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(54) Title: LIQUEFACTION OF CHEESE

(57) Abstract: The invention relates to the processing of cheese, and in particular to a method of liquefying cheese to produce a low viscosity product with enhanced handling properties. The invention also relates to various cheese products prepared from such liquefied cheese, those products retaining varietal characteristics of the cheese subjected to liquefaction, as well as exhibiting useful storage longevity.

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LIQUEFACTION OF CHEESE

Field of the Invention

The invention relates to the processing of cheese, and in particular to a method of
5 liquefying cheese to produce a low viscosity product with enhanced handling properties.
The invention also relates to various cheese products prepared from such liquefied cheese,
those products retaining varietal characteristics of the cheese subjected to liquefaction, as
well as exhibiting useful storage longevity.

10 Background of the Invention

In the early 20th century, J.L.Kraft recognised that there was a disparity between the most
cost-effective way of producing Cheddar (in large wheels and such) and the most cost-
effective way of selling that cheese to a consumer (in smaller blocks). Traditionally it was
a matter of slicing a portion of cheese off from the larger wheel. The practical
15 disadvantages of this process (which accelerated spoilage) were felt hardest in applications
such as the preparation of ration packs for the Armed Forces.

It has since been shown that there are methods available that enable cheese to be processed
into such shapes as slices. The methods of processing cheese usually include the
20 incorporation of artificial additives into the cheese mass. There is little doubt that the
modern consumer shuns the incorporation of materials of an unnatural nature into their
consumed foodstuffs. This modern conception appears to be at odds with the obvious
health benefits associated with the consumption of cheese and the convenience that
processed cheese products provide. Modern health-conscious consumers demand a higher
25 level of quality than ever, and seek to consume foods that are free from additives that are
deemed to be 'artificial'. Furthermore, the efficiency of modern high throughput
processing and packaging machinery is facilitated by products that remain substantially
fluid for longer periods to be pumped, poured and so on. There is clearly a need for
developing a cheese product free of artificial additives, and a process for manufacture of
30 same, that possesses the varietal flavour of its parent product, has enhanced handling
properties and resists spoilage.

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Summary of the Invention

The present invention is predicated, in part, on the discovery that the incorporation of one or more emulsifying salts (such as citrate, tartrate and phosph(on)ate salts) is not necessary to process cheese to a desired level of sterilisation, viscosity and taste if careful attention is
5 given to the conditions under which the cheese is heated. Given the judicious choice of heating regime and incorporation of moisture, the methods of the present invention are capable of forming a liquefied hot cheese mass. Thus, in several aspects, the invention provides methods of liquefying cheese, and the products of said methods.

10 The liquefied hot cheese mass has a relatively much lower viscosity, and remains so for longer periods at diminished temperature, than previously discovered or envisaged, and possesses enhanced handling properties (such as pumpability). The hot cheese mass may be subjected to further processing steps including: cooling to near room temperature to produce a substantially liquid cheese product (such as a spreadable gel); separately,
15 sequentially or simultaneously cooling the cheese mass to near room temperature and evaporating a substantial proportion of water therefrom to afford a solid cheese product (such as a baked cheese biscuit); and finely dividing the mass with subsequent evaporation of a substantial proportion of water therefrom to afford a solid cheese product (such as a cheese powder).

20 Accordingly, in one aspect the invention provides a method for liquefying cheese comprising raising the temperature of the cheese in the presence of water to greater than 82 °C under conditions which allow the water to be incorporated into the cheese without syneresis to provide liquefied cheese in a substantially homogenous state, without the use
25 of additional emulsifying agents.

As used herein, the term 'liquefying' refers to the transformation of a 'substantially solid' material into a 'substantially liquid' material. In particular, a 'substantially solid' material exhibits the properties of a solid on a macroscopic level. On a macroscopic level, a solid
30 does not readily flow. It is understood that in composite materials (such as cheese) there may be components that have different melting points and heat capacities. In this respect,

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cheese is made up predominantly of water, fat and protein (predominantly casein). It is known that, at room temperature, certain fats present within a cheese mass may be substantially more liquid in character than the protein therein. Nonetheless, the term 'substantially solid' is understood to encompass such composite materials wherein certain components may be considered in isolation to be liquid but, as a whole, the composite material displays the properties of a solid. Likewise, a 'substantially liquid' material exhibits the properties of a liquid on a macroscopic level. On a macroscopic level, a liquid readily flows. The term 'substantially liquid' may be construed to encompass those composite materials wherein certain components may be considered in isolation to be solid or gaseous but, as a whole, the composite material displays the properties of a liquid. It is understood that the viscosity of a material typically varies as a function of temperature, materials typically becoming less viscous as their temperature increases. It is also known that a change in density of a material often makes a significant contribution to the decrease in viscosity observed in the material as it is heated. As used herein, an example of a 'liquefying' process is a macroscopic phase transition of a substantially solid material to a substantially liquid material, observable through a decrease in viscosity under conditions of constant volume or constant pressure.

As used herein, the term 'syneresis' refers to the draining of less viscous components of the cheese mass from the more viscous components therein. Typically 'syneresis' refers to the separation within a cheese mass of a substantial proportion of the water and/or fat from the protein. Syneresis is often observed when the water or fats pool together.

As used herein, the term 'homogenous' refers to a property of a material wherein the components therein are uniformly distributed throughout. Examples of substantially homogenous materials are homogenised milk and blocks of Cheddar cheese.

