Wisconsin Center for Dairy Research

DAIRY PIPELINE

A TECHNICAL RESOURCE FOR DAIRY MANUFACTURERS

VOLUME 22 NUMBER 2, 2010

Reports describe global dairy contribution to green house gases

By Franco X. Milani, associate professor, Department of Food Science, University of Wisconsin—Madison

If you pay attention to the popular press you may have noticed that cows, both beef and dairy, regularly appear in articles chronicling their purported contributions to anthropogenic (man-made) green house gases (GHG). Just how much green house gas does the dairy industry, as well as other animal agriculture, put out into the world? In an attempt to answer this question, the Food and Agriculture Organization (FAO) of the United Nations in 2006 produced a lengthy report titled "Livestock's Long Shadow". It summarized the environmental impact that animal agriculture has on water use, wastewater generation, biodiversity, land use changes, as well as green house gases. The top line message from that report concluded that all animal agriculture contributes 18% of global green house gases. Surprisingly, this was larger than the 14% contribution from global transportation. FAO has since acknowledged that the numbers may not be a fair comparison. The definition of the livestock sector and its potential for producing GHGs was far more comprehensive than the definition used for the transportation sector.

In an effort to get a true benchmark for dairy, the International Dairy Federation, along with groups such as Sustainable Agriculture Initiative (SAI) and Global Dairy Platform (GDP), teamed up with FAO to conduct research specifically on dairy which resulted in a published report earlier this year titled "Green House Gas Emissions from the Dairy Sector." Using current information from dairy production and environmental research, the report details information explaining how dairy contributes GHG, concluding that the world dairy sector contributes 2.7% of all GHG. If you include the meat from dairy, that is meat from cows, then dairy accounts for 4.0% of all GHG. Given that dairy is a single food segment, this is a significant number. However, since the data was derived from many sources, the authors estimate the certainty to be +/- 26%.

To describe where and why the dairy industry generates green house gases the report focuses on a functional unit that can be compared across sectors. In this case, milk output per cow is important so the functional unit is the amount of GHG generated relative to a unit of milk, typically expressed as kg CO_2-equivalents per kg fat and protein corrected milk, abbreviated kg CO_2-eq per kg FPCM. The authors used the term CO_2 equivalents because other gases, such as methane and nitrous oxide, are converted into equivalent amount

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What's Inside:

