Wisconsin Center for Dairy Research

Dairy Pipeline

A Technical Resource for Dairy Manufacturers Volume 17 Number 4

Wisconsin dairy plants make progress controlling chlorides

By Bill Wendorff, Dept. of Food Science

Five years ago, the Wisconsin Department of Natural Resources (WDNR) established a new regulation limiting discharges of chlorides to surface waters. At that time, dairy industry representatives requested WDNR develop a chloride control regulation that was based on source reduction for critical industries versus a water quality based effluent limit (WQBEL) based on NR 105 (Surface Water Quality Criteria and Secondary Values for Toxic Substances). The final regulation, subchapter IV to NR106 (WDNR, 2000), provided for the allowance of voluntary source reduction activities on an interim basis with target limitations until the plant was in compliance with their final WQBEL. After reading about recent violations of environmental regulations in other U.S. cheese plants due to chlorides, we felt it was time to assess Wisconsin chloride regulation. Are Wisconsin cheese plants effectively controlling chlorides in wastewater discharges?

NR 106.90 allows for a three-tiered system for source reduction in dairy plants, which is established in ascending order of increasing capital and operating costs. An additional tier is added to the plants' WPDES permit each time it is renewed until the WQBEL is met for their chloride discharge. Tier 1 requires dairy plants to train personnel to be more aware of salt conservation, emphasizing simple, cost-effective housekeeping measures. Tier 2, in the second permit cycle, would require improved handling of brines and cheeses into and out of brines, optimizing water softener operation by switching to a demand initiated regeneration (DIR) controller, and potential use of condenser (COW) water for first rinse in the CIP system and for boiler makeup water. If needed in the third permit cycle, Tier 3 would require dairy plants making brined cheeses to evaluate the use of membrane filtration for reconditioning brine or switching to a no-brine make procedure for cheeses.

Most plants are in their first cycle

At the present time, most dairy plants are in their first permit cycle or just completing their first permit cycle since the chloride regulation was put in place in 2000. WDNR reports that the majority of dairy plants have been able to meet their WQBEL using Tier 1 source reduction activities that involve effectively monitoring waste flows and proper training of plant personnel. Less than 15% of the cheese plants will need to go to Tier 2 source reduction techniques in their next permit cycle to try to reach their WQBELs for chlorides.

Several dairy plants have reported on their successes with Tier 1 source reduction activities. Cedar Valley Cheese of Belgium, WI and Northern Environmental Technologies, Inc., Waupun, WI obtained a Wisconsin Department of Agriculture, Trade and Consumer Protection

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What's Inside:

Fortifying foods by adding protein—What's driving the trend?

Part 2, Proteins in food systems

By Galina Lubchesky, Valerie Kurka, Scott Rankin, and Karen Paulus

Growing acceptance of protein ingredients by consumers, regulatory agencies, and processors, as well as technological advances, have substantially expanded the use of both soy and whey protein products. When food product developers target improving sensory, visual, rheological, hydration, textural or surfactant property of the food product, it is likely that they can find a protein ingredient capable of delivering that specific functionality.

Protein ingredients are successfully used in a variety of low-fat formulations and are instrumental when formulating low-carbohydrate products. In addition, protein ingredients replace many food additives, producing products with improved consumer acceptance due to an improved and healthier ingredient statement.

However, selecting the correct protein ingredient is critical for achieving maximum benefit in the finished food product. The selection process is easier if a food developer works closely with a vendor. Clear goals and priorities can help to make the choice. For example, when the health claim of soy protein is the target, it is more economical to use a protein ingredient with minimum functionality. More functional properties only increase cost of an ingredient, and they can even have a negative effect on the finished product. One option might be to use a specifically modified protein ingredient for the targeted functionality.

