

# DAIRY PIPELINE

## A COLLABORATION FOR THE AGES: HOARD'S DAIRYMAN FARM CREAMERY PARTNERS WITH CDR AND CHEESEMAKERS TO CREATE UNIQUE CHEESES

What do you get when you take the knowledge and skill of Wisconsin cheesemakers and the Center for Dairy Research (CDR) and combine it with high-quality Guernsey milk from Hoard's Dairyman Farm? The answer appears to be some really great, unique cheese.

In the Fall of 2018, Hoard's Dairyman Farm Creamery released *Belaire*, a Port Salut-style cheese. *Belaire* has been well received, earning a top 10 finish in the semi-soft cheese category at the 2019 United State Championship Cheese Contest and winning a gold medal this summer at the Green County Fair.

In addition to *Belaire*, Hoard's Dairyman Farm Creamery has released two more cheeses in 2019: *St. Saviour*, a Camembert-style cheese; and *Castel*, a Manchego-style cheese.

Sandy Speich, Director of Hoard's Dairyman Farm Creamery, said they wanted to make cheeses that showcase the qualities of the farm's Guernsey milk. "It's higher in fat, higher in protein so you get a much better yield," Speich said. "The cheese is very creamy and buttery from all the fat and it's also high in beta carotene, so it gives you a nice golden-yellow color."



The Hoard's Dairyman Farm Creamery website describes the *Belaire* as having a pale-yellow interior highlighted with a distinctive bright orange rind. Its high-fat content gives the cheese a creamy, subtle flavor and soft texture.

It's described as being similar to Muenster but with a bolder, creamier taste.

The *St. Saviour*, a Camembert-style cheese, has a rich, buttery flavor from a soft, creamy core inside a bloomy white rind. The Hoard's Dairyman Farm Creamery website recommends that both the core and the rind be enjoyed together for the "true *St. Saviour* experience."

The *Castel*, a Manchego-style cheese, has a golden interior with a distinctive brown rind. It's a slightly sweet cheese with notes similar to those found in aged Gouda and Parmesan. It has a drier body that makes it easy to grate but it also stands up on its own as a flavorful table cheese. Like the other cheeses, it also has the rich, creamery flavor associated with high-fat Guernsey milk. ➔



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The names of the cheeses pay homage to the Isle of Guernsey, an island off the Northern coast of France, which is the home of the Guernsey cow. Belaire is named after the naval captain who brought the first Guernsey cattle to America. Castel and St. Saviour are parishes on the Isle of Guernsey.

### Steeped in History

As many in the dairy industry know, Hoard's Dairyman Farm is steeped in history. The lineage of some of the Guernsey cows on the farm can be traced back to W.D. Hoard's original herd that was established in 1899. The herd is the longest continually registered Guernsey herd in North America. According to the Hoard's Dairyman website, the herd ranks number 1 in the nation for milk, fat and protein in the category of 100 or more cows. The American Guernsey Association has also recognized Hoard's Dairyman Farm as the Top Commercial Herd.



*Belaire, a Port Salut-style cheese from Hoard's Dairyman Farm Creamery.*

With all that quality milk available, this isn't the first time Hoard's Dairyman has made cheese. Hoard's Dairyman magazine used to make cheese to send out at the holidays as a special gift for the magazine's advertisers. The cheeses were well received, and people asked where they could buy them. Hoard's Dairyman approached the cheese factory where they made their seasonal cheeses but the factory was in the process of shutting down. That was about 30 years ago. Speich said the idea of making cheese was always in the back of people's mind at Hoard's Dairyman. Then, several years ago, they began working with CDR.

"We looked at their milk supply and identified what was special about their Guernsey milk and we used that to inspire our choice of cheese varieties that would really showcase that milk," said Gina Mode, CDR Assistant Coordinator for Cheese Industry and Applications Group.

As mentioned earlier, Guernsey milk has higher fat and protein content than other bovine milks. It also has a

unique golden color. "Guernseys do not break down the beta carotene that's in the feed," Mode said. "So, you get that beautiful golden color in the milk and cheese. In fact, Guernsey milk used to be prized for making butter."

CDR's TURBO program was also able to assist with the project. Hoard's Dairyman Farm Creamery applied for and received a \$20,000 reimbursement grant to purchase cheese forms and other cheesemaking equipment. The grant was awarded through a \$200,000 reimbursable grant program administered jointly by the CDR TURBO program and the Wisconsin Economic Development Corporation (WEDC).

### Working with Wisconsin Cheesemakers

Initially, Hoard's Dairyman Farm Creamery had a goal of building its own cheese factory, but those plans have been set aside as they've had success partnering with exceptional Wisconsin cheesemakers. Ben and Bruce Workman at Edelweiss Creamery make the Belaire and Castel cheeses and Jon Metzsig at Union Star/Willow Creek Creamery makes the St. Saviour. Bruce Workman and Jon Metzsig are Wisconsin Master Cheesemakers.

Metzsig, who has just completed the first make of the St. Saviour, said the process went well and added that the quality of the milk is a highlight.

"I can tell that it's good milk. They do a good job at the [Hoard's] farm," he said, adding that quality milk is essential for cheesemaking. "Your cheese can't be any better than the starting product, which is the milk. You can't make good cheese out of bad milk; it's not possible."