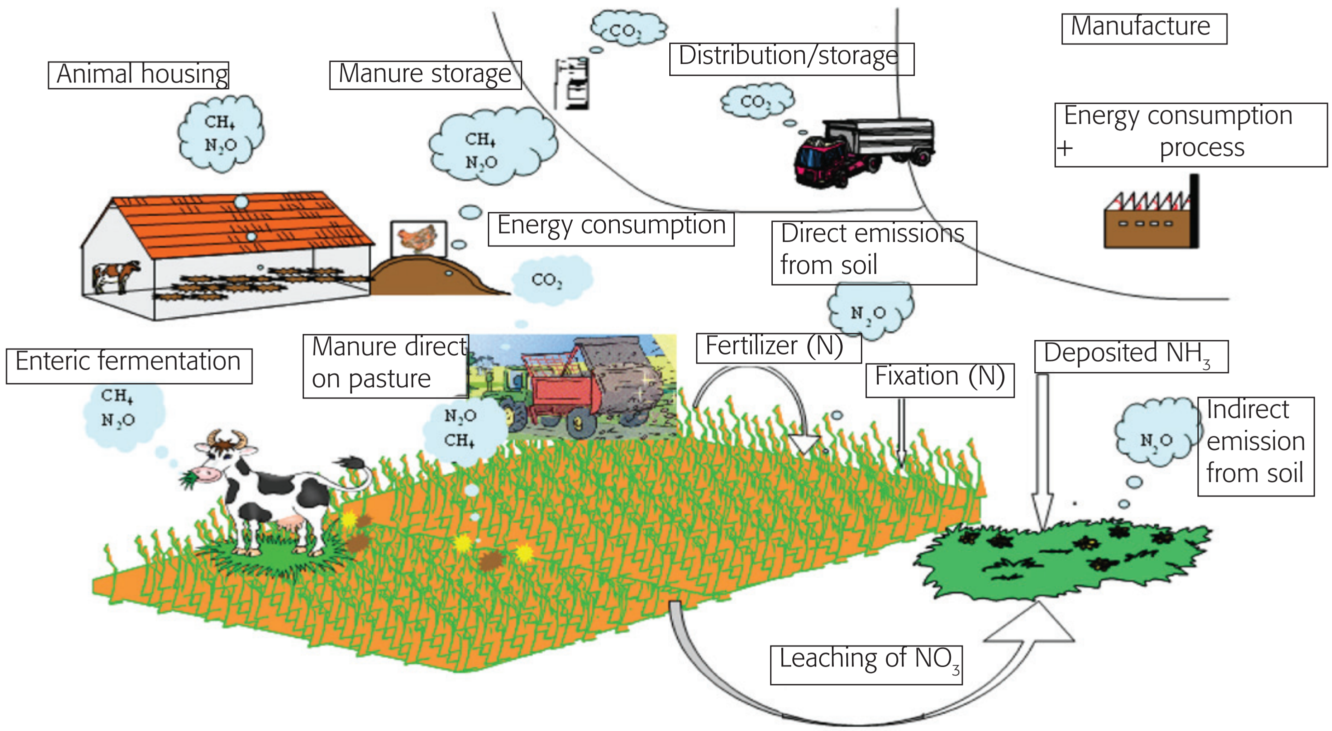

Figure 1. Green house gases and food production, reprinted courtesy of International Dairy Federation.

What is the dairy sector doing about green house gas emissions?

The global dairy sector has already implemented a significant number of initiatives to mitigate GHG emissions. Groups such as the International Dairy Federation, of which CDR is an active member, have worked to develop a Green Paper that captures specific actions implemented in a number of key areas to address the environmental impact on climate change. It is an online catalogue of initiatives and improvements already made and those in progress as evidence of the diary sector's commitment to change. You can review more than 270 case studies via the International Dairy Federation (IDF) Dairy Sustainability website, a transparent portal that shares best practices and actions taken by the global dairy sector (http://www.dairy-sustainability-initiative.org)

Some examples:

- Supporting research globally into methods for reducing the methane and nitrous oxide emissions from farming operations

- Developing new technologies to improve energy efficiency on farms, particularly in relation to milk cooling, hot water production, milking equipment, and water pumping as well as using renewable energy supplies on farm and in manufacturing plants

- Increasing the efficiency of fertilizer use to reduce nitrous oxide emissions

- Developing wastewater treatment technologies that capture methane from waste and use the methane as an energy source

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of CO_2 to simplify the metric. For example, one kg of methane is equivalent to about 21 kg of CO_2. To illustrate the importance of milk output per cow, the most industrialized parts of the world have a GHG range of about 1 to 2 kg CO_2-eq per kg FPCM at the farm gate. In contrast, sub-Saharan Africa has about 7.5 kg CO2-eq per kg FPCM. It is well known that milk output per cow from these two regions is vastly different because heat stress and the lower quality diets of arid regions decrease milk output.

Another fascinating finding from the report focuses on the part of the food chain where CO_2 is generated. A food chain is a series of distinct operations called unit processes; you could select operations from growing the feed, rearing the cattle, raw milk transportation, processing and packaging, retail distribution, to the final consumption of the milk. For the world, the authors reported that an average of 93% of the total GHG from dairy is attributed to on-farm sources—the GHG associated with growing crops and raising cattle. This contrasts to what many people intuitively believe, that most of the GHG associated with dairy is generated when milk is processed, transported and delivered to your table. Surprisingly, the majority of the on-farm GHG is from methane that escapes from the rumen of the cow. As you might guess, trying to reduce production of methane from the cow, while maintaining productivity, is a very active research area. (See below for related article.)

Surprisingly, the majority of the on-farm GHG is from methane that escapes from the rumen of the cow.

