CENTER FOR DAIRY RESEARCH

DAIRY PIPELINE

A TECHNICAL RESOURCE FOR DAIRY MANUFACTURERS

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HOW THE CHEESEMAKING PROCESS INFLUENCES MELT AND STRETCH

Cheese is a very versatile food with a wide array of flavors and textures. Cheese can also be made to have a range of different functional characteristics like melting/non-melting. There is a whole spectrum of cheese melt—complete melt (typical pizza cheese), restricted melt (cheese in sausage/meats) and non-melting (cooking cheeses). Cheese melt and stretch has been especially important in recent years as pizza consumption has increased as well as other frozen or packaged foods that utilize cheese as an ingredient (burritos, calzones, etc.).

So, what do we mean when we talk about cheese melt? A chemist will say melt occurs when a substance changes from a solid or crystalline state to a liquid. A food scientist will describe melt as the ability to flow or spread. Typically, we think of cheese melting from high heat, perhaps during baking or grilling. However, some cheeses, like ripened Camembert or Limburger, melt or flow at refrigeration temperature.

Casein Network

The ability of cheese to melt and stretch depends on the interactions of the caseins, the major protein found in milk. Cheese is essentially a spongy matrix of fats, serum or whey, and minerals held together by casein molecules (or aggregates). The melt and stretch properties are based on the number of interactions between casein molecules. We will get into this in more detail, but casein aggregates or strands are held together by bound calcium phosphate in casein network. The fewer the interactions, or the less bound calcium phosphate in the casein network, the greater the melt. Cheese stretch requires an intact, interconnected casein network. If there are very few interactions between casein molecules (or aggregates), there will be less stretch and the melted cheese will be more fluid or "soupy," lacking good stretch. Stretch is the result of casein–casein interactions that are broken easily but also readily reform at different locations in the casein network. For instance, think of holding a piece of warm Mozzarella, take one end in each hand and gently pull it apart. The casein molecules are grabbing and releasing each other while sliding past as you pull the cheese.

Stretch is the ability of the casein network in the cheese to maintain its integrity and not break when pressure is applied to the cheese. We see Mozzarella stretch on a baked pizza but stretch also takes place in cooler temperatures, for instance a Swiss Cheese developing eyes is an example of cheese stretch. ➡

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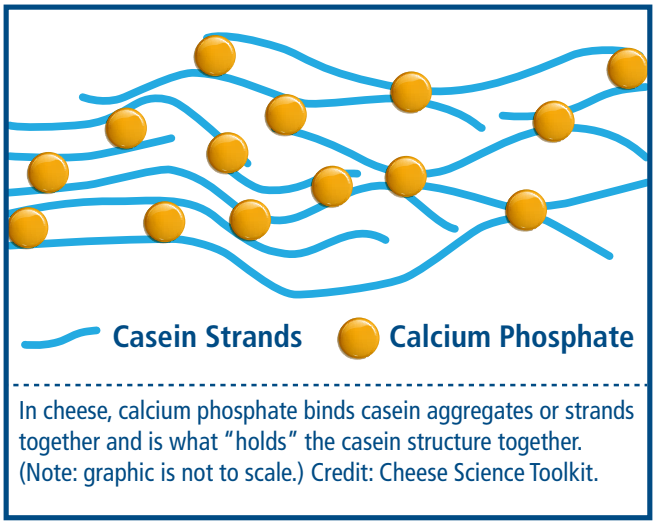
What's Inside:



In cheese, calcium phosphate binds casein aggregates or strands together and is what "holds" the casein structure together. (Note: graphic is not to scale.) Credit: Cheese Science Toolkit.

There are several factors we need to review to understand the casein to casein interactions. Each has an influence on melt and stretch, and there is a great deal of interplay. First, we need to consider the cheese composition, or casein density. Then, there is the amount of interplay between casein molecules partly due to the bound calcium phosphate. These interactions are strongly influenced by pH and temperature. Finally, there is dissolution or breakdown of the casein molecule—proteolysis.

Cheese Composition and its Impact on Melt and Stretch

What's in milk and cheese? There is protein (casein and whey proteins), fats (triglycerides and fatty acids), carbohydrates (lactose, etc.), minerals (calcium, phosphate, etc.) and water. Most of the casein in milk is in micelles or "bundles" of casein molecules. When we make cheese, we add a coagulant to the milk which causes the casein micelles to group together and form casein aggregates or strands. The spaces or pores between the casein aggregates are filled with serum (whey) and milkfat. When the cheese is cut, individual curds begin to shrink as they release the serum. Stirring, heating and acid development also drives serum out of the curd particles. During this time, as the pH of the curd decreases, the casein micelles within the casein aggregates are rearranging and forming new associations. Casein molecules begin to fuse together and form continuous networks or strands of casein molecules, which is necessary for cheese stretch. However, if there is too much acid development, the casein molecules will "disconnect" and reform into aggregates. There is less contact or interactions among the casein aggregates at low pH (<5.0) and therefore less stretch.

