PREVENTING PUFFY PACKAGES: THE SCIENCE BEHIND GAS FORMERS AND HOW TO PREVENT THEM

From puffy packages to splits and cracks, gassy cheese defects continue to present challenges for the cheese industry. The result of microbial metabolism by specific microorganisms, the gas that is produced is most commonly carbon dioxide and it is generated from residual lactose, galactose, citric acid, amino acids or lactic acid in most cases. In fact, the only other gas that is produced is hydrogen, but it is likely only produced by Clostridia species and is often associated with a foul odor.

When approached by cheesemakers, converters or end users about a gassy cheese defect, the discussion ultimately turns to prevention. Generally, prevention starts with improved cleaning and sanitation, but it seems that no matter how much effort is put into this process there are times when cleaning doesn’t solve the problem. This may be due to a number of factors including the possibility that the cleaning and sanitation effort is occurring in the wrong location, recontamination may be taking place or the cleaning solution may not be targeting the true cause. Sometimes, the reasoning is even more complicated than cleaning and sanitation, however, and can instead lead us to ask whether bacteria survive pasteurization? What numbers in milk can eventually lead to the problem? And, can the culprit bacteria form biofilms? This brief look at gassy defects provides some answers as well as a few new questions that CDR is continuing to investigate. As always, I welcome your thoughts and questions at jumbo@cdr.wisc.edu.

Gas Forming Bacteria

Facultative heterofermentative ► Facultative heterofermentative Lactobacilli are generally the dominant group of non-starter bacteria found in cheese, unless there is a high level of contamination by another type of bacteria. They may survive, albeit generally in very low numbers, in milk after pasteurization but attain numbers as high as one billion in an aged cheese. A few species can produce carbon dioxide under the appropriate conditions although the substrate they use is often unknown. A few strains have also been documented to ferment galactose and may use galactose-containing materials derived from the cell walls of dead bacteria.

Homofermentative ► Under ideal conditions of temperature, nutrients and sugar levels, obligate homofermentative bacteria always produce lactic acid as the major end product from lactose fermentation (>90 percent will be lactic acid) but produce no appreciable amounts of carbon dioxide and only very small amounts of acetic acid and ethanol under stress conditions. All of the primary acid producers (starters) used in cheese production are obligate homofermentative bacteria.

Obligate heterofermentative ► Obligate heterofermentative bacteria also form lactic acid (~50 percent of the end products) but always form a large amount of carbon dioxide and acetic acid or ethanol. Obligate heterofermentative bacteria are common culprits in splits and blown or puffy packages.
It’s worth noting that over the past five years, we have seen a sharp increase in gassy cheese defects, in particular slits and puffy packages in Parmesan, Swiss, and Cheddar cheeses. Perhaps the most interesting thing about this uptick in defects is that they are often seen in cheeses that contain starter cultures, or adjuncts, that promote galactose accumulation in the cheese. In many cases, the cheeses were also stored or ripened at temperatures above or close to 50° F. This later observation is consistent with the very early reports on gassy cheeses going back almost 100 years. Note that, galactose can be found in Cheddar if *Lactobacillus helveticus* or *Streptococcus thermophilus* were part of the original culture blend.

Additionally, thanks to new DNA-based identification techniques, we have learned that gas producing bacteria are often facultative heterofermentative *Lactobacilli*. In fact, initially we missed the isolation of these galactose fermenting bacteria as the gas former because we used lactose as the substrate for gas production rather than galactose. So, we’ve learned we need to keep an eye out for unique conditions and test accordingly.

**Conditions Leading to the Formation of Gas**

The environment within the cheese is the decisive factor in determining which bacteria grow and survive. Regardless of the identification of the microorganism that is producing the gas, there are two generalities about the conditions leading to gas formation. First, there needs to be a sufficient amount of a fermentable substrate that when metabolized, results in sufficient gas production in order to cause the visual defect. And, second, the bacteria must be able to thrive in the cheese environment in such a way that it is able to replicate to reach sufficient levels to metabolize the substrate and form gas. Early gas formation in cheese, one to two weeks, usually indicates that the cheese had a lot of residual sugar, i.e. lactose, and that there were a lot of the gas former in the cheese right after the cheese was made. This also indicates either a very high level of contamination in the milk or cheese, or that the conditions (usually warm temperatures and high pH) were just right to allow rapid growth of the gas formers. Most common early gas formers have been coliforms, heterofermentative *Lactobacillus* species, or *Weissella* sp.

If gassy defects erupt several months after the cheese was made, it usually indicates that initially there were insufficient numbers of bacteria in the cheese when it was made. Others have found that spore formers such as *Clostridia*, are more common in the case of late blowing cheese. The substrate for *Clostridia* is lactic acid, while the substrate for heterofermentative bacteria is residual galactose or carbohydrate material in cell debrix from lysed bacteria (usually starter bacteria). Specific *Lactobacillus* sp. can also metabolize amino acids released through extensive proteolysis. With amino acid metabolism we have not seen the puffy packages or large slits in the cheese, but rather tiny slits or almost microscopic gas bubbles in the cheese matrix. It’s worth noting that amino acid metabolism also often results in an unclean flavor (see Dairy Pipeline Vol. 29 #3 for more).