As used herein, the term 'additional' refers to any quantity of one or more 'emulsifying agents' not naturally found in the particular cheese variety that is the subject of the method.

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In another aspect, the invention provides a method for liquefying cheese comprising

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raising the temperature of the cheese and water under conditions which allow the water to be incorporated into the cheese without syneresis to provide liquefied cheese in a substantially homogenous state and having a viscosity at the raised temperature of less than 1500 mPa.s, without the use of additional emulsifying agents.

5

Detailed Description of Preferred Embodiments of the Invention

The methods of the present invention are suitable for application to most cheese varieties. Cheeses are often distinguished through variations in the origin of the milk, the process of manufacture and/or the conditions of maturation. Especially suited to the present
10 invention are cheeses of the acid or rennet varieties. Preferably, cheese varieties suitable for use in the present invention include Cottage, Cream, Colby, Gouda as well as both young and mature Cheddar varieties. Through the optional application of specific procedures prior to heating, the methods of the present invention may be applied to many other varieties of cheese.

15

It is understood that different cheeses often contain different amounts of water. Whilst a large number of cheeses are relatively dry to touch (for example mature Cheddar cheese), other cheeses contain a relatively large amount of water, a portion of which may not be incorporated within the cheese solids (for example Cottage cheese). The source of this
20 unincorporated portion of water may be residual whey. In this respect, the methods of the present invention provide for the incorporation of water into cheese that has otherwise not been previously incorporated into the cheese prior to performing the methods. For example, Cottage cheese of itself may be subjected to the methods of the invention without the addition of water from another source. The resultant product is typically a stable,
25 spreadable cheese product.

The methods of the present invention are not limited to their application to only one cheese variety at a time. It may, in fact, be desirable to use cheese mixtures or blends in certain circumstances. The blending of cheese mixtures or varieties may preferably occur prior to
30 subjecting the mixture to the methods of the present invention, but it may also occur during any one of the methods of the present invention and it may occur after any one of

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the methods of the present invention. In one example, Cheddar cheese may be combined with a more mature product of the same variety. In another example Cheddar cheese may be combined with Colby cheese. The blending of cheese mixtures or varieties may be accomplished by maceration before the mixture is subjected to any one of the methods of the present invention. In another example, the source of water used in the methods of the invention may be a cheese, preferably a watery cheese with a high residual whey content. In such an example, the cheese which is the source of water and another cheese which is to be liquefied are contacted and the mixture is heated according to a method of the invention. In another example, two hot liquid cheese masses derived from different varieties may be combined after subjecting each cheese mass to a different heating regime. In a still further example of the versatility of the present invention, blends of two or more cheese masses obtained from the application of two or more different methods of the present invention may be blended together and subjected to any further one or more steps.

15 Preferably, the process of raising the temperature of the cheese in the presence of water also involves mixing the cheese and water. More preferably, the two entities are thoroughly mixed. Mixing may be enhanced through the fine division of the cheese using a milling, macerating or grinding process. In one embodiment, the cheese and water are brought into contact in a vessel with simultaneous thorough mixing using an impeller.

20 Preferably the impeller can rotate at a variable speed, wherein the speed is adjusted so as to control the amount of heat generated due to the friction of the impeller blade with the cheese mass. Preferably the amount of heat generated due to friction is minimised during the early stages of mixing. Preferably the cheese and water are mixed under conditions such that the water is incorporated completely into the cheese mass. The incorporation of

25 the water into the cheese mass prior to heating may or may not be stable. In another embodiment of the methods of the present invention, water in the form of steam may be introduced during the process of raising the temperature. The steam may, or may not, comprise the entirety of the water, in the presence of which the cheese is heated. It is understood that applying steam directly to cheese at room temperature often leads to syneresis. Accordingly, when steam is applied directly to the cheese it is preferable that

30 the cheese has been conditioned to accept the water and heat from the steam without

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syneresis. In some embodiments, this result may be achieved by carefully heating the cheese to 60 °C prior to the steam being injected. Without wishing to be bound by theory it is believed that heating cheese under conditions that promote syneresis leads to the irreversible shrinkage of the casein portion of the cheese and expulsion of water therefrom.

5 On the other hand, the methods of the present invention promotes expansion of the casein portion of the cheese and inclusion of water therein. It is believed that the inclusion of water facilitates the production of a fine emulsion of the components of the cheese which is retained upon cooling.

10 As used herein, the process of 'contacting' involves the bringing into close physical proximity of two or more discrete entities. In particular, as used herein, the process of 'contacting' involves the bringing into close proximity of two or more discrete entities for a time, and under conditions, sufficient to allow a portion of those two or more discrete entities to interact on a molecular level.

15

The inclusion of variable quantities of water in the methods of the present invention alters the composition of the final product. The source of water may be pure water, a solution (for example a sugary solution) or may be a watery cheese. An example of a watery cheese is a rennet cheese with a relatively high whey content, such as Cottage cheese. One

20 reason for raising the temperature of the cheese in the presence of water in the present invention is to aid in heat absorption and/or decrease the viscosity of the hot and/or cooled product. Water may also be added during the process in order to break up the cheese mass. The amount of water that may be added may depend on one or more factors.

