Wisconsin Center for Dairy Research

DAIRY PIPELINE

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Raw Milk Quality: How does the US Compare?

by Pamela Ruegg, Dept. of Dairy Science, University of Wisconsin, Madison and
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The quality of raw milk has an impact on milk production efficiency, cheese yields and protein composition. In the United States, raw milk quality is regulated at the farm level by the Pasteurized Milk Ordinance (PMO). In 1967, the relationship between somatic cell count (SCC) and mastitis was recognized, and the PMO was amended to phase in a SCC limit of 1,500,000 cells on Grade A milk. The SCC limit was reduced to 1,000,000 cells effective July 1, 1989 and further reduced to 750,000 effective July 1, 1993. Since 1993, several proposals to further reduce the SCC limit in the PMO have been defeated. Elsewhere, SCC limits have been steadily adjusted downward, leading some to question the quality of US milk as compared to international standards. The debate on US raw milk quality standards has included recent comments from the international community.[1]

Current milk quality standards in Wisconsin include the following requirements: 1) no visible adulteration or objectionable odor, 2) standard plate counts (SPC) of <100,000 and <300,000 for Grade A and Grade B milk respectively, 3) no drug residues, 4) SCC <750,000, 5) temperature < 45° and 50° F for Grade A and Grade B milk respectively, and 6) no pesticide residues. While US standards for SPC are comparable to peer countries, the current US SCC limit is conspicuously higher (Figure 1).

The ability to compare international standards of SCC to US standards is often challenged based upon differences in methods of calculation. Many European countries calculate SCC based upon a 3-month

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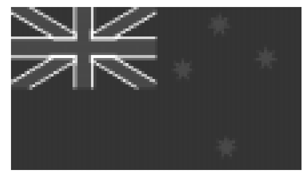
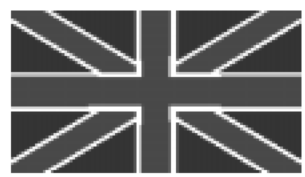
What's Inside:

From New Zealand:



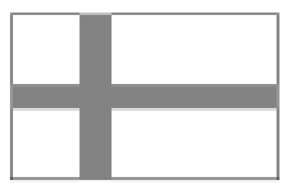
"...it could become difficult to defend a situation where milk is sourced from herds with around 60% of the cows infected in at least one quarter and where probably 40% of the milk volume comes directly from infected mammary glands."

From the UK:



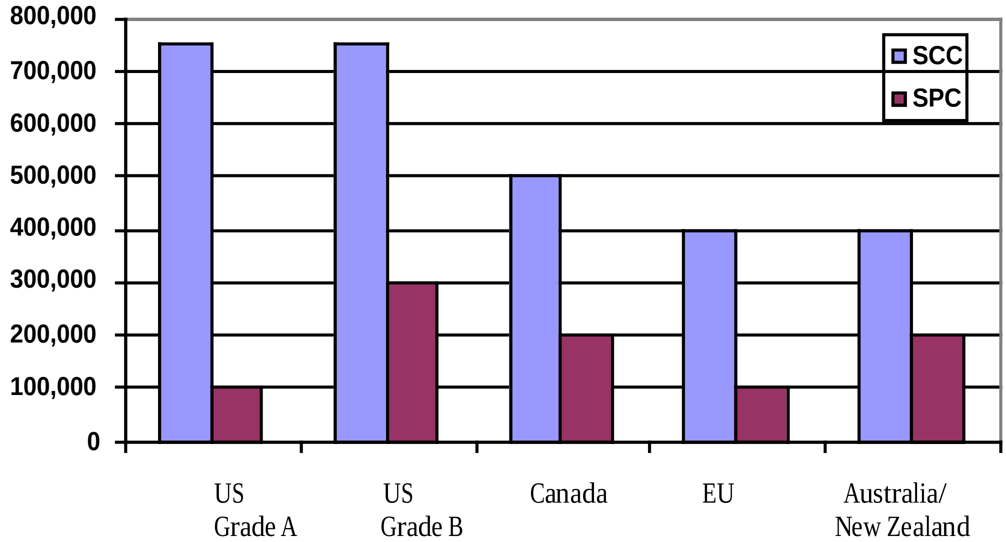
"Now it is probable that 60% of supplies (in the UK) have a BTSCC less than 150,000 for most of the year."

From Finland:



"The only risk I see in US regulations is that a farm can produce milk for consumption when the SCC is continuously at the 500,000 to 700,000 level. That is mastitis milk, with no doubt—and we use that knowledge in our marketing."

