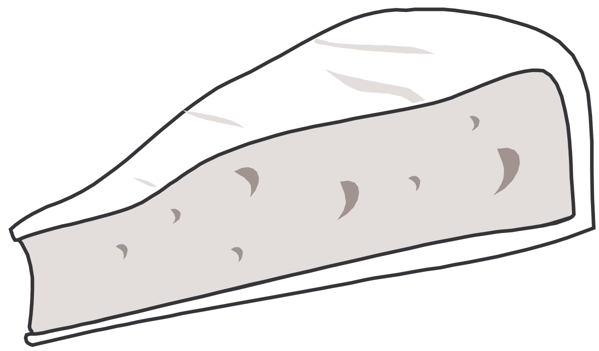
Wisconsin Center for Dairy Research

DAIRY PIPELINE

A Technical Resource for Dairy Manufacturers   Volume 17 Number 1

Salting your cheese—how to get it right

By Mark Johnson and Karen Paulus, Wisconsin Center for Dairy Research



Like many steps in the cheese making process, salting is more complicated than it looks. Salt is important; it shapes and constrains the character of your cheese. For example, salt influences whey drainage, which in turn influences the moisture content of the finished cheese. At the same time, salt is a factor in the form and character of the cheese rind. Deep inside the cheese, salt influences flavor, as well as the growth and survival of starter and non-starter bacteria.

Cheese defects are clues that something went wrong. When it comes to salting cheese both adding too much salt or too little salt produce a variety of defects. Of course, the amount of salt needed varies by type of cheese so you do need to know what your cheese should taste like, as well as the body and texture you are aiming for. With that in mind, under salting your cheese can produce a pasty and weak bodied cheese. Other possible effects of not enough salt are abnormal ripening and one of the most common flavor problems—bitter. Also, if the salt content is too low you face the possibility of unwanted bacterial growth, or even yeast that can survive and grow.

If you have over salted the cheese you might produce a harsh bodied cheese with a closed texture, or perhaps a cracked rind. Off flavors described as cooked or slightly burnt and a slowed ripening are more hints that you are using too much salt.

Cheese makers have three different salting methods to choose from, and sometimes these are combined and more than one is used. They include adding salt to curd prior to hooping or direct salting, brine salting, or brining and, finally, applying salt to the cheese surface or dry salting.

Dry salting is the method of choice for camembert, brie and English blue cheeses. It is gaining in popularity among cheese makers producing other specialty cheeses that are ripened before packaging. It is also, perhaps, the original salting technique. Artisan or farmstead cheese makers have shown an increased interest in using dry salting as an alternative to direct salting and brine salting or in combination with direct salting.

Dry salting is labor intensive

Depending upon the cheese maker, dry salting has the disadvantage of being labor intensive; this may be a minor drawback to some but advantageous to others since the artisan has the opportunity to check the condition of the cheese almost every day. However, dry salting may offer advantages for air ripened cheeses. For example, no lasting brine is created—which means no disposal or excess brine or cleaning of brine—since any moisture that is pulled to

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What's Inside:

Composition and production of permeate and delactosed permeate

by Karen E. Smith, PhD, Wisconsin Center for Dairy Research

The separation of dairy proteins by ultrafiltration continues to be a growth industry. The whey processing industry is one of the main success stories that has benefited from separation technologies. Filtration processes to concentrate whey proteins have led to the development of very high value, functional and nutritious ingredients that fill a nutritional need in energy bars, sports drinks, and even smoothies. Filtration results in components that are retained by the membranes and those that permeate the membrane. Typically the retained components are the higher value components. The commercial food ingredient permeate is a byproduct of whey protein concentrate (WPC) or ultra filtered (UF) milk production.

Permeate actually is a term used to cover a family of products. They have a minimum of 59% lactose, maximum of 10% protein and maximum of 27% ash. However, the protein value is misleading since little or no protein is present. Manufacturers in the U.S. can use the term "dairy product solids," "de-proteinized whey," "modified whey," "reduced protein whey" or "permeate" when they label this ingredient on a product.

Sweet, acid, casein or rennet whey, or milk, may be used as a starting material. Composition of permeate will vary somewhat, depending on the original material used. In the United States, sweet whey and milk are the most common starting materials for permeate production.

