Wisconsin Center for Dairy Research

Dairy Pipeline

A Technical Resource for Dairy Manufacturers Volume 20 Number 2 2008

New mozzarella breaks lowfat impasse

Researchers have focused on improving lowfat cheese for the last 20 years; although the progress certainly shows, some problems remain. Consumers aren't always happy with the flavor, texture and functionality of lowfat cheese. Fat carries flavor in many foods and cheese is no exception. Thus, cutting back on fat often has a negative effect on the flavor, as well as the texture of cheese and how it melts and flows. Some solutions that improve the functionality—the melt, flow, and sliceability—adversely affect the color of the cheese; other solutions shorten the shelf life.

John Lucey, Associate Professor of Food Science at the University of Wisconsin—Madison and his colleagues at the Center for Dairy Research (CDR) have recently solved some of these lowfat cheese problems by approaching the dilemma from a different angle. With an eye on the cheese used in the school lunch program, they wanted to develop a lowfat cheese that works on pizza and in other food service applications. The new approach involves turning a functional base cheese into a lowfat process cheese that does indeed work on pizza. Here is how it evolved.

Tailoring cheese to meet particular needs is old hat for this group of researchers and they used the same problem solving approach when faced with the challenge of improving lowfat cheese. In addition, they relied on years of cheesemaking experience and decades of scrutinizing the science of making cheese. First they focused on producing a low fat base cheese. They systematically varied the make by trying different types of acids during preacidification, as well as varying the pH at rennet addition.

The new approach involves turning a functional base cheese into a lowfat process cheese that does indeed work on pizza.

By getting the pH down to 5 they were able to produce a cheese with good melting characteristics, but it was sticky and gooey. Finally, they settled on a higher pH and adding citrate, which produced a cheese that had a good melt but wasn't sticky. At a molecular level, the citric acid chelates the calcium, pulling it away from the casein and tying it up. As those casein micelles pull apart the result is a smoother, whiter cheese. (See sidebar.)

Satisfied with a base they could work with, the team started phase 2, turning the base cheese into a process cheese. Graduate student Ciara Brickley served as the eyes and ears for the scientists as she made many bench top batches of cheese and later scaled up the best possibilities in the pilot plant. Over and over again they adjusted the amount and type of melting salts and evaluated the results. Lucey notes that they produced some cheese that was close, "But it wasn't what we really wanted."

Then he found himself thinking about emulsifiers used in other foods and decided to try adding fat emulsifiers, specifically, mono and diglycerides. These agents are pretty common, they are found naturally in milk. Some companies add fat emulsifiers to dough to alter the texture of dough and make it smoother.

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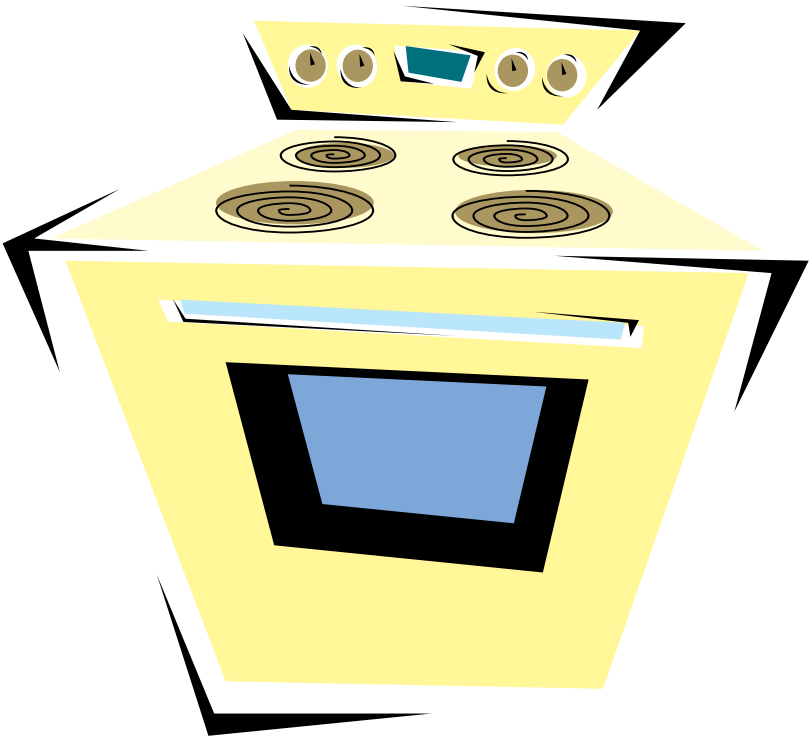
The research team used the same approach of adding varying levels of mono and diglycerides to the base cheese and then making it into a process cheese. They started at amounts comparable to those used when adding melting salts like sodium phosphates to process cheese. However, when they impulsively doubled the amount of glycerides they noticed a remarkable effect. This cheese was chewy enough, but not sticky, and white, with a very nice melt and flow—all desirable characteristics, especially on pizza.

