Wisconsin Center for Dairy Research

# DAIRY PIPELINE

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# Milk proteins and cheese composition—the influence of genetic variants

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A local dairy farmer approached the Wisconsin Center for Dairy Research with questions about using kappa casein genotype BB Holstein cows for cheese making. This genotype is interesting since kappa casein genotype BB milk has a high casein to fat ratio. A tremendous amount of work has already been done on this topic (Cheese Yield and Factors Affecting its Control, Topic 4: Genetic variants of milk proteins and cheese yield, IDF Seminar Proceedings, Cork, Ireland, April 1993), particularly in reference to clotting and yield. However, very little has been published on the sensory and functional qualities of cheese made from this milk. We pursued our interest in the sensory aspects of the cheese (flavor and texture) and the thermal meltability of cheese made from kappa casein BB milk.

In a herd of over 250 cows we found six cows that had the BB kappa casein genotype. Thirty cows had the genotype AA for kappa casein. Cheddar cheese was manufactured from milk obtained from Holstein cows with the AA or BB kappa-casein genotype. The milks were pooled from 3-6 individual cows and from at least two separate milkings. Five vats of cheese were made from each type of milk over three months. Only one vat of cheese was made from each milk each day. Table 1 lists the average composition of the milks and cheeses.

## What's Inside:



The milk from cows with the AA genotype were higher in protein (3.07 vs 2.97), casein (2.45 vs 2.42), and fat (3.59 vs 3.39) than milk from cows with the BB genotype. The higher casein and fat resulted in higher cheese yield (9.89 vs 9.60). There were no differences in moisture in the cheeses made with either genotype of milk (ca. 38.5%). The milk from cows with the BB genotype had slightly higher non-protein nitrogen as a percentage of the total nitrogen than milk from cows with the AA genotype, but the percent casein as a percent of the true protein was higher (81.6 vs 80.2%). Table 2 indicates that fat retention was higher in cheese made from milk from BB genotype cows (90.7 vs 88.4) and the nitrogen retention was higher also,(74.9 vs 73.6). The coagula were cut at the same firmness, but the milk from cows of the BB genotype clotted faster than milk from cows with the AA genotype (20 vs 34 min).

## Cheese characteristics

Sensory analysis of the cheddar cheese indicated no differences between the cheeses that could be attributed to the genotype of the cow. Similarly, thermal melt tests did not indicate any differences between cheeses that could be attributed to the milk from which the cheese was made. A new test that measures the softening point of the cheese indicated a trend towards a slightly higher softening point in cheese made with milk from cows of the AA genotype. The significance of this, if any, has not yet been elucidated.

Low moisture part skim mozzarella was made on three separate occasions using milk from Holstein cows with AA, AB, and BB genotype for kappa casein. Mozzarella cheese was also manufactured from milk obtained from Brown Swiss cows with the BB kappa casein genotype. The milks from the

*continued on page 6*

# Salting Muenster-type Cheese

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## Summary

Muenster-type cheeses were salted by immersion in a traditional saturated brine solution or by direct addition of salt to the curd. Cheeses were evaluated at 0, 30, 60, 90, 120 and 180 days of age for numbers and type of microflora, casein hydrolysis and amounts of free fatty acids. No significant differences were found in the populations of starter, lactobacilli and yeast for the brine and direct salted cheeses. The amounts of free fatty acids liberated were similar for both cheeses. The hydrolysis of $\alpha_{s1}$-casein was complete at 90 days of age while only 40% of the $\beta$-casein was hydrolyzed at 180 days of age. The center of the brine salted cheeses had the highest number of starter microorganisms, followed by the middle and outer layers, respectively. The salt concentrations were similar in the three layers after 4 months of age. Results of this study show that comparable Muenster-type cheese can be produced with either of the salting procedures. With direct salt addition to curd, a 59% reduction in salt emissions from the Muenster manufacturing process were experienced.


Muenster cheese is a traditional brine salted cheese. However, recent restrictions on chloride (Cl) discharges into the environment (6) suggest that it might be time to reassess the traditional process. On average, brine solution discharges from cheese plants range from 637 mg of Cl/L to 911 mg of Cl /L (6), far exceeding proposed limits. High concentrations of chlorides in water are a health hazard to people with heart or kidney disease, prompting the Wisconsin Department of Natural Resources (DNR) to propose lowering the chloride standard. They suggest reducing chlorides in surface water discharges from 395 mg of Cl /L to 310 mg of Cl /L (8). With these environmental restrictions on chloride discharges (3, 5, 7, 8), cheese plants may need to consider new salting procedures for some of the traditional European brine-salted cheeses (1).

Salt influences the sensory characteristics of cheese. It is an important flavor additive and it also controls the growth of the starter culture and secondary microflora that contribute to the final flavor of cheese. The most common ways of salting cheese are: direct addition of salt to the curd, rubbing dry salt on the surface of the cheese, and submerging the block of cheese in a saturated brine solution (4). The extent of salt absorption influences the final composition of the cheese. For example, as the cheese absorbs salt, whey is expelled and the cheese reaches the proper moisture content (7).

