software, a 5 kg load cell and a 4 mm diameter stainless steel cylindrical spindle. Measurements are taken directly after removal from the refrigerator, on a sample stored for 15 days at 4 °C, the average of the maximum forces recorded by the device is used. The spindle penetrates the sample at 2 mm/sec up to 10 mm (i.e. 50% of the total height of the sample).

When this butter is subjected to stress, it exhibits such ductility that, in a 3-point bending test carried out on a sample of said butter, said butter having been kept for 15 days at 4°C and said sample having been kept for 24 hours at 9°C and having dimensions of 17 cm in length by 2 cm in width and 1.8 cm in height, by applying a compression cylinder with a diameter of 10 mm and a length of 93 mm, with a 5 kg load cell at a rate of 2 mm/s between two fixed points 5 cm apart over a distance of 30 mm, no total rupture is visually detectable.

Example 2: Comparison of the properties between a butter sheet of the invention and a butter outside the invention.

As previously explained, the manufacturing method of the invention involves at least one butter treatment cycle, comprising a step of mechanical shearing of said butter for 500 s⁻¹ to 3000 s⁻¹ and cooling of the butter by at least 12°C with kinetics ranging from -7.0°C/min to 45°C/min. To highlight the unexpected benefit of this step,

the properties of a produced butter sheet according to the invention and a butter sheet produced by a method differing from the method of the invention only in that it does not include such a treatment cycle (referred to as non-textured butter) are compared.

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Comparison of thermal profiles as illustrated in the Figure

The thermal profile of the butter according to the invention (in gray) differs from that of the untextured butter (in black) not only by a decrease in the temperature of its mid-melting peak (22.55°C vs. 23.70°C), but also by its enthalpy of fusion (-79.16 J/g vs. -74.71 J/g).

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The shearing + rapid cooling cycle according to the invention induces a different crystallization of the milk fat compared to that obtained during «conventional» production stopping at the kneading stage. This crystallization directs the production of mid-melting crystals, which will allow the firmness and plasticity characteristics expected for butters sheet to be obtained.

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Comparison of firmness, plasticity, and diacetyl content

The results are presented in the following table.

Properties	Butter of the invention	Butter outside the invention
Firmness (at 8°C)	8 N	3.66 N
Plasticity (10.5°C)	3 cm	1.03 cm
Diacetyl content	1.6 mg/kg	1.57 mg/kg

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The results highlight a much higher firmness and plasticity for the butter of the invention, as well as a diacetyl content at least equal to that of the butter outside the invention, showing preservation of the aroma.

CLAIMS

1. A method for continuously manufacturing a butter sheet from cow's milk, said method comprising the following steps:

pasteurization of the milk,

skimming the pasteurized milk to recover the cream,

pasteurization of the cream,

maturation of the pasteurized cream comprising at least one biological maturation,

churning of the matured cream to obtain butter grains,

kneading of the butter grains to obtain the butter,

said method being characterized in that it further comprises

at least one cycle, preferably at least two cycles, of butter treatment, which may be identical or different, the cycle(s) comprising a step of mechanical shearing of said butter for 500 s^{-1} to 3000 s^{-1} and cooling of the butter by at least 12°C with kinetics ranging from $-7.0^{\circ}\text{C}/\text{min}$ to $-45^{\circ}\text{C}/\text{min}$; and

a crystallization of the butter thus sheared and cooled.

2. The method according to claim 1, characterized in that the cooling of the sheared butter is carried out by means of a scraped surface heat exchanger.

3. The method according to claim 1 or 2, characterized in that the crystallization of the sheared and cooled butter is carried out by a resting time of at least 5 minutes, preferably 5-15 minutes, and more preferably 9-13 minutes, at a temperature of $5\text{-}16^{\circ}\text{C}$.

4. The method according to any one of claims 1 to 3, characterized in that the crystallization of the sheared and cooled butter is carried out in a resting tube.

5. The method according to any one of claims 1 to 4, characterized in that said biological maturation of the pasteurized cream is carried out by the addition of lactic ferments and holding at a temperature of $7\text{-}21^{\circ}\text{C}$ for 16-48 hours.

6. The method according to claim 5, characterized in that the biological maturation of the pasteurized cream is carried out until its pH reaches a value of 5.8-5.6.

7. The method according to any one of claims 1 to 6, characterized in that the maturation of the pasteurized cream further comprises a physical maturation.

8. The method according to claim 7, characterized in that the physical maturation comprises one or more cycles of heat treatments, identical or different, each comprising a temperature increase to a value of $6\text{-}21^{\circ}\text{C}$; holding at this temperature for 10-30 min; and a temperature decrease to a value of $21\text{-}4^{\circ}\text{C}$.

9. A butter sheet, with a high butane-2,3-dione content, obtainable by the method according to any one of claims 1 to 8, said butter sheet

having a content of butane-2,3-dione (or diacetyl) originating only from the biological maturation of the cream, which ranges from 0.5 ppm to 3 ppm, preferably from 0.8 ppm to 3 ppm, better still from 1 ppm to 3 ppm, and

5 having a ductility such that, in a 3-point bending test carried out on a sample of said butter, said butter having been kept for 15 days at 4°C and said sample having itself been kept for 24 hours at 9°C and having a dimension of 17 cm in length by 2 cm in width and 1.8 cm in height, by the application of a compression cylinder with a diameter of 10 mm and a length of 93 mm, with a 5 kg load cell at a rate of 2 mm/s between two fixed points 5 cm apart over a distance of 30 mm, no total rupture is
10 visually detectable.

10. The butter according to claim 9, characterized in that it does not contain butane-2,3-dione that does not originate from the biological maturation of the cream.

11. The butter according to claim 9 or 10, characterized in that it further meets the following properties:

15 fat content of at least 82% (w/w),
water content of at most 16% (w/w),
protein fraction content of at most 2% (w/w),
density of at least 0.95, and
strength of at least 8 N at 8°C after 15 days at 4°C
20 the percentages being given relative to butter.

12. The butter according to any one of claims 9 to 11, characterized in that it comes from milk from late summer or early autumn.

13. The butter according to any one of claims 9 to 12, characterized in that it is free from nodular crystals.

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