Ultrafiltration is the process that produces permeate (Figure 1). Ultrafiltration membranes retain protein and fat while allowing lactose and minerals to pass. It is the lactose and minerals portion crossing the membrane that is referred to as permeate. The protein fraction, with a portion of the lactose and minerals originally present, becomes WPC or UF milk depending on the starting material. The dairy industry typically uses membranes with a molecular weight cut off of 10,000 daltons. Thus, any component smaller than 10,000 daltons will be part of the permeate fraction. However, the size of the component is only a guide regarding ability to cross the membrane. That is because some components, such as glycomacropeptide with its large water shell, appear larger than their molecular weight. In addition, some components have an unusual shape, or perhaps a repelling characteristic (charge, hydrophobic, etc.) It is also possible for smaller compounds to be bound to larger components, such as calcium with casein, which could limit passage through a membrane despite an apparent small size.

More lactose, in the form of permeate, must be removed to produce UF milks or WPC's with higher concentrations of protein.

Figure 1. Production of WPC and UF milk

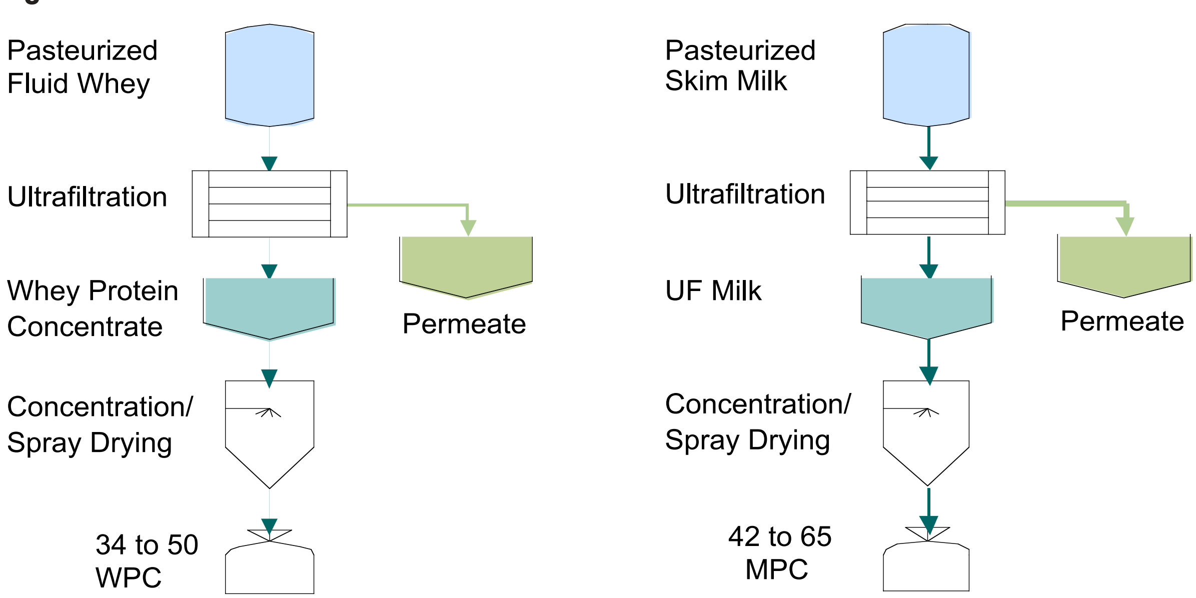

Figure 2. Production of WPC and UF with greater concentrations of protein

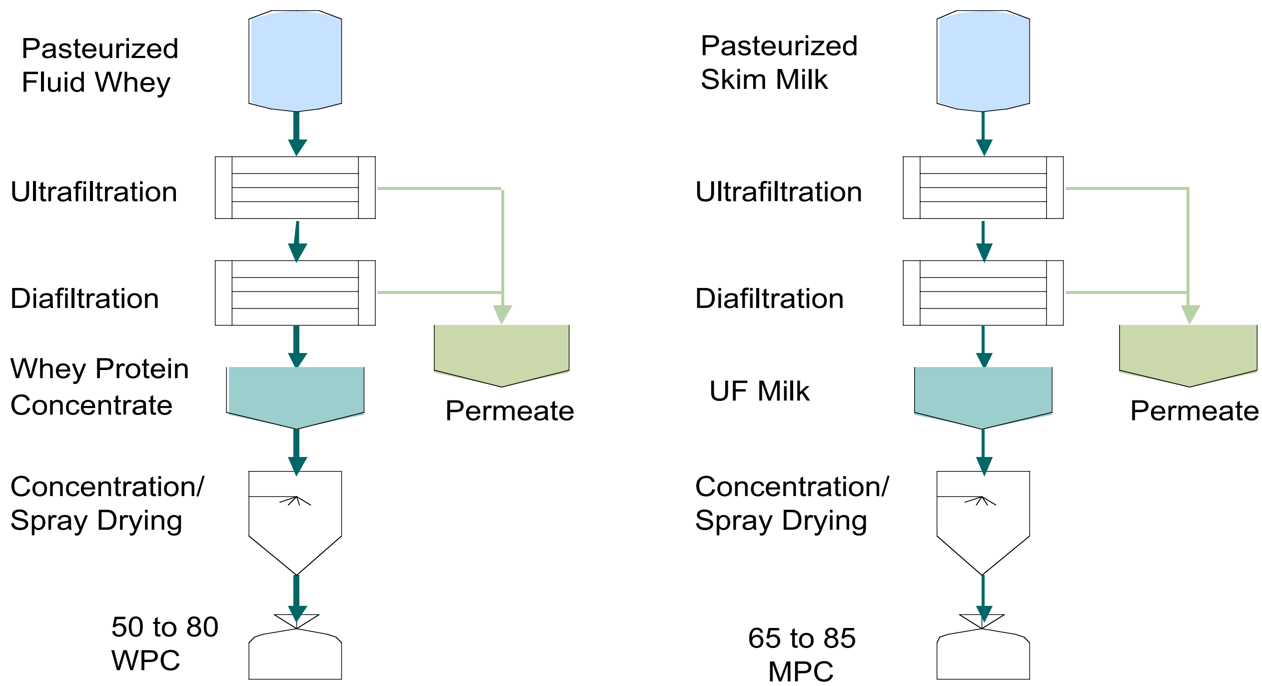

Table 1. Composition of permeate from milk and whey

Component	Permeate from			
	Sweet whey (powder)	Milk (liquid)	Sweet whey (liquid)	Acid whey (liquid)
	%			
Lactose	81.7	4.9	4.9	4.1
Protein	0.5	na	na	na
NPN	1.7	na	na	na
Crude protein	na	0.3	0.3	0.4
Ash	8.3	0.5	0.5	0.7
Fat	0.2	na	na	na
Lactic acid	na	-	0.2	0.5
Moisture	5.0	-	-	-
Total solids	-	5.8	5.8	5.8
	mg/100g			
Calcium	na	28	30	95
Phosphorous	na	33	40	55

na - value not available from source of data

Diafiltration, or the use of water to "wash" additional amounts of lactose from whey or milk, is used to produce the higher protein products (Figure 2).