"It's different," says Mark Johnson. "It has a bland flavor, not an off-flavor. And, it holds up."

During earlier trials, when the research team had tried adding other melting salts, they could taste the phosphate, so in this case bland is a plus. They then tried adding a few flavors to the cheese, including pepperoni which "baked through" allowing the flavor to survive after being baked on a pizza. This cheese looks good, too. When the team tried other emulsifiers their lowfat cheese was translucent. Not with their final, successful effort—this cheese remains white.

"It's different," says Mark Johnson. "It has a bland flavor, not an off-flavor. And, it holds up."

When it comes to baking, cheese can be finicky. Forced air, deck, and turbo ovens are three different oven types with three different effects on pizza cheese and its functional properties. Melt, flow and color are affected, and in the case of lowfat and nonfat cheese, a thin skin that looks like a plastic sheet can develop on the surface. However, this new cheese is flexible in the oven. Since it flows at a lower temperature, you can bake it at a lower temperature and avoid the skinning defect. You can also use a "regular" oven to bake a pizza with this cheese.



Rani Govindasamy-Lucey adds that, "Another plus offered by this mozzarella cheese is reduced or low sodium." Replacing melting salts, which contain sodium, with mono and diglycerides means decreasing the sodium levels in the cheese. This is important for many people who have been advised to limit their salt intake, including people with high blood pressure, cardiovascular disease, asthma, kidney disease and migraine headaches. The researchers have applied for a patent on their process and if you would like to know more about this lowfat mozzarella contact John Lucey at jlucey@cdr.wisc.edu.

Our hypothesis to explain the impact of pH on stickiness in direct acidified cheese

By Rani Govindsamy-Lucey

One of the key defects in nonfat process cheese is excessive cohesiveness and adhesiveness. This cheese can be very sticky and hard to cut (machinability issues) and it is also hard to eat since it can stick to both fingers and teeth. We believe that a nonfat cheese base made by direct acidification of milk has these attributes because of the excessive loss of insoluble calcium, which greatly increases the mobility of the casein molecules. In a critical region of pH, where there is considerable loss of insoluble calcium, the cheese becomes a tacky, cohesive, viscous material. Olson and co-workers originally observed this several decades ago in direct acidified mozzarella if they removed too much calcium. (Keller, B., Olson, N.F., Richardson, T., 1974. Mineral retention and rheological properties of Mozzarella cheese made by direct acidification. J. Dairy Sci. 57:174-180).

In direct-acidified cheeses, we think that this stickiness is caused by excessive cohesive interactions between casein molecules during the highly mobile fluid-like state seen in a low pH cheese curd. These cohesive interactions are primarily hydrophobic associations between hydrophobic residues on caseins. If cheese is directly acidified to pH 5.0, this cheese has lost most of its insoluble calcium, but this cheese base is not sticky. In the vicinity of pH 5.0, there are increased electrostatic attractions between caseins with the approach of the isoelectric point. (Lee, M.R., Johnson, M. E. and Lucey, J. A. 2005. Impact of modifications in acid development on the insoluble Ca content and rheological properties of Cheddar cheese. J. Dairy Sci. 88:3798-3809).

A loss of insoluble calcium cross-linking material increases the mobility of casein interactions, allowing caseins the molecular freedom to associate hydrophobically. As long as the pH is above pH 5.0 there is a sufficient low negative charge repulsion to help prevent excessive electrostatic attraction between caseins. Low pH results in enhanced electrostatic attraction, which reduces casein bond mobility and thus reduces stickiness. Hydrophobic interactions between caseins can be disrupted by the addition of oil or hydrophobic coatings, for example, lecithin is sometimes sprayed between slices of process cheese if the slices are sticky.