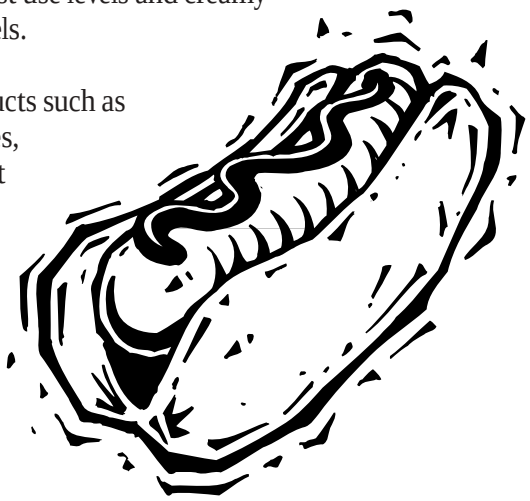
Introducing a protein ingredient into existing formulations can pose a challenge. It is likely that some formula and processing adjustments may be necessary. For instance, replacing a substantial amount of fat may require increasing the use of seasonings since fat and protein carry flavor differently. It is also important to consider future processing of a product. Heat stability of a protein ingredient may be an issue because of the possibility of denaturing protein ingredients at high concentrations under heat treatment. Partial hydrolysis enhances both heat stability and digestibility, but extensive hydrolysis may cause some bitterness as well as spontaneous gel formation. Even though fortification with protein ingredients usually improves a product label, don't overlook allergy issues. For instance, when incorporating a whey protein ingredient in a non-dairy product, don't forget to declare the presence of a dairy ingredient.

Over the years soy and whey proteins have found niches far beyond their initial applications as meat extenders, milk protein replacement in infant formula and nutritional bars. Technological advances have solved the problem of off-flavors in soy proteins and the tendency of whey protein to harden over time in nutritional bars. Currently, soy and whey ingredients are used in most food product categories.

Processed meats

Nutritional enhancement, improved functionality, and cost-effectiveness are three major factors driving the increasing use of protein ingredients in processed meats. Technical advances have produced a wide range of protein ingredients available for partial replacement or supplementation of meat constituents.

In emulsified meat products, whey and soy proteins offer excellent water binding and fat emulsification properties critical to product success. In both coarse and fine emulsions like frankfurters, bologna, patties, loaves and sausages, protein ingredients help prevent moisture loss, significantly increase yield, and improve firmness and texture. Water binding also improves the sliceability of processed meat products. In addition, whey and soy protein ingredients form stable emulsions preventing oiling-off and "fat-caps" by reducing fat globule mobility and minimizing coalescence. The high solubility of whey and soy protein ingredients provides a smooth texture at most use levels and creamy textures at higher levels.



In ground meat products such as meatballs, meat patties, Salisbury steaks, meat sauces, and chili, texture-contributing properties are most important. Textured proteins, manufactured by an extrusion process,

provide optimum structure during cooking and improve cook yields. The fibrous matrix mimics the look and texture of meat. Until recently, textured soy protein was the most common meat extender and analog. Over the past few years, the meat industry has also turned to textured whey protein as a meat extender.

Processed poultry products are the fastest growing segment of the poultry market. Both soy and whey proteins are very important ingredients for formulating processed poultry products such as nuggets, patties, and poultry rolls and comminuted chicken loaves. The exceptional functionality of protein ingredients produces high quality products with improved succulence, palatability, binding and texture characteristics.

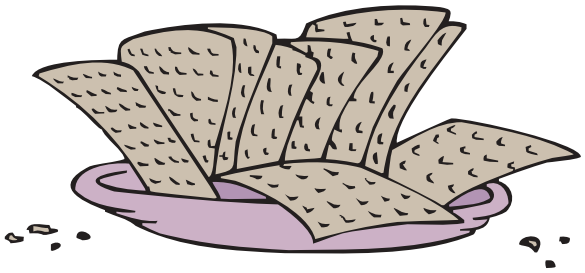
In addition, soy and whey proteins are used in battered and/or breaded products such as bone-in breaded chicken and boneless breaded poultry products (strips, tenders, nuggets, and patties). In any breaded application, protein ingredients improve yield, and enhance the texture and moisture retention through freezing/thawing and reheating. In fast food and foodservice operations, breaded products with added protein ingredients retain their palatability, texture and juiciness longer under heating lamps, minimizing the amount of discarded product.

