Wisconsin Center for Dairy Research

# DAIRY PIPELINE

A Technical Resource for Dairy Manufacturers Volume 19 Number 4 2007

## Handling Cheese to Maintain Quality

*By Bill Wendorff and Marianne Smukowski*


From photography to pharmaceuticals, maintaining high product quality has been a recurring refrain. It is no different in the dairy world. In the previous issue of the Dairy Pipeline, Bishop and Smukowski (2007) reviewed the issue of cheese safety at room temperature. They concluded that most cheeses containing <50% moisture, active lactic acid starter cultures, with traditional levels of salt, pH, fat, etc., do not allow the growth of pathogens when held at temperatures between 4 and 30°C (39 and 86°F). In this issue, we follow up with a discussion focused on handling cheeses to maintain quality.

We know that cheese quality in the marketplace can deteriorate with storage. At least that was the case back in 2003 when we reported on defects in U.S. graded cheeses. (Smukowski et al., Dairy Pipeline 2003). We found that at four days of age, 99.4% of cheddar cheese was A Grade; at 10 days, 94.8% was A Grade; and at 30-60 days, 92.8% was A Grade. However, when we evaluated mild cheddar at retail markets, less than 9% of the cheese was A Grade quality. We saw similar decreasing quality in colby, jack, and swiss cheeses. This trend was alarming because quality defects in natural cheeses can definitely decrease overall acceptance and value. Therefore, it is essential that people handling cheese understand how to maintain product quality throughout aging, while the cheese is in the distribution and marketing channels.

What's Inside:



### Cheese manufacture

Natural cheese is a cultured product that is biologically active throughout its life. Cheese quality starts at the very beginning, with milk quality. Milk should be produced under sanitary conditions and then cooled properly at the farm. This limits contamination and growth of spoilage bacteria and the pyschrotrophic bacteria capable of producing heat-stable enzymes that break down protein and fat. Remember that raw milk cheeses are susceptible to defects from the growth of any spoilage organism that may come in with the milk supply. Thus, many cheesemakers use pasteurization or thermilization to reduce the number of contaminating organisms in milk, although heat treatments do not affect the heat-stable enzymes (from prior bacterial growth) that may still be present in the milk used for cheesemaking.

It is important to produce cheese under the strictest sanitary conditions to limit the environmental microbial contaminants that may produce defects in the finished cheese. In addition, following proper cheese manufacturing practices—including controlling moisture and paying attention to acid development—will not only ensure that the template is set for good quality throughout the life of the cheese but will also maintain a pH

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# Hispanic cheese and the advantage of authenticity

In the early 1900's Italian immigrants to the United States preferred cheese from the old country, and the Hispanic population is no different.

Although Hispanic cheeses account for only 1.6% of total US cheese production, watch this market because it is growing. In fact, while total cheese production increased at an average rate of 2.6% per year, Hispanic cheese production has shown double digit increases most years since 1998 and increased over 75% from 2000 to 2005. The Hispanic population, at 14.8 % in 2006, is the largest minority group in the United States.

If you have ever traveled far from home or lived in a different country then you probably know the feeling of longing for familiar tastes and smells. Americans abroad report cravings for boxed macaroni and cheese and UK expats living in the US miss English chocolate bars. For me, it was six months of travel in Asia that kindled an intense craving for pretzels. I could find all sorts of snack foods and they were ok, but they weren't pretzels. When I spied a small package of stick pretzels in a grocery store in Kuala Lumpur, I was excited, and really looking forward to the crunchy, salty, little morsels I would be chomping on soon. My enthusiasm turned to dismay when my taste buds detected sugar granules instead of the salt I expected. I was tricked and keenly disappointed. It's possible your Hispanic cheese customers are having a similar experience.

In the early 1900's Italian immigrants to the United States preferred cheese from the old country, and the Hispanic population is no different. According to Scott Rankin, associate professor of Food Science at the University of Wisconsin—Madison, a large segment of the US Hispanic cheese volume is comprised of cheeses made in their country of origin and brought into the United States. Why is this? One explanation could stem from complaints from Hispanic consumers that US-made Hispanic cheeses lack "authentic" flavor.

