DUPONT™ INSIGHTS FOR CULTURED DAIRY

March 2017 | Issue 18

Welcome to the eighteenth edition of our Insights for Cultured Dairy newsletter! The purpose of this newsletter is to share information within the dairy industry about stabilizers, cultures, antimicrobials, probiotics, fiber addition, processing, and specific ingredients used in cultured product and cheese applications. We will always add a recipe utilizing cottage cheese and discuss troubleshooting issues from the field. We hope you enjoy it and look forward to your feedback! If you would like to see specific subjects covered in this publication or if you want to be added to the electronic mailing list, please contact us at: http://www.danisco.com/food-beverages/dairy/insights-for-cultured-dairy-newsletter/

From the Field
By Doug Vargo

Learnings from the Field: Not All Lumps Are Stabilizer!

DuPont gets presented with all kinds of interesting situations when we do technical service in a dairy plant. One recent event that comes to mind is worth mentioning, because it is something that we can all learn from. One plant was having trouble pumping cooled buttermilk onto a tank truck for use as an ingredient in making biscuits at a local bakery. The in-line screens were getting clogged up and eventually causing a severe loss of flow and making it impossible to empty the large 10,000-12,000 gallon silos of buttermilk into the tankers for delivery. Even if the buttermilk could be pumped onto the tanker from the producing dairy, once the tanker arrived at the bakery's delivery dock, the bakery's pump was used and the in-line screen at the bakery was also getting clogged up making unloading of the buttermilk tanker extremely difficult.

Photo A

Since this dairy used our buttermilk stabilizer and another supplier's culture, the culture supplier and I were called in to troubleshoot the problem for them. (Remember, when something goes wrong in a dairy, 99% of the time they think it is the fault of either the culture or the stabilizer ☺). Upon arrival at the dairy, I was presented with the following in-line screen with whitish and yellow material on it. See photograph A above.

The culture supplier was already there and upon my arrival in the plant manager's office he shouted out, "Look at this! Your stabilizer is clogging up these in-line screens." Calmly I started to examine the in-line screen. As a food scientist, we are trained to use instruments to help us determine the body and texture of foods. I also rely on common sense and our senses of touch, feel, sight and smell to determine what might be the cause of the problem. I examined the whirl-pak bag and smelled the screen. Immediately, I smelled an odor of vinegar and/or diacetyl. I took a small amount of the material on the in-line screen and rubbed it between my index finger and thumb in a swirling motion. I was examining if the clumped material had a gritty feel to it, and if it dissolved or broke down when it was rubbed. It was not gritty, melted down smooth, and felt greasy, just like butter or fat clumps. If it was stabilizer, it would have a sandy or gritty feel to it, would not have melted in the palm of my hand or felt greasy, and would not have broken down or dissolved. We tasted the lumped material and guess what? It tasted just like butter! The plant manager's comment was, "If it looks like a duck, walks like a duck, and quacks like a duck, then it must be a duck!" Mystery solved. It was butterfat! Since we knew what the material was, all we had to do now is find out where the butterfat clumps (or churned fat) were forming in the buttermilk.

My immediate comment was, "The only way I know how to get rid of churned fat is to homogenize it in". The plant manager immediately said the buttermilk *was homogenized*. However, the production supervisor said it is only homogenized if it is processed on HTST #1. When it is homogenized on HTST #2 it is not homogenized. I said, "That is your problem right there. I don't care where the buttermilk is processed from now on; I want it homogenized at 1000 p.s.i. on the HTST units." I watched them batch up a 10,000 gallon batch of buttermilk. I was looking for places where the butterfat could be churned such as in the Liqwifier during batching. Sure enough, the 1% fat buttermilk usually has the skim milk used as the fluid mixture that is sent to the Liqwifier. However, the production supervisor said on some occasions that whole milk is added to the Liqwifier rather than skim milk and the stabilizer added to whole milk rather than skim milk. It was stated that, "How can the butterfat get churned when there is so little (1%) fat content in the finished buttermilk?"

