

DAIRY PIPELINE

A Technical Resource for Dairy Manufacturers

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Confronting the challenge of low salt cheese

By Mark Johnson and Karen Paulus

That first zingy bite of a potato chip might lead you to think you are eating one of the saltiest foods you could get your hands on. But you aren't. Canned soups, pizza, and fast-food hamburgers can pack an even bigger wallop of sodium chloride per serving. And most cheeses, cheddar for example, are no lightweights in the low salt scuffle.

Sodium chloride, or NaCl, has gotten more attention since the Center for Science in the Public Interest (CSPI) requested the Food and Drug Administration (FDA) to change the regulatory status of salt as well as set limits on salt in processed foods. Currently, salt is considered GRAS, or generally regarded as safe. CSPI would like to see salt regulated as a food additive. The FDA public hearings were held on November 29, 2007 with written comments accepted until March 28th, 2008. As yet, the FDA hasn't made any decisions on this issue.

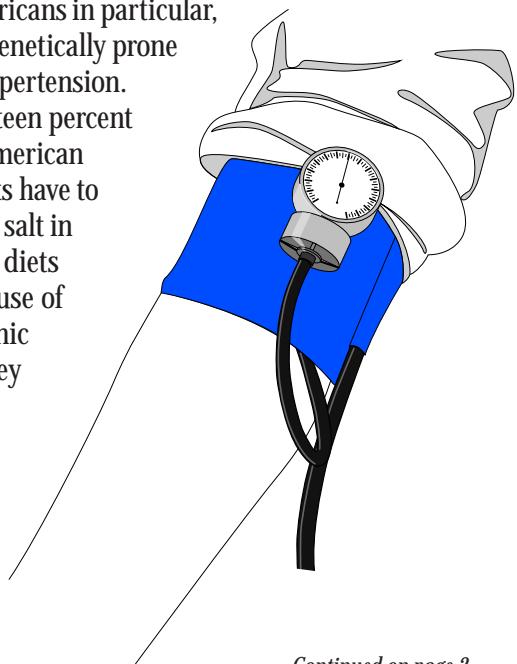
Sodium is an essential part of the diet and found naturally in many foods, including milk. It seasons food, enhances flavor, and has historically been a crucial factor in food preservation. However, as health professionals have steadily lowered the recommended daily intake of sodium, consumption has actually increased and even doubled in some age groups from the early 1970's to the mid 1990's. Currently, health professionals recommend that Americans aim for 1500 to 2400 mg of sodium per day, an amount between two thirds and one teaspoon of salt. We are actually consuming about 4000 mg per day.

This amount of salt alarms public health experts, particularly epidemiologists who tend to focus on populations rather than

individuals. Although many clinical studies have indicated an association between mean blood pressure and mean dietary sodium chloride, can we extrapolate from there to assume there is a link between a high salt diet in the general population and mortality? Many scientists make this argument but some researchers remain unconvinced. (Cohen et al, 2008) Understanding this complex issue is complicated by the confounding effects of physical activity, weight, alcohol consumption, and other dietary factors, like calcium and the influence of low potassium levels on blood pressure. Other challenges include accounting for individual genetic differences, and limiting factors like the practicality of measuring actual sodium intake in large population studies.

What we do know is that as people get older they tend to develop hypertension, kidney disease, cardiovascular disease—or all three. Some groups, African Americans in particular, are genetically prone to hypertension.

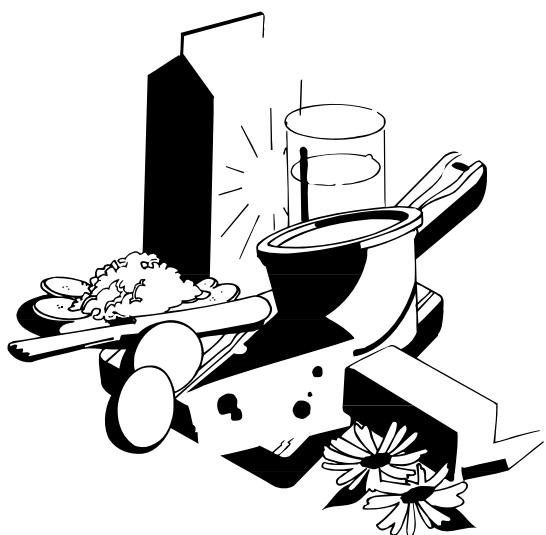
Thirteen percent of American adults have to limit salt in their diets because of chronic kidney



Continued on page 2

What's Inside:

Confronting the challenge of low salt cheese	1
Milk Markets and More	6
News from CDR	9
Curd Clinic	10

Continued from page 1

Milk is a minor source of sodium in cheese; most is added in the form of sodium chloride. Although humans have used salt to preserve food for many centuries, the main reason salt is added to cheese these days is to control and enhance flavor.

