

DAIRY PIPELINE

A TECHNICAL RESOURCE FOR DAIRY MANUFACTURERS

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Impact of Breed on the Cheesemaking Potential of Milk; Volume vs Content

By Bill Wendorff and Karen Paulus, Wisconsin Center for Dairy Research

All cheesemakers agree that quality cheese begins with quality milk. But what is quality milk? One measure is the cheesemaking potential of milk, defined as the yield and quality of cheese produced from a unit of milk. The most significant factors affecting the cheesemaking potential of milk include bovine genes, environment and physiology. These three factors are behind the differences in chemical and physical properties of milk that influence coagulation properties that, in turn, influence the quality and yield of cheese. Previous research suggests that milk composition, which is influenced by the breed of cow, has the greatest effect on the cheese yield capacity of milk (Lawrence, 1991). This article summarizes published research that examines the impact that breed of cow has on cheese yield and quality.

Dairy breeds in the US

In the U.S., six major breeds of dairy cattle supply milk for cheesemaking and of these, black and white Holsteins make up over 90% of the U.S. dairy herd (US EPA, 2011). The Holstein cow is known for her production of large volumes of milk, milk fat and protein (Table 1). Holsteins have dominated milk



Photo courtesy of Hoards Dairyman

production in the U.S. since 1945. Jersey is the second most popular cow in the US and represents about 7% of the U.S. herd. The other 4 breeds, Ayrshire, Brown Swiss, Guernsey, and Milking Shorthorn, represent only 2% of the U.S. milking herd. Milk composition and milk component yields for the 6 major breeds are shown in Table 1 on page 5.

Why Holsteins?

Holsteins produce the largest volume of milk as well as the highest yield of fat and protein per lactation. Since most dairy producers get paid for total lb. of fat and protein delivered to the cheese plant, Holstein is the preferred breed for milk production with the current multiple component pricing system in place. However, if a cheese yield pricing system were in place, Jersey, Guernsey, and Brown Swiss cows would be more profitable than Holsteins (Schmidt and Pritchard, 1988). On the other hand, the functionality of the milk components is an

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CDR in the Future

Current plant cannot meet future needs

By Deb Wendorf Boyke

"CDR continues to offer these services that have been a major factor in the vibrancy of our industry, but in a building that is tired."



Babcock Hall, the first UW building erected following World War II, is showing its age.

In today's environment, being on the cutting edge isn't easy. Things are changing so quickly, organizations are doing more with less, and budgets may be restricted. That's where the Wisconsin Center for Dairy Research (CDR) shines. We partner with industry to be to their R&D department or an extension of their R&D, providing new ideas for opportunity or solutions to challenges.

CDR scientists and technologists have strived to be a leader in the areas of research, technology, training and outreach. To do that, it has hired the best staff with field experience to complement the strong research base provided by the UW-Madison Department of Food Science. By collaborating, it can provide perspectives your organization may need to further build your business or make your product even better. This has all been done in a facility built in the 1950's; the first UW building erected following World War II.

Our success stories are your success stories

Remember that CDR's success stories are your success stories. There are numerous examples such as, the introduction of products like sarvecchio, juustoleipa, Pleasant Ridge Reserve, Special K20 protein beverage, Tula Foods Better Whey Yogurt, and Seymour blue cheese. Our technical support has led to new accounts for manufacturers and helped countless companies increase their orders. A recent example is the reopening of an old plant that began making a new variety of cheese, going from 3 employees to 54 employees in 4 years. Not to mention enhancing the skill sets of manufacturers throughout our industry through the variety of short courses offered each year in addition to customized training for individual companies. By partnering with industry, in 2010 alone CDR worked with:

- 100+ Wisconsin dairy companies
- 40 companies that buy/utilize Wisconsin dairy products
- 20 Wisconsin-based industry suppliers
- 15 Wisconsin-based organizations and regulatory agencies that support Wisconsin cheese and dairy ingredient companies
- 15 national and international organizations and regulatory agencies that support US cheese and dairy ingredient companies

Collaborative work with the UW Food Science

Add to that the collaborative work with the UW Food Science department in the area of education, such as:

- 22 short courses reaching 1000+ industry attendees/year of which several courses are required for a Wisconsin cheese maker license and/or the Wisconsin Master Cheesemaker® program

- 17+ industry and foodservice trainings reaching 450+ people/year

Thanks to the investment and support of both Wisconsin (WMMB) and national (DMI) dairy producers through the dairy check off program, CDR continues to offer these services that have been a major factor in the vibrancy of our industry, but in a building that is tired. Babcock Hall has served Food Science and CDR well for over 50 years, but to continue to provide cutting edge research, technical support and education the industry needs to look ahead. What will you need from CDR for the future and does CDR have the facilities/equipment and capabilities to meet those diverse needs?