Figure 1. Comparison of Regulatory Guidelines for Raw Milk



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geometric mean versus the use of an arithmetic mean. Geometric means are a useful method to normalize distributions and reduce variance of raw data which is not normally distributed.[2] For regulatory purposes, geometric means are advantageous because single violations of regulatory standards are not overemphasized. While is is fair to say that geometric means are always lower than arithmetic means, the impact of that difference may be exaggerated. It is somewhat misleading to assume that the difference in method of calculation contributes greatly to differences in SCC observed between countries. A comparison of 3-month geometric and 3 month arithmetic means for 192 WI dairy farms indicates that the difference is relatively small (Table 1).

Table 1. Comparison of Geometric and Arithmetic Mean for 192 WI Dairy Farms

Type of Calculation	3 Month Mean	3 Month Median	Minimum	Maximum
Geometric	340,721	306,000	56,000	1,076,500
Arithmetic	352,364	325,000	58,300	1,103,000
Difference	11,643	19,000	2,800	26,500

A comparison of arithmetic mean SCC from 5 Scandinavian countries and milk samples collected for regulatory purposes in WI in 1997 (233,222 grade A samples) demonstrates that differences in milk quality between countries are evident (Figure 2). As expected, countries with lower regulatory limits have increased quality (as measured by SCC).

Additional information about SCC can be obtained by comparing the distribution of herd SCC values of other countries to the SCC values of Wisconsin grade A milk (Figure 3). Wisconsin has considerably more herds with high (>500,000 cells) SCC as compared to international markets. The SCC distribution of WI grade A herds is most similar to Great Britain. The international data shown in Figure 3, was available only for 1993, and it should be noted that more recent data for several European countries indicates that mean herd SCC values have dropped since that time. For example, geometric mean SCC values for Denmark are reported as 274,000, 248,000, 242,000 and 244,000 for 1993, 1994, 1995 and 1996,

"Wisconsin has considerably more herds with high (>500,000 cells) SCC as compared to international markets."

Figure 2. Arithmetic Mean SCC Values for 1997

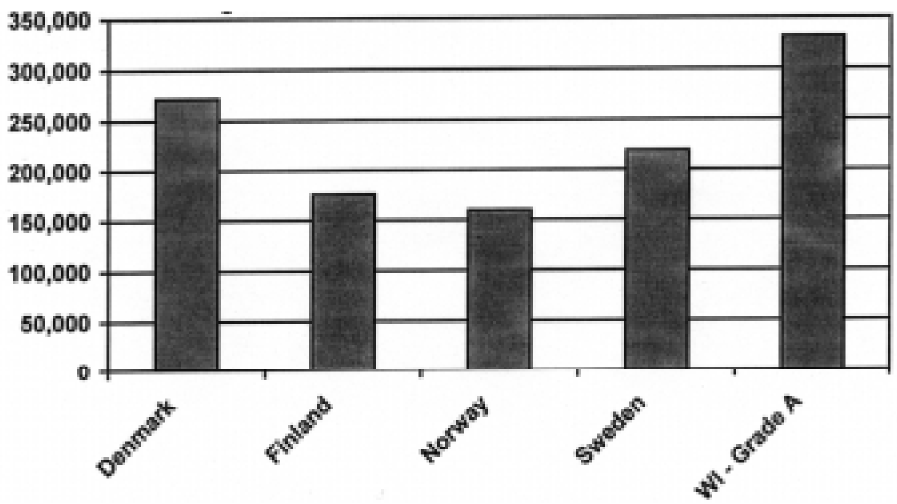
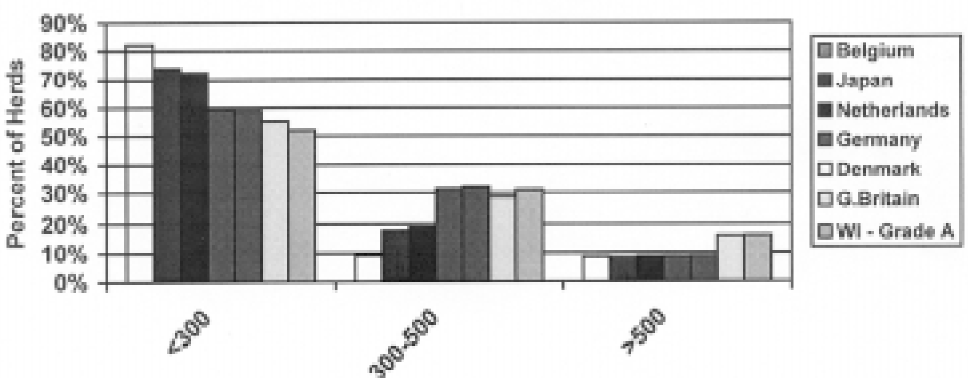


Figure 3. Distribution of Herd SCC Values by Country or State. (1993 data, 1998 data for WI)



SCC Category (x1000)

