Wisconsin Center for Dairy Research

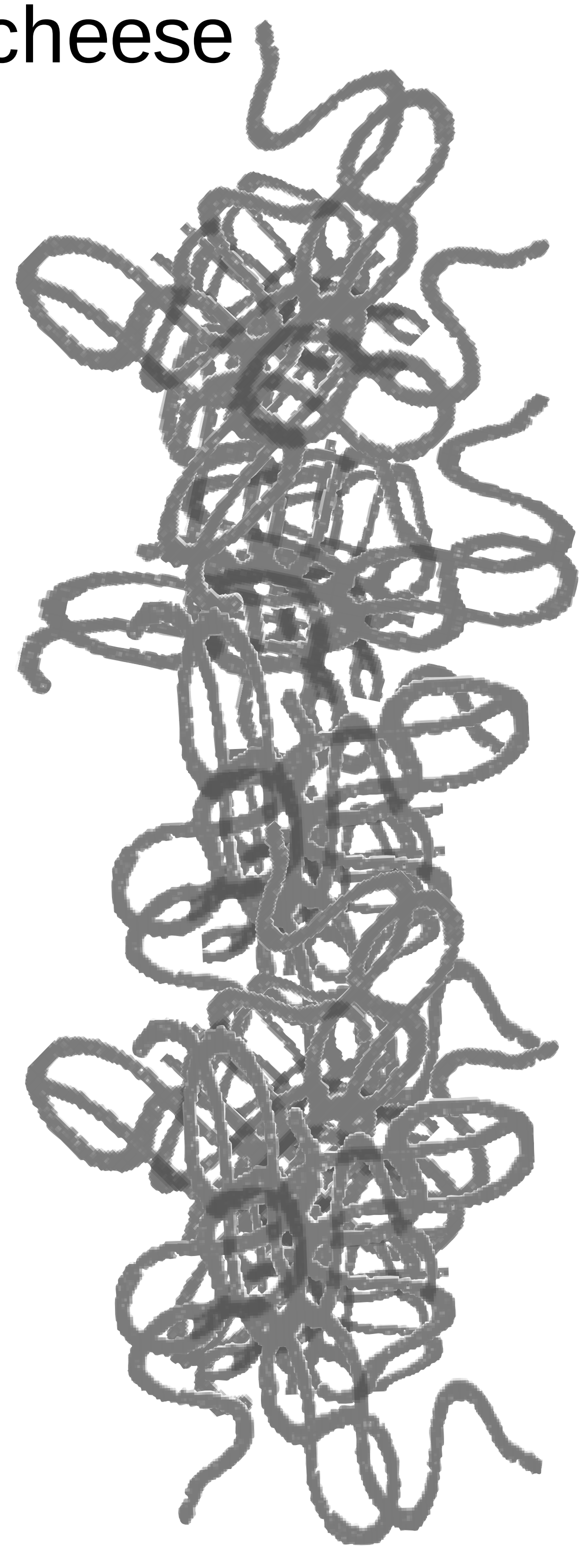
DAIRY PIPELINE

A Technical Resource for Dairy Manufacturers

Spring 1999, Volume 11 Number 2

Casein—How it colors cheese

by Mark Johnson, Wisconsin Center for Dairy Research



A nondiscriminating amateur might sort cheese into two colors: yellow and white. However, the perceptive professional knows that you can really see many variations in both color and opacity of cheese. What influences cheese color? The answer to this question is actually quite complex. To simplify it, we can distinguish between natural color versus added substances that alter the color of cheese. Annatto is the most common colorant added to cheese, useful because it masks the seasonal variation of natural cheese color.

When we see color, we are really seeing the wavelengths of light that an object scatters, or reflects. For example, carotene, a natural milk colorant from grass, adds a yellow-orange tint because carotene molecules scatter only the yellow-orange wavelengths of light. All the rest are absorbed. Black objects absorb all wavelengths of light and reflect none. The brightest whites we see are those that reflect all wavelengths.

The natural color of cheese

Let's take a closer look at the natural color of cheese. There are two phases of cheese, a solid and a liquid phase. Each contains material that reflects specific wavelengths of light and therefore produces different colors. However, the light reflected from some components of cheese may overwhelm the light reflected from other components. This can change with time, and therefore the color of cheese can change as the cheese ages. For example, the color of fat in cheese is a combination of three factors; the protein membrane, the natural chemistry of the fat, (which is a light yellow) and the fat soluble yellow carotenes that the cow eats. The more carotene in the cow's food (grass) the more yellow or yellow-orange the fat. Likewise, the more fat in cheese the more yellow and less white the cheese.

