Wisconsin Center for Dairy Research

DAIRY PIPELINE

A TECHNICAL RESOURCE FOR DAIRY MANUFACTURERS

VOLUME 22 NUMBER 1, 2010

Take a timely look at dried dairy ingredients

by Karen Paulus, Wisconsin Center for Dairy Research

Did you know that you can replace the salt in baked goods with dried dairy ingredients? If you attended the Scottsdale 2010 Dairy Innovation Forum or the Dairy Ingredient Symposium in San Francisco then you might have discovered that whey permeate not only replaces salt but it also improves the flavor of an almond apricot muffin. CDR's Dairy Ingredients group went to both meetings, offering attendees samples of three different formulations of the muffin: a control muffin, a muffin with deproteinized whey permeate (DPW), and a muffin with delactosed permeate (DLP). The overwhelming favorite was muffin number 2; in this informal session most people preferred the muffin which contained deproteinized whey. (See Figure 1.) Why did it taste better when the salt was replaced with DPW?

Deproteinized whey is actually the dried permeate stream, left behind when more valuable whey proteins are separated and removed by a filtration process. (See Figure 2.) Permeate also remains behind when ultra filtered (UF) milk is sent off on its way to the cheese vat. Delactosed permeate is left after processing permeate to remove lactose, it has half the lactose as permeate. (See Figure 3.) You can think of permeate as the quilting scraps, or maybe the soup bones of whey processing. This isn't a Cindarella story, but permeate might be more useful and have more value than we thought.

Surprisingly, you can use a significant amount of dried permeate (5-8%) in products like muffins, scones, and cookies and maintain the original quality, or even surpass it. (See Dairy Pipeline Vol. 17 No. 4 for more discussion.) Permeate improves the surface browning and the crumb texture of these baked goods while providing a clean dairy flavor. However, there is another significant benefit gained from using permeate in these products—you can leave out the salt. (See Figure 4.) Permeate does contain 0.6% sodium, but it also has a "salty" flavor and these two factors make up for the skipped salt. The real advantage appears on the ingredient label. For example, skipping the salt and adding DPW lowered the sodium from 230 mg in the original to 70 mg in muffin number 2.

Functionality of lactose

When you look at the composition of DPW and DLP (See Figure 5 on page 3). you can see that they both have a high percentage of lactose. Lactose provides a unique functionality in baked goods. It participates in the Maillard reaction, and the result is the nice surface browning mentioned earlier. Lactose also absorbs volatile flavors and attracts and absorbs synthetic and natural pigments, thus improving color and flavor.

continued on page 2

What's Inside:

Continued from page 1

Figure 1. Apricot almond muffins

Ingredients	Number 1 Control Muffin (230 mg sodium)	Number 2 w/DPW (70 mg sodium)	Number 3 w/DLP (90 mg sodium)
Unsalted butter	6.59	6.59	6.59
Sugar	5.78	5.78	5.78
Almond Paste	4.45	4.45	4.45
Water	21.27	23.12	23.12
Whole egg	12.72	6.43	10.19
All Purpose Flour	34.68	34.68	34.68
Baking Powder	1.16	1.16	1.16
Salt	0.52	---	---
Deproteinized Whey	---	4.96	---
Delactose Permeate	---	---	1.20
Dried Apricots	7.63	7.63	7.63
Sliced Almonds	5.20	5.20	5.20
Total	100.00	100.00	100.00

Figure 4. Replacing sodium with permeate in baked goods

Product (Serving Size)	Control Sodium Content (mg)	DPW/No Salt Sodium Content (mg)
Scones (55 g)	230	110
Chocolate Chip Cookies (30 g)	100	40
Snack Cake (55 g)	45	40
Pound Cake (88 g)	150	80
Muffins (55 g)	230	85

Procedure for making muffins:

Mix butter, sugar, almond paste in mixer until well blended.
Add water, eggs and beat several minutes until blended.
Add dry ingredients, flour, baking powder and salt, to wet ones, mixing just until incorporated; careful not to over mix.
Gently fold in apricots and almonds.

