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A TALE OF TWO CHEESES: HOW CDR HELPED SARO YAYLOYAN USE WISCONSIN MILK TO BRING TRADITIONAL ARMENIAN CHEESE TO AMERICA

For cheesemaker and entrepreneur Saro Yayloyan, bringing traditional Armenian cheese to the United States was a personal journey that spans a decade and two continents. In fact, it all began while Yayloyan was studying architecture in his native Armenia. It was there that he learned of a program that would allow him to travel to the United States to gain work experience. Eager to learn and explore new opportunities, Yayloyan applied to the program, enduring a process that he says was difficult and costly. With the support of his family and a little tenacity, Yayloyan was accepted and made his way to Egg Harbor, Wisconsin where he had secured a job in the service industry. Surrounded by some of the best cheese in the world, it wasn't long before Yayloyan found his way into a cheese plant and began exploring the art of cheesemaking.

From there, Yayloyan's passion grew, but despite his connections within the cheese industry he found it difficult to find traditional Armenian cheese styles such as Lori and Chanakh in the United States. So in 2015, Yayloyan decided to do something about it. He reached out to the Cheese Industry and Applications Group at the Center for Dairy Research (CDR) on the University of Wisconsin-Madison campus to inquire about the development of Armenian-style cheeses.

"About six years ago, I attended a short course at the Center for Dairy Research, where I learned about cheesemaking," said Yayloyan. "I didn't know if they could help me, but I thought I would ask. Gina (Mode) and John (Jaeggi) said they could help and we set up a plan."

CDR offers cheesemakers the opportunity to do product development on site in the CDR pilot plant, on a fee for service basis, while also offering troubleshooting assistance, analytical testing and sensory support, all backed by research. For Yayloyan, CDR staff were able to help him with everything from the make sheet or recipe to securing a manufacturing plant.

"We first met with Saro in 2015 when he came to the center for assistance developing a domestic version of Armenian Lori-style cheese," said Gina Mode, assistant coordinator for the CDR Cheese Industry and Applications Group. "We discussed his objectives, developed a make schedule, and made several vats of cheese in our pilot plant. The fact that Saro was a cheesemaker expedited the process – we spoke the same language and he had a clear idea of what he wanted to achieve. We were also able to put Saro in touch with a local Wisconsin cheesemaker to start producing the cheese using Wisconsin milk."

While Yayloyan is a cheesemaker, he is still working towards a facility of his own. In the meantime, CDR put him in contact with Josh Erickson at Silver Lewis Cheese Company in Monticello, WI, who was willing to help Yayloyan to manufacture the Lori-style cheese he had developed with the help of CDR.

"Josh at Silver Lewis Cheese Co-op was willing to step up and take a chance on me, my company, and Lori cheese when no one else was," Yayloyan said. "Josh has been extremely flexible with adjustments we need to make to the recipes to try to reach our desired outcome. He is knowledgeable and experienced in various ways of making cheese so he can offer suggestions to make our product the best it can be."

To facilitate this unique business relationship between Yayloyan and Silver Lewis Cheese Company, the CDR Cheese Industry and Applications Group connected Erickson and Yayloyan with the CDR Technology Transfer, University Research, Business Opportunity (TURBO) program coordinator, Vic Grassman, who was able to provide Silver Lewis Cheese Company with a reimbursable grant through the Wisconsin Economic Development Corporation (WEDC) that allowed Erickson to purchase the equipment he needed to make this unique style of cheese.

"Silver Lewis Cheese Co-op is a wonderful example of how the combination of the TURBO Program and WEDC grant funds helped a small, rural Wisconsin cheese producer not only develop a new product line but also enabled them to purchase the equipment needed to produce new sales," said Grassman.

From there, Yayloyan was able to secure a distributor who could help him ship the Lori cheese from Monticello, WI to Los Angeles, California, where Yayloyan says there is a growing population of Armenian-Americans looking to indulge in traditional cheeses. Yayloyan is selling his cheese under the company name, Hay Americyan Foods, LLC, which is a nod to his Armenian culture and his wife, who helped him to come up with the name and supported his development of the company.