198,000 Grade A samples from 18, 000 farms

respectively. It should also be noted that the WI SCC values are not weighted by the amount of milk produced. Several US studies have demonstrated lower SCC values in herds that ship more milk. [3,4]

Consumer expectations of the quality of milk are evolving. Consumers continue to expect milk to be fresh, nutritional, good tasting and free of adulteration. As societies become wealthier and more removed from the farm, additional concerns about animal well-being and the environmental impact of animal care practices emerge. In the US, societal concern has evolved from maximizing production, to optimizing profit. In much of the EU, consumers have additional concerns about balancing the environment, food safety and quality with profitability. Consumers expect to feel confident that raw milk in a bulk tank is produced under high quality standards. Processors can recognize societal concerns by rewarding producers with aggressive premium programs. The production of high quality milk is beneficial to both the producer and to consumers. Producers benefit economically by enhanced efficiency of production, reduced treatment costs and by producing milk that is higher value to processors. Consumers benefit by knowing that the animals producing the milk are healthy and that the products are good.

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Using blended milk to manufacture reduced fat Muenster cheese

by Leyda Ponce de Leon, 1998 recipeint of the Norman F. Olson Cheese Research Scholarship, Department of Food Science

Developing reduced fat cheeses has been very challenging, most likely because desirable cheese flavor depends on the presence of fat. Reduced fat cheeses tend to be flat, meaty and brothy (1). Approaches to improving flavor have included modifying the cheese making procedures (2), or genetically altering the starter culture, but none have been truly successful (1).

Since sheep milkfat contains twice as many short chain fatty acids as cow milkfat, we wondered whether this could improve the flavor of some blended milk lowfat cheeses. In this project, we blended sheep's milk with cow's skim milk to improve the flavor of reduced fat Muenster cheese.

The gross composition of cow's versus sheep's milk is shown in Table 1 (3). As shown in the table, sheep's milk has twice the solids compared to cow's milk. It also has almost twice the fat of cow's milk. The high fat content is responsible for the unique flavor and aroma of sheep's milk cheese (1,4). Among the lipids in sheep's milk, there are also free fatty acids that play an important role in the flavor of cheese either by themselves or as precursors for the formation of ketones (5).

Table 1. Gross composition of cow's and sheep's milk

Component	Cow's milk (%)	Sheep's milk (%)
Fat	3.86	7.09
Protein	3.22	5.72
Lactose	4.73	4.61
Ash	0.72	0.93

Table 2. Fatty acid composition of sheep's and cow's milk (6)

Fatty acid	Sheep's milk (g/100g milk)	Cow's milk (g/100g milk)
butyric (4:0)	0.20	0.11
caproic (6:0)	0.14	0.06
caprylic (8:0)	0.14	0.04
capric(10:0)	0.40	0.08
lauric (12:0)	0.24	0.09
myristic (14:0)	0.66	0.34
palmitic (16:0)	1.62	0.88
stearic (18:0)	0.90	0.40

Table 2 compares the fatty acid profile of sheep's milk and cow's milk. Note that the low molecular weight fatty acids (C4:0-C10:0) are more abundant in sheep's milk than in cow's milk (20-25% versus 10-12%) (3). You can see this when you compare the fatty acid profiles of Roquefort and Blue cheeses. Roquefort cheese is made solely with sheep's milk and has a strong musky flavor that may be due to the high amount of caprylic acid (C8:0) found in this cheese. Blue cheese is made with cow's milk and has a higher amount of butyric (C4:0) and caproic acid (C6:0), which gives it a picante flavor (5,7).

Usually, in cheese, the longer chain fatty acids are more abundant than the short chain fatty acids (9). However, the short chain fatty acids are responsible for some of the flavor notes in cheeses (5,7). Varieties of cheese that have strong flavor such as blue cheese or gruyere tend to have large amounts of free fatty acids, and those that exhibit milder flavors contain moderate amounts of free fatty acids (5). Fatty acid profiles in cheeses can be determined using gas chromatography (8). Although gas chromatography is useful to measure fatty acid profiles, it cannot determine which fatty acids are responsible for the flavor of cheese. However, sensory analysis has been useful to determine the role of fatty acids in cheese flavor (10).

The differences in fatty acid profiles exhibited in cheese are due to the initial concentration of free fatty acids in the milk and the seasonal variance of milk composition. Other factors influencing the concentration of free fatty acids in cheese are the microbial flora, ripening temperature, pH, salt and moisture content (9). The final pH of the cheese has a critical influence on the expression of flavor notes due to fatty acids. Cheeses with high pH will suppress the flavor expression of the fatty acids. Although milk lipases are inactivated during pasteurization, the starter culture and other adventitious organisms may produce lipases that act upon the triglycerides to release fatty acids during the ripening time.