Resounding response from industry

The resounding response from industry visiting the plant has been NO, the current plant cannot meet the future needs of the industry and still be cutting edge. So several months ago, CDR and Food Science announced plans for the Babcock Dairy Renovation. This would include upgrading the HVAC for the Dairy Plant, renovating the existing dairy plant and adding more square footage for the CDR pilot plant. But what does that really mean? And, what does CDR want to do that it currently can't due to physical plant limitations?

First and foremost, the Babcock Dairy Plant has not been renovated or upgraded since it was designed in the late 1940's, 60 years ago! That in itself tells a story. We have had utility system failures that led to trials being destroyed, employees receiving electrical shocks, and air handling conditions that aren't healthy for employees, e.g. no real ventilation in the summer.

Second, there are security issues. The Dairy Plant manufactures ice cream, cheese and bottles milk to supply the campus, in addition to all the trial work that CDR staff conducts. The expectations for the dairy manufacturing environment are much more demanding today than they were back in the 1950s when the plant was built.



Short courses get crowded in the plant



The only cooling system in the Dairy plant and short course cheesemakers all know how well it works on a hot summer day.

There is little controlled access in this busy, public setting on campus. There are also quality issues from the standpoint that the building is no longer conducive to creating the clean manufacturing environment that is expected today.

Busting at the seams

Third is capacity, both within the Dairy Plant and CDR. As trial numbers, short course and attendee numbers, as well as the variety of industry requests (e.g. more yogurt and cultured product projects; blue cheese, smear-ripened, and cave-aged cheese projects) all continue to increase, CDR is finding itself busting at the seams to accommodate everything, which is a good problem to have.

We need to make sure that the new facility allows us to go to the next level. Some examples are:

- Ability to offer cultured products pilot facilities to meet this growing market
- Room to add new equipment such as in the area of membrane filtration/separation, a rapidly growing sector for the industry
- More hands-on training
- Intern opportunities for beginner cheesemakers

That brings us to today. With the new State budget bill and the potential for the UW-Madison to gain public authority, many

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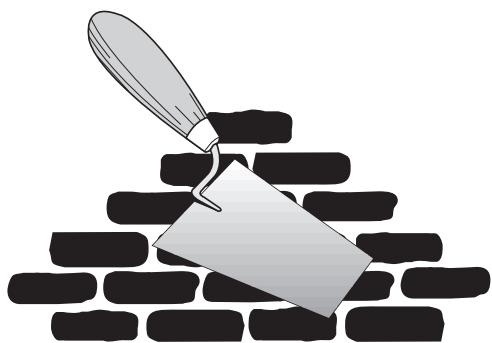
Future CDR

questions remain about the impact on any building project on campus. However, we've done our due diligence in presenting this project to the College of Agriculture and Life Sciences (CALS) Facilities, Planning and Management committee which ranks, within CALS, all proposed building projects for the next biennium. The good news is that CALS and UW Foundation have made this project one of their top priorities!

In the meantime, irrespective of ranking, we must raise the money first. With this type of project, the University expects us to raise 50% of the projected costs through contributions, namely from industry. To achieve this goal, CDR and Food Science are working with the UW Foundation, the official fundraising and gift-receiving arm of the UW.

Wisconsin Cheese Makers Association is an active partner in this effort and last December helped kickoff this campaign with an initial pledge of \$500,000. Pledges are now coming in, for example, a significant pledge from Henning Cheese, and most recently a pledge from the Eastern Wisconsin Cheesemakers and Buttermakers Association. It's a great start, but we need to build on that momentum. This building project is a top priority for the new CDR director John Lucey. The building is not about CDR or UW; it is about making sure our industry has the facility and partner it needs to thrive in the coming years.

We're excited about this venture; let's do it together! 



Dairy Breeds

important factor influencing the quality and yield of cheese from various sources of milk. Differences in milk clotting properties among various breeds have been reported by previous researchers (Auldist et al., 2004; De Marchi, et al., 2007; Wedholm et al., 2006). In some cases, the higher concentrations of fat and protein in non-Holstein milk may offset the current economic advantage offered by Holstein milk. Following is a report on the cheesemaking potential of milk from each of the major breeds of dairy cows.