Launched in May 2016, sales of the Lori cheese, which is a mild, semi-soft, Havarti-like cheese, are doing well and Yayloyan is hopeful that one day he will be able to sell it around the country. Right now, however, he is focusing on his next project, the development of a Chanakh-style cheese that would add to his traditional Armenian cheese line. Again, he's enlisted the help of CDR to make this dream a reality.

"Saro's Chanakh cheese project is a very interesting one," said Andy Johnson, assistant coordinator, CDR Cheese Industry and Applications Group and lead CDR staff member on the Chanakh project. "I have never made this cheese before. It was very interesting learning from Saro about this traditional Armenian cheese and how important it is to the Armenian community in this country. It would be great if, through Saro, both cheeses could be produced in Wisconsin and sold to the Armenian markets throughout the country."

While Chanakh is not yet on the market, Yayloyan says that customers can purchase Lori at Jons Marketplace and Super King stores in Los Angeles, California and other small vendors in the L.A. area. He hopes that the Chanakh cheese will be available there soon. For those at CDR, who work to bring innovative, nutritious and profitable products to the global marketplace, working with Yayloyan to bring this dream to life has been a meaningful experience.

"Saro was great to work with. He is a young energetic guy who is looking to develop a traditional cheese but is also open to trying new ideas and experimenting," said Johnson. "I am trying to support Saro in any way I can with this project and his entire cheese business, as I see him being an important part of the next generation of cheese business leaders in this state."

Mode added, "It's very satisfying to have played a part in bringing Saro's vision to life."

For more on the TURBO program and its reimbursable grant opportunities visit: www.turbo.cdr.wisc.edu
To learn how the CDR Cheese Research and Applications program can help you, visit: www.cdr.wisc.edu/cheese

2018 MASTER ARTISAN COURSE SERIES "SHEEP, GOAT AND MIXED MILK CHEESES"

The Master Artisan Cheese Short Course, September 18-20, is a three-day hands-on course aimed at Wisconsin Master Cheesemakers and other cheesemaking professionals. This year, the focus of the course is sheep, goat, and mixed milk cheeses, and will explore cheesemaking technology and theory unique to these cheeses through hands-on cheesemaking and course lectures. The course lectures will cover all aspects of cheesemaking technology including milk composition, microbiology and cheese production methods, while examining different sheep, goat, and mixed milk cheeses from around the world. Participants will then have the opportunity to put into practice what was learned in lecture by making different styles of cheese in the pilot plant. On the final day, participants will also receive a copy of *Handbook of Milk of Non-Bovine Mammals*.

WHY IS MY PERMEATE CAKING?

Contributed by Karen Smith, Ph.D., CDR

Permeate and other dairy powders are shipped all around the globe and sometimes they arrive in less than flowable conditions, much to the consternation of the customer. A costly burden, manufacturers often ask why this happens and how to better predict and prevent this occurrence. The following article provides insight on this topic including a step-by-step outline of the test professionals at CDR use to predict caking.

First, what is meant by caking?

Caking occurs when a product that was loose and flowable becomes lumpy or even brick-like upon storage (Figure 1). Contrast this with clumping and sticking that occurs during drying (Figure 2). Some dairy components can cause both problems but we are going to focus on only those that result in caking of the product over time.

Figure 1 *Caked dairy powder.*

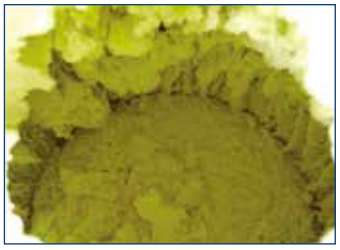


Figure 2 *Sticking during drying.*

So what causes caking?

Components in the powder that are hygroscopic or water loving are the culprits. Hygroscopic materials have the ability to absorb water. Proteins, lactose and minerals are the hygroscopic components in dairy powders. While proteins are water loving they do not cause problems with caking because they can bind water without becoming sticky. Minerals binding water are only a problem at very high moisture contents that are not seen with dairy powders. Lactose, however is generally extremely hygroscopic, leading to issues with caking.

