

# DAIRY PIPELINE

## Displaying cheese safely, is there a “right” temperature?

By Rusty Bishop and Marianne Smukowski, Wisconsin Center for Dairy Research

Any retailer working behind the counter selling cheese knows that offering a sample is a good way to make a sale. And an artful display of cheddar daisies, pear shaped provolone and stacked, natural rind cheese wheels is a sight that can draw customers into the store in the first place. However, whether you are a grocer using available aisle space, a cheesemaker offering samples at your local farmers market, or the owner of an upscale cheese store in a large city, it’s likely you share this question; is it safe to display and store unrefrigerated cheese?



Rusty Bishop and Marianne Smukowski recently published their answer, after evaluating and reviewing available information on bacterial pathogen growth, stasis, and death in cheeses to determine safe storage temperatures. Their paper was originally published in Food Protection Trends in October 2006 and the complete text can also be read on the CDR website ([www.cdr.wisc.edu](http://www.cdr.wisc.edu)) under archived news. Here is a summary of their review.

Considering the variety and large volume of cheeses consumed throughout the world, it is rather amazing that the incidence of foodborne outbreaks in cheese is extremely low. For this we can thank the inherent characteristics of most cheeses for creating a hostile environment for bacterial pathogens, especially at elevated ripening and storage temperatures.

Transformation of curd into full-flavored cheese is accomplished during ripening through the action of milk enzymes, rennet, and various organisms in the cheese, including the starter culture. The biochemical changes which occur during cheese ripening are complex and involve fermentation of the carbohydrate, hydrolysis of fats and proteins with subsequent

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# Research Update

## Native whey protein powder—A new product?

“I have never tasted whey protein powder that was so clean.”

When Mike Molitor, CDR's pilot plant project manager, tasted the whey protein he just dried, his first impulse was to enter it in the World Dairy Expo Dairy Product Championship Contest. “I have never tasted whey protein powder so clean,” he says, “I knew it could win.” But he also knew it had an unfair advantage over the other products because his powder had never gone through the cheesemaking process. Instead, Mike separated these “native” whey proteins directly from milk, thus bypassing the potentially harsh effects of cheese cultures, enzymes, coloring and heat treatment of cheese making.

Molitor was drying this native whey for KJ Burrington's DMI-funded applications project. Actually, it is a joint project with researchers at North Carolina State, MaryAnne Drake and Allen Foegoeding who plan to compare native whey, which is sometimes called ideal whey or serum protein concentrate, to the whey protein produced during the cheese making process. Specifically they want to see how native whey protein performs in a drink; answering questions about taste, clarity and shelf-life.

K.J. Burrington says native whey is different, “You would have to consider it to be a new product.” That means whey processors who might want to produce it need to keep it separate from the usual whey production.



To produce native whey protein Molitor used a polymeric microfiltration (MF) element, like the membranes used to separate beta casein from milk. (See next page). He used skim milk, running the equipment warm, to separate the native whey proteins but retain the beta casein in the retentate. Next, Molitor standardized the retentate for the CDR's cheese research group. So far, Mark Johnson and John Jaeggi have used it to make reduced fat cheese. The next step involves producing a zero fat base for making process cheese. Mark Johnson notes that the polymeric membranes running a bit cooler offer a definite quality advantage because you have fewer microbial issues.

### Comparing cheese whey to native whey

Component	Cheese whey	Native whey
Starter culture	Yes	No
Secondary flora	Yes	Negligible
Rennet enzymes	Yes	No
Residuals (GMP/CMP)	Yes	No
Pasteurization steps	2	1
Fat/phospholipids	Yes	Negligible
pH	<6.5	6.6

From Karen Smith, CDR

For more information see: S. Govindasamy-Lucey, J. Jaeggi, M. Johnson, T. Wang and J. Lucey (2007). Use of cold microfiltration retentates produced with polymeric membranes for standardization of milks for manufacture of pizza cheese in the Journal of Dairy Science, Vol. 90, pages 4552-4568.



## Beta casein steps into the limelight

John Lucey and James O'Mahoney of the University of Wisconsin Food Science Dept. and Karen Smith, CDR, developed and recently submitted an application to patent a new, low-cost separation method that removes some of the beta casein from milk without compromising the beta casein or the milk. This group didn't set out to make purified beta casein. Instead, the scientists wanted to answer a question about the meltability of cheese. In particular, they wondered which casein subgroup influenced melt qualities and they also wanted to know what would happen to melt as they varied the proportion of casein subgroups in cheese.