## "Authentic" Hispanic cheese flavor

What is "authentic" Hispanic cheese flavor? Certainly, it is influenced by different animal feeds, milk handling, and heat treatments. And then there is the variation in milk microflora, sanitation, refrigeration and cheese composition. For example, in many Hispanic countries, milkfat is supplemented or replaced with plant-derived oils. High levels of milk powder are another potential flavor influence. See Figure 1. for a comparison of cheese ingredients.

A research project at the University of Wisconsin-Madison, recently funded by Dairy Management Inc. (DMI), aims to answer some of these authenticity questions. Since 80% of Hispanics living in the United States emigrated from Mexico, Central America or the Caribbean the study will focus on popular cheeses from these areas. Representative samples of fresh cheese (panela and queso fresco), aged cheese (cotija, queso seco) and pasta filata cheese (oaxaca, quesillo) will be analyzed for composition, functional properties, microbiological analysis, non-native cheese components and sensory analysis. After comparing the samples to US style Hispanic cheeses, the researchers hope to isolate and identify differences, with the final goal of helping US cheesemakers compete with imported cheeses.

### Initial efforts

Initial efforts, led by graduate student Luis Jimenez-Maroto and post doc Arnoldo Lopez-Hernandez, have focused on descriptive sensory panels, micro and composition. Trained panelists have been evaluating the appearance, texture, and flavor attributes of US-made Hispanic cheese as well as commercial samples of corresponding Salvadorian and Mexican-made cheese. The researchers have also conducted focus groups with UW students from the Mexican Student Association.

The focus group found some differences, shown in the photos on page seven. For example, most of the US-made panela cheeses were very salty. In addition, some samples were oxidized and a sanitizer off-flavor was found. In other cheeses, the focus group often found rancid flavor notes, which is expected for cotija, but not for oaxaca. Some shredded cheese mixtures, labeled "Mexican Blend", contained colby, jack and cheddar cheeses, which are not Mexican cheeses!

We know that people looking for Hispanic cheese begin by looking for a brand they know and

*continued on page 7*

**Figure 1. Comparing cheese ingredients**

## Ingredients – U.S. Cheese

| Fresh | Pasta Filata |
|---|---|
| Pasteurized Whole Milk | Milk |
| Cultured Pasteurized Whole Milk | Pasteurized Whole Milk |
| Skim Milk | Part Skim |
| Salt, Sea Salt | Skim Milk |
| Rennet, Enzymes | Salt, Sea Salt |
| Cultures | Enzymes |
| Calcium Chloride | Cultures |
| Sorbic Acid | |

## Ingredients – Mexican Cheese

| Fresh | Pasta Filata |
|---|---|
| Pasteurized Whole Cow Milk | Whole Cow Milk |
| Pasteurized Part-skim Cow Milk | Pasteurized Whole Cow Milk |
| Reconstituted Skim Milk | Pasteurized Part-Skim Cow Milk |
| Milk Powder | Reconstituted Skim Milk |
| Lactic Protein Concentrate | Dry Whole Milk |
| Caseinates | Nonfat Dry Milk |
| Cow Milk Cream | Caseinates |
| Butyric Fat | Lactic Proteins |
| Edible Fat | Lactic Protein Concentrate |
| Salt | Butyric Fat |
| Iodized Salt | Edible Fat |
| Rennet | Vegetable Fat |
| Calcium Chloride | Salt |
| Added Water | Iodized Salt |
| Enzymatic Flavor | Rennet |
| Natural Colorant | Lactic Cultures |
| Stabilizers | Calcium Chloride |
| Potassium Sorbate | Modified Starch |
| | Added Water |
| | Acidifiers |
| | Natural Flavorings |
| | Natural Colorants |
| | Annatto |
| | Stabilizers |
| | Preservatives |

*continued from page 1*

level unfriendly to pathogens. The cultures, secondary microflora, contaminants, and enzymes present in the cheese after manufacture will be active throughout the life of the cheese. The impact they have on cheese quality will depend on how the cheese is handled because that influences the environmental conditions within cheese.