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What's Inside:

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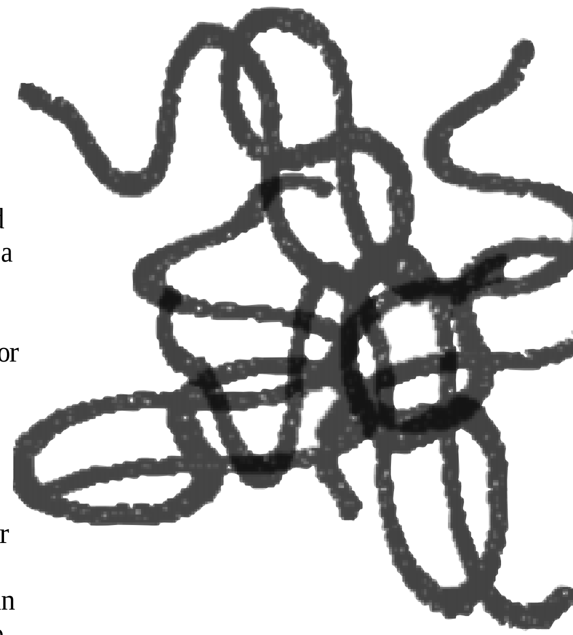
Casein exists as micelles—very small packets of hundreds of casein molecules linked together through various types of bonding. When a coagulant is added to milk, the micelles link together, or aggregate, and form a bigger cluster. This dense cluster reflects all light, so we see it as white. Without acid development, the casein micelles remain associated as clusters, reflecting light and appearing white. Queso Fresco cheese is a good example, although the high salt content of Queso Fresco type cheeses also contributes to keeping the micelles bound as clusters. However, the development of acid by the starter culture changes the color because casein bonding is very sensitive to pH changes.



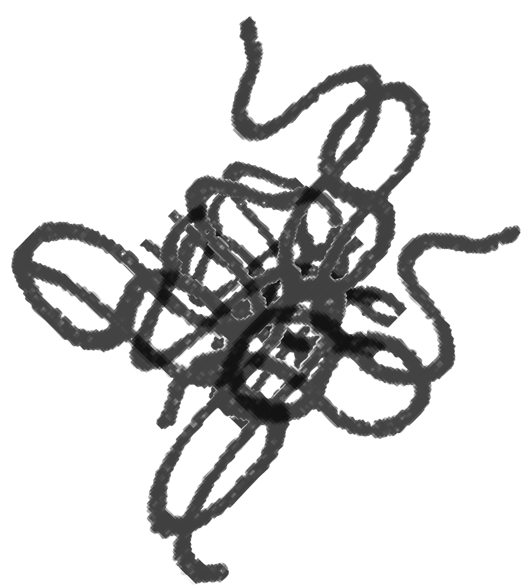
Casein cluster, less tightly bound

Rearranging the casein molecules

Major rearrangements of the casein molecules occur during cheese ripening, especially within the first few days. There is some free whey, or serum, in all cheese when it is very young. The absorption of this free moisture depends on pH and the amount of calcium bound to the casein molecules. Absorption of the water decreases the ability of the casein to reflect white light. Think of it as a separation or dilution of the the casein network—now the micelles are not as dense. The change is readily apparent in fat free or low fat cheeses. Not only do these cheeses become less white, but they also become more translucent. This decrease in whiteness may not be as apparent in higher fat cheeses since the fat globules also reflect white light—which adds to the opacity of the cheese.

"Water is pushed out from the casein and the casein molecules begin to cluster again."

In order for the casein to absorb water, there must be a loss of calcium. With the calcium loss, there will be a negative charge on the casein molecule. This is partially neutralized by sodium or hydrogen ions, both monovalent positive charged ions, in the cheese. However, these ions are associated with water. This is important since the water in cheese is absorbed, or becomes closely associated with the casein, through these ions. In essence, water shares the ions with the casein molecules. Thus, casein becomes more soluble through hydrophilic interactions. However, if the pH continues to decrease, the casein molecules begin to bind tightly to the hydrogen ions and will not share with water. Consequently, water is pushed out from the casein and the casein molecules begin to cluster again. The cheese will become whiter and more opaque.



Casein, dense cluster

Bonding between casein molecules at a low pH is due to hydrophobic interactions and is strongest around pH 4.6. Cottage cheese curd (pH 4.6-4.8) is white because casein molecules aggregate through hydrophobic interactions and form a dense association. At a higher pH, the charge on the casein (and its bonding with water) prevents the hydrophobic interactions from taking place. However, at a high salt concentration the salt actually competes with the casein molecules in the cheese for water and subsequently pulls the water away from the casein molecules, causing them to aggregate. The cheese then becomes whiter. You can see this effect in brined cheeses—the outside of the cheese displays a ring of bright white cheese while the interior of the cheese is not as white. In brined cheeses, moisture from the interior of the cheese eventually finds it way to the outside layer. As the salt moves towards the interior, the rind becomes less white.

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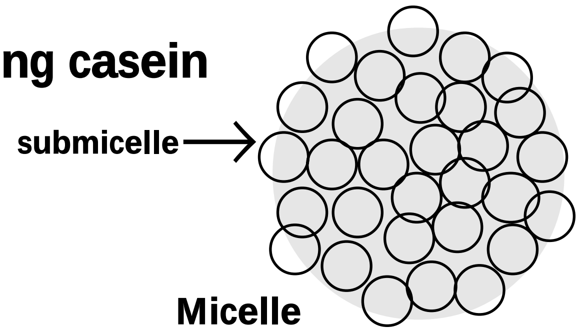
Casein—the major milk protein