Of course, to answer these questions, Lucey and his group first had to figure out how to isolate beta casein. You have probably heard of beta casein, or  $\beta$  casein, before. It is one of the subgroups of casein, the major protein in milk and the most important protein in cheese. Scientists have known how to separate these casein subgroups — beta, alpha  $s_1$ , alpha  $s_2$ , and kappa casein—for decades. However, the process that Lucey's group developed was helped along by two key features. The scientists got their first boost by taking advantage of recently improved spiral wound polymeric microfiltration membranes. These membranes differ from the ceramic types that they can replace; for example, smaller pumps are needed and they are much less expensive to run since they use less energy. In addition, and this is the second step forward, the polymeric membranes work well running cold. Since the 1970's, researchers have known that up to 20% of the beta casein separates from the micelle under refrigeration temperatures and now Lucey's group was able to take advantage of the concept and operate polymeric membranes cold to isolate beta casein. Of course, beta casein wasn't pure yet, since it shared the permeate stream with whey proteins. After more work in the lab, the group discovered a novel approach to separate beta casein from the other components.

Once the scientists isolated beta casein, they went back to the original research question focusing on cheese meltability. They discovered that reducing the proportion of beta casein as a percentage of total casein resulted in cheese with greater melt. This means that removing the beta casein actually improves the meltability of cheese made with the depleted casein fraction—which is good because now beta casein can emerge as a star in its own right.

$\beta$  casein certainly offers many possibilities, both nutritional and functional. For example, beta casein is a high quality foaming agent and an outstanding emulsifier. Thus, beta casein could compete with the imported sodium caseinates now used in applications like coffee creamers and whipped toppings. According to Lucey, "Pure beta casein can do these jobs better than caseinate."

Beta casein is a great starting point for manufacturing bioactive peptides. (See Sidebar, below) Also, manufacturers of infant formula are always looking at ways to improve their product and pure beta casein would allow them to make bovine-based milk more like human milk. In cow's milk, beta casein makes up 36% of total casein but human milk contains mainly beta and kappa casein, without the alpha caseins.

After developing this new separation process, Lucey's group produced several highly valuable streams. Along with purified beta casein, they produced the partly depleted beta casein retentate which is useful for cheesemaking. A third product is native whey, which is described in detail on the previous page. Although it remains to be seen if beta casein takes on a starring role in the dairy protein world, it is true that now pure beta casein is free to ascend in the marketplace. 

### Targeted proteins

Dairy proteins are no longer nutritious orphans seeking a home. Instead, the latest approach is a targeted one that seeks active ingredients in dairy proteins, ingredients that provide a specific function. Lactium® is a good example. Inspired by the tranquility of a just fed infant, researchers at a French University and Ingredia, a dairy ingredient company, isolated a peptide from casein that has "relaxing properties." According to Ingredia, Lactium® is a bioactive protein that can help people "reduce and regulate" their response to stress. It is also described as a sleep aid. Now sold in capsule form around the world, Lactium® is also available in Europe as part of a reconstituted fitness shake. Here in North America Lactium® is sold as Tryto Zen™ by Symbiotics, De-Stress™ by Biotics Research, and PNT 200 by Immunotec Research Ltd.

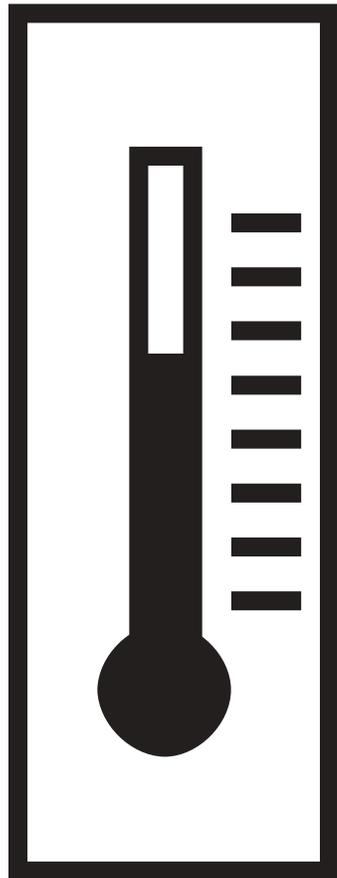


Lactium® may also have some uses in the animal world. Not only is it marketed as a supplement for anxious pets, but Lactium® may soon be used to soothe pigs before slaughter—an application which could prevent degradation of the meat in swine susceptible to stress.

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“Ironically, pathogens that survive the manufacturing process can actually decrease faster at higher storage temperatures.”