Ayrshire

The average annual output for Ayrshire cows in Wisconsin is 15,690 lb of milk with 3.9% fat and 3.15% protein (WDATCP, 2010). They produce about 2/3 the volume of milk of Holsteins but Ayrshire's also produce milk with approximately 5% more fat and 4% more protein. Since clotting time and curd firmness for Ayrshire milk is about the same as with Holstein milk (Tervala et al., 1983), the primary advantage of Ayrshire milk lies in the increased concentration of fat and protein that gives a slight increase in cheese yield. The protein composition of Ayrshire milk does not add a significant advantage since it has a frequency of 7% β -form of κ -casein (κ -CN β) compared to 14% for Holstein (Ikonen et al., 1999). The κ -CN β allele is associated with more desirable coagulation properties and improved cheese yield (Macheboeuf et al., 1993). Producers of Ayrshire milk would be best suited to a market with cheese yield pricing. (Keller and Allaire, 1990).

Brown Swiss

The average annual output for Brown Swiss cows in Wisconsin is 18,800 lb of milk with 4.1% fat and 3.37% protein (WDATCP, 2010). Brown Swiss cows produce 9% less milk per day than Holstein cows but the milk has higher concentrations of protein, casein, and titratable acidity than Holstein cows (De Marchi et al., 2008). Rennet coagulation time was shorter and curd firmness was greater for Brown Swiss milk compared to Holstein milk (De Marchi et al., 2008; Mistry et al., 2002). Cheese yield and protein and fat recoveries were higher than those for Holstein (Mistry et al., 2002). Cheese made with Brown Swiss milk has a deeper yellow color when compared to cheese from Holstein milk (De Marchi et al., 2008). Cerbulis and Farrell (1975) reported that of the 6 major breeds of dairy cows in the US, Brown Swiss ranked highest in yield of true protein. Protein quality for cheesemaking is much better than Holstein milk since Brown Swiss herds have a frequency, 67%, of the κ -CN β allele compared to 18% for Holstein (Eenennaam and Medrano, 1991). Schmidt and Pritchard (1988) reported that Brown Swiss milk would be the most competitive with Holsteins on profitability on a multiple component pricing system.

Guernsey

The average annual output for Guernsey cows in Wisconsin is 16,133 lb of milk with 4.56% fat and 3.33% protein (WDATCP,

Table 1. The effects of breed on the content and yield of milkfat and milk protein.*

Breed	Milk Content (%)		Milk Yield (lb/lactation)	
	Fat	Protein	Fat	Protein
Ayrshire	3.99	3.34	464	389
Brown Swiss	4.16	3.53	537	462
Holstein	3.40	3.32	581	497
Guernsey	4.87	3.62	519	389
Jersey	5.13	3.80	506	385
Milking Shorthorn	3.60	3.20	-	-

* (Lawrence, 1991) Based on data from an inter-regional project in the U.S.

2010). They produce about 70% of the volume of milk of Holsteins but produce milk with approximately 27% more fat and 14% more protein (Cerbulis and Farrell, 1974). In Guernsey milk, non-protein nitrogen accounts for only 3.9% of the total nitrogen. Guernseys are known for the deep yellow color of the fat in their milk, generated from β -carotene retained from feed. Custer (1979) reported a cheese yield of 10.62% for Guernsey milk compared to 9.67% for Holsteins. Protein quality for cheesemaking is slightly better than Holstein since Guernsey has a frequency of 27% for the κ -CN β allele compared to 18% for Holstein (Eenennaam and Medrano, 1991). Producers of Guernsey milk would be best suited to a market with multiple component pricing system. (Keller and Allaire, 1990). Schmidt and Pritchard (1988) reported that after Brown Swiss, Guernsey would be the next most competitive breed with Holsteins when determining profitability on a milk component pricing system.