Is caking limited to permeate?

No, permeate just happens to be very good at it.

Nonfat dry milk actually is a classic example of caking with a dairy powder (Figure 3). Nonfat dry milk contains large amounts of amorphous lactose which is very hygroscopic. The amorphous lactose is able to find moisture both in the air and through imperfections in the liner of the packaging material. As the amorphous lactose grabs water molecules the lactose becomes sticky causing powder particles to bind together and form large lumps.

Figure 3 *Caked NFDM.*

What is amorphous lactose?

Lactose comes in several forms: α-hydrate; β-lactose; α-anhydrous (stable and unstable) and; amorphous. When discussing caking we only need to focus on the α-hydrate and amorphous forms of lactose.

Alpha-lactose has one molecule of water built into the crystal and is very stable and not subject to caking. Amorphous lactose, by contrast, contains no water and is thermodynamically unstable. The terms amorphous or glass are used interchangeably and refer to something without structure (Figure 4). Amorphous lactose appears to be a solid but structurally is a liquid. Water is needed for amorphous lactose to form the stable α-lactose crystal.

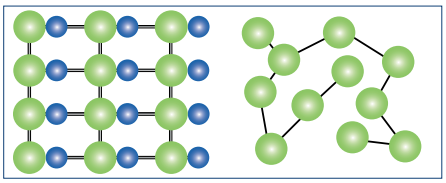


Figure 4 *Crystalline and amorphous structures.*

How does amorphous lactose cause powder to cake?

As we saw previously, powders both with and without protein can cake. The presence of protein simply reduces the severity of caking in susceptible products. We are ignoring the presence of minerals since they do not play a significant role in caking of dairy powders. Let us first look at the process of caking where only lactose is present.

Permeate powder contains α-lactose crystals, amorphous lactose and water (Figure 5). The amorphous lactose attracts water both from within the package and the surrounding atmosphere. The water allows the amorphous lactose to become more mobile and the molecules start to align with each other. Some of the amorphous lactose will find enough water that it will crystallize into α-lactose. Although conversion of amorphous lactose to α-lactose typically is desired, the process causes problems when it occurs in powder. The remaining amorphous lactose becomes "sticky" thanks to the presence of water causing the powder to clump together.

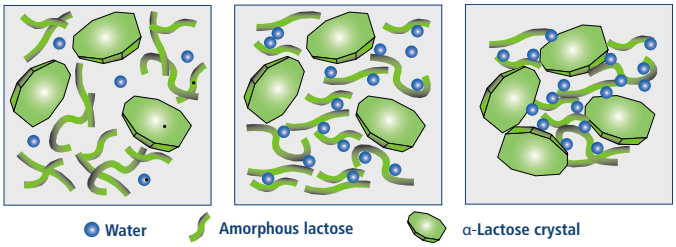


Figure 5 *Process of caking in powder without protein.*

The scenario changes when protein is also present (Figure 6). Both protein and amorphous lactose attract water. The presence of protein limits the availability of water for mobilizing and crystallizing the amorphous lactose. Because less water is available and protein does not become sticky

when binding water, powders containing protein such as NFDM and WPC will exhibit less clumping as compared to powders without protein.

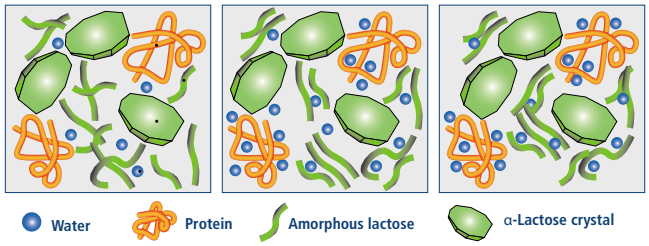


Figure 6 *Process of caking in powder containing protein.*

So shouldn't commercial lactose clump even more than permeate since commercial lactose is 99.8% lactose?

Yes, BUT commercial lactose is produced by first crystallizing the lactose and then washing away the impurities so that it should contain very little amorphous lactose. Crystalline lactose that contains larger amounts of amorphous lactose does in fact cake which makes it excellent for use in tableting (pill manufacture) applications.