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decarboxylation, deamination, and/or hydrogenation as well as production of carbonyls, nitrogenous compounds, fatty acids, and sulfur compounds, all of which contribute to the overall body, texture, and flavor of the final product. These inherent characteristics also create a hostile environment for pathogens. In addition to the ripening process, natural cheese characteristics like reduced moisture, low water activity, low pH from organic acid production, salt, heat treatment, competing flora, biochemical metabolites, and bacteriocins enhance safety.

### **Preserving food by fermentation**

From pickling to sauerkraut to cheese, fermentation is an age-old food preservation method used to inhibit the growth and survival of pathogenic bacteria. Lactic acid bacteria commonly used to produce fermented dairy products are antagonistic to food-borne pathogens; they will either inhibit pathogen growth or inactivate them. Some starter cultures are detrimental to food spoilage organisms as well as various pathogens. Working together, metabolites such as lactic and other acids, diacetyl, hydrogen peroxide, and various antibiotic-like substances produced by lactic acid bacteria are responsible for this action.

### **Influence of temperature**

The vast majority of cheese manufactured in the United States is made from pasteurized or heat-treated milk, which produces cheese free of most pathogens. A review of the literature related to the potential for growth of pathogens in hard cheeses that are aged for at least 60 days shows that pathogen growth is unlikely because of factors inherent to these cheeses. For example, the temperature of curd cooking, aging, curing, ripening and storage has an impact on pathogen growth and survival in cheese. Thus, in hard cheese types like parmesan, pathogen growth is limited by higher curd cooking temperatures. Parmesan has additional safety factors in its favor since it is more acidic than other cheeses and it has a lower moisture content and lower water activity, which limits microbial growth.

Ironically, pathogens that survive the manufacturing process can actually decrease faster at higher storage temperatures. For a description, look up a 1980 International Dairy Federation (IDF Bulletin 122) that concludes the death rate of Salmonella in samsoe cheese was slower at 10-12°C (50-54°F) than at 16-20°C (61-68°F).

### **Salt as a safety factor**

In most cheese varieties, salt concentrations reach levels of 1.6-3.0% total in the cheese, though this would not affect most of the pathogenic bacteria in cheese. But remember, salt is dissolved in the aqueous phase of the cheese only, the actual site of bacterial growth. Given the respective calculated values, salt concentrations in the aqueous phase reach levels of 2.2-6.5% or higher and will, in fact, at least slow down the growth rate of most bacteria.



## Conclusions and recommendations

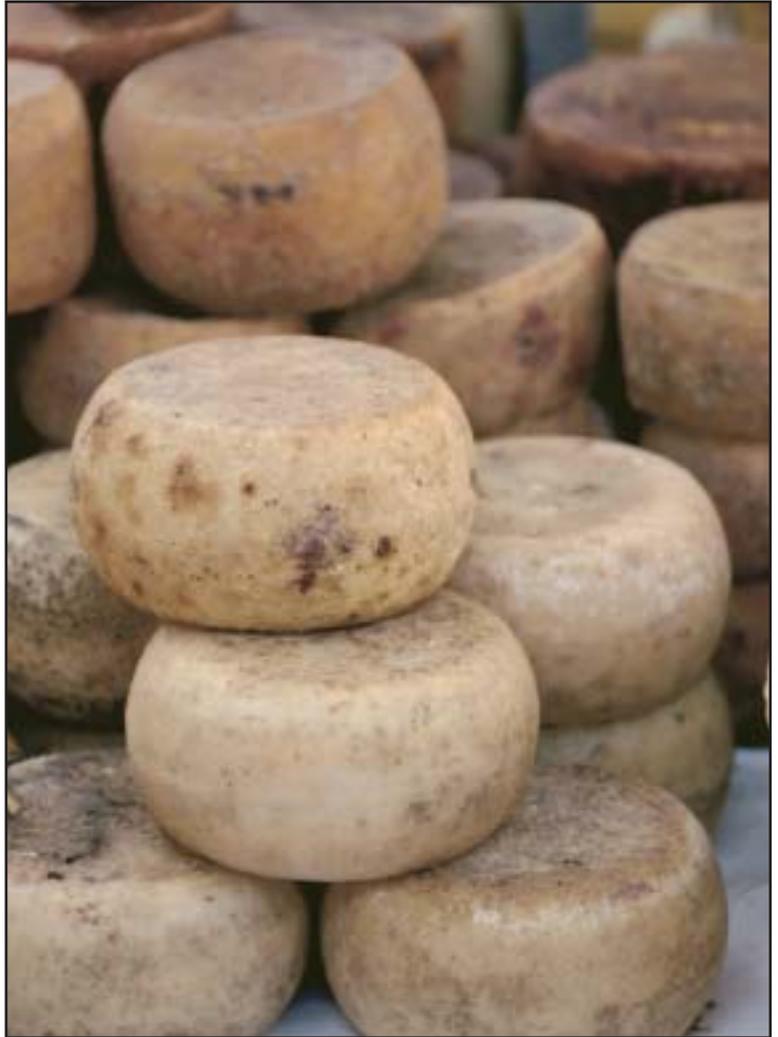
Data adequately illustrates the fact that most cheeses containing < 50% moisture (or more, in the case of feta), active lactic acid starter cultures, with traditional levels of salt, pH, fat, etc., do not allow the growth of pathogens when held at temperatures between 4 and 30°C. (39 and 86°F) In fact, in a vast majority of the cheeses, a higher temperature during ripening/aging and storage leads to significant bactericidal activity. See Table 3 on page 6 for a summary of the reviewed science and data.