The amount of GHG from processing milk products varies a lot, mostly due to the wide range of energy input associated with each product type. An example from the report focuses on processing European milk products. The report lists an average total GHG emission of 0.155 kg CO_2-eq per kg FPCM, starting from the farm gate through retail sale. That total could be broken down to 0.086 kg CO_2-eq per kg FPCM was due to processing, 0.038 kg CO_2-eq per kg FPCM was due to packaging, and 0.030 was due to transportation. They did not include the GHG generated due to the consumer transport to buy the product, storage of the product (home refrigeration), waste of the product, and the disposal of the

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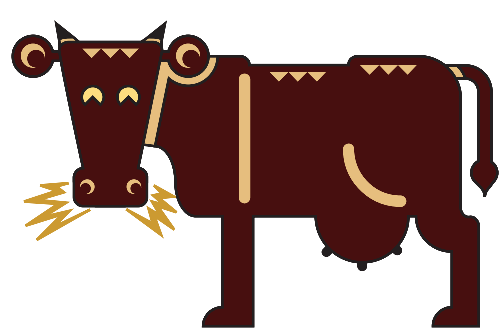
Measuring methane on the farm

Some city slickers think that the idea of cows contributing to climate change is so ludicrous that it is just one more reason to laugh off the whole issue. But it is true that ruminants release methane, a gas that is 21 times more potent than CO_2 (carbon dioxide) in warming the atmosphere. Cows are foregut fermenters, unlike us—we are hindgut fermenters. For cows, this means gases are released by breathing. (You can guess what it means for humans.) A cow can have up to 200 pounds of grass fermenting in that foregut, producing hydrogen gas during the process. Microbes then turn it into methane, which is released into the atmosphere.

Researchers in Argentina, a country that has more than 55 million cows, were surprised to find that a 1200 pound cow produces between 200 to 265 gallons of emissions. That seems to be on the high side and the numbers do vary; some scientists measured the amount at 26 to 53 gallons on average, others suggest it can be up to 132 gallons per day per cow.

As you can imagine, collecting gas burped up by a cow is not an easy task. Thus, a variety of techniques have been developed to measure bovine methane, including enclosed rooms, hoods, masks, plastic backpacks, and a new laser technology device called a Burp O-meter. The latter was used on English cows in a study comparing the effect of when and how cows are fed on emissions.
Editor



Green house gases

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packaging. Since there is such a wide variation in consumer behavior the authors decided not to include that information in the study. Packaging solid waste is another issue, since some packaging is more likely to be recycled than others. Currently, a large percentage of packaging is landfilled, producing methane as the paper or plastic degrades in the ground.

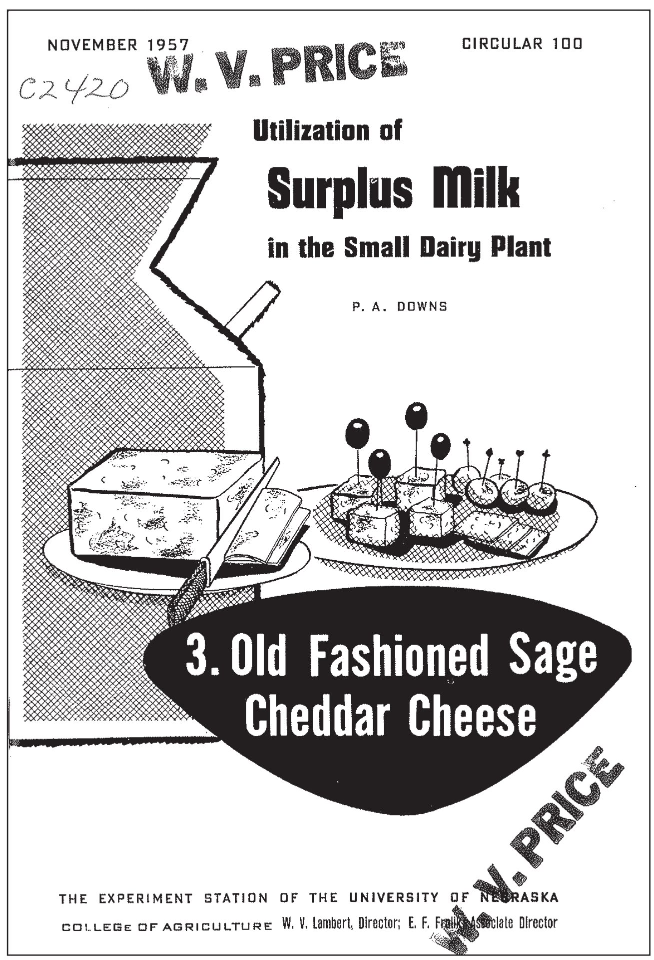
In summary, this study is important because it not only adds essential information about environmental issues in our industry, allowing systematic interpretation and science-based choices as we look at areas to improve, but provides a benchmark for us to use as we work to reduce GHGs. And, although dairy products are associated with significant amounts of GHG when compared to other foods, it's important to remind consumers that the uniqueness, desirability, economic value and high degree of nutrition still make dairy products a very compelling food source.