So how can I determine if my product will cake?

Tests such as moisture, water activity, composition and product history are used but there are limitations with each.

Moisture – Lactose has both free and bound moisture. Bound water is part of the α-lactose crystal structure while free moisture is not associated with the crystal. Together bound and free moisture make up total moisture. Depending on the analytical method used, one or both are measured. It is the free moisture value that is of concern with caking and product standards.

Loss on drying, typically done with a vacuum oven, measures free water. Standards of identity require free moisture to be less than 1% however, depending on the type of lactose, a loss on drying of less than 0.5% is typical.

The Karl Fischer test measures both free and bound water. Since bound water is assumed to be 5% of the α-lactose crystal structure, anything above 5% moisture by Karl Fischer is considered to be free moisture. For example, if the moisture for lactose is 5.3% by Karl Fischer it is listed as 5% bound moisture, 0.3% free moisture and 5.3% total moisture.

Lactose + water = α-lactose monohydrate crystal
342 + 18 = 360
95% + 5% = 100%
An example of moisture in lactose would be:

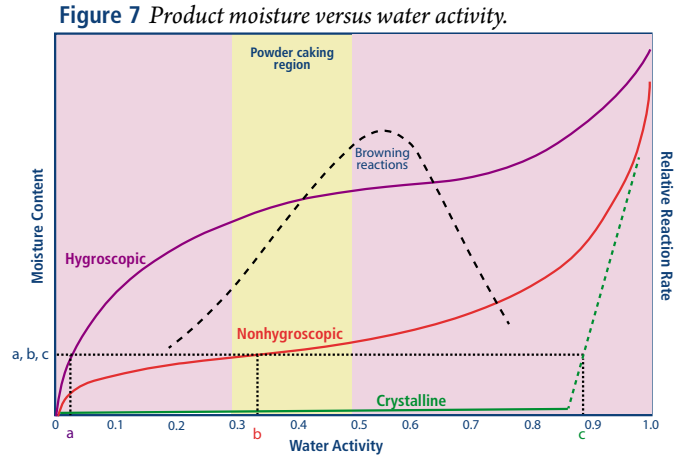
Bound	*Free*	*Total*
5%	*0.3%*	*5.3%*

Using moisture to determine if a powder will cake has limitations. If the value for moisture is high then there is a problem. However, if the value is "correct" then there may or may not be a problem with caking. Quick methods are not accurate and the vacuum method is hard to do accurately for such low moistures. The Karl Fischer test gives accurate numbers but do they relate to caking? Unfortunately, the answer is not necessarily.

Water activity a_w – Water activity is a quick and easy test that describes how tightly held the water is by the molecules. Water activity values range from 0 to 1. A water activity of 1 indicates that all of the water is available while a value of 0 means that none of the water is available. Another way to think of water activity is "How tightly held is the water?"

A plot of product moisture versus water activity gives a curve that indicates product susceptibility to caking, browning, mold growth, etc. (Figure 7). For example, caking of powders typically starts with water activities ranging from 0.3 to 0.5. The relationship of water activity to moisture content of a given product depends on the curve for that product. For a hygroscopic or water loving powder the moisture content would be much higher before a water activity sufficient to cause caking would be reached as compared to nonhygroscopic or crystalline product. This is illustrated in Figure 7 where a hygroscopic, nonhygroscopic and crystalline product with the same moisture content are compared (a, b, c). The hygroscopic material would have a water activity <0.1, the nonhygroscopic powder was a water activity between 0.3 and 0.4 and the crystalline material has a water activity of 0.9.

Figure 7 *Product moisture versus water activity.*



Water activity therefore has severe limitations when used to indicate caking. The test is easy and quick to do but the water activity of a powder changes quickly upon exposure to air so the test must be done immediately from the dryer to have any relevance to caking activity. As discussed above, different products have different water activity plots so it is important to know the plot for your product before you can draw conclusions about caking. Certainly, a higher than typical water activity could indicate a problem but a "correct" value may or may not mean the product will cake upon storage.