Milk Markets and More

by Brian W. Gould, Associate Professor, Agricultural and Applied Economics University of Wisconsin—Madison

Summary of the Dairy Subtitle of the Food, Conservation, and Energy Act of 2008 (2008 Farm Bill)

The Food, Conservation, and Energy Act of 2008, also known as the 2008 Farm Bill, was enacted by Congress on May 22 after both the Senate and the House voted to override President Bush's veto of the bill on May 21. Actually, only 14 of the 15 titles of the Farm Bill became law on May 22. Title III (Trade) was inadvertently omitted from the version of the Bill that was vetoed and then overridden by Congress. A parliamentary decision enacted the 14 titles that were dealt with and left the Trade Title in limbo at this writing.
In contrast to the last two farm bills, dairy was not the cause of the lengthy delay in enacting the 2008 Agricultural Act. No major changes from current dairy policies were proposed by either the House or Senate.

Highlights of the 2008 Dairy Subtitle

The Milk Price Support Program is re-named the Dairy Product Price Support Program. USDA continues to purchase butter, nonfat dry milk and cheddar cheese at the same prices applicable under previous legislation, but the prices are no longer linked to a support price for milk. The current support prices are:
Butter: $1.05
Cheddar Cheese: Blocks: $1.13, Barrels: $1.10
Nonfat Dry milk: $0.80

The Secretary of Agriculture may (but is not required to) reduce the purchase prices for butter, nonfat dry milk, and cheese if government removals exceed specified levels in any 12-month period. This provision replaces the butter-powder tilt provision in the previous three farm bills. Table 1. describes situations that may lead to price reductions.

The 1996 Farm Bill involved regional frictions related to the proposed changes in milk marketing orders and creation of the Northeast Interstate Dairy Compact. In 2002, attempts to reinstate the compact reignited regional differences and ultimately led to the Milk Income Loss Contract (MILC) program. (For historical background, see Jesse and Cropp, *Dairy Title, Federal Agricultural Improvement and Reform Act of 1996*, Marketing and Policy Briefing Paper No. 55, April 1996; and Jesse and Cropp, (found at http://future.aae.wisc.edu/pubs/pubs/show/328) and *Dairy Title: Food Security and Rural*

Table 1.

Authorized Reductions in CCC Purchase Prices if Net Removals for 12 Consecutive Months Exceed Triggers Amounts		
Product	Net Removals Trigger	Maximum Authorized Price Reduction/lb
Cheddar cheese	Greater than 200 mil. lbs. but less than 400 mil. lbs. Greater than 400 mil. lbs.	10 cents 20 cents
Butter	Greater than 450 mil. lbs. but less than 650 mil. lbs. Greater than 650 mil. lbs.	10 cents 20 cents
Nonfat dry milk	Greater than 600 mil. lbs. but less than 800 mil. lbs. Greater than 800 mil. lbs.	5 cents 10 cents

Investment Act of 2002, Marketing and Policy Briefing Paper No. 76, May 2002. (Find it at: http://future.aae.wisc.edu/pubs/pubs/show/19)