These unique cheeses require a high level of skill to produce. Mode pointed out that Ben Workman, who has taken the lead in producing the Castel, makes the cheese in a traditional copper vat. "It's a real pleasure to watch him make Castel," Mode said. "It's very striking visually – you have the gorgeous golden Guernsey milk in that big copper vat. It's really great to see that kind of cheesemaking today."

"That's always kind of a challenge," Ben Workman said of making the cheese in a copper kettle. "We don't make a lot of other things in it other than Swiss. We had to



*Ben Workman of Edelweiss Creamery (pictured with his children Silas and Iliana) won a gold medal this summer at the Green County Fair for the Belaire, a Port Salut-style cheese from Hoard's Dairyman Farm Creamery.*

be a little more innovative than we're used to when we transferred it from the copper kettle to the forms."

"Partnering with the Workman's has been so easy," Speich said. "They know what they're doing. They're always very helpful, and they really have been guiding me through this whole thing." Speich added that Jon Metzger has also been great to work with although he's "a little more quiet than the Workmans," she said with a laugh.

Throughout the process Hoard's Dairyman Farm Creamery, CDR, and the cheesemakers have been working together to produce these unique cheeses. The resulting cheeses really are fruits of this collaboration. For example, while CDR was developing the recipe for Belaire, Edelweiss Creamery

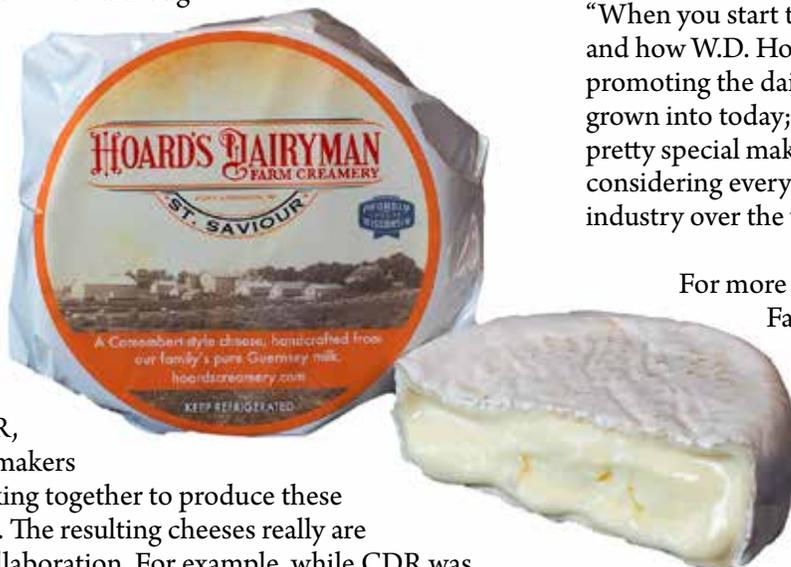
was developing their own recipe for Port Salut. It was a happy coincidence and the final recipe that is being used today combines elements of both. "What's currently being made is everything brought together and it's just a really beautiful cheese," Mode said.

"Since we've been making it, it has quickly become one of my favorite cheeses," Ben Workman said of the Belaire cheese. "I couldn't be happier with it. It has a nice consistent body and flavor."

Everyone involved in the project admits that it's been a long time in the making. Various challenges along the way needed to be addressed like the logistics of getting the milk from the Hoard's Dairyman Farm to the partner cheese plants. In addition, the Castel requires quite a bit of time to age. The St. Saviour (Camembert) also posed some challenges. CDR was searching for a cheesemaker who could add the white mold directly to the milk, rather than spraying it on the rind later in the process. In the end, Hoard's Dairyman Farm Creamery, CDR and Wisconsin cheesemakers have been able to find solutions to these challenges and it's a good thing because the final result is some unique cheese.

This project is also special because it draws on some of the resources and expertise that make Wisconsin an extraordinary state when it comes to cheesemaking. First, there's the milk from Hoard's Dairyman Farm's historic Guernsey herd. Second, the project showcases the expertise and creativity of Wisconsin Master Cheesemakers and CDR staff. And third, the project benefited from the CDR TURBO Program. The project is also showcasing the state's next generation of cheesemakers.

"When you start talking about the history of Hoard's and how W.D. Hoard started out writing articles promoting the dairy industry and then seeing what it's grown into today; it's kind of amazing," Metzger said. "It's pretty special making cheese with milk from Hoard's, considering everything they've done for the dairy industry over the years."



For more information on Hoard's Dairyman Farm Creamery cheeses (including where you can purchase the cheeses), visit: [www.hoardscreamery.com](http://www.hoardscreamery.com).

## THE IMPORTANCE OF DAIRY INGREDIENTS' FUNCTIONALITY

Technical reviewers: KJ Burrington & Susan Larson, CDR

An often-overlooked aspect of product development is functionality testing. Too often, food developers will add an ingredient to a formulation without testing that ingredient's functional characteristics. While companies can develop products without understanding the performance of each dairy ingredient, it can help save time and reduce the number of development trials if a developer understands the performance attributes of a dairy ingredient they are using.

One of the points of pride of the Center for Dairy Research's Ingredients and Functionality program is its functionality testing services. With about 20 years of experience in this area, CDR was one of the early adopters and leaders in functionality testing.