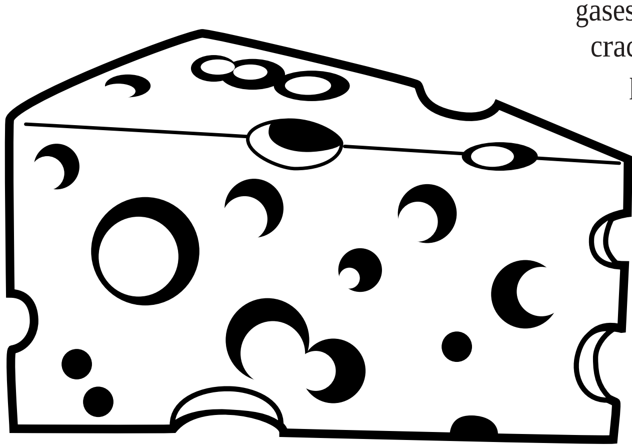
### Aging cheese

During aging, ripening of the cheese involves breakdown of the body and development of cheese flavor. The changes are caused by the activity of cheese cultures, nonstarter lactic acid bacteria (NSLAB), and any other added ripening bacteria, yeast or molds. Contaminating microorganisms from raw milk, the environment, biofilms on dairy equipment, or plant personnel may have found their way to the cheese during the cheese making process. Their activity in the cheese is influenced by cheese composition, temperature, pH, salt content, water activity, and amount of oxygen present in the cheese environment. Ripening activities in natural cheeses will continue to occur as the cheese ages. Higher aging temperatures, higher moisture or water activity, and decreased salt will promote a faster growth rate of ripening organisms and lead to a quicker breakdown of the body of the cheese. Higher temperatures will also stimulate increased rates of enzyme action on cheese components and affect the type of flavors developed during the aging process. As the ripening organisms grow, the environment within the cheese changes from slightly aerobic to anaerobic. Cheese packaging influences the type of environment in the cheese during aging and distribution.

> "The cultures, secondary microflora, contaminants, and enzymes present in the cheese after manufacture will be active throughout the life of the cheese."

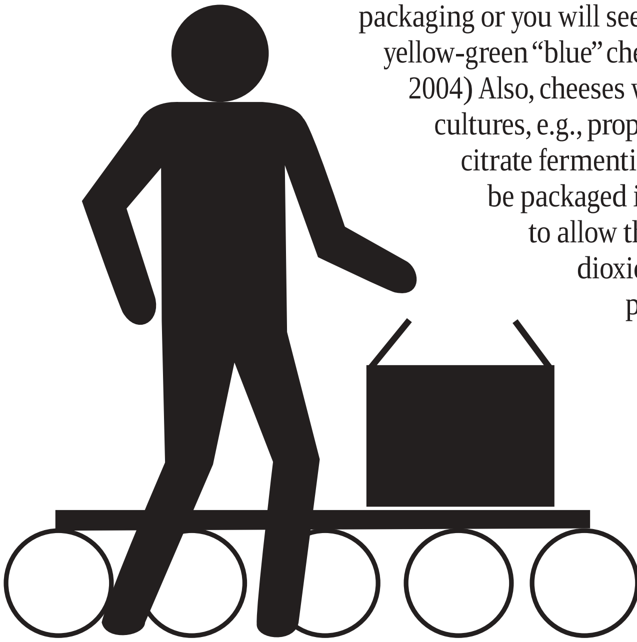
### Distributing cheese

Since natural cheese is a biologically active product, conditions during transport and storage of cheese do influence microbial growth and enzyme activity. Temperature abuse is a common problem during transport; it can accelerate microbial activity and increase the potential for defects. Specific problems such as rancidity, bitterness, and fermented flavors may be exacerbated by temperature abuse. Higher handling temperatures may cause gases to expand in eyed cheeses, which can then cause splits and cracks. Also, physical abuse during handling can contribute to problems with splits and cracks in eyed cheeses if blocks or pallets are dropped or bumped.



### Displaying cheese

Key factors in cheese displays that affect cheese quality are packaging, lighting, and storage temperature. Cheese packaging controls the environment of the cheese through the handling and marketing process. For example, mold ripened cheeses require aerobic conditions for proper mold growth and flavor production. Thus, they need to be packaged in



breathable films or perforated paper packaging or you will see problems like yellow-green "blue" cheese. (Johnson, 2004) Also, cheeses with gas-producing cultures, e.g., propionic bacteria or citrate fermenting bacteria, need to be packaged in breathable films to allow the release of carbon dioxide to avoid puffy or pillowed packages (Johnson, 2004). Warmer storage temperatures, again, will stimulate more gas production by fermenting bacteria, which cause an expansion of gas vapors. On the other hand, lactic cultures and other nonstarter lactic acid bacteria (NSLAB) involved in ripening of cheese tend to be facultative anaerobes and function best in films with limited oxygen permeability and good moisture barriers. These films are most commonly selected for packaging the majority of natural cheeses to retard mold growth and prevent loss of moisture from commodity cheeses.