Table 1.
Approximate composition and sodium content per serving for cheese

Cheese	% moisture	% sodium chloride	mg sodium per 30 g serving
Feta	55	3.2	375
Blue	44	3.0	351
Parmesan	32	2.6	300
Muenster	43	1.8	210
Cheddar	38	1.8	210
Swiss	38	1.0	117
Fresh mozzarella	65	1.0	117
Cottage	82	1.2	430 mg per 110 g serving

disease, currently the count is 26 million people but the number is rising. According to CSPI, 65 million American adults have hypertension or high blood pressure, and 90% of us will eventually develop it. Following the DASH (Dietary Approaches to Stop Hypertension) diet, which is high in fruits, vegetables, and low fat dairy products while lowering sodium and raising potassium, is recommended for lowering blood pressure. And, of course, effective medication is also available to treat high blood pressure.

All of the groups mentioned above are watching how much salt they eat, but it is more critical for some of them. For example, people with chronic kidney or heart disease have to pay close attention to exactly how much salt they are eating, they need to count each mg. The second tier, people diagnosed with hypertension but successfully treated, are still watching the amount of sodium they eat but they have more flexible diets than the first group. The third group, health conscious people hoping to prevent hypertension, likely pay attention to sodium but they may not want to give up their favorite cheese. Given that the bulge of baby boomers is aging into the decades where hypertension appears (over 50 for men and over 60 for women), it might be useful to take a look at the issue of sodium chloride in cheese. After all, we are talking about a huge market!

Milk is a minor source of sodium

Milk is a minor source of sodium in cheese; most is added in the form of sodium chloride. Although humans have used salt to preserve food for many centuries, the main reason salt is added to cheese these days is to control and enhance flavor.

The degree of saltiness observed in any food is a learned or conditioned behavior and we have become accustomed to the idea that certain foods have salty flavor notes. In fact, there is a line item on the USDA cheese grading scorecard for the cheese grader to assess the salt contribution to the overall flavor of the cheese—is it too high or too low? There are no federal standards of identity for

salt content of any cheese (other than specifics when labeling cheese reduced or low sodium). Instead the saltiness attribute is at the discretion of the grader, a judge who has extensive experience and knows what a great cheese should taste like. The cheesemaker is adding no more or no less salt than they need to produce a quality cheese.

Table 2.

Sodium free	less than 5 mg of sodium per serving
Very low sodium	35 mg or less per serving
Low sodium	140 mg or less per serving
Reduced sodium	usual sodium level is reduced by 25%
Unsalted, no salt added or without added salt	made without the salt that is normally used, but still contains the sodium that's a natural part of the food itself

The expected salt taste sensation is different for each variety of cheese but the amount of salt added is not arbitrary, indeed it has been “developed” over centuries. Sometimes the reasons aren’t obvious. For example, the salt content in cheese can control the proliferation of undesirable microorganisms while allowing for the growth and metabolism of a desirable species. Thus the high salt content of blue cheese allows for the rapid growth of the desired mold, *Penicillium roquefortii* and prevents salt sensitive microorganisms from growing and causing defects. In the case of feta, a rather high moisture cheese, salt slows the growth of undesirable microorganisms and slows proteolytic activity that would produce a soft cheese. Parmesan cheese is a low moisture, high salt cheese, and both factors are important to give it a very extended shelf-life of several years. The cheeses mentioned above are the higher salt cheeses, 2.5-3.5% salt. (See Table 1.)

Intermediate salted cheeses (1.5-1.8% salt) such as cheddar, low moisture part skim mozzarella, gouda, and muenster cheeses do not always have a dominant salty taste. But if you reduce the salt to less than 1.5% it generally gets noticed. A cheese in excess of 1.8% may taste like a cheese that is too salty. Lower salt cheeses (0.9-1.2%) such as swiss and fresh mozzarella are not expected to be salty and higher salt contents may detract or even prevent the development of the desired flavor and cheese characteristics. For example, the eyes in a swiss cheese result from the metabolism that leads to gas formation when *Propionibacterium* is added. This particular type of bacteria will not grow at higher salt levels. In fresh mozzarella, the desired delicate, milky, sweet flavors mainly come from the milk and even intermediate salt levels may add an undesirable salty note.

