In 2011, Homan began his work with CDR, attending brainstorming sessions at the Center and discussing possible cheese varieties with the CDR Cheese group. At this time, Red Barn was already supplying the milk for their first cheese, Heritage Weis Reserve, a white Cheddar, which was being made by Wayne Hintz at Springside Cheese in Oconto Falls, Wisconsin. The cheese had been a success winning several U.S. and World Championship awards and Homan was now interested in adding additional cheeses to their line. After several brainstorming sessions, CDR Cheese Applications Coordinator John Jaeggi and Cheese Applications Assistant Coordinator Dana Wolle helped Homan in his decision to manufacture a New Zealand style Cheddar which Homan named Edun.

“We were pleased with the New Zealand style Cheddar recipe because that style is known to let the quality of the milk and the simple notes of a cheese really shine through,” said Homan.

After spending their childhoods on dairy farms in the Midwest Terry and Paula Homan wanted to do something to ensure a bright future for the small, family dairy farm. A large animal veterinarian by trade, Terry Homan was looking for a way to incorporate his passion for good animal husbandry into a business that would support the growth of Wisconsin family owned dairies. In 2008 the Homan family had the opportunity to fulfill that dream, opening Red Barn Family Farms, LLC, which operates out of Appleton, Wisconsin.

“We saw a lot of value in the family farm and we wanted to see them succeed,” said Terry Homan. “We started out small, sourcing fluid milk from two local farms who agreed to adhere to our Red Barn Rules.”

The Red Barn Rules are at the core of the Homan business and are based off of the Veterinarian Oath, which states that scientific knowledge and skills should be used to benefit society through the protection of animal health, welfare, the conservation of animal resources and the promotion of public health. Therefore, all of Red Barn Family Farm milk comes from small, family-run farms that milk 70 or fewer cows and are American Humane Association Certified. Homan also uses a unique pay structure that rewards the farmers for excellent milk quality and animal health, both of which are measured several times a year per the Red Barn Rules agreement.

“I really believe that this attention to detail is what makes our milk great,” said Homan, who quickly became interested in developing a line of cheeses that could be manufactured from the fluid milk he was sourcing. “We realized pretty early on that incorporating cheese into our line was going to be an important part of our future. We were interested in developing a cheese that would really let the quality of the milk speak for itself and that’s where the Center for Dairy Research was able to help us.”
By 2012 Homan, Willow Creek cheesemaker Jon Metzig and the CDR Cheese group were making test batches of the cheese in the CDR pilot plant. The batch trials were successful so the team moved the scale-up trials to Willow Creek where Metzig is currently manufacturing the cheese, which requires six months to a year of aging before it can be sold.

“We were very thankful to John Jaeggi for shepherding us along during this process,” said Homan. “In the end, we have a great cheese that has a wonderful buttery, sweet milky flavor. It melts beautifully and is ideal for baking or for use as a table cheese. We also now have the option of selling this cheese as a reserve. We’ve found that the cheese has a nutty flavor with a mild tang when it has been aged out three to four years and we hope to begin selling the reserve in various retailers around Wisconsin soon.”

In addition to Edun, Homan and the CDR Cheese group had an idea for another cheese. This time, Red Barns was looking to develop an American original that could fill a niche in the cheese industry.

“We were excited to help Red Barn Family Farms in developing another cheese,” said Jaeggi. “We wanted to recommend a unique cheese that would be successful in the market place. Based on the brainstorming sessions, a Parrano style cheese seemed to fit well into Terry’s line of products and it is a unique style that very few people are manufacturing.”

Parrano style cheese is essentially a hybrid between Parmesan and Gouda. Known for its unique mix of fruity flavors with caramelized buttery notes, this style of cheese is considered to be the best of both worlds when it comes to Parmesans and Goudas.

“We are very excited about our Parrano style cheese which we named Ctopola,” said Homan. “It’s our first American original and we are so pleased with the recipe that CDR helped us to develop.”

Much like Edun, the first few batches of cupola were made at CDR with the help of the CDR Cheese group. Homan partnered with cheesemaker Katie Fuhrmann of LaClare Farms to manufacture Ctopola which is produced in 11 lb Gouda style wheels and is generally aged for six to nine months before being sold.

“Ctopola is a sweet cheese with a milky background,” said Homan. “It has a sweet caramel note and many people think it tastes like a toasted pineapple. It is an excellent table cheese but we’ve also had success melting it on fish, croquets and really in any dish that calls for a sweet Parmesan flavor.”

