In these trying times it is more important than ever to monitor your cheesemaking practices. Paying attention to detail and charting the variability in your plant can be the key to staying solvent and even making a profit.

Like fruit juice, ham, and even shampoo, the moisture level in cheese is linked to both quality and the bottom line. If you look up maximize in the Merriam-Webster dictionary you will find it means to increase to a maximum value. They define optimize as making something as perfect, as functional, as possible. For some cheese varieties, maximizing and optimizing mean the same thing. For example, you can go right up to the cheese standard limits when making mild cheddar or colby. Your cheese will be at the maximum moisture level and it will have the expected texture and body. This is not true for all cheeses. The standards actually allow for more moisture in both monterey jack and muenster than your own assessment of quality might allow. Thus, it is certainly possible to produce a muenster cheese with a legal moisture content but low in quality ratings, that is: weak bodied and gummy.

Certainly most cheesemakers and plant managers know the relationship between cheese moisture and profit (or loss). But do all the workers in the plant know this connection and how they can influence it? Maybe it is time to take another look at how you operate, and communicate.

The key to optimizing cheese moisture is to know where you are and know where you want to go—your target level. The only way to really know where you are at is to monitor every vat of cheese. To do this effectively you have to pay attention to both sampling techniques and laboratory procedures. In other words, if you are going to do it, do it right. Spend the money to participate in laboratory proficiency testing and assess your process.

Once you know you are collecting good data, use it wisely. Charting results can highlight trends; you might say that a figure illustrates a thousand numbers. Compare Figures 2 and 3 to see the effect of range or standard deviation on moisture levels. Which figure explains the issue better?
Research Update

NTB: A variation of the Maillard reaction?
By Karen Paulus and Scott Rankin

Toast, pizza, and roasted marshmallows all hold a common factor: a flavor enhancing browning reaction is at the core of their identity. Often referred to as the Maillard reaction, the browning is the result of chemical reactions between residual reducing sugars and amino acids during heating—in this case, cooking.

There is another browning reaction that may be noticed in various cheeses that turn brown as they age. For example, under some conditions, parmesan can develop a brown tone with an affiliated undesirable flavor. On the other hand, browning in gouda cheese can contribute some very positive flavor and color attributes. This particular type of browning is referred to as non-thermal browning or NTB. Unlike typical Maillard browning reactions, NTB occurs in the absence of elevated heat and in many cases in the absence of residual sugars. A possible theory as to the cause of this reaction is a variation of the Maillard reaction. Other hypotheses about the cause of this browning have appeared in the scientific literature, but none have been successfully applied to explain or control NTB.

Possible pathways to NTB involve factors such as redox potential, available oxygen, the type and concentration of $\alpha$-dicarbonyl compounds, amino acid type and concentration, the presence of Mn ions, and microbial tyrosinase activity (Carreira et al, 2001, 2002; William and Withers, 2007). Unlike the Maillard reaction, which involves amino acids and residual sugars, NTB is thought to occur in the absence of sugars, long after they have fermented from the cheese system (Hayashi and Namiki, 1985). Instead, some preliminary studies indicate that NTB may indeed result from the Maillard reaction, however in this case the amino acids react with non-sugar carbonyl compounds, such as diacetyl, glyoxal and/or methylglyoxal.

These carbonyl compounds are generated through specific metabolic pathways of lactic acid bacteria (LAB), and earlier work has also shown that environmental non-starter lactic bacteria (NSLAB) can produce these carbonyl compounds at notably high levels (Lindsay and McDonald, 1992).
Rankin’s team began this project by seeking the underlying molecular culprits, reasoning that they would better understand the reactions if they knew more about the chemical structure of the brown pigments and their corresponding volatile aroma components. The researchers requested parmesan cheese from several Wisconsin cheese plants, procuring samples of parmesan both with and without brown pigment. Cheese samples were evaluated for the presence of pigments and volatile compounds using a variety of extraction and recovery methods.