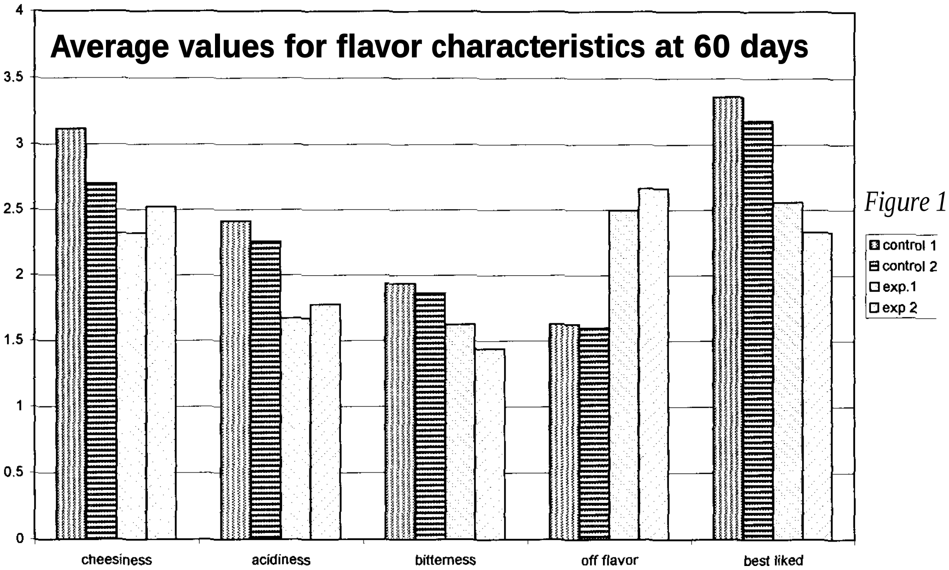

Figure 1

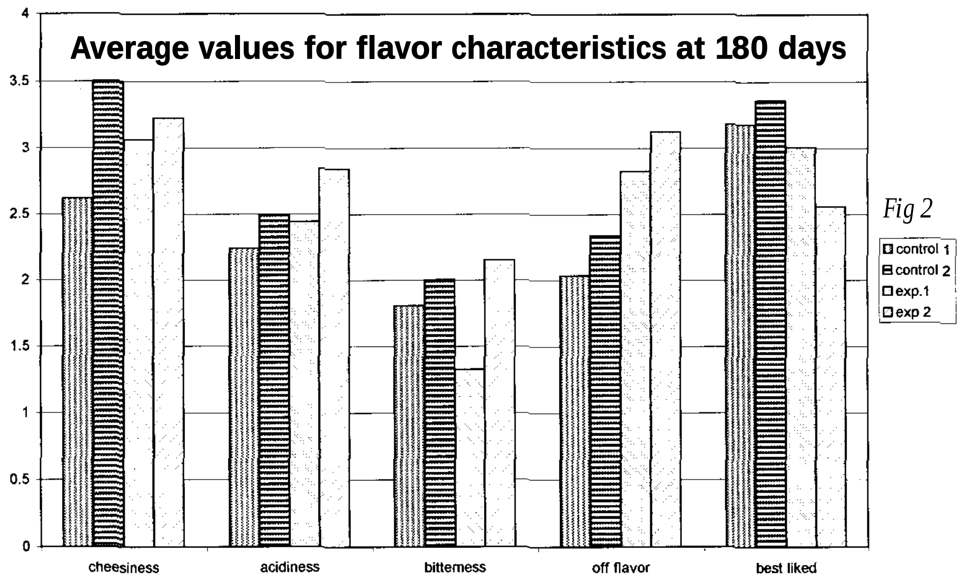

Fig 2

We blended 20% sheep whole milk with 80% cow skim milk to produce a low fat Muenster cheese. To evaluate this addition of sheep's milk in reduced fat Muenster, we manufactured a control cheese with 1.7% fat cow's milk. By standardizing both cheese milks to 1.73 casein/fat we produced cheeses with similar composition. The cheeses were ripened at 50˚C for six months and casein hydrolysis, pH, free fatty acids, and microbial populations were monitored during the ripening time.

Bovine casein has 4 main fractions which are α_{s-1}, α_{s2}, β and κ. In contrast, ovine casein has six fractions: three α_s, two β and one κ. We found that the amount of α_{s-1} continuously decreased while α_{s-1} I casein increased. The amount of beta casein remained constant. The blended cheeses produced a higher amount of α_{s-1} casein than the control cheeses. When we looked at the amount of free fatty acids we found that the concentrations remained fairly constant, although the blended cheeses produced a higher amount of C4 to C10 than the control cheeses.