Holstein

The average output for Holstein cows in Wisconsin is 24,032 lb of milk with 3.7% fat and 3.02% protein (WDATCP, 2010). Holsteins are known for producing large volumes of milk and the most economical production of milk fat and milk protein (Keller and Allaire, 1990). Holstein milk has a fair milk quality for cheese making (De Marchi et al., 2007). Other breeds have produced milk with faster milk coagulating properties than Holstein, however, no differences were noted between breeds in chemical composition or cholesterol content of cheeses produced (Auldist et al., 2004; De Marchi et al., 2008). Cheese from Holstein milk had a greater content of each saturated fatty acid from C:4 to C:16 and total saturated fatty acids than Brown Swiss milk. Auldist et al. (2004) reported that Holstein milk fat was softer than Jersey milk fat. Holstein milk fat had more conjugated linoleic acid (CLA) than Jersey milk fat. They also reported that when Holstein milk was standardized to the same solids concentration as Jersey milk, there were no differences in cheese yield between breeds. Since Holsteins are the most efficient breed in producing large volumes of milk and strong levels of milk fat and protein, it will remain the prominent breed for producing low cost commodity cheeses.

Jersey

The average annual output for Jersey cows in Wisconsin is 16,835 lb of milk with 4.84% fat and 3.59% protein (WDATCP, 2010). Jerseys are known for producing milk with a high content of milk fat and milk proteins—especially suited for cheese production. Milk from Jerseys has been reported to have 19% additional casein and whey protein, as well as 50% more milk fat than milk from Holsteins (Czerniewicz et al., 2006). Custer (1979) reports cheese yields of 11.33% for Jersey milk compared to 9.67% for Holstein milk. Auldist et al. (2004) reported that Jersey milk yielded 10% more cheese per kg than Holstein milk when using protein:fat standardized milk, but for milks with the same solids concentration there were no differences in cheese yield. Jersey milk coagulated faster and formed firmer curd than Holstein milk. Yield of cottage cheese curd from high solids Jersey skimmilk was 18.19% compared to 14.37% for lower solids Holstein skimmilk (Martin et al., 1992). The higher casein content of Jersey skimmilk accounted for the firmer curd and reduced level of fines in comparison to Holstein skimmilk (Mutzelberg et al., 1982). Jersey milk has a frequency of 86% of the κ -CN β allele compared to 18% for Holstein milk, making the protein quality for cheesemaking significantly better (Eenennaam and Medrano, 1991). Jerseys had higher proportions of long-chained saturated fatty acids and lower proportions of long-chain unsaturated fatty acids, which means harder fat from Jersey milk (Auldist et al., 2004). Curd from Jersey milk also loses moisture more readily during

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Milking Shorthorn

Conclusion

Breed is the main genetic factor affecting the milk quality characteristics that influence individuality of some cheeses and more rapid coagulation of milk. The β variants of κ -casein have been associated with increased cheese yield for two reasons. One is the increased casein content of milk and the other is a possible increase in free calcium which produces a firmer rennet curd (Eenennaam and Medrano, 1991). The frequency of the β variant of κ -casein is high in Jersey and Brown Swiss, moderate in Guernsey and low in Holstein, Ayrshire, and Milking Shorthorn. Several researchers (Auldist et al., 2004; De

Breed	Frequency of κ -CN β allele
Jersey	86%
Brown Swiss	67%
Guernsey	27%
Holstein	18%
Milking Shorthorn	11%
Aryshire	7%

Cheeses were comparable

The type of milk used for cheese production can be critical when it comes to cheeses with protected geographic indication, e.g., European label protected denomination of origin (De Marchi et al., 2008). At the current time, very little has been published regarding the influence of breed of cow on the aging properties of different cheeses. Many reports indicate small differences in color, fat composition, and rates of milk coagulation, but no differences in chemical or physical properties of the cheeses (Auld et al., 2004; De Marchi et al., 2008). Generally, milks with lower C/F ratios are favored for bloomy rind cheeses while milks with higher C/F ratios are favored for aged hard cheeses. Jersey milk has been used for bloomy rind cheeses, e.g., brie, camembert, and blue cheeses while Brown Swiss is used for sbrinz, emmental, and gruyere (Ehlers and Hurt, 2008). U.S. cheesemakers are just beginning to evaluate which breeds work best in which locations and with which feed.

If milk from certain breeds is especially suited for producing particular cheeses, then segregating milk from different breeds could maximize the value of the milk.

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Wisconsin Master Cheesemaker Class of 2011



Tim Pehl, Chula Vista Cheese

In April two new masters will join the ranks of this esteemed group of cheesemakers. One of them is Tim Pehl, who started making cheese at Roy's Dairy in 1985, and earned his cheesemakers license in 1988. For 16 years he made provolone and mozzarella, then blue and gorgonzola, and now he's making Hispanic style cheese at Chula Vista in Browntown, Wisconsin.