Along with the problems caused by chloride discharges, brine solutions raise other issues. For example, they may become contaminated with microorganisms that affect the quality of the cheese. In addition, brine salted cheeses also are more likely to vary in chemical composition, which also affects cheese quality. Disposal of contaminated brine is a major problem for cheesemakers (6).

### Alternative procedures

Several researchers have developed alternativeprocedures for salting cheeses. Barbano et al. (1) modified the manufacture of mozzarella cheese with a stirred curd, no-brine procedure. The curd was stirred during and after whey was drained, until the curd pH reached 5.50. Salt was added while the curd was continuously stirred. When the curd reached a pH of 5.30, the curd was stretched, molded and then cooled with water. Another no-brine, non-pasta filata process for mozzarella cheese was developed by the Wisconsin Center for Dairy Research (2). In this process, the curd was stirred, washed, and salted by direct addition of salt. This new procedure also improved the functional characteristics of the cheese, including melt and stretch.

Our objectives during this study were to determine the feasibility of directly adding salt rather than brine salting for Muenster-type cheeses. We also assessed the impact of the salting procedure on the composition of Muenster-type cheeses.

Previous researchers (1,2) have eliminated problems associated with brine salting by adding salt directly to the curd before molding or hooping. In the direct salted Muenster-type cheese, we added 24.9 g of salt per kg of cheese and we lost 10.2 g of salt/kg of cheese in the form of salty whey. In the brine salted Muenster-type cheese, we experienced a 3% decrease in moisture of the cheese during brining due to the whey expulsion into the brine. This increase in brine volume represented excess brine solution that required disposal. Besides this salt loss, Muenster cheesemakers also experience contaminated brines periodically that require disposal. A typical Muenster cheesemaker uses about 4 liters of brine to properly immerse and brine 1 kg of cheese. Based on an industry survey (6), a typical Muenster plant would use the brine for 3 months before disposal due to contamination. Assuming 20 production days per month and 3 months of brine usage, each liter of brine would have treated 15 kg of cheese. The disposal of that brine represents the equivalent of 18.4 g of salt discharged per kg of cheese. With disposal of the excess brine from whey expulsion plus disposal of the contaminated brine the total salt discharge is equivalent to 25 g of salt/kg of cheese. By changing the salting procedure of Muenster cheese to directly add salt to the curd, a cheesemaker could reduce the salt discharge from the Muenster cheesemaking process by 59%.

Based on the results of this study, we concluded that the method of applying salt did not affect the final composition of Muenster-type cheeses. We found that the hydrolysis of $\alpha_{s1}$-casein and $\beta$-casein was not significantly different between the brine and direct salted cheeses. The TCA soluble nitrogen was not significantly different between the brine and direct salted cheeses, either. Sensory analyses were not conducted on these cheeses, however, a licensed cheese grader found the two types of cheese comparable. By directly adding salt to the curd in the Muenster manufacturing process, an acceptable cheese can be produced, while significantly reducing chloride discharges.

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# Is it time for Wisconsin *terroir*?

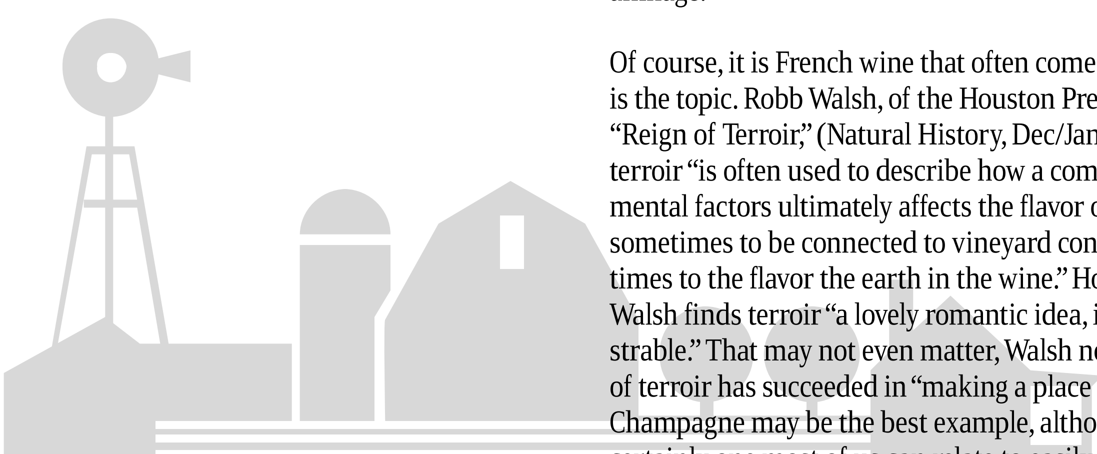
Propelled by stories of mad cow disease, irradiation for safety, genetically modified organisms, and the USDA review of the size of holes in Swiss cheese, media coverage of food issues has become rather common. A quick look at the European press indicates that public interest in food issues is even higher overseas. The International Institute at the University of Wisconsin-Madison took advantage of this attention and recently hosted a conference focusing on "Taste, Technology and *Terroir*: A Transatlantic Dialogue on Food as Culture."