Spores of gas formers, *Clostridia* and *Bacillus*, survive pasteurization, but vegetative cells of most other gas formers do not, at least at detectable levels. There are at least two *Lactobacillus* sp., *Lb. curvatus* and *Lb. fermentum*, that we have identified as gas formers that survive pasteurization in numbers sufficient enough to establish biofilms in the regenerative section of the pasteurizer. Craig Oberg (Weber State University) reported at the Global Cheese Technology Forum in Reno, NV in October 2017 that a common voracious gas former he discovered could not survive pasteurization. Many of our gas forming isolates have also been reported not to survive pasteurization, yet many of them have been isolated from cheese made from pasteurized milk. This leads us to the conclusion that gas formers are environmental contaminants. Yet that begs another, often unanswered question, “How do these bacteria gain access to pasteurized milk or cheese curd made from that milk, especially in cheesemaking systems that are enclosed and not open to human touch or raw milk contamination?” Another way of asking that question is to say, how does a bacteria found in raw milk, and known to be killed by pasteurization, gain access to an environment which is cleaned and sanitized and where cross contamination of a clean environment is seemingly kept under control? These questions remain to be answered.

Bacteria are certainly light enough to be airborne as are mold spores, and antitodal evidence implies seasonality, i.e worse in spring (wet, more microbial growth and windy) and much less so in the winter (dry, less microbial growth in the outside environment). We cannot rule out airborne contamination or bacteria brought in on people even though direct contact with the inside of equipment is avoided. I do not believe, however, that the numbers of bacteria in the air are sufficient to cause the gassy defect through direct contamination, but it may be that eventual biofilm formation is established in the plant and the biofilm is the source of contamination. The number of gas holes in some cheese (indication of the initial gas formers in the milk or curd) indicates that incidental contamination of curd via air is probably not the direct source of the bacteria causing gassy defects. There are simply not enough contaminants found in the air to grossly contaminate the cheese. In my opinion, raw milk...
is the initial source of the gas formers and the formation of biofilms on equipment from bacteria initially found in raw milk are a secondary feed source to contaminate milk and cheese. Are there components in raw milk, i.e. small pieces of grass, straw, that protect gas formers from death by pasteurization? I do not know the answer to that, but would find it surprising if that were true.

In the case of Swiss, Gouda, and Havarti, gas forming bacteria are deliberately added to produce eyes or flavor components where carbon dioxide is a by-product of fermentation. Packages of these cheeses are notorious for bloating especially if the cheeses are held at temperatures above 45°F. Although warm for a cheese, many retailers have the mistaken belief that this is a cold temperature and it is the cheesemakers faulty cheesemaking that causes the packages to bloat or splits to form in cheeses with eyes. Maybe and maybe not, but it is expected that cheeses made with bacteria that are gas formers may exhibit undesirable attributes of excessive gas formation if given the right conditions to do so.

**Numbers Needed to Contaminate the Cheese**

As to the question on numbers, the answer is unknown as to the minimum level of contamination of gas formers needed to eventually cause the gassy defect. Some researchers have suggested that by the time sufficient gas is formed in cheese to visually see the defect, you need at least 100,000 colony forming unit (CFU) per gram of cheese, and perhaps at least a million. It does not take long for *Lactobacilli* to reach that level, especially in cheese that is at 50°F or higher. Even though pasteurized milk for cheesemaking may have less than one CFU of *Lactobacilli* we routinely observe *Lactobacilli* numbers in commercially produced cheese at levels greater than 100,000 in just a few days. In samples where the *Lactobacilli* numbers in pasteurized milk have been greater than one but less than 10 CFU per ml of milk we have observed numbers of *Lactobacilli* in cheese (barrel and 640’s) at two weeks with greater than 100 million per gram of cheese.

An issue we have encountered many times is that a gas former is present at levels high enough to cause the problem, but too low to be detected in the presence of higher levels of other bacteria. It’s an easy day when a gas former is quickly isolated on the first attempt (usually a young cheese), but that’s not always possible. There are methods used to distinguish gas formers from non-formers on an agar plate or gel, but this often requires that there are sufficient numbers of gas formers compared to the non-gas formers. We have found that we get better results at isolating gas formers by inoculating cheese directly into a broth and then streaking on an agar plate and retesting several isolates for gas formation.

The problem often encountered when testing milk or equipment surfaces for the gas formers is that these tests often fail to identify gas formers or coliforms, yet the cheese indicates their presence. The gas former is not the only bacteria that gains entry into the milk or through contamination of equipment. The gas former is competing for nutrients and living space with other bacteria and are more than likely to be vastly outnumbered. We have observed in several cases that the gas former was outnumbered by at least 100 fold by bacteria other than those deliberately added. Fellow contaminants were more likely to be isolated and counted and not the gas former. Early gas formers in cheese such as coliforms and *Lb. fermentum* may decrease in number rapidly in cheese once the sugar substrate is fully utilized while other gas forming bacteria may be found in cheese several months after they have initially caused the defect.