The result: in general, the pigments are not readily extractable in organic solvents but do appear to be soluble after some degree of proteolysis. Gas chromatography-mass spectroscopy was employed to identify the most abundant compounds in the concentrated extraction liquid. In general, they found the same volatile compounds in both sets of cheese, brown and non-brown (See Table 1). However, the cheese with the brown pigment had higher amounts of these components.

The research team also set up parallel studies documenting the color, appearance, composition, and pH of a variety of samples exhibiting different degrees of browning. To date, no significant differences have emerged to explain the browning. The potential role of α-dicarbonyl compounds and temperature on NTB was also studied. So far, they have seen no effect of diacetyl, glyoxal, or methylglyoxal on the development of brown discoloration in a series of experimental cheeses.

The group is also looking at the effect of the heat treatment of milk on the browning of parmesan cheese. The scientists evaluated the effects of three treatments: a control standardized milk, nonfat dry milk, and high heat-treated milk as well as the effect of storage temperature and the effect of heat treatment. Since the brown pigment may take a long time to develop, they are still monitoring the cheeses.

This project will continue to follow the chemical trail to NTB cheese. Understanding and controlling this phenomenon will enable cheese plants to avoid or enhance NTB reactions depending on the desired outcome.

**References**


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**Table 1. Volatiles notably higher in NTB cheeses**

<table>
<thead>
<tr>
<th>Aldehydes</th>
<th>Nonanal; 2-Decenal; 2,4-Decadienal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pyranones</strong></td>
<td>2H-Pyran-2-one, tetrahydro-6-pentyl-</td>
</tr>
<tr>
<td></td>
<td>2H-Pyran-2-one, 6-heptyltetrahydro-</td>
</tr>
<tr>
<td></td>
<td>2H-Pyran-2-one, tetrahydro-6-nonyl-</td>
</tr>
<tr>
<td><strong>Ketones</strong></td>
<td>2-Undecanone, 2-Tridecanone, Dodecalactone</td>
</tr>
<tr>
<td><strong>Fatty acids</strong></td>
<td>Butanoic, Hexanoic, Pentanoic, Nonanoic, n-Decanoic, Undecanoic, Dodecanoic, Tetradecanoic, Pentadecanoic, n-Hexadecanoic, Oleic</td>
</tr>
</tbody>
</table>
**News from CDR**

**Governor’s state mandated furloughs will affect CDR**

Governor Doyle’s state furlough mandate, established in response to Wisconsin’s projected budget shortfall, requires all CDR staff to take 8 furlough days each year for the next two years. To implement this mandate, the UW system will be closed on the following dates:

<table>
<thead>
<tr>
<th>2009-2010</th>
<th>2010-2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>November 27, 2009</td>
<td>November 26, 2010</td>
</tr>
<tr>
<td>December 30, 2009</td>
<td>December 30, 2010</td>
</tr>
<tr>
<td>April 2, 2010</td>
<td>March 18, 2011</td>
</tr>
<tr>
<td>May 21, 2010</td>
<td>May 20, 2011</td>
</tr>
</tbody>
</table>

This means that CDR will also be closed on those days. In addition, CDR staff will need to take 4 additional days of furlough per year at their individual discretion.

On these furlough days, staff is mandated to do no work, this means not receiving phone calls, and not checking email or voice mail. Staff is also mandated to work only 32 hours in each week a furlough day is taken. Since this may have an impact on our ability to respond to your requests in a timely manner, we wanted to share as much information with you as possible. If you have any questions, feel free to contact CDR staff.

**CDR launches new website design**

Check out the new look of the CDR website…it has a new look, streamlined navigation, but many of the same great features of the old website. We continue to add new features, like a Frequently Asked Questions (FAQs) section for each program area, easier to use CDR staff directory, and overall easier navigation of the site. We’re also working on an updated version of the Cheese Database which we will post in the future. We welcome your feedback, please send it.