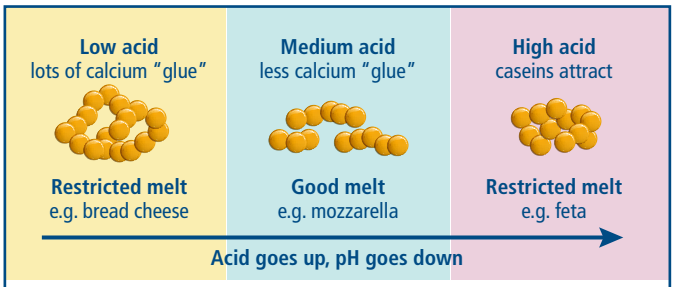
Fat also plays an important role in cheese melt and stretch. In general, higher fat cheeses melt and stretch easier than lower fat cheeses because fat helps dilute the casein network. Milkfat globules surround the casein aggregates but do not interact with them. The milkfat globules separate some of the casein strands, which decreases the number of interactions between casein aggregates. This weakens the casein network and produces a cheese that will melt and stretch more readily and at a cooler temperature than a lower fat cheese.

Typically, lower moisture cheeses will have less melt – think of a young Gouda, which has a higher moisture content compared to an aged Gouda, which is lower in moisture. However, increasing moisture does not guarantee an increase in melt and stretch. For instance, Cottage Cheese is about 80% water but doesn't stretch because of its low pH (~4.6). When the pH is low (<5.0), the casein molecules have equal positive and negative charges and this cause them to stick together resulting in a cheese that will not stretch or melt.

Raising the salt content can also impact the melt/flow of cheese. Salt reduces the hydration of the caseins structure and causes a tightening of the casein network, resulting in a cheese with reduced melt and flow (e.g. Parmesan or Pecorino Romano).

Acidity and Stretch/Melt

Acidity plays a very important role in the ability of cheese to melt and stretch because pH will determine how much bound calcium phosphate is retained in the casein structure. Calcium phosphate binds casein aggregates together and is what "holds" them together when a cheese is stretched. The actual pH at which cheese will begin to melt or stretch depends on the casein content and the amount of bound calcium phosphate in the casein network.



Credit: Cheese Science Toolkit.

Cheeses with a higher pH (~6.3) have more bound calcium phosphate in the casein network, which cause the caseins to be bound or "glued" together, resulting in less melt and stretch. Cheeses with a higher pH include Juustoleipa (Bread Cheese), Queso Fresco and Queso Panela.

As the pH decreases (~5.2-5.4), some of the calcium phosphate is dissolved from the casein network and is replaced by hydrogen H+. This results in a balance of bound and unbound calcium phosphate that allows for a cheese to melt and stretch. Cheeses in the ~5.2-5.4 pH range have good melt and stretch and include Low Moisture Part Skim Mozzarella, Whole Milk Mozzarella, Colby, and Muenster.

However, if the acidity drops to ~4.6 then most of the calcium phosphate is dissolved from the casein structure. As mentioned previously, when the calcium phosphate is dissolved, the charge of the casein molecules will cause them to stick together. Cheeses with low pH include Cottage Cheese, Feta and Cream Cheese.

As we discussed earlier, cheeses with a higher fat content will stretch and melt more readily because of the milkfat globules that are dispersed into the casein network, which limit the interactions between casein strands. So, higher fat cheeses may require a higher bound calcium content (higher pH) to achieve the desired stretch and melt. Likewise, lower fat cheeses, which have a dense casein structure, may require a lower pH to reach the correct bound calcium content to allow the cheese to stretch and melt properly.

In a higher pH cheese, like Juustoleipa, there is more bound calcium phosphate in the casein network, which restricts the melt and stretch of the cheese.

Proteolysis Impact on Melt and Stretch

Proteolysis is the breakdown of proteins into smaller peptides or amino acids. It occurs, typically during aging, when the bonds within the casein molecule are broken by residual rennet or by the acitivity of microorganisms. Proteolysis essentially chops apart the casein network, which results in a cheese that will readily melt but will have limited stretch. Remember, for good stretch, an intact casein network is needed to form strands.

Proteolysis can be slowed down by using less coagulant so that there will be less residual rennet. When making cheeses like Swiss, Parmesan, or Romano, higher cook temperatures can be used to inactivate some of the coagulant. Similarly, when making Mozzrella, a high stretching water temperature can be used to inactive some of the coagulant.

Mold or surface ripened cheeses are examples of cheese that intentionally undergo extensive proteolysis. After aging, these cheeses will essentially melt and flow at room temperature but, of course, have no stretch because the casein network is too broken down to stretch.

Buffering Impact on Melt and Stretch

In addition to proteolysis, another important process occurs during aging: buffering. The "buffering" phase occurs when bound calcium is displaced with hydrogen (H+) and the hydration of the casein. Buffering make take several days to complete and at this time the pH of the cheese will raise or "buffer" up. The loss of bound calcium phosphate in the casein is pH dependent. The lower the pH of the cheese, the faster the hydration and the faster you'll see changes in the melt. This process is important for the increase in the melt and stretch in very young cheese.

Calcium phosphate loss also depends on the pH of the milk at set and the pH of the cheese at drain. The lower the pH at each of these steps, the less bound calcium. For instance, let's say we have two cheeses – "Cheese A" and "Cheese B." Both cheeses have similar finish pHs around 5.4. However, Cheese A has good stretch and melt but Cheese B has bad stretch and melt. To understand what happened, we have to look back at the acid development of the two cheeses. When we look back, we will see that in the case of Cheese B, not enough acid was developed early in the cheesemaking process, resulting in more bound calcium phosphate. This is a common problem in the industry, people are rushing the cheesemaking process and not allowing enough time for the pH to drop sufficiently before adding the coagulant.

In summary, cheese melt and stretch all comes back to the cheese's casein network. Cheese composition, pH, and aging all impact a cheese's casein network and, ultimately, the melt and stretch of a cheese. Understanding these interactions and how these different factors interplay is essential to developing a cheese that achieves the intended functional attributes like melt and stretch.