For cheeses manufactured in the United States with pasteurized (> 63°C or 145°F for > 16 sec) or heat-treated milk, under hygienic conditions outlined in Good Hygienic Practices, Good Manufacturing Practices, and HACCP systems, using active lactic acid cultures, and according to CFR specifications, the following cheeses should be considered by regulatory agencies (FDA, USDA, state, local, etc.) exempt from any and all refrigeration requirements for aging, storage, shipping, and retail display, with a maximum temperature of 30°C (86°F):

Asiago (medium and aged)  
Cheddar  
Colby  
Feta  
Monterey Jack  
Muenster  
Parmesan  
Pasteurized process cheese  
Provolone  
Romano  
Swiss / Emmentaler

If this exemption would only apply to pre-packaged cheeses, parmesan and romano, and possibly medium and aged asiago —because of their inherent characteristics— would not have to be pre-packaged for this refrigeration exemption. Soft/fresh asiago, blue, brick, cream and mozzarella require further investigation before a recommendation for exemption could be made.

There is one common thread among all the ripened cheeses evaluated (this would exclude mozzarella); the curing/ripening/aging step is detrimental to bacterial pathogens, especially at elevated temperatures up to 30°C (86°F). Therefore, for safety purposes, refrigerated storage of the cheeses would appear to be



unnecessary and possibly be counterproductive. However, when you shift the focus to quality, storing cheese at higher temperatures will influence body, texture and flavor deterioration. In addition, some cheeses will sweat and begin to oil off. Keep this balance between safety and quality in mind as you store and display your cheese. 

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“Keep this balance between safety and quality in mind as you store and display your cheese.”

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Table 3. Summary of data on cheeses reviewed, with compositional calculations.

Cheese Type	Typical % H2O	CFR Limit % H2O	A <sup>w</sup>	Typical pH	Typical % NaCl	Typical % Aqueous NaCl	% FDM **
Asiago	32-34	35	0.93	5.2-5.5	1.9-2.2	5.75	45
Cheddar	38	39	0.95	5.2	1.7	4.47	52
Colby	39	40	0.95	5.2	1.7	4.36	52
Feta	53	NA	0.95	4.5	3.0	5.66	29-52
Monterey Jack	38-42	44		5.25	1.7	4.05-4.47	52
Mozzarella	45-52	45-52		4.9-5.4	1.6	3.07 – 3.56	52
Muenster	43	46	0.98	5.2	1.8	4.18	52
Parmesan	31	32	0.92	5.4	2.6	8.38	38
Process (sliceable)	40		0.92	5.6	2.2	5.50	50
Provolone	42.5	45	0.91	5.2	1.8	4.24	45
Romano	33.5	34	0.92	5.3	2.2	6.57	40
Swiss / Emmentaler	38	41	0.97	5.6	1.2	3.16	43
Brick	43	44		5.3	1.6	3.72	52
Blue	43	46	0.97	6.0	2.5	5.82	52

\* A/S Temp => Increased pathogen kill at elevated aging/storage temperatures.

\*\* %FDM=> %Fat in Dry Matter

+ Ah – *Aeromonas hydrophils*, Cj – *Campylobacter jejuni*, Clb – *Clostridium botulinum*, Ec – *Escherichia coli* O157:H7, P – *Pseudomonas aeruginosa*, Sa – *Salmonella sp.*, Sta – *Staphylococcus aureus*, Ye – *Yersinia enterocolitica*

“ Data adequately illustrates the fact that most cheeses containing < 50% moisture (or more, in the case of feta), active lactic acid starter cultures, and 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).”