"Functionality is one of our core competencies and one of the core services that we provide to companies," said KJ Burrington, CDR's Dairy Ingredients, Beverages & Cultured Products Coordinator. "Measuring functionality gives you a way to benchmark an ingredient's performance attributes and compare it to other ingredients in a quantitative way. We started doing functionality testing early in our program history and we've added some methods over the years."

CDR began functionality testing in 1998 when it started evaluating whey ingredients. Then, as the U.S. began expanding into milk protein ingredients, CDR also began testing those ingredients. Today, CDR offers a wide array of ever-expanding functionality tests, including: Emulsification, Solubility, Water Binding, Viscosity, Gel Strength, Heat Stability, Dispersibility, Foaming, and more.

Testing ingredients is more important than ever as more dairy ingredients (and suppliers) are coming on the market. There is a long list of ingredients from both milk-derived powders (MPCs, etc.) and whey derived powders (WPIs, etc.).

There are many ways that functionality testing can be used by both suppliers and customers to ensure that the best ingredient is being used in an application. Burrington recalled one example in which a beverage manufacturer hired CDR to run functionality tests on every whey protein isolate (WPI) that was manufactured in the U.S. The company also wanted to know how the different isolates performed in a model beverage application. CDR tested attributes like heat stability, water-binding, solubility, clarity—all characteristics important when developing a beverage. With the results of CDR's findings, the company knew exactly how each WPI performed and they could pick the best one for their beverage.

Functionality isn't just helpful to the end user of the ingredient. It's also useful for ingredient suppliers. In fact, one of the first functionality projects that CDR worked on was for a whey protein ingredient manufacturer. The company was in the process of developing ingredients with specific functional characteristics. By adjusting how they processed the ingredients, the company could produce ingredients with different characteristics, like enhanced water-binding or heat stability. CDR helped the company benchmark these changes so that it could develop ingredients with specific attributes.

"Based on their functional properties, the company could then recommend the best ingredient to be used in a specific application," Burrington said. "For instance, maybe one ingredient had better heat stability, so they could recommend it for soups and sauces—products that are highly heat processed." ➔



This functionality demonstration illustrates how milk proteins and whey proteins perform in beverages at different pHs. The three beakers on the left contain solutions with whey proteins (WPI) and the three on the right contain milk proteins (MPI). As demonstrated in this test, whey proteins perform well (good solubility) in acidic beverages (pH 3.0) while milk proteins are better suited for neutral beverages (pH 7.0). In acidic beverages (pH 3.0 and pH 4.6) milk proteins lose their solubility.

In this case, by using functionality testing, CDR helped the manufacturer define the characteristics of each ingredient and determine what applications they were best designed for.

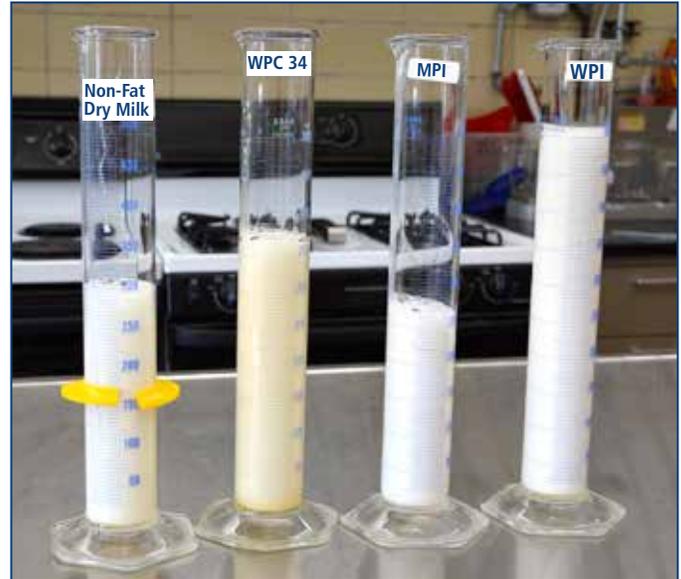
Functionality testing has also played an important role as the U.S. dairy industry continues efforts to expand its export market. When products or ingredients are exposed to different climates, those ingredients may perform differently or change in appearance (color changes, etc.). By using functionality testing, companies can determine what products or ingredients are best for specific climates or anticipate product concerns that may develop under more extreme holding conditions.

Similarly, large companies with different plants that produce the same product will use functionality testing to ensure that their product is consistent across all plants. Functionality testing is also key to understanding how a product or ingredient functions over the span of its shelf life.

In addition, functionality is an area that is constantly changing as new ingredients come on the market and companies develop innovative new products that require ingredients with specific functionality. For instance, Burrington said that one big issue in the dairy ingredient industry is the proper use of milk protein concentrates (MPCs). MPCs are a newer ingredient and some companies have run into challenges when using them. One issue is that MPCs containing 70% or more protein are slow to hydrate. In addition, companies are finding that some MPCs manufactured in the U.S. take longer to hydrate than MPCs from other countries.

“If a dairy ingredient is not hydrated properly, it’s not going to function well,” Burrington said. “That goes for all dairy ingredients. The key to good functionality is to make sure that you have a well hydrated ingredient.”

Functionality is an important research tool as well. CDR conducted a large study in 2017-18 that analyzed and compared the functionality of various dairy and plant proteins. For the project, CDR needed to identify ingredients that could be used in low acid and high acid beverages without creating product quality or processing issues. You can view the results of this study at [www.ThinkUSAdairy.org](http://www.ThinkUSAdairy.org) (select “Using Dairy,” then “Resources & Insights” and then scroll down to the link for “A New Era for Protein: Why U.S. Dairy Delivers in the Crowded Protein Marketplace”).