Examples of such factors are the variety of cheese, amount of cheese and the temperature

25 that the cheese mass is to be heated to. Other examples of such factors are the desired final hot viscosity, the desired final cold viscosity where appropriate and/or the nature of any evaporating step or process that may take place. In preferred embodiments, the methods of the present invention use water in a ratio to cheese that is between approximately 10:1 and 1:10 by weight. Preferably, the methods of the present invention

30 use water in a ratio to cheese that is between approximately 1:1 and 1:5 by weight. Even more preferably, the methods of the present invention use water in a ratio to cheese that is

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between approximately 1:2 and 1:2.5 by weight. The methods of the present invention may also be adapted to incorporate water during the heating regime. Water provided in such a manner may be provided in liquid or gaseous (steam) form. Preferably, if steam is injected into the cheese mass, consideration is taken for the amount of water from that source that will condense into the cheese. Such consideration may result in a reduced amount of water being initially contacted with the cheese prior to heating than would otherwise be contacted were the use of steam not to be employed.

For the methods of the present invention the temperature of the cheese mass is preferably raised such that the differential in temperature between the hottest and coolest parts of the cheese mass is minimised for some portion of the method. Preferably, the differential in temperature is minimised when the temperature of the cheese mass is raised between the initial temperature and a temperature which is between about 50 °C and about 60 °C. As used herein, the term 'initial temperature' refers to the temperature of the cheese mass before the step of raising the temperature of the cheese in the presence of water. The initial temperature is preferably less than 30 °C and more preferably less than 25 °C. Preferably the temperature differential between the hottest and coolest parts of the cheese mass is no more than 5 °C. More preferably, the temperature differential is no more than 3 °C. Most preferably, the temperature differential is no more than 2 °C. Methods to determine temperature differentials would be well known to a skilled person.

There are various means by which the temperature differential may be reduced. In particular, it is understood that the cheese processor has at their disposal many techniques to ensure the efficient transfer of heat from hotter parts of the cheese mass to cooler parts of the cheese mass. One such technique is the use of a slow increase in temperature that allows conduction of heat away from the heating surface to the cooler parts of the cheese mass at a rate similar to the rate of heating of those portions of the cheese mass that are closest to the heating surface. Preferably, the temperature of the cheese in the presence of water is raised at a rate of less than 5 °C per minute, more preferably at a rate of less than 3 °C per minute and most preferably at a rate of approximately 1.5 °C per minute. The rate of increase in temperature may vary over the course of the method. Another

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technique to minimise the temperature differential is the use of a slow increase in temperature and halting the heating process at regular intervals for a period of time, thereby allowing conduction of heat away from the heating surface to the cooler parts of the cheese mass at a rate similar to the rate of heating of those portions of the cheese mass that are closest to the heating surface. In certain embodiments, the present invention utilises a heating method wherein the temperature of the heat source is increased slowly with optional periods wherein the increase in temperature of the heating surface is halted. In such embodiments the heating method incorporates periods wherein the increase in temperature of the heating surface is halted, the temperature of the heat source is preferably increased at a rate of less than 5 °C per minute for a period of less than 5 minutes, followed by halting the temperature increase for a period of less than 5 minutes. More preferably the temperature of the heat source is increased at a rate of between 2 and 3 °C (preferably 2 °C) per minute for 2.5 minutes, followed by halting the temperature increase for a period of 1 minute.

Another technique for minimising the difference in temperature between the hottest and coolest parts of the cheese mass, available to the cheese processor, is the sealing of the heating vessel to reduce heat loss through radiation, conduction or convection is another such technique to minimise the temperature differential. The sealing process may be done in such a way as to effect either complete (wherein the pressure within the vessel does change with varying temperature) or partial sealing (wherein the pressure within the vessel does not substantially change with varying temperature). Regardless of the degree of sealing of the vessel, the cheese mass may be subjected to reduced and/or increased pressure. In some embodiments regulation of the pressure allows control of the amount of water that is lost or retained from the cheese mass. In particular, the cheese mass may be subjected to reduced pressure in the form of a partial vacuum. The partial vacuum may be imparted through the action of a mechanical device or water aspirator. The direct injection of steam into the cheese mass represents another technique whereby heat can be efficiently dissipated into its cooler regions.

Completely or partially sealing the vessel may also be useful to prevent loss of cheese

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and/or water from the vessel whilst the mass is mixed.

In some embodiments of the present invention, the maximum temperature that the cheese is heated to at atmospheric pressure is between about 82 °C and about 100 °C. More preferably the maximum temperature that the cheese is heated to at atmospheric pressure is between about 85 °C and about 95 °C.

Furthermore, the methods of the present invention may also include additional steps wherein the cheese mass is subjected to one or more heating and/or cooling steps. In particular, the cheese mass may be subjected to a cooling step prior to heating the cheese mass to the highest temperature contemplated by that method. The cheese mass may be subjected to a temperature cycling regime. In particular, the cheese mass may be heated then cooled then reheated. This process may be repeated any number of times until a product of the desired consistency is obtained. In a preferred embodiment, the cheese mass is heated from an initial temperature to a temperature between 45 °C and 60 °C, more preferably between 50 °C and 55 °C, after which time the cheese mass is cooled to a temperature below 40 °C, before the cheese mass is heated to a temperature of above 82 °C. In an especially preferred embodiment, the step of raising the temperature of the cheese mass from the initial temperature to above 45 °C is conducted under such conditions as to minimise the temperature differential between the hottest and coolest parts of the cheese. The cycling of the heating regime may be particularly beneficial in the processing of cheese having a structure of greater strength possibly due to the intactness of the protein, such as young Cheddar and Colby varieties.