Active Culture	Age at sale (days)	Other inherent characteristics	Pathogen Kill+
Thermophile	180-365	A/S Temp*	Ah, Cj, Ec, Lm, P, Sa, Sta, Ye
Mesophile	15-1,000	A/S Temp*	Lm, Sa, Sta, Ye
Mesophile	15-80	A/S Temp*	Ec, Lm, Sta, Ye
Mesophile	7-90	A/S Temp*	Lm
Mesophile	15-150	A/S Temp*	Lm
Thermophile	5-150	Hot water/steam treatment	Lm kill cook/stretch Lm, Sa growth
Thermophile	10-150	A/S Temp*	Lm
Thermophile	300-600	A/S Temp* Aged >300d High temp curd cook Lipase activity	Lm
None	14-180	A/S Temp* Heated >150°F/>30 sec	Clb, Ec, Lm, Sa, Sta
Thermophile	15-150	A/S Temp*	Lm
Thermophile	150-180	A/S Temp*	Lm
Thermophile	61-300	A/S Temp*	Ah, Cj, Ec, Lm, Pa, Sa, Sta, Ye
Mesophile	7-50	A/S Temp*	Ec, Lm
Mesophile	61-240		Lm

Lm – *L. monocytogenes*,

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# News from CDR

## UW Dairy Alerts now on CDR website

In the past, Bill Wendorff of the UW Department of Food Science produced a technical report, the Dairy Alert, to answer questions about specific, current issues in the dairy industry. These reports are still timely and since we occasionally get requests for them we decided to post them on our website. If you have an interest in any of the following topics, go to the resources section of our website, cdr.wisc.edu, download and dig in.

- Wastewater Volume-How do we compare? May, 2007
- Managing Nitrogen in Dairy Wastes, September, 1998
- Efficient Use of Whey Cream in Cheesemaking, October, 1997
- Good Salt Management in Cheese Plants, November, 1996
- Freezing Point Impacts on Quality Premiums, December, 1993
- Revised Guidelines for Landspreading Whey & Whey Permeate, June, 1993

## This is slick!

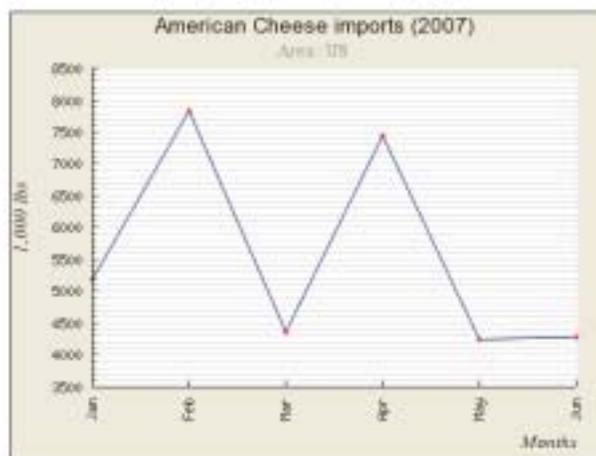
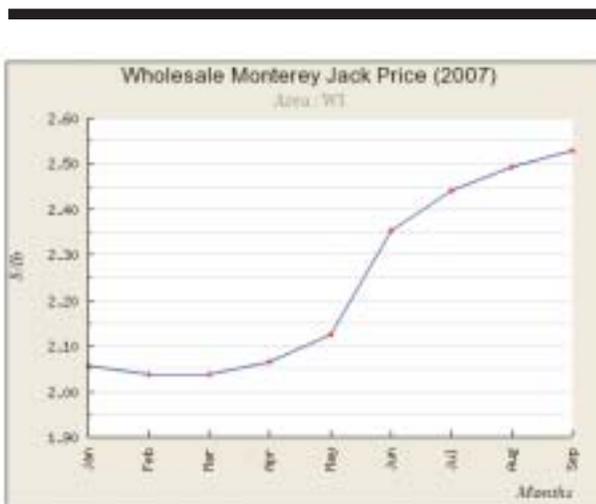
Brian Gould's expanded, updated website is packed with data and the tools you need to make sense of it. Wondering about yogurt consumption? How about the 2007 price of wholesale monterey jack? Maybe you want to know more about cheese imports, all this and more is right at your fingertips. Follow this link :<http://future.aae.wisc.edu> or you can find a link to Understanding Dairy Markets/Dairy Price Risk Management on CDR's website, [www.cdr.wisc.edu](http://www.cdr.wisc.edu)

## CDR—Where will we be in 2013?

That is the question CDR is looking at while working through a self analysis, also known as strategic planning. Two big questions include how can we work together better, and how can we work with industry better. So far, we have a new mission statement and a whole pile of Action Plans.