**Preventing Gassy Cheese**

In order for pasteurization to be effective at limiting the number of gas formers in milk, cheesemakers must reduce the number of contaminants in raw milk. This requires due diligence on the farm and in the plant. In this regard, I recommend looking for the gas former directly in raw milk or by enumeration of total *Lactobacilli*. Heterofermentative *Lactobacilli* numbers exceeding 200 CFU per ml of raw milk is cause for concern. Numbers of total *Lactobacilli* in pasteurized milk should be less than one CFU per ml of milk. Numbers greater than five CFU per ml may also be problematic. The number of actual gas formers may be far less than the total number of *Lactobacilli* in either the raw or pasteurized milk, but total *Lactobacilli* is an indication of their presence. I would not count on pasteurization to totally eliminate heterofermentative bacteria from raw milk, so, the goal should be very low numbers of these bacteria and thorough cleaning and sanitation.

From there, it falls to the plant to ensure that the cheesemaking environment is clean. Better cleaning and sanitation is often met with skepticism as almost everyone believes that they are cleaning and sanitizing to the fullest extent possible. Yet, the areas most likely to
contain biofilms are not cleaned every day, i.e. gaskets are not replaced or taken apart and cleaned and sanitized. So, how do we measure success of the cleaning and sanitation system employed? We look for the gas formers directly and it always includes counting the contaminants in the milk supply before and after pasteurization. We also check for residual sugar and gas formers in very young cheese. These sugars should be totally fermented within a few days at most.

In addition to on farm and in plant sanitation, storage or ripening temperatures also play a role in gassy cheese. A high storage or ripening temperature will increase the likelihood that cheese will develop gas defects. Metabolic activities and growth of microorganisms increase as the cheese storage temperature increases and generally temperatures above 50°F is often the main contributing factor in gas development in a cheese. A common denominator of many gassy cheeses is that they were ripened or stored at temperatures of 50°F or higher. Repacking these cheeses and storage at 50°F results in puffy packages that often still contain the presence of a very small amount of citric acid. This combined with the absence of lactose, citric acid or galactose in the repackaged cheese indicates that material released from bacteria after lysis or amino acids could be the substrates fermented by the culprit bacteria resulting in gas formation. Carbon dioxide may be produced at 50°F from either heterofermentative or facultatively heterofermentative bacteria. The latter often being the culprit but hard to detect as the gas former.

Conclusion
Continued investigations into the ecology of bacteria contaminating milk and cheese using DNA technologies will undoubtedly shed new light on the bacteria that can cause gassy defects. In addition, the studying of the biochemistry of these culprits will shed light on what substrates these bacteria ferment to produce gas. However, the strategies described here to reduce the numbers of potential gas formers in cheese coupled with storing cheese at lower temperatures will greatly reduce the incidence of these unsightly defects. 🎉

Contributed by Mark Johnson, Ph.D., CDR

A2 GENE: FACTS AND MYTHS
Contributed by Don Otter, Ph.D., CDR

Over the past few months, CDR has received a number of inquiries about the A2 and A1 genetic variations in milk, particularly in regards to a2 milk®, a product that has been available in places such as Australia since the early 2000s, but only recently made its way to the United States. While A2 is often associated with The a2 Milk Company®, A2 itself is actually a genetic variant of the milk β-casein protein. To clarify and assist consumers, cheesemakers and farmers looking to better understand the A2 gene and how that impacts milk, we’ve compiled the following FAQ. If you have additional questions, please feel free to contact, Don Otter, Ph.D. at dotter@cdr.wisc.edu. Ultimately, the consumption of these types of milk is a choice by consumers; CDR is only providing some current perspectives based on available science.

Question: What is a2 milk® and how is it different from ‘normal’ milk?
Answer: All milk contains proteins, which include casein and whey proteins. Of the proteins in cow’s milk, about 80 percent are casein. There are four types of casein, αs1, αs2, β and κ-casein, occurring in the molar ratio 4:1:4:1. a2 milk® contains a particular genetic variant of the milk β-casein protein. To clarify and assist consumers, cheesemakers and farmers looking to better understand the A2 gene and how that impacts milk, we’ve compiled the following FAQ. If you have additional questions, please feel free to contact, Don Otter, Ph.D. at dotter@cdr.wisc.edu. Ultimately, the consumption of these types of milk is a choice by consumers; CDR is only providing some current perspectives based on available science.

Which cows produce β-casein A2?