Sources
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DAIRY PROTEIN PROVIDES VERSATILE FUNCTIONALITY OVER PLANT PROTEIN

Technical contributor: Nathan Price, CDR

Consumers are increasingly looking for more from their food. Nutritional factors such as increased protein content remain high on the list of priorities for consumers. At the same time, consumers desire clean label products with natural and healthy ingredients. Food manufacturers are keenly aware of the need to meet these demands while still delivering great tasting products.

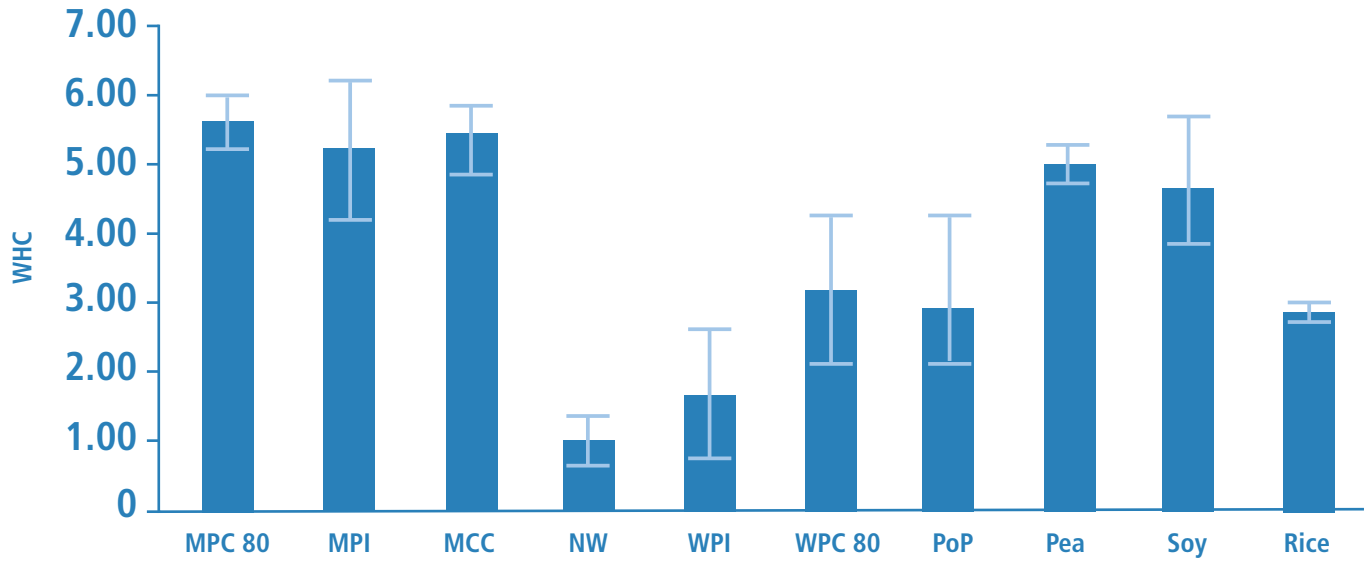
The good news is that dairy products and proteins can deliver both great taste, superior functionality while also meeting consumers' demand for clean label products with natural ingredients. However, dairy industry professionals understand plant proteins are a source that consumers have increasingly turned to as they actively seek more protein in their diets (1). In 2020, the plant protein market had a global value of 9.7 billion dollars and is expected to continue to have significant growth in the coming years (2).

It is important to note, that while plant-based proteins continue to be developed to meet the concerns of consumers, dairy proteins have many significant advantages over their botanical counterparts. All proteins are not created equal.

Functional Superiority

A study conducted at the Center for Dairy Research and funded by the U. S. Dairy Export Council compared the functional properties of various plant and dairy proteins (1). There were interesting differences in the water holding capacity and heat stability of these protein types. Milk protein concentrates (MPC) had the highest water holding capacity, with soy and pea proteins having slightly lower water holding capacities (Figure 1). Whey protein concentrates (WPC), rice and potato proteins had similar but lower water holding capacities than the other proteins. ➡

Figure 1. Water holding capacity (WHC) of various plant and milk proteins.



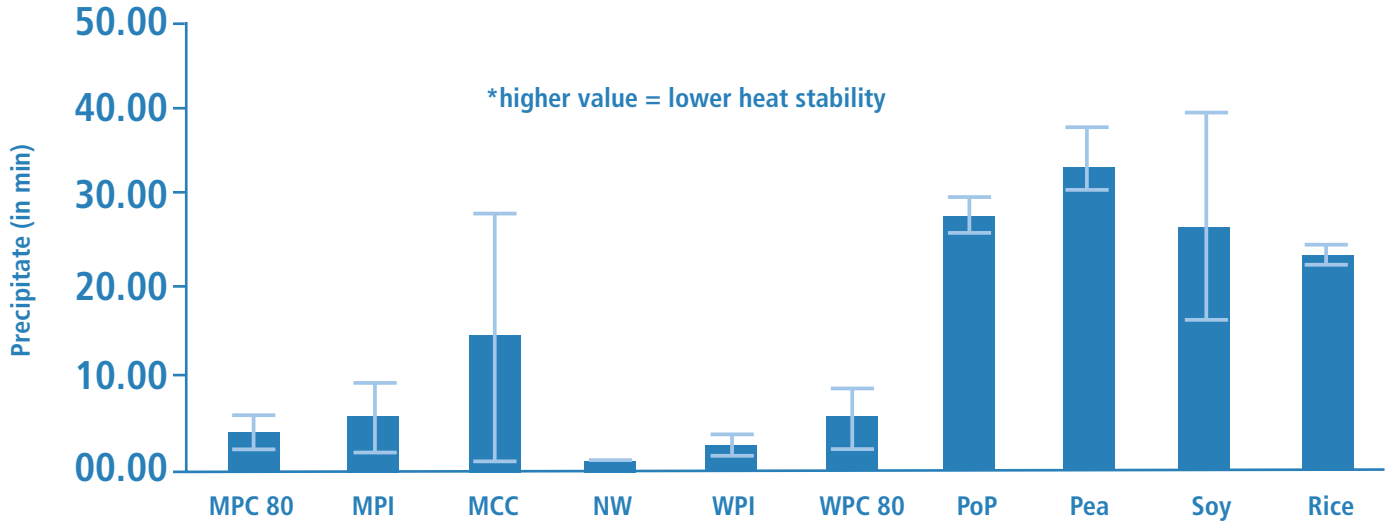
Methodology: Neumann et al., 1984.