An average composition for sweet whey, acid whey and milk permeate is listed in Table 1. Please note that only trace amounts of protein are listed. Commercial specifications however, list protein typically at 3.5 to 5% with a 10% maximum (Table 2). The discrepancy is due to the dairy industry testing for total nitrogen and then automatically multiplying the result by 6.38. The nitrogen found by testing actually is largely nonprotein nitrogen (NPN) rather than true protein. Examples of NPN compounds found in milk and whey include: urea, creatine, creatinine, uric acid, orotic acid, and ammonia.

Permeate powder is produced by concentrating the liquid permeate to supersaturate the lactose (Figure 3). The concentrated permeate is first cooled to maximize formation of lactose crystals and then dried. Crystallizing lactose produces a less hygroscopic product.

A very significant problem arises because of the amount of permeate produced relative to the amount of WPC or UF milk produced. Graph 1 shows the amount of liquid permeate versus WPC produced for WPC's of increasing protein contents.

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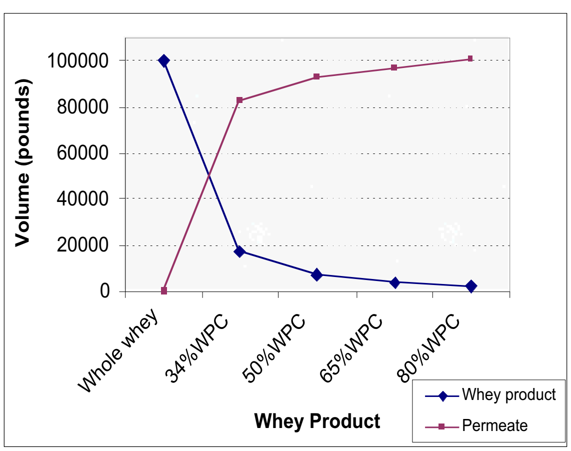
Table 2. Typical composition of food grade permeate (USDEC)

Component	%
Protein	3.0 - 8.0
Lactose	65.0 - 85.0
Fat	<1.5
Ash	8.0 - 20.0
Moisture	3.0 - 5.0
	- - mg/100g -
Calcium	870
Phosphorous	720
Sodium	570
Magnesium	130

Delactosed permeate or DLP is a by -product of lactose production (Figure 4). Permeate generally is used as the starting material for lactose manufacture. Because of the variability in lactose operations, DLP does not have a typical composition. Since only lactose is removed during lactose production it would be fair to say that DLP will have significantly less lactose and therefore more minerals than permeate. It is extremely difficult, if not impossible, to dry DLP. Currently it is land applied or used as a molasses extender for cattle. Check out the next issue of the Dairy Pipeline for an in depth look at the uses of permeate.