Proteins improve bakery products

Protein ingredients are important components in virtually every category of the baking industry. Fortifying baked goods with soy and/or whey protein greatly enhances the nutritional value of cereal-based products. An incomplete essential amino acid profile in cereal-based proteins can cause serious malnutrition problems for vegetarians and people in developing countries who lack high-quality protein. Soy and whey proteins complement cereal proteins, producing food with the optimum balance of essential amino acids and improved nutritional quality. These proteins also provide exceptional functional and economical benefits to the baking industry.

Most commonly, soy protein ingredients are used in combination with whey protein ingredients in baked products. Defatted soy flour, used as a partial milk (non fat dry milk) replacer, is the most economical and traditional soy ingredient in baked applications. Due to its high water-binding abilities, defatted soy flour enhances dough's moisture retention, improving its machinability and decreasing the rate of staling after baking. In addition, defatted soy flour improves toasting properties, crust color, texture and crumb characteristics in bread and rolls. However, the formation of unfavorable flavor limits the use of defatted soy flour in breads and rolls. The flavor improves with heat treatment.

Many whey and soy protein concentrates and isolates are available to developers of baked products. Carefully selecting the



right ingredients and properly adjusting the processing are critical steps when seeking the maximum benefits of protein ingredients to develop a value-added product. Factors that affect the protein functionality in bakery formulations include protein concentration, degree of denaturation, mineral and lipid content, amount of heat treatment received during manufacturing, ionic environment and pH.

Supplementing with soy and whey protein ingredients provides the following benefits to bread formulations: enhanced crumb structure, improved bread flavor, extended shelf-life via decrease in rate of staling, and improved toasting qualities. Whey protein products also enhance crust browning through the Maillard browning reaction. Typically, in bread formulations, soy and/or whey protein ingredients are used at levels ranging from 1% to 5%. Food formulators may need to adjust some processing parameters to obtain maximum benefits. For example, lower baking times and temperatures prevent developing of excessively dark crust color if whey products are used. (Burrington, 1999). Also, water requirements may require adjustment depending on the protein concentration and level of denaturation because these factors affect water-binding abilities of the product.

In cakes, cake mixes, cookies, crackers, biscuits, pancakes, and sweet pastry applications, highly functional properties of soy and whey protein ingredients are used to produce smoother, more pliable and more uniform dough as well as finished baked products with improved grain, texture, crust color, symmetry and extended shelf life. In addition, total or partial substitution of more expensive ingredients leads to economical and nutritional benefits. Both soy and whey protein ingredients can be used to replace Non Fat Dry Milk and fat. Adding 2% whey protein

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concentrate (80% protein concentration) to low fat pound cake, results in higher volume, improved moistness, flavor and softness compared to a full fat control and a low fat control with no WPC added (Burrington, 1999).

Economical Aspects

The interest in low-carb diets is not the only reason behind the growth in the protein ingredient market—which exceeds $3 billion in the US and $10 billion globally (Starling, 2004). More interest in a healthy diet coupled with public awareness of the health benefits of some protein ingredients, more vegetarians, and a wariness of meat products are other factors contributing to the rising popularity of protein ingredients. However, the prevailing reason for protein fortification still remains the ability of protein ingredients to impart non-nutritional characteristics to food products. Fortifying with protein ingredients improves any functional characteristic of food product leading to an increase in consumer acceptance and/or shelf-life extension and, therefore, increased sales. Another economical benefit is cost savings. Cost savings can be achieved by replacing a more expensive additive with a specific protein ingredient that has corresponding functional attribute. For example, incorporating 30% soy protein, based on meat weight, into lean ground beef or chicken can decrease the cost per pound of a processed meat product by 25 percent.
In addition, fortifying with protein ingredients allows the use of lower value ingredients, such as less expensive chicken or beef meat, without compromising the quality of the final product. The most significant economical advantage of fortification with protein ingredients comes from their exceptional water-binding ability. Increasing the water holding capacity of a food product also raises yields, prevents moisture loss and enhances product juiciness while improving texture.