It is understood that the methods of the present invention are predicated in part on the non-use of 'additional emulsifying agents'. In particular, as hereinbefore described, certain salts (namely the sodium salts of citrate, tartrate and phosph(on)ate) promote the emulsification of the fat and protein within the cheese mass. It is further understood that certain cheeses, of themselves, possess small quantities of salts such as sodium citrate (*J. Dairy Sci.*, **2002**, 85, 3155-3163). The use of the expression 'without the use of additional emulsifying agents' is in no means meant to deter the nominal addressee from adding any

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conventionally known or envisaged additives that do not act as emulsifying agents. In particular, the methods of the present invention are particularly suited to the production of novel, flavoured products by the addition of certain flavouring agents to the cheese mass. Well-known herbs and spices represent examples of such additives. Other examples of such additives include selected meat products and other wholesome ingredients commonly added to natural and processed varieties. Preferably, the products of the methods of the present invention will have retained much of the varietal flavour of the 'unprocessed' ingredient. For example, Cheddar cheese processed according to the present invention will have retained much of the flavour of the unprocessed Cheddar cheese.

10

Certain varieties of cheese respond differentially to the methods of the present invention. In this respect, it has been found that the use of certain treatment regimes, prior to the application of the method to that cheese, assists in producing an optimal product. Accordingly, as used herein, the term 'pre-treatment' refers to a treatment regime prior to the heating methods substantially as hereinbefore described. Colby, Gouda and young Cheddar varieties often respond well to the heating methods if they are previously cooled to below -10 °C, before being allowed to naturally warm to between 10 °C and 25 °C. Such varieties often respond especially well to the heating methods if they are previously cooled to approximately -15 °C, before being allowed to naturally warm to approximately 18 °C. Without wishing to be limited by theory it is believed that the mechanical action of ice crystal formation upon the protein aggregate is a substantial disruptive force and in turn enables the cheese mass to subsequently absorb water more efficiently. Another method of pre-treatment involves a rapid maturation process whereby the cheese to be subjected to the method is stored at greater than 15 °C, preferably greater than approximately 20 °C, for a period of greater than one week, preferably greater than two weeks. Another method of pre-treatment involves milling the cheese in the presence of an aliquot of water, and allowing the product to absorb moisture for a period time, preferably 5 minutes or longer. This method of pre-treatment is particularly well-suited to hard cheese varieties.

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Following liquefaction, the cheese mass may be made the subject of one or more

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additional steps. In one embodiment, the methods of the present invention may include the step of cooling the free-flowing hot liquid to room temperature either with, or without, mixing. The cooled product typically takes the form of a spreadable gel. A spreadable gel is a semi-liquid product which does not fracture on division but rather may be spread on a surface, such as a paste. The spreadable gel may take the form of a material that flows or may take the form of a more viscous paste. The cooled gels of the present invention are preferably stable at room temperature (or preferably cooler) for greater than one month, more preferably for greater than twelve months. In a preferred embodiment of the present invention, the products of the methods are stable for greater than twelve months at a temperature of less than 10 °C, more preferably less than 5 °C. Upon standing, the cooled gels of the present invention preferably resist spoilage and are not prone to substantial desiccation. In fact, many of the gels produced upon cooling the products of the methods of the present invention, and following exposure to the atmosphere, develop a mildly dessicated layer on their surface due to evaporation of moisture. Without wishing to be bound by theory, it is this effect that is believed to discourage spoilage which may result from the growth of micro-organisms. When covered, dessication is very slow and the cheese product remains wholesome for a substantial period of time.

In another embodiment, the methods of the present invention may be elaborated to include the step of subjecting the mass to conditions of such temperature, pressure and humidity as to effect evaporation of a substantial proportion of the water in that liquid mass. Without wishing to be bound by theory it is believed that modifying such conditions provides control over the amount of moisture absorbed by the protein within the cheese mass. The product of such an elaborated method may take the form of a block or slice of substantially solid cheese, or taken to a further reduced level of moisture such as to form a biscuit. In another embodiment, the method of the present invention may be elaborated by incorporating the steps of finely dividing the hot liquid cheese mass before subjecting it to conditions under which evaporation of some of its moisture may occur. As used herein, the term 'finely dividing' refers to methods whereby the mass is divided into particles such as droplets. In particular, the cheese mass may be passed through a nozzle, creating such shear as to separate it into discrete droplets of pre-determined and desired size. The finely

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divided material may be subjected to conditions of such temperature, pressure and humidity as to effect evaporation of a substantial proportion of the water within that finely divided material. This evaporation may occur while the material is in a suspended state and/or following contact with a surface. In any event, the step of evaporation may, or may
5 not, follow a cooling step, whereby the hot liquid mass is cooled to a pre-determined temperature.