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<th>Breed</th>
<th>Description</th>
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<tr>
<td>Holstein, Friesian, Ayshire and British Shorthorn cows</td>
<td>typically produce milk containing approximately 50:50 A1 and A2 β-casein.</td>
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<td>A2 β-casein</td>
<td>is predominant in Channel Island cows, Guernsey and Jersey; in Southern French breeds, Charolais and Limousin and some Zebu cattle. Sheep, goats, buffalo, camels, donkeys and yaks all produce milk that mostly contains A2 β-casein.</td>
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illnesses and diseases. All these suggestions are unproven, and regulatory authorities have not seen credible evidence to support such claims.  

**Question:** What is it about a2 milk® that is different from A1 milk?  
**Answer:** During digestion of milk, the milk proteins are broken up into smaller peptides and amino acids. Some of these peptides are bioactive, meaning they have impacts on human health. Of the 209 amino acids in β-casein, a supposed crucial amino acid in A2 milk is deemed to be the amino acid found at position 67. This amino acid occurs immediately after the sequence 60 to 66 of β-casein, an amino acid sequence that has been shown to be bioactive and has been named β-casomorphin-7.

**Question:** What is ‘β-casomorphin-7’ (BCM-7) and how is it produced?  
**Answer:** BCM-7 is a bioactive peptide of seven amino acids occurring in the amino acid sequence of β-casein as amino acids 60 to 66. After drinking milk, the digestive enzymes in the small intestine release BCM-7 from the β-casein protein by cleaving the Val60-Tyr61 and Ile66-His67 peptide bonds. When the amino acid proline (Pro) is present in the 67 position, the digestive enzymes are not able to cleave the Ile66-Pro67 peptide bond as readily. BCM-7 can act as a weak opioid receptor agonist potentially affecting the gastrointestinal (GI) motility, absorption, secretion and immune function. However, detailed human trials supporting this theory are lacking.

**Question:** Can BCM-7 be produced from A2 milk®?  
**Answer:** Early research suggested that BCM-7 could not be released from a2 milk®, but two recent scientific papers have shown the release of BCM-7 from three of the 15 different types of β-casein genetic variants (including variants A1 and A2) using simulated digestion with human gastrointestinal juices and digestion of β-casein from infant formula. Using gastrointestinal juices from humans would appear to be a closer model to what would happen during actual milk consumption.

**Question:** What health claims are there for A2 milk®?  
**Answer:** Various claims were originally made about the consumption of A1 β-casein but a comprehensive review by the European Food Safety Authority (EFSA) found no relationship between any of the chronic diseases suggested and drinking milk containing A1 β-casein. Currently, the suppliers of A2 products only mention that people who have discomfort when drinking cows’ milk may be able to drink a2 milk® without the downsides or less discomfort. The current scientific evidence supporting any types of health benefits of A2 (or more correctly, non-A1) milk is not very conclusive.

**Question:** How can you test whether your cows will express A2?  
**Answer:** There are two ways to determine what genetic variant of β-casein your cows will produce. The A2 Milk Company® holds a number of patents for a genetic DNA test and claims for the subsequent products produced from A1 β-casein-free milk. In the U.S. the University of California-Davis is testing cows for the A2 gene using the A2 DNA test. Independently, the milk proteins from milk samples of individual cows could be analysed by performance liquid chromatographic methods linked to mass spectrometric detectors (LC-MS).

**Question:** Can anyone operate in the A2 space?  
**Answer:** While you cannot use the A2 milk® name or logo in your product name, it may be possible to use a descriptor on your label to say your milk came from A1-free or A2 β-casein producing cows. A patent and trademark lawyer should be consulted to determine the legal position of any A2 or A1-free product, label or claim.

**Literature**  
PAVING THE WAY: TRAINING AND TECHNICAL SUPPORT IN THE EXPORT MARKET

Contributed by KJ Burrington, CDR

As the industry moves to increase the export volumes of U.S. dairy products and ingredients, it will be increasingly important for the U.S. to have strong research, marketing and training programs in order to compete globally. Fortunately, the Center for Dairy Research (CDR) has great partners like the United States Dairy Export Council (USDEC) with whom we have partnered with for many years to provide a combination of research, training and more for the U.S. dairy industry and export markets around the world. We are always eager to share our work and discuss with industry how we can best help companies to meet their export goals. This article serves that goal, providing an overview of the ways in which CDR and USDEC have worked together to further exports while also expanding upon the ways we can all work together to increase the export volumes of U.S. dairy.

Sharing a Common Goal

The U.S. Dairy Export Council has a 22-year history of working with U.S. manufacturers and suppliers of dairy ingredients. They provide many important member services, which are well explained on their website www.usdec.org but are summarized in the following statement: “The U.S. Dairy Export Council (USDEC) is a non-profit, independent membership organization that represents the global trade interests of U.S. dairy producers, proprietary processors and cooperatives, ingredient suppliers and export traders. Founded in 1995, USDEC’s mission is to enhance demand for U.S. dairy products and ingredients by securing access and assisting suppliers to meet market needs that facilitate sales. Dairy Management Inc., the farmer-funded marketing, promotion and research organization, is USDEC’s primary funder through the dairy checkoff program. The United States Department of Agriculture’s (USDA) Foreign Agricultural Service provides export market development support, and membership dues fund the Council’s trade policy initiatives.”