Cheesemakers also take advantage of the variability in salt sensitivity among bacteria when choosing a starter strain. In fact, the salt sensitivity of the acid producing cultures, or starters, necessary to produce the desired cheese dictates the amount of salt used. The extent of acid development, or the lowest pH the cheese comes to, is due to several factors: activity of acid producing cultures, the amount of sugar in the milk and

cheese, and the rate of acid development (especially the amount of acid developed prior to whey removal). The rate and extent of acid development controls the amount of colloidal calcium phosphate in the cheese, which in turn is the main buffering agent in cheese and acts to modulate the final or lowest pH of the cheese. For cheddar, the pH could be 4.9 or less with out the influence of sodium chloride on starter cultures. Why does this matter? Because a pH of 4.9 can cause defects in appearance, body and texture. (For more information regarding the effects of salt in cheese see Dairy Pipeline Vol. 17 No.1)

Making reduced sodium cheese

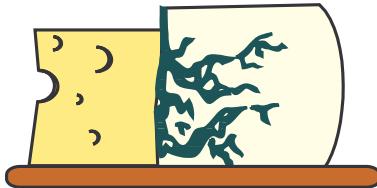
Cheesemakers have two options for adjusting the amount of sodium in cheese. Either they can use less sodium chloride or they can use salt substitutes. To meet the requirement for reduced sodium cheese, the sodium content of the cheese must be at least 25% less per serving than the reference cheese. (Table 2.) That means two things. First, the cheese company is free to set the reference amount in their cheese. However it implies that they have to establish the typical level or the salt content they usually strive for, which forces the cheesemaker to avoid artificially stating an absurdly high level that is never really used.

Second, the actual level of salt or sodium in a cheese will vary between cheese varieties and therefore may be somewhat misleading to consumers unless they read the label closely. A specified reduction in sodium content does not mean that all cheeses with that reduction contain the same amount of sodium. The label must list the actual sodium content per serving and also list the serving size. Reduced sodium cheese varieties, produced by simply adding less salt, are available. You can find reduced salt cheddar, colby, muenster, monterey jack, and swiss, with a sodium chloride level reduced by 25% to yield a range of 1.8 to 1.2% to 1.35 to 0.9% for the respective cheeses.

For some cheeses it is possible to reduce the sodium content by 25% without having a great

continued from page 3

Can you meet the requirements of a low sodium cheese—less than 0.71% salt—without compromising the expected flavor of the cheese? Probably not. Exceptions may be swiss cheese or fresh mozzarella, cheeses already low in sodium.



impact on flavor. For example, many blue veined cheeses are high salt cheeses, with typical salt contents of over 3%. A 25% reduction in salt would put the salt level at 2.25 %, a level that award-winning manufacturers of blue-veined cheeses already achieve. However, asking the manufacturers to reduce their salt further may adversely influence cheese quality.

A standard of identity exists for only two low sodium cheeses, cheddar and colby. In the case of colby it also explicitly states that sodium chloride can not be added at all. In both cheeses the low sodium definition from the CFR Chapter 21 part 133.116 (cheddar) and 133.121 (colby) states that the cheese can not contain more than 96 mg of sodium per pound of finished food. That is equivalent to 6.3 mg of sodium per serving or 10.6 mg of sodium per 50 g. In essence, this is a cheese with no added salt since milk itself contains enough natural sodium to produce a cheese with this level. The label also must include the name of any added salt substitutes if used. Some cheeses are available with this level of sodium reduction. Examples include Heluva Good Low Sodium Cheddar at 5 mg per serving and Black Diamond Cheddar Cheese and Lorraine Original Cheese both at 15 mg per serving.

The CFR Chapter 21, part 101.12 lists 30g as the serving size for most cheeses with the following exceptions, cottage (110 g), hard grating cheese such as parmesan and romano (5 g), dry cottage cheese curd and ricotta (55 g). However, the nutritional labeling requirements for low sodium foods indicate that foods with a serving size of 30 g or less must not contain more than 140 mg sodium per 50 g of that food. For most cheeses, including hard grating cheese, the amount of salt could not exceed 0.71% to meet that requirement. In the case of cottage cheese it would be 0.33%. Can you meet the requirements of a low sodium cheese—less than 0.71% salt—without compromising the expected flavor of the cheese? Probably not. Exceptions may be swiss cheese or fresh mozzarella, cheeses already low in sodium.

Is the cheese quality always compromised when reducing sodium chloride by 33% or more? For a professional cheese grader the answer would likely be yes. However for the consumer, who is looking for a cheese with less salt, the answer may be no—or at least the cheese may be acceptable even if it is not preferred. The top complaint about reduced salt cheeses is that they lack desired flavor and flavor intensity. This is an issue difficult to avoid since flavor changes are the result of adjustments that cheesemakers use to avoid excessive acidity and bitterness when they reduce the salt in cheese.

Some consumers who need to reduce their consumption of sodium promote mixing a weak-flavored low sodium cheese with a small amount of full-flavored cheese that has a typical salt content. Also, many consumers of reduced sodium cheeses like the functionality, or the melt and stretch, of the cheese and they use it as an ingredient in food, addressing the lack of flavor by adding other flavorful ingredients. Still other consumers simply reject the reduced sodium cheeses and just opt to eat less of the higher salt cheeses.