## Mission

To enhance the competitive position of the dairy industry through leadership in innovative strategic research, technology development and application.



## Skimming the Shelf—



### What's New in Print?

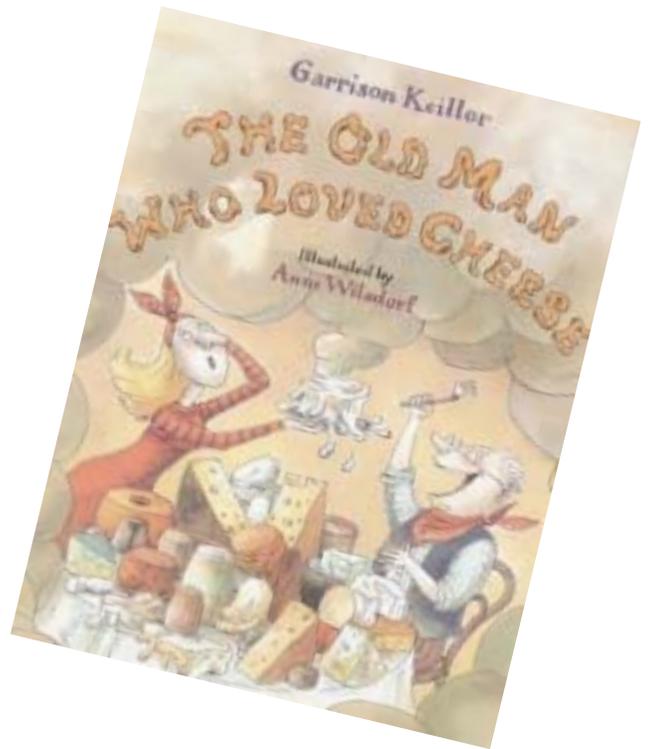
#### The Old Man Who Loved Cheese

By Garrison Keillor

Last year I visited my brother's family over the holidays and was enthusiastically greeted by my nephew. Bailey had found a book in his school library that was a story about cheese, and he had special permission to keep it an extra week so he could read it to me. He is a great reader and I felt pretty special as we sat together and he began to read "The Old Man Who Loved Cheese," by Garrison Keillor. Here is how the story starts:

*There was an old man named Wallace P. Flynn  
Who lived in a house in the trees—  
You could smell him for several miles downwind  
Because of his fondness for cheese*

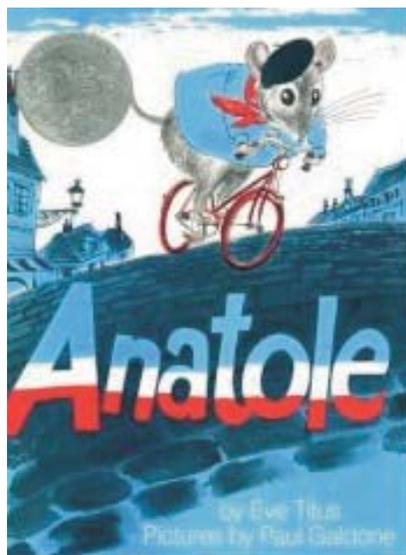
Anne Wilsdorf illustrated this lovely book, which will teach kids how to pronounce all kinds of cheese, although you may not like the ending!



#### The Stinky Cheese Man

By Jon Scieszka and Lane Smith

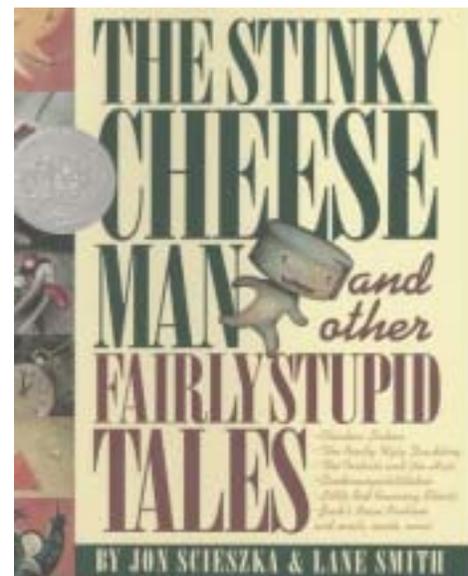
I think these authors got real tired of traditional fairy tales. And then they did something about it. The stinky cheese man is a new take on that old stand by about the gingerbread man; he still comes to a sad end but smart alecks might like this version better.