Similarly, CDR is mainly funded by the dairy checkoff program through the WI Milk Marketing Board (WMMB) and the National Dairy Council (NDC). The Center also seeks to enhance demand for U.S. dairy products by collaborating with the U.S. dairy industry to bring innovative, nutritious and profitable products to the global marketplace. Together, CDR and USDEC share that common goal, which allows us to help industry through many of the initiatives outlined below.

Reverse Trade Missions and Mission Trips

I started my career at CDR as the Coordinator for the newly formed Whey Applications Program in 1997.

CDR started its dairy ingredient training relationship with USDEC shortly after that with a Reverse Trade Mission group from Latin America focused on Confection Applications in 1999. A Reverse Trade Mission (RTM) includes people that work at dairy or food companies from a specific country or region. The people typically work in R&D, but they also might be from purchasing or marketing. They come to CDR to learn about the basics of dairy ingredient composition, processing, functionality and applications. The training combines classroom presentations as well as hands on work in the Applications Lab. Since 1999, CDR has been part of over a dozen of these RTMs. We have also been a part of six cheese trade missions over the past five years.

In addition to RTMs, CDR has provided training outside the U.S. by being a part of Mission Trips to countries where USDEC has overseas offices. I have been a part of these mission trips since 2008, as the food scientist that provides training related to dairy ingredients in support of U.S. dairy ingredient manufacturers. Through USDEC organized seminars and 1:1 meetings with food and dairy companies we have provided training in Mexico, Central America, Japan, South Korea, China, Vietnam, Singapore, Indonesia, Philippines and Thailand.

It is an important way to reach product developers and other influencers at food companies because they see CDR and USDEC as supporting the U.S. dairy industry. CDR has built relationships with U.S. suppliers over the last 20 years and worked with the majority of the dairy ingredients manufacturers in the U.S., so we have a good understanding of each company’s ingredient performance. In many cases, CDR has helped the U.S. dairy ingredient manufacturer understand their own ingredients by doing functionality tests and evaluating the
ingredients in different food applications. This knowledge base helps CDR to recommend U.S ingredients to overseas companies that will best fit their needs, ensuring a greater degree of success. I have been told by more than one R&D person they value our science-based explanation about the performance of milk and whey ingredients, how they differ, and how to get optimal performance out of each of them in different applications. In addition, we show the group examples of many different successful food and beverage products in the U.S. that use U.S. dairy ingredients; sometimes it is a picture or even the actual product for tasting. USDEC backs up the technical information by providing application monographs that are based on research and applications work done in the U.S. that have been translated into the appropriate language for the audience. Primarily, U.S. dairy farmers fund the research and applications work and the message given to overseas companies is that the U.S. has an increasing supply of high quality dairy ingredients that can compete in the global market.

Carving Out Space for U.S. Products
After visiting Asia many times over the last nine years, it is clear that while the dairy ingredient companies from Europe and Oceania were there first, the U.S. now has a much greater presence. Companies also recognize the quality of U.S. dairy ingredients. That fact became clear recently when I was visiting and meeting with a group of nine product developers from a large dairy company in Seoul, Korea after the USDEC U.S. Dairy Business Conference in November. We discussed the topic of poor heat stability of whey protein ingredients in ready to use infant formulas and I asked the product developers if they had tried any of the U.S. heat stable whey protein concentrates (WPC). The response I got was that they had tried heat stable WPC from all over the world and the U.S. ingredients were the most heat stable. They also said they would like even better heat stability than what the U.S. has to offer. That is the first time I have heard that U.S. dairy ingredients were the best at anything on a visit overseas, so it was encouraging to hear.

Heat stability of dairy ingredients is very important for many overseas companies because most of their dairy-based beverages are UHT or retort processed to be shelf stable at room temperature. Heat stability of whey proteins has been a research focus for Dairy Management, Inc. (DMI) since 2005. They funded a large body of research at various U.S. universities from 2005-2012, to improve the heat stability of whey protein ingredients. This work was summarized in a USDEC/DMI Technical Report: Whey Protein Heat Stability published in 2012 (www.thinkusadairy.org/resources-and-insights/resources-and-insights/application-and-technical-materials/technical-report-whey-protein-heat-stability)

Since then CDR has shared this information with several whey protein manufacturers and performed heat stability testing to evaluate the improvements. By sharing research during the mission trips, we have seen a steady increase in whey exports; with whey protein concentrate (WPC) exports increasing 51 percent from 182,000MT in 2010 to 275,000 in 2016 and whey protein isolate increasing 106 percent from 17,000MT in 2010 to 35,000MT in 2016.