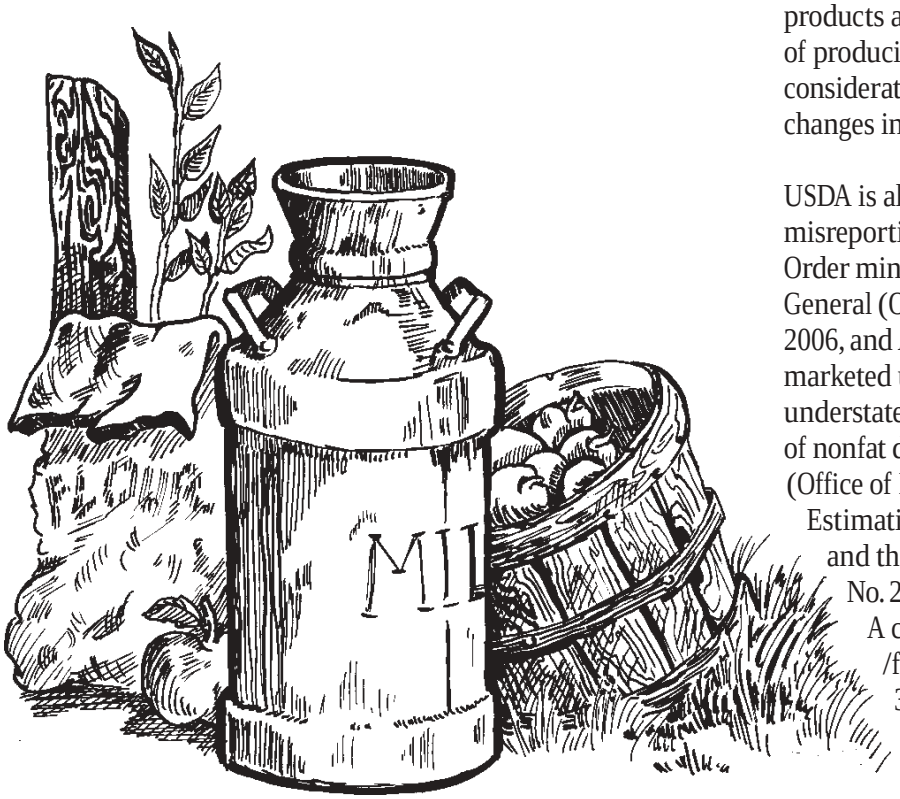
Under the 2008 Farm Bill, the MILC program is reauthorized with several changes in program parameters. First, a feed cost adjuster to the target Class I price was adopted. The adjuster is based on the estimated cost per hundredweight of a 16 percent protein dairy ration that USDA uses to calculate the Milk-Feed Price Ratio. The initial base feed cost is $7.35/hundredweight(cwt), increasing to $9.50/cwt in September 2012.

In addition, when the market price falls short of the target price the portion of the amount paid out on eligible milk is raised from 34 to 45 percent. Also, the production cap per farm is raised from 2.4 million pounds annually after 2008 to 2.985 million pounds.

Dairy Promotion and Research Program

There are two changes to the farmer-funded dairy promotion and research program. Assessments will now be collected from previously exempted dairy farmers in Alaska, Hawaii and Puerto Rico. Also, imports will be assessed at a rate of one-half the rate applying to U.S. milk production (7.5¢/cwt equivalent).

The Dairy Forward Pricing program that operated on a pilot basis from 1999 through 2004 is reinstated as part of the 2008 Bill. It is applied to milk not classified as Class I and producers can continue to use minimum payment provisions of the Federal Milk Marketing Order system. No forward contract can be initiated after Sept. 30, 2012 and no contract can extend beyond Sept. 30, 2015.



The Dairy Export Incentive Program (DEIP) and the Dairy Indemnity Program are extended intact. Thus, mandatory reporting of dairy product sales data is reauthorized and an electronic reporting system is enabled, although the electronic reporting system will be established subject to the availability of funds. Currently, sales data (with a one week lag in the reported data) is reported weekly. For example, the weekly NASS report published on May 23rd contained dairy product sales data associated with the week of May 17th. In 2008 the increased frequency of data reporting is emphasized. In the final Bill, there is no mention of the daily reporting requirement specified in the original Senate version. There is an obvious escape clause in this provision since funds need to be appropriated to increase the reporting frequency provisions.

USDA is required to take steps to expedite the process of amending Federal Milk Marketing Orders. Although hearing timeframes are established, the entire process for amending a Federal Order after receiving a proposal would still be at least one year under these new rules. In any hearing considering adjustments to Federal Order make allowances used in pricing formulas, USDA is required to calculate and consider prices of feed and fuel incurred by dairy farmers in the relevant marketing area. Given that make allowances are set in reference to the cost of manufacturing dairy products and they have no relationship to the cost of producing milk, it is unclear why these considerations are necessary when considering changes in make allowances

USDA is also required to study the impact of misreporting of nonfat dry milk prices on Federal Order minimum prices. USDA's Office of Inspector General (OIG) estimated that between April 29, 2006, and April 14, 2007, the total value of milk marketed under the Federal Order system was understated by $50 million due to a misreporting of nonfat dry milk prices and quantities sold. (Office of Inspector General, 2008. Survey and Estimation Internal Controls for Nonfat Dry Milk and the Dairy Products Prices Report, Report No. 26901-01-IR, Washington D.C., February. A copy of this report can be found at: http://future.aae.wisc.edu/pubs/pubs/show/326).