#### Anatole

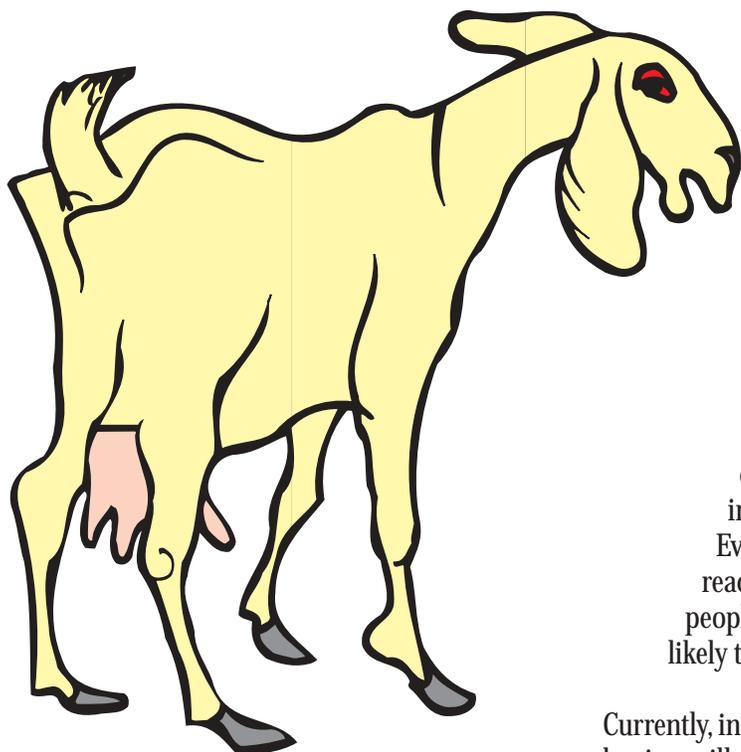
By Eve Titus

One thing the Internet has really helped me with is finding out of print books. You may need to do the same to find Keillor's book as well as an older classic, Anatole. Originally published in 1956, Eve Titus wrote this story about a mouse who decides to earn his cheese by rating the cheeses at the Duval factory. It turns out that Anatole is a pretty good cheese grader, and a mouse magnifique!



# Curd Clinic

*Curd Clinic Doctor for this issue is Bill Wendorff,  
Department of Food Science*



**Q.** The growing number of goat and sheep herds has prompted a parallel growth of interest in milk quality from those herds. Several processors have asked, “Is there a quick procedure to determine if goat milk or sheep milk has been adulterated with cow milk?”

**A.** Since the price for raw goat milk is twice that of cow milk and sheep milk is four times that of cow milk, it is not surprising that an unscrupulous producer might be tempted to dilute their goat milk or sheep milk with cow milk to make more money. However, it is likely that a skilled cheesemaker will notice the differences in cheese yield and flavor development in the cheeses produced from this adulterated milk. Even more disturbing is the potential for allergic reactions in consumers of the cheese, particularly since people sensitive to bovine protein components may be likely to try goat and sheep’s milk cheeses.

Currently, in the U.S. there is no official procedure for detecting bovine milk blended with goat or sheep milk. However, in the European Union, the Official Method of Analysis is based on the identification of bovine  $g_2$ - and  $g_3$ -casein using gel electrophoresis and immunoblotting procedures (1). The limit of detection for bovine milk in a blended milk supply is 0.5%. Other analytical methods of analysis (2,3) have used HPLC to determine fatty acid patterns for the milk sample in question. A limit of 5% cow’s milk could be detected in sheep’s milk using the  $C_{12}/C_{10}$  and  $C_{14}/C_{12}$  acid relationships. All of these procedures are quantitative or semi-quantitative and also they require sophisticated laboratory equipment and extensive time to obtain results.

### **New method developed**

A simple and rapid qualitative method for detecting the presence of bovine immunoglobulin (IgG) in goat or sheep milk has been developed and is now available from Midland Bioproducts Corp., Boone, Iowa. The test can detect the presence of bovine IgG in sheep or goat milk at concentrations as low as 1.0% within 20 minutes. The test will work with raw, pasteurized, and sterilized milk. The test milk sample is diluted in an ampoule of dilution liquid provided and then several drops of the diluted sample are placed in the sample well of the test cassette. In about 20 minutes, a reaction band will indicate the presence of bovine IgG in the sample. The absence of a

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“It is likely that a skilled cheesemaker will notice the differences in cheese yield and flavor development in the cheeses produced from adulterated milk.”