**Brian Gould honored by County Ag Agents**

In April 2009, Brian Gould won the 2009 2nd Mile Award from the Wisconsin Association of County Agricultural Agents. The Second Mile Award recognizes the support University Extension specialists provide to Wisconsin county agricultural extension agents and expresses appreciation for that support. This award really recognizes the service that Brian has provided for many years, but it also sends a strong signal regarding the value that county agents see in his contributions over the past two years.

C DR website sports a new look (www.cdr.wisc.edu)
Announcing a new dairy short course

A funny thing happened at the United States Championship Cheese Contest, presented by the Wisconsin Cheese Makers Association 2009. According to Bill Wendorff, emeritus professor of Food Science, almost 27% of the entries were flavored cheeses. Contest entries included cheese with a wide variety of flavors: everything from cracked peppercorn to kalamata olives, chili-lime, salmon and dill, cumin, habanaro and mango, figs, and wasabi. This is an amazing array.

CDR is responding to the increasing popularity of flavored cheese by organizing a short course to address the issues unique to flavored cheeses. The course will cover the influence of salt, starter cultures, coagulants, and other flavors that develop during manufacture. Instructors will also discuss adding natural flavor materials, like peppers, fruits, herbs and neutraceuticals like omega-3. If you are thinking about expanding your repertoire of cheese, consider joining us.

This short course, Natural Flavorings for Natural Cheeses, takes place September 15 to 17. If you have questions about the curriculum, call John Jaeggi (608 262-2264) or Bill Wendorff (608 263-2015). Direct registration questions to CALS Conference Services at 9608 263-1672.

Register online at www.peopleware.net/2723
Using statistical process control, the underpinning of Six Sigma, TQM, and quality control, allows you to track variability in moisture. And you do need to track variability because it is impossible to optimize a highly variable system. Figure 2 lists the measured moisture levels at two different plants. Notice that the averages are the same but the range is very different. Which plant will have an easier time controlling variability?

**How do you reduce variability?**
The answer is consistency. I am talking about the every day tasks, the practical, active chores in a cheese plant. For example, are pasteurization temperatures uniform? How about vat temperatures? How do you know; do you test thermometers for accuracy? Is your renneting temperature consistent? How about the rate of acid production? What is the stir time on the table? Does anyone monitor it? I think you might get the picture.

Do your employees see the big picture? Empower them with knowledge and include them in the process. This is a key point because when the information gets out to the folks working in the plant and they understand why consistency is so important then they have the picture, too. And you have taken a big step towards optimizing your operation.

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**Figure 1.**

<table>
<thead>
<tr>
<th>Daily yield differences for 1,000,000#/day plant</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Yield at 38.5% moisture</strong> = 10.43 lbs/cwt = 104,300 lbs</td>
</tr>
<tr>
<td><strong>Yield at 37.5% moisture</strong> = 10.27 lbs/cwt = 102,700 lbs</td>
</tr>
<tr>
<td><strong>Difference</strong> = 1,600 lbs cheese/day</td>
</tr>
<tr>
<td><strong>At $1.30/ lb cheese</strong></td>
</tr>
<tr>
<td>5 days/week = $540,800/year</td>
</tr>
<tr>
<td>6 days/week = $648,960/year</td>
</tr>
<tr>
<td>7 days/week = $757,120/year</td>
</tr>
</tbody>
</table>

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**More examples of key consistency issues**

- Performing procedures exactly on time
- Pasteurization temperatures uniform
- Starter addition amounts, strain selection, culture format
- Vat temperatures
- Ripening
- Renneting temperature
- Curd firmness at cut
- Rates of acid production
- Uniform cutting of coagulum
- Uniform rates, times, temperature of cook
- Stir time on the table
- Curd temperature on the table
- Temperature and amount of rinse water
- Mat depth on matting conveyor
- Proper salt application
- Curd temperature in matting conveyor
- Curd pressing times and temperatures
- Ensure your thermometers are accurate
- Ensure your acidometers and pH meters are accurate
- Consider an on floor curd moisture analyzer
- Keep excellent records.
Figure 2.
Mild Cheddar Cheese