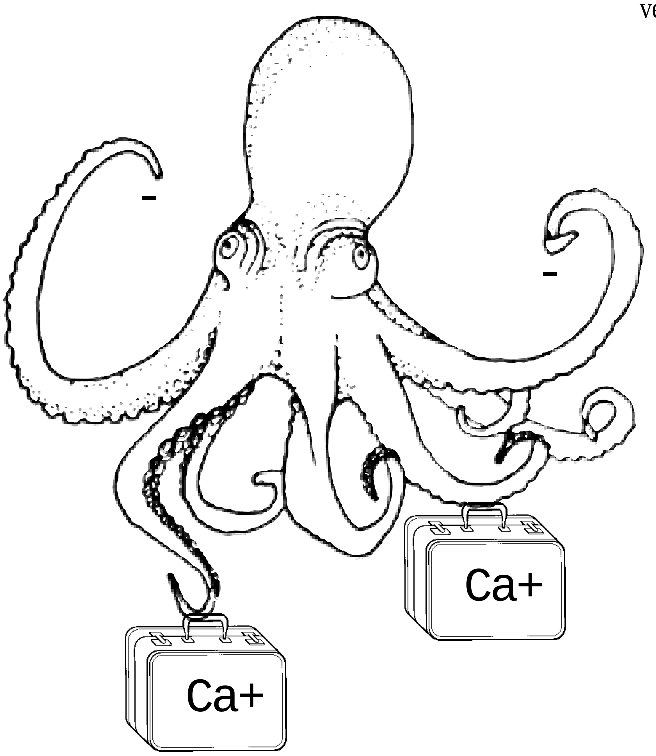
Visualizing casein



Caseins are the major class of protein in milk, making up 80% of the protein in bovine milk. All proteins are assembled from amino acids, a group of twenty chemical compounds that are arranged in specific configurations which give each protein a unique identity and structure. The size of protein molecules depends on the number of linked amino acids, 100 to 200 is common, but you will find them both much smaller and much larger.

Casein can be further divided into three subgroups: α, β and κ. All three types form similar bonds with calcium, magnesium, and complex salts to hold the molecules together. These molecules form casein submicelles, which then bond together as micelles—400 to 500 bound submicelles form a medium micelle. The size of the casein micelle depends on the concentration of calcium ions, if calcium leaves… the micelle separates into submicelles. The bonds that form among micelles, and on the surface of micelles, are the key to curd formation in cheese.

While learning about casein, I talked with Dr. Harry Farrell, a USDA researcher who has studied casein for decades. After all those years searching out the secrets of casein some people might be rather tired of the whole topic. Not Harry—his continued enthusiasm for casein pays homage to this molecule that is unique in nature. There is no other protein that is like casein, perhaps because it's role is so specialized. Casein is a storage protein, but is also a carrier protein. Casein is the vehicle that carries calcium in milk, delivering it from mammalian mothers to their offspring. Each species has unique calcium needs, which is reflected in milk.



When you compare cow's milk to human milk you see major differences in the amount and type of casein (Sood, S.M.). The variation reflects a species difference in the growth and development of newborns—calves have an immediate need for calcium since they are walking and need strong bones right away. Humans put their energy into finishing neural development, bone growth comes later. This is the main reason you'll find more casein in cows milk.
—Editor

References

Sood, S. M. Sidhu, K. S., and Dewan, R. K. Heat Stability and the Voluminosity and Hydration of Casein Micelles of Different Species. NZJ Dairy Sci Tech 14:217-25, 1979.

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bright white cheese while the interior of the cheese is not as white. In brined cheeses, moisture from the interior of the cheese eventually finds it way to the outside layer. As the salt moves towards the interior, the rind becomes less white.

When cheese is heated it can become whiter and more opaque. This phenomenon is also due to the increased density of the casein network as a result of increased hydrophobic interactions between casein molecules, which become stronger as the cheese is heated. Heating influences aggregation of casein molecules and pushes the water out from the casein network. This is especially apparent when a high moisture, zero fat cheese, is heated, perhaps on a pizza pie. You'll see large pools of free water.

Effect of temperature

During cold storage of cheese, the cheese may appear less white than it does at room temperature. At low temperatures, water absorption increases and the density of the casein molecules decreases. As the cheese is warmed, the reverse is true. Remember that the pH and bound calcium content of the cheese are also important. Thus, a cheese with a high pH and more bound calcium will not lose its whiteness. This is not true of a cheese with a lower pH stored at a low temperature. However, both cottage cheese and very young Camembert have a low pH but maintain their whiteness when refrigerated. This is because cheeses with a very low pH maintain hydrophobic interactions and the casein remains densely clustered. However, as Camembert ripens you begin to see a color change, starting at the outside and moving inside. The color is less white and more translucent as the pH increases.

Mottling may be due to pH differences between the white, opaque areas and the less white, more translucent areas within the cheese. The pH differences lead to different aggregations of the casein molecules, and thus the water holding abilities of the casein. At the Center for Dairy Research, we have observed that the white areas of Mozzarella will have a pH of 5.2, while the translucent areas will have a pH of 5.0. The color differences are not readily apparent when the cheese is cold, but you can see them when the cheese warms. The white areas are firmer and, when squeezed, easily express water. The translucent areas are soft and do not express any water when squeezed. Mottling in cheese can be avoided by adding titanium dioxide; a common additive to reduced or fat free Mozzarella cheese which increases cheese whiteness and opacity.

"Remember that the pH and bound calcium content of the cheese are also important ... a cheese with a high pH and more bound calcium will not lose its whiteness."