Key: Milk Protein Isolate=MPI, Milk Protein Concentrate=MPC 80, Micellar Casein Concentrate=MCC, Milk Whey Protein/Native Whey=NW, Whey Protein Isolate=WPI, Whey Protein Concentrate=WPC 80, Potato Protein=PoP, Pea Protein=Pea, Soy Protein=Soy, Rice Protein=Rice

Source: Kapoor, R., Burrington, K.J., Jiang, H., Larson, S., Drake, M.A. 2017. Characterization of functional and sensory properties of select commercial food protein ingredients. 2017 International Whey Conference, Chicago.

Milk and whey protein concentrates also showed superior heat stability compared to all the plant-based proteins at pH 7 (Figure 2). The higher water holding capacity of milk proteins and the heat stability of both milk and whey proteins indicates that they would perform well in a wide array of food applications such as soups, sauces, bakery and food beverage. It is this wide range of functionalities that allows both milk and whey proteins to perform well across a wide array of food products.

Figure 2. Heat stability of various plant and milk proteins at pH 7.



Methodology: Harper and Lee, 1988.

Key: Milk Protein Isolate=MPI, Milk Protein Concentrate=MPC 80, Micellar Casein Concentrate=MCC, Milk Whey Protein/Native Whey=NW, Whey Protein Isolate=WPI, Whey Protein Concentrate=WPC 80, Potato Protein=PoP, Pea Protein=Pea, Soy Protein=Soy, Rice Protein=Rice

Source: Kapoor, R., Burrington, K.J., Jiang, H., Larson, S., Drake, M.A. 2017. Characterization of functional and sensory properties of select commercial food protein ingredients. 2017 International Whey Conference, Chicago.

Milk is Minimally Processed

As outlined above, the functionality of proteins is a key consideration for product development. Minor differences in functionality between protein sources often requires further processing and can also mean major formulation changes to deliver on consumer expectations of quality.

Plant proteins typically have larger molecular weights compared to dairy protein, which limit their functional properties. As such, further processing or additional ingredients are typically required to improve the functionality of plant-based proteins. This is in addition to the subsequent addition of other additives needed to boost functionality in finished food products.

Milk, on the other hand is subjected to simple, physical processes that separate and concentrate the various protein fractions which retain their superior functionality properties.

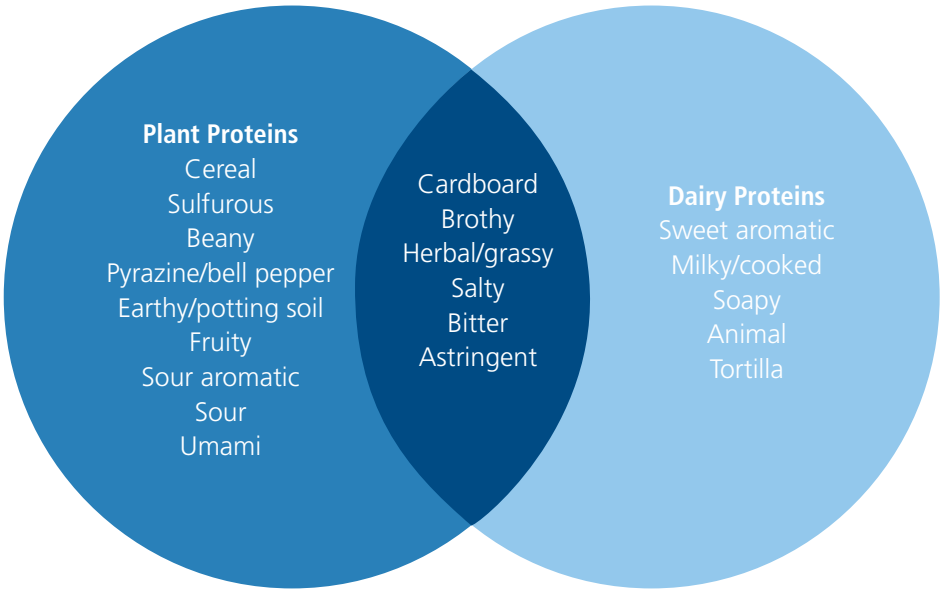
Taste and Nutrition

Milk has been designed by nature to provide essential nutrition in a format that is digestible, bioavailable, and palatable. We have been tapping into the nutritional characteristics of milk for thousands of years, turning it into familiar products such as cheese and yogurt.