The method is applicable to both batch and continuous manufacturing processes. In particular, the method may be applied through the use of, for example, a cheese 'kettle'
10 comprising a jacketed container wherein the jacket is capable of circulating a heating/cooling liquid. The kettle may also incorporate into its design a port whereby steam or liquid may be injected at a predetermined time. The vessel may also allow for the contents to be readily emptied at any stage. Furthermore, application of a continuous manufacturing process to the present invention is anticipated. A vessel, such as a pipe,
15 through which the flow of a material may be regulated, represents a particularly suitable apparatus through which the methods of the present invention may be performed. In this respect, the methods of the present invention may take place according to the movement of the cheese mass through a pipe into zones of heating and cooling. Vessels consisting of one or more tubes can be constructed to circulate the cheese mass via a pump or pumps at
20 high velocity and with induced turbulent flow, to efficiently distribute the supplied heat, whilst also mixing and homogenizing the mass. Such means can make efficient use of the heat energy by being directed in a countercurrent flow arrangement. Steam injection, when applicable, can take effect in a vessel which has been designed specifically for the purpose. Such a vessel may employ an arrangement of rotating cutters through which the
25 mass is directed and aggressively mixed with steam, via nozzles, during progression through the vessel.

Viscosity is a useful measure of the products and intermediates of the methods of the present invention. In this respect, determination of the viscosity of a cheese mass can be
30 made at a 'hot' temperature and at a 'warm' temperature. It is understood that both the hot and warm viscosities of the cheese mass are, in part, dependant on the varietal nature of

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that cheese. Young Cheddar varieties, in a similar manner to Colby, Gouda and other varieties having a comparatively strong influence of intact casein, display higher hot and warm viscosities than varieties such as mature Cheddar. Manipulation of the amount of water in the final product provides a means of influencing the viscosity of the cooled
5 cheese. It is known that the viscosity of a material is intrinsically linked, amongst other factors, to the temperature and density of that material and the instrument that is used to determine that value. For the purposes of the experiments of the present invention, the respective viscosities were determined at atmospheric pressure, at the given temperature and determined using an AND sine wave 'vibro' SV-10 viscometer (A&D Mercury Pty.
10 Ltd.) having standard RS-232C connectivity and Win viscometer software. This viscometer measures 'viscosity by detecting the driving electric current necessary to resonate the two sensor plates at constant frequency of 30 Hz and amplitude of less than 1mm' (A&D Mercury Pty. Ltd.).

15 The 'hot viscosity' is preferably determined when the temperature of the cheese mass is between 75 °C and 90 °C. More preferably the viscosity is determined when the temperature of the cheese mass is between 80 °C and 85 °C. The viscosity of the cheese mass may be determined by removing a sample of the cheese from the mass and subjecting it to the apparatus of a viscometer. The hot viscosity (80 °C) of the product formed by
20 subjecting young Cheddar varieties to the methods of the present invention is preferably below 2000 mPa.s, more preferably below 1500 mPa.s and most preferably below 1200 mPa.s. The hot viscosity (83 °C) of the product formed by subjecting mature Cheddar to the methods of the present invention is preferably below 100 mPa.s, more preferably below 50 mPa.s and most preferably below 30 mPa.s. The hot viscosity (77.5 °C) of the
25 product formed by subjecting Colby to the methods of the present invention is preferably below 200 mPa.s, more preferably below 150 mPa.s and most preferably below 100 mPa.s. The viscosity of the cheese mass may also be determined using an 'in-line' viscometer, which may determine the viscosity of the cheese mass without requiring a sample to be removed.

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The 'warm viscosity' is preferably determined when the temperature of the cheese mass is

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between 35 °C and 45 °C. More preferably the warm viscosity is determined when the temperature of the cheese mass is between 39 °C and 41 °C, most preferably at about 40 °C. In general terms, there is approximately one order of magnitude increase in temperature between the hot viscosity and the warm viscosity for a given cheese variety.

- 5 In this respect, the warm viscosity (40 °C) of the product formed by subjecting young Cheddar varieties to the methods of the present invention is preferably below 13,000 mPa.s and most preferably below 12,000 mPa.s. The warm viscosity (40 °C) of the product formed by subjecting mature Cheddar to the methods of the present invention is preferably below 300 mPa.s and most preferably below 150 mPa.s. The warm viscosity
10 (40 °C) of the product formed by subjecting Colby to the methods of the present invention is preferably below 4,000 mPa.s, more preferably below 3,000 mPa.s and most preferably below 2,500 mPa.s.

- The viscosity of each product may be varied by altering the amount of water the cheese is
15 in the presence of before and during the heating method. Manipulation of the viscosity of the product may impact on the economy of reduction of the cheese solids, the application to which the final product is directed and the efficacy of production.

- In one example, mature Cheddar cheese heated under conditions which allow the water to
20 be incorporated into the cheese without syneresis to approximately 60 °C, followed by steam injection directly into the mass raising the temperature to approximately 95 °C, and having a solids content of approximately 45%, may have a hot viscosity of less than 100 mPa.s. The same product may, upon cooling to room temperature, become a gel product having a viscosity of greater than 10,000 mPa.s. In this respect the hot cheese mass is
25 particularly well-suited to be subjected efficiently and economically to a drying process.

- In another example, wherein the desired product is a spreadable gel, the properties of flavour and structure may be more important. In this respect, the incorporation of water, and heating regime, may be directed towards producing a product with a hot viscosity of
30 up to 2000 mPa.s.

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The invention will now be described with reference to the following examples which illustrate some preferred aspects of the present invention. However, it is to be understood that the particularity of the following description of the invention is not to supersede the generality of the preceding description of the invention.

