TECHNICAL BULLETIN

STRATEGIES TO PROPERLY STORE OR EXTEND THE SHELF LIFE OF CHEESE

The dairy and food industries have been disrupted by the COVID-19 pandemic. CDR staff have taken many calls and heard the concerns from industry partners. Retail cheese sales have been strong but demand from food service has essentially stopped as schools and most dine-in restaurants have closed. Alternative dining options like delivery, carryout or drive-throughs can't keep up with the more than 40% of U.S. cheese volume that normally moves through food service.

Many dairy processors that primarily serve the food service sector are now asking their farmers to significantly cut production. In some cases, dairy processors are even dropping farms, leaving the farmers with no buyer for their milk.

Based on these factors, cheese plants that have relied on food service, especially for varieties such as Mozzarella, Cheddar, and Parmesan, are evaluating their options. Many have diverted cheese to their retail customers, which has resulted in significantly lower cheese prices, translating into on farm milk prices currently below $14.00/hundred weight.

To help cheese manufacturers, CDR researchers have developed this technical bulletin, which explores strategies to extend the shelf-life of cheese. Right now, the industry needs time to find new customers whether it is through exports, retail, or potential government purchases. Unfortunately, many countries are also seeing a drop in the food service sector. Finally, much of the information and technical knowledge shared in the following strategies is the result of CDR research that was funded through dairy farmer dollars from the Dairy Checkoff program and industry support.

STRATEGY: FREEZING

Storage Time: Varies (6-12 months are common)

Pros: Can hold cheese in a freezer for up to a year depending on cheese type; many semi-soft, semi-hard, and hard cheeses are good candidates for freezing.

Cons: Not a good option for low pH cheeses; varying degrees of negative impact on functionality/body depending on cheese type; ice crystal concerns; thawing requirements; limited freezer space availability.

The general rule of thumb for freezing cheese is to freeze the cheese as quickly as possible and thaw the cheese as slowly as possible. Ideally, thawing takes place under refrigeration and best to allow around a week to allow the moisture in the cheese to re-equilibrate back into the cheese matrix (although some companies only allow a couple of days).

Many cheeses freeze well, including: Cheddar, Muenster, Mozzarella, Colby, Colby Jack, Provolone, Brick, Cheese Curds, and Hard Italian Cheeses. Some cheeses like Mozzarella can be held for up to a year in a freezer. However, end use of the cheese must be considered. For instance, Cheddar can be frozen but it will not slice well after thawing. Oftentimes, Cheddar is frozen, and then used in frozen entrees or for further processing. Fresh Mozzarella may need to be vacuum packed first (not held in water) before freezing.

These cheeses are not recommended for freezing: Cream Cheese, Mascarpone, Blue Cheese, Ricotta, and Feta. Note: Feta and Blue Cheese can be frozen but, when thawed, will crumble. If the Feta or Blue Cheese isn't being converted (crumbles are okay), freezing is an option. The mold in Blue Cheese might also change to more of a green color when frozen.

One of the dangers of freezing of cheese is the formation of large ice crystals, which can result in damage to the cheese texture and ultimately impact functionality and sensory acceptance. Therefore, high-moisture cheeses like Ricotta, and low pH cheeses like Cottage and Cream Cheese are damaged when frozen (crumbly texture). Hispanic cheeses like Queso Fresco should be okay to freeze if it is ground and reformed before packaging, whereas Queso Blanco would likely become grainy.

If a cheese is expected to be sold within about six months, it is probably advantageous to hold it in low temperature storage rather than freezing. If the cheese needs to be held longer than six months, freezing may be the better option.

Cheese should not be held in a self-defrosting freezer as the temperature (freeze/thaw) cycles will result in damage to the cheese texture. Once thawed the cheese continues to age.

One important point, which is applicable to all storage strategies, is that bad cheese will not get better in storage or HPP. A poor-quality Mozzarella will come out of frozen storage worse than when it went in. However, if a good quality Mozzarella is frozen, it will come of the freezer in about the same condition that it went in (if thawed and handled correctly).

STRATEGY: LOW TEMPERATURE "SUPER-CHILLING" STORAGE (AROUND 28-32°F)

Storage Time: Can extend or slow down shelf-life by about six months.

Pros: Can be used for most cheeses; minimal impact on functionality/body; good for converted cheeses (slices, shreds); no ice crystal or thawing issues since above freezing point. Can be implemented easily at most storage facilities.

Cons: Does not fully stop cheese ripening so this strategy can be used for about six to nine months for cheeses like Mozzarella; slows down flavor development in Cheddar.