What about salt substitutes?

Using salt substitutes is another approach to reducing the sodium content of cheese and other foods. In cheese you are more likely to see salt substitutes used when the salt content is reduced more than 33%. The most popular salt substitute currently used is KCl, or potassium chloride, in a blend with NaCl. Although individual taste varies, some consumers can taste KCl if the blend includes more than 50% KCl. Using potassium chloride as a salt substitute may change in the future as new ingredients are developed that don't affect cheese quality, or more precisely, consumer acceptability. It is important to note that KCl must be included on the label since it is extremely important for people with kidney disease to know about potassium.

Does KCl cause bitterness in cheese? The answer is chemically, no. KCl gives a metallic bite to the palate, which is not the classic bitterness of caffeine or quinine. The taste is similar to the burnt

end of a match but not the sulfur smell. The bitterness response in reduced sodium cheeses with or without added KCl is in part due to the metallic note from KCl but is also in part from the more classic bitterness that is derived from hydrophobic peptides. The bitter peptides are produced from the degradation of larger peptides that are first derived from the activity of the coagulant. Consequently the bitterness most often observed in cheese—any cheese—is due to both the activity of the coagulant and the strain of starter (and its sensitivity to salt) used to develop acid during cheese making.

Safety is a factor

At a recent seminar, sponsored by the Food Research Institute, Kathy Glass addressed the role of sodium salts in the safety of ready-to-eat foods. Although salt is added to cheese to control and enhance flavor and not the sole method to control pathogen growth, it is still a factor in the multiple hurdle approach to food safety. Glass notes, “For every effort made to reduce salt levels in foods, a replacement for its antimicrobial activity needs to be considered.”

Challenges

Reducing the sodium chloride content of cheese presents particular challenges since salt has many roles in cheese. Cheesemakers use it to maintain expected flavor, body, texture, and shelf-life by controlling the activities of enzymes and microorganisms. Consumers expect some degree of saltiness in cheese but would also like a larger selection of lower sodium cheeses. A larger selection also makes sense when you consider the various motivations of cheese consumers. As mentioned earlier, people with chronic diseases have different needs than those concerned with preventing hypertension. For consumers interested in preventing hypertension, cheese has many positive nutritional attributes like minerals such as calcium and potassium, which may offset some negative contributions of sodium chloride in the diet. Consumer preference studies of lower sodium cheese have not been conducted with any of these groups.

While efforts have been made to market a table cheese, i.e. cheese eaten directly, perhaps we need to investigate using low sodium cheeses as ingredients. A look at consumer blogs indicates that people who buy low sodium cheese like to add it to meals for its functional characteristics, like melt and stretch.

Directing efforts to overcome the human behavioral response to reduced sodium products will be exceptionally challenging, especially in adults already conditioned to desire salt. Perhaps the bigger challenge will be to find funding for research into the fundamental chemistry of flavor development in the reduced sodium cheese environment, especially if the perception of the market potential is small.



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- The Salt Institute
<http://www.saltinstitute.org/>

Milk Markets and More

by Brian W. Gould, Associate Professor, Agricultural and Applied Economics University of Wisconsin—Madison

The Value of Dry Whey

The market for whey has returned to what could be considered "normal" conditions from the unprecedented prices observed for most of 2007. Figure 1 displays the dramatic changes in wholesale dry whey prices over the 2004-2008 period along with the average value since Federal Order Reform in January 2000. The extreme price conditions experienced in 2007 are clearly indicated.

The impact on the cheese industry cannot be overstated. For some, it represented a significant and positive revenue source. For other cheese manufacturers, especially those without access to whey drying facilities, these high prices actually created a financially trying situation. The primary explanation stems from the California and Federal Milk Marketing Order (FMMO) minimum milk pricing systems existing at that time. It was implicitly assumed that cheese manufacturers were able to obtain the NASS monthly dry whey prices when paying their farmer patrons. For

example, in May 2007, it was assumed the cheese plant received more than \$0.75/lb for the dry whey. However, many small cheese plants were receiving much less.

California 4b Milk Pricing and Dry Whey Contribution

The reaction to these relatively high whey prices used in pricing milk for the cheese manufacturer differed significantly. In California, the milk pricing for 4b milk (milk used for cheese manufacture) was changed effective December 1, 2007 to set a fixed net whey contribution to the non-fat solids value. The FMMO pricing system was not changed appreciably.