Graph 1. Production of permeate versus WPC of various protein concentrations



Thanks to Todd Hutson, Filtration Engineering for the data used in this graph

Figure 3. Production of permeate powder

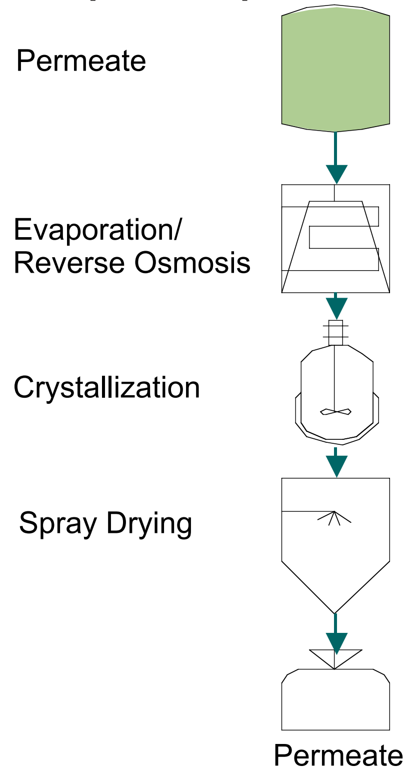
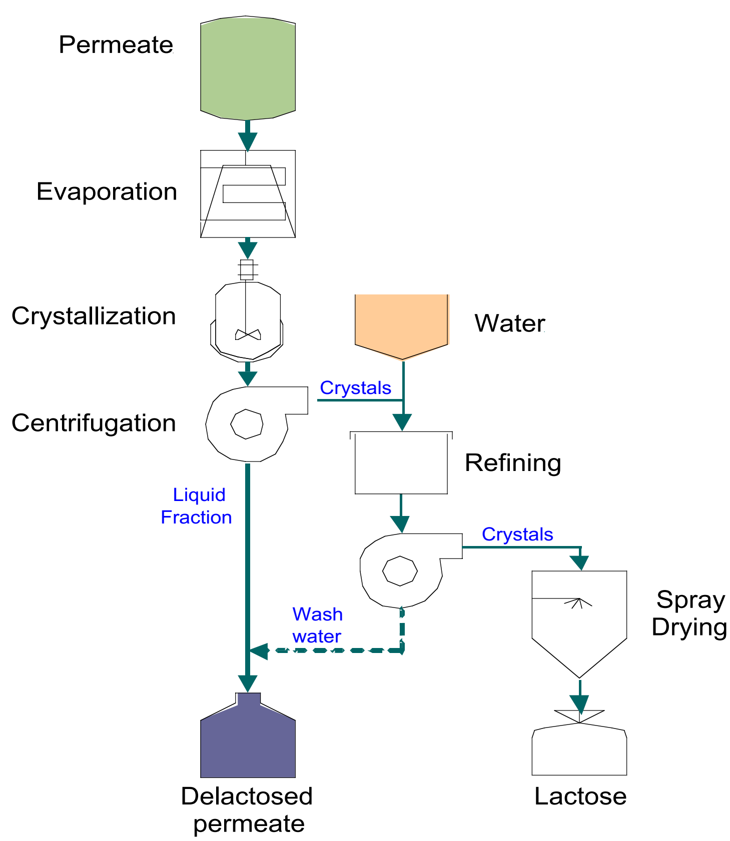


Figure 4. Production of lactose and DLP from permeate



Salting

continued from page one

the cheese surface will eventually evaporate. Another advantage is the creation of a rind, in fact a very dense rind. This happens when salt pulls moisture from the cheese to the cheese surface. At a very high salt concentration, there is rapid movement of moisture to the cheese surface, where it evaporates. When the cheese at or near the surface rapidly dries it leaves a dense layer of cheese —the rind.

High salt actually causes the casein network to tighten into aggregates (see Moisture migration in cheese, Dairy Pipeline Vol.15 No. 2) creating a porous network filled with serum. The movement of the serum carries small molecular weight compounds that are soluble in water—amino acids, peptides and lactic acid—to the surface. If you want of picture of this process, think of what happens when you squeeze a water-filled sponge. Both the sponge and the water are still present, but in different positions. The sponge remains small as long as pressure is applied and the water easily drains off. Similarly, in cheese, as the salt causes the casein network to tighten, serum collects between the aggregates and can easily move within the large pores. In fact, it moves to the cheese surface where there is lots of salt. As moisture evaporates, or is pulled from the cheese, the network collapses into much smaller pores to create the rind.