At this time, Edun and Heritage Weis Reserve can be purchased on the company’s website. The site also includes a list of stores that carry Red Barn Family Farm products. There is currently a waiting list for those interested in purchasing Ctopola.

“We really value the animals, the farmers, and everyone who has worked with us and helped us along the way,” said Homan. “Our emphasis on ethics, animal husbandry and the small, family farm is really about providing the best of what Wisconsin has to offer. We are excited to continue our work and we are looking forward to launching a new cheese we’ve been working on with CDR in late 2015.”

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**Wisconsin’s dairy industry in 2013**

_Facts about the Wisconsin dairy industry compiled by The Wisconsin Milk Marketing Board:

- **3.206 billion** Gallons of milk produced
- **10.860** Number of licensed dairy farms
- **1.27 million** Number of dairy cows
- **2.84 billion** Pounds of cheese produced
- **962 million** Pounds of Mozzarella cheese produced
- **25.5%** Cheese production as a percentage of the U.S. total

**America’s Dairyland**

 SOURCE: The Wisconsin Milk Marketing Board compiled from the USDA and other federal government sources

 NOTE: Numbers are rounded up or down

 State Journal
Sweet, acid and fermented whey can fall into additional categories such as organic, Grade A, kosher and halal. These designations are often misunderstood as there can be complex rules and regulations that surround each category. Given the confusion that surrounds this information CDR researcher Karen Smith, Ph.D. recently developed a handbook on the basics of whey processing that will facilitate a better understanding of these categories. Excerpts from her handbook can be found below including exceptions and examples that should be noted when dealing with each category. For more information on this topic please contact Dr. Smith smith@cdr.wisc.edu.

Organic
Organic whey must meet regulations for organic products as defined by the United States Department of Agriculture (USDA) in the Code of Federal Regulations (CFR). Auditors ensure compliance to prescribed practices which are designed to ensure segregation of organic and nonorganic products within a plant and use of organic ingredients (such as defoamer) in organic whey ingredients.

Grade A
Grade A whey products must be produced from Grade A milk that is processed in a Grade A plant. The Grade A designation focuses on aspects such as design of equipment, product sampling, water quality and handling, dairy farm construction, cleaning/sanitizing procedures, product testing, employee training, etc. with plant inspections to ensure compliance with all aspects of the designation.

Grade A is outlined in the "Grade A Pasteurized Milk Ordinance" (Includes provisions from the Grade A Condensed and Dry Milk Products and Condensed and Dry Whey - Supplement I to the Grade A PMO. The document is produced by the United States Public Health Services [USPHS] and Food and Drug Administration [FDA]).

Kosher
Kosher refers to foods that conform to the rules of kashrut (Jewish dietary law). Kosher dietary law prohibits several food products such as: pork, shellfish, mixtures of meat and dairy and, animal blood. Alcohol is permitted but the source of the alcohol can be a concern.

Kosher whey must meet the rules of the rabbinical organization and the rabbi giving approval. There are several organizations that oversee the application of kosher requirements. Circle K and Circle U are two of the more common organizations that are involved with the dairy industry. Symbols such as those in Figure 1 on bags of dry whey ingredients indicate the product is kosher with the "D" indicating the product is dairy. In contrast, the letter “P”, or parve, means neutral and indicates a food with neither dairy nor meat ingredients.

All kosher milk products must be derived from kosher animals and may not be mixed with the milk from a non-kosher animal. A kosher animal must both have cloven hooves and chew its cud. Pigs are excluded because although they have cloven hooves they do not chew their cud. Camels likewise are excluded because they are cud chews but do not have cloven hooves. Cows, goats and sheep are considered kosher animals.

There are several kosher requirements specific to dairy. Rennet used to produce cheese must either be from kosher calves or kosher certified fermentation produced chymosin. The vast majority of rennet used by the dairy industry is produced by fermentation and is therefore kosher. Rennet from an animal such as a camel or non-kosher calf would not be permitted in a kosher product. Any enzymes, for example proteases and lipases, used in the process must be kosher. This includes enzymes used in the production of cheese or products such as lactose hydrolyzed whey or whey hydrolysates. Any defoamers used as processing aides must not contain animal fats and the origin and prior handling of all ingredients must be known. Included in this category would be items such as starter media for cheese production, salt, calcium chloride, etc. A kosher certificate is required unless the item is kosher by definition (milk, for example, is kosher by definition).

It should be noted that kosher whey often comes from cheese that is not certified kosher. As long as all of the components of the cheese are kosher even if the cheese itself has not been certified as kosher, the whey from such cheese can still be considered kosher.