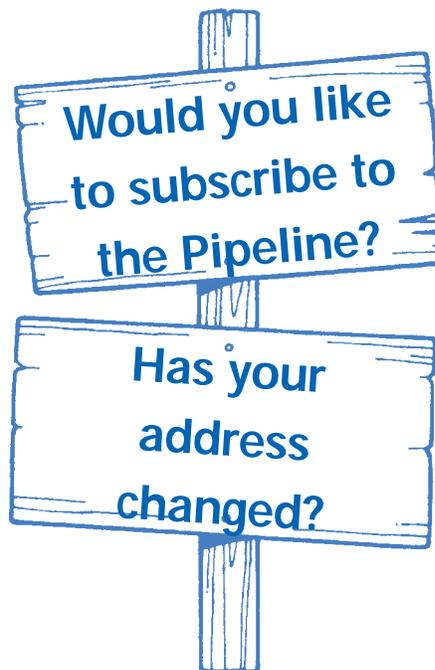
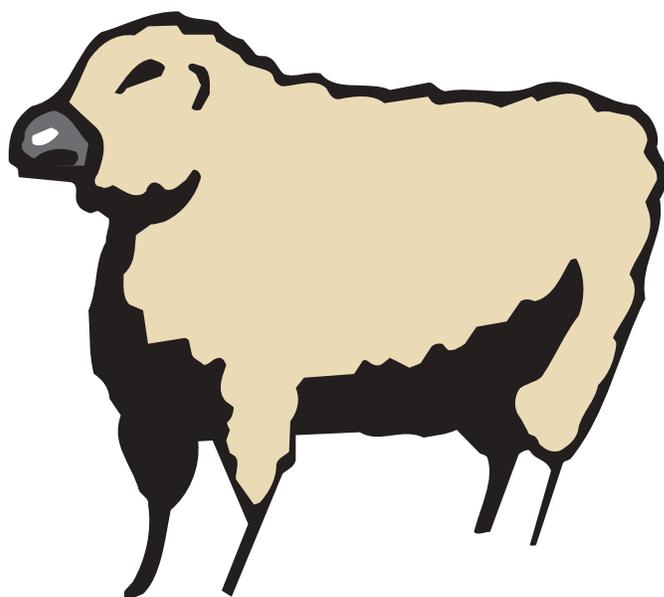
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reaction band indicates either no bovine IgG in the sample or an amount that is less than 1.0% (v/v). Further information on the Bovine IgG Indicator for Sheep or Goat Milk is available at: [www.midlandbio.com](http://www.midlandbio.com) or by calling 800-370-6367.

We have evaluated the Midland test kit in our laboratory on both goat and sheep milk samples with as low as 2% added cow milk with good success. The Midland test procedure can be used as a quick screening test on raw milk samples in question. For quantitative determination of the level of bovine milk addition in an adulterated sample, you would need to perform a more extensive analytical procedure, such as the EU gel electrophoresis procedure (1).

**References**

1. European Commission. EC 213/2001. *Off J Eur Comm* 44 L37/99 (2001)
2. Palo, V. 1975. Falsification proof of sheep's cheese by cow's cheese. *Int. Dairy Fed.* A7-Doc3.
3. Ramos, M, J. Martinez-Castro, and M. Juarez. 1977. Detection of cow's milk in Manchego cheese. *J. Dairy Sci.* 60: 870-877.



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You can also find the Dairy Pipeline on our website: [www.cdr.wisc.edu](http://www.cdr.wisc.edu)

## Calendar

**Oct. 30-31 Dairy Ingredients Utilization Workshop**, Madison, WI. Call Bill Wendorff at (608) 263-2015 or K.J. Burrington at (608) 265-9297.

**Nov. 1-3 Great Lakes Dairy Sheep Symposium**. Guelph, Ontario, Canada. For information, contact the Agricultural Information Contact Centre in Guelph at (519) 826-4047 or e-mail at: [ag.info.omafra@ontario.ca](mailto:ag.info.omafra@ontario.ca).

**Nov. 6-7 Cheese Grading and Evaluation Short Course**. Madison, WI. Call Scott Rankin at (608) 263-2008.

**Nov. 13-14 Dairy & Food Plant Wastewater Short Course**, Madison, WI. Call Bill Wendorff at (608) 263-2015.

**Dec. 5-7 Ice Cream Makers Short Course**, Madison, WI. Call Scott Rankin at (608) 263-2008.

**Jan. 8-9 Milk Pasteurization and Process Control School**, Madison, WI. Call Scott Rankin at (608) 263-2008.

**Jan. 24-25 Producing Safe Dairy Products**. River Falls, WI. Call Raneen 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.



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