In addition, there may be some free fat that forms at the surface, as the porous casein network also allows fat to move through it in response to gravity. The fat can also plug the pores as the network collapses. The dense layer, or rind, inhibits or slows further moisture loss from the cheese as well as salt movement into the cheese. The interior of the cheese retains its moisture for a longer period of time. Because of the rapid formation of the dense casein layer, dry salting results in a slower uptake of salt by the cheese compared to brining. This is particularly true when the brine concentration is less than 20 %. Indeed, many European cheese manufacturers purposely use lower salt concentrations in their brines to increase the rate of salt uptake without rind formation.

“Think of what happens when you squeeze a water-filled sponge. The sponge remains small as long as pressure is applied and the water easily drains off. Similarly, in cheese, as the salt causes the casein network to tighten, water collects between the aggregates and can easily move within the large pores.”

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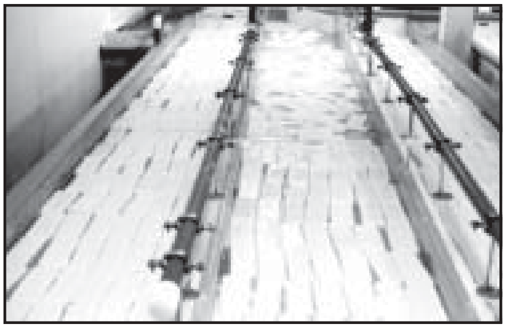
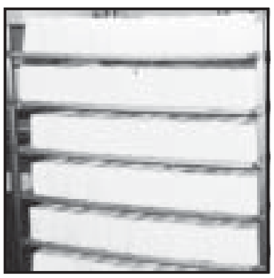
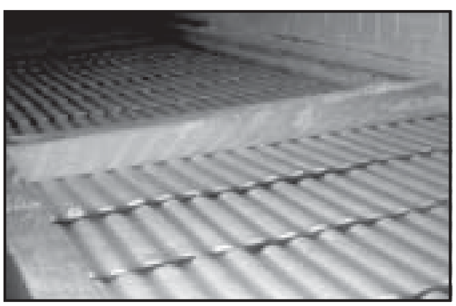
Brining Systems



Channel brine system



Pit brine system



Static brine system

Two tiered brine system

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Brine salting

If you are making edam, gouda, provolone or brick cheese, chances are that you soak your molded cheese in a brine solution for a few hours to a couple of days. During the brining process sodium and chloride, ions move into the cheese, driven by osmotic pressure between the brine and the moisture in the cheese. At the same time, water diffuses out of the cheese until equilibrium is reached. Brining is a bit more complicated than other methods of salting though. Not only do you have to pay attention to salt, you need to know how pH and calcium influence the process.

Sodium chloride (NaCl) is the major component of brine, but calcium chloride is another important ingredient. Like NaCl in brine, calcium influences the equilibrium of the system. Trying to produce a brined cheese without adding calcium to the solution will lead to surface and rind defects. This is because the calcium migrates in, or out, of the cheese in an attempt to equalize the concentration. To control this migration make sure the calcium level in your brine matches the calcium level in your cheese. Thus, a typical calcium level for swiss cheese is 0.1%, while a mozzarella brine would be 0.07% calcium. You should only have to add calcium chloride when you first set up a brine system, once you establish the correct level you shouldn't have to add any more.

Like calcium, the pH of the brine should match the pH of the cheese. In fact, pH influences the movement of calcium in the brine. If the pH is too low, calcium ions flow out of the cheese while hydrogen ions from the brine flow in. Surface proteins in the cheese will shrink and you will see short, firm rinds. A higher pH on the cheese surface has the opposite effect—swelling proteins that produce a greasy or slippery surface.

The pH of the cheese also influences the rate that salt is absorbed. Acid cheeses absorb salt faster because they have bigger pores. Thus feta cheese, at a pH around 4.8 absorbs salt fast enough to remain a high moisture cheese.

Maintenance

When Bill Wendorff teaches the Cheese Technology Short course he almost always has a student who expresses disbelief that *Listeria monocytogenes* can live in cheese brines. But it is true. Listeria is a salt tolerant microbe that can survive for weeks in highly concentrated salt brines. If conditions allow, Listeria can grow and thrive on the cheese surface when it is removed from the brine. For this, and other reasons, it is important to maintain a clean and safe brine.

A continuous membrane filtration system is expensive, but it effectively filters out protein, fat, fines and bacteria while leaving sodium, calcium, and hydrogen behind. Another option is to skim the cold cheese brine and then batch pasteurize and filter the brine through cheesecloth.