Currently, both soy and whey proteins dominate the protein ingredients market. However, new protein ingredients, such as pulse, rice, potato, canola, and colostrum are being introduced.

Conclusion

Knowledgeable consumers, scientific evidence and public awareness of the health benefits of protein ingredients and the popularity of low-carb, high-protein diets affect the growing use of protein ingredients. Exceptional functionality of protein ingredients enhances sensory, visual, hydration, surfactant and rheological properties of food products in all food categories. In addition, fortifying with protein ingredients offers substantial economic benefits through cost savings.

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(WDATCP) Agricultural Development and Diversification (ADD) grant to evaluate reducing wastewater management costs at an Italian cheese manufacturing plant (McCone and Buser, 2004). The study found that approximately three-fourths of the salty wastewater from the plant was generated by diffuse sources, sources not attributable to a particular piece of equipment. Equipment cleanup and leakage and spillage associated with the production process, particularly the brining operation, were felt to be important sources of wastewater contributing to the salty wastewater flow. The ADD grant study concluded with the following recommendations to reduce the costs of dealing with salty wastewater:

- Establish standard operating procedures (SOPs) that define activities that should and should not occur during production and packaging operations.
- Review and revise cleaning processes.
- Never use water to flush solid material into floor drains.
- Use non-softened and non-heated water whenever possible (e.g., for rinsing floors).
- Initiate a training program to educate employees about the importance of the new and/or revised procedures needed to reduce chloride emissions.
- Divert cheese molding drip pan drainage to the non-salty process water waste stream.
- Install a volume-demand regeneration sequencer to control water softener zeolite regeneration.
- Store and dispose of water softener regeneration brine separately as a discrete waste stream.
- Examine alternate methods to decrease the volume of brine curing solution.

Several other cheese plants manufacturing brined cheeses have also completed waste reduction studies for their plants. They found that the most significant sources of chloride emissions came from salt spills in the finish vat, brine tank and packaging areas. Additional recommendations that came from those studies include:

- Installation of automatic brine flow and brine tank level control systems to maintain proper tank levels and prevent overfilling.
- Installation of automatic molding equipment to eliminate manual handling of curd.
- Installation of drip pans under conveying systems to recycle salt drippings back to the brine system.
- Floor drains in the brine room should be piped separately from the rest of the process wastewater system.

For those cheese plants unable to meet their WQBEL for chloride in their first permit cycle, NR 106.90(3)(c) requires the following Tier 2 source reduction activities in the second permit cycle:

- Improve the handling of salt brines and the handling of cheese into and out of brine systems. Consider capital improvements such as automating the brine system, properly designed drip pans and splash guards.
- Optimize softener operation to ensure the appropriate regeneration interval and salt dosages are used.
- If the softener regeneration is manual or timer-initiated, evaluate the feasibility of switching to a DIR controller.

In developing the chloride regulation in NR 106 in 2000 (WDNR, 2000), WDNR stated that end-of-pipe treatment of chloride in wastewater was impractical. Appropriate chloride source reduction activities were preferable environmentally to end-of-pipe effluent treatment in most cases. WDNR worked with industry representatives to develop appropriate source reduction activities for critical industries (Wendorff, 1998).

Based on the results represented in WPDES permit reports thus far, it appears that the source reduction activities proposed for Wisconsin dairies in NR 106.90 were appropriate and effectively reduced chloride emissions in dairy plant wastewater. Most plants have also found that with source reduction activities for chlorides, they have also been able to reduce their biological oxygen demand (BOD) and phosphorus levels in wastewater. Wastewater treatment costs for dairy plants have saved money not only by reducing the volume of salty process wastewater that needed to be treated but also by reducing the biological load in wastewater and improving the efficiency of operations and the recovery of product from production processes.