With a #16 scoop, place batter into muffin pan treated with no-stick baking spray. Bake at 375º F (188º C) for 14 minutes.

Yield: 12 Muffins

continued from page 1

Permeate contains non-protein nitrogen compounds, like urea, creatine, creatinine, uric acid, orotic acid, and ammonia which can act as flavor potentiators in food and enhance salty flavor, another influence that may contribute to successfully replacing salt with permeate.

Calcium enhances flavor perception

Recent research published in the Journal of Biological Chemistry (Vol 285, No. 2, 2010) describes a role for calcium sensing receptors in taste perception. Humans can identify five basic tastes; sweet, sour, salty, bitter, and umami. We also respond to a variety of substances that enhance these basic tastes. The kokumi taste, first described in 1990, was isolated from extracts of garlic and onion. Tasteless on its own, it enhances the umami taste in the presence of monosodium glutamate (MSG). Now, calcium has been added to the list of candidates that invoke kokumi taste and enhance flavor perception. It is possible this is another factor behind the ability of permeate to replace salt.

Replacing salt in baked goods is an encouraging beginning, but other enticing ideas include using DPW and DLP in high sodium food categories like soups, sauces, processed meats and process cheese. And consider this, snack seasonings with less sodium and more flavor! We believe it's possible.

Questions about replacing salt with permeate? Contact KJ Burrington at the Center for Dairy Research. Phone: (608) 265-9297 Email: burrington@cdr.wisc.edu

Figure 5. Permeate Ingredients

Composition	Deproteinized Whey[1] (DPW) %	Delactosed Permeate (DLP) %
Protein *(non-protein nitrogen)	3.50*	7.32
Carbohydrate (Lactose)	82.00	59.60
Fat	<1.0	0.03
Moisture	4.50	3.00
Ash	8.50	26.97
Sodium	0.83	2.00
Calcium	0.44	3.76
Potassium	2.47	6.29
Magnesium	0.11	0.24