Intensity of fluorescent lighting in display cases is a critical factor to consider when you focus on maintaining the quality of natural cheeses. Lighting intensity should be held to no more than 160-200 foot candles at the exposed surface of the cheese (Wendorff, 2006). Higher light intensities will cause pink discoloration or bleaching in annatto-colored cheeses and oxidized flavors in all types of cheese (Hong et al., 1995). Heat from high intensity lighting can also increase the temperature of cheese in some display cases.

Bishop and Smukowski (2007) previously reported on temperature of cheese displays in relation to cheese safety. However, cheeses displayed at ambient temperatures in an aisle display will certainly lose quality quicker than cheeses displayed under refrigeration. The higher storage temperatures do promote faster microbial growth and enzyme activities, leading to a faster breakdown of the body of the cheese and potentially generating flavor defects that will shorten the acceptable shelf life of the cheese. This scenario is the most likely explanation for the high percentage of cheeses at the retail market that exhibit short, weak and pasty body defects and acid, bitter, and whey taint flavor defects (Smukowski et al., 2003). In addition, some cheeses at higher display temperatures will sweat or lose serum

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## Glossary

### Pasteurization
Louis Pasteur was the first person to demonstrate that microorganisms caused the souring of milk in 1837. Around 1860 he used heat to destroy unwanted organisms in beer and wine. Although pasteurization of milk kills disease-producing bacteria, as well as yeast and molds, some *Lactobacillus* and *Streptococcus* do survive.

### Pasteurization temps and times
145ºF (63ºC) for 30 minutes (low temperature long time, LTLT or vat pasteurization)
161ºF (72ºC) for 15 seconds (high temperature short time, HTST)

### Thermilization or heat treatment
Heating milk to 65ºC (149ºF) for 16 to 18 seconds will destroy pathogenic organisms that threaten cheese safety. (Johnson et al, 1989)

### Psychrotropic
This word is derived from psychros meaning cold and trephein, to nourish, and it describes organisms that grow at temperatures between 0ºC and 7ºC (32ºF and 45ºF).

### Heat stable enzymes
Milk contains around 60 indigenous enzymes and many of them survive HTST pasteurizaton. We know that some enzymes are active before cheesemaking and some are active during ripening, which can affect flavor both positively and negatively. Somatic cells are a source of enzymes and elevated cell numbers in milk affect the quality and yield of cheese.

### Non-starter lactic acid bacteria (NSLAB)
Unlike the bacteria added to cheese to metabolize lactose to lactic acid, these are residents of the ripening cheese and they contribute to flavor development.

### Propionic Acid Bacteria (PAB)
Bacteria that produce propionic acid, important in the transformation of lactate to propionate, acetate, and $CO_2$ to promote eye formation during ripening of swiss type cheeses.

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### Aerobic
Living or active only in the presence of oxygen

### Anaerobic
Living or active in the absence of oxygen

and produce calcium lactate crystals. Hard grating cheeses, with lower moisture contents, can tolerate higher display temperatures without developing significant defects.

### Conclusion
Maintaining quality in natural cheeses from the time of manufacture to the time of purchase is a real challenge since natural cheeses are a biologically active food influenced by handling conditions. The quality template for the cheese starts with milk quality and is set at the time of manufacture. Cheese cultures and secondary microflora are regulated by cheese composition, temperature, pH, salt content, water activity, and amount of oxygen present in the cheese environment. However, handling procedures throughout the life of that cheese will determine which organisms and enzymes will react in the cheese, as well as the reaction speed and timing. The goal as a cheese transporter, distributor or retailer should be to control those handling procedures to maintain the "window of top quality" of the cheese for as long as possible during the life of that cheese.