A trained sensory panel evaluated 10% solutions of various plant and dairy proteins to evaluate the sensory experience for each source (1). The results from this comparison can be seen in Figure 3. Dairy proteins exhibited sweet aromatic and cooked/milky attributes. Comparatively plant protein exhibited beany, earthy, sulfurous, and sour notes. These flavors may require additional flavors or masking agents to improve the sensory experience with these protein sources. The flavor profile of dairy proteins ensures that no additives are required to mask off-notes, indeed, the dairy flavor characteristics are key desirable attributes that plant based products struggle to match.

Not only does dairy protein have better taste, it also provides unmatched nutrition. The protein in milk contains all the essential amino acids. This is not always the case with plant proteins which are regarded to be nutritionally inferior as they can be deficient in some essential amino acids as well as having lower digestibility. For example, some cereal proteins are deficient in lysine whereas pulse proteins are typically deficient in methionine, cystine, and tryptophan (3). Due to these factors, higher amounts of plant proteins are required to deliver the same nutritional quality as dairy's complete protein package. Additionally, milk contains micronutrients, such as calcium, that are generally lacking in plant-based ingredients. Plant based foods often need to be fortified with these and other micronutrients to meet the nutritional demands of consumers.

Figure 3. Flavor difference between plant and dairy proteins.



Source: Kapoor, R., Burrington, K.J., Jiang, H., Larson, S., Drake, M.A. 2017. Characterization of functional and sensory properties of select commercial food protein ingredients.

In short, dairy proteins do not require additives or further processing to access their functional and nutritional properties – all of which ensures that dairy is the leading choice for food and beverage products that meet consumer demand for nutrition, functional stability, clean label and great taste.

CDR Can Help

Whey and milk proteins help meet formulator's versatile needs for sustainably produced, nutritious, functional, and securely sourced ingredients. The CDR has many capabilities to help you understand and utilize the outstanding properties of dairy products in a wide variety of applications. These applications include beverage, frozen dessert, bakery, and nutrition bars. Because milk has the unique composition of protein, fat, carbohydrates, and minerals it can provide nutrition, function and flavor to any type of application. In addition, the CDR will have many more exciting new capabilities when the CDR building project is completed. Among these new capabilities will be the Beverage Innovation Center that will support industry in the development of new beverages utilizing dairy ingredients.

For more information about working with CDR or the Babcock hall building project, please visit our website for contact details and our ways of working. www.cdr.wisc.edu

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(1) A New Era for Protein: Why U.S. Dairy Delivers in the Crowded Protein Marketplace. Think USA Dairy. https://www.thinkusadairy.org/resources-and-insights/resources-and-insights/application-and-technical-materials/a-new-era-for-protein-why-us-dairy-delivers-in-the-crowded-protein-marketplace. 9/15/21.

(2) Plant protein market- Growth, Trends, Covid-19 impact, and forecast 2021-2026. Mordor Intelligence. https://www.mordorintelligence.com/industry-reports/plant-protein-market. 9/10/21.

(3) Singh, N. 2017. Pulses: an overview. J. Food Sci Technol. 54:853-857.

ADJUNCT CULTURES: ACHIEVING CONSISTENT FLAVOR DEVELOPMENT

Technical reviewer: Rebecca Hohlstein, CDR

During the cheesemaking process, complex enzymatic reactions occur that contribute to cheese's body, texture, functionality and taste or flavor. Perhaps the biggest challenge in cheesemaking is producing batch after batch of high-quality cheese with consistent flavor, sensory and functionality attributes.

Adjunct cultures are one tool that can help cheesemakers consistently achieve the desired flavor or taste in their cheese. They can help produce complex cheese flavors with less ripening or aging time.

Adjunct cultures can also help cheesemakers meet "flavor trends" among consumers. Cheesemakers are looking for unique flavors that can set their cheeses apart from others. Consumers are very receptive to these flavors. Many consumers are also no longer familiar with traditional cheese flavors so flavor adjuncts can be used to reacquaint consumers with traditional cheese flavors of Fontina, Sbrinz, and Manchego. In summary, adjunct cultures can be helpful for producers as they can provide a way to create taste diversification in their cheese. In addition, adjunct cultures are part of the declaration of cultures on the cheese label and don't require a label declaration.

What Are Adjunct Cultures?

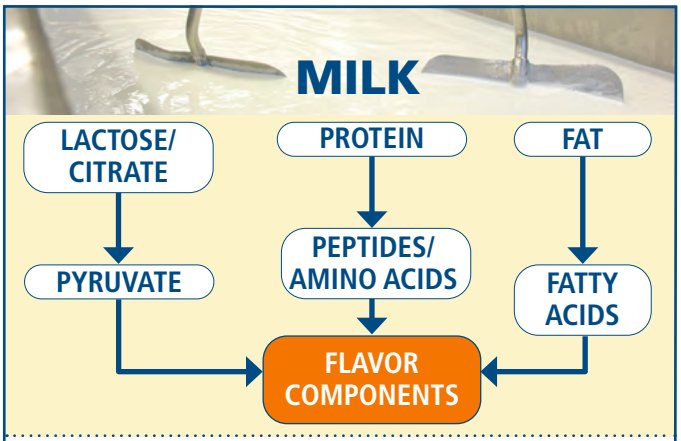
Specifically, adjunct cultures are microbes that are added during the cheesemaking process to produce flavor without producing lactic acid. Adjunct cultures are typically lactic acid bacteria (LAB) that are identified via a screening process from starter lactic acid bacteria (SLAB) or non-starter lactic acid bacteria (NSLAB). They are strains of bacteria that have been identified as producing specific flavors, tastes or sensory experiences. For instance, *Lactobacillus helveticus* is commonly used as an adjunct culture capable of producing a variety of flavors such as brothy, sweet, nutty, and pineapple. It gives cheeses a pleasant sweet flavor and can contribute to or help promote the growth of tyrosine crystals.