The intent was to look at the idea of food as culture, and "to examine the ways in which food, science and politics come together in the arena of genetically modified food (GMF)." In addition, the conference focused on "the changing relationships in these areas between France, the European Union, and the US, with a focus on Wisconsin."

First, I can tell you that the conference was rather fun—the talk was about food and culture and the culture wasn't even a microorganism! I can also suggest that Wisconsin cheesemakers pay attention to the French. Here's why.

*Terroir* … refers to the link between taste and place, not just the soil, minerals, earth and climate but also the culture and sense of identity.

*Terroir* is a French word, perhaps more accurately described as a French concept, that really has no equivalent in English. It refers to the link between taste and place, not just the soil, minerals, earth and climate but also the culture and sense of identity. Amy Trubeck, New England Culinary Institute, explains that it is important to the French, and much more understandable and apparent, that place influences the taste of food. The French have faith in "a method of nurturing nature" that allows taste of place to exist. They take cultural stewardship very seriously, controlling the link between taste and place with the Appellation d'Origine Controlee, or AOC protection. AOC regulations establish precise definitions, for an AOC cheese this could spell out the type of milk, region and method of production and the length of affinage.



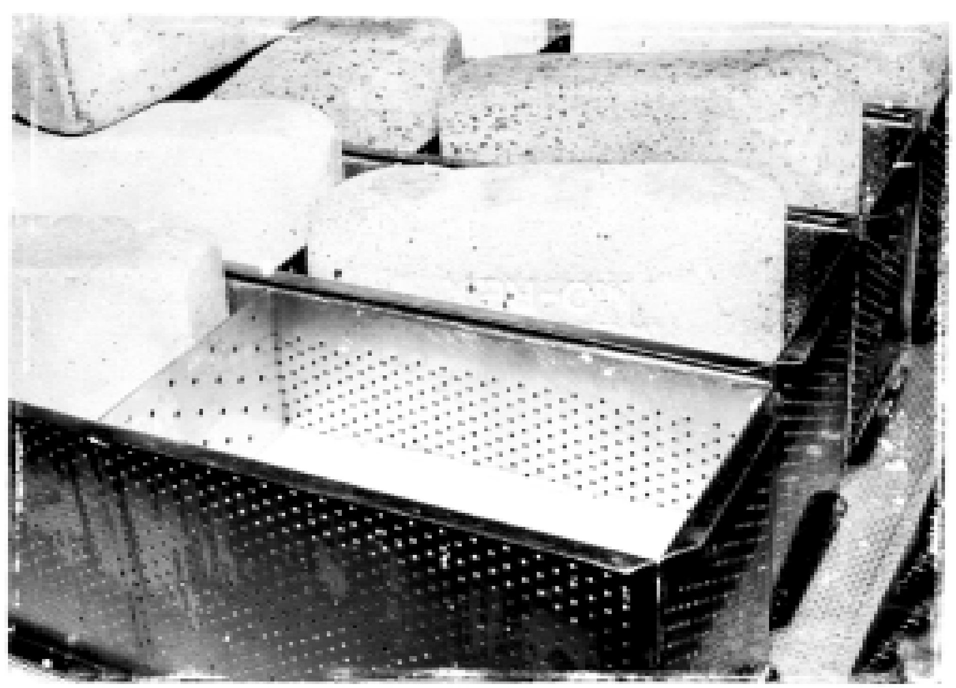
Of course, it is French wine that often comes to mind when terroir is the topic. Robb Walsh, of the Houston Press, and author of the "Reign of Terroir," (Natural History, Dec/Jan 2000) notes that terroir "is often used to describe how a combination of environmental factors ultimately affects the flavor of wine. Terroir is said sometimes to be connected to vineyard conditions and sometimes to the flavor the earth in the wine." However, although Walsh finds terroir "a lovely romantic idea, it's not always demonstrable." That may not even matter, Walsh notes that the concept of terroir has succeeded in "making a place a brand name." Champagne may be the best example, although Roquefort is certainly one most of us can relate to easily.

Roquefort is a French AOC cheese, in fact it the first AOC cheese, granted AOC protection in 1925. Only ewes from particular regions of France produce milk for Roquefort, although it is the place of ripening —the caves of Roquefort—that make it truly unique. By 1411, when Charles VI granted them a monopoly, the people of Roquefort had been ripening cheese in these naturally ventilated caves for hundreds of years. Faults and fissures, called fluerines, function as chimneys and help maintain a constant humidity and temperature that also nurtures the blue mold, *Penicillium roqueforti*.