Brine solutions don't last forever. If you haven't used your brine tank for a while you may end up with diluted brine on the surface. This can lead to bacterial contamination on the brine surface; it is a medium that will support them and if it isn't cleaned and maintained it will contaminate your cheese.

Experts agree that there is a real trend toward dry salting, because of the contamination you can get in brine. However, if you pay attention to your brine tank and maintain it properly then brine salting is a safe option. Recently, concerns about ground water quality have lead to closer scrutiny and restrictions on the amount of both chloride and phosphorus in wastewater. What does this mean for cheesemakers? It means you want to be as efficient as possible when salting cheese; you want your cheese to absorb the salt you apply and not wash that salt down the drain.

"Experts agree that there is a real trend toward dry salting, because of the contamination you can get in brine. However, if you pay attention to your brine tank and maintain it properly then brine salting is a safe option."

Previous Pipeline articles focusing on salt include:

Vol. 12 #3 Salting muenster-type cheeses

Vol. 12 #4 Areview of factors influencing salt retention

Vol. 14 #4 Salt crystal size and salt retention in chedder cheese

Vol. 15 #2 Moisture migration in cheese

"You want to be as efficient as possible when salting cheese; you want your cheese to absorb the salt you apply and not wash that salt down the drain."

News from CDR

Jim Path leaves a legacy

John Jaeggi, left, gives Jim Path, right, a friendly send-off

There are many factors behind the increasing number of specialty cheeses available today. However, I'd like to focus on one who has worked at the Center for Dairy Research for almost 14 years; his name is Jim Path. Jim has friends in Germany, Italy, Denmark, France, Poland, Mexico, Finland and the Upper peninsula of Michigan. Most of these friends are cheesemakers and many have traveled to Wisconsin to teach at one of the artisan cheesemaking courses that Jim helped to organize. Jim's passion for both travel and cheese enriched his co-workers, his classes and Wisconsin cheesemakers. Jim leaves us the legacy of the Wisconsin Master Cheesemaker Program®and the make schedule for juustolepia cheese!

Customizing Cheese Flavor Short Course

August 30-31, 2005
Madison, WI

Let's face it, taste is the reason people seek out their favorite foods; and for many that means cheese. The diversity of flavors in cheese has increased, driving significant growth in the specialty cheese industry. Cheesemakers can actually control the development of many desired flavors in cheese and this new short course will tell you how. This two-day short course will cover milk flavors, enzymes, cultures, ingredient or flavor additions, and environmental conditions that cheesemakers can use to produce unique flavored cheeses. The course includes classroom discussions as well as sensory evaluation of cheeses influenced by various flavor contributors.

Questions about the curriculum may be directed to Bill Wendorff at (608) 263-2015 or John Jaeggi at (608) 262-2264.

The CDR web site has a new look

Although it still has a few quirks, CDR's updated website is up and running. Please let us know if we have hidden or removed a feature that you need.

On becoming a complete cheesemaker

Cheesemakers sign on to the Wisconsin Master Cheesemaker, program for a variety of reasons. However, by the time they graduate they are likely to agree with Master Cheesemaker Jeff Mattes who says of the program, "It is a great tool to make you a more complete cheesemaker."

Four new Masters were inducted into the ranks of the Wisconsin Master Cheesemakers at the April 2005 Cheese Expo in La Crosse, Wisconsin. At the same time, three Masters were certified as Masters of additional cheeses.

The 2005 class of Wisconsin Master cheesemakers have combined decades of cheesemaking experience with courses offered by the Wisconsin Center for Dairy Research, the University of Wisconsin-Extension and the Wisconsin Milk Marketing Board. Gianni Toffolon notes that it is a personal satisfaction to be a Master Cheesemaker but he was really happy about everything he learned from the classes. "It all helps to fine tune what the cheesemaker already knows."

Steve Tollers also enjoyed the learning experiences offered by the Wisconsin Master Cheesemaker ®Program. Although he believes cheesemaking is an art, it was the detailed information supporting the craft that he got from his classes. As a result, Tollers moved past the do this, then do that approach to cheesemaking because he knows more about the factors that influence cheese. He has noticed that he "can answer employee questions much better now!"

John Moran enjoyed the variety of educators and all the cheesemakers he met as he worked toward Master status. He notes that 'things are changing so fast in the dairy industry, you really need to keep up." Meeting other cheesemakers added to his knowledge of Wisconsin cheesemaking, Moran says. "Usually you only know your own plant, but talking with other cheesemakers allows you to find out what is going on elsewhere."