Website for "Green House Gas Emissions from the Dairy Sector": http://www.fao.org/agriculture/lead/themes0/climate/emissions/en/

Website for "Livestock's Long Shadow": http://www.fao.org/docrep/010/a0701e/a0701e00.htm

From the Archives

Anyone who has visited Babcock Hall in the last few months knows that this aging building is undergoing some renovation. We have pitched old glassware, purged filing cabinets and stirred up a lot of dust. But we have also found some interesting photos and a slew of articles saved by Walter V. Price. Although cheese itself goes far back in the history of humans, the history of the science of cheesemaking doesn't go nearly as far. When we read these old extension bulletins, early research papers and talks given at the Wisconsin Cheesemakers annual meetings we are always struck by the familiarity of the issues. We think some of the publications we found might be interesting to the readers of the Dairy Pipeline so expect to see more of them in the future issues. We'll start with this one, an introduction to Walter V. Price. I did not get a chance to meet him, he had retired from the university years before I arrived and he died in 1995 at the age of 99. Mark Johnson met him though, and he remembers that Dr. Price didn't need anything but a piece of hot iron to measure pH accurately.
Editor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Surplus Milk
in the Small Dairy Plant
P. A. DOWNS
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Autobiography of Walter V. Price

Price, Walter V. (Walter Van) 1896-1995

I was born in Schenectady, New York, in 1896. All of my schooling was in New York State, including University training at Cornell. My graduate studies were completed at Cornell University where I earned the degree of Doctor Philosophy in 1925.

Walter V. Price, sitting at his desk in Babcock Hall

After serving in the Navy during the First World War, I was hired in 1919 as an Assistant to work at Cornell with Professor W. W. Fisk, who at that time was well known as an author of textbooks on cheese making and ice cream making. My first assignment was to give a laboratory examination in cheese making to a captain in the Marine Corps. Remembering some previous contacts with Marines when I was a cove passer in the Navy, I was greatly tempted on general principles to flunk this Marine. I didn't, and this may account for the fact that I was eventually promoted to a professorship at Cornell, which I left in 1929 to come to the University of Wisconsin under Dean H. L. Russell, and my old associate, Dr. H. C. Jackson. They urged me to choose any subject in the dairy field for research, and then proceeded to raise so many questions about cheese that they left little or no time for anything else.

Since the 1919 episode with the Marine, I have been teaching continuously except for one or two brief excursions into commercial work. I suppose about 2, 000 students at Wisconsin and Cornell have yawned through my lectures, perspired in my laboratories, and damned my examinations in the past 44 years. But some of these men are cherished friends to this day. Now a new student may tell me that his dad took work with me years ago. It's wonderful to have known all these men, but it's tough when a 250 pound oldster asks, "Remember me?" and then turns out to be that 125 pound youngster who could hardly swing a floor brush in my class of 25 years ago.

With the help of many good men who have teamed up with me in our research program, we have published about 60 scientific papers, given about the same number of talks to scientific groups, written about half as many bulletins, and about double that number of articles for trade papers. I've even managed to write a textbook on cheese after being coached by Dr. L. L. VanSlyke, who had done so much for the cheese industry in the early years of the 1900's. These activities probably explain why the American Association for the Advancement of Science elected me a fellow in 1931, and why the American Dairy Science Association gave me the Borden Award in 1950, and the first Paul-Lewis Award in 1959. Perhaps these activities also influenced some of the members of this Association who elected me a Director and later a President.

In professional work I find it necessary to be a member of the American Chemical Society, the American Association for the Advancement of Science, the International Association of Milk and Food Sanitarians, as well as the American Dairy Science Association. I am proud to have been elected to the Honor Societies of Sigma Xi and Phi Kappa Phi.

It is a pleasure to report that I have been most happily married for 42 years and that I have two daughters and seven grandchildren.

"Further, deponent saith not."