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Within 90 days of enactment, the Secretary of Agriculture is required to submit to the House Agriculture Committee and the Senate Committee on Agriculture, Nutrition and Forestry a report outlining previous and current reporting procedures for nonfat dry milk. The Secretary is instructed to provide an assessment of the impact of these procedures on Federal Order minimum prices for the period July 1, 2006, through May 22, 2008 and will augment the analysis already conducted by OIG.

The Farm Bill language also creates a Federal Milk Marketing Order review commission to evaluate current federal and state milk pricing regulations and provide related recommendations for change to Congress. The Commission is charged with considering legislative and regulatory options for ensuring and enhancing the future competitiveness of dairy products, both in the U.S. and abroad, ensuring transparency in dairy pricing, and simplifying the Federal Order system. The Commission is also asked to evaluate whether the Federal Milk Order system serves the interests of producers, processors, and consumers and to study the costs and benefits of adjusting milk composition standards.

USDA is required to take steps to expedite the process of amending Federal Milk Marketing Orders.

Resources

For more information about the 2008 Farm Bill, refer to the section of the Understanding Dairy Markets website dedicated to a review of the 2008 Farm Bill (http://future.aae.wisc.edu/farm_bill.html).

Much of the material contained in this issue was obtained from Jesse, Cropp and Gould, 2008. *Dairy Subtitle: Food, Conservation, and Energy Act of 2008*, Marketing and Policy Briefing Paper #94, Dept. of Ag. and Applied Economics, University of Wisconsin-Madison, http://future.aae.wisc.edu/pubs/pubs/show/329

A full copy of the entire farm bill can be downloaded from: http://future.aae.wisc.edu/publications/farm_bill/2008_Farm_Bill_GPO.pdf

A copy of just the Dairy Subtitle can be downloaded from: http://future.aae.wisc.edu/publications/farm_bill/dairy_title.pdf

Introducing a new short course:

Cheeses of Ireland and the United Kingdom

September 9-10, 2008

The details
This two-day short course will cover the broad range of cheeses from acid, crumbly, and farmhouse to the British Blues. You will learn about the differences between cheeses from the various regions of these countries. In addition, pilot plant cheesemaking will help explain the variety of physical and flavor characteristics of the cheeses. Discussions will also include managing the aging process to produce unique flavored cheeses.

This short course is organized for all cheesemakers interested in producing unique Irish and English cheeses and for cheese processors and marketers interested in handling these specialty cheeses for value-added markets. This course qualifies as an advanced artisan course for Wisconsin Master Cheesemakers and is a required course for candidates in the Wisconsin Master Cheesemaker® Program.

Featured speakers include: Simon Porter, Cargill (UK), Mateo Kehler, Jasper Hill Farm, John Lucey, UW Food Science, Scott Rankin, UW Food Science, and Bill Novak, Novak's Cheese Enterprises, LLC

For further information:
Registration
CALS Conference Services at (608) 263-1672
Program
Dean Sommer (608) 265-6469
John Jaeggi (608) 262-2264

Enroll by August 22, 2008

Curd Clinic

Curd clinic doc for this issue is Mark Johnson, CDR

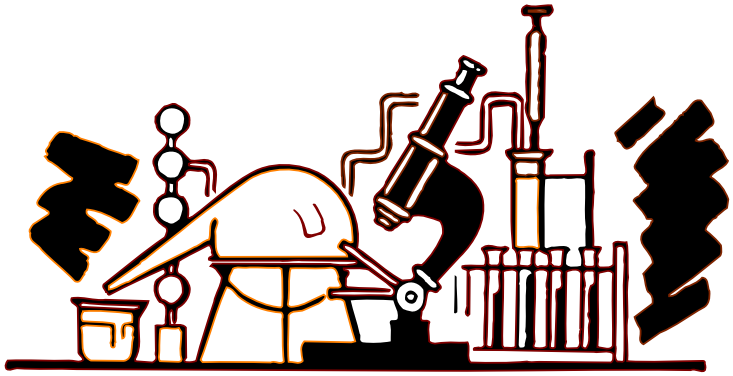
Q. I have a very basic question for you: what is the difference between acidity and pH?