Roquefort is one of the most popular French cheeses, distinctively flavored by place. However it is only one of many French cheeses defined by the landscape. Page through Masui and Yamada's "French Cheeses" and you will find that Bleu de Termignon is made by a woman who keeps her cows high up in the National Park of Vanoise, "where the animals feed on grass and flowers. It is here that the source of the mold is found." Or Bleu du Haut Jura, an AOC cheese made from the milk of cows who "graze in the mountains of Jura. It is said that the mold of the mountain grass and flowers passes into the milk, where it flourishes."

Since the 13th century people in the Jura mountains have also produced another popular French cheese, Comte, from raw cows milk. Published in a recent Journal of Dairy Science (2000 J Dairy Sci 83:1692-1704) is a study comparing flavor attributes of Comte by geographical region. Monnet, Berodier, and Badot sorted 20 cheese cooperatives into subsections, first by geography and then, independently, by sensory panels. They found that "the taste variations corresponded to soil variations."

Although terroir might be an unfamiliar word for Wisconsin cheesemakers, the concept is not. In fact, in a recent series of stories on Wisconsin cheese, the Milwaukee Journal Sentinel headlined part of the article, "Difference in cheeses begins with the soil." They quoted Myron Olson, Master Cheesemaker of Limburger cheese from Chalet Cheese Co-op, commenting that "the uniqueness is in the soil." In fact, we've known for decades that climate, time of year, breed of cow, and, especially, feed, do influence the flavor of milk, and thus the flavor of cheese.



Certainly, we have our own culture of cheesemaking here in Wisconsin. Along with a unique blend of resident non-starter lactic acid bacteria, many small Wisconsin cheese plants have cheesemakers with years of experience and perhaps a father, uncle, grandmother or grandfather who made cheese before them.

We do have the reputation for quality. Several years ago, CDR set up a booth at a large trade show in Chicago. We were just across the aisle from Dairy Management Inc.™ and both groups had cheese available to sample. I was amazed how many people stopped at DMI™, then came to our booth and, after trying our samples, declared that the Wisconsin cheese was better. It really wouldn't have been all that remarkable, except that we had supplied DMI and the cheeses were the same.

Now, I'm not suggesting a Wisconsin AOC. But as you market those Wisconsin cheeses, cultivate your role as a cultural steward. And milk it, too.

*Wondering who wrote this article? Anytime you see an article without a byline, you can assume the editor wrote it.*

*Joe Widmer, of Widmer's Cheese Cellars, makes brick cheese in Theresa, WI. Joe uses the same 5 lb bricks that his grandfather started with, 70 years ago.*

*continued from page 1*

**Table 1. Compositional Analysis of Milk and Cheddar Cheese**

| Standardized Milk | AA Milk | BB Milk |
|---|---|---|
| % Total Protein[1] | 3.28 ± .06[A] | 3.18 ± .05[B] |
| % True Protein[2] | 3.07 ± .06[A] | 2.97 ± .05[B] |
| % Casein | 2.45 ± .11[A] | 2.42 ± .02[A] |
| % Casein / % Total Protein | 75.00 ± 1.73 [A] | 76.00 ± .71[A] |
| % Casein / % True Protein | 80.21 ± 1.94[A] | 81.61 ± 1.15[A] |
| % Fat | 3.59 ± .28[A] | 3.39 ± .14[B] |
| Casein / Fat | .68 | .71 |
| Make Sheet Information | | |
| Coagulation addition to cut[3] | 34 ± 2 min | 20 ± 1/2 min |
| pH at cut | 6.58 ± .03 | 6.52 ± .03 |
| Cheese Composition | | |
| % Moisture | 38.41 ± .92[A] | 38.68 ± .70[A] |
| % FDM | 52.05 ± 2.1[A] | 52.23 ± .83[B] |
| % Cheese Yield (Actual) | 9.89 ± .41[A] | 9.60 ± .23[A] |
| % Cheese Yield (milk and cheese adjusted) | 9.89 | 9.93 |
| Yield Data | | |
| R value (solids nonfat, noncasein factor) | 1.102 ±.016 [A] | 1.091 ± .006[A] |
| % Fat Recovery in Cheese | 88.43 ± .83[B] | 90.71 ± .94[A] |
| % Nitrogen Recovery in Cheese | 73.67 ± .78 [A] | 74.97 ± 1.22[A] |

[1]% Total Nitrogen x 6.35
[2]% Total Nitrogen - Non Protein Nitrogen x 6.35
[3]Coagulae cut at the same firmness as determined by cheese maker
[A, B]Means with the same letter are not significantly different

AA cows clotted slower than the milks from the other cows. The difference between the clotting times of AA and BB milks is much less than when cheddar cheese was made, because the pH at coagulant addition was much lower when making mozzarella (6.55 for Cheddar and 6.35 for mozzarella). No differences in any of the sensory attributes among the cheeses could be directly attributable to the type of milk from which the cheese was made. There is a trend towards a softer body in the cheese made from BB milk and a trend towards a less chewy and better elastic stretch when cheese made from BB milk was baked on a pizza.