Research Update

Probiotics remains a

by Karen Paulus, editor

We use their machinery, their genes, to accomplish some of these tasks, in fact scientists suspect that we evolved together.

Jim Steele, professor of Food Science at University of Wisconsin—Madison, admits to once being skeptical about probiotics. However, he has changed his mind after the publication of a number of double blind, placebo controlled studies demonstrated the marked effect that probiotics can have on the immune system and human digestive health. In fact, he takes a daily dose of probiotics. (Although that may also be influenced by his wife's role as the global business director of probiotics at the food ingredient company Danisco.)

The word probiotic was derived from Greek, meaning "for life." But probiotics also have an official definition, they are "Live microorganisms which when administered in adequate amounts confer a health benefit on the host." (Reid et al, 2003) This sounds good at first, but the official definition underscores some of the major issues associated with probiotics. For example, which live microorganisms confer which health benefits? And what is an adequate amount of a probiotic? Does it make a difference if they are delivered via dairy products?

Examining microbial communities

Probiotics is an active area for researchers, in fact, 9 of the top 25 articles in the Journal of Dairy Science (from January to March, 2010) focused on probiotics. But this is only a small segment of a very active area of biology. Fueled by technical advances, the entire field of microbiology has shifted from looking at individual microbes to examining microbial communities. The National Institute of Health (NIH) developed the Human Microbiome Project (HMP) in 2007 to examine microbial communities associated with humans. A team of scientists is gathering microbial samples from 18 sites on 300 volunteers; the researchers plan to sequence the entire genome of the microbes, over 900 and counting.

To understand the complexity and variety of human microbe interaction try looking at it from the microbe perspective. The very competitive realm they live in forces adaptation, some microbes are generalists and can thrive many places, others are very unique, not just colonizing the mouth, but seeking a specific ecosystem provided by tonsils. They need us as much as we need them; we provide the ecosystem and they stimulate our immune systems, allow us to digest plants, and even send signals that our cells respond to. We use their machinery, their genes, to accomplish some of these tasks, in fact scientists suspect that we evolved together. The gastrointestinal tract (GIT) is one of the busier sites where

n active research area

microbes reproduce and intermingle. Because of the exposure to many potential pathogens from food and water, factors that influence a pathogens ability to colonize the GIT are critical. Additionally, the GIT is a prominent part of the human immune system and it's interaction with the gut microbiota is thought to play a critical role in modulating its activity. Therefore, the ingestion of probiotics can have a wide range of health impacts. It is likely that probiotics work through a variety of mechanisms; scientists have been able to demonstrate that one particular *Lactobacillus* contributes by producing bacteriocins, small anti-bacterial peptides, that protect mice from *Listeria monocytogenes.* (Corr et al.) Other scientists are evaluating the possibility that some probiotics influence gene expression in pathogens, others secrete factors that protect the gut lining, and still others prevent pathogens from reproducing. All of these possibilities are active areas of study.

The gastrointestinal tract (GIT) is a prominent part of the human immune system.

In addition to GIT health issues, many people take probiotics for immune related health outcomes, such as immunopotentiation (resistance to colds and flu) or anti-inflammatory effects. Studies looking at these issues seem to back them up, although sometimes the effects are small. For example, a Danisco funded study of Chinese school children demonstrated that two types of probiotics were more effective than a placebo in reducing coughing, fevers, and days missing from school due to cold and flu symptoms. (Leyer et al. 2009)

Why dairy?

According to Steele, the market for probiotics in food is dominated by dairy. Yogurt is the main product, but you can find probiotics in milk, fermented drinks and even ice cream. A common probiotic, *Lactobacillus acidophius*, is found in 80% of yogurt in the US because of it's ability to grow during product manufacture and survive processing and storage. In addition, dairy products offer a natural buffer (calcium phosphate), which can protect probiotics during passage through stomach acids.

Regulatory

Here in the United States food claims, like the ones seen on some yogurts touting the benefits of probiotics, must follow regulations. However, our regulations can be confusing. Some fall in the category of drug claims, some are health claims and currently there are no approved health claims for probiotics. (See Usprobiotics.org for more info.)