[1]Also referred to as permeate, high lactose whey, or dairy product solids

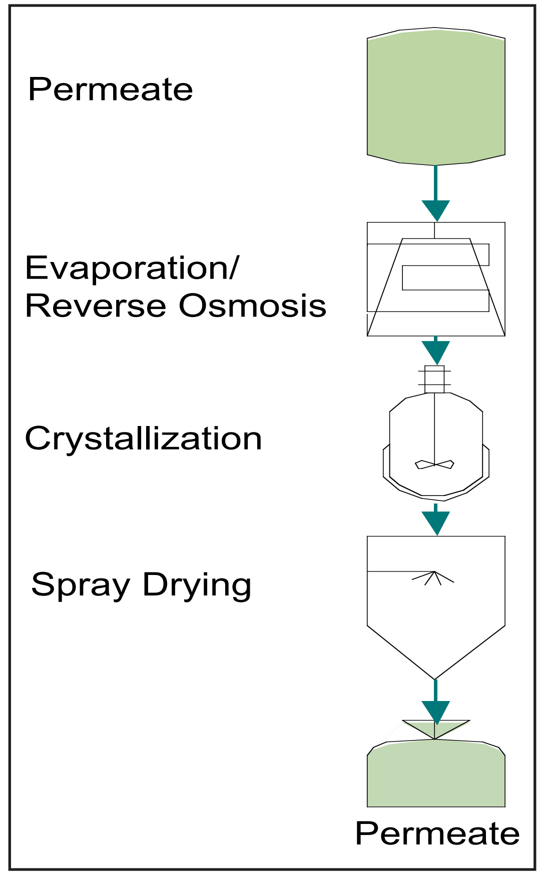

Figure 2. Production of permeate powder

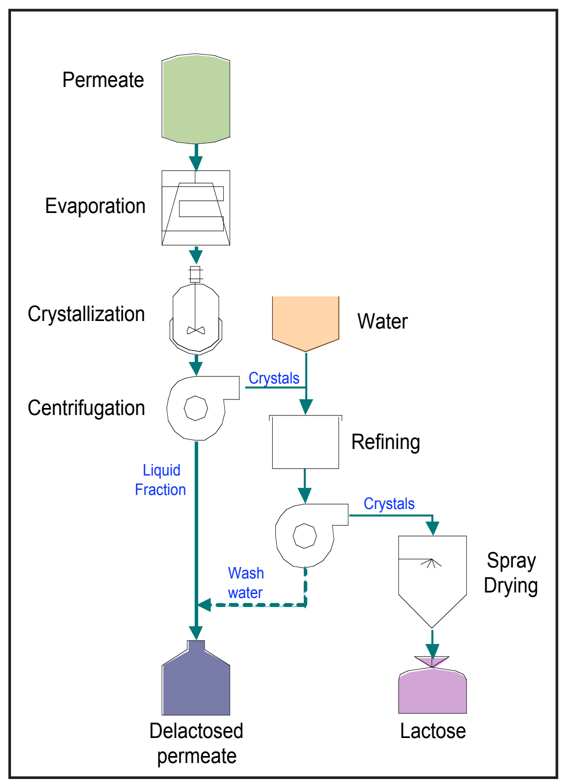

Figure 3. Production of lactose and DLP from permeate

Dr. Rusty Bishop Retires; Dr. Mark Johnson to Serve as Interim Director

by Deb Wendorf Boyke

A chapter in the Wisconsin Center for Dairy Research history book is closed. Dr. Rusty Bishop, Director of the Center for the past 17 years, announced his retirement effective March 31, to become the Director of Research and Development at Schreiber Foods, Green Bay, Wisconsin. "After 17 wonderful years at CDR, I was ready for a new challenge and a new adventure by taking my skills to a corporate environment," shared Bishop in his announcement to staff. "It was not an easy or quick decision."

During Bishop's tenure, he has leveraged the investments of the state, dairy producer checkoff, and industry to create a research center that is based on science, yet is user-friendly to Wisconsin's manufacturers—small, medium and large; has assembled the best collective talent pool in the world who are experts in all aspects of dairy technology; and has launched initial planning, with industry and UW commitment, to expand Babcock Hall dairy facility to include a new Dairy Foods Technology Center and a complete renovation of the existing facility.

Dr. Norm Olson laid the foundation for what is today a leading dairy research center. Bishop added the trusses and walls, building a model program that demonstrates the University's "Wisconsin Idea" which promotes the philosophy that the boundaries of the University are the boundaries of the state. "Rusty has truly integrated the dairy foods research program with the outreach and education/training missions of the Department of Food Science," states Irwin Goldman, Interim Dean, UW College of Agriculture and Life Sciences, "setting CDR apart as a leader in pushing the technology envelope that supports innovation in Wisconsin." Rusty has also added the international dimension through his work with the International Dairy Federation, having served as chair of the Scientific Program Coordination Committee, leading the IDF strategic planning effort, as well as currently serving on its Board of Directors.

In the past 12 years, CDR has generated more than $47 million in funding to leverage the University's investment.

Through CDR's work with dairy manufacturers, processors and food formulators, staff has worked with nearly every cheese maker in the state and beyond, as well as many of the top food companies, suppliers, and cheese converters. In the past 12 years, CDR has generated more than $47 million in funding to leverage the University's investment.

Rusty's leadership

"Dairy producers recognize the important contributions of CDR to meet the technology needs of the Wisconsin dairy industry," states Matt Mathison, Wisconsin Milk Marketing Board. "That is why they have supported the work of CDR through the WMMB partnership for almost 25 years. Through Rusty's leadership, this partnership has grown stronger over the years and we are confident that CDR will continue their efforts to strengthen and grow our great dairy industry."