(Additional information on chloride reduction from cheese plants is available from the November 18, 1996 UW Dairy Alert! available on the CDR website at: www.cdr.wisc.edu)

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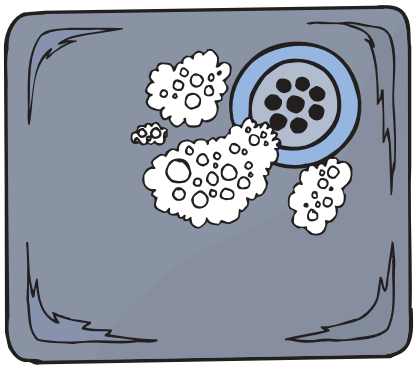


CDR launches a new short course

CDR is offering a unique opportunity to people who want to learn about the art and science of cheesemaking. We are developing a new short course featuring lectures about cheesemaking, cheese handling, packaging, economics, and the basics of cheese grading and evaluation. Participants will gain first hand experience when they make cheese in the Babcock Hall pilot plant.

"The Cheese Handling Short Course" is a class for culinary professionals, end users of cheese, brokers, distributors, retailers, and marketers." The four-day class is scheduled for May 1 to May 4, 2006. Enroll by April 10th. For more information, contact Dean Summer (608) 265-6469.

Whey Permeate, continued from page 9

Below is a summary on the categories where permeate use has been most successful, suggested use levels and possible limitations:

Baked Item	Suggested Use Levels	Permeate Functionality	Other Comments
Cookies	5 to 8%	Promotes browning, contributes sweetness, and crispy texture	May need to adjust time/ temperature for baking if browning is excessive. May spread more
Low Fat Pie Crust	4 to 6%	Promotes browning and flakiness	May need to adjust time/ temperature
Muffins	4 to 6%	Promotes surface browning and tender crumb structure	
Scones or Biscuits	5 to 8%	Promotes surface browning and tender crumb structure	May be a slightly softer dough with more spread
Pound Cake	3 to 5%	Promotes surface browning, reduce salt level	May need to adjust time/ temperature. Cake volume may be lower

Research Update

Whey permeate offers benefits in baked products

By Kathy Nelson, Wisconsin Center for Dairy Research

Whey proteins have risen from obscurity to ordinary, finding a niche in everything from sports drinks to cake mixes. Can whey permeate find the same success?

During ultrafiltration and diafiltration, whey proteins are retained by the membrane, while low molecular weight substances, such as lactose and minerals, pass through and become the permeate stream. Once moisture is removed from the liquid permeate stream, an off-white, free-flowing powder with a mild dairy flavor, remains. Whey permeate, dairy products solids, de-proteinized whey or modified whey, are all names that refer to the collection of substances left after protein, and some lactose and minerals, have been removed from whey. The main constituent of permeate is lactose, and therefore, it is the lactose that dictates the ability of permeate to improve the texture of baked products, affect the appearance and color, extend sweeteners or shortening, and provide a cost-effective source of dairy minerals, such as calcium and phosphorus.

Table 1.

Component	Sweet Whey Permeate (Powder)(%)
Lactose	65.0-85.0
Protein*	3.0-8.0
Ash	8.0-20.0
Fat	<1.5
Moisture	3.0-5.0
Calcium	0.75-0.90
Phosphorus	0.70-0.75

* Please note that permeate contains only trace amounts of protein. Commercial specifications however, list protein typically around 3.5 to 5%. The discrepancy is due to the dairy industry testing for total nitrogen, a number which is then automatically multiplied by 6.38. The nitrogen found by testing 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.

The composition of whey permeate will vary due to milk source, cheese type and processing conditions. Cow's milk is typically used for cheesemaking in the USA , and cheeses are generally cultured cheeses, such as cheddar or mozzarella, leaving liquid whey, known as sweet whey. Other things that can influence permeate composition include the filtration, evaporation, and spray drying conditions used. See Table 1. from USDEC (US Dairy Export Council) showing typical composition of food grade permeate from sweet whey.