<table>
<thead>
<tr>
<th>Vat</th>
<th>Moisture Plant 1</th>
<th>Moisture Plant 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>39.3</td>
<td>38.8</td>
</tr>
<tr>
<td>2</td>
<td>38.7</td>
<td>38.4</td>
</tr>
<tr>
<td>3</td>
<td>37.9</td>
<td>38.6</td>
</tr>
<tr>
<td>4</td>
<td>38.3</td>
<td>38.3</td>
</tr>
<tr>
<td>5</td>
<td>39.1</td>
<td>38.5</td>
</tr>
<tr>
<td>6</td>
<td>37.7</td>
<td>38.4</td>
</tr>
<tr>
<td>7</td>
<td>38.5</td>
<td>38.8</td>
</tr>
<tr>
<td>8</td>
<td>37.6</td>
<td>38.2</td>
</tr>
<tr>
<td>9</td>
<td>38.9</td>
<td>38.4</td>
</tr>
<tr>
<td>10</td>
<td>39.0</td>
<td>38.6</td>
</tr>
<tr>
<td>Average</td>
<td>38.5</td>
<td>38.5</td>
</tr>
<tr>
<td>Range</td>
<td>1.7</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Compare Figures 2 and 3 to see the effect of range or standard deviation on moisture levels. Which figure explains the issue better?

Figure 3.

Compare Figures 2 and 3 to see the effect of range or standard deviation on moisture levels. Which figure explains the issue better?
Q. The recent recall of dried dairy powders seems rather extensive, and expensive. How can I monitor and prevent potential salmonella contamination in my operation?

A. You are right about the extent of this recall, as of July 24th, 277 products have been recalled since late June. Diamond Crystal, Kroger, IGA, and Cub Foods are just a few of the companies participating in this product recall, which started after the USDA found salmonella in dairy shake powder. The contamination could have come from any of the ingredients in the powder mix but when the FDA found contaminated equipment in a Minnesota processing plant the buck stopped there. Nonfat dried milk, whey protein, fruit stabilizers, and thickening agents produced by the plant need to be traced and recalled by the companies that bought them.

It is much more common to find salmonella in raw milk, although pasteurization takes care of that. However, dry dairy ingredient processing plants are particularly susceptible to salmonella contamination. Although incoming raw milk is pasteurized before processing, it can be difficult to protect the product along its conveyer journey through evaporators, dryers, sifters, and baggers. In addition dryers suck in lots of air, potentially contaminated with salmonella, and the bacterium itself has a promoting characteristic: it is quite tolerant of dry conditions. In the case of dry whey products, the liquid whey is always repasteurized but post-pasteurization salmonella contamination is still a concern with any dry dairy product.

Not the first time

Dairy processors learned about salmonella several decades earlier; this isn’t the first time milk powder has been linked to salmonella contamination, or as Yogi Berra might say, “This is like deja vu all over again.” Back in 1965 and 1966 an outbreak of salmonella, with 29 interstate confirmed cases, was traced to a Minnesota plant producing instant nonfat dry milk. At the time, poultry was recognized as a common source of salmonella but this particular outbreak saw dairy powders joining dried yeast, cottonseed flour, and pet turtles on the list of new sources of human salmonellosis.

Not the first time

Since that first episode scientists have examined the issue of salmonella in dry milk processing plants and they have shared their conclusions on how to monitor problems and prevent contamination in finished products. In 1982, Jarl and Arnold correlated the incidence of salmonellae in a dry milk processing plant with contamination in the finished product. And then they told us how to apply their work. If you follow their advice in your plant you would emphasize cleaning and sanitation to control the environment and then verify the effect by weekly sampling from specific areas. Jarl and Arnold recommend sampling the sites listed in Table 1. If you find more than two positive environmental samples then you need to test your finished product. Any positive