Using Research and Education to Find the Optimal Product for Each Market
Another reason that continued training and technical support for dairy and food companies is important both overseas and in the U.S. is because every time I visit an R&D group, there are always newly hired food scientists and many of them have no dairy background. It reinforces the need to routinely visit companies to provide them up-to-date information on new U.S. dairy ingredients that are available and give them the science behind the functionality and potential food applications. One-on-one visits are also critical to building relationships and trust in CDR, USDEC, and the U.S. dairy industry as being their go-to source for information and quality dairy ingredients. U.S. food companies have had a tremendous amount of interest in protein because of consumer trends and companies overseas are no different. This new interest overseas has led to a lot of training on the differences between milk protein and whey protein ingredients and how to use them in high protein foods. I hope that these missions have helped to make U.S. sales jobs easier.

Those same manufacturers also have a lot of permeate or lactose to sell as well. CDR has spent a lot of time developing food applications for permeate. We’ve particularly focused on its ability to reduce sodium in foods and its ability to provide cost reduction in formulations. These formulations have been showcased for RTM groups at CDR, at off-site locations, and/or
at the Institute of Food Technologists (IFT) annual meeting. One RTM that took place in Chicago, in December, 2014 with R&D representatives from nine different food and beverage companies from SE Asia, was focused on permeate. These companies all made a variety of products such as soft serve ice cream, confections, baked products, beverages and snacks. I presented information on the permeate composition and functionality in food applications. Different baked products developed by the CDR Dairy Ingredients staff were also available for tasting so that the group could see the effect on the taste and texture when using whey permeate. Many of these formulations, as well as others CDR has developed, can be found on www.ThinkUSAdairy.org.

In May of 2016, I traveled to Southeast Asia with USDEC and visited many of those companies and saw some of the people I had trained in 2014. I was amazed to see that many of them had already formulated U.S. whey permeate into products that were being sold on the market. I was able to see and taste products and answer questions related to permeate. One of the issues they were having with permeate was browning and clumping during storage. This issue is one that was typical with sweet whey many years ago. It is not an unusual problem for whey ingredients that are high in lactose and being shipped to warm humid climates. The feedback was that permeate from Europe does not brown or clump. I communicated this feedback to the dairy ingredient manufacturers and in some cases, we can use that information to develop new food applications or recommend new research that needs to be done. This is one issue that would be important to resolve for the permeate manufacturers, especially by the time permeate is approved for food use in China. This approval process is one that USDEC, the American Dairy Products Institute and their members have been working on for a few years. I also have been fortunate to be a part of the education process for Chinese regulators and decision makers. Once the CODEX standard for permeate is approved; this should help support the approval process in China.

At times, dairy ingredient issues can be significant enough that we hear it from both U.S. and overseas food companies. One example is, a few years ago, I started getting feedback from U.S. food companies related to issues with chalky texture of milk protein concentrates and isolates (with over 70 percent protein) in protein beverages and Greek Style yogurts. About the same time, I was getting feedback from brokers in China that some of the U.S. MPC ingredients were not very heat stable. Having worked with whey proteins in high protein/high acid clear beverages since 2000, we knew that hydration time and temperature was important for good clarity and heat stability. We also knew from past research that MPC is much slower to hydrate which meant that we needed to communicate optimal hydration conditions in terms of time and temperature to companies making high protein foods. This issue has led us to survey the literature for different methods of measuring hydration and overall solubility of an MPC. In the past year and a half, we chose a method and have used it to determine the optimal hydration conditions for MPC. We have also passed this information on to U.S. MPC and MPI manufacturers and many companies that make high protein yogurts and beverages. It has made a huge difference in helping them to make a product with a good texture and flavor. This year CDR also held our first Dairy Protein Beverage Applications Short Course and one of the main topics was optimizing the performance of dairy protein ingredients in beverages.

Conclusion
It is our goal in the Dairy Ingredient, Beverages and Cultured Products Programs at CDR to help make the use of U.S. dairy ingredients easier and more understandable for food product developers, especially now that we are in a world of alternative proteins and where every other food protein is “a whey protein wanna-be”. CDR and USDEC are here to help. Whether you are a product developer in the U.S. or overseas, CDR can help you make innovative foods with U.S. dairy ingredients that are good tasting and nutritious. 🍪
CDR VIDEO/WEBSITE UPDATES

The Center for Dairy Research website offers industry a number of unique resources that can aid your company in everything from education to product development. One of the most recent additions to the site is a video section that includes educational clips on a variety of topics. At this time, you can view videos describing CDR program area services, a special feature on the Master Artisan Short Course, which includes the step-by-step manufacture of Burrata and a special feature on dairy beverages, which includes the step-by-step manufacture of a CDR and United States Dairy Export Council (USDEC) original, Whey Cherry Switchel. There’s more to come, so check out the videos and let us know what you would like to see featured on the video page. www.cdr.wisc.edu/about/cdr_video