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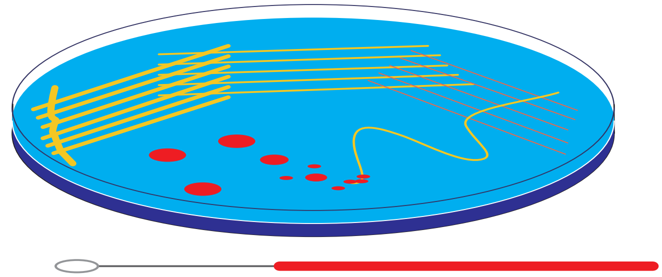
Supplements are a different story, and you can find miraculous cures for just about everything on the internet; that is if you are willing to pay for it. In Europe, the European Food Safety Authority (EFSA) is assessing the science behind health claims before allowing them. EFSA's responses to date indicate that they will be requiring strong clinical evidence before approving any health claims. So far, EFSA has not approved any immune or gut health claims for probiotic yogurt.



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Usprobiotics.org

News from CDR

New on CDR's website—A Comprehensive Guide for Cheesemakers

Occasionally we develop targeted articles that are a bit too long for our newsletter but we think cheesemakers will find them useful. Thus we are collecting a series titled Comprehensive Guides for Cheesemakers. Bill Wendorff starts out the series with an article on smoked cheese, and now he has compiled another one focusing on brining cheese. We made a place for them on our website and you can link to both articles through CDR's home page, www.cdr.wisc.edu

Below, CDR folks Dana Wolle and Susan Larson at IFT in Chicago

Above, Protein packed "Breakfast Bite"

IFT 2010

The Institute of Food Technologist Annual Convention and Food Show is a great opportunity to display dairy as a premiere ingredient to our key target audiences, and this year proved to be no exception. Held July 17-20, 2010 at McCormick Place in Chicago, the Wisconsin Center for Dairy Research (CDR) teamed up with the United States Dairy Export Council (USDEC), formerly Dairy Management Inc., to showcase the value-added health benefits of dairy ingredients.

Led by K.J. Burrington, the CDR Dairy Ingredients group developed three prototypes highlighting the nutritional punch dairy ingredients deliver. Susan Larson's warm "breakfast bite" (shown below, left) features 40% less sodium and delivers 70% more protein than similar products, and tastes great. Filled with cheddar cheese, egg, peppers and onion, it is a very satisfying and convenient breakfast to take on the run.

For those craving a frozen snack as an alternative to the common snack bar, Dana Wolle developed the "protein chiller", providing an excellent source of protein (12g) and calcium (265mg). Reminiscent to the beloved Fudgesicle®, the frozen chocolate treat on a stick yields just 120 calories and three grams of fat.

Hungry for grandma's coconut cream pie? Appealing to consumer's traditional love of dairy, Sarah Minasian developed a coconut cream tartlet featuring whole milk, heavy cream and butter. Garnished with a dollop of whipped cream and toasted coconut, the miniature cream pie suggests indulgence in bite-size moderation is responsibly healthy. Additionally, the Dairy Ingredients team worked with two other dairy manufacturers allowing them to display the versatility and reduced sodium content application benefits of whey permeate in their booths. Applications included buttery tart cherry scones, sweet cranberry-orange muffins, and according to Minasian, the "can't stop eating" BBQ popcorn seasoning. As a result of this collaborative effort, both companies received many requests for additional information and samples, and feel CDR's contribution was crucial for educating the industry on applications for whey permeate.

Curd Clinic

Curd clinic doctor for this issue is John Jaeggi, coordinator of CDR's cheese industry and applications program

Q. I was in the audience at the International Cheese Technology Expo held in Madison, WI last April. During a presentation on producing low sodium cheese the speaker mentioned that it was better to measure the sodium in cheese, instead of the salt. How do you measure sodium and why do you do it?

A. Most cheesemakers use one of several common instruments that analyzes chloride to come up with a measurement of salt, or sodium chloride (NaCl). However, when you use this method you are also measuring the potassium chloride (KCl) in your sample since the instrument only measures chloride. So if you assume it is all from NaCl then you are inflating the amount of sodium in your cheese.

Table 1.