<table>
<thead>
<tr>
<th>Table 1. Critical control points for surveillance sampling.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Adapted from Jarl and Arnold)</td>
</tr>
<tr>
<td>Roof debris</td>
</tr>
<tr>
<td>Dryer intake air filter overlay</td>
</tr>
<tr>
<td>Powder cooler overlay</td>
</tr>
<tr>
<td>Dryer room floor sweepings</td>
</tr>
<tr>
<td>Central/shop vacuum systems</td>
</tr>
<tr>
<td>Sifter tailings</td>
</tr>
<tr>
<td>Sifter room floor sweepings</td>
</tr>
<tr>
<td>Bag room floor sweepings</td>
</tr>
<tr>
<td>Warehouse floor sweepings</td>
</tr>
</tbody>
</table>
test of sifter tailings means mandatory testing of your finished product. Finished product should also be tested after every shutdown for major construction or repair. Jarl and Arnold contend, “The user of dry milk products from a supplier with this type of quality control program is assured a salmonellae-free ingredient.”

Many things have changed since that first confirmed dairy powder contamination 44 years ago. Look at the list of recalled products; it isn’t just nonfat dry milk like back in 1965. These days dried dairy products are included in everything from instant oatmeal to gravy to recovery drinks, a sure sign that consumers are getting the message about the nutritional impact of dairy proteins.

One more thing has changed since 1965. All the people involved in that original incident have likely retired. This means that the institutional memory regarding the risks of salmonella in dried dairy ingredients has gotten a little foggy and we may have gotten a bit complacent about the issue. Here are a few more features to think about.

**From Marianne Smukowski:**
Remember that you need to be able to trace everything back. So don’t mix lots or be tempted to gradually fill a tote using leftover powder at the end of the days run.

When it comes to sampling for salmonella, I encourage plants to sample every lot of powder manufactured, sample at startup, as well as sampling floor sweepings, tailings and air filters. You need strong prerequisites for your HACCP plan and you need to follow Good Manufacturing Practices (GMP). Although the last revision of GMP’s was back in 1986 plans to modernize are proceeding but they have not been finalized.

**From Dean Sommer:**
When thinking about processing dairy powders this mantra should be going through your mind: moisture, moisture, moisture. Processing plants are easily contaminated with salmonella and moisture promotes growth. Keep your plant as dry as possible. It is also extremely important to control the plant environment; this includes restricting foot traffic through processing areas.

And, finally, this language was inserted in Wisconsin regulations to address the issue of adding nonfat dry milk (NFDM) to pasteurized milk used in cheesemaking. But do you really want to do this? What if that dry dairy product was contaminated with salmonella? To be sure, it is a convenient way to add protein but you still have to consider safety and quality factors. For example, you should think about extraneous control since it is very common to find small specks of scorch particles and even bits of metal or rubber from drying equipment ending up in dry dairy powder. The smartest way to operate starts with rehydrating the NDM powder in water and then pumping it through a filter to remove any extraneous material. And, of course, all this is done prior to repasteurization.

Often the NDM powder is packaged in multi-wall bags, numerous layers of brown paper and typically one layer of plastic film to prevent moisture migration into the bag. A good GMP program requires stripping the bag prior to dumping the powder out. This means tearing off the outermost layer of the paper bag, which helps to ensure that the operator doesn’t dump dirt or other particulate matter or nasty microbes into the NDM when emptying the bags. Of course, this is a lot of work and it takes time. However, if you empty bags directly into the vat post pasteurization you have no control over dirt, specks, or pieces of bag or plastic or even unwanted microbes. On the other hand, if you add NDM pre-pasteurization, pump through a filter and then pasteurize you have added essential layers of protection to your plant.

**ATCP 80.41 Pasteurization required.** (1) Except as provided under sub. (2), every dairy product shall be pasteurized at the dairy plant where that dairy product is manufactured.

(2) Subsection (1) does not apply to any of the following:

(h) Grade B dairy products produced by adding previously pasteurized dry dairy products with a low water activity to previously pasteurized grade B dairy products, if approved by the department.