*This functionality test is illustrating the foaming abilities of four different dairy ingredients. As seen above, whey proteins (WPI) have much greater foaming capabilities than milk proteins (MPI). Non-fat dry milk and WPC 34, which contain a mix of both whey and milk proteins, have moderate foaming abilities.*

As you can see, functionality testing is a tool that is beneficial not only to end users of ingredients but also to suppliers and researchers.

“Over the years, I think we’ve done a lot for ingredient companies to help them understand the performance of their ingredients,” said Burrington. “This work is also helpful for the users, the food companies, to select the best ingredient for their applications.”

One final recommendation, Burrington suggests that companies take the time to do functionality testing to characterize the dairy ingredients that they are purchasing, so they can select the right ingredient for their application. If they don’t have the time or the expertise to do the testing, then CDR is happy to do it for them.

“It’s most cost effective to screen early,” said Susan Larson, CDR Associate Researcher. “You can waste a lot of ingredients if something isn’t working. There are a lot of dairy ingredients out there so you want to start with best foot forward.”

For more information on CDR’s functionality testing services, visit [www.cdr.wisc.edu/ingredients](http://www.cdr.wisc.edu/ingredients) or contact KJ Burrington at [burrington@cdr.wisc.edu](mailto:burrington@cdr.wisc.edu) or 608-265-9297. ☀

## PART 1: ESSENTIAL PRINCIPLES OF CHEESEMAKING: STARTER CULTURES

Technical reviewers: Andy Johnson and Dean Sommer, CDR

The goal of every cheesemaker is to make consistent, quality cheese. However, given all of the variables that go into cheesemaking, it can be challenging. One of the best ways to build knowledge is to get back to the basics. This article is part one of a two-part series that takes a deep dive into essential principles that cheesemakers of all levels should know in order to make quality cheese.

Part 1: Establishing and Maintaining a Starter Culture Program

Part 2: Measuring and Controlling Acidity and Moisture During the Cheesemaking Process (next issue)

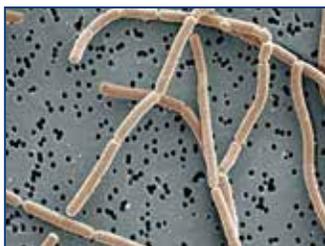
### Starter Culture—The “Engine” of Cheesemaking

Starter cultures are bacteria that, when added to milk, metabolize lactose and produce lactic acid. “The engine for cheesemaking is your starter culture,” says Dean Sommer, CDR cheese and food technologist. Starter cultures are needed because there are not enough naturally occurring bacteria in milk (especially pasteurized milk) to ferment lactose at the desired rate. Typically, pasteurized milk will have <100 bacteria per ml of milk capable of fermenting lactose. With starter culture there will be more than 1,000,000 bacteria per ml of milk specifically selected to ferment milk rapidly.

Properly using and maintaining starter culture is crucial to producing good cheese. Given the importance of starter culture, it’s recommended that cheesemakers find a trusted culture house representative to work with. Culture propagation, distribution, selection, use, and monitoring is a complicated business that is best left for the professionals.

### Types of Starter Cultures

When it comes to the actual types and varieties of starter culture, there are a couple important distinctions. One distinction is the difference between coccus and bacillus bacteria. Coccus are round shaped bacteria (i.e. *Lactococcus lactis ssp. lactis*, *Lactococcus lactis ssp. cremoris*, and *Streptococcus thermophilus*). And bacillus are rod-shaped, like *Lactobacillus bulgaricus* and *Lactobacillus helveticus*.



Example of bacillus (rods) bacteria.

Another important distinction is the difference between mesophilic and thermophilic starter cultures. Mesophilic bacteria grow best in moderate temperatures. The optimal temperature for acid production from mesophilic cultures is typically 80-100°F.



Examples of coccus (round) bacteria.

Mesophilic bacteria metabolically slow down >102°F. Historically, mesophilic cultures are used to make Cheddar, Colby, Monterey Jack, Brick, Baby Swiss, Gouda, Edam, Blue, Brie, Cream cheese, Feta, Havarti, and Limburger.

### Starter Cultures are Bacteria

<b>Coccus</b>	<i>Lactococcus lactis ssp. lactis</i> (M)
	<i>Lactococcus lactis ssp. cremoris</i> (M)
	<i>Streptococcus thermophilus</i> (T)
<b>Rods</b>	<i>Lactobacillus bulgaricus</i> (T)
	<i>Lactobacillus helveticus</i> (T)

M = mesophilic culture (Cheddar styles)  
T = thermophilic culture (Italian/Swiss styles)

### Mesophilic

70°F (21°C) minimum for acid production

86°F (30°C) optimal for growth and acid production

Typically like 80-100°F, begin to slow down at >102°F

### Thermophilic

68°F (20°) minimum for growth

98.6 - 112°(37 - 44°C) optimal for growth & acid production

Typically like 100-115°F, can withstand 140°F+

In contrast, thermophilic starter cultures grow best in hotter temperatures—typically between 100-115°F and can withstand temperatures at 140°F and greater. Thermophilic cultures are used to make Mozzarella, Provolone, Parmesan, Romano, Asiago, Swiss, Muenster, and Gruyere.