Pehl seems a bit surprised to admit that, "I started working at a cheese factory, not knowing I was going to make a career out of it. And the next thing I know I've got 26 years of experience, and I am only 46!" He has watched as automation steadily increased in cheese plants, and, over time, he has seen a growing emphasis on quality control, both from the regulatory side and from the customer. It is an improvement he approves of, noting that cheese moves right from the hands of a cheesemaker to consumers.

Pehl is proud of his cheesemaking career. "It really is a career, and a rewarding career, anybody in the business knows it is a lot of work but there is never a dull moment in this busy industry."



Mike Matucheski, Sartori Cheese

Beer and cheese have more in common than their places atop the Wisconsin food pyramid. Just ask Mike Matucheski, the second Wisconsin Master cheesemaker in the class of 2011. He made both products at home long before he started his cheesemaking career at an Antigo cheese factory. Matucheski was the last worker hired by Kraft, the former owners of the plant. He stayed through the years of Antigo Cheese and is now working for the current owners, Sartori Cheese. As a kid, Matucheski was one who would try any kind of cheese his parents offered to him. Now, after eighteen years of making cheese in Antigo, Wisconsin he is still experimenting with cheese, both tasting it and making it. Award winning cheeses, from basil and olive oil asiago to Sartori Reserve® Black Pepper BellaVitano® and including the ever popular Sartori Reserve® SarVecchio® Parmesan continue to emerge from the creative vats of the Sartori Company.

Masters earning certification for additional cheeses:

Bruce Workman, Edelweiss Creamery
2011 Certified in brick and muenster

Steve Stettler, Decatur Dairy
2011 Certified in swiss style cheese



Do you want to be a Master Cheesemaker?

Applications due May 13, 2011, Contact Marianne Smukowski for information:
msmuk@cdr.wisc.edu or 608-265-6346

News from CDR

New director of the Wisconsin Center for Dairy Research (CDR): John Lucey, professor of Food Science

Effective March 1, 2011. John Lucey, professor of Food Science, University of Wisconsin-Madison, has been named Director of the Wisconsin Center for Dairy Research (CDR).

Lucey joined the UW-Madison Food Science department in 1999. Over the past 20 years he has worked in food science departments or research centers in four different countries, (Ireland, the Netherlands, New Zealand, and the US) each with a strong dairy foods emphasis. Lucey's research interests cover a wide range of dairy technology and products including cheese texture/chemistry, gelation of milk, cultured products like yogurt, and the production/functionality of milk protein ingredients. In 2001 he received the American Dairy Science Association (ADSA) Foundation Scholar award, and in 2005 the DSM award for Cheese and Cultured Products Research from ADSA.



No stranger to CDR and the industry it supports, Lucey has been a member of the CDR Industry Team since he joined the Food Science department in 1999; has been a contributor to numerous short courses conducted by the Center; and collaborates on research projects with many of the scientists and staff at CDR. In addition, he has run a large research group; has been awarded more than \$3 million in competitive grants; and has published nearly 100 peer-reviewed articles and 20 book chapters.

Looking forward to this new position in CDR, Lucey shares, "The staff at CDR has played a critical role in the development of a vibrant dairy industry in Wisconsin as well as in the US. I will strive to ensure that the CDR continues to have a major impact on our dairy industry, especially in an increasingly complex and challenging environment."

Join us in La Crosse

Join us in La Crosse at the 2011 Wisconsin Cheese Industry Conference, co-sponsored by CDR and the Wisconsin Cheese Makers Association (WCMA), April 13-14. This year CDR is presenting two concurrent sessions on Wednesday morning, followed by new CDR Director John Lucey's presentation at 11 a.m. According to Dean Sommer, CDR decided the split session approach was the only option. "We have some great projects to talk about and concurrent sessions allow us to present complete and thorough reviews of our work in both dairy ingredients and cheese research."

8:30–10:30 a.m.