Adjunct cultures serve a different purpose than starter cultures. Starter cultures are bacteria that, when added to milk, metabolize lactose and produce lactic acid, which drives the cheesemaking process. Whereas adjunct cultures are added for reasons other than acid production, usually flavor development. That said, adjuncts do produce a small amount of acid so cheesemakers may have to reduce the amount of acidifying culture used.

During the cheese making process, adjunct cultures metabolize lactose. Then the cultures reduce the remaining galactose or glucose. Finally, lysis occurs during cheese aging to release flavor enzymes.

Flavor Development in Cheese

Flavor development in cheese depends on a number of different factors including the animal, breed, diet/season, milk quality, enzymes used, microorganisms present and storage conditions. Every choice that a cheesemaker makes during the cheesemaking process impacts flavor development, including how the milk is handled or treated, the starter culture used, and, among other factors how the cheese is ripened.



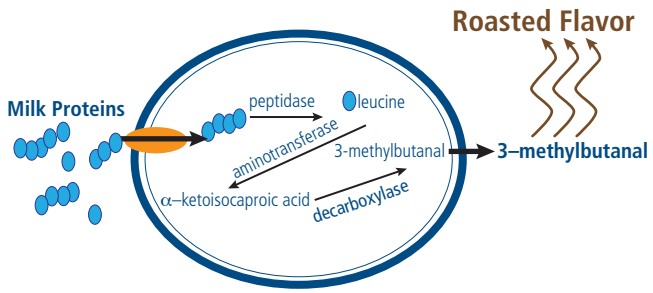
Where does cheese flavor come from? Cheese flavor derives from the breakdown of lactose/citrate into pyruvate, the breakdown of protein into peptides and amino acids and the breakdown of fat into fatty acids.

More specifically, cheese flavor comes from the conversion of lactose/citrate into pyruvate (glycolysis and citrate metabolism), protein into peptides/amino acids (proteolysis), and fat into fatty acids (lipolysis). These all contribute to the flavor development of cheese. For instance, the breakdown of fat into fatty acids produces a range of flavors from buttery to ketone and gives many cheese varieties such as Brie, Camembert, and Blue Cheese its predominant flavor.

Identifying Flavor-Producing Strains

The question is how do we know which strain or strains of bacteria contribute to these different "flavor pathways" to ➡

create a desired flavor or taste? To select adjunct cultures, strains were originally isolated from artisanal cheeses. Scientists investigate the potential for flavor enhancement by examining the ability of a bacterial strain to absorb particular amino acids and convert them into flavorful compounds. Each strain of bacteria is identified as to exactly what flavor or taste qualities a specific strain of bacteria will contribute to (e.g. fat, fruity, sweet, floral, bitter). Strains that produce desired flavors or tastes are then isolated and used to produce adjunct cultures. Adjunct cultures can be a single strain or a combination of strains. Producers or providers of adjunct cultures can provide technical informational sheets about each



Adjunct cultures produce flavors through complex amino acid transferase processes that results in a specific flavor. In this case, a "roasted" flavor is being produced.

adjunct culture with details on what flavors or other characteristics it can produce (e.g. debittering, increase flavor intensity/complexity). In addition, adjunct culture producers continue to improve upon their products and are developing new strains or combination of strains that can develop "roasted" or "savory" flavors to cheese.

Adjunct Cultures and the Cheesemaking Process

Companies that supply adjunct cultures can provide cheesemakers with detailed technical sheets with suggested dosage, usages guidelines as well and storage and handling instructions.

Usage rates vary with applications depending on desired flavor intensity and the temperatures that will be used during ripening. Typically, adjunct culture usage rates are around 500 grams/3,000-10,000 liters of milk. In addition, the usage rate of acidifying cultures typically can be reduced when using adjunct cultures.

In summary, adjunct cultures are another tool in the cheesemakers toolkit to produce consistent, high-quality cheese with complex flavor profiles or notes with less aging or ripening time. Adjunct cultures can help cheesemakers meet consumer demand and increasing interest in artisan cheeses with unique flavors.

ADVANCED CHEESE TECHNOLOGY SHORT COURSE IS NOVEMBER 15-18

The Center for Dairy Research (CDR) is holding its Advanced Cheese Technology Online Short Course, November 15-18 in person at the Babcock Hall on the University of Wisconsin-Madison campus. The deadline to register is November 1. Please note: You must complete CDR's Cheesemaking 101 course before registering for the Advanced Cheese Technology Short Course.

The Advanced Cheese Technology Short Course is an intensive four-day course covering cheesemaking production principles and technology. This course is intended for apprentice cheesemakers with at least 12 months experience or students with a basic science background. Students should have experience in algebra and general chemistry. Completion of this course will give the student six months credit toward the apprenticeship requirement for the state cheesemakers license.