"The University clearly recognizes the contributions that CDR has made to this State under Rusty's leadership, and the key role he has played in the growth and success of CDR," adds Goldman. "During this interim period Dr. Mark Johnson has agreed to serve as Interim Director with a transition team of Dean Sommer and Tom Szalkucki, all of whom are senior staff with deep knowledge of the Center. We, along with the Center staff and the Department of Food Science, feel this team will provide an excellent way for both internal and external stakeholders to work with CDR in the interim period.

To ensure a seamless transition, the College will be initiating a nationwide search as quickly as possible.

News from CDR

Cheeses and fermented milks from the Eastern Mediterranean

If you are interested in the unique dairy products from this region then consider registering for the next artisan short course set for September 21 to 23, 2010. Hands on labs will feature a variety of brined cheeses, whey cheeses, mixed milk cheeses and fermented milk. Sensory sessions, culinary labs and marketing advice will round out the course. Any questions, contact John Jaeggi, (608) 262-2264 or jaeggi@cdr.wisc.edu.

Greece, Turkey, Cyprus, the Balkans....

Wisconsin INnovates for Success

Wisconsin innovates for success (WINS)

In every scientific field, from cancer research to dairy science, researchers tend to propose projects conservative in nature, often following up on a tenet already established. Funders are reluctant to support novel projects unless considerable preliminary work supports the concept. But where can you go for the initial support to do the preliminary work? Scientists at the Wisconsin Center for Dairy Research (CDR) would like to foster a research environment that supports testing unique and untried ideas, particularly in the early stage. We have developed WINS, a new research program that can provide preliminary funding to researchers who want to follow up on a novel application or test an original idea. We want WINS administrators to be able to review a request for funding quickly and—if they decide it is the right set of circumstances—grant the request expeditiously. WINS will supplement and expand CDR's research program, rather than replace current funding sources.

Timely
Relevant
Expeditious
Unique
Novel
Original

Babcock Hall Renovation

The hammering, drilling, and dust continues at the west end of the 2nd Floor of Babcock Hall, but the east end is looking pretty good. The next short course, Pasture to Plate which runs from May 2nd to 6th will return to our regular classroom, Room 205.

2010 Master C

Steve Hurd, Park Cheese
Fontina and provolone

Mark Gustafson, Sartori Foods
Asiago and parmesan

Randy Pitman, Mill Creek Cheese
Muenster and queso quesadilla

What makes a Master Cheesemaker?

Six new Masters will graduate at the International Cheese Technology Exposition on April 22nd, 2010. The number of Wisconsin Master Cheesemakers continues to grow, and the variety and qualities they bring to this unique group is also expanding. The six new Masters exemplify the strengths of this program, as well as the strengths of Wisconsin's dairy industry.

Nurturing the desire to learn

Teachers know that students learn in different ways. They work with visual learners who tend to think in pictures, auditory learners who need to listen to absorb lectures, discussions and commentary and tactile learners who prefer hands on experience while actively moving and touching. The Master program incorporates all of these approaches while building on the extensive cheesemaking experiences that candidates bring with them. Steve Hurd, of Park Cheese in Brownsville, is a good example of a Master Cheesemaker who has developed his own style of life long learning. He was 18 in 1978 when he started working at Meinerz Creamery in Fredericksburg, Iowa and from there he moved around a bit as he learned how to make mozzarella, butter, sour cream, cream cheese, provolone, feta, Monterey jack, cheddar, parmesan, ricotta, romano, bel paese, and scamorza. Although Hurd left college early, his education never stopped. The Master program fit his approach to cheesemaking and his quest to learn something new every day.

Mark Gustafson, of Sartori Foods in Plymouth, is the youngest Master yet and he admits that he doesn't have a long history in the business. However, the chance to learn more about the hidden aspects of cheesemaking drew him to the program. Like most cheesemakers, Gustafson began his career doing some of the unskilled labor, like putting boxes together. Mark credits his family for his success, especially his father, Leon, who was a plant manager at Lynn Dairy for many years before moving to DSM and his wife, Candy, who has always been supportive.