5

EXAMPLES

Example 1

Cheddar cheese (1 kg, matured for 6 to 8 months) and water (400 mL), at room
10 temperature, were added to a sealed and jacketed vessel equipped with a cutter and bowl
scraper. The cutter was set to rotate at 900 rpm, mixing the cheese and water into a paste
within approximately 3 minutes. The cutter speed was increased to 1500 rpm. The
temperature of the water circulating through the jacket of the vessel was increased from
23 °C, at a rate of approximately 3 °C per minute, pausing every 5 °C for 1 minute, until a
15 temperature of 60 °C was reached. Subsequently, the warm circulating water was replaced
with water at a temperature of 20 °C, lowering the temperature of the cheese mixture to 20
°C. Subsequent heating of the circulating water increased the temperature of the cheese
mixture to 40 °C, whereupon heating was slowed to incorporate a stepwise heating regime
wherein the temperature was held steady for 1 minute every 5 °C rise, until the product
20 had attained a temperature of 95 °C.

The viscosity of the cheese upon cooling to 83 °C was 20 mPa.s. The viscosity of the
cheese upon further cooling to 40 °C was 147 mPa.s.

25 Example 2

Cheddar cheese (1 kg, matured for 6 to 8 months) and water (400 mL), at room
temperature, were added to a sealed and jacketed vessel equipped with a cutter and bowl
scraper. The cutter was set to rotate at 900 rpm, mixing the cheese and water into a paste
within approximately 3 minutes. The cutter speed was increased to 1500 rpm. The
30 temperature of the water circulating through the jacket of the vessel was increased from
23 °C, at a rate of approximately 3 °C per minute, pausing every 5 °C for 1 minute, until a

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temperature of 60 °C was reached. Subsequently, the temperature of the circulating water was continuously increased to 93 °C at a rate of approximately 3 °C per minute.

The viscosity of the cheese upon cooling to 83 °C was 20 mPa.s. The viscosity of the cheese upon further cooling to 40 °C was 147 mPa.s. When cooled to 5 °C the viscosity of the product exceeded 5000 mPa.s and remained so when warmed to a temperature of 25 °C.

Example 3

Cheddar cheese (1 kg, matured for 6 to 8 months) and water (400 mL), at room temperature, were added to a sealed and jacketed vessel equipped with a cutter and bowl scraper. The cutter was set to rotate at 900 rpm, mixing the cheese and water into a paste within approximately 3 minutes. The cutter speed was increased to 1500 rpm. The temperature of the water circulating through the jacket of the vessel was increased from 23 °C, at a rate of approximately 3 °C per minute, pausing every 5 °C for 1 minute, until a temperature of 60 °C was reached. Subsequently, the circulation of water through the jacket was halted, and steam was injected at a pressure of 0.9 bar. Within 3 minutes, the temperature of the cheese mixture had increased to 95 °C, at which time the input of steam was stopped.

The viscosity of the cheese upon cooling to 84.8 °C was 7.3 mPa.s. The viscosity of the cheese upon further cooling to 40 °C was 53.5 mPa.s. When cooled to 5 °C, the viscosity of the product exceeded 5000 mPa.s.

Example 4

Cheddar cheese (1 kg, matured for 1 to 2 months), at room temperature, was added to a sealed and jacketed vessel equipped with a cutter and bowl scraper. The cutter was set to rotate at 900 rpm, cutting the cheese into small pieces. Water (500 mL, RT) was then added to the finely divided cheese, and the two were mixed thoroughly. The cutter speed was increased to 1500 rpm. The temperature of the water circulating through the jacket of the vessel was increased from 23 °C, at a rate of approximately 3 °C per minute, pausing

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every 5 °C for 1 minute, until a temperature of 60 °C was reached. Subsequently, the warm circulating water was replaced with water at a temperature of 18 °C, lowering the temperature of the cheese mixture to 27 °C. The temperature of the water circulating through the jacket of the vessel was subsequently increased at a rate of approximately 3 °C per minute, pausing every 5 °C for 1 minute, until a temperature of 89 °C was reached. During this rise in temperature, an aliquot of water (100 mL) was added to the cheese mixture.

The viscosity of the cheese upon cooling to 77.5 °C was 90.7 mPa.s. The viscosity of the cheese upon further cooling to 40 °C was 2487 mPa.s. When cooled to 5 °C, the viscosity of the product exceeded 5000 mPa.s.

Example 5

Colby (1 kg) at room temperature, was added to a covered and jacketed vessel equipped with a cutter and bowl scraper. The cutter was set to rotate at 900 rpm, cutting the cheese into small pieces. Water (400 mL, RT) was then added to the finely divided cheese, and the two were mixed thoroughly. The cutter speed was increased in steps to 1500 rpm. The temperature of the water circulating through the jacket was increased from 23 °C, at a rate of approximately 3 °C per minute, pausing every 5 °C for 1 minute until a temperature of 52 °C was reached. The product was then allowed to cool naturally to ambient temperature (for convenience), overnight.

The gelled product was further reduced to a paste by the addition of (100 mL, RT) and under the influence of the cutter rotating at 1500 rpm, the heating regime was repeated with the exception that pauses were not made during the progression to 95 °C.

The viscosity of the cheese upon cooling to 71.5 °C was 100 mPa.s. The viscosity of the cheese upon further cooling to 40 °C was 2885 mPa.s.