As cheese ages

While the hydration of the intact casein molecule can cause a decrease in whiteness, proteolysis can also transform casein to a more soluble state— with the same decrease in white color. Thus, as a cheese ages, it becomes less white. When casein no longer strongly reflects white light, the color of the cheese will be dominated by the reflecting components originally in the water phase. For example, the riboflavin in the whey, which appears greenish-yellow is a big influence. These compounds were originally overwhelmed by the intensity of the reflected white light from the casein. Riboflavin can be oxidized by fluorescent light, and will become whiter if the cheese is exposed to fluorescent light. It may even appear more opaque.

	High pH	High salt	High temperature
Low pH	White	White	White
Low salt	Off-white*	——	White
Low temperature	Off-white*	White	——

*Colors can be yellowish, slight green, dull white, cream, or gray.

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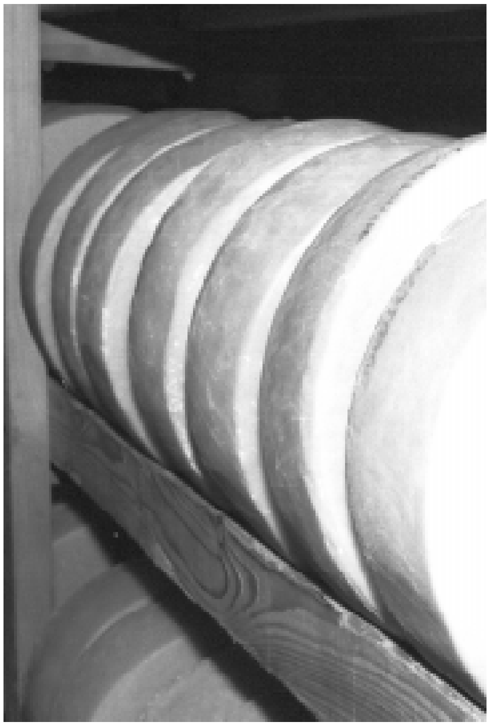


“The Maillard reaction, is a non-enzymatic browning process that produces a complex rearrangement of sugar-proteins that influence color and flavor.”

Although casein, fat and riboflavin are important factors determining the color of cheese, other compounds also have a major impact, which will subsequently dominate the color. Metabolism of bacteria in cheese may lead to the formation of dicarbonyl compounds, which react with amino acids. The reaction produces pink or brown pigments. This is known as Maillard browning. The Maillard reaction, is a non-enzymatic browning process that produces a complex rearrangement of sugar-proteins that influence color and flavor. This reaction is enhanced in low moisture cheeses like Parmesan, and by increasing the storage temperature. Thus, as Parmesan cheese ages it becomes more brown. (However, as cheese ages there is an increase in proteolysis and less casein aggregation.)

You may have noticed that off-white, or whey colored cheeses will turn white when in contact with water— especially when heated in water. But they turn darker when dried with heat. Bacteria, yeast, and molds may also produce other pigments imparting various colors to cheese.

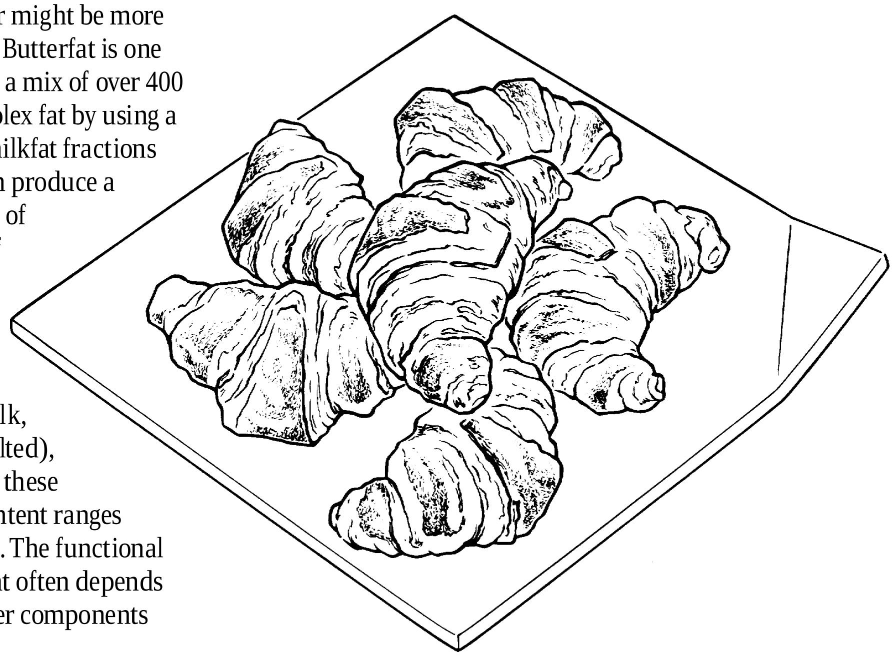
During cheese making, you can also add some steps during processing to increase the whiteness of the cheese: homogenization of the cream, or adiing titanium dioxide or adding peroxide. You may want to check the regulations and standards of identity before taking this appoach, though.

After all this information about the natural color of cheese, you may be yearning to be that amateur that considers only yellow and white cheese. However, you can “see” some of the chemistry of cheese when you discern the variation in natural cheese color and it can be another guide in the cheesemaking process. At the very least, perhaps you’ll never view cheese the same way again!