### Proteolytic Activity, Salt Sensitivity

So, what determines the type of starter culture to use? It depends on a couple different factors. First, tradition and experience certainly play a role in which starter culture is preferred for which cheese (i.e. *Lactococcus lactis ssp. cremoris* for aged Cheddar). Secondly, each culture has different rates of acid development, salt tolerance, and proteolytic activity. This is important because these factors ultimately impact the body, texture and flavor development of the cheese. ➔

Cultures have different potential for proteolysis. For instance, the culture *Lactobacillus helveticus* is very proteolytic and is used for Parmesan where the goal is to have a lot of flavor development from protein breakdown. Whereas *Streptococcus thermophilus*, used for making Swiss, is not very proteolytic and much of the flavor is derived from the added propionic bacteria.

Salt tolerances are also very important. *Streptococcus thermophilus* is very sensitive to salt and does not grow well over ~2 % S/M (salt-to-moisture), while *Lactococcus lactis* ssp. *lactis* and ssp. *cremoris* can tolerate ~5% S/M. This can be used as a tool for a cheesemaker to control acid development by introducing salt during the cheesemaking process to slow down acid production.

Other factors play a role in which starter culture is used for which cheeses. For instance, other metabolic activities like gas production and flavor development are needed for some cheeses and selected bacteria are added in addition to the lactose fermenters. In bulk starter applications, culture strain and growth media selection are important considerations for desired culture performance.

The one characteristic that is desired in all starter cultures is consistency. The goal is to have starter culture where the rate and extent of acid development is predictable and the same every time.

### Acid Development

As mentioned at the beginning of the article, starter cultures produce acid and lower the pH of the milk. Why do we need to produce acid? What is its function? First of all, acid helps inhibit the growth of undesirable bacteria. When we look at what preserves cheese, the salt content of the cheese helps but the main driver is acid. Secondly, starter culture ferments (consumes) the lactose in milk. If the starter culture didn't ferment the lactose, other undesirable bacteria would consume the lactose, which would cause undesirable gas production and off flavors.

Selecting the proper starter culture is crucial. The starter culture will create the correct environment that will result in the right enzymatic and chemical reactions, which, in turn, will produce the desired flavor in the cheese. Likewise, if the starter culture performs correctly, it will also produce the correct texture, body and functionality of the cheese.

Much of cheesemaking is a balancing act and starter culture plays a big role in creating just the right environment for the cheese. For instance, in the case of Mozzarella, you need the culture to produce just the right amount of acid to solubilize just the right amount

of calcium from the protein structure. If this happens, the result is a Mozzarella with a nice stretch in a baked application. However, if the starter culture doesn't produce enough acid it will result in a Mozzarella that has a tough body and won't stretch. On the other side, if too much acid is produced, it will cause the Mozzarella to be soupy and have a weak body. When making Mozzarella or any other cheese, the cheesemaker has to control the cheesemaking process and produce just the right amount of acid for that cheese type.

### Starter Culture Formats

In addition to different bacteria species, cultures are available as a defined single strain, undefined mixed strain and defined multiple strain. Single strain is not very common. Undefined mixed strain was once quite popular but are not used as often today. The more popular format is the multiple strain starter cultures. These mix two or more well-known cultures and are very good at producing consistent amounts and rates of acid development.

Cultures are also available in different formats: frozen direct set cultures, freeze-dried direct set cultures, and bulk cultures. They each have their **advantages** and **disadvantages**.

<b>Deep Frozen Direct Vat Set (DVS) or Direct Vat Inoculum (DVI)</b> – These are highly concentrated cultures in readily soluble form for direct inoculation into milk.
<b>Advantages:</b> Consistent performance and activity, strain balance maintained, no capital investment in bulk culture propagation facility and personnel (also slightly better yield than bulk culture, convenient and easy to use, can run 1-2% more milk volume per day, flexible system (less planning needed), and less potential for phage infection.
<b>Disadvantages:</b> Need specialized culture freezer.
<b>Freeze-Dried Direct Set Cultures (DVS/DVI)</b> – These are highly concentrated cultures in powder form for direct inoculation into milk.
<b>Advantages:</b> No specialized culture freezer needed, can use partial containers, easier to ship, compact containers for storage.
<b>Disadvantages:</b> Really slow to produce acid at first.
<b>Bulk Cultures</b> – These are deep-frozen or freeze-dried, concentrated cultures for propagation of bulk starter (see “Bulk Culture Propagation” page 8). The cheesemaker is responsible for purity and performance of the grown bulk culture.
<b>Advantages:</b> Cheaper (especially for larger plants), faster activity in the vats, don't need to mix thermophiles and mesophiles, supplier can customize strain combinations for your cheese, can pull individual strains out of a culture combination, can customize starter media, typically adding 0.3-1.0% for pH controlled, 1.0-2.0% for conventional non-pH controlled (extra acid a positive!).
<b>Disadvantages:</b> Need specialized equipment, dedicated bulk starter rooms and highly trained personnel to manage a bulk culture program and facility, and has a greater potential for phage infection. ➔

## Receiving and Storing Frozen Starter Culture

It is very important that starter culture is correctly handled because if it is abused it will not perform properly. If receiving frozen starter culture, make sure that dry ice is still present in the shipping container. Frozen starter culture pellets must be frozen and free flowing; if the pellets are fused together that means that it was not held at the correct temperature. Similarly, once you have the frozen starter culture, it must be kept frozen. Do not partially thaw and then refreeze; this will result in the pellets fusing together (as mentioned above) and will result in loss of activity and inconsistent activity.



