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 disclosure, 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.

In one aspect, the present disclosure refers to 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°C/min to -45°C/min; and

a crystallization of the butter thus sheared and cooled.

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 disclosure, 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.

In another aspect, the present disclosure refers to a butter sheet, with a high butane-2,3-dione content, obtainable by the method as defined above, 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

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 visually detectable.

Thus, the disclosure 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 example of the disclosure, 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 disclosure 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 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 achieving good dough during the manufacture of puff pastry. Thus, preferably, a butter of the disclosure is free of nodular crystals.

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

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,

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 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.

According to the disclosure, 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 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 disclosure 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 disclosure may further involve a washing, generally with water, the butter grains resulting from churning the cream.

The method of the disclosure 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