Producing Specialty Milkfat

by K. E. Kaylegian, Wisconsin Center for Dairy Research

Like whey, whey proteins, and milk itself, butter might be more valuable when it is separated into components. Butterfat is one of the most complex edible fats available—it is a mix of over 400 different fatty acids. You can simplify this complex fat by using a separation process, like fractionation, to sort milkfat fractions by their melting temperatures. This process can produce a specialty product that retains the quality flavor of butter while meeting the performance needs of food manufacturers.



Milkfat is present in most dairy foods—fluid milk (1%, 2%, whole, buttermilk), cream (light, heavy, concentrated), dried products (milk, cream, butter, buttermilk,), butter (salted, unsalted), anhydrous milkfat (AMF), and butter oil. All of these forms have varying levels of fat (the milkfat content ranges from 1 to 99.8%), water, and other components. The functional performance, or role, of milkfat as an ingredient often depends on the total fat content and the presence of other components (e.g., proteins and phospholipids).

Although butter contributes desirable flavor, appearance, and textural properties to foods, its functional performance is limited. The native chemical, physical, and functional properties of milkfat vary naturally (1), which can make it less predictable than desired. The predictability is important since fat ingredients contribute a range of functional properties, both during processing and in the finished product. For example, when used as an ingredient, milkfat contributes structure, lubrication, layering and heat transfer during processing (Table 1). In the finished product, milkfat supplies flavor, texture, structure and spreadability.

Table 1.
Functional attributes of milkfat ingredients

During Processing	Finished product
structure	flavor
firmness	texture
plasticity	mouthfeel
lubrication	appearance
aeration	structure
shortening	spreadibility
layering	firmness
viscosity	antibloom properties
flow	
solution and dispersion	
heat transfer	
emulsification	

Milkfat contributes to structure

The flavor that milkfat supplies is important for most applications, but some milkfat attributes are only important for selected applications. For example, spreadability is important for table spreads but is not relevant for chocolate applications. Structure formation is also very specific to the application. In table spreads, structure refers to the formation of a sufficient solid crystal network to hold the liquid fat and moisture. This network cannot be too brittle or too soft for optimal spreadability and stand-up properties. In pastries, the dough layers are separated by layers of fat that must remain solid during the initial phases of baking to form a barrier between dough layers and provide a flaky texture. In cookies, the gluten formation between adjacent flour particles is disrupted by coating them with liquid fat, resulting in the "short" texture characteristic of a shortbread cookies.

Specialty milkfat ingredients are an emerging category of milkfat ingredients—they are tailor made for a specific product. These specialty ingredients are based on milkfat fractions, and are generally 80 to 100% milkfat. Rather than using butter for all food applications, specialty ingredients are designed to optimize the functional characteristics that are desirable and important in a particular application. For example, a specialty milkfat ingredient can be designed just for layered pastries—it would not be the best ingredient to use in cakes, chocolate, or table spreads. Each finished product or application has its own characteristic attributes (e.g., flavor, texture, and structure), as well as unique formula and processing demands. It is essential to understand as much as possible about the final application, including all stages of manufacture, distribution, and storage before producing specialty milkfat.

Manufacturing milkfat ingredients

Specialty milkfat ingredients can be manufactured using five basic steps: 1) fractionate milkfat to create blending stocks with a range of physical and chemical properties, 2) blend milkfat fractions and intact milkfat to target specifications, 3) add other functional ingredients (optional; aqueous phase, salt, emulsifiers), 4) texturize mixture to proper finished form (optional), and 5) package (1). These processing steps influence the melting profile and melting point, plasticity, and total fat content. Although this approach to manufacturing specialty milkfat ingredients is new in the United States, it has been used in Europe since the 1970s and in New Zealand since the late 1980s.

Milkfat fractionation means separating whole milkfat into components, or fractions, that have different physical and chemical properties. The best raw material for producing fractions is anhydrous milkfat, because it is 99.8% fat. Dry crystallization with either vacuum or pressure filtration is the most common method used to fractionate milkfat commercially. Understanding as much as possible about the final application helps to obtain the best performance from the ingredient with the least amount of processing necessary. For example, a chocolate manufacturer melts the specialty milkfat when it is added to the chocolate. They would not want water in the system; therefore, an aqueous phase is not needed, and the product does not need to be texturized. However, a pastry manufacturer needs water in the finished product for leavening and also requires plasticity in fats for rolling. Sometimes bakery ingredients need texturization to stabilize the emulsion properties.

Summary

Producing specialty milkfat ingredients in the US is an emerging field. Right now, actual performance testing of the ingredient in the product is the only way to judge the true suitability of the ingredient. However, understanding the performance needs and using fractionation, blending, and texturization technologies does gives the dairy industry new opportunities to tailor milkfat ingredients to meet the needs of specific applications and increase the use of milkfat.

Acknowledgments

The author thanks and acknowledges the support of Dairy Management Inc., the Wisconsin Milk Marketing Board, and the Wisconsin Center for Dairy Research Milkfat Fractionation Consortium.

References

Kaylegian, K. E., and R. C. Lindsay. 1995. Handbook of Milkfat Fractionation Technology and Applications. Am. Oil Chem. Soc. Press, Champaign, IL.

Labeling milkfat fractions

Milkfat fractions are newly available ingredients in the US, and many people want to know how they can be labeled. In an opinion prepared by Covington & Burling (Washington, D.C.), the following recommendations were made.