*Temperature abused culture.*

Frozen starter cultures must be stored at  $-45^{\circ}\text{F}$  or colder and should have about a 12 month shelf life (or check best by date). Freeze dried starter culture needs to be stored at  $0^{\circ}\text{F}$  or colder and also should have about a 12 month shelf life (or best by date). It's also important to practice good inventory practices with your starter culture (i.e. first in first out).

## Adding Frozen Direct Set Cultures

When using frozen direct set cultures, aseptically open the package and pour the pellets directly into cheese milk. Do not bring cultures out of the freezer too far in advance. After pouring out the pellets, rinse the empty bags/containers with sanitizer and remove from the area to prevent bacteriophage contamination.

One note, it is not recommended to use partial bags of mixed strain culture because, depending on how it was manufactured, you may get an inconsistent proportion of the strains. It is recommended that the entire bag be used. It's also important to add enough starter culture. For frozen starter, you need about 0.005 to 0.02% frozen starter (DVS).

## Bulk Culture Propagation

Using bulk culture is a much more complex undertaking and takes some additional steps. In a bulk culture system, the cheesemaker fills up the starter tank(s) with reconstituted starter media and then heats the media to  $185^{\circ}\text{F}$  to  $195^{\circ}\text{F}$  for 45 minutes. (Alternatively, a HTST unit with a longer holding tube can be used.) Heat treatment is an important step because it helps kill off pathogens and bacteriophage. Once the media has been heat treated, it is then brought back down to the correct temperature of incubation. Once that

temperature is reached, the bulk starter culture can be added. Once, the bulk culture is added, the tank must be closely monitored—if the bulk culture is allowed to over incubate it can produce too much acid and kill itself off. This can be avoided by neutralizing the bulk starter culture by using an internally buffered starter media or with an external agent (i.e. liquid ammonium hydroxide). Neutralizing the bulk starter culture can also help produce higher numbers of bacteria cells and healthier cultures. After these steps, the bulk starter is cooled and ready to use. It should have a thick consistency, like a drinkable yogurt.

As illustrated above, bulk culture requires more expertise and handling. That is why it is recommended that plants put the responsibility of the bulk culture program in the hands of its most dependable, experienced employees.

Another important part of making bulk starter is monitoring equipment and keeping everything clean. This includes managing the starter tank. The agitator bushings should be checked and replaced when necessary. The tank itself should have a blacklight schedule to check for cracks and pits in the tank. Additionally, there needs to be a proper rotation of culture blends. There should also be a dedicated unit for the starter tank. Typically, the starter tank is a single use CIP system that is separate from other plant CIP units (to avoid contamination). The air used in and around the bulk tanks should also be HEPA filtered air. This, again, is to avoid a bacteriophage infection.

## The Challenge of Bacteriophage

Bacteriophage, or phage, are viruses that infects bacteria, like starter culture. Bacteriophage survive normal pasteurization temperatures and are pH tolerant (not destroyed by an acid or alkaline). Under an electron microscope, they look like a lunar landing module with a head connected to a tail with legs. They exist simply to propagate and spread their DNA. They do that by landing on a bacteria cell, injecting that cell with the bacteriophage's DNA, which causes the cell to replicate the phage DNA. New bacteriophages are then replicated inside the host bacteria cell until they burst the cell and the new bacteriophage find other cells to infect and repeat the process.

This cycle (called the lytic cycle) can get out of control quickly in the cheese vat or bulk culture tank to the point that the bacteriophage will overwhelm the starter culture and slow or even stop acid development. Bacteriophage replicate much more quickly than starter culture bacteria—one bacteriophage can become 1.6 billion in less than two hours. ➔

As a cheesemaker, if you have a vat where absolutely no acid production takes place, then most likely, you had a bacteriophage infection in the bulk starter tank. In this scenario there really isn't anything that can be done to salvage the cheese. However, if you have a vat where acid development slows or stops, you probably have a case of the bacteriophage killing the culture in the vat. In this case, you can get a different strain of starter culture and add it to the vat in an effort to jump start acid development. Another option (time permitting) is to simply let the vat sit until the pH drops appropriately. Of course, the best option is to take precautions to minimize and control bacteriophage in the first place.

Bacteriophage can enter the plant in a number of different ways. People can bring it into the plant (incorrect traffic pattern, dirty uniforms, boots). Raw milk can harbor bacteriophage especially when milk trucks are also used to haul whey products. Residual starter residues, if not handled correctly, can also contain bacteriophage (properly clean out and discard used bags/containers of starter culture). It can also be found in milk or whey residues on or near cheese vats. Unclean, dirty equipment, including milk tankers that also haul whey products can have bacteriophage. Not having proper airflow and filters (HEPA) can also spread bacteriophage.

"If I see one thing problematic in plants, it's air flow," Sommer said. "Air should flow from high sensitive areas to less sensitive areas."