Advanced Cheese Technology Lecture Topics:

- Dairy Starters/Ripening
- Standardization of Milk
- Cheese Yield
- Coagulants and Coagulation
- Cheese Chemistry
- American Cheese Styles
- Italian Cheese Varieties
- Swiss and Eye Cheeses
- Acid Set Cheeses
- Acid-Heat Coagulated Cheese
- Mold Ripened Cheeses
- Surface Ripened Cheeses
- Cheese Technology
- Cheese Sensory

Certificate in Dairy Processing Starts in January

CDR will hold its Certificate in Dairy Processing online dairy training program beginning January 20. This program is focused on providing promising plant workers and operators with a clear understanding of dairy plant processes. The Certificate in Dairy Processing features a ten-week series of modules covering key aspects of dairy processing through online sessions and other learning opportunities. Online courses are scheduled to occur every Thursday 3pm-5pm Central time from 1/20/22 until 3/24/22. The deadline to register is January 5.

For more information or to register for CDR short courses, visit: www.cdr.wisc.edu/short-courses

CDR WELCOMES NEW STAFF

Heather Cooper, Events Coordinator

Heather brings to CDR years of experience in meeting and conference coordination.

She previously worked for the University of Wisconsin-Madison's College of Agriculture and Life Sciences Conference Services for over 20 years where she helped manage CDR short course registration. Heather has an undergraduate degree in Communications from the University of Wisconsin-Oshkosh. At CDR, Heather is part of the communications group and is instrumental in supporting the Center's many training and education program as well as its other events and meetings.

Jim Cropp, Instrumentation Technologist I/ Assistant Pilot Plant Manager

A native of Wisconsin, Jim received a bachelor's degree in Food Science and Technology from the University of Wisconsin-River Falls.

Jim is an experienced food industry professional with significant technical expertise across plant management, production management, quality management and more. His strong technical background in the dairy industry includes cultured dairy, wet processing, dry blending, spray drying, extrusion, cheese spreads and sauces, aseptic processing and packaging as well as high-speed juice processing and packaging. As a part of the dairy processing staff at CDR, Jim will be providing direct technical assistance to clients as they develop their concepts/products in the CDR facility as well as on-site support with troubleshooting and scale-up assistance. CDR is excited to have someone with Jim's skill set join the staff and he is looking forward to working with CDR's diverse set of clients.

Jim Grisamore, Research Specialist

Jim is an experienced chemist and analyst with a Bachelor's of Science in Biology from Northland College in Ashland, Wisconsin. Jim has held chemist and analyst positions for more than 20 years in environmental testing facilities where he was involved in analyzing pesticides/herbicides samples using gas chromatography equipment. As a research specialist in the CDR Analytical lab, Jim will be responsible for the analysis of free fatty acids by gas chromatography.

Luis A. Jiménez-Maroto, Assistant Coordinator, Cheese Industry and Applications

With more than a decade of experience with dairy foods, Luis Jiménez-Maroto has a wide range of expertise in research, data analysis, sensory, judging, and education. Luis earned an undergraduate degree in Food

Engineering at the Monterrey Institute of Technology and Higher Education in Mexico and obtained a master's degree in Food Science at the University of Wisconsin-Madison. Luis has served as the CDR Sensory Coordinator and worked with the UW-Madison Department of Food Science, leading research related to the organoleptic properties of cheese and other dairy products. He is completing a Ph.D. in Food Science under Dr. John Lucey on the effects of high-pressure processing and low temperature storage on the long-term performance and shelf life of various cheeses. Luis now works in the Cheese Industry and Applications group at CDR, where he is involved in cheese trials and troubleshooting, lecturing at short courses and other outreach efforts.

Emily Slatter, DBIA Program Coordinator

Emily has more than 6 years of experience in program management working in Washington D.C. for the National Academies of Science, Engineering and

Medicine Fellowships Office and at an international exchange organization. With an MBA from Western Governors University and a Bachelor's degree in Political Science from Middlebury College, Emily also has international experience working as an educator in China, France and South Korea. As DBIA Program Coordinator, Emily administers grant programs and provides business development training and support for dairy entrepreneurs in the Midwest. Emily is excited to support the continued innovation of dairy farmers and dairy processors!

GROSSEN'S AGED GOUDA RECEIVES TOP HONORS

CDR Research Cheesemaker Gary Grossen won top honors at the Green County Fair Cheese Contest in Monroe, Wisconsin for his Aged Gouda.

The fair takes place in southern Wisconsin, where many talented cheesemakers produce high-quality specialty cheeses. It is the largest county fair cheese championship contest in Wisconsin and typically receives well over 100 entries.

The four judges are seasoned veterans who have also served at other cheese contests such as the Wisconsin State Fair, World Championship Cheese Contest, American Cheese Society, and the US Championship Cheese Contest. Judges regularly remark that the Green County Cheese Contest is among the hardest contest to judge due to the consistency and quality of the cheese.

John Jaeggi, CDR Coordinator of Cheese Industry and Applications, was especially complimentary of Grossen's aged Gouda, "I can attest when I sampled a wheel it was absolutely amongst the best Gouda I have had! No one's Gouda compares to Gary. None. Anyone can follow a recipe. It takes a true Master to take a recipe and make a cheese that is special."

Grossen is a Wisconsin Master Cheesemaker (certified in Brick, Cheddar, Gouda, Havarti, Muenster) with more than 60 years of experience in the dairy industry. He worked in his family's cheese plant in Monroe, Wisconsin for more than 50 years, making Brick, Muenster, Colby, and 200-pound wheels of Swiss in traditional copper kettles. In 2005, Grossen came to the University of Wisconsin and worked in the Babcock Dairy Plant where he made award-winning cheeses. At CDR, Grossen helps with all aspects of cheesemaking from milk pasteurization to assisting with research and industry trials. His cheeses have won many awards at national and international competitions.