When you compare cheese yields of milk from AA milk to BB milk in our study, you'll notice that lower solids in the BB milk resulted in lower cheese yields. The lower solids content of BB milk was not in line with previous studies , and may have been influenced by the small number BB cows in this study.

Cheeses were comparable in composition, and differences in functionality or sensory attributes were not statistically significant. These characteristics could be influenced by slight variations in moisture, pH and fat-in-dry matter, rather than BB genotype. Although milk from cows of different kappa-casein genotypes do not appear to offer any positive or negative sensory characteristics to the cheese, at equal casein and fat levels milk from BB cows is preferred for cheese making because of the higher fat and nitrogen retention. However, at this time, there is no justification to switch to all kappa casein genotype BB cows, unless the total casein and fat content can be increased. In fact, more research on cheese yield and characteristics should be completed before a big shift to kappa casein BB is undertaken.

**Table 2.**
**Fat and Nitrogen Recovery Values**

| Cheese Making Date | Genotype AA | Genotype BB | Difference (BB-AA) |
|---|---|---|---|
| Fat Recovery: | | | |
| 97-04-11 | 88.7 | 92.0 | 3.3 |
| 97-05-22 | 87.8 | 90.6 | 2.9 |
| 97-05-30 | 89.4 | 90.4 | 1.0 |
| 97-06-06 | 88.9 | 89.5 | 0.6 |
| 97-06-12 | 87.4 | 91.1 | 3.7 |
| Nitrogen Recovery: | | | |
| 97-04-11 | 74.4 | 73.4 | -1.1 |
| 97-05-22 | 73.9 | 76.5 | 2.6 |
| 97-05-30 | 74.2 | 74.3 | 0.1 |
| 97-06-06 | 72.4 | 75.1 | 2.6 |
| 97-06-12 | 73.4 | 75.7 | 2.3 |

## Ideal cheese milk?

Puhan and Jakob, of the Swiss Federal Institute of Technology in Zurich, Switzerland, contributed to the 1993 IDF seminar on cheese yield. Like most researchers, they concluded that "For the time being, kappa casein variants should not generally be used as a criterion for selection in dairy cattle breeding." However, it is important to avoid decreasing the frequency of the kappa casein B allele .

They further explained that although their cheesemaking trials did indeed show that kappa casein B milk was superior for cheesemaking, many other factors influence the yield and quality of cheese. In practice, bulk milk from many sources fills the cheese vat, which dilutes the effect of the B casein. However, they described a case where a small herd supplying a small cheese factory in Switzerland did cause a big problem. Serious cheese defects, such as short body and cracks, were definitely caused by insufficient rennetablity of the milk. After testing the cows, the researchers found that the average protein content was 3.06%, SCC was normal, and only 6 out of 16 cows carried the B casein genotype. The long term solution for this herd was adding cows with the kappa casein B genotype. Their conclusion: "It would be tempting to select cows for the ideal cheese milk with the following casein phenotypes:

| $\alpha s_1$-Cn CC | B-Cn BB or CC | κ-Cn BB | β-Lg BB |
|---|---|---|---|
| firm curd | good rennetability<br>high cheese yield | good rennetability<br>high cheese yield | high casein number<br>high cheese yield |

## Benefits of Crossbreeding

If you are looking for the B genotype, you'll find that the frequency of the kappa casein B is higher in both Brown Swiss and Jersey cows. Although L. B. Hansen, University of Minnesota, concluded that crossbreeding Holsteins and Jerseys could offer potential benefits, he wasn't trying to increase the kappa casein B genotypes in a herd. Instead, Hansen was addressing the issue of Holstein inbreeding and the increasing degree of relatedness. In a recent Journal of Dairy Science, Hansen notes that selection for milk yield has been effective. However, "selection in a population of finite size inevitably results in an increase in genetic relationship among individuals in the population." Artificial insemination has had an incredible impact, allowing individual sires to produce thousands of progeny. Hansen points out that, "as relationships accumulate, genetic diversity is diminished." Very little is being done to slow the increases in relationship, and "accumulation of genetic relationships within Holsteins has continued to the point that concern is warranted." He suggests that "continued increase of relationships might result in crossbreeding becoming routine for dairy cattle, as it is for most other food-producing animals."