Sensory panels conducted at 60 and 180 days are summarized in Figures 1 and 2. Although the panelists noted more off-flavors in the blended cheese, at 180 days the panelists liked them as much as the control cheese. The blended cheese had a firmer body than the control cheese. These are preliminary results as we continue our data analysis.

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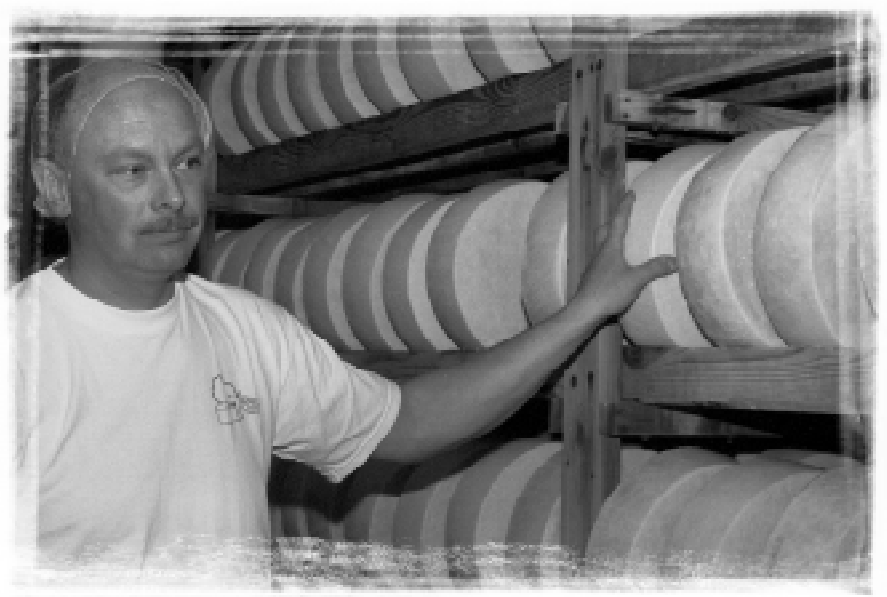
Celebrating Wisconsin Master Cheesemakers, 1999

Eight Wisconsin Master Cheesemakers will be honored at the Wisconsin Cheese Industry Conference in LaCrosse on April 14th. These licensed cheese makers have attended courses, passed exams, and produced cheese that passed grading tests in order to earn their titles. The Wisconsin Master Cheesemaker® program, unique in the United States, was established by the Wisconsin Center for Dairy Research, UW-Extension, and the Wisconsin Milk Marketing Board to train, nuture and reward the talent and dedication of Wisconsin's cheesemakers.

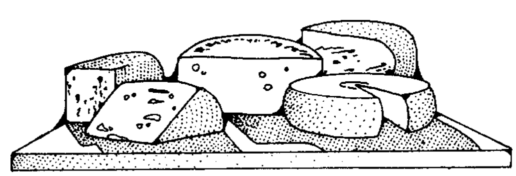


Larry Steckbauer, Antigo Cheese Co.
1999 Wisconsin Master Cheesemaker

When you talk with these Master Cheesemakers, you quickly realize that they have more in common than coursework. They all share an excitement and passion for their work, making cheese is more than just a job, it's a craft. And making specialty cheeses is often the most creative and successful way to practice that craft.

Kurt Heitmann, Alto Dairy
1999 Wisconsin Master Cheesemaker

After decades of declining numbers of Wisconsin cheese plants, the survivors are finding success in the growing specialty cheese market. Recent figures from Wisconsin Agricultural Statistics Services (WASS) indicate that specialty cheese production in Wisconsin has grown from 4.1 percent of total cheese output in 1993 to 6.1 percent in 1997.



1999 Wisconsin Master Cheesemakers

Ron Buholzer, Klondike Cheese
Steve Buholzer, Klondike Cheese
Kurt Heitmann, Alto Dairy
Kerry Henning, Henning Cheese
Dan Meister, Meister Cheese
Larry Steckbauer, Antigo Cheese
Steve Stettler, Decatur Dairy Inc.
Bruce Workman, Roth Kase USA Ltd.

What is a specialty cheese?