I did the math and calculated that when 10,000 gallons of 1% buttermilk is made there is still 863# of fat in the product [10,000 gal. x 8.63#/gal = 86,300# of finished buttermilk made x (0.01 percent as a decimal at 1% fat) = 863# of fat that would have to pass through that in-line screen]. So apparently when whole milk was used to add the stabilizer, and when the buttermilk was run on HTST #2 **without homogenization**, churned fat clumps from either the Liqwifier or subsequent transfer pumps were remaining in the cultured buttermilk and clogging up the in-line screen after the buttermilk was cooled and transferred to the tanker for delivery to the bakery.

A lot of times deviations to procedures or improper processing methods are discovered in the dairy itself, which we discover when we go in and dig for information and talk to the personnel involved in making the product. The very next batch was made and homogenized on HTST #2 and the in-line screen looked like this (see photo B below) after the 10,000 gallons of buttermilk was cooled and pumped onto the tanker. In fact, after it was made certain that <u>all buttermilk</u> was homogenized, there was never a report of clogged in-line screens ever again!

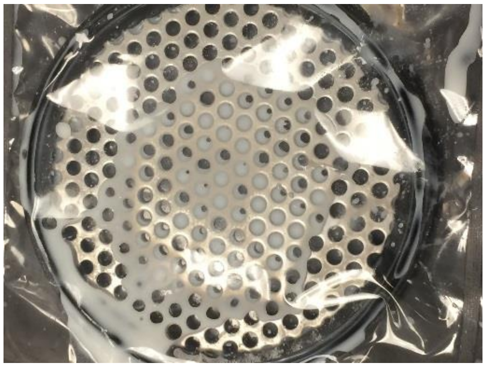


Photo B

Although this problem was not culture or stabilizer related, I do take great satisfaction in helping a dairy solve a problem. I share these experiences with you, our readers, so that it doesn't happen in your facility! One thing experience has taught me is this: in the dairy industry many of the problems are the same, just the location changes!

The Cheese Corner
By Doug Vargo

The Perfect Swiss Cheese – Well, Almost!

Every now and then, one comes across a dairy product that you just have to admire or take a picture of! Following is one of those dairy products that was worthy of a picture. Too often I have gone to the store or supermarket to purchase Swiss cheese at their deli department. The Swiss cheese that I have taken home has had varying degrees of eye formation. While the flavor might not have been faulted, the size and kind of eye formation certainly could have and should have been faulted.

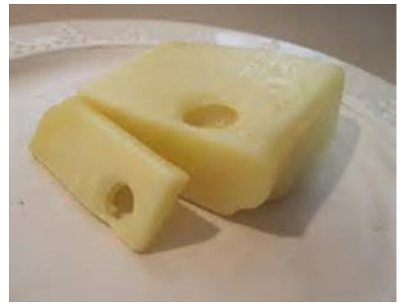
Swiss cheese is supposed to have eyes in it. I get rather disappointed when there is none in the slice of Swiss cheese that I am about to eat, referred to as "blind" (no eyes at all) by the Swiss cheese processors. The Swiss cheese manufacturers talk about perfect eye formation, with dime sized holes in the Swiss cheese. I find these ideal slices of Swiss cheese out in the marketplace far and few between. Most of the time if the Swiss cheese isn't blind, then it has splits or cracks in it, or has very small pinholes or "nesting" on the outer edge of the piece. These conditions are all defects in the Swiss cheese. They don't affect the taste of the product so much, but do affect the appearance. Swiss cheese can be "over set" with too many holes or too large of Swiss cheese eyes in it, or can be "under set" with too few of eyes or eyes that are too small.

Check out this “almost perfect” slice of Swiss cheese purchased from my local deli. Note the very consistent dime sized holes in the slice (a dime was placed on the outside top edge for reference). There are neither too many eyes nor too few eyes. There are no pinholes or nesting on the outer edge of the piece. If it wasn’t for a very small crack just to the left of the middle eye, this might be considered as close to perfect of an appearance in Swiss cheeses as you are going to get. And the flavor wasn’t bad either!