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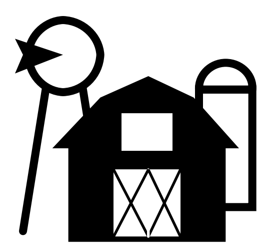

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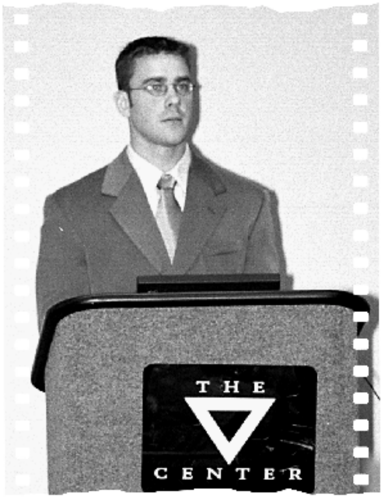
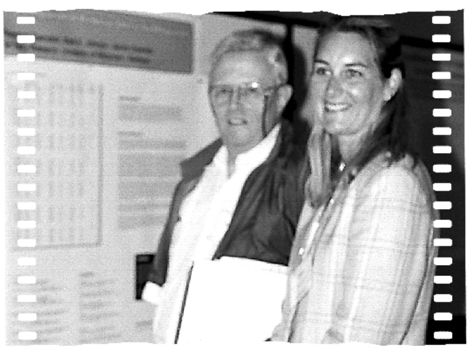
Cheese Yield and Factors Affecting its Control, Topic 4: Genetic variants of milk proteins and cheese yield, IDF Seminar Proceedings, Cork, Ireland, April 1993




*Matt Zimbric, above, discusses the melting profile of mozzarella at ADSA.*



*Amy Dikkeboom and Doug Emmons talk about cheese yield formulas.*

### Opportunity

For undergrads and graduate students—Third Annual Discoveries in Dairy Ingredients Contest Here's a contest that challenges participants to develop innovative product formulations using nonfat dry milk, dry whey or whey derivatives, including whey protein concentrate and whey protein isolate. For eligibility, prizes and rules call Dairy Management Inc.™ at 1-800-248-8829, check the web at www.doitwithdairy.com

### CDR staff presents at the American Dairy Science Association in Baltimore

John Jaeggi, Amy Dikkeboom Kerry Kaylegian and Matt Zimbric all traveled to Baltimore to present results of CDR research projects, from melt profiles of mozzarella to milkfat fraction properties. Rani Govindasamy -Lucey chaired a session and Mark Johnson presented at a pre-meeting workshop. In addition, Ed Dudley, Department of Food Science, won the ADSA graduate student competition with a presentation on citrate catabolism and succinate production by nonstarter lactobacilli.

### Manage cheese yield the EACY© way

EACY© (Economic Analysis of Cheese Yield), a user-friendly program for any Windows© based computer, is available to help you manage cheese yield data.

EACY© is designed to identify the components of raw milk and track these components as milk is made into cheese and whey-based products. You can use this program to predict cheese yield for alternative milk compositions, to standardize raw milk to meet user defined cheesemilk characteristics, and to evaluate the economic consequences of changes in milk quality, cheese characteristics or market conditions.

EACY© is flexible; it was written to accommodate future industry changes, from designing new cheese and whey derived products to pin pointing alternate standardization procedures. For more information about EACY©, consult the CDR web site at the following address: www.cdr.wisc.edu

To purchase the program contact:
Dr. Brian W. Gould, Wisconsin Center for Dairy Research
Gould@aae.wisc.edu
(608) 263-3212

### Marth's food safety contributions noted

Elmer H. Marth, emeritus professor of Food Science, of Bacteriology and of Food Microbiology and Toxicology at the University of Wisconsin-Madison, recently received the NFPA Food Safety Award from the International Association for Food Protection. Marth was honored for the long-term excellence of his contributions to food safety through research, teaching, publications and public service. Food safety research in Dr. Marth's laboratory included studies of aflatoxin, aflatoxin $M_1$ patulin, rubratoxin, enteropathogenic *Escherichia coli*, *Listeria monocytogenes*, *Salmonella*, *Staphylococcus aureus*, and degradation to sorbic acid by molds.

# Skimming the Shelf—

## What's New in Print?

### New Publications from the International Dairy Federation

Special Issue No. 0001/2000
"Practical Guide for Control of Cheese Yields"
According to IDF, this book "Examines all the factors affecting cheese yield, from milk composition, hygienic quality, and heat treatment through cheese processing, refining and sampling, to the management, forecasting and optimization of yield."

Bulletin No. 346/2000
"Packaging of Milk Products"
Topics discussed at an IDF special conference in September 1999 include: Light induced changes in dairy products, edible films and coatings, modeling of product/packaging interactions, and advances in modified atmosphere and active packaging.