Building for the future

Randy Pitman admits that he always liked hanging around cheese plants, a trait that led him where he is today. He started making cheese when he was seventeen, first at the Spece cheese factory before moving to the Franklin factory and then the Davis factory. By then he had learned a lot from some great cheesemakers and he was ready to strike out on his own. An ad in the Cheese Reporter helped him find the Mill Creek cheese factory, which has been operating continuously for 118 years. Chances are that run will not be interrupted any time soon; Pitman is expanding his plant and when all the construction is done it will be over twice the size it is now. That's good because this is a family operation, John's

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wife Mary shares his 2:30 am start time. Son Jonathan is already at work by then and daughter Amber takes a day shift to round out the family crew. Pitman is building for the future and it looks bright for Mill Creek Cheese.

In 1969 Jim Johnson was a high school student looking for a part time job. He found one, washing milk cans and returning them to a pristine condition. After graduation, his part time work turned into a summer job and when one of the cheesemakers was injured he stepped in to learn how to make cheese. Johnson enjoyed the Master classes, pleased to increase his understanding of how and why everything works together in the vat. You can hear some of that pleasure in his voice as he explains, “You see a drop of milk and you never really think about what’s inside it. Then you take classes and realize there is a whole other world inside that drop of milk and the way it’s handled influences the cheese. Now I know why things turn out the way they do.”

Brian Jackson’s first job in the cheese plant involved scrubbing, too, but it was the floor instead of the milk cans. Like many other Master Cheesemakers, when Jackson got his drivers license he wanted to buy a car and working at a cheese plant helped him do that. He left the Nova and cheese plants behind when he joined the Army and headed off to basic training. Eventually Jackson returned to making cheese, first in Vermont, then Kentucky, and finally back to Wisconsin.

Mark Frederixon is content in western Wisconsin; he grew up in the area, went away to earn a degree in Biology at UW-LaCrosse and when he came home in 1981 he applied for an opening at the local cheese plant. In time, Frederixon moved into Quality Assurance and then became plant superintendent at the whey drying plant before landing in his current role, plant manager of the cheese plant. Early in his career he was fortunate to learn the craft of cheesemking from some highly skilled individuals, including Leonard Stevens and Glen Ward. By working in most areas of the plant, as well as interacting with farmers and haulers, Frederixon was able to hone both his cheesemaking and problem solving skills.

Returning Masters

We also have three returning Masters, cheesemakers who are earning Master certification in additional cheeses. They include Ken Heiman (monterey jack), Paul Reigle (monterey jack and gouda), and Bruce Willis (monterey jack and mozzarella).

Jim Johnson, Foremost Farms USA
Mozzarella

Brian Jackson, Foremost Farms USQ
Monterey jack and cheddar

Mark Frederixon, AMPI
Cheddar

Research Update

This is the story of a good idea that worked.

Good ideas are easy to come by, but they don't always pan out. This is the story of a good idea that worked.

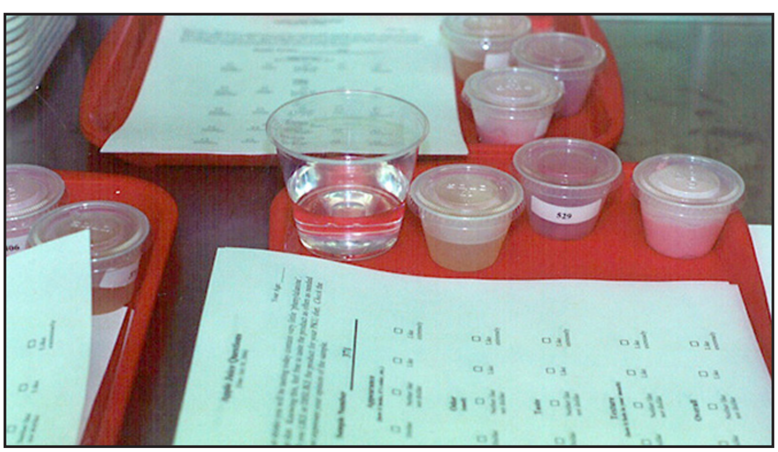
GMP, or κ-casein glycomacropeptide, is one of the whey proteins that can be separated and purified by ion exchange membrane technology. Like the rest of the whey proteins, its value depends on the market. In other words what does it supply that consumers want? Early research suggested that it might influence satiety, or how hungry you feel, as well as influencing immune function by accelerating the growth of white blood cells and inhibiting bacterial and viral adhesion to prevent intestinal infections. But what makes GMP really special is the fact that it is the only natural protein that lacks the amino acid phenylalanine.