While we are on the topic of Swiss cheese, here are a few more examples showing various degrees of eye formation, demonstrated by photographs used in the Swiss industry…

Over Set (too many or too large of eyes):

Under Set (too few or too small of eyes):



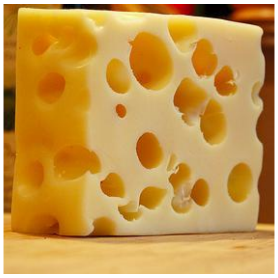
Blind Swiss (no eyes foreground wedge):

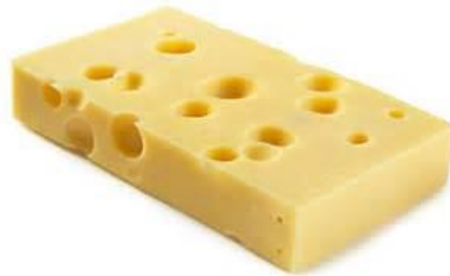
Nesting or Pinning Around the Outer Edge:

Splits & Cracks and
Gassing in Swiss (heterofermentative lactobacilli)

Deformed or Cabbage Eyes:

And some more pretty nice looking Swiss cheese:





I find the language used in the cheese industry fascinating and love to demonstrate that language with pictures!

Dairy Chemistry – Part IV of IV: Milk fat

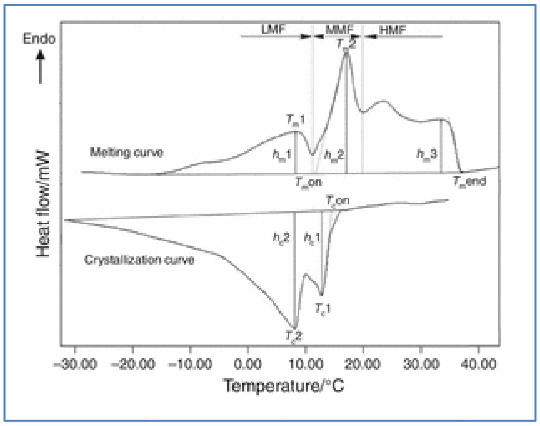
By Jon Hopkinson, PhD.

Since milk is intended to be a food for young mammals, it needs to supply protein for growth and some energy source for the young. In most mammals there are two such sources: lactose and fat. Lactose gives the young a comparatively fast boost of energy and the fat gives them a slower more sustained source of energy. The fat in milk is a complex mixture of triglycerides (three fatty acids connected to a glycerol backbone). The fatty acids in milk come from three sources: directly from the diet of the animal, synthesized within the mammary gland and synthesized within the whole body of the animal. The actual proportion of each fatty acid in milk depends on the health of the animal, it's diet, the season of year, temperature, the stage of lactation the species, subspecies variant, the microbiology of the rumen (in cows) and a plethora of other factors. The average fat in cow's milk runs about 3.7% (again, depending on many factors). The fatty acids in milk are also variable differing in chain length (mostly between 4 and 18 carbons long) with even numbers of carbon atoms being predominate. They also differ in the number (0 to 3) and placement of double bonds. They even differ in the geometric position of the hydrogen around the double bond (cis and trans positions, cis is more common). A fatty acid with single bonds completely along the fatty acid chain is called saturated (saturated with hydrogen). A fatty acid with one or more double bonds is called unsaturated. Milk fat also contains other lipids, such as mono and diglycerides, phospholipids, cerebrosides, gangliosides, sterols (cholesterol and cholesterol esters) and carotenoids.

The following table contains the approximate content for the fatty acids in milk fat:

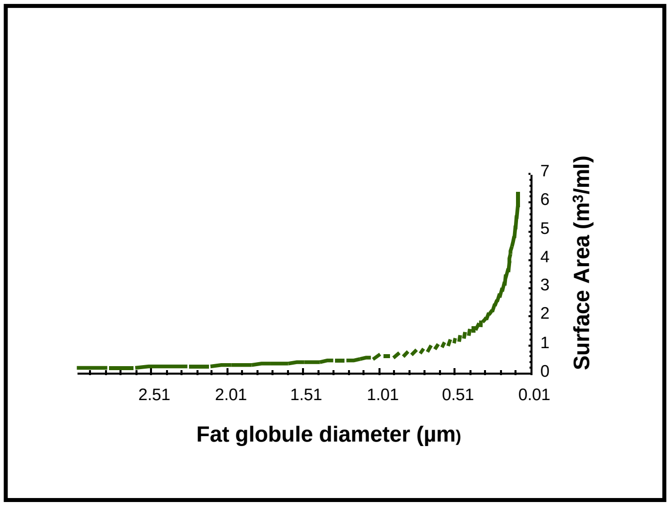
Notation	Position on glycerol -1	Position on glycerol -2	Position on glycerol -3	Amount in Milk fat (from various sources)	Melting point of fatty acid
4:0 (Butyric)	2%	1%	97%	8.5%	−5.1 °C (22.8 °F)
6:0 (Caproic)	4%	12%	84%	4.0%	−3.4 °C (25.9 °F)
8:0 (Caprylic)	13%	42%	45%	1.8%	16.7 °C (62.1 °F)
10:0 (Capric)	17%	50%	33%	3.0%	31.6 °C (88.9 °F)
12:0 (Lauric)	24%	50%	26%	3.6%	43.8 °C (110.8 °F)
14:0 (Myristic)	27%	56%	17%	1.6%	54.4 °C (129.9 °F)
14:1 (Myristoleic)	10%	45%	45%	Trace%	-4 °C (24.8^{0}F)
15:0 (Pentadecanoic)	40%	53%	7%	2.5%	51 to 53 °C (124 to 127 °F)
16:0 (Palmitic)	46%	42%	12%	23.5%	62.9 °C (145.2 °F)
16:1 δ9 (Palmitoleic)	40%	37%	23%	27.0%	−0.1 °C (31.8 °F)
18:0 (Stearic)	58%	20%	22%	10.0%	69.3 °C (156.7 °F)
18:1 δ9 (Oleic)	43%	25%	32%	21.0%	13 to 14 °C (55 to 57 °F)
18:2 δ9,12 (Linoleic)	40%	40%	20%	1.8%	−5 °C (23 °F)
18:3 δ9,12,15(α-Linolenic)	39%	32%	29%	0.4%	-11°C (12 °F)
Other				8.3%	

The melting profile for milk fat is correspondingly complicated. It appears to have at least 5 separate melting peaks and at least two crystallization points. (There may be more, and there are some points where the fat is melting as one form of crystal and recrystallizing into another at the same time.)



From: Melting and Crystallization DSC Profiles of Milk Fat Depending on Selected Factors, 2013, Jolanta Tomaszewska-Gras

It is good to note that at -30^{0}C (-22^{0}F) the fat has not completely hardened (when cooling at 5^{0}C/min) and when heating (same rate) it has not completely melted when the temperature is above 35^{0}C (95^{0}F). Most fats, such as coconut or hydrogenated soy oil, do not have this wide of a melting / crystallization range. This can have a strong effect on products when switching from, and to, milk fat. Melted fat is much easier to churn out and, when handling products containing milk fat, it is important to make sure most of the fat is in the solid form. Shear, such as that found in a pipe elbow or centrifugal pump,s can cause dairy products with liquid or partially liquid fat globules to agglomerate and form visible deposits of fat in the product and on the surfaces that come into contact with the product. This is also the reason for the need for ageing times in ice cream and for chilling whipping cream before whipping. Both ice cream and whipped cream depend on a partially agglomerated (partially churned) structure for their stability after whipping. Fat that is mostly solid can form microscopic connections between particles of fat and this results, in the dry appearance and more ridged structure of properly whipped cream and ice cream. Further, during fat crystallization depending on cooling rates emulsifier types and fat composition the fat in the globules can crystallize in different ways. Like chocolate, the structure of the fat that results can have an effect on the properties of the product. For example, under certain circumstances the fat can be encouraged to form crystals that emerge from the fat globule surface. This causes the fat globules to take on somewhat irregular shapes (as opposed to spherical). These irregular shapes are thought to encourage agglomeration resulting in the ability of a whipped product to maintain its shape after melting.