Product composition – Knowing the amount of amorphous lactose certainly would be a good indicator of potential for

the product to cake. However, it simply is not practical to determine amorphous lactose on a routine basis.

Product history – This information can be an indicator of future problems. For example, if the lactose has not fully crystallized before the material in the crystallizer is processed then there will be greater amounts of amorphous lactose present and increased potential for caking.

So what would be a good test to use?

There is a test that is specific for determining if a product will cake upon storage. The test is fast, easy and inexpensive and works for all dairy powders (lactose, permeate, whey protein concentrate, milk protein concentrate, etc.).

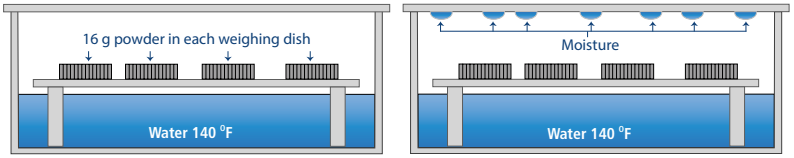
Equipment Needed – (Figure 8)
Plastic container with a shelf, aluminum weighing dish (2" diameter) balance, spatula and hot water (140°F).

Figure 8 *Test equipment*

Instructions – (Figure 9)

- Fill container with 140° F water just below bottom of tray
- Weigh 16g powder into an aluminum weighing dish
- Close lid on container and wait 1 hour
- Open container and place dishes on table for 1 hour
- Tip weigh dish over and empty contents onto paper
- Test powder with spatula
- Evaluate and rate from 1 – 5
    1. Free flowing
    2. Slight crust – breaks up easily
    3. Crust – breaks into chunks, not free flowing
    4. Crust – breaks into chunks, gummy
    5. Crust – does not break up, gummy

Figure 9 *Example of set up for testing caking.*



What are some typical results and how do I interpret the score?

Below is an example of some typical results and scores. (Figure 10). Although it is not possible to tell from the photos whether or not the sample is gummy or how difficult it is to break into pieces it is possible to see major differences.

Scores of 1 or 2 indicate a product that will not cake even under harsh conditions.

Nonfat dry milk – 3 – as expected, NFDM cakes upon storage due to presence of large amounts of amorphous lactose. The protein present limits the hardness of the cake of powder.

MPC70, 80 and 85 – 1 – the large amount of protein and very low amount of lactose in MPCs results in a free flowing powder.

Figure 10 *Results for some dairy powders.*

Whey – 2 to 5 – whey exhibited a wide range of caking scores. How the whey is processed has a very large effect on the tendency of the resulting powder to cake as evident in this result. Clearly, two of the samples had large amounts of amorphous lactose and without the presence of significant amounts of protein the samples readily caked.

WPC35, 80 and WPI – 1 to 2 – the effect of protein on inhibiting caking is clear with the WPC powders. Powders ranged from a score of 1 – 2 and would not have problems with caking during storage.

Whey Protein Phospholipid Concentrate (WPPC) – 1 – WPPC consists largely of protein and fat and therefore caking by amorphous lactose is not a significant problem.

Whey and milk permeates – 1 to 4 – permeates from whey and milk had a wide range for caking scores. Again, this is a result of how the permeate was processed. Permeates that were processed such that they contained less amorphous lactose did not cake.

How do dairy ingredients stack up in general when it comes to caking?

Three things are important to consider when evaluating the potential of a dairy ingredient to cake: amount of lactose, amount of protein and form of lactose present (Table 1). Products that have large amounts of lactose and little protein along with lactose largely in the glass or amorphous form have a high caking potential. It does not mean, however, that

because these products have a high potential to cake that they will cake. It simply means that greater care must be taken to ensure that there is the least amount of amorphous lactose in the final product as possible.