A. Ahhhh, this is a complex question! And it can have a complex answer. Let's start by taking a closer look at the question and consider who might be asking it, because that will influence the answer. When we talk to a group of cheesemakers, a few of them may be tracking the acid development in their cheese by measuring titratable acidity, and now they want to know how this compares to pH. If I am working with cheese graders, they may be thinking of the cheese standards and the definition of acid flavor defects, which may or may not be related to a low pH. A group of research chefs might ask this question as they ponder over both flavor defects and the mysteries of pH, wondering if acidity and pH are indeed the same thing. Context will influence the answer, just as it influenced the question.

Why it is important to cheesemakers

It is important to clarify this concept because the key to making good cheese involves controlling both the rate and extent of acid development. The pH, and the pH history (or the record of pH over time), is a major factor influencing the physical properties of cheese. For example, the pH may go down to 5.0 and then it might come back up to 5.6 over three months. We want to know that history. Thus, if the cheesemaker is going to press a cheese overnight, we tell them to measure pH at 12 hours. If the pH drops to 5.4 and stays there, we know the cheese will be curdy, but if the pH comes back up, then the final cheese will be smoother. (The "Rise and Fall of pH" was covered in detail in the Dairy Pipeline, Vol. 14, Number 4, 2002)

It wasn't too long ago that most cheesemakers measured the titratable acidity of milk and whey to follow the acid development during cheesemaking. In an early issue of the Dairy Pipeline (Vol 2, No.3, 1990) Norm Olson compared the difference between measuring pH and titratable acidity. He points out that pH measures free hydrogen ions, but titratable acidity measures anything that neutralizes the base used in the test. This means several components in milk, like proteins, phosphates, citrates, or CO_2 (carbon dioxide), can



masquerade as acids and influence the measurement of titratable acidity. Thus, milk composition adds another variable to the test. For this reason, most cheesemakers have switched to using pH.

To me personally, referring to acid cheese instinctively means that it is low pH. That's what I learned in chemistry class and that is the language I use to describe it. When I talk about an acid cheese, besides a low pH, it has certain characteristics, like a short body, or it may be brittle or grainy. Cheese graders might interpret acid to mean the cheese is high in lactic acid flavor, but not necessarily a low pH.

It is important to understand the concept of acidity to understand cheesemaking and it is important to understand acid cheese to understand cheese defects. Acid cheese defects are right up there on the top of the list of cheese defects. (See "Cheese Defects in U.S. Graded Cheeses" Dairy Pipeline, Volume 15 No. 3, 2003)

Like I said in the beginning, this is a complex concept, and I hope I have helped to clarify it for you.

Acid flavor defect

From USDA, Ag. Marketing Service, Dairy Programs
Acid flavor is a defect which results from excessive microbial acid development during any stage of cheesemaking or curing. It may occur by using high acid milk, ripening too long before setting, using an excessive amount of starter, large or uneven cutting of the cheese curd, leaving the curd in the whey too long before draining, cooking too fast, improper draining of whey from the curd, or any other practice which causes the development of acid faster and to a greater extent than normal. Many times the acid flavor is associated with low pH and low salt content.

Historical descriptions of assessing acid development

The hot iron test

From *Cheese Making*, by John W. Decker, 1900

When there is an eighth of an inch of acid on the curd, the whey should be drawn off. Strictly speaking, acid cannot be measured by the inch, but the acid seems to act on the curd in some way, so that when a piece is touched to a hot iron and drawn away, it will leave fine, silky threads behind, sticking to the iron. With normal working milk, when the curd is first cooked up, it will not string at all; but when the acid has reached a certain strength it will begin to string, at first barely sticking to the iron, and as the acid increases, the strings will get longer, till they may be several inches in length.

However, if too much acid is added, it will make a soft, mushy curd, which will not string. The acid softens the curd so that it readily sticks to the hot iron. About two-tenths of one per cent of acid in the whey must be present to make it string an eighth of an inch. As the acid increases the strings get longer. Experience has taught us, that as a usual thing we cannot let the curd take more than one-eighth on an inch of acid in the whey without disastrous results.