Permeate offers benefits

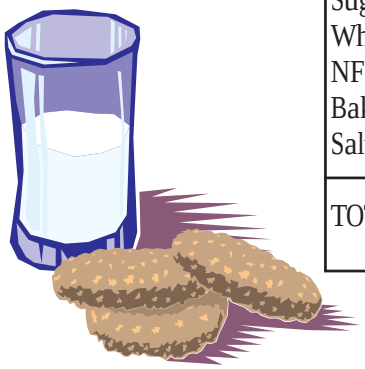
Permeate can offer many benefits in baked products, like enhanced surface browning and flavor development, moisture retention and development of a tender crumb structure. Permeate has a "salty" flavor, and, for this reason, salt can often be reduced or eliminated in a formulation. Permeate does contain approximately 0.6% sodium and will influence the nutritional label. This is a positive influence, though. For example, reviewing the scone formulation, you can see that the NFDM and permeate replacement will have similar levels of sodium. But when you eliminate the salt, you improve the nutritional label because the sodium decreases by half.

Permeate can replace other dairy ingredients, particularly those low in protein (sweet whey, WPC-34 or NFDM), or present in low amounts (2% or under). Using permeate to replace structural components, such as flour or eggs, can be more difficult since permeate lacks protein. Success will vary with the application.

A significant amount (5-8%) of permeate can be used in products like muffins, scones, or cookies, resulting in products of similar or superior quality. In scones and muffins (see example 1) permeate could be used to replace either the NFDM, or both egg and NFDM, without sacrificing quality. In replacing both egg and NFDM, the water contributed by the egg needs to be taken into account. The resulting product is evenly browned, with a softer crumb and similar volume to the control, at a significant cost savings. Cookies typically contain lower levels of flour and higher fat and sugar, compared to scones. When using permeate in cookies (see example 2), the strategy for replacement is slightly different. Flour and/or egg should be kept constant to supply the needed structure, while reducing sugar and fat in the formula. Cookies containing permeate tend to be a crispier,

Example 1. Permeate in scones

Ingredients	Control Formula (%)	Permeate replacement of NFDM(%)	Permeate replacement of Egg + NFDM(%)
Flour, all-purpose	50.00	50.00	50.00
Water	18.97	18.97	25.86
Butter	10.34	10.34	10.34
Whole Fresh Egg	9.48	9.48	-
Sugar	6.90	6.90	6.90
Whey Permeate	-	2.07	4.66
NFDM	2.07	-	-
Baking Powder	1.72	1.72	1.72
Salt	0.52	0.52	0.52
TOTAL	100.00 %	100.00 %	100.00 %



shorter texture, with more browning and spread. Other products, such as pie crust, would employ a similar strategy, and result in similar benefits.

Cakes or quick breads present a greater challenge, since protein is critical to the structure of the finished product, and permeate cannot contribute any structural material. For this reason, permeate is most successfully used in low fat or whole grain cakes or quick breads, especially those with fiber. The whole grain snack cake (see example 3) is one such application. The strategy in a case like this is to choose a target amount of permeate and replace proportionately across all the ingredients in the formula.

Example 2. Permeate in Chocolate Chip Cookies

Ingredients	Control Formula (%)	Permeate Formula (%)
Flour, all-purpose	27.54	27.54
Butter, unsalted	19.84	16.61
Semi-sweet Chocolate Chips	14.86	14.51
Brown Sugar	14.33	13.11
Granulated White Sugar	12.59	11.36
Whole Fresh Egg	9.62	9.62
Whey Permeate	-	6.03
Salt	0.52	0.52
Bicarbonate of Soda	0.40	0.40
Vanilla	0.30	0.30
TOTAL	100.00 %	100.00 %