Figure 2 shows the current pricing system used to determine the minimum value of milk used for cheese manufacture in California. Under this pricing system, the 4b price is the sum of the fat and solids-not-fat (SNF) values. Fat value is a function of the CME butter spot price after adjusting for California's market conditions and the non-milk butter make allowance, \$0.1560. The solids-not-fat value is a function of the value of CME cheddar cheese spot price, the CME spot butter price and a fixed net whey value. For the cheese and butter components of the SNF value adjustments are made for local market conditions and the non-milk manufacture cost.

continued on page 8

Figure 1. Monthly NASS Average U.S. Dry Whey Prices

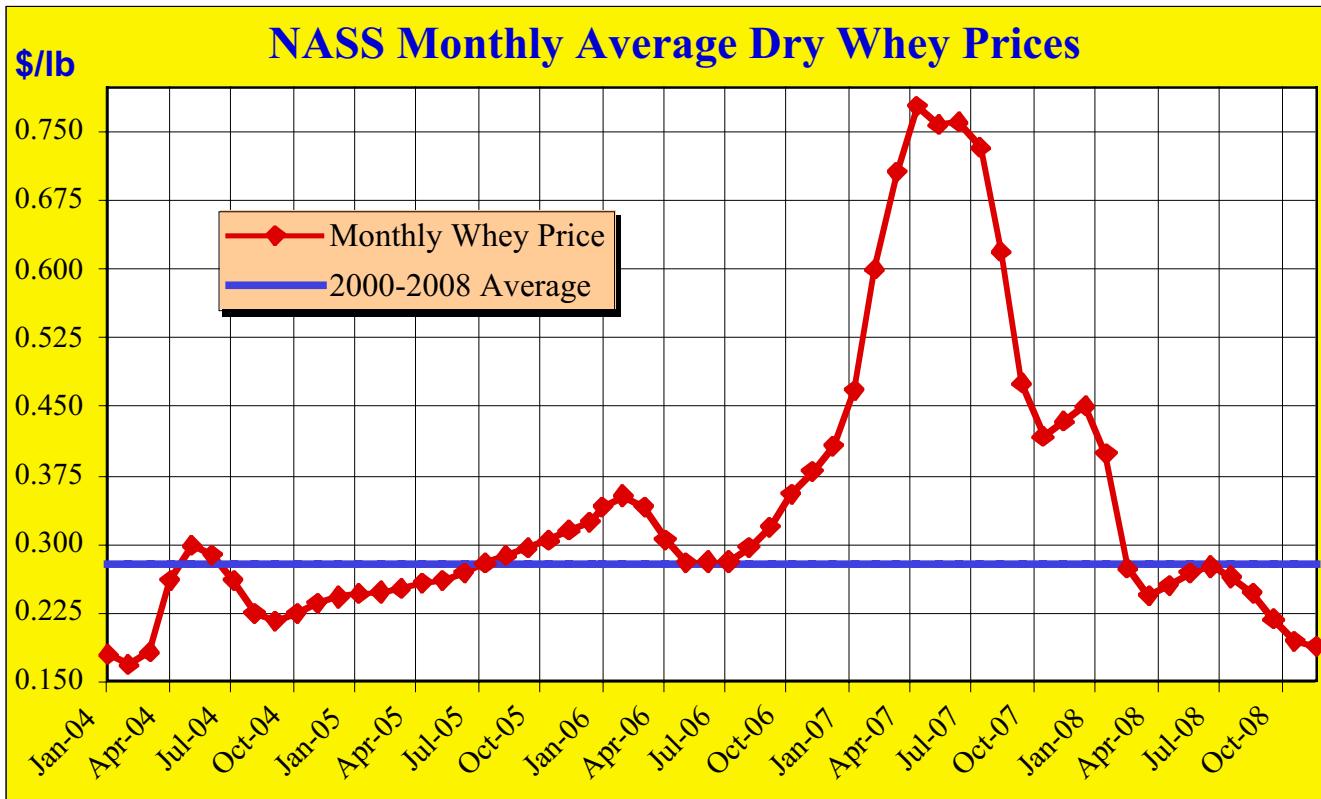
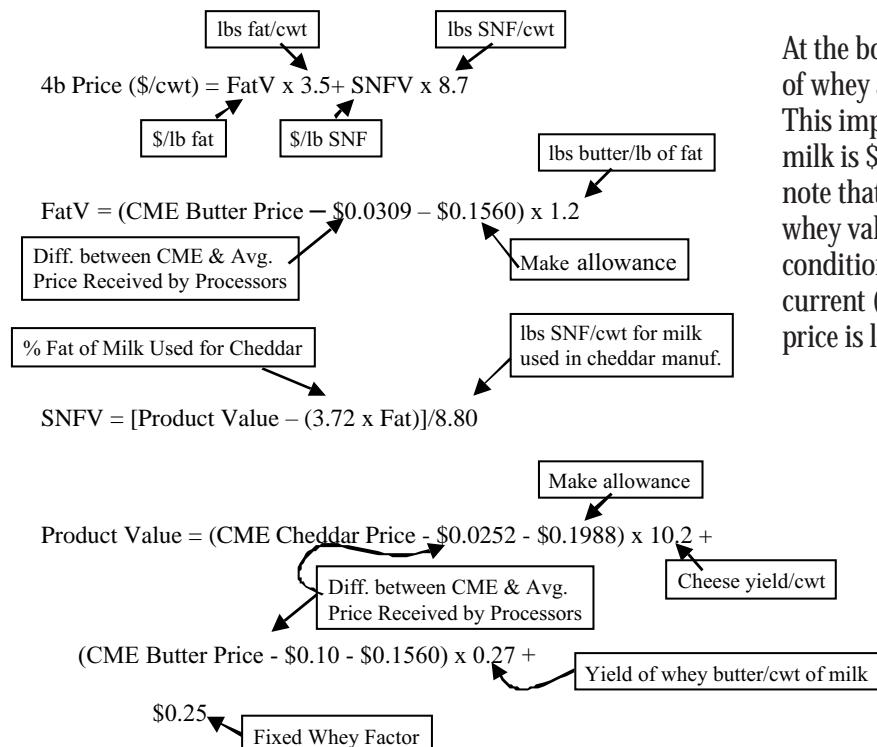