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## News from CDR

### CDR 2007 Regional Workshop available on DVD
Wishing you could have attended the CDR fall regional workshops on Cheese Yield & Standardization and Cheese Health & Wellness, but just couldn't fit it into your schedule? Due to several requests, we are now offering the workshop on DVD. This three DVD set along with one CD of all PowerPoint presentations is available from CDR for only $30. Order yours now by emailing Marge Schobert, mschober@cdr.wisc.edu.

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recognize. If nothing is available then they look for something similar. For Hispanic cheese this means the cheese should have a simple label. Also, the cheese should be the proper shape—which may include basket marks. In addition, Hispanic cheeses are often fresh cheeses that have a short shelf life, thus the expiration date is printed in a large font and is easy to find on the package.

### The next steps

The researchers are compiling compositional data on the Mexican and US made cheeses and they are still collecting samples from Costa Rica, Puerto Rico and the Dominican Republic.

Hispanic cheese should have a simple label.

**Oaxaca made in Mexico**

**Oaxaca made in the U.S.**


**Panela made in Mexico**


**Panela made in the U.S.**

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# Dairy Markets and More

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

You are reading an introductory column by Brian W. Gould, an Associate Professor in the Department of Agricultural and Applied Economics at the University of Wisconsin. *Dairy Markets and More,* will be a regular feature in the Dairy Pipeline, focusing on various aspects of U.S. and international dairy markets. Gould, who maintains the University of Wisconsin Dairy Marketing website found at http://future.aae.wisc.edu, has been affiliated with the Center for Dairy Research since 1988 and currently is responsible for CDR's Dairy Marketing and Economics Program.

In this issue, I'd like to examine recent trends in the dry whey markets. Dairy farm operators, cheese manufacturers and others in the Federal Milk Marketing Order System (FMMO), need to pay attention to the monthly average NASS dry whey price. This whey price has a direct impact on Class III prices via the valuation of the Other Solids component. Figure 1 shows a general representation of Class III pricing under the FMMO system and diagrams the relationship between NASS (National Agricultural Statistics Service) wholesale prices and component values.

Using the formula below you can reframe the relationship between wholesale commodity prices and component values to the relationship between these same prices and the Class III price.

**Class III price =**
**9.64 x NASS Cheese Price + 0.42 x NASS Butter Price + 5.86 x NASS Dry Whey Price– 2.82**

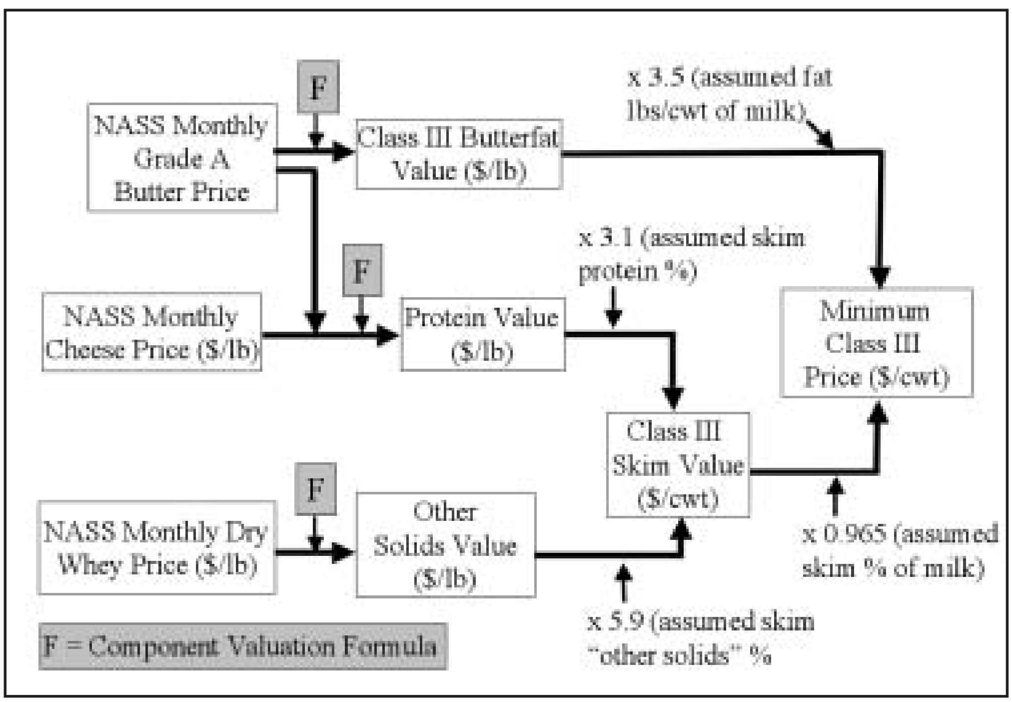



**Figure 1. Class III FMMO pricing structure**

(The 2.82 factor is the combined make allowance associated with the manufacture of cheddar cheese, butter and dry whey per cwt of the standard milk.)