Example 6

A mature and mild Cheddar blend comprising 500 g of each at a temperature of 16 °C was

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added to a covered and jacketed vessel equipped with a cutter and bowl scraper. The cutter was set to rotate at 1500 rpm and a partial vacuum drawn to enable 450 g of water to be drawn slowly into the bowl. The mixing and cutting process continued rendering the mixture into a fine paste. The temperature of the water circulating through the jacket was increased from 25 °C, at a rate of approximately 2 °C per minute to 50 °C. The product was then allowed to cool slowly to 27 °C. From 27 °C, the cutter and bowl scraper were engaged and the temperature raised by 3 °C per minute to 95 °C.

Example 7

Cottage cheese contains approximately 80% moisture. In this example, Cream cheese was heated in the presence of Cottage cheese, which was used as a source of water.

Light creamed Cottage cheese and Cream cheese blended at the ratio of 1:2 (approximately 23.8% fat) were progressively heated from ambient temperature to 95 °C at the rate of 2 °C per minute. The cutter and bowl scraper were used at a moderate setting (50%) to mix and homogenise the product.

The viscosity of the cheese upon cooling to 82 °C was 350 mPa.s. The viscosity of the cheese upon further cooling to 40 °C was 3260 mPa.s.

Example 8

Cottage cheese contains approximately 80% moisture. In this example, Cream cheese was heated in the presence of Cottage cheese, which was used as a source of water.

Light creamed Cottage cheese and Cream cheese blended at the ratio of 4:3 (approximately 16.5% fat) were progressively heated from ambient temperature to 95 °C at the rate of 2 °C per minute. The cutter and bowl scraper were used at a moderate setting (50%) to mix and homogenise the product.

The viscosity of the cheese upon cooling to 87 °C was 314 mPa.s. The viscosity of the cheese upon further cooling to 42.5 °C was 2953 mPa.s.

Example 9

Cottage cheese contains approximately 80% moisture. In this example, Cream cheese was heated in the presence of Cottage cheese, which was used as a source of water.

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Light creamed Cottage cheese and Cream cheese blended at the ratio of 4:1 (approximately 9.5% fat) were progressively heated from ambient temperature to 95 °C at the rate of 2 °C per minute. The cutter and bowl scraper were used at a moderate setting (50%) to mix and homogenise the product.

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The viscosity of the cheese upon cooling to 86 °C was 168 mPa.s. The viscosity of the cheese upon further cooling to 40 °C was 2668 mPa.s.

Example 10

15 Cottage cheese contains approximately 80% moisture. In this example, Cottage cheese itself was heated without the addition of another aliquot of water.

Light creamed Cottage cheese having a fat content of approximately 3.4% was progressively heated from ambient temperature to 95 °C at the rate of 2 °C per minute.

20 The cutter and bowl scraper were used at a moderate setting (50%) to mix and homogenise the product.

The viscosity of the cheese upon cooling to 88 °C was 21 mPa.s. The viscosity of the cheese upon further cooling to 43 °C was 285 mPa.s.

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CLAIMS:

1. A method for liquefying cheese comprising raising the temperature of the cheese in the presence of water to greater than 82 °C under conditions which allow the water to be incorporated into the cheese without syneresis to provide liquefied cheese in a substantially homogenous state, without the use of additional emulsifying agents.
2. The method according to claim 1 wherein the cheese that is liquefied comprises one or more varieties selected from acid and rennet varieties of cheese.
3. The method according to claim 1 or claim 2 wherein the cheese that is liquefied comprises one or more varieties selected from the group consisting of Cottage Cheese, Cream Cheese, Colby, Gouda, young Cheddar and mature Cheddar.
4. The method according to any one of claims 1 to 3 wherein the cheese that is liquefied is Cheddar.
5. The method according to any one of claims 1 to 4 wherein the amount of water is in a ratio of water to cheese of between approximately 10:1 and approximately 1:10 by weight.
6. The method according to claim 5 wherein the ratio of water to cheese is between approximately 1:1 and 1:5 by weight.
7. The method according to claim 5 wherein the ratio of water to cheese is between approximately 1:2 and 1:2.5 by weight.
8. The method according to any one of claims 1 to 7 wherein the cheese and water are thoroughly mixed.
9. The method according to any one of claims 1 to 8 wherein the temperature of

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cheese and water is raised at a rate such that the difference in temperature between the hottest and coolest parts of the cheese mass is no more than 5 °C.

10. The method according to any one of claims 1 to 9 wherein the temperature of
5 cheese and water is raised at a rate of less than 5 °C per minute.

11. The method according to claim 10 wherein the temperature of cheese and water is raised at a rate of less than 5 °C per minute from the initial temperature until the average temperature of the cheese and water is between 45 °C and 60 °C.

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12. The method according to any one of claims 1 to 11 wherein the temperature of cheese and water is raised at a rate of less than 5 °C per minute for less than 5 minutes, followed by a period that is less than 5 minutes wherein there is substantially no rise in average temperature of the cheese and water.

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13. The method according to claim 11 wherein the rate of temperature increase of the cheese and water between the initial temperature and 50 °C is lower than the rate of increase of the cheese and water between 60 °C and 82 °C.

20 14. The method according to any one of claims 1 to 13 wherein the temperature is raised from 60 °C to 82 °C using a direct injection of steam into the cheese and water.