So far I have explored some of the physical properties of the fat in milk. It is important to understand it's packaging in the milk as well. It is important to understand this because fat and water do not mix. Anything that is hydrophobic in the vicinity will accumulate at the water – fat interface. Under normal circumstances the fat in milk exists in small particles called fat globules. In milk there are approximately 10^8 fat globules for every milligram of fat; for homogenized milk there are about 10^{11}. Fat in cow's milk has an average diameter of 3 microns and ranges between .02 and 10 microns. The diameters are roughly distributed normally (bell shaped curve) about the average. When the mammary cell assembles the fat to be expressed into the milk, the cells push the fat out through their cell membranes. The cell membrane is composed of phospholipids and proteins and these are deposited, along with some cytoplasm components, on to the fat particle during this process. As soon as the milk has been expressed from the secreting cells a sort of equilibrium is formed with the fat globule membrane and the other milk components. Some proteins (phospholipids etc.) from the milk exchange with those within the (original) fat globule membrane. Although this equilibrium is quickly formed, it is always dynamic with molecules coming and going onto and off the membrane constantly. During homogenization (I will talk about homogenization more completely in another chapter) the shear that the fat globules are subjected to easily strips the (native) fat globule membrane from the fat. And in this process the fat globule size will be altered so that there are many more, smaller globules. Because of the increased number of small fat globules there is a corresponding huge increase in total fat globule surface area. This increase in surface is energetically disfavored because of the hydrophobic nature of fat. The deficit in surface active material generated by homogenization is filled by protein, mostly casein (casein has emulsification properties) and any other surface active components in the product being homogenized (original fat globule membrane components, emulsifiers, other protein, phospholipids, etc.) that are in the vicinity of the fat globule. If these materials are insufficient to cover the fat globules completely an interesting phenomenon happens. Cream with a high butterfat and low milk solids nonfat when homogenized will have such a deficit in membrane material. The fat will then be incompletely covered and will then be able to spontaneously agglomerate in order to expose less of the fat surface to the water. The first result of this will be a larger fat globule average size. Second, there will be a tendency to churn if agitation levels are high enough. If the product is handled correctly, on cooling the cream will solidify into a mass similar to sour cream but at a neutral pH. This effect is related to why ice cream requires more emulsifier at lower fat than it does for higher fat. In ice cream, the whipped structure is produced by partially agglomerating the fat in the freezer. In high fat ice creams (above 12% dairy fat) there is a slight deficit in membrane material this allows the fat to agglomerate during whipping. In low fat ice cream, there is an excess of protein surrounding the fat globules, this acts to prevent agglomeration and the formation of a fat structure in the product. Emulsifiers, especially fat soluble emulsifiers are used to displace some of the protein from the fat globule surface, which in turn helps encourage agglomeration, allowing the desired structure to form. The partial agglomeration of fat can lead to accelerated creaming of the fat into a dense layer of fat. This is because the partially coalesced fat forms larger diameter particles. These rising particles gather even more particles, as they raise and this accelerates the creaming. At the top of the container the agglomerated fat can further agglomerate and form a plug of dense cream at the top of a container. This plug can be strong enough to allow the bottle to be turned upside down without the contents escaping. This phenomenon can also cause problems, if the protein has been affected by processing like high temperature pasteurization, drying, acidification or any other process that will affect the protein, the functionality of the membrane will be affected as well. Often, for instance, products made using dry protein sources can cause problems when the same formulation using wet products does not. The reason for this is that the dry protein requires a much longer period of hydration in order to relax into a more native state where it has sufficient interface functionality (it may never regain it all). This can result in differences between plants where one plant uses dry milk powder and the other uses condensed milk. Similarly, production schedules where the hydration times are varied can cause inconsistencies within the schedules.

It is important for dairy product developers to be cognitive of the importance of fat in their products even at very low levels. A grasp of the physical states of fat and how they can interact with the other components in dairy products is critical to producing quality products for the consumer.

Cottage Cheese – The Forgotten High Protein Food?

By Doug Vargo

This seems like a lighter vegetarian main dish made with cottage cheese that might be delicious as we approach the Spring and need to shed a few pounds! If you love quiche or spinach pie, you are going to love this recipe. Enjoy!