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CDR SHORT COURSE

Milk Pasteurization  ●  January 9-10
Certificate in Dairy Processing  ●  January 16-April 10
Batch Freezer  ●  January 17-19
Wisconsin Dairy Field Reps.  ●  February 6-7
Wisconsin Process Cheese  ●  February 20-22
Cheese Technology  ●  March 12-16
Cheese Grading  ●  March 20-22
Business 101 for Food & Beverage Entrepreneurs  ●  April 4-5
World of Cheese from Pasture to Plate  ●  April 23-27
Cleaning and Sanitation  ●  May 1
HACCP  ●  May 2
Certificate in Dairy Processing  ●  May 3-July 26
Applied Dairy Chemistry  ●  May 8-9
Cheese Grading  ●  June 5-7
Milk Pasteurization  ●  August 7-8
Certificate in Dairy Processing  ●  September 5-November 28
Dairy Protein Beverages  ●  September 12-13
Master Artisan Course  ●  September 18-20
Cheese Technology  ●  October 1-5
Dairy Ingredient Manufacturing  ●  October 24-25
Cheese Grading  ●  November 7-9
Ice Cream  ●  December 5-7

For more information on each short course see www.cdr.wisc.edu/shortcourses

CONGRATULATIONS TO MARIANNE

Congratulations to CDR Safety and Quality Coordinator Marianne Smukowski on being awarded the 2017 Food Safety Leadership Award from the Wisconsin Association for Food Protection (WAFP). This award is given to those who show a deep commitment to improving food safety through research, training or outreach.

NOTE:

In the last issue of the Dairy Pipeline, Volume 29, Number 3, a recipe was published on page four that contained minor errors. We apologize for this error. The corrected recipe is available online at: www.cdr.wisc.edu/Ingredients/cdr_recipes
SUPPORTING THE NEXT GENERATION OF FOOD SCIENCE PROFESSIONALS

At the Center for Dairy Research, it is our mission to provide the foremost scientific expertise in dairy research, technical support and education. In support of this mission, we continue to seek new ways to develop the next generation of dairy food professionals. In 2015, the CDR Industry Team (CIT) agreed to help with this effort by voting to support two new research projects as well as two new food science graduate students who began their research at the University of Wisconsin-Madison in fall 2016 (see Volume 29 Number 2 for a feature on those students). The tradition continued in 2017, with several new graduate students partnering with CDR staff and the Lucey Lab to work on a number of projects supported by a combination of funding from CIT and the National Dairy Council.

We are thankful for this industry and dairy farmer support and we welcome the opportunity to share a bit about the students and their research with our readers. If you have additional questions about CDR's mission, CIT membership or the student projects, please contact jlucey@cdr.wisc.edu.

Erin Katherine Aversa
Q. What degrees do you currently hold, what degree are you pursuing and how did you become interested in food science?
A. I currently hold a bachelor’s degree in food science from the University of Massachusetts- Amherst. I am working on receiving my master’s degree in Dr. John Lucey’s lab at UW-Madison, studying food science but focusing on cheese research. I first became interested in food science in high school when I was taking AP Chemistry. I was researching related fields and stumbled upon food science; I have been hooked ever since.

Q. Do you have any experience in a dairy plant or on the farm?
A. I did an internship during my junior year of college where I made and worked with processed cheese. I have also been on many dairy plant tours.

Q. What are you researching and what do you hope to discover?
A. I am working on extending the shelf life of natural LMPS mozzarella cheese for export markets. The cheese will be used for pizza application and will be studied over a period of 12 months. The main part of the project is the use of a new type of waterless cooker that can heat curd quickly to high temperature, which will hopefully lessen the degradation of functionality over time. We will also be looking at dairy derived emulsifiers to hopefully reduce oiling out during stretching.

Q. What are your plans for the future?
A. I hope to acquire a job in the dairy industry after the completion of my degree, preferably on the research and development side researching new applications and product ideas.

Claire Collins
Q. What degrees do you currently hold, what degree are you pursuing and how did you become interested in food science?
A. I currently have a Bachelor’s of Science degree in food science with a minor in Culinary Science from Iowa State University. I graduated in May 2017. I originally became interested in nutrition in middle school, leading to an interest in cooking and baking. While originally looking at nutrition programs for my undergraduate studies, I discovered food science to be in many of the same departments. After researching what food science is, I realized I was more interested in working in a lab setting directly with food than studying nutrition.

Q. Do you have any experience in a dairy plant or on the farm?
A. As an undergrad at Iowa State, I worked as an undergraduate research assistant under Dr. Stephanie Clark. Through various projects, I was able to collect milk at the ISU Dairy Teaching Farm for sampling, assist in making batches of Baby Swiss cheese, sonicate milk samples, and help serve samples to a trained yogurt panel.

Q. What are you researching and what do you hope to discover?
A. I am currently researching 640 pound blocks of Cheddar cheese. I am trying to develop different strategies in order to minimize the amount of moisture migration that occurs within the blocks and am hoping to help create more consistent blocks of manufactured cheese.

Q. What are your plans for the future?
A. After finishing my master’s degree, I plan to work in the dairy industry, specifically continuing to work with cheese.