Session A: Dairy Ingredients

KJ Burrington, Moderator

Combined native whey and casein concentrate production, Dr. John Lucey

Conjugation of whey protein for heat stability
Dr. Srinivasan Damodaran

Pro-cream and DLP blends as an ingredient for various food product applications, Rajesh Bund

Session B: Cheese

Dean Sommer, Moderator

Health & Wellness is still top of mind – Learn about current CDR and Food Science research projects, Dr. Rani Govindasamy-Lucey

Current issues related to cheese defects, Dr. Mark Johnson

Food Safety – what's ahead and what does it mean for cheese makers, Marianne Smukowski

New technology in cheese manufacturing,
John Jaeggi



Curd Clinic

Q. I have been hearing a lot more about SSOPs, or Sanitation Standard Operating Procedures. While I realize HACCP plans and quality control systems are essential in a modern cheese plant does my modest cheese plant really need a SSOP?

A. Yes, I think you do need to develop Sanitation Standard Operating Procedures for your plant. Proper cleaning and sanitation is just as important as the taste, smell, and look of your cheese, something I know you pay attention to. Allan Ver Voort, Ecolab Food and Beverage, notes that cheesemakers follow make schedules, or recipes, for cheesemaking and they should think of SSOP's as a plant specific "recipe for protecting the quality of cheese." Don't forget that SSOP's are a prerequisite, and a supporting document, for your HACCP plan.

"You should pay particular attention to the following four cleaning factors: concentration, timing, temperature and mechanical action."

SSOP's, developed correctly, clearly list step-by-step instructions for all product contact equipment as well as environmental surfaces in the plant. You should pay particular attention to the following four cleaning factors: concentration, timing, temperature and mechanical action. Thus, you need to spell out the concentration of cleaner needed, including how to mix it. Timing is important, for example you need to note how much time equipment is in contact with the cleaner. Temperature is another crucial factor since certain types of cleaners work better at a specific temp. Remember that temperature control is crucial for clean in place (CIP) systems because it affects the ability of the cleaner to keep minerals, fats and proteins in solution for removal. When the wash temperature cools it allows those components drop out of solution, effectively leaving equipment dirtier after cleaning. The fourth factor is mechanical action, referring to manual cleaning (ie elbow grease) or mechanical flow (CIP). The directions need to be thorough, concise, and so clear that someone could walk in off the street and follow them.



As noted by master cheesemaker Tim Pehl earlier in this issue, quality control in plants producing food is more important than ever before. Sanitation is no longer a chore that the newest hire takes care of; it is an essential element in the battle to keep pathogens out of both plant and product. In addition, SSOP's help you protect product quality by controlling nonpathogens that can shorten the shelf-life of your cheese and undermine your ability to produce a uniform product.

So, do small and medium sized plants need SSOP's as much as the big guys? Yes. Even though many small artisan cheesemakers operate a one-person cheese room it is still a good idea to develop SSOP's. What if you got sick or had an accident and suddenly needed help? It would be a lot easier to have the directions for cleaning and sanitizing your vat already in place. Most large

plants employ a lead sanitarian who develops SSOP's, is familiar with GMP's and is in charge of the HACCP plan and able to train employees and follow up with any quality issues.

SSOP's are crucial for medium sized cheese plants. In the past, many workers regarded sanitation as a chore, and it is natural for humans to tend to take short cuts over time. Ver Voort refers to this tendency as "free-lancing."

"If every employee does it their own way, then there is no right way," he observes.

Although it is challenging to keep SSOP's up to date and they are difficult to enforce, you will be glad you did when you are going through an audit and your SSOP is pulled out to follow along while auditors watch a worker do it the right way.

Small, medium or large, every cheesemaking facility should have Sanitation Standard Operating Procedures in place. 



Calendar

continued from back page

July 10-14, American Dairy Science Association (ADSA)/ ASAS, Annual Meeting, New Orleans, Louisiana

August 3-6 American Cheese Society (ACS), Annual Meeting, Montreal, Canada

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Calendar

April 13-14, Wisconsin Cheese Industry Conference, co-sponsored by Wisconsin Cheese Makers Association (WCMA) and the Wisconsin Center for Dairy Research (WCDR), La Crosse, WI ☺

April 25 to 27, American Dairy Products Institute (ADPI) and American Butter Institute (ABI) Annual Conference, Chicago, IL

May 1-5, The World of Cheese from Pasture to Plate ☺

May 10, Cleaning and Sanitation ☺

May 11, HACCP ☺

May 17-18, Applied Dairy Chemistry ☺

June 7-9, Cheese Grading Short Course ☺

June 11-14 Institute of Food Technologists (IFT) Annual Meeting, New Orleans, Louisiana

June 21-22, Basic Dairy Laboratory Techniques Workshop ☺

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