It's difficult to agree on a definition, but according to Jim Path, CDR, these are elements that specialty cheeses have in common:

Perception of value-added

Low volume (less than 50 million pounds per year)

Labor intensive

Location

Ethnic background

Special manufacturing process

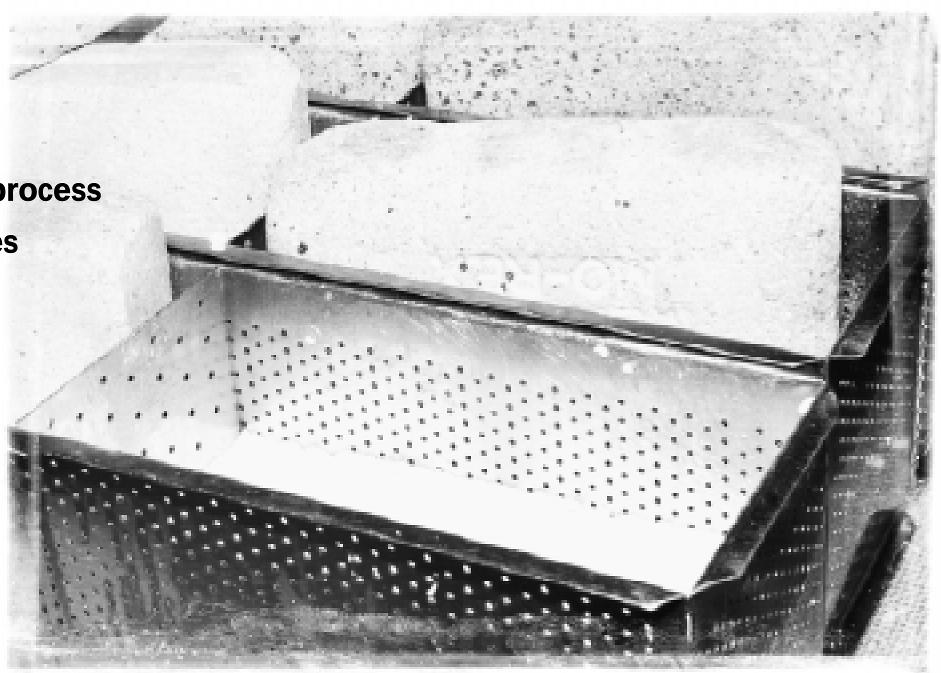
Special bacterial cultures

Special packaging

Unique flavors

Unique shapes

Joe Widmer, of Widmer's Cheese Cellars, follows family tradition making brick cheese inTheresa, Wisconsin. Joe uses the same 5 lb bricks that his grandfather started with, 70 years ago. (Pictured below)



Curd Clinic

Q: Like many cheesemakers, I am trying to get more value from my whey. I decided to try making some Ricotta cheese but I'm discouraged—along with the cheese, I am producing a sludge on the bottom of my vat. This cuts my yield, and I know it also means that something is going wrong. Can you help me solve this problem?

A: Certainly consumer interest in ethnic foods, and the desire for new culinary experiences suggests that you just might find a market for your Ricotta cheese. Cooking with fresh, local products is another growing trend that might influence local sales. Goat cheese makers might consider another niche market, namely, goat cheese Ricotta.

USDA statistics indicate that US per capita consumption of Ricotta (and similar cheese) almost doubled from 1980 to 1996. It's likely that these figures for Ricotta include whole milk Ricotta as well as Ricotta made from whey and blends made from whey and milk. Traditional whey Ricotta, or Ricotone, is rarely made these days because sweet whey (pH>6.4) is not always available, yields are low, and the hand skimming process is hot and tedious. All of these issues can be reduced or avoided by adding milk or skim milk before heating. (See make procedure below.) In fact, most cheesemakers standardize the protein and fat in Ricotta manufacture to increase yield and control body characteristics.

In "Cheese and Fermented Milk Foods," Frank Kosikowski notes that Greek and Roman populations made Ricotta cheese. In fact, the word Ricotta comes from the Latin word "recoclus," which refers to recooking the whey to make the cheese.

Ricotta is somewhat unusual just because it is a whey cheese. However, it has another unique characteristic—most cheeses are formed from curd that precipitates to the bottom of the vat, but Ricotta curds flocculate and float to the surface. The second edition of "Cheese and Fermented Milk Foods," by Kosikowski and Mistry has a good description of the "Flotation Principle in Cheese Making." Consider reviewing that description, looking over the make procedure on page 9 and trying these trouble shooting ideas to solve your Ricotta problem.

Heating

It's best to completely denaturate the proteins before you acidify—this should take 5 minutes at 80˚ C. Floating curd is also encouraged by direct steam injection heating. Ideally, you should use a round jacketed vat, and heat using both direct steam and jacket heating. If you use direct steam, no mechanical agitation is necessary. It is important not to disturb the curd particles as they are coalescing, or aggregating, to form ever growing flocs which float and accumulate in a thick matt on the surface.

Also note, that part of the whey proteins will coagulate and float with no addition of acid. This curd, sometimes called the first rise, is lighter in both color (whiter) and texture than the second rise. Traditionally, the first rise was used as a side dish, and the second rise obtained by acidification after removing the first rise, was used as cooking ingredient in dishes such as manicotti.