The results imply that every $0.01 cent increase (decrease) in the price of whey results in a $0.0586 increase (decrease) in the value of Class III milk. This is important given the trend observed over the last year in dry whey markets. Figure 2 shows the monthly NASS Dry Whey price since Federal Order Reform in January 2000. A quick glance at the graph illustrates that, compared to the 2000-2006 average dry whey price of $0.237, monthly values observed in 2007 are unprecedented. What does this mean for the Class III price? We can do the math to see that the $0.7789 dry whey price recorded in April '07 added $3.176 to the Class III price above the average obtained over 2000-2006. ($0.7789 – 0.2370) x 5.86 = $3.176)

Since the high dry whey price observed in April, U.S. whey prices have gone down. These lower whey prices are due to a number of factors, including a softening demand in reaction to the high prices, an increasing supply of other protein sources (e.g., NFDM).and increased dry whey stock. The question remain: Where are prices headed and will they return to traditional levels? One source of information you can turn to is the futures market and recent settle prices for cash-settle dry whey contracts. Figure 3 shows these settle prices at of the end of business on January 15th, 2008. For comparison we show the monthly average Western dry whey price observed over 1995-2007 along with the top 3rd and bottom 3rd of the empirical monthly distributions. Even with the drop predicted over the first half of the year, the dry whey settle price continues to be above the 13 year monthly averages.

With California changing the method used to incorporate dry whey into their 4b pricing, the FMMO will be under significant pressure to also address the implications of dry whey prices for both dairy manufacturers and dairy farm operators. We may address this in the next column.

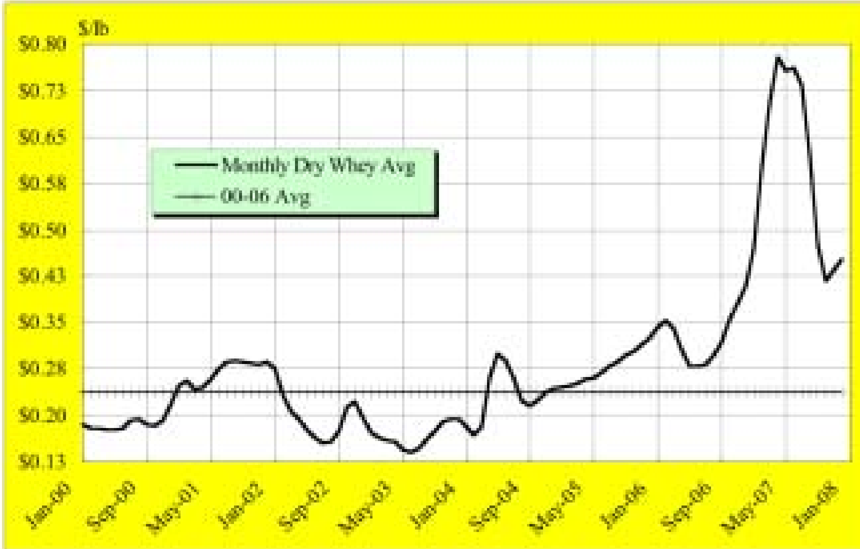



**Figure 2. NASS Monthly Dry Whey Prices**


**Figure 3. Dry Whey Cash Settles**

## Additional Sources

Jesse, E., and R. Cropp, 2004. Basic *Milk Pricing Concepts for Dairy Farmers*, University of Wisconsin Extension Publication #A3379, http://future.aae.wisc.edu/pubs/pubs/show/70

University of Wisconsin Dairy Marketing Website
*Spreadsheet Models of FMMO Milk Pricing*:
http://future.aae.wisc.edu/collection/software/advanced_prices_final_version1.xls
*Spreadsheet Model of California Milk Pricing System Showing Impacts of Changes in Dry Whey Assumptions:*
http://future.aae.wisc.edu/collection/software/California_4ab_new_12_07.xls
*Flowchart of California 4a/4b Price Changes as of 12/07:*
http://future.aae.wisc.edu/collection/software/new_4a_4b_formulas.pdf

# Curd Clinic

*Curd Clinic Doctor for this issue is Dean Sommer, Cheese and Food Technologist at CDR*

**Q.** This has never happened in my plant, but I have heard of an off-flavor in cheese described as medicinal. Apparently, a very small amount of a particular compound causes it; can you tell me more?