Bulletin No. 347/2000
"Organic Dairy Products"
Going organic, what does it mean? Costs involved, effect on productivity and veterinary practice and the transition from conventional production to organic.

www.fil-idf.org
e-mail: Info@fil-idf.org

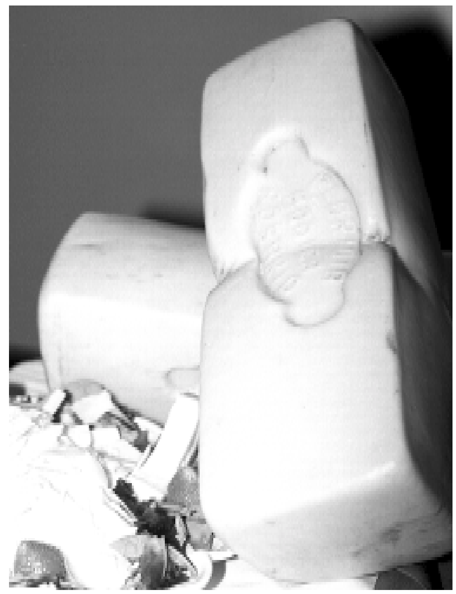
### The New American Cheese

Author Laura Werlin confesses to a life long passion for cheese, and she does her best to kindle the same passion in her readers. Werlin notes that specialty cheesemakers have had to rely on word of mouth, self taught marketing skills, and good luck to get themselves noticed. "Yet getting their message out is key to educating the American public about specialty cheese."

Werlin's pages focusing on cheese tasting, storing, and pairing wine and cheese to serve a cheese course are short but offer a good start for information seekers. She also covers the basics of cheesemaking, and sums up the evolution of cheesemaking in the US.

This is not a book to start paging through when you are hungry. The recipes (and lush photos) will taunt you till you try at least one. From cabbage and goat cheese salad to chicken breast stuffed with spinach and fromage blanc, these recipes encourage experimentation with specialty cheese. Sprinkled among the recipes are cheesemaker profiles, including nine from Wisconsin.

Published in 2000 by Stewart, Tabori and Chang
A division of U.S. Media Holdings, Inc.
115 West 18th St.
New York, NY 10011



### Ragusano
### Heritage and landscape:
### The art of traditional cheese-making

Text by Francesco Amata, Guiseppe Licitra, and Diego Mormorio. Photographs by Guiseppe Leone
Consorzio Ricerca
Filiera Lattiero-Casearia
Ragusa, Sicily
Federico Motta Editore

It really isn't fair to mention a book that might be impossible to get. However, this book, which includes photos and essays of the history of agriculture, landscape and cheesemaking in the Sicilian province of Ragusa, is an exquisite Italian expression of terroir.

Pages of intriguing black and white photos, including many of cheesemaking, take you to Ragusa to show you the landscape, the people and process of producing the artisan cheese Ragusano.

*Curd Clinic doctor for this issue is Cristina Esteves. Cristina received her BS and MS from the University of Coimbra, Portugal. In 1997 she accepted a position as Assistant Professor at the Polythecnical Institute of Braganca, Portugal, where she taught Molecular Biology and Enzymatic Tecnhology for 2 years. Since 1992, her research has focused on vegetable coagulants. She is currently a Visiting Assistant Scientist at the University of Wisconsin-Madison and is working on her PhD with Dr. J. Lucey. Her research characterizes the gelation process of the vegetable coagulants of* Cynara carduncullus L. *and* Cynara humilis *L. compared to chymosin.*

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# Curd Clinic

**Q.** I've heard that there is a plant that cheesemakers can use to coagulate milk for cheese. Can you tell me more about it?

**A.** Cheesemakers have used the vegetable coagulant, *Cynara cardunculus* L. for more than 2000 years in Portugal. *C. cardunculus* L. is a thistle that grows wild in Portugal and other southern European countries.

### Portugese cheesemakers harvest coagulant

Cheesemakers harvest *C. cardunculus* L. plants on their farms. They remove the purple part of the flower (stigmas), which contains the coagulant. The stigmas of *C. cardunculus* L. are then dried at room temperature in the dark. In the dried form, the coagulant is very stable and can be stored for years. *C. cardunculus* L. may also be purchased from local shops. Before using *C. cardunculus* L., the stigmas are crushed in water with a mortar and a pestle. When the resulting extract is filtered it is ready to be added to the milk.

### Coagulant characteristics

Similar to calf rennet, the vegetable coagulant of *C. cardunculus* L. contains two different enzymes, cardosin A and cardosin B. These two enzymes have been purified and characterized, and the cDNA sequences have been obtained. Cardosin B is more proteolytic than cardosin A and is found in lower amounts in the coagulant. Due to its characteristics, cardosin A is considered a chymosin-like enzyme, whereas cardosin B is a pepsin-like enzyme. Moreover, the relative proportions of cardosin A and B in *C. cardunculus* L. are similar to those of chymosin and pepsin in calf rennet. The similarities between the two types of coagulants may explain why this vegetable rennet performs well in cheesemaking.

In previous studies, we found that *Cynara humilis* L., another thistle similar to *Cynara cardunculus* L., contains only the chymosin-like compound cardosin A. Thus, *C. humilis* L. resembles fermentation-produced chymosin. *C. humilis* L. can also be used for making cheese.