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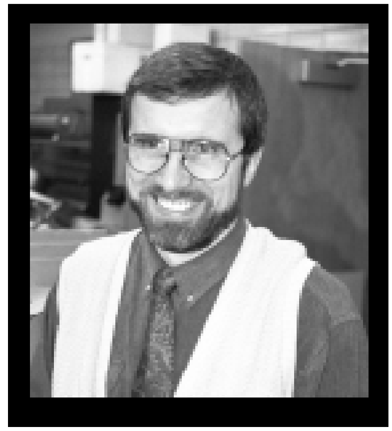

Curd Clinic Doctor for this issue is A.R. Hill, Associate Professor, Dept. of Food Science, University of Guelph, Guelph, Ontario

Questions for the Curd Clinic?
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e-mail: Paulus@cdr.wisc.edu

Ricotta Cheese

Ricotta cheese is made from heat-acid precipitation of proteins from whey or whey-milk blends. The best Ricotta is made from very sweet whey (pH 6.4 - 6.5) without any addition of milk or acid. During heating whey proteins begin to coagulate at about 70˚ C. The rate of coagulation increases as the temperature is raised to 90˚ C and a thick layer of curd forms on the surface of the whey. When coagulation is complete and the curd is firm (after 10 - 20 min. at 90˚ C), the curd is removed with perforated scoops and placed in forms. After removing the first rise, addition of acid (to about pH 5.6) will induce a second rise of coarser curd. If the pH is correct the whey should become clear. It is now uncommon to make Ricotta cheese from whey only because: (1) Sweet whey with pH>6.4 is not always available; (2) the traditional hand skimming process of removing the floating curd is hot and tedious; and (3) yields are low. All of these problems are avoided or reduced by adding milk or skim milk before heating. Whey pH as low as 6.1 is then acceptable (although still not ideal), the curd can be recovered by mechanical means and the yield is increased. The following is a procedure for the manufacture of Ricotta cheese from blends of milk and whey.

Procedure

1. Collect whey (pH>6.0) in a cylindrical vat. Sweeter whey (pH>6.4) is preferred. Immediately heat the whey to 50˚C to stop culture growth and prevent further acid development.

2. Add milk or skim milk (about 10% of the weight of the whey).

3. Heat slowly by direct steam injection from the bottom of the vat to 90˚C without agitation.

4. Add citric acid (5% solution) to induce complete coagulation of caseins and whey proteins. The required amount is about 140 g citric acid monohydrate per 1,000 kg of whey-milk blend. The required amount can be determined exactly by titrating a sample of the blend to pH 5.4 at 20˚C. Alternatively, add the acid slowly until the whey becomes clear.

5. As the curd floats to the surface, gently move the curd from the outside of the vat towards the centre. A thick mat of curd will develop. This process will take 10 to 15 minutes.

6. Hold the curd for an additional 10 min. at 90˚C. Then scoop the curd into the forms using perforated ladles. Fill the forms in rotation until they are level full.

7. Cover the forms with a clean cloth, place chopped ice on the cloth and roll the drain table into a cold room (0 - 4˚C). When the curd is cool it can be packaged for immediate sale.

Note: Ricotta cheese may also be creamed and/or pressed before packaging. A cured, dry Ricotta type cheese called Myzithra is made in Greece.

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Whey pH

You will make a better Ricotta if you predraw the whey in order to keep the inital pH of the whey over 6.5. The curd loses its texture and may form a sludge if the initial or final pH is too low.

Addition of milk

Traditional Ricotta was made from Mozzarella whey without adding milk. However, Mozzarella was traditionally made from buffalo milk which has more protein (both casein and whey protein) than cow's milk. It has become common practice to add about 10% by weight of whole milk, or partly skimmed milk, to sweet whey to increase both protein and fat content.

Acidification

Acidification should take place gradually over a period of 10 minutes, without agitation. Use hot, (80˚C) very dilute acid and add it slowly and uniformly over the surface of the vat. This slow addition permits gradual but uniform pH adjustment. Both gradual pH
adjustment and minimal agitation are required to encourage floculation and flotation. If you add acid too fast, the curd particles become dense and sink, rather than forming loosely associated flocs which float to the surface. Some agitation is provided by direct steam agitation. When flocs begin to form, reduce or stop direct steam agitation and continue heating with the jacket only.

After forming and hooping, the curd pH should be 5.6 - 5.8 to optimize recovery of whey proteins. For whole milk Ricotta, about 0.3% of the milk weight of citric acid monhydrate is required. Blends of milk and whey will require some what less. You can estimate the required amount of any acidulant by titrating a measured weight of the whey/milk blend at room temperature with the acidulant to pH 5.6-5.8. Weigh out the required amount of acid and dilute it in about 20 times its weight of water. The acid solution should be added hot (80˚C).