Continued on page 6
Over the past few years, consumers have shown a greater interest in understanding where their food comes from and how it is manufactured. It can be difficult, however, for a plant to explain all of the stages a product goes through during manufacture, so we’ve created this visual which can be used as an educational tool. This graphic illustrates the path of a product from “Farm to Fork” in order to help consumers learn more about the equipment and processes used to manufacture their food. This particular visual illustrates the path that whey products take as they move through manufacture but CDR has also created a similar graphic that can be used to explain the manufacture of yogurt. If you have any questions or comments regarding these visuals, please feel free to contact Karen Smith, Ph.D at smith@cdr.wisc.edu.
### Non-Toxigenic E. Coli: New Regulations Under Consideration

**Technical Contributors:** Dean Sommer & Marianne Smukowski, CDR; Kathy Glass, Ph.D., Food Research Institute

Escherichia coli or *E. coli* is a gram negative organism that comes in a variety of strains. *E. coli* is a member of the Enterobacteriaceae family of bacteria which include a host of disease causing bacteria including Salmonella, Yersinia, Shigella, and other bad actors. Most people associate the term *E. coli* with the *E. coli* O157:H7 strain which is infectious and known for causing severe illnesses, but the vast majority of *E. coli* strains are actually harmless.

Given that non-toxigenic *E. coli* is not infectious many in the dairy industry may be wondering why the Food and Drug Administration (FDA) has shown a great deal of concern regarding non-toxigenic *E. coli* in cheese. The reason for this is grounded in the biology of non-toxigenic *E. coli* and the fact that the presence of a non-toxic strain serves as an indicator for an increased probability of contamination from other pathogenic bacteria as well.

### Kosher and Halal Certification Compatibilities

Whey and whey ingredients generally are readily certified as both kosher and halal. Milk from cows, sheep and goats is considered acceptable by both groups. Pork or pork derived materials are prohibited by both. Alcohol is expressly forbidden by Islamic law so no components containing alcohol may be used to have both certifications. Enzymes from non-animal sources generally are permitted by both groups.

One area of conflict is with enzymes produced through the slaughter of animals. For example, a lipase extracted from kid or goat would be an enzyme from an animal source. Chymosin produced by bacterial fermentation would not be an example of an animal sourced product.

Enzymes from animals are permitted by both groups as long as the animal has been properly slaughtered. Unfortunately, kosher and halal slaughter processes differ and are not mutually compatible. Therefore, there are certain ingredients, typically enzymes such as lipases, that can either be kosher or halal but not both. Whey resulting from such a product also could only be certified as one or the other but not both. The determining factor for certification would be whether the product used was kosher or halal.

### The Science Behind E. Coli

As stated above, *E. coli* is a gram negative organism that is typically sensitive to heat. When milk is pasteurized, *E. coli* is destroyed. Given this fact, any *E. coli*, non-toxic or otherwise, that is found on a cheese product after pasteurization is a red flag that contamination occurred somewhere in the process after pasteurization. Since *E. coli* is an organism that is generally found in the digestive track, any *E. coli* present on a pasteurized milk cheese is a sure sign that insanitary conditions have occurred, whether it be poor sanitation of machinery or the unwashed hands of an employee. So, the presence of *E. coli* can be used as an indicator that there is an increased probability of pathogenic bacteria in that product. In regards to raw milk, *E. coli* is a common contaminant of raw milk since it is present in manure and the farm environment.

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**Figure 2:** Symbols indicating halal certification.
including often on the cow’s hide and the surface of the cow’s teats and udder. Some strains can also cause mastitis and thus can be found in the milk directly coming from the udder. Therefore the presence of non-toxigenic \textit{E. coli} could have come either from the raw milk itself or from cross-contamination during processing in the cheese plant. However, in either case, whether you are using raw or pasteurized milk, finding \textit{E. coli} in your cheese is a cause for concern.

\textbf{By the Numbers}

The FDA regulates the allowable levels of non-toxigenic \textit{E. coli} by using MPN/g which stands for Most Probable Number per gram. This is a statistically based microbiological laboratory technique where multiple dilutions of the sample are inoculated in multiple tubes of media per dilution. The result is a more sensitive method than counting organisms on standard plates or films and a quantitative method which will give you a more reliable estimation of the count of numbers of organisms present. This technique has been used for decades as a way to test for coliform contamination of well water samples.

Previously, FDA had a limit on non-toxigenic \textit{E. coli} of 10,000 MPN/g cheese. Within the last few years, FDA has lowered the enforcement limit on this organism. Currently, if five subsamples of cheese are tested, three of the subsamples must be $<10$ MPN/g and no sample can be $>100$ MPN/g cheese. Clearly the new limits are much more stringent, but reflect the need for process control and plant and employee hygiene to maintain food safety.