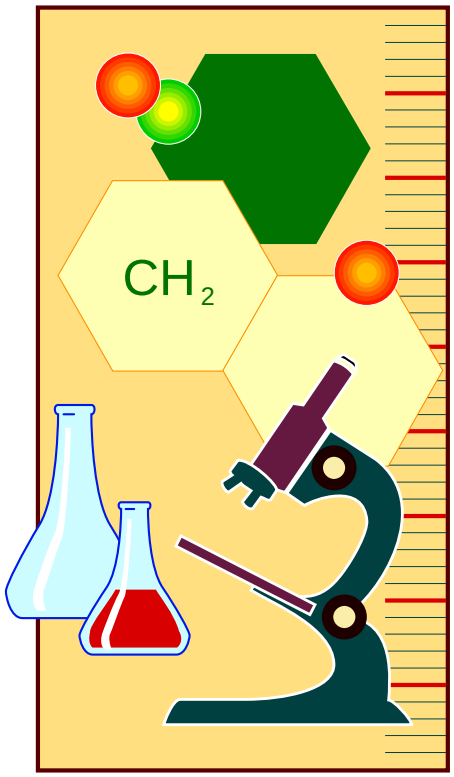
In general, permeate is a low-cost ingredient and useful in many applications. However, you do need to be aware of both the benefits and limits to its use, as well as strategies for replacement. It is important to verify performance and make adjustments, as necessary.

Concluded on page 7

Example 3. Permeate in Whole Grain Snack Cake

Ingredients	Control Formula (%)	Permeate Formula (%)
Dried Fruit	14.44	13.33
Applesauce	14.07	12.98
Quick Oats	13.69	12.63
Honey	13.32	12.28
Flour, all-purpose	12.58	11.60
Whole Fresh Egg	8.44	7.78
Whey Permeate	-	7.78
Brown sugar	6.75	6.23
Walnuts, chopped	6.00	5.53
Bran Flakes	4.69	4.32
Canola Oil	4.13	3.80
Sesame Seed	1.50	1.38
Baking Powder	0.28	0.26
Ginger, ground	0.11	0.10
TOTAL	100.00 %	100.00 %

Curd Clinic



Curd Clinic doctor for this issue is Kristen Houck, microbiologist at the Wisconsin Center for Dairy Research

Q. Certainly proper compositional sampling is important and pertinent (see the Curd Clinic Vol. 17 #3). However, would you please describe the techniques for proper aseptic sampling of barrel and block cheese for microbiological analyses?

A. According to Standard Methods for the Examination of Dairy Products, Chapter 3, "sampling a 640 lb block of cheese depends on the cheese and method of production." In general, three plugs should be taken from the block. A stainless steel trier should be wiped with 70% ethanol before taking the sample. A 70% ethanol solution is preferable because the dilution allows it to permeate the bacterial cell membrane better than 95% ethanol, killing bacteria more effectively. Also, if you use a 70% solution you do not have to flame the trier before sampling.

Important factors to consider when sampling for microbiological analysis include the following (from Standard Methods for the Examination of Dairy Products, Chapter 3):
-Don't introduce additional bacteria to the sample
-Protect sample from contamination
-Maintain sample integrity, so bacteria levels remain the same as when sample was taken. You don't want to kill or grow bacteria during transportation.
-Record sampling conditions i.e. date, time, temperature, location

The International Dairy Federation also outlines the exact procedure for taking samples via triers for microbiological examination (IDF standard 50C:1995):
-Take micro sample first using aseptic technique and from the same plugs as those being used for chemical and sensory analysis
-100 g sample is recommended
- Use a larger trier first, to obtain a plug that will be used for closing the hole, then use a smaller trier for the sample itself
-Wipe trier between each sample plug with 70% undenatured ethanol

It is important to remember that aseptic technique is one step in assuring an accurate sample for microbiological analysis. In general, aseptic technique means keeping conditions as clean as possible. For example, use clean and (preferably sterilized) utensils when sampling. Other factors that influence the accuracy of analysis include sampling technique, sample size, sample storage and transportation to the laboratory. A myriad of factors can also influence the results once the sample is in the laboratory itself (sample preparation, analysis and interpretation).

What happens in the real world?