One thing we have learned from studying genes and how they direct cells to multiply, divide and do their jobs is that whatever can go wrong, eventually will go wrong. PKU, or phenylketonuria, is an example. People with PKU are born with a cellular glitch that prevents them from metabolizing phenylalanine (or phe), an essential amino acid needed for healthy growth and development. Like all of us, people with PKU need phe, but harmful levels quickly build up in their bodies when they eat proteins like milk, eggs, meat and fish that all contain phe. Previous issues of the Dairy Pipeline (Volume 12 No. 4 and Volume 18 No. 3) described the tricky dietary issues that kids and adults with PKU have to conquer, as well as the possibility that GMP might be an exciting new addition to traditional treatment.

Mark Etzel, Professor of Food Science, is an advocate of whey protein, particularly GMP. He developed an ion exchange method that can increase the purity of GMP, an important step that can provide pure samples to researchers studying the biological activity of this interesting peptide. It is also an important step in the quest to use GMP in the dietary management of phenylketonuria because pure GMP means less contamination with phe.

Kathy Nelson, a food scientist who recently retired from CDR, was another key person bringing this GMP idea to fruition. She developed several tasty prototypes made with GMP, including puddings, crackers, fruit leather, peanut butter and sports drinks. The next step was a study of GMP and its effect on genetically altered mice; they have PKU. Encouraging results led to more studies, this time looking at the effect of GMP on young adults with PKU. GMP is a natural, intact protein and when it was compared to the traditional PKU treatment of an amino acid mixture it offered some definite benefits. First, GMP does a better job of lowering levels of phe in people with PKU. GMP also opens up new possibilities for the PKU diet; kids can take high quality, better tasting products in their lunches, they have will have more choices and the opportunity to even out their protein intake through out the day. And, an important issue for school age kids—they will be eating food that looks like the food other kids eat!

A new product for folks with PKU is now available; Cambrooke Foods is selling BetterMilk™, the first treatment to supply an intact protein, aka GMP. And it is only the first!

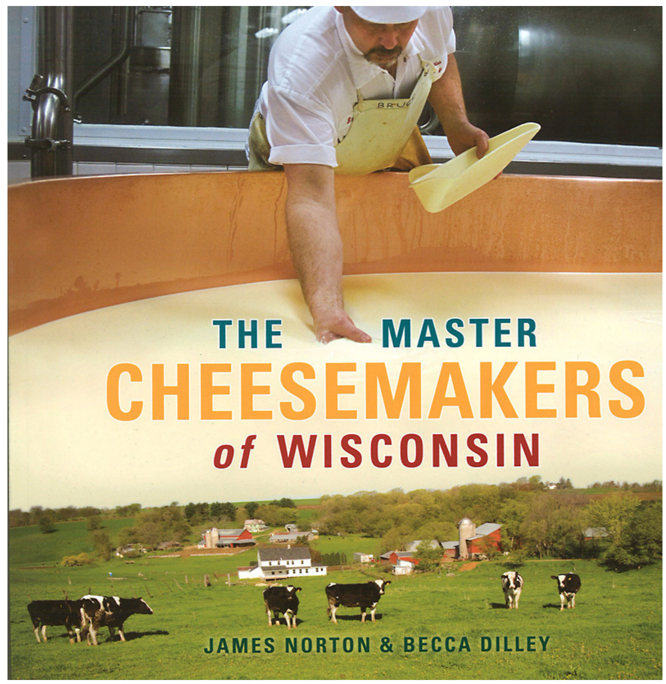


Early sensory testing of prototypes, including pudding and juices.