Table 1 *Summary of factors influencing caking and susceptibility to caking of dairy powders.*

Product	Lactose (%)	Protein (%)	Lactose Form		Caking Potential
			Glass	α-Crystal	
NFDM	53	37	X		Medium
MPC42	48	43	X		Medium
MPC70	19	72	X		Low
MPI	0.5	92	X		Very low
Whey	77	13	X	X	High
WPC 34	54	34	X		Medium
WPC 80	8	80	X		Low
WPI	2	93	X		Very low
Permeate	90	1	X	X	Very high
Lactose	99.9	0		X	Very low

So how can I limit caking by my product?
Some methods are more practical than others.
▼ **Slow the absorption of water by the powder**
✳ Use a moisture impervious container. Powdered milk originally was packaged in a metal can thereby keeping moisture in the air from reaching the product.
✳ Use a heavier liner in the bag. Heavier liners typically are a better moisture barrier.
✳ Add lecithin to coat amorphous lactose. Although people have offered this as a possible solution it is not very practical.
▼ **Use a free flowing agent**
✳ In addition to coating and smoothing rough edges of particles so they flow easily, free flowing agents adsorb excess moisture in the product and atmosphere to help limit caking. Free flowing agents are used in products such as table salt to limit clumping. Examples of free flowing agents include calcium silicate, cornstarch, cellulose powders, sodium aluminosilicate and calcium and magnesium carbonate.
✳ Some compounds such as magnesium carbonate may also be referred to as desiccants because of their ability to absorb water.
▼ **Crystallize more lactose**
✳ Run higher total solids from the evaporator. The higher the total solids, the greater the percentage of lactose that can crystallize thereby reducing the overall concentration of amorphous lactose present in the liquid.
✳ Cool to a lower temperature in the crystallizer.
✳ Fully crystallize the lactose in the crystallizer. The process of lactose crystallization is very slow so it is important to allow sufficient time. A refractometer can indicate when a crystallizer is done. Because a refractometer measures only lactose in solution refractometer readings will decline until no additional lactose is crystallizing. Lactose crystallization typically takes at least 16 hours.
✳ Use a secondary dryer to convert additional amorphous lactose to α-lactose.
▼ **Do not mill the product**
✳ Milling creates heat and results in production of amorphous lactose on the surface of the α-lactose crystal.
▼ **Limit temperature and humidity variation in storage**
✳ Often not very practical

So where should I start?

Establish a baseline for your current product(s) using the simple caking test. Product scoring a 1 or 2 should be fine and not cake even under harsh conditions.

Determine why your product cakes. Almost always the problem centers around the presence of too much amorphous lactose so conversion of more amorphous lactose to the α-lactose crystal is a great place to start. Higher total solids from the evaporator, cooler crystallizer, and more time crystallizing are excellent first approaches to the problem. For companies manufacturing lactose the refining step can also be a problem area if insufficient amorphous lactose is removed.

Also, don't forget to ask for help. Customers tend to generalize about a country having caked product in the international market so putting forth a poor product does not help anyone in the U.S. dairy industry. If necessary, segregate product and ship product that will not cake to those markets where it is very likely that storage conditions and time favor caking.

For more information contact Karen Smith smith@cdr.wisc.edu

THANK YOU AND GOOD BYE

After seven wonderful years and 26 editions of the *Dairy Pipeline*, I will be leaving CDR to embark on a new journey. It has been an honor to work on this publication and share important information with each of you. It was particularly wonderful getting to know so many of you as we worked together to get your questions answered and share your greatest successes with the world. Whether it was an article on why cheese curds squeak or the story of a new product such a Yodelay Yogurt or Little Mountain, I truly enjoyed my time celebrating and discussing dairy. Thank you for so many wonderful years and for making the *Dairy Pipeline* a success.

Should you have any questions, concerns or ideas regarding this publication, please feel free to contact communications@cdr.wisc.edu

PARTNERING FOR INNOVATION: CREATING DAIRY-BASED RECIPES FOR IFT18

Contributed by Sarah Minasian, CDR

The Institute of Food Technologists (IFT) Annual Meeting and Food Expo will take place this July in Chicago, Illinois. As CDR's research chef and part of the Dairy Ingredient Applications Group, I have developed two prototypes that will be showcased at the US Dairy Export (USDEC) booth, along with a prototype developed by Midwest Foods Dairy Research Center. The products are a savory Asian granola which will be sampled at the booth and protein enhanced Calamansi Gelatin Snack, will be shared in the USDEC booth as a handout.