According to Terry Lensmire of Trega Foods, aseptic technique for sampling 40 lb blocks includes using a clean sanitized knife to cut the plastic away before directly sampling the cheese. Or, you can use a clean cloth with sanitizer to wipe the plastic before sampling directly through it.

Another factor to consider is the tendency for triers to break when sampling cold cheese. Many people warm the trier in hot water, wipe with 70% alcohol or a sanitizer and then take a sample.

After sampling, it is common to plug the block with a sealing compound (commonly called schmutz). Lensmire says that some samplers approach this differently, depending on the age of the cheese. If you are going to age the cheese the micro sample is collected and then the top part of the plug is countersunk and sealed. Apply the sealer so that you push all the air out while creating a seal that doesn't allow any air to enter.

News from CDR

A few more new faces at CDR

Kit-Yin Ling and Carrie Saynisch have both joined CDR's Analytical Group. Kit moved a few blocks from Molecular Biology where she worked in a crystallography lab. She admits to liking cheese and milk, but Kit also has a green thumb and a passion for gardening.

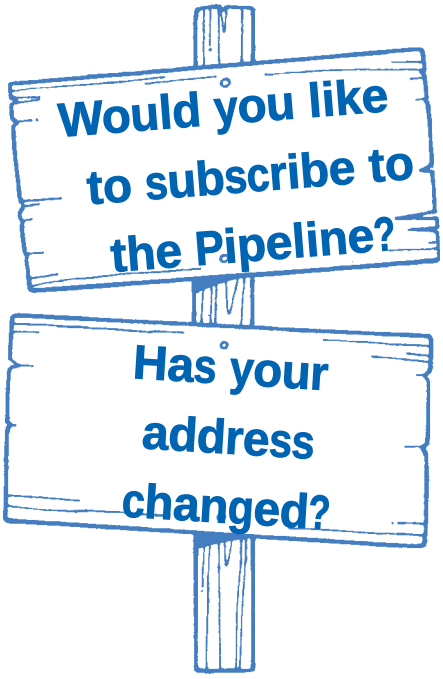
Kit-Yin Ling

Carrie Saynisch came to Madison for college and then stayed to work at Silliker Laboratories where she developed the microbiology skills she brings to CDR.

Carrie Saynisch

David Schroeder, a second generation cheesemaker, brings decades of cheesemaking experience to the cheese group. Formerly of Linden cheese, Dave has been making blue cheese since 2000.

David Schroeder



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The Dairy Pipeline
Center for Dairy Research
1605 Linden Dr.
Madison, WI 53706-1565
phone: 608/262-5970
fax: 608/262-1578

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Karen Paulus, Editor
e-mail: Paulus@cdr.wisc.edu
phone: 608/262-8015

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

Calendar

Jan. 19-20 Producing Safe Dairy Products. River Falls, WI. Call Ranee May at (715) 425-3704 for information.

Feb. 7-8 Quality Milk Conference (WI Dairy Field Reps). Madison, WI. Call Scott Rankin at (608) 263-2008.

Feb. 28-Mar. 1 Wisconsin Process Cheese Short Course. Madison, WI. Call Bill Wendorff at (608) 263-2015 or John Jaeggi at (608) 262-2264 for more details.

Mar. 27-31 Wisconsin Cheese Technology Short Course, Madison, WI Call Bill Wendorff at (608) 263-2015.

Apr. 25-27 International Cheese Technology Exposition, Madison, WI. For information, call Judy Keller at (608) 828-4550.

May 9 Wisconsin CIP Workshop, Madison, WI. Call Bill Wendorff at (608) 263-2015.

May 10 Dairy HACCP Workshop, Madison, WI. Call Marianne Smukowski at (608) 265-6346.

May 16-17 Applied Dairy Chemistry Short Course, Madison, WI. Call Scott Rankin at (608) 263-2008.

Wisconsin **Center for Dairy Research**
University of Wisconsin-Madison
1605 Linden Drive
Madison, Wisconsin 53706-1565