\textit{E. coli} in the dairy plant

Cheesemakers often ask, can \textit{E. coli} live freely in the dairy plant? There is actually little published data on this topic, but at this time the scientific community seems to agree that while unlikely, \textit{E. coli} can find a niche within the plant environment and live freely for an extended period of time. Keep in mind that any \textit{E. coli} in the plant originated from some fecal contamination, such as manure contaminated milk or unsanitary hands of plant workers, but once the bacteria finds a comfortable home, it can live in a plant environment for a considerable period of time. Niche areas can include cracked jackets of processing vessels and curd tables, cheese fine saver equipment, cracked jackets of milk storage tanks, and separators so be sure to clean those areas very thoroughly. Experience shows that \textit{E. coli} in a dairy product may not necessarily indicate an immediate direct contact of fecal material (such as the unsanitary hands of a dairy plant worker or direct contact with animal fecal material), but rather a secondary contact with an unsanitary niche environment in the plant, so regular and proper sanitation is imperative.

Cheesemakers have also often asked, will \textit{E. coli} or other coliforms die off during cheese aging? The first thing to note is the scientific difference between \textit{E. coli} and other coliforms. While both are in the group Enterobacteriaceae, \textit{E. coli} is thought to originate in the intestinal tracts of warm blooded animals, whereas the other members of the coliform group can often be found free living in the general environment.

That is why specifically the genus Escherichia (the \textit{E. in E. coli}) is termed a fecal coliform and the other members of the coliform group are not. Other than some strains of \textit{E. coli} most of the members of the coliform group are considered harmless. Nevertheless, the presence of any coliforms in a finished dairy product is taken as a sign of possible unsanitary conditions during the milk harvesting and handling, and/or the dairy product manufacturing processes.

So, to answer the question, yes, the bacteria will likely die off over time, but the rate of death is dependent on the strain. Generally, experience says that \textit{E. coli} dies off at a rate of a one log reduction in counts per month during cheese storage assuming the cheese has a relatively low pH, such as $<5.2$ and preferably $<5.1$, a salt content of 1.5 percent or higher, and a moisture content of $<42\%$. Furthermore, coliforms and \textit{E. coli} will die off faster in cheeses with inhibitory and harsh bacterial environmental composition if the cheeses are stored at a warmer temperature, such as 45-50F. However, this rate of die off is very strain specific; some strains are acid and salt tolerant, and it has been observed that some strains of coliforms and \textit{E. coli} will survive with little die off for many months or even years of aging. Ultimately, it isn’t reliable to count on die off during cheese aging and ripening to reduce coliform or \textit{E. coli} counts in cheese. Also, remember that just because \textit{E. coli} dies off during aging is no guarantee that other pathogens have also died off at the same rate. Therefore, every effort should be made to prevent \textit{E. coli} contamination of the product during manufacture.

\textbf{What should we expect in regards to regulations?}

The FDA continues to review its policy with respect to non-toxigenic \textit{E. coli} and continues to keep a dialog open with the dairy industry including the American Cheese Society and the International Dairy Foods Association. There is little doubt, however, that the tolerance for non-toxigenic \textit{E. coli} has decreased and one might suspect that trend is likely to continue. Therefore, due to the importance of creating safe and wholesome products and maintaining a positive future for our industry, it is best for the industry to adopt practices that will prevent non-toxigenic \textit{E. coli} contamination of our cheeses and dairy products so that we can continue to guarantee a safe and delicious product for our consumers.
Mark your calendars for the April Wisconsin Cheese Industry Conference (WCIC) co-hosted by CDR and WCMA at the Alliant Energy Center, Madison, Wisc. CDR will be offering a technical session on Thursday morning, April 23, 2015 focusing on the latest research related to topics such as product safety, microbiology of cheese rinds, and use of Milk Protein Concentrates in cheesemaking. This year CDR will also be conducting two workshops on flavor defects on Thursday afternoon: one on cheese and one on whey. These hands-on workshops will feature sampling, troubleshooting and solutions.

Join the nation’s top seminar for the cheese, butter and whey industry. For conference updates, visit www.cheeseconference.org.

**Short Course Calendar:**
- Milk Pasteurization, January 6-7
- Batch Freezer Course, January 13-15
- Dairy Field Reps, February 10-12
- Process Cheese, February 24-25
- Buttermakers, March 3-5
- Cheese Tech, March 23-27

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

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