### Coagulation

*C. cardunculus* L. initiates coagulation in cow and sheep milk by cleaving the k-casein in the same position as chymosin. Both *C. cardunculus* L. and chymosin cleave the same type of sites in $\alpha_s$- and $\beta$-caseins, although *C. cardunculus* L. cleaves more sites than chymosin.

### Cheese

The majority of Portuguese cheeses are produced with vegetable coagulant. These cheeses, considered a delicacy, have unique

**Table 2.Cheeses produced with the plant coagulant *Cynara cardunculus***

| |
|---|
| **Portugal**<br>**Queijo Serra da Estrela (PDO)**<br>**Queijo Serpa (PDO)**<br>**Queijo de Azeitao (PDO)**<br>**Queijo de Castelo Branco (PDO)**<br>**Queijo de Nisa (PDO)**<br>**Queijo de Evora (PDO)** |
| **Spain**<br>**Queso los Pedroches**<br>**Queso de la Serena (PDO)**<br>**Torta del Casar** |
| **Italy**<br>**Cacio Fiori** |

*PDO = Protected Denomination of Origin*

flavor and texture characteristics. To assure quality and authenticity, these Portuguese cheeses are legally protected by the Denomination of Protected Origin created by the European Union. Table 1 lists some of the cheeses produced with *C. cardunculus* L. in Portugal, Spain and Italy. *C. cardunculus* L. is used in sheep milk, or mixtures of sheep, goat and/or cow milk. In sheep milk, *C. cardunculus* L. produces cheeses with a strong flavor and aroma. Cheeses ripened for 1 month are smooth and have a soft texture. *C. cardunculus* L. is adequate for the production of soft bodied cheeses, specially sheep milk cheese. Since the coagulants of *C. cardunculus* L. and *C. humilis* L. are obtained from plants, using them to make cheese produces distinct vegetarian cheeses.

*continued from page 10*


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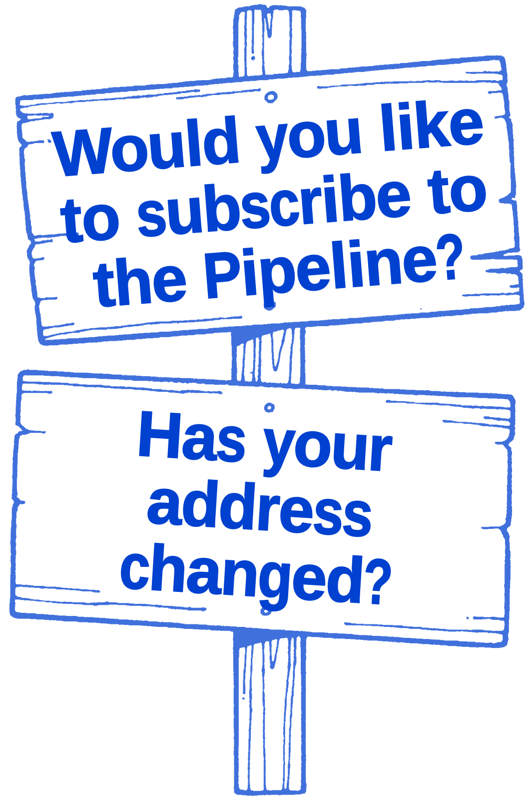


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# Calendar

**Nov. 7-8 Wisconsin Cheese Grading Short Course.** Madison, WI. Call Bill Wendorff at (608) 263-2015.

**Jan. 8-12 Ice Cream Makers Short Course.** Madison, WI. Call Bob Bradley at (608) 263-2007 for information, or the CALS Conference Office (608) 263-1672 to register.

**Jan. 22-25 Milk Pasteurization and Process Control School.** Madison, WI. Call Bob Bradley at (608) 263-2007 for information, or the CALS Outreach Services (608) 263-1672 to register.

**Feb. 6-7 Wisconsin Dairy Field Reps Conference.** Madison, WI. Call Bill Wendorff at (608) 263-2015.

**Feb. 27-28 Wisconsin Process Cheese Short Course.** Madison, WI. Call Jim Path at (608) 262-2253 or Bill Wendorff at (608) 263-2015 for more details.

**Mar. 26-30 Wisconsin Cheese Technology Short Course.** Madison, WI Program Coordinator: Dr. Bill Wendorff, (608) 263-2015.

It's Not Too Late—
The Wisconsin Series, Farmstead Dairy Value-added Field Days
Specialty Cheese Company, Lowell, WI
October 26, 2000 (10 a.m. to 3 p.m.) Register by calling the Wisconsin Farm Center at 1.800.942.2474. Cost is $25 and includes lunch.

The Specialty Cheese Company, owned and operated by Paul Scharfman, makes 35 different kinds of cheese. Scharfman would like to organize "cheese condominiums" to allow individual producers and groups to use the resources of an established cheese plant to develop specialty products. Tour the plant, talk about marketing and explore the condo idea at this field day.

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