Milkfat fractions produced from anhydrous milkfat (AMF) using traditional dry crystallization and separation methods can be labeled like other milkfat ingredients.

Traditional milkfat ingredients are labeled based on their gross composition and fat level. Milkfat fractions that are 99.8% milkfat can be labeled as "milkfat," "anhydrous milkfat," or "anhydrous butterfat," and milkfat fractions that are at least 99.6% milkfat can be labeled as "butteroil." The term "butter" implies a product that is 80% milkfat. The "butter" label can be used for products made from milkfat fractions that are blended with an aqueous phase obtained from milk (skim milk or buttermilk) to a finished product level of 80% milkfat. In the case of specialized, non-standardized products, such as a spreadable butter, some type of common or usual name or modifier must be used to distinguish the product from the standardized version. Examples of non-standardized butters are cold spreadable butter and high melting pastry butter.

For more information, contact Kerry Kaylegian, Wisconsin Center for Dairy Research, 608-265-3086.

Very high melting fractions
melt above 45˚C (113˚F)

High melting fractions
melt between 35˚C (95˚F) and 45˚C (113˚F)

Middle melting fractions
melt between 25˚C (77˚F) and 35˚C (95˚F)

Low melting fractions
melt between 10˚C (50˚F), and 25˚C (77˚F)

Very low melting fractions
melt below 10˚C (50˚F)

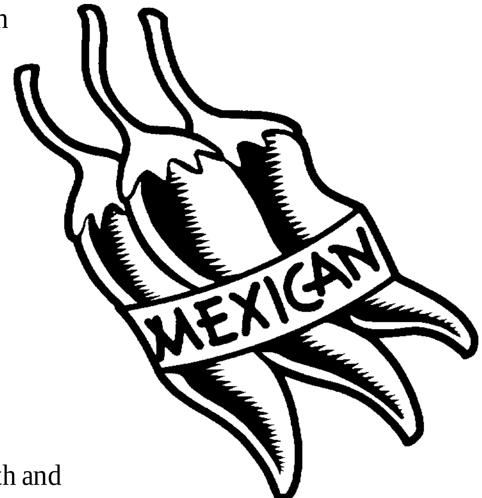
News from CDR

CDR staff heads for IFT

Interested in sampling dulce de leche? (See page 10) Both Karen Smith and KJ Burrington, staff from CDR's Whey Applications program, will be at the 1999 IFT Food Expo ® with some product samples. You can find them at the DMI booth, #1563, along with other technical representatives who can answer questions and share information about dry dairy ingredients and using dairy ingredients in everything from soup to donuts. The Food Expo is in Chicago this year, July 25-28. For more program information and registration call (312) 782-8424.

"New" Food Safety Workshop

Food safety is a topic that you can always revisit. We have reviewed and revamped our food safety workshop —register now! (See the schedule on the opposite page.)



Artisan Course in September

Jim Path is presenting another Cheese Artisan course on September 28th and 29th. Consider joining us to "Explore the Cheeses of Mexico and Latin America." During this workshop, you will gain "hands-on" experience making Oaxaca, Panela and other popular, traditional Hispanic cheeses. Course instructors, Luis Gonzales, Felipe Guisa, and Jeff Jay will also discuss manufacturing these cheeses to meet the cooking needs of chefs and consumers. For more information contact Jim Path at CDR, (608) 262-2253 or by e-mail: jpath@cdr.wisc.edu

Calendar, continued from pg 12

Oct. 18-22 Wisconsin Cheese Technology Short Course, Madison, WI — This 5-day short course provides a technical approach to the discussion of the principles and practices of cheesemaking. Program Coordinator: Dr. Bill Wendorff, (608) 263-2015.

Nov. 9-10 Wisconsin Cheese Grading Short Course, Madison, WI — This intensive two-day course covers the principles and practices used in grading natural cheeses. Program Coordinator: Dr. Bill Wendorff, (608) 263-2015.

Managing Dairy Food Safety Workshop

Sponsored by:
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Auditorium, Rm. 205, Babcock Hall
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This one-day workshop will:

- Reiterate the need for maintaining a "clean" environment and manufacturing quality products. You can do this by following GMP's throughout your plant and observing regulatory and customer requirements.
- Provide practical "how to" information for maintaining a "clean" plant by following GMP's and implementing a quality system.
- Discuss potential problems and issues when a product is "unsatisfactory," including a review of lab results, mock recalls and third party audits.

For more information

If you have questions about the workshop or need a brochure, please contact Mary Thompson, Wisconsin Center for Dairy Research, Babcock Hall, Rm. 241, 1605 Linden Drive, Madison, WI 53706-1565
phone: 608.262.2217
email: thompson@cdr.wisc.edu