Gregg Palubicki found the Master Cheesemaker classes very useful and admits, "The test was actually a good experience, also very helpful." Like his classmates, he enjoyed meeting other cheesemakers. Palubicki notes, If I could, I would send all my cheesemakers to courses in Madison."

The 2005 class of Master Cheesemakers demonstrate that meeting other cheesemakers, learning about the science of cheesemaking, and making a commitment to continuing education can indeed develop a complete cheesemaker.

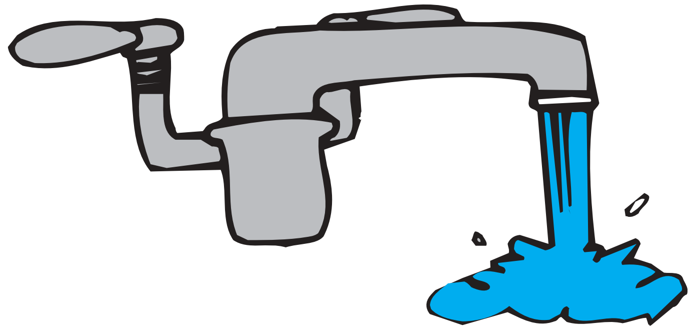
Top row
Jeff Mattes of Sartoro Foods, Walt Brandli retired from the UW Dairy Plant

Middle row
Bruce Workman, of Edelweiss Town Hall Cheese, Gregg Palubicki of Alto Dairy Cooperative

Bottom row
John Moran of Wisconsin Dairy State Cheese, Steve Tollers of Burnett Dairy Coop, Gianni Toffolon of BelGioioso

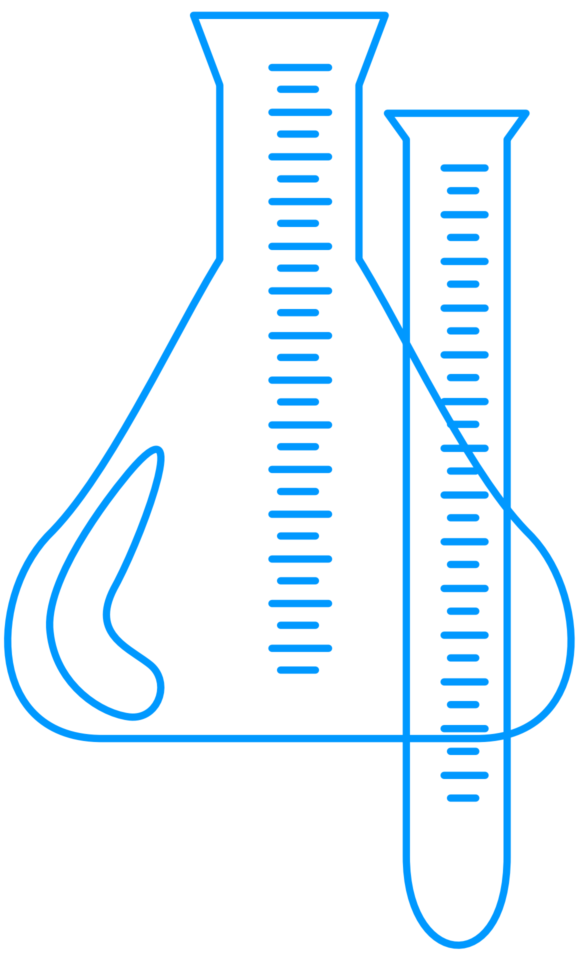
Curd Clinic

Curd Clinic doctor for this issue is Mark Johnson, scientist. CDR



Q. I have noticed that I need to use 10% more salt when I am making colby or jack cheese compared to cheddar cheese. Can you tell me why?

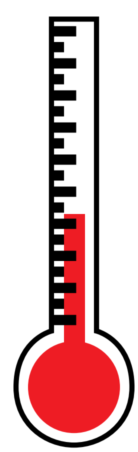
A. Before answering your question, I am going to assume that the final salt content and and yield are the same. Otherwise, the higher yield in colby and jack may explain the highter salt content. That said, there are a couple of reasons why you might have to add more salt while making colby cheese compared to cheddar. The first one is temperature; a warmer curd has a faster rate of salt absorption. In fact, there is a critical temperature for salt absorption in cheese curd. Fox (1993) compared higher and lower temperatures before concluding salt has the least affinity for absorption at 32°C, or 90°F. At 32°C, a layer of fat is exuded onto the curd's surface, particularly in freshly milled curd, which prevents salt from readily absorbing into the curd. At lower temperatures, this fat has not been released from the curd to the surface. At higher temperatures, the exuded fat is dispersed into the whey, or at the curd surface, as a liquid (Fox, 1993).