Figure 2. Current California system for setting the minimum 4b milk price

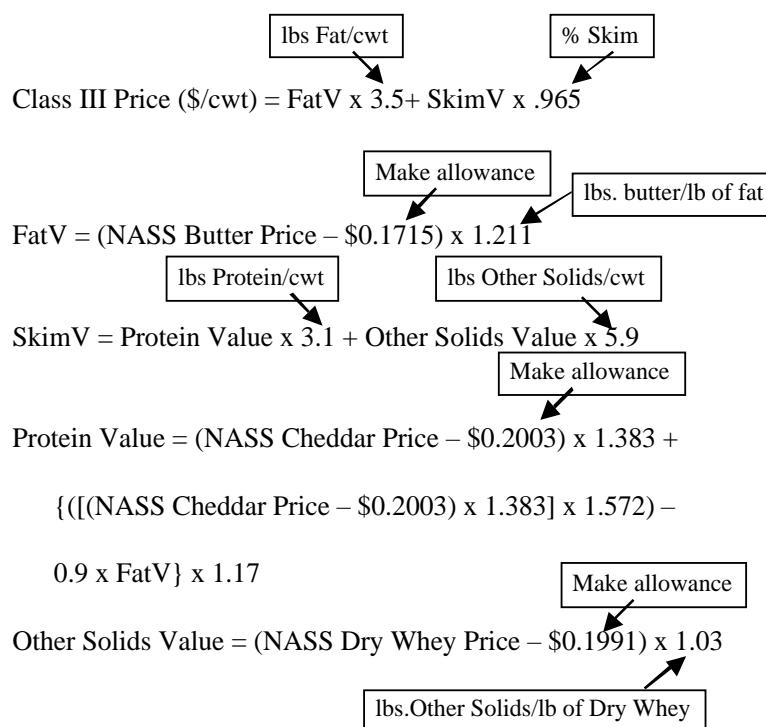
$$4b \text{ Price } (\$/\text{cwt}) = \text{FatV} \times 3.5 + \text{SNFV} \times 8.7$$



At the bottom of Figure 2 we see that the net value of whey added to the per lb SNF value is \$0.25. This implies that the net whey value per cwt of milk is $\$0.25 \times 8.7 / 8.8 = \0.247 . It is important to note that under the current structure, this net whey value does not change with market conditions. This is important given that the current (mid-December) national NASS dry whey price is less than \$0.20/lb.

Figure 3. Current FMMO system for determining Class III milk prices

$$\text{Class III Price } (\$/\text{cwt}) = \text{FatV} \times 3.5 + \text{SkimV} \times .965$$



In contrast to the California system used to value 4b milk, the valuation of Class III milk under the FMMO system is based on the fat value and the skim value of the raw milk. As shown in Figure 3, a 3.5% fat content is assumed and the skim portion represents 96.5% of the standard raw milk. The fat value is based on the monthly NASS butter price after accounting for an assumed non-milk make allowance.

continued from page 7

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Federal Class III pricing

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The skim portion of the standard milk is assumed to be composed of 3.1% true protein and 5.9% other (nonfat/non-protein) solids. The protein valuation formula is fairly complicated because it attempts to account for the value of butterfat in cheese in excess of the value of butterfat in butter. It also accounts for the fact that protein has value in cheese in addition to the direct impact on cheese yield. This added value is attributed to the fact that casein retains butterfat in cheese.¹