**A.** The source of the medicinal off flavor is a well-known chemical reaction that can ruin the flavor of seafood, carrots, beer, and bottled water, as well as milk, cheese and casein. Mark Johnson says this defect, also referred to as phenolic taint, or disinfectant taint, tastes like an old medicine cabinet smells. Not only is it a particularly nasty taste, it also has a very low flavor threshold, which means you can taste it at very low concentrations, as low as 10 parts per trillion.

## A relatively common reaction

In dairy products, the defect stems from a relatively common reaction seen when natural compounds in milk react with bromide ions under ultraviolet light or in the presence of cleaning chemicals like hydrogen peroxide or sodium hypochlorite, commonly known as bleach. This bromination reaction (see Figure 1.) produces bromophenols, the source of the medicinal taste.

This particular flavor defect tastes so bad that New Zealand researchers made a special point to thank their colleagues who tasted their tainted cheese during a research project. Mills et al were searching for the origin of the defect in gouda cheese, which seemed most pronounced in the cheese rind. Subsequent experiments demonstrated that sodium bromide and 4-methylphenol, in the presence of ultraviolet light or sodium hypochlorite, produced 2-bromo-4-methylphenol—the problem compound. This reaction took place in the brine, when plant operators attempted to control microflora by adding sodium hypochlorite, and then exposing the brine to ultraviolet light.

## Natural phenols are in cheese

In a 1997 presentation at the Wisconsin Cheese Industry Conference, Dr. Robert Lindsay told attendees that the precursor compounds for this medicinal defect, natural phenols, are present in cheese. In fact, they contribute to flavor notes in smoked provolone and the desirable background flavor in parmesan. (Ha and Lindsay) Although both chlorophenol and bromophenol reactions involve hypochlorite sanitizers and follow a similar pathway the bromophenol reaction products are detected at lower concentrations. If you want to prevent a problem with medicinal taint then eliminate hydrogen peroxide, sodium hypochlorite and the use of UV lights in brining.

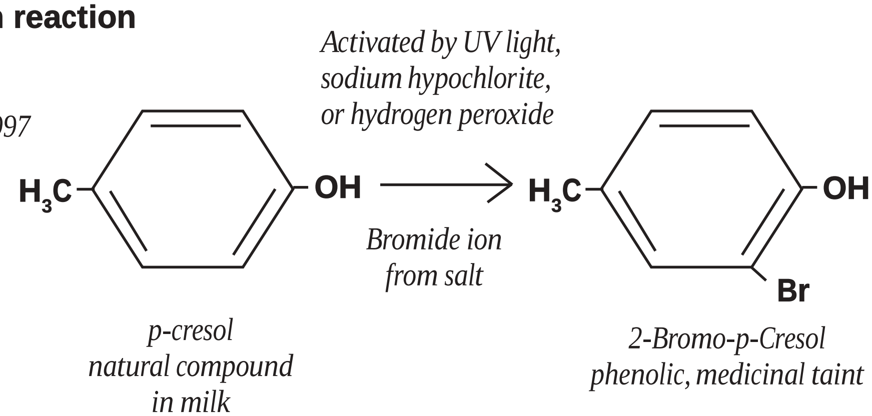
Farmstead cheesemakers can (and have) inadvertently flavored cheese with the medicinal taint by setting forms, equipment, or cheese on a wet surface cleaned with excessive amounts of bleach.

Over the years, scientists have suggested several other routes that the phenolic flavor defects have taken. For example, Wilster (Wilster 1980) notes that medicinal flavors have been found in milk and the defect was attributed to feeding seed grain preserved with paradichlorbenzene. He also points out that certain types of bacteria can produce a medicinal flavor. Back in 1964, Badings et al confirmed a bacterial link by tracing the phenolic flavor in gouda cheese to natural rennet contaminated by an unspecified *Lactobacillus.* Others have implicated strains of *Pseudomonas* in the formation of the phenolic taint.