So how do I come up with these prototype ideas? My application "thinking cap" is on-going as I attend food shows and conferences, read food industry periodicals, blogs and newsletters, watch television food shows and dine out at cutting-edge restaurants. With endless combinations of food, flavorings and methods, there's an infinite amount of options out there. And that's where USDEC comes in helping to narrow my focus by taking their marketing strategy into account.

During the initial ideation stage, parameters are set by factoring in USDEC's three-fold marketing strategy. Their current strategy is to target the Asian market with adult-oriented flavors, particularly keeping an aging demographic in mind. Take this strategy and combine it with forecasted trend spotting and the ways of the world, mix it until well shaken and top it with full-fat whipped cream and maraschino cherry, and you might get lucky.

There's been a tendency to leave sugar on the stalk and lean toward the savory—without too much salt that is. Snacking is in, as is health. Add this to an adult-oriented flavor and Asian specific ingredients such as sesame oil, nori (dried seaweed), white and black sesame seeds, soy sauce and bean paste, and we're starting to build something.

Crunching is oftentimes associated with snacking, and what better to crunch on than crispy baked granola that comes with its own historical healthy glow? So that's where I went—I combined the aforementioned savory Asian ingredients with oats, honey as an alternative sweetener, sunflower seeds, coconut, sriracha seasoning for a touch of heat, whey permeate as a flavor enhancer, and whey protein crisps which account for 60% of the 6 grams of protein per seving. And you know what? It tastes pretty darn good. Almost addictive by itself, we found it to also pair well as a topping on coconut flavored yogurt. But don't stop there—the Savory Asian Granola would work equally well as a topping on baked potatoes, salad, Asian noodles or even vanilla or fruit-flavored frozen yogurt or ice cream.

The second prototype, a protein enhanced calamansi gelatin snack meets USDEC's Asian target by utilizing the citrus fruit calamansi, which is indigenous to the Philippines. Although calamansi is not that recognizable by the general public, there have been sightings of it on upscale menus. Adult palates will welcome its sweet-tart lemon-lime-orange flavor, and the aging demographic will appreciate its whopping 13 grams of protein (from whey protein isolate) per cup serving in its easy to eat "slurpable" formula.

If you plan on attending IFT18 in Chicago this July, please stop by the USDEC booth to sample our prototypes and/or pick up the corresponding formulation literature, and let us know what you think. We believe you'll come away pleasantly surprised, and ideally, inspired to create similar products promoting dairy ingredients when you get back home. If you are unable to attend IFT18, know that the formulas will be available after the show on the USDEC website, www.ThinkUSADairy.org.

JOIN US IN CONGRATULATING JOHN JAEGGI ON HIS CALS SERVICE AWARD

On May 2nd, 2018, CDR Cheese Research and Applications Coordinator, John Jaeggi received the University of Wisconsin - Madison, College of Agricultural and Life Science (CALS) 2018 Academic Staff Award for Excellence in Service. This award is given annually to those who "go above and beyond the scope of their duties and demonstrate outstanding sustained service and dedication to their individual units."

After more than 30 years in the industry serving as a cheesemaker, judge and technical expert, we certainly believe that John is deserving of this award. Please join us in congratulating him!

Kathryn VandenBosch, CALS Dean and John Jaeggi

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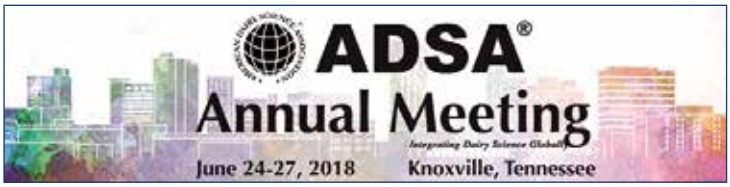
Short Course Calendar:

- Cheese Grading, June 5-7
- Buttermakers, June 20-21
- Buttermakers Apprenticeship, June 25-29
- 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

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

Events



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