Skimming the Shelf— What's New in Print?

Attentive readers will learn the difference between colby and cheddar...

The Master Cheesemakers of Wisconsin
by James Norton and Becca Dilley



Years ago, when I was traveling around the world, I met up with a friendly young couple from Wyoming. We were sitting around a table at a park in East Malaysia, or Borneo, and we were talking about all the wonderful things we had seen in our travels. Perhaps we were also a bit homesick because I remember Marit talking about her town out west and then the United States in general. "Don't we live in a beautiful country!" she concluded proudly.

When I was reading Norton and Dilley's book, the Master Cheesemakers of Wisconsin, I gazed at the pages of beautiful photos of Wisconsin and thought to myself, "Don't we live in a beautiful state!"

It is an interesting state, too, and Norton and Dilley have highlighted one of our most interesting and unique claims to fame: master cheesemakers with many years of knowledge and experience. No other state can boast of the immense variety of cheeses and the variety of cheese plants that we have here. From very large commodity cheese plants, to thriving specialty cheese plants, to artisan and farmstead operations, Wisconsin has it all. And now, in this well written, entertaining book, you can read about the experts who make cheese in these plants.

When you read this book, you will learn about Tom Torkelson making cheese from canned Amish milk, the three generations of LaGranders still making cheese, Joe Widmer pressing his brick cheese with bricks that his grandfather used, and David Metzig and his family, who live in the second floor above their cheese plant.

Cheesemakers are the main focus of this book, but attentive readers will learn the difference between colby and cheddar, what it means to "cheddar" a cheese, and even how long it takes to cool a 640 block (10 days). Quality is a repetitive thread throughout the text, Wisconsin cheesemakers are proud of the cheese they make and they admit they couldn't produce such high quality cheese if they didn't have equally high quality milk delivered from Wisconsin farms.

Norton and Dilley have produced a fun book highlighting a unique feature of Wisconsin cheesemaking, the masters who make the cheese we love.

Karen Paulus, editor

Curd Clinic

Curd Clinic doctor for this issue is FX Milani, Assistant professor in Food Science at UW-Madison

Q.

What influences the quality of the seal on a gas-flushed package? I have noticed that some packages of cheese definitely look better than others.

A.

You aren't the only person who has noticed this type of variation, we occasionally get calls from cut and wrap operators about cheese packaging after flushing with carbon dioxide (CO_2). The questioners usually ask why some cheeses have a tighter "pull down," or seal, than others. Often it is in relation to cheese chunks, mostly for retail sale, using barrier packaging and CO_2 to create a modified atmosphere package. The CO_2 flushes out air, preventing both yeast and mold growth as well as air induced issues like stale flavors and oxidation.

The CO_2 has another benefit: when it absorbs into the water phase of the cheese it produces a small amount of carbonic acid which removes some of the CO_2 vapor pressure from inside the package. Since the pressure is higher on the outside of the package, the film draws down next to the cheese in a neat and close fit.

Packaging changed decades ago when the Hayssen Company introduced a mark out style of packaging for cheese. This style involves a roll stock barrier film that is fed from below at the end of the cheese conveyor belt. As the individual cheese chunks transition from the conveyor to the film, the film is brought up around the sides of the cheese chunks and a side seal is continuously applied along the length of the tube from above. As the tube with the cheese chunks is advanced, heater bars then pinch between the cheese chunks and form the end seals of the package. After end seals are formed, the packages are cut apart through the center of the end seal. You can now add CO_2 through a small diameter tube (called a snorkel) that runs the length of the film tube but ends before the seal bars pinch the packages. The CO_2 is pumped into the film tube by the snorkel. The air is flushed back toward the entering cheese and out of the newly formed package tube. This provides packages with very little air and modified atmosphere package filled with CO_2. Then, within about a day, the CO_2 is absorbed in the cheese and the film is drawn tight against the cheese.