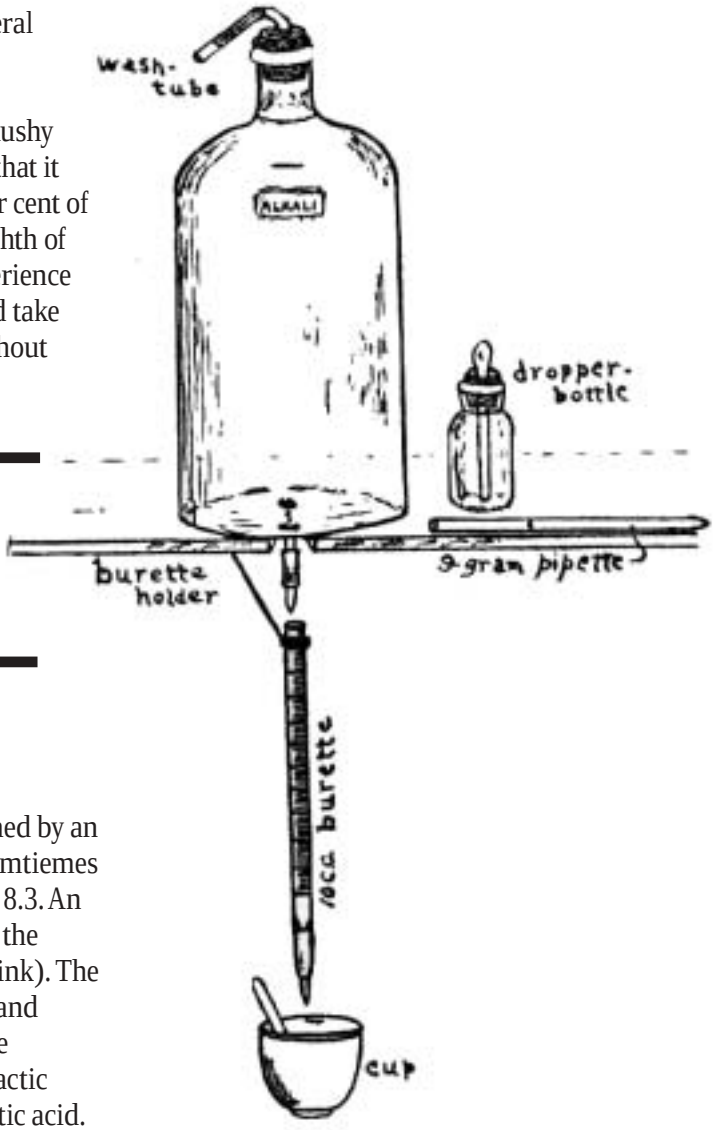


Illustration of titrable acid apparatus from *Fancy Cheese in America* by C.A. Publow, 1910

Titratable acid

UW Dairy Pipeline, December, 1990 Vol.2 No.3

The titratable acidity of milk or other liquids is determined by an incremental addition of a sodium hydroxide solution (somtiemes called base or alkali) to raise the pH of the milk to about 8.3. An acid-base indicator, phenolphthalein, is used to estimate the endpoint pH of 8.3 (solution changes from colorless to pink). The strength of the sodium hydroxide solution (0.1 normal) and amount (9 grams) are chosen so that the quantity of base required for titration can be converted to percentage of lactic acid in the sample. One milliliter of base equals 0.1% lactic acid.

News from CDR

If you are lucky, you have worked with someone like Bill Wendorff. He is not the loudest person in the room, but he is the one gets the job done. On time. With a smile. Although Bill is retiring from the Department of Food Science-Extension, at UW-Madison after 19 years, we anticipate occasionally finding him in his new office on the second floor of Babcock Hall. That is because we still need him!

In 1990, Bill started improving and adding short courses. The traditional cheesemakers introductory course had been taught here in Madison for 98 years. Bill added the latest research findings to the course, strengthening the technical background of attending cheesemakers. Bill went on to develop the grading short course, the waste management short course; in fact, he developed 18 different short courses reaching over 5400 students. He assisted over 560 apprentice cheesemakers in obtaining their state licenses. Professor Wendorff also made time for a research program, focusing on the physical and sensory problems in cheese and regulatory and environmental issues that had an impact on the dairy industry. He authored over 95 scientific papers and six book chapters.

Bill Wendorff

If Bill hadn't joined the UW faculty all those years ago, you might not even be reading this. Bill was instrumental in starting the UW Dairy Pipeline in 1989. I am hoping that contributing to the Dairy Pipeline is a habit Bill won't want to drop, because I still need him!