Without realizing it, plants sometimes create "phage loops" or places where phage is amplified. Some examples of this include:

- ▶ Improperly treated whey cream going into cheese milk.
- ▶ Under-heated liquid WPC used as secondary starter solids.
- ▶ Cheese vats not on separate CIP system and/or sharing the same CIP system with the belts/towers.
- ▶ Phage contamination of incoming milk.
- ▶ Using the same pumps and lines to move incoming milk and to load-out whey cream, whey and WPC.
- ▶ Hauling raw milk in the same trucks used to move whey products.

### Preventing Phage Problems

There are some steps that should be taken to avoid phage outbreaks in your plant. Properly rotating cultures can help keep phage down. This is one reason why it is advantageous to purchase cultures from one culture house. Culture houses will have culture rotation schedules available that are designed to avoid phage outbreaks. Additionally, limiting the amount of a specific culture used at one time can help keep phage outbreaks down. The number of vat fills per culture blend varies

between plants and is dependent on different factors such as air flow and sanitation.

Again, sanitation is also critically important. "Whenever I see a plant with sanitation issues, I know that they're ripe for phage issues," Sommer said.

Here are some additional recommendations to help avoid phage outbreaks in your plant:

- ▶ Wash (chlorinated alkaline then acid) and sanitize cheese vats between every fill.
- ▶ Allow enough time to clean and sanitize equipment properly (plants don't want to take time to clean).
- ▶ Don't run long days (18 hours at the maximum).
- ▶ Don't run seven days per week.
- ▶ Use effective sanitizers (talk to your chemical representative).
- ▶ Use peracetic acid or 200ppm sodium hypochlorite to rinse off clean equipment (do not use quat sanitizers).
- ▶ Keep floors dry. There is a correlation between phage and wet floors. Bacteria can't multiply without water. This is also good for listeria control.

Lastly, it is important that plants maintain a sound phage monitoring program. Whether it is done in house or by sending whey samples to your culture supplier, it is imperative to know the phage levels in the plant for each strain to catch problems before they result in the production of poor quality cheese. Phage are always a threat, so constant vigilance is required to prevent phage related cheese quality issues.

See also "*Understanding and Preventing Bacteriophage*," *Dairy Pipeline*, Volume 29, Number 2. 🌟

## UPDATED: PROPERTIES OF CHEMICAL SANITIZERS

The Center for Dairy Research has updated an important resource for dairy plants—the Properties of Chemical Sanitizers chart. This chart provides comprehensive information on chemical sanitizers, including: applications, advantages/disadvantages, germicidal activity, germicidal specificity, and much more.

This is a resource every plant should have readily available. The chart was developed by Marianne Smukowski, CDR; Dr. R.L. Bradley, Professor Emeritus, University of Wisconsin-Madison Department of Food Science; Gabe Miller, Food Safety LLC; and Dave Bloomquist, DFB Consulting LLC. To view or download the chart, visit [www.cdr.wisc.edu/safety](http://www.cdr.wisc.edu/safety) and select "Chemical Sanitizers." 🌟

## CENTER FOR DAIRY RESEARCH AND WISCONSIN CHEESE MAKERS ASSOCIATION AWARDED DAIRY BUSINESS INNOVATION INITIATIVE GRANT

The U.S. Department of Agriculture (USDA) selected the Center for Dairy Research (CDR) and Wisconsin Cheese Makers Association (WCMA) to host a regional Dairy Business Innovation Initiative, serving Wisconsin, Minnesota, Iowa, South Dakota, and Illinois. With initial funding of more than \$450,000, this project will offer low- or no-cost workshops designed to grow the dairy industry and allocate grants directly to dairy businesses for product development and marketing.



“This initiative will help support farmstead or small dairy businesses as they explore opportunities to create new value-added dairy products like specialty cheeses, in addition by providing targeted grants to dairy businesses it will encourage more entrepreneurial efforts,” said John Lucey, CDR Director.

“We’re pleased to be guiding investments in the U.S. dairy industry that can boost sales of value-added dairy products domestically and abroad, and – ultimately – increase profitability for family farmers,” said John Umhoefer, WCMA Executive Director. “We’re grateful for Senator Baldwin’s leadership on this concept and USDA’s quick follow-through to aid the dairy industry. And we couldn’t have a better partner than Center for Dairy Research.”



This regional initiative will be known as the **Dairy Business Innovation Alliance (DBIA)**. The purpose of the DBIA is to research opportunities and train farms, cooperatives and dairy processors to build new, diverse business opportunities. Many farms are family operations built on tradition and a strong adherence to their land, livestock and communities. New skills are needed in entrepreneurship, product development, market research, and others like branding. The goal is to help increase on-farm diversification of business opportunities; create value-added dairy products such as specialty cheeses; and focus on export opportunities for farm-scale and processor dairy products.

The **DBIA** will seek to support and promote this work through a grant program and direct technical assistance, which will include efforts like the development of workshops across the region. The ultimate goal is to increase sales and demand for milk products as well as creating product development templates that, combined

with knowledge gathered through this process, can be replicated throughout the U.S.

U.S. Senator Tammy Baldwin (D-Wisconsin) developed the Dairy Business Innovation Initiative program, successfully shepherding its passage through the 2018 Farm Bill. Baldwin championed the CDR/WCMA application, along with Congressmen Glen Grothman (R-WI6), Ron Kind (D-WI3), Mark Pocan (D-WI2), Bryan Steil (R-WI1), and Wisconsin Department of Agriculture, Trade, and Consumer Protection Secretary Brad Pfaff.