For cheeses like Whole Milk and LMPS Mozzarella that are stored (but do not need ripening), refrigerated storage conditions commercially are typically 40±2°F (some companies use lower temperatures like 32-36°F). Storing cheese at colder than normal temperatures (<40°F) can slow down proteolysis and breakdown of the cheese body. Research at CDR has demonstrated that holding cheese at temperatures around 30-32°F results in the cheese almost being in suspended animation and having very slow body breakdown. This strategy extends the shelf life of cheeses like LMPS Mozzarella and Cheddar by around 6 months compared to typical storage temperatures (when low temperature storage is combined with alterations in the cheesemaking recipe).

Low temperature storage technique also works well for shredded or sliced cheeses. Storing cheese at ultra-low, but non-freezing temperatures, may be a superior method for extending the shelf life of many cheese varieties and forms of cheese, from bulk to chunks to shreds to slices.

This is also the method of choice for cheese varieties, such as Ricotta or Cream Cheese, that cannot be frozen because of catastrophic changes to the body and texture of the cheese after freezing and thawing.

STRATEGY: HIGH PRESSURE PROCESSING (HPP)

Storage Time: Can extend shelf life by several months (3-6 months or even longer has been demonstrated for some varieties depending on the process conditions).

Pros: Cheese can be stored in normal refrigeration after HPP; CDR research found HPP can successfully extend the shelf life of LMPS Mozzarella, Cheddar and Block Gouda. Cheese can be treated after manufacture and processed in the retail packaging. Toll HPP facilities are available that can process your cheese.

Cons: The additional cost may not be economical for some cheeses (so HPP may not be suitable for bulk/commodity cheeses). Currently these HPP systems are a batch process, so handling large volumes could be slow.

High pressure processing (HPP) systems apply and then release high amounts of hydrostatic pressure by the compression of a fluid medium, typically water. The process of applying and releasing pressure induces physical, chemical and biochemical changes in microorganisms, including the inactivation of foodborne pathogens, spoilage organisms as well as enzymes. Widely used for food safety purposes, HPP is used to destroy pathogens in meats and a range of food/beverage products.

The food product (cheese) is in its final packaging when it goes through the HPP system. After the treatment, the cheese can be stored under normal refrigeration.

A CDR research project studied how HPP (600 MPa for 3 minutes) can be used to extend the shelf life and functionality of LMPS Mozzarella. By altering the cheese make procedure, as well as using HPP, which can inactivate enzymes (and thus slow proteolytic activity), CDR researchers were able to produce LMPS Mozzarella that still had good body, shreddability and functionality on pizza even after nine months of refrigerated storage.

One issue may be costs, although these costs are decreasing as HPP systems increase their throughput and the technology evolves. There are two commercial toll facilities in Wisconsin and many more throughout the U.S.

HPP might be an option for those cheeses that can't be frozen and have a shorter shelf life (Mascarpone, Ricotta, etc.). Producers of cheese spreads utilize HPP to extend the shelf life of the product.

STRATEGY: MODIFY CHEESE MAKE

Storage Time: In combination with other strategies can be used to extend shelf-life by weeks or months.

Pros: Relatively simple adjustments can slow down proteolysis and extend shelf life.

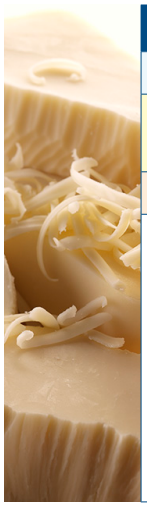
Cons: Some strategies may lower cheese yield. May also require adjustments in standardization, ingredients, make protocols and production time splits.

Cheesemakers can alter the cheese make procedure to lengthen the shelf life of the cheese. The most important of these changes is to lower the moisture content. While this will have a negative impact on yield, it can significantly increase the shelf life of cheese.

Also, consider using a coagulant that has less proteolytic activity (in the cheese). There are a number of these coagulants commercially available (e.g., ChyMax-M; MaxiRen-XDS). These are especially helpful for aged cheeses because these coagulants will slow down proteolysis (protein breakdown) during aging, which will result in a longer shelf life.

Another strategy is to increase salt levels in cheese close to the maximum allowed. A higher salt level will also slow proteolysis and lengthen shelf life. Keep the pH values of the cheese in the mid to high end of your specifications. This will decrease the impact of lactic acid on solubilizing calcium from the casein matrix, which will result in a better cheese body for a longer time period. For cheeses like Cheddar we have found that using higher milk pasteurization temperatures as well as higher protein fortification of the cheese milk results in a slower breakdown of body during ripening.

For cheeses that we want to have a long shelf-life we also need to consider milk quality and sanitation. It is important to reduce contamination from nonstarter bacteria as the longer storage time could allow defects or problems to occur, such as gas or off-flavors