Wednesday, September 1, 1999

9:00 - 9:10	Welcome –Mary Thompson, Wisconsin Center for Dairy Research Introduction - Ron Weiss, Food Research Institute
9:10 - 9:30	Pathogens of Concern for Safe Dairy Products Dr. Elmer Marth, Professor Emeritus, Dept of Food Science, University of Wisconsin - Madison
9:30 - 10:00	Regulatory Requirements for Plant Sanitation Mike Barnett,Food Safety Specialist Wisconsin Dept of Agriculture, Trade & Consumer Protection
10:00 - 10:30	Buyer Specifications Dick Willets, Group Director Research & Development Sargento
10:45 - 11:15	Good Manufacturing Practices Cheryl Bingham, Director, Compliance FDA, Minneapolis Office
11:15 - 11:45	Importance of HACCP Implementation Marianne Smukowski,Dairy Safety/Quality Coordinator Wisconsin Center for Dairy Research
11:45 - 12:15	Implementing HACCP - Industry Response Dean Sommer, Vice President, Technical Services Alto Dairy
12:15 - 1:15	Lunch on your own
1:15 - 1:45	Recall Program, Industry Perspective Tom Everson. Vice President, Technology Division Grande Cheese Company
1:45 - 2:15	Recall Program, Legal Perspective Speaker to be announced
2:15 - 2:35	Quality Milk Pamela Ruegg, Milk Quality Specialist Department of Dairy Science, University of Wisconsin - Extension
2:35 - 2:45	Resources Display Mary Thompson, Communications Coordinator Wisconsin Center for Dairy Research
2:45 – 3:00	Questions and Answers for speakers Ron Weiss, Research Program Manager Food Research Institute

Dulce de Leche—What is it ?

by Karen Smith and K.J. Burrington, Whey Applications, CDR

We've all watched whey emerge from the waste stream of the cheese vat to a main stream food ingredient. We hear about the "whey refinery," separating whey into components and finding uses for each of them. If you read food ingredient labels you have probably already noticed that you can find whey on the ingredient list of a wide range of products from snack foods to processed meats.

Dulce de leche is a dairy-based confectionery product. It is also one more product that could incorporate whey proteins, replacing some of the milk solids currently used. This is an ideal niche for whey since dulce de leche is very popular in Argentina, Uruguay, Chile, Brazil, Mexico and Columbia where milk solids are sometimes in short supply.

Dulce de Leche doesn't translate directly into English, but loosely translated it means sweets of the milk—or dessert of milk, dairy spread, milk jam and toffee jam. Product names and characteristics vary by country, but, generally, dulce de leche has a smooth texture and a delicate, caramel-like flavor. In Columbia and neighboring countries, people call it "arequipe" while in Chile it is known as "manjar." "Cajeta," the Mexican version, is made from goat milk unless noted on the label.

There are two distinct types of dulce de leche. At home, many people use the "casero" type which is shiny with a reddish brown color and a slightly stringy texture. Confectioneries and bakeries use the "pastelero" type, which is lighter in color and has a very short texture that holds the pastelero on cakes and other products.

Dulce de leche is traditionally prepared by mixing whole milk with sucrose and then boiling it until the mixture contains 70% (wt/wt) total solids. During the cooking, browning reactions produce a colored product with a caramel-like flavor. Sodium bicarbonate is used to increase the pH and improve browning and flavor development. Vanilla, or vanillin, often is added to flavor the final product. Manufacturers in Latin America use proprietary recipes and processing technologies to differentiate their brands.

You may have noticed that dulce de leche is gaining popularity in the United States as an ice cream flavor. Häagan-Dazs has been producing dulce de leche ice cream since February 1998—currently it is second only to vanilla ice cream in sales. Blue Bunny, Starbucks and Carvel also produce dulce de leche ice cream and Breyers is planning to introduce the flavor.

Procedure:

1. Rehydrate the whey powder (in milk or water)
2. Add sodium bicarbonate and cream to milk and heat to 140˚F (60˚C)
3. Add sugar and corn syrup to mixture
4. Cook to 70 – 71 % solids [approximately 225˚F (108˚C)]
5. Add flavor
6. Fill containers hot, close and cool

Ingredient	Percent
Milk, whole	37.08
Sugar (sucrose)	26.68
Corn syrup, 42 D.E.	19.27
Whey protein (WPC-34)	11.12
Cream	5.56
Sodium bicarbonate[1]	0.22
Vanilla extract	0.07
Totals	100.00 %

Composition

Total solids 71.0%
Sugars 50.0%
Total Milk Solids 21.0%
- Lactose 9.0%
- Protein 6.0%
- Fat 4.5%
- Ash 1.5%

[1]Amount can be increased or decreased to control color.

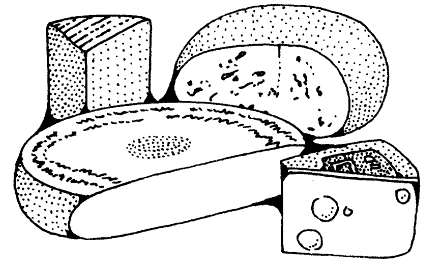
Curd Clinic

Q: I sell a lot of cheese curds at my retail store and I've noticed that my customers seem to buy them for the squeak. I'd like to try a retail market that is several states away—is there any way to make the squeak last longer?

A: Sure, we can help you spread the curd! The answer to this question, as is often the case around here, is based on research done several years ago by Dr. Norm Olson, emeritus professor of Food Science and the first director of the Center for Dairy Research.