Colby curd is cooler than cheddar curd because of the cold water rinse. In addition, cool curd holds water but this water is more easily pressed from the curd. When salt is added the water rapidly absorbs the salt but upon subsequent pressing the salt laden water is pressed out of the curds.

The method you use to make cheddar cheese also influences the amount of salt you use. For example, stirring dry curd produces a shell or dense layer on the outer layer of the curd particle. This layer impedes the penetration of salt into the curd particle. On the other hand, a fresh layer formed when a slab of cheddar curd is milled creates new surface area that has not yet formed the shell. This new layer picks up salt faster. However, if you stir the milled curd too long before salting, it will also form the dense layer at the surface, as well as leak more fat.

“There is a critical temperature for salt absorption in cheese curd.“



Calendar

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Sept. 20-21 Dairy, Food and Environmental Health Symposium. Co-sponsored by Wisconsin Association of Food Protection, WI Association of Dairy Plant Field Reps, and WI Environmental Health Assn., Wausau, WI. For more information, check the WAFP website at www.wafp-wi.org.

Oct. 4-9 World Dairy Expo, Madison, WI. For information see www.world-dairy-expo.com.

Oct. 10-14 Cheese Technology Short Course, Madison, WI. Call Bill Wendorff at (608) 263-2015.

Oct. 18-19 Dairy Ingredient Utilization Short Course, Madison, WI. Call Bill Wendorff at (608) 263-2015 or K.J. Burrington at (608) 265-9297.

2005 IDF World Dairy Summit

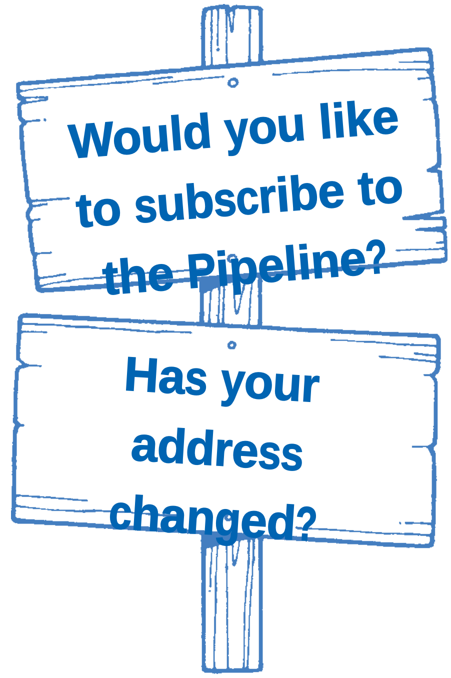
September 17-22, 2005
Vancouver, BC, Canada

Program Highlights:

- World Dairy Situation
- My Price, Your Cost—Sharing the Pie
- Dairy in the Food Industry of the Future
- Nutri-Marketing: Emerging Dairy Health Claims
- Technology for Functional Foods
- Extended Shelf Life Technology
- How Can One Food Mean So Much to So Many?
- Promoting and Protecting Dairy
- Adapting Farm Practices to New Markets

For more information:

www.idf2005.com



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Karen Paulus, Editor
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phone: 608/262-8015

You can also find the Dairy Pipeline on our website: www.cdr.wisc.edu

Calendar

June 1 Incident Management Planning to Protect Your Company, Madison, WI. Sponsored by WI Assn. for Food Protection. For further information, call Neil Vassau at (608) 833-6181.

June 7-8 Wisconsin Cheese Grading Short Course, Madison, WI. Call Scott Rankin at (608) 263-2008.

June 21-23 WDPA and Marschall Dairy Symposium, Hyatt Regency, Milwaukee, WI. Sponsored by WI Dairy Products Assn. For further information, contact WDPA at (608) 836-3336.

July 16-20 IFT Annual Meeting, New Orleans, LA. For information see www.am-fe.ift.org.

July 21-23 American Cheese Society Annual Meeting. Louisville, KY.. For info, call (502) 583-3783.

July 24-28 American Dairy Science Association Annual Meeting, sponsored by American Dairy Science Assn. Cincinnati, OH. For more information call ADSA, (217) 356-5146.

Aug. 16-17 Milk Pasteurization and Process Control School. Madison, WI. Call Scott Rankin at (608) 263-2008 for information, or the CALS Outreach Services (608) 263-1672 to register.

Aug. 30-31 Customizing Cheese Flavor Short Course, Madison, WI. (A Master Cheesemaker Short Course) Call Bill Wendorff at (608) 263-2015 or John Jaeggi at (608) 262-2264 for information.

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