“Wisconsin’s dairy businesses are a key driver of our state’s economy, but recently our dairy farmers have faced very challenging times with an oversupply of milk, low milk prices and tough impacts from tariffs. It’s critical that farmers, cheesemakers and dairy processors have tools to innovate and develop new Made in Wisconsin dairy products to build a brighter future for our dairy farms and drive our rural economy forward,” said Senator Baldwin.

The **Dairy Business Innovation Alliance** is set to run through 2021. Future announcements regarding training and grant opportunities will be publicly available at [www.cdr.wisc.edu](http://www.cdr.wisc.edu) and [www.wischeesemakers.org](http://www.wischeesemakers.org). 🌟

### CDR WELCOMES NEW EMPLOYEES

#### Rodrigo Ibáñez Alfaro, Associate Scientist

CDR welcomes associate scientist Rodrigo Ibáñez Alfaro. In his role at CDR, Rodrigo is researching microbiological topics related to cheese and dairy products, along with writing research proposals and supporting research and outreach activities. A native of



Chile, Rodrigo earned his Ph.D. in Food Science and Technology from University College Cork (Ireland), studying factors affecting the quality of low-fat cheeses. In 2014, he was a Research Scholar in the Department of Food Science at UW-Madison and collaborated on research projects with CDR under the supervision of CDR

Director John Lucey. In recent years, Rodrigo has gained knowledge and experience conducting research in cheese science and technology. Rodrigo hopes his contribution in research will improve the quality and competitiveness of U.S. dairy products. 🌟

## Valeria Rizzi, Sensory Coordinator

CDR is pleased to announce the hiring of Valeria Rizzi as the new Sensory Coordinator. Valeria has a Master of Science in Food Science and Technology from Texas A&M University. She recently completed a sensory internship in Ferrero S.P.A. in Alba, Italy. During her internship she worked with Kinder Eggs and the Seasonal Products Technical Performance Team. In this role, she helped to conduct shelf studies, designed and administered sensory tests for product improvement and development. She is well-versed in the different sensory techniques, such as descriptive analyses, consumer testing, and discriminative testing. As sensory coordinator, she will be responsible for the sensory analysis of food projects, with emphasis on cheese and dairy ingredients in support of industry and internal applications research. 🌟



## SMUKOWSKI ELECTED ACS PRESIDENT

CDR's Marianne Smukowski has been elected as the 2019-20 President of the American Cheese Society (ACS).

Marianne joined CDR in 1994 and is currently the coordinator of the Dairy Safety/Quality and Master Cheesemaker Programs at CDR. She is responsible for working with cheese and dairy product manufacturers as they implement food safety plans, as well as providing third-party audits. She often serves as a liaison between dairy manufacturers and regulatory staff. Marianne is the technical advisor for the Wisconsin Master Cheesemaker® program.



“Marianne is a strong advocate for cheesemakers, and a strong leader for ACS who values the important work we do to advance the industry. Marianne is also a great ‘connector’ – able to connect people, ideas, and information through her consensus-building style,” said Nora Weiser, executive director of ACS.

“I have been involved with ACS in a number of roles including a judge for the cheese competition, member of the regulatory and advisory, finance and nominating committees,” Smukowski said. “As one of just a few academics to serve as president of ACS, it is quite an honor and privilege to lead ACS.” 🌟

## FDA TESTING RAW MILK CHEESES

Under a new directive from the Food and Drug Administration's (FDA) Center for Food Safety and Nutrition (CFSAN), a new sampling assignment has begun for raw milk cheese, brined cheese and smeared-ripened cheese.

Based on scientific literature, research, and recalls in other countries, FDA has identified these cheeses as high risk. Specifically, the FDA is testing for:

*S. aureus* in raw milk cheese (200 samples)



*L. monocytogenes* in brined cheese (300 samples)



*L. monocytogenes* in smeared ripened cheese (300 samples)



The testing assignment started October 1 and is scheduled to run through September 30, 2020. Samples are being collected from manufacturers, distributors, and retailers in the following states: Wisconsin, New Hampshire, Vermont, New York, Pennsylvania, California, Washington, and Oregon. The cheese will be tested at the point ready for consumption (after 60 days for raw milk cheese).

Currently, the FDA would like to see <10 CFU/g of indicator bacteria in the samples it collects. However, Marianne Smukowski, Dairy Safety & Quality Coordinator for CDR, said that most of the manufacturers aim for <100 CFU/g indicator bacteria in its cheese.

It is not known what the exact repercussions would be from a positive test but, typically, a positive result for a pathogen results in a recall of the affected product. Therefore, when a product is sampled for testing it is recommended that all products that could be subject to a recall be placed on hold and isolated until the results are confirmed as negative and the product is released.

The Wisconsin dairy industry has been a leader in food safety. “Wisconsin usually comes out pretty good with these testing assignments,” Smukowski said. 🌟

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## Short Course Calendar

- ▶ Cheese Grading, November 6-8
- ▶ Ice Cream, December 3-5\*
- ▶ Making Consistent, Quality Cheese with Concentrated Milk, December 10-12
- ▶ Certificate in Dairy Processing, January 9-March 19

**For detailed information on CDR short courses:**

[www.cdr.wisc.edu/shortcourses](http://www.cdr.wisc.edu/shortcourses)

## Events



To receive a complimentary subscription to the Dairy Pipeline, contact the Center for Dairy Research.

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