Spinach Pie or Quiche Made with Cottage Cheese

- 1 onion, chopped
- 2 cloves of garlic, minced
- 1-10 oz. pkg. of frozen chopped spinach thawed
- ¾ cup of cottage cheese
- 1 cup grated Muenster cheese
- 1 cup of whole milk
- ½ tsp. dried thyme leaves
- 3 eggs
- ½ cup Jiffy baking mix
- ¼ tsp. pepper
- ⅓ cup grated Parmesan cheese
- ⅓ tsp. ground nutmeg

Bake Time: 35 minutes

Prep Time: 15 minutes

Yield: 6-8 servings

Directions: Preheat oven to 350F. Grease a 9” pie pan or plate and set aside. Drain spinach in a colander, dry excess moisture with a paper towel. Heat some olive oil in a skillet and cook the onion and garlic until tender (about 4 minutes). Stir in drained spinach. Place this mixture in the prepared pie plate and top it with the cottage cheese and Muenster cheese. In a medium bowl, combine milk, thyme, eggs, baking mix, and pepper. Mix with a wire whisk until smooth. Pour this mixture over the cottage cheese/muenster in the pie plate. Sprinkle the top with the Parmesan cheese and nutmeg.

Bake in a 350 degree oven for 30- 35 minutes until a knife inserted in the center comes out clean. Let it cool 5 minutes before serving. Enjoy!

Discussion Threads – Questions from the Field

By Doug Vargo

Question: You talk about cottage cheese a lot! What does the ideal cup of cottage cheese look like in regards to dressing or free dressing? And what are common dressing-to-curd ratios for small curd cottage cheese?

Answer: The amount of cottage cheese dressing applied to the cottage cheese curd is a subjective thing. You want to have enough dressing on the curd so that the finished cottage cheese does not appear dry and pasty in the finished carton. (See photo 1 below). Conversely, you do not want to have so much dressing on the curd that the finished cottage cheese looks wet and soupy. (See photo 2). Therefore, the short and sweet answer is to apply as much dressing on the cottage cheese curd as the curd will take. Absorption in to the curd will be completely dependent upon curd texture. A firm and mealy cottage cheese piece will not absorb as much dressing as a properly cooked porous and meaty curd piece. An undercooked curd piece will be soft, wet, and mushy and again will not absorb the cottage cheese dressing very well.

Photo 1

Photo 2

A properly cooked vat of small curd cottage cheese will be meaty, yet porous enough to absorb a fair amount of dressing (see photo 3). Personally, I like slightly more dressing on the cottage cheese curd than what is shown in photo #3.

Photo 3

Remember cottage cheese is consumed at the earliest 3-5 days from the packaging date, and most often 10 days later or more, so enough dressing needs to be applied initially so that the cottage cheese does not get dry and pasty (as in photo #1). Dressing cottage cheese is like taking a leap of faith initially, put enough dressing on that it looks slightly wet on day 1-3 so that it doesn't dry up during the shelf-life or in 10-20 days or so when it is most likely consumed. If you have ever had a cup of dry and pasty cottage cheese, I can say from experience you are not going to run back and purchase another one anytime soon!

<u>Dressing-to-curd ratios</u>: In the past having a 43% dressing to 57% curd ratio was considered average and probably the norm. Now in today's marketplace, small curd dressing ratios of 48-50% are common, and some dairies can achieve a 52% dressing to 48% curd ratio in their small curd cottage cheese. As you know, dressing is lower in cost pound for pound than cottage cheese curd is. Therefore, the more dressing you can put on the cottage cheese curd, the more money your dairy is making on their cottage cheese! Guess which dairy is making money and which dairy might not be with the small profit margins that the larger supermarket and club stores are now giving? A dairy once told me if they didn't dress their cottage cheese curd at 50% dressing and 50% curd, they didn't make any money when they sold it to their largest supermarket customer. Another plant manager told me that his dairy made >$100,000 more per year when they would do nothing more than raise the dressing to curd ratio from 43% dressing added to the curd to 46% added to the dry curd. The pressure is on more than ever for the cheese cooks to get that curd texture just right, so that those higher dressing to curd ratios can be achieved without having the cottage cheese appear wet and soupy. If you need help in achieving higher dressing to curd ratios and think you need a different cottage cheese dressing stabilizer, then DuPont's Hi Dress Stabilizer 1880 might be just the product that you need. Contact me or your local DuPont sales representative today!

We hope you have enjoyed the latest issue of "DuPont Insights for Cultured Dairy." See you next issue!