Figure 1.

Solve for the ratio	5.6 = 6.46 + log [disassociated] / [associated]
Rearrange	5.6 – 6.46 = log [disassociated] / [associated]
Take the log	-0.86 = log [disassociated] / [associated]
Ratio is determined	0.138 = [disassociated] / [associated]

So why do we see so much variation using this style of packaging? Some cheeses have a very tight film adherence while other cheese don't get a good pull down no matter how much CO_2 you flush. The variation is related to pH and the ability of the

CO_2 to absorb water. Essentially, as the cheese gets more acid, less CO_2 is absorbed. You chemistry whizzes will remember that the relationship can be described by the classic Henderson-Hasselbalch equation:

$$pH = pKa + \log [\text{disassociated}] / [\text{associated}]$$

This equation allows us to relate pH to concentration. The brackets above represent the concentration of the two forms of CO_2 we see at the pH of the cheese. The two pKa for CO_2 are 6.46 and 10.49 pH units. We can ignore the second association of hydrogen ion at pH 10.49, since the contribution will be very low, and focus on a first association. Using this equation you can see what happens with a cheese at pH 5.6, like an aged swiss. (See Figure 1.)

We calculate a ratio that is 0.138. That means for every 7.25 molecules of CO_2 there is 1 molecule of carbonic acid that is removed from the partial pressure of the CO_2 in the package as carbonic acid is formed and stabilized in the cheese.

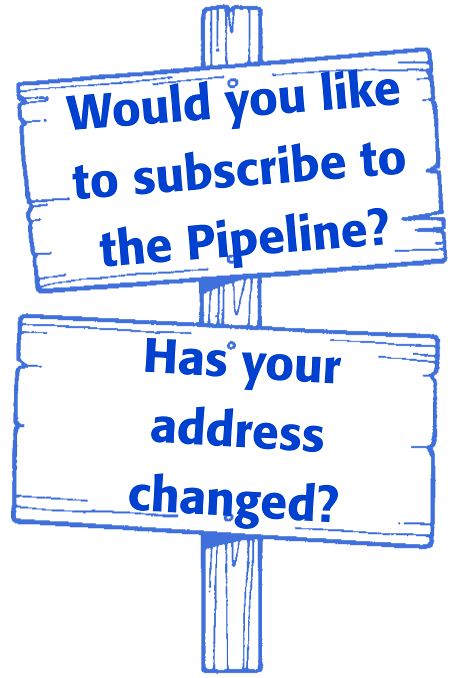
Now look at a cheddar cheese at pH 5.1. Calculating just as we did for swiss, we find that the ratio now is 0.043. This means that there would be 23.2 molecules of CO_2 for every 1 molecule of carbonic acid that is removed from the partial pressure as carbonic acid in the cheese. The net effect is a negative pressure change in cheddar that is 3 times less when compared to the higher pH change in swiss, it explains why the package will not be tight against the cheese. Why is this important? Well, not only does it look different, but a loose package also makes the cheese more likely to form calcium lactate crystals in the loose areas.

Figure 2.

$$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow CHO_3^- + H^+$$

(carbonic acid)

A high acid environment drives this equation to the left.



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Calendar

World of Cheese from Pasture to Plate
May 2-6, 2010. Dean Sommer (608) 265-6469

Cleaning and Sanitation Workshop
May 11, 2010. Franco Milani (608) 890-2640

Dairy HACCP Workshop
May 12, 2010. Marianne Smukowski (608) 265-6346

Applied Dairy Chemistry Short Course
May 18-19, 2010. Scott Rankin (608) 263-2008

Cheese Grading and Evaluation Short Course
June 1-2, 2010

Milk Pasteurization and Control School
August 3-4, 2010

Wisconsin Cheese Technology Short Course
October 4-8, 2010