Minerals		Example- (mg/100g cheese)
B 182.577	(boron)	72.94
Bi 190.171	(bismuth)	ND
Ca 422.673	(calcium)	890.47
Cu 327.395	(copper)	ND
Fe 261.187	(iron)	ND
K 769.897	(potassium)	139.12
Mg 285.213	(magnesium)	29.20
Mn 260.568	(manganese)	ND
Na 588.995	(sodium)	674.64
P 177.434	(phosphorus)	616.78
S 181.972	(sulphur)	316.41

How do you get around this issue? I recommend measuring the chloride and also getting a mineral analysis on the same cheese to get the real content of sodium. (See Table 1. for typical results.) You don't have to do this every time, only in the initial development. Remember, to make a low sodium cheese you need to reduce the sodium content of your regular cheese by 25%.

When you are satisfied with your low sodium cheese do another mineral analysis and test the chloride. Now you have the real value of sodium in your cheese and you know how it relates to the chloride results. With this information you can go back to measuring chloride, comparing it to your "standard" values that also tell you the relative sodium level. If you are using a NaCl/KCl blend in your product, remember that a chloride analyzer provides the total chloride for the blend, with no way to determine sodium.

The chemistry behind measuring NaCL was also covered in an earlier Curd Clinic, Volume 14, No. 2, available on our website:

www.cdr.wisc.edu/newsletter/2002_issues

Artisan short course filling fast

This is your chance to learn how to make quark, kefir, kasseri, graveria, or mizithra.

We still have a few places available in our next short course, Cheeses and Fermented Milks of the Eastern Mediterranean. This is your chance to learn how to make quark, kefir, kasseri, graveria, or mizithra. Instructors include Dr. Samir Kalit from the University of Zagreb, Republic of Croatia, and Dr. Golfo Moatsou, from the Agricultural University in Athens, Greece. A culinary session will focus on the functional characteristics of the cheeses as well as cheese applications in Eastern Mediterranean foods. Contact John Jaeggi for information, (608) 262-2264 or Jaeggi@cdr.wisc.edu or you can register by contacting www.cals.wisc.edu

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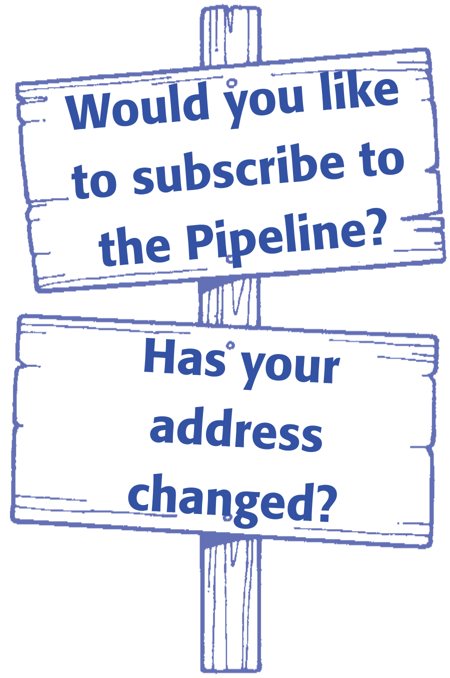
Calendar

To register: www.cals.wisc.edu/ccs/Current Programs.html

October 26-28 National Milk Producers Federation/ Dairy Management Inc Annual Meeting, Reno, NV.

November 3-4 Cheese Grading and Evaluation short course, Madison, WI. www.cdr.wisc.edu/shortcourses; To register: www.cals.wisc.edu/ccs/Current Programs.html

November 8 – 11 International Dairy Federation World Dairy Summit, Auckland, NZ. www.wds2010.com



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Calendar

August 25 – 28 American Cheese Society, Seattle, WA. www.cheesesociety.org

September 13-15 International Dairy Show, Dallas, TX. www.dairyshow.com

September 21-23 Cheeses of the Eastern Mediterranean short course, Madison, WI. www.cdr.wisc.edu/shortcourses/eastern_mediterranean_10.html ;
To register: www.cals.wisc.edu/ccs/Current Programs.html

September 28 – October 2 World Dairy Expo, Madison, WI. www.world-dairy-expo.com

October 4-8 Cheese Technology short course, Madison, WI www.cdr.wisc.edu/shortcourses/cheese_tech.html ;
To register: www.cals.wisc.edu/ccs/Current Programs.html

October 26-27 Dairy Ingredient Manufacturing short course, Madison, WI. www.cdr.wisc.edu/shortcourses/dairy_ingredient_manufacture.html

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