The key to preserving the squeak in Cheddar cheese curds depends on both the amount and structure of intact casein. Dr. Olson found that amount of intact alpha$_{s-1}$ (α_{s-1}) casein in cheese is directly related to the structure, or firmness, of the cheese. (Creamer and Olson, 1982) During normal cheese ripening, the cheese loses its squeakiness when as little as 15 to 20% of intact α_{s-1} casein is hydrolyzed. (Lawrence et al, 1987) Residual milk coagulant present in the curd is responsible for the initial breakdown of α_{s-1} casein. You can reduce residual milk coagulant levels in the cheese by simply reducing the amount of coagulant that you initially use. We cut the milk coagulant by 1/2 to 2/3 when we make our squeaky cheese. Of course, now you have to compensate for the slower clotting time by adjusting milk ripening and curd cutting times. To ensure good milk coagulum formation, we increased our milk ripening temperature from 90° to 95° F and added the maximum levels of $CaCl_2$.

The other key is maintaining the proper casein structure by paying attention to the cheese pH. The goal is to carefully monitor the final pH of the curd, it should never dip below 5.25. For example, during chesemaking we drained, milled and salted the curd at 6.25-6.30, 5.60, and 5.55, respectively. With a final pH of 5.30 to 5.40, the cheese structure remains more rigid.



Curd clinic doctors for this issue are Carol Chen and John Jaeggi, CDR's Cheese Application Program

Questions for the Curd Clinic?
Write to:
CDR, *UW Dairy Pipeline*
1605 Linden Dr.
Madison, WI 53706
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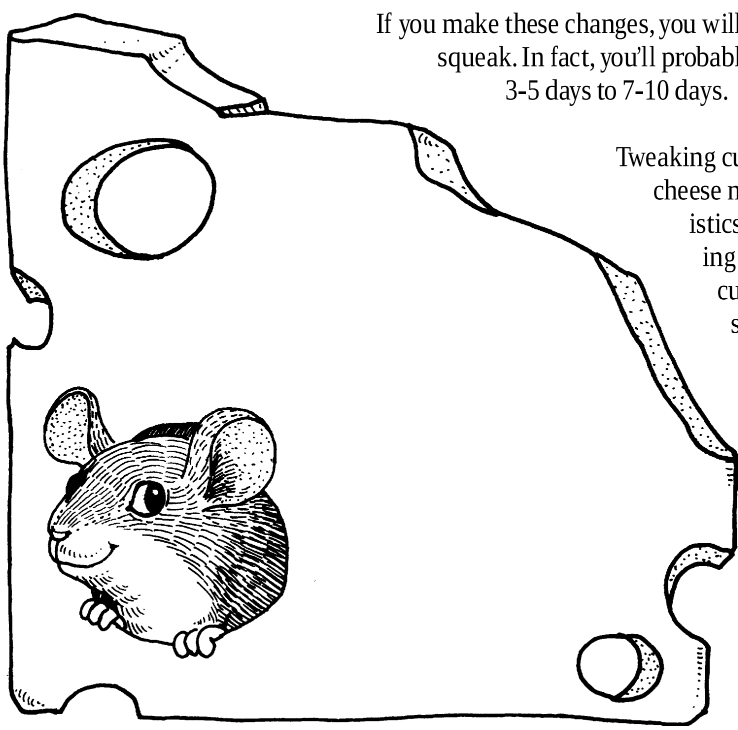

If you make these changes, you will be able to produce cheese curds with a longer lasting squeak. In fact, you'll probably double the number of days your cheese will squeak, from 3-5 days to 7-10 days.

Tweaking curd squeak is a good example of using the science behind cheese manufacture to tailor cheese behavior and physical characteristics for a specific end use. Please note that we are only suggesting these changes for batches of cheese that you plan to sell as curds—if you pressed this curd, if wouldn't develop the smooth texture you expect in an aged Cheddar!

References

1. Creamer, L.K. and N.F. Olson. 1982. Rheological evaluation of Cheddar cheese. J. Food Sci. 47:631-636

2. Lawrence, R.C., L.K. Creamer, and J. Gilles. 1987. Texture development during cheese ripening. J. Dairy Sci. 70:1748-1760

Calendar

July 24-28 **IFT Annual Meeting**, Chicago, IL. For info, call (312) 782-8424.

Aug. 1-4 **IAMFES Annual Meeting**, Dearborn, MI. For info, call (515) 276-3344.

Aug. 16-19 **Milk Pasteurization and Control School**, Madison, WI — This 4-day short course provides in-depth training for those dairy industry personnel involved with thermal processing of milk and milk products. Program Coordinator: Dr. Bob Bradley, (608) 263-2007.

Aug. 12-15 **American Cheese Society Annual Meeting**, Shelburne, VT. For info, call (414) 728-4458.

Sept. 1 **Producing Safe Dairy Foods**, Madison, WI — This course deals with the major forms of foodborne illness that sometimes affect dairy foods and offers suggestions for controlling these problems. Program Coordinator, Mary Thompson, (608) 262-2217.

Sept. 9-10 **Marschall Italian & Specialty Cheese Seminar**, Santa Clara, CA. For info, call (219) 264-2557.

Sept. 23-24 **Jt. Educational Conference**, Wausau, WI – Co-sponsored by WI Assn. of Milk & Food Sanitarians, WI Dairy Plant Field Reps Assn., and WI Environ. Health Assn. For information, contact Dr. Bill Wendorff, (608) 263-2015.

Oct. 13-14 North Central Cheese Industries Assn. Annual Convention, Minneapolis, MN. For info, call Dr. Dave Henning at (605) 688-5477.

Oct. 28-31 **IDFA Annual Convention**, Chicago, IL. Sponsored by International Dairy Foods Assn., (202) 737-4332.

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