Susan Larson

Susan Larson joined the staff of CDR on June 25th , 2008. Susan earned a B.S. and M.S. in Food Science from the University of Tennessee-Knoxville and a PhD from the University of Minnesota and she comes to us with 21 years of industry experience at Kraft Foods in their Oscar Mayer division. Susan will be working with CDR's dairy ingredient and cheese groups on some product development projects. She will also be answering the DMI technical support line (1-800-248-8829) and handling Innovate with Dairy contacts.

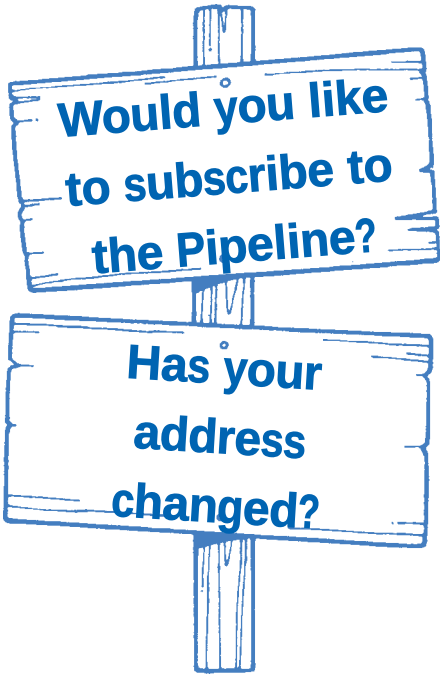
CDR/US-IDF to host 2012 IDF Symposium on cheese ripening and technology

Want an opportunity to network with cheese researchers, scientists and technologists from around the world? You will have to wait for a while, but it will be worth it. The United States and CDR will host the next IDF Symposium on Cheese Ripening and Technology in 2012.Previously this symposium, which is held every 4 years by a different host country, brought over 350 researchers and scientists from more than 30 countries to locations like Lund, Sweden; BesanÁon, France; Banff, Canada; Prague, Czech Republic; and this year Bern, Switzerland. The 2012 symposium planned for Madison, Wisconsin, will be the sixth such meeting and will cover topics such as cheese ripening, microbiology, characterization and flavor formation. More details will be shared as the 2012 program is developed and a meeting venue in Madison secured.

Sassy Cow Creamery Grand Opening, May 2008 From left Will Hughes, WI Dept Ag, Trade, and Consumer Protection, Jane Royer Carter, Dairy Business Innovation Center, Rob Baerwolf, James Baerwolf

Sassy Cow Creamery

Located seven miles north of Sun Prairie, Sassy Cow Creamery is Wisconsin's newest farmstead milk bottling facility. This creamery is unique, it offers both traditional and organic milk at the farmstead retail store. The Baerwolf family bottles milk from their nearby herds, a 100 cow organic dairy and a 400 cow traditional herd.



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Karen Paulus, Editor
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phone: 608/262-8015

You can also find the Dairy Pipeline on our website: www.cdr.wisc.edu

Calendar

June 28-July 1 IFT Annual Meeting, New Orleans, LA. For information see www.ift.org.

July 7-10 American Dairy Science Association Annual Meeting, Indianapolis, IN. For more information see www.adsa.org.

July 23-26 American Cheese Society Annual Meeting. Chicago, IL. For info, see www.cheesesociety.org.

Aug. 3-6 International Assn. for Food Protection Annual Meeting, Columbus, OH. For information see www.foodprotection.org.

Aug. 5-6 Milk Pasteurization and Process Control School. Madison, WI. Call Scott Rankin at (608) 263-2008 for information, or the CALS Outreach Services (608) 263-1672 to register.

Sept. 9-10 Cheeses of Ireland and the UK, Madison, WI. Call John Jaeggi at (608) 262-2264 or Dean Sommer at (608) 265-6469 for information.

Sept. 30-Oct. 5 World Dairy Expo, Madison, WI. For information see www.world-dairy-expo.com.

Oct. 6-10 Cheese Technology Short Course, Madison, WI. Call Mark Johnson at (608) 262-0275 or Bill Wendorff at (608) 263-2015.

Oct. 30-31 Dairy Ingredient Manufacturing Workshop, Madison, WI. Call Karen Smith at (608) 265-9605 or Bill Wendorff at (608) 263-2015.

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