As mentioned earlier, phenols are naturally found in milk. However, problems can occur when more phenol is added, for example when ointments containing phenolic disinfectants are applied to dairy cattle, or when using water supplies containing

**Figure 1. Bromination reaction**

*Adapted from R.C. Lindsay, Wisconsin Cheese Industry Conference, Green Bay, WI 1997*



chlorophenols. And to complicate the picture even more, Schlegel and Babel (1963) describe their research quantifying the amount of phenol and hypochlorite needed to form a chlorophenol flavor in milk. They suggest you are more likely to see this reaction if you add additional phenol to the milk before the hypochlorite. When chlorine is added first it reacts with the milk and is not available to combine with the phenol.

### Cheese plant operators need to be careful

From a practical standpoint, cheese plant operators need to be extremely careful when using sodium hypochlorite or UV lights in brine systems. Operators also need to be careful when rehydrating milk powders in water or adding any nondairy ingredients, such as processing aids, even in tiny amounts. Any ingredient containing phenolic precursors, which may be produced by contaminating bacteria such as *Pseudomonas*, will react with hypochlorite ions in water to produce the strong, medicinal flavor compounds. Therefore, following best practices indicates you should always add some milk solids to chlorinated water before adding any other process aids or ingredients which could contain phenolic precursors. This is similar to adding a cup of milk to rennet dilution water to prevent rennet inactivation by hypochlorite. But, in this case, we want to inactivate the hypochlorite to prevent it from reacting with phenols and producing off flavors in cheese.

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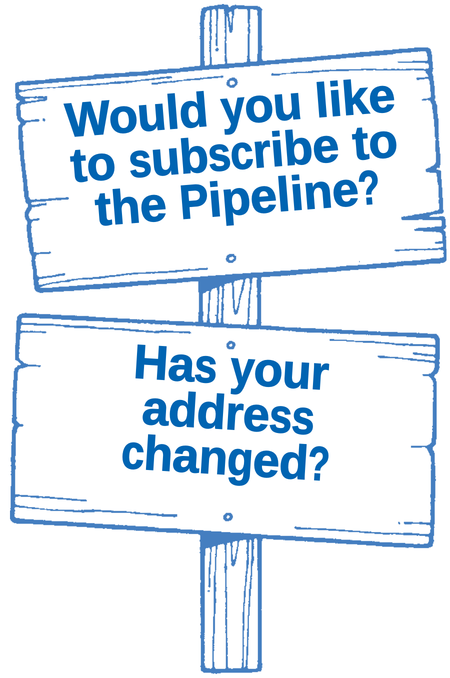


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# Calendar

**Jan. 24-25 Producing Safe Dairy Products.** River Falls, WI. Call Ranee May at (715) 425-3704 for information.

**Feb. 5-6 Quality Milk Conference (WI Dairy Field Reps).** Madison, WI. Call Scott Rankin at (608) 263-2008.

**Feb. 26-27 Wisconsin Process Cheese Short Course.** Madison, WI. Call Bill Wendorff at (608) 263-2015 or John Jaeggi at (608) 262-2264 for more details.

**Mar. 24-28 Wisconsin Cheese Technology Short Course,** Madison, WI. Call Bill Wendorff at (608) 263-2015.

**Apr. 22-24 International CheeseTechnology Exposition, Madison,** WI. For information, call Judy Keller at (608) 828-4550.

**May 5-8 World of Cheese—Pasture to Plate,** Madison, WI. Call Dean Sommer at (608) 265-6469.

**May 13 Wisconsin CIP Workshop,** Madison, WI. Call Bill Wendorff at (608) 263-2015.

**May 14 Dairy HACCP Workshop,** Madison, WI. Call Marianne Smukowski at (608) 265-6346.

**May 20-21 Applied Dairy Chemistry Short Course,** Madison, WI. Call Scott Rankin at (608) 263-2008.

**June 3-4 Wisconsin Cheese Grading and Evaluation Short Course, Madison WI.** Call Scott Rankin at (608) 263-2008.


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