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Institutional memory regarding the risks of salmonella in dried dairy ingredients has gotten a little foggy.
Romero participates in protein workshop
Juan Romero, Analytical Group Coordinator at CDR, served on the planning committee and presented a talk on A Dairy Perspective on the Use and Applications, Challenges Ahead at a recent Food Protein Workshop, sponsored by U.S. Pharmacopeia. The workshop, titled Developing a Toolbox of Analytical Solutions to Address Adulteration, was held from June 16 – 17, 2009 at the USP Headquarters in Rockville, Maryland.

Food Science promotion
John Lucey is now a full professor in the Department of Food Science, University of Wisconsin-Madison. Take a look at the list from ADSA to see why this prolific researcher earned tenure.

CDR presentations at 2009 ADSA


Curd Clinic
continued from page 9

References


FDA website: http://www.accessdata.fda.gov/scripts/Milk/

More questions? Contact Marianne Smukowski, CDR’s safety/quality specialist at (608) 265-6346 or msmuk@cdr.wisc.edu

or Dean Sommer at (608) 265-6469 dsommer@cdr.wisc.edu
Great Lakes Dairy Sheep Symposium

The 15th Great Lakes Dairy Sheep Symposium will be held on November 12-14, 2009 at the Albany Marriott in Albany, New York. For information visit dsana.org or contact Claire Sandrock at mikolayunas@wisc.edu.

The Great Lakes Dairy Sheep Symposium is the major annual event of the dairy sheep industry in North America. For 15 years, this event has attracted dairy sheep producers from Canada, Mexico and throughout the United States. Topics include beginning sheep dairying, cheese plant design, sheep intake on pasture, hormonal control of ewe reproduction, genetic markers for milk production, nutrition and economics. Through support of the Babcock Institute, our international speaker will be Dr. Gerardo Caja from Barcelona, Spain. He will address the milk-ability of dairy ewes and dairy sheep production in Spain. The final day will include tours of local dairy sheep producers and processing plants that manufacture sheep milk cheeses. The Great Lakes Dairy Sheep Symposium provides an educational environment and fosters connections among dairy sheep producers, processors and researchers.

Calendar, continued

Nov. 3-4 Cheese Grading and Evaluation Short Course. Madison, WI. Call Scott Rankin at (608) 263-2008 or register on-line: www.peopleware.net/2723

Nov. 12-14 Great Lakes Dairy Sheep Symposium. Albany, New York. For information, contact the Dairy Sheep Assoc. of North America at dsana.org or e-mail Claire Mikolayunas Sandrock at: mikolayunas@wisc.edu.

Dec. 1-3 Ice Cream Makers Short Course, Madison, WI. Call Scott Rankin at (608) 263-2008 or register on-line: www.peopleware.net/2723

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1605 Linden Dr.
Madison, WI 53706
phone: 608/262-8015
fax: 608/262-1578

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Company ________________________________
Street address ________________________________
City ________________________________
State ________________________________
Zip ________________________________
Country ________________________________
(and mailing code) ________________________________

☐ CHANGE ☐ ADD ☐ REMOVE
Calendar

Aug. 5-8  American Cheese Society Annual Meeting. Austin, TX. For info, see www.cheesesociety.org.

Aug. 4-5  Milk Pasteurization and Process Control School. Madison, WI. Call Scott Rankin at (608) 263-2008 for information, or register on-line: www.peopleware.net/2723

Sept. 8-9  Cultured Dairy Products Short Course, Madison, WI. Call KJ Burrington at (608) 265-9297 or register on-line: www.peopleware.net/2723

Sept. 15-17  Natural Flavorings for Natural Cheeses, Madison, WI. Call John Jaeggi at (608) 262-2264 or register on-line: www.peopleware.net/2723

Oct. 5-9  Cheese Technology Short Course, Madison, WI. Call Mark Johnson at (608) 262-0275 or register on-line: www.peopleware.net/2723

Oct. 27-28  Dairy Ingredient Utilization Workshop, Madison, WI. Call KJ Burrington at (608) 265-9297 or register on-line: www.peopleware.net/2723

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