LUCEY AWARDED OWEN FENNEMA PROFESSORSHIP

CDR Director John Lucey was awarded the Owen R. Fennema Professorship in Food Chemistry by the University of Wisconsin-Madison Department of Food Science. In addition to serving as CDR Director, Lucey is a professor in the Department of Food Science. This professorship supports a faculty member who demonstrates excellence in teaching and research in food chemistry. Lucey has published more than 140 peer-reviewed papers on various aspects of dairy chemistry and supervised over 40 graduate students at UW-Madison.

Owen Fennema was a food science professor at UW-Madison for almost 40 years. UW-Madison's Department of Food Science website adds, "A tireless advocate for advancing the field of food science, Fennema has been called the father of food chemistry. His textbook, Fennema's Food Chemistry, has been published in four editions and multiple languages."

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"It's a very nice honor as it recognizes Owen Fennema who was an outstanding food chemist," Lucey said. "Like many food science undergraduates, I used his food chemistry textbook for my class."

This award will provide funds for 5 years to support research work and graduate students. Dr. Lucey said he hopes to do more research on topics such as the health and wellness aspects of milk/dairy.

CDR GRADUATE STUDENTS RECEIVE AWARDS

Aakash 'Varsha' Swaminathan and Daniel Wilbanks—graduate students in CDR Director John Lucey's lab at the University of Wisconsin-Madison Department of Food Science—received awards or scholarships to support their education and dairy research projects.

Varsha, a Ph.D. candidate, received the Norman F. Olson Cheese Research Scholarship from CDR and the Wisconsin Cheese Makers Association.

Varsha is researching low-moisture part-skim (LMPS) Mozzarella, also known as pizza cheese. Here is how Varsha explains her research: "It is predicted that the pizza industry will grow even more in the next decade and this calls for tailoring the functional attributes of pizza cheese such as its texture attributes including its melt, stretch, chewiness, etc. Calcium balances in cheese during manufacture are the most important factor that contribute to the functionality of LMPS Mozzarella, but very little data is available on this and thus my research focuses on studying the above-mentioned topic."

The Norman F. Olson Cheese Research Scholarship will help support Varsha's research. The award is named after Dr. Olson, the creator and first director of the Center for Dairy Research. The scholarship is awarded to students majoring in food science at the University of Wisconsin-Madison.

"Dr. Norm Olson's work has inspired me and by receiving this scholarship, I feel recognized for my research work and also very honored," Varsha wrote. "This award motivates me and brings me one step closer to my career goal, that is to become a cheese scientist and to contribute to the growth of the cheese industry through research, innovation, and development."

Daniel Wilbanks, a Ph.D. candidate, received the John Brandt Memorial Scholarship from the Land O' Lakes Foundation and a Graduate Student Award from the International Dairy Foods Association (IDFA). The John Brandt Memorial Scholarship, named after the Land O' Lakes founder, is awarded to one or two students each year who have demonstrated exceptional commitment and aptitude toward their field of study.

Daniel is researching high protein yogurt beverages, "I hope to be able to formulate high protein yogurt beverages that remain fluid when stored for long periods of time at room temperature."

Both awards will help support Daniel's education and research.

"It means a lot to me to earn these scholarships. It validates much of my work that I've accomplished so far and gives me confidence that my research may generate more interest in dairy products around the world."

CDR REMEMBERS PAT POLOWSKY

CDR staff are deeply saddened by the loss of colleague and friend, Pat Polowsky. Pat died August 29, 2021. An educator extraordinaire, Pat had the gift of taking complicated subjects and making them simple. His technical savy and graphic skills made him a master at illustrating dairy food concepts.

He earned a Bachelor's Degree in Food Science from Purdue University and Master Degree in Food Science from the University of Vermont. He had previously worked for ConAgra Foods, Cabot Creamery Cooperative, Vermont Cheese Council, Wal-Mart and Nature's Fynd. Pat was well known and respected throughout the food and dairy industries for his technical knowledge as well as his skills as an educator. Pat was also the author of the popular Cheese Science Toolkit (www.cheesescience.org) where he covered the science behind cheese with fun and educational graphics. At CDR, Pat served as training facilitator helping, CDR improve and launch new short courses and training tools.

We loved his humor as he always had a story to tell. Pat was always willing to help no matter the task, from IT support to sensory, and creating PowerPoints to moving boxes, he did it with a smile. We are fortunate to have worked together to enhance the dairy industry.

Pat's family has established a scholarship in his memory at Purdue University. To contribute to the scholarship, visit https://connect.purdue.edu/s/givenow?dids=068286&appealcode=18372

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Upcoming CDR Trainings

The Center for Dairy Research is here to help you with dairy product training for your employees. Below is a listing of upcoming CDR short courses, webinars and other training opportunities.
Cheesemaking 101 – What a Licensed Cheesemaker Should Know (Online) | October 12 & November 16
Food Safety (HACCP) Workshop (Online) | October 12
Process Cheese Course (Online) | October 19
Dairy Ingredients Fundamentals | October 20
Master Short Course Series – Understanding and Controlling Defects in Cheese | October 27-29
Advanced Cheese Technology Short Course | November 15-18
Certificate in Dairy Processing (Online) | January 20 (class is 11 weeks)
For the latest information or to register visit www.cdr.wisc.edu/short-courses

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