Dry whey prices are used to determine other solids value of Class III milk. In contrast to the California 4b milk price system, the contribution of wholesale dry whey prices to the pricing of Class III milk changes from month to month. Thus, when the NASS average monthly dry whey price is less than \$0.1991/lb, dry whey generates a negative contribution to the minimum Class III price. This has been true for the Announced Class III price for October and November 2008, although these negative values were substantially less than -\$0.01/cwt.² Also, minor make allowance changes to the other solids valuation formula

The question remains, will these systems continue to serve the interests of cheese manufacturers?

went into effect with the release of the October 2008 prices. Prior to October 2008, the dry whey make allowance for other solids calculation was 0.1956 compared to the current make allowance of \$0.1991. Over the Jan-Sept. 2008 period the average contribution per cwt. to the Class III skim milk value from other solids (dry whey) was \$0.0786. Again, this value was net of make allowance.

Summary

The valuation of non-fat/non-protein components of cheese milk is an on-going problem for the cheese industry. This problem stems from using a small number of products to represent the multitude of products and by-products produced by cheese manufacturers to maximize the value of the plant's revenue stream. In addition, different technologies and plant sizes/economies highlight the difficulty of using a single product-based formula system to value cheese milk. California is using a system that essentially insulates the industry from movements in market valuation of whey-based products. The FMMO pricing system allows for changes in whey markets to be reflected in Class III pricing. The question remains whether, in the long run, these systems will continue to best serve the interests of cheese manufacturers when determining the full value of milk used to produce cheese.

Resources

For an overview of pricing under the FMMO system refer to the following publication:

Ed Jesse and Bob Cropp, 2008. *Basic Milk Pricing Concepts for Dairy Farmers*, Publication A3379, University of Wisconsin-Extension, October. This can be obtained via the following URL: <http://future.aae.wisc.edu/pubs/pubs/show/354>.

Spreadsheet models of the current California and FMMO milk pricing systems can be found at the following URL:
<http://future.aae.wisc.edu/docs/excel.html>

continued on page 8

¹ Ed Jesse and Bob Cropp, 2008. *Basic Milk Pricing Concepts for Dairy Farmers*, Publication A3379, University of Wisconsin-Extension, October. This can be obtained via the following URL: <http://future.aae.wisc.edu/pubs/pubs/show/354>.

² As of this writing, it is expected that there will also be a negative contribution to the Announced December Class III price. A spreadsheet showing these negative effects can be obtained via the following URL: http://future.aae.wisc.edu/collection/software/advanced_prices_final_version1.xls.

News from CDR

WI Cheese Industry Conference

April 22-23, 2009

Join more than 1200 cheese industry leaders from around the nation on April 22-23 at the Wisconsin Cheese Industry Conference held at the La Crosse Center (La Crosse, WI). Gain information about the latest in cheese technology, product marketing and dairy issues affecting our industry.

The conference, co-sponsored by the Wisconsin Cheese Makers Association and the Wisconsin Center for Dairy Research, opens Wednesday morning, April 22 with a general session featuring Keynote speaker Dr. Lowell Catlett, followed by an afternoon tabletop mini-exposition and an evening of fun at the Champion Cheese auction. Thursday, April 23 features two sessions sponsored by WCDR - "Solving the Cheese Defect Puzzle" during the morning CDR cheese technology update; and during the afternoon whey technology update - "The Latest Insights Related to Bioactive Components in Whey and Their Potential Health Benefits" by Bruce German, University of California-Davis, Nestle Research Center. The conference closes Thursday evening with the United States Champion Cheese Contest Reception and Awards Banquet.

For more information, visit the WCMA website at www.wischeduc.org or the CDR website at www.cdr.wisc.edu. 



Resources, continued from page 8

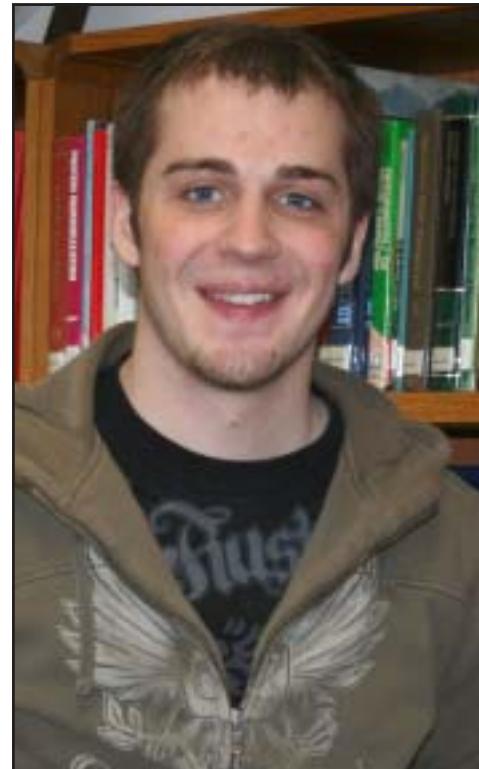
The Understanding Dairy Markets website (<http://future.aae.wisc.edu>) is a comprehensive source of dairy market data. Data with respect to the domestic pricing of dry whey refer to the following URLs:

NASS Average Dry Whey Prices Used in Announced Class III Pricing:

http://future.aae.wisc.edu/data/monthly_values/by_area/2009?tab=prices

U.S. Average Monthly Dry Whey Price:

http://future.aae.wisc.edu/data/monthly_values/by_area/20?tab=prices



CDR welcomes Wallace Barrow

Wallace Barrow recently joined the IT section of CDR, helping us to fight off viruses, deflect spam, and keep our computers running.

Weekly U.S. Dry Whey Price:

http://future.aae.wisc.edu/data/weekly_values/by_area/1611?tab=prices
U.S. Average Monthly Whey Protein Concentrate Price:

[http://future.aae.wisc.edu/data/
monthly_values/by_area/19?tab=prices](http://future.aae.wisc.edu/data/monthly_values/by_area/19?tab=prices)

U.S. Weekly Whey Protein Concentrate Price:
<http://future.aae.wisc.edu/data/>



Curd Clinic



Curd clinic doctor for this issue is Mike Molitor, pilot plant project manager, at CDR

Cooks appreciate the texture and viscosity of Greek yogurt. In short, they appreciate its functionality.

Q. I have been getting a lot of phone calls about Greek yogurt. What is it and why are consumers looking for it?

A. Greek yogurts are indeed showing up in markets across the United States. From Chaboni produced by AgroFarma Inc. in New York to Voskos made by Sun Valley Dairy in California, this high protein cultured dairy product is trendy.

Traditionally, Greek yogurt was made by straining whole milk yogurt with cheesecloth to remove some whey. Straining concentrates the protein and butterfat into an acidic, smooth and rich, nutrient dense cultured product. Today's Greek yogurts have a wide range of butterfat content; in fact, commercial Greek yogurts can range from nonfat to >10% butterfat. When strained to remove any significant quantity of whey, Greek yogurt would obviously contain significantly more protein than fluid milk, some Greek yogurt is >9% protein.

Commercially, Greek yogurts can be strained by one of three fundamentally different methods. You can go the traditional route, using cloth or bags, the mechanical method employing centrifugal force to spin out whey, or a more contemporary continuous method cross flow filtration or ultrafiltration (UF). Using UF as a plate & frame configuration is most typical, or possibly UF spiral elements. The extreme viscosity of Greek yogurt makes it a very challenging product for spiral UF elements, but it's reported to be done.

While everyone agrees that traditional Greek yogurt requires straining to concentrate the butterfat and protein, Greek style yogurt may reach high butterfat and/or protein concentration after ingredient fortification. Thus, if a Greek style yogurt label indicates protein content similar to fluid milk (around 3%, or lower protein than a typical NFDM fortified yogurt), then it's probable that little or no straining was employed.

Why do people seek out Greek yogurt? As mentioned above, it is a nutrient rich food and it can be low in fat as well as high in protein. This yogurt is smooth and rich, with a pleasing mouth feel. Cooks, especially those who dislike the heaviness of mayonnaise but want more body than regular yogurt offers, appreciate the texture and viscosity of Greek yogurt. In short, they appreciate its functionality. In addition, consumers these days are looking for "authentic" foods, or food made in a traditional manner with less processing and fewer additives. Another factor in its favor is that Greek yogurt is part of the Mediterranean diet, touted for its heart-healthy attributes.



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Calendar

Jan. 22-23 Producing Safe Dairy Products. River Falls, WI. Call Ranee May at (715) 425-3704 for information.

Feb. 3-4 Quality Milk Conference (WI Dairy Field Reps). Madison, WI. Call Scott Rankin at (608) 263-2008.

Feb. 24-25 Wisconsin Process Cheese Short Course. Madison, WI. Call John Jaeggi at (608) 262-2264 for more details.

Mar. 23-27 Wisconsin Cheese Technology Short Course, Madison, WI. Call Mark Johnson at (608) 262-0275

Apr. 22-23 Wisconsin Cheese Industry Conference, La Crosse, WI. For information, call Judy Keller at (608) 828-4550.

May 3-7 Cheese Utilization Short Course, Madison, WI. Call Dean Sommer at (608) 265-6469.

May 12 Wisconsin CIP Workshop, Madison, WI. Call Bill Wendorff at (608) 263-2015.

May 13 Dairy HACCP Workshop, Madison, WI. Call Marianne Smukowski at (608) 265-6346.

May 19-20 Applied Dairy Chemistry Short Course, Madison, WI. Call Scott Rankin at (608) 263-2008.



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