Brittney Riebel
Q. What degrees do you currently hold, what degree are you pursuing and how did you become interested in food science?
A. I received my Bachelor of Science degree in food science with a minor in food safety from North Dakota State University in May 2016. Currently, I am halfway through my second year working towards earning a master’s degree with adviser Dr. John Lucey. My interest in food science began in early high school through numerous 4-H food and nutrition projects.

Q. Do you have any experience in a dairy plant or on the farm?
A. Though I did not grow up on a farm, I grew up in a rural farming community where several of my uncles and friends’ families farmed. Additionally, I was an active
member in 4-H for 11 years and was very involved in raising and showing goats and rabbits for many years.

Q. What are you researching and what do you hope to discover?
A. I am working on designing a novel Cheddar cheese base to be used for processing that has minimal proteolysis and retains a very high level of insoluble calcium crosslinking of protein during extended refrigerated storage. This base would maintain good “body”, desirable as an ingredient in process cheese, thus suiting greater flexibility and market applications.

Q. What are your plans for the future?
A. Once I complete my master’s degree, I plan to work in the dairy industry, hoping to work in an R&D or ingredient application position.

Varsha Swaminathan

Q. What degrees do you currently hold, what degree are you pursuing and how did you become interested in food science?
A. I got my bachelor’s degree in Food Process Engineering and I’m currently pursuing my master’s in food science. While working on my undergraduate degree, I visited a lot of food industries and learned a lot about how various types of foods are being processed. Now, I want to look at the foods from a different perspective and learn more about the components and the factors that make them behave a certain way. Hence, food science.

Q. Do you have any experience in a dairy plant or on the farm?
A. I was an intern at a dairy plant (Hatsun Agro Products limited, Tamil Nadu, India) for about three months. After coming to the United States, I worked at the Babcock Dairy plant for two months assisting with the cheese production.

Q. What are you researching and what do you hope to discover?
A. I’m working on the separation of phospholipids from whey protein phospholipid concentrate (WPPC). WPPC is one of the underutilized dairy ingredients. Due to its inconsistent composition, it does not have a good overall functionality, but it has a relatively high amount of phospholipids. We believe that by isolating the phospholipids, we will be able to produce two unique ingredients (protein and phospholipids) with improved functionality. A product enriched in phospholipids could potentially be described as “dairy-based lecithin”.

Q. What are your plans for the future?
A. I am planning to do a Ph.D. after my master’s to ensure that I have a strong foundation in the field, but ultimately, I want to work in the dairy industry.

Emily Simonson

Q. What degrees do you currently hold, what degree are you pursuing and how did you become interested in food science?
A. I have a bachelor’s in food science and Technology from Iowa State University. I’ve always been interested in food science, since my mother has her Ph.D. in food science and has been in the industry my whole life. She has been a great role model to look up to and has been a great source of inspiration and knowledge during my studies and internships.

Q. Do you have any experience in a dairy plant or on the farm?
A. I have no dairy plant or farm experience, but during my time as an undergraduate I was involved in the Dairy Product Evaluation Team for two years and I was on the National Dairy Council (NDC) New Dairy Product Development Team my junior year, in which we won 2nd place. I also did two R&D internships with Land O’ Lakes and was able to work with butter and process cheese during my time there.

Q. What are you researching and what do you hope to discover?
A. I’m researching the use of Whey Protein Phospholipid Concentrate (WPPC) in food applications, focusing on process cheese at the moment. I’m hoping to be able to test different usage levels as a replacement for other dairy ingredients and will be observing any changes to the properties in the hopes that WPPC is a viable replacement in that system.

Q. What are your plans for the future?
A. After obtaining my masters in Food Science, I’m looking forward to starting full-time work in the dairy industry. At this point, I’m hoping to go back to working in R&D, since it’s such a great passion of mine. 🍀
TAKE ADVANTAGE OF THE COMMERCIALIZATION ASSISTANCE AVAILABLE THROUGH THE CDR TURBO PROGRAM

Serving as a complete package for start-ups and growing companies who are interested in the food technology sector, the CDR TURBO (Tech Transfer, University Research and Business Opportunities) program provides U.S. companies with access to a number of product development and business planning resources. These resources include access to the CDR pilot plant facilities as well as CDR staff, who have a well-established reputation for successful dairy product development. We are honored to have helped so many members of the industry to grow and succeed and we look forward to new opportunities in 2018. To learn how the TURBO program can help you, contact TURBO program manager, Vic Grassman at vgrassman@cdr.wisc.edu

Dairy Pipeline

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Short Course Calendar:

- Milk Pasteurization, January 9-10
- Certificate in Dairy Processing, January 16-April 10
- Batch Freezer, January 17-19
- Wisconsin Dairy Field Reps., February 6-7
- Process Cheese, February 20-22
- Cheese Technology, March 12-16
- Business 101 for Food & Beverage Entrepreneurs, April 4-5

For detailed information on each CDR short course: www.cdr.wisc.edu/shortcourses

Events

Future Dairy Forum 2018

January 21-24

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