You'll find that the type of acid you use for acidifying does influence Ricotta flavor. Citric acid adds a sweet flavor note compared to acetic acid.

Moisture control

You can control this by letting the curd dry on top, don't dip too soon.

Shelf Life

One disadvantage of Ricotta cheese is a short shelf life. Ricotta is an excellent growth medium that lacks active lactic culture—this makes it very vulnerable to microbial spoilage. The curd is practically sterile when it is ladled into the forms, but can easily be contaminated during cooling. It is important to cover the forms as quickly as possible after filling, and then cool immediately. Allow the covered curd to drain in a cold room (0 to 4 ˚C). Some manufacturers cover the curd in ice to accelerate cooling.

Calendar, continued

Sept. 1 Producing Safe Dairy Foods. Madison, WI. Call Mary Thompson (608) 262-2217 for more details.

Sept. 23-24 Dairy, Food and Environmental Health Symposium. cosponsored by Wisconsin Association of Milk and Food Sanitarians, WI Association of Dairy Plant Field Reps, and WI Environmental Health Assn., Wausau, WI. For more information, call Dr. George Nelson at (715) 232-0404.

Oct. 18-22 Wisconsin Cheese Technology Short Course. Madison, WI. Call Bill Wendorff at (608) 263-2015.

News from CDR

Joe von Elbe, professor emeritus Food Science, discusses candy making with USDEC visitors

The US Dairy Export Council (USDEC) organized a March mission for 8 Latin American representatives from the candy industry. The tour included plant visits to Land O'Lakes, ADM Cocoa, Davisco Food Int. and the Center for Dairy Research. Here at CDR, K.J. Burrington, Karen Smith and Joe Von Elbe, emeritus professor of Food Science, gave a candy minicourse to show the visitors how they could use whey ingredients in their products. If you are interested in future USDEC missions, contact KimSu Small, program coordinator. Phone: (703) 469-2370 or e-mail: KSmall@usdec.org

Curious about dairy-based futures and options for risk management ?

The Wisconsin Center for Dairy Research and Department of Agricultural and Applied Economics have launched a new web site focusing on futures and options for risk management by the dairy sector. This new web site consists of two sections. One contains a collection of historical data of dairy industry prices, stocks and production. It includes files of cash, futures and options prices for BFP, MiniBFP, butter, Cheddar cheese, milk and NFDM that users can download. The second major section (which we are still developing) is a series of on-line self guided tutorials designed to teach you the basic concepts of using dairy futures. Dairy farm operators, users of farm milk and finished dairy products will find this site useful. The address of the University of Wisconsin Dairy Futures web site is:

www.aae.wisc.edu/future

Food Science researchers hired by UW-Madison

The Department of Food Science has filled two vacant faculty positions by hiring Dr. John Lucey and Dr. Leslie Plhak. Dr. Plhak is leaving Louisiana State University to fill this food chemistry position in Madison.

If you attended the 1995 Cheese Makers conference then you may remember Dr. Lucey and his presentation on rotational grazing and cheese quality. CDR benefits twice from the Lucey hire, since Dr. Selvarani Govindasamy-Lucey (or Rani Lucey) will join CDR as a Researcher, working with Mark Johnson and CDR's cheese group. We expect to welcome the newcomers by July, 1999.

Calendar

May 4-5 Dairy Plant Water & Waste Management Short Course, Madison, WI. Call Bill Wendorff at (608) 263-2015.

May 11-12 Cultured Dairy Products Symposium, Milwaukee, WI. Sponsored by Chr. Hansen's, Inc., (414) 476-3630.

May 12 Wisconsin Dairy Products Association Annual Butter and Cheese Grading Clinic. Wisconsin Dells, WI. For information call WDPA, (608) 836-3336.

May 19-20 Applied Dairy Chemistry Short Course, Madison, WI. Call Bill Wendorff at (608) 263-2015.

June 2-3 Wisconsin Cheese Grading Short Course. Madison, WI. Call Bill Wendorff at (608) 263-2015.

June 20-23 American Dairy Science Association Annual Meeting, sponsored by American Dairy Science Assn. Memphis, TN. For more information call, ADSA, (217) 356-3182.

July 24-28 Institute of Food Technologists Annual Meeting, sponsored by Inst. of Food Technol. Chicago, IL. For more information, call IFT (312) 782-8424.

Aug. 1-4 IAMFES Annual Meeting, sponsored by International Assn. of Milk, Food and Environ. Sanitarians. Dearborn , MI. for more information, call IAMFES (515) 276-3344.

Aug. 11-15 Amer. Cheese Soc. Annual Meeting, sponsored by American Cheese Society. Shelburne, VT. For more information, call ACS (414) 728-4458.

Aug. 16-19 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.

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