15. The method according to any one of claims 1 to 14 wherein the step of raising the temperature of the cheese and water to greater than 82 °C further comprises a step wherein
25 the temperature of the cheese and water is lowered.

16. The method according to claim 15 wherein the temperature of the cheese and water is raised from an initial temperature to a temperature greater than 45 °C, before the temperature of the cheese and water is lowered to less than 40 °C, before the temperature
30 of the cheese and water is raised to greater than 82 °C.

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17. The method according to any one of claims 1 to 16 further comprising the step of
subjecting the cheese to a pre-treatment step prior to step (b).
18. The method according to claim 17 wherein the pre-treatment step comprises
5 cooling the cheese to below -10 °C, before allowing the cheese to warm to between 10 °C
and 25 °C.
19. The method according to claim 18 wherein the pre-treatment step comprises
cooling the cheese to approximately -15 °C, before allowing the cheese to warm to
10 approximately 18 °C.
20. The method according to claim 17 wherein the pre-treatment step comprises
storing the cheese at a temperature of greater than 15 °C for greater than one week.
- 15 21. A method for preparing a cheese product which is a spreadable gel comprising the
steps of:
- a) raising the temperature of the cheese in the presence of water to greater than
82 °C under conditions which allow the water to be incorporated into the
cheese without syneresis to provide liquefied cheese in a substantially
20 homogenous state; and
 - b) cooling the liquefied cheese to less than 30 °C,
without the use of additional emulsifying agents.
22. A method for producing a solid cheese product comprising the steps of:
- 25 a) raising the temperature of the cheese in the presence of water to greater than
82 °C under conditions which allow the water to be incorporated into the
cheese without syneresis to provide liquefied cheese in a substantially
homogenous state; and
 - b) removing a substantial proportion of water from the liquefied cheese,
30 without the use of additional emulsifying agents.

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23. A method according to claim 22 for producing a particulate cheese product comprising the steps of:

- 5 a) raising the temperature of the cheese in the presence of water to greater than 82 °C under conditions which allow the water to be incorporated into the cheese without syneresis to provide liquefied cheese in a substantially homogenous state;
 - b) finely dividing the liquefied cheese; and
 - 10 c) subjecting the finely divided cheese to conditions of such temperature, humidity and pressure as to remove a substantial proportion of the water from the cheese,
- without the use of additional emulsifying agents.

24. A method according to claim 22 for producing a cheese biscuit product comprising the steps of:

- 15 a) raising the temperature of the cheese in the presence of water to greater than 82 °C under conditions which allow the water to be incorporated into the cheese without syneresis to provide liquefied cheese in a substantially homogenous state; and
 - 20 b) subjecting the liquefied cheese to conditions of such temperature, humidity and pressure as to remove a substantial proportion of the water from the cheese,
- without the use of additional emulsifying agents.

25. A method for liquefying cheese comprising raising the temperature of the cheese in the presence of water under conditions which allow the water to be incorporated into the cheese without syneresis to provide liquefied cheese in a substantially homogenous state and having a viscosity at the raised temperature of less than 1500 mPa.s, without the use of additional emulsifying agents.

30 26. A method according to claim 1 or claim 25 substantially as hereinbefore described with reference to any one of the examples.

INTERNATIONAL SEARCH REPORT

 International application No.
PCT/AU2008/000512

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

A23C 19/00 (2006.01) **A23C 19/08** (2006.01) **A23C 19/086** (2006.01)

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)

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)

Databases: DWPI, JAPIO, FSTA, CAPLUS, Medline

Keywords: (IPC A23C 19/00) and (chees?, gel?, liqu?, past?, spread?, squeeze?, water, hydrat?, melt?, heat?, method?, process?, cheddar, gouda, cottage, cream, colby)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Derwent Abstract Accession No. 92-277823/34, P13 EP 499041 A1 (STEPHAN & SOEHNE GMBH & CO.) 19 August 1992 Abstract	1-8, 14, 21, 25
(X)	US 4 329 374 A (INVERNIZZI <i>et al.</i>) 11 May 1982 See entire document	1-8, 14, 17, 21, 25
X	JAPIO Online Abstract Accession No. 1992-011836 JP 04-011836 A (ULVAC JAPAN LTD) 16 January 1992 Abstract	1-8, 21, 25



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	"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
"E"	earlier application or patent but published on or after the international filing date	"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
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"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family
"P"	document published prior to the international filing date but later than the priority date claimed		

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JAPIO Online Abstract Accession No. 1990-092239 JP 02-092239 A (SNOW BRAND MILK PROD CO LTD) 03 April 1990 Abstract	1-8, 14, 17, 21, 25
X	JAPIO Online Abstract Accession No. 1988-294742 JP 63-294742 A (FUJI OIL CO LTD) 01 December 1988 Abstract	1-8, 17, 22-25

Information on patent family members

PCT/AU2008/000512

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
EP	0499041	CA	2061190	CN	1064193	CS	9200449
		DE	4104686	HU	67067	JP	5064543
		PL	293366	US	5240724	US	5249514
		ZA	9200792				
US	4329374	AR	213993	CA	1110490	CH	628211
		DE	2808826	ES	467452	FR	2382196
		GB	1569083	GR	64107	JP	53121964
		NL	7802336	NZ	186520	ZA	7801042
JP	4011836	NONE					
JP	2092239	NONE					
JP	63294742	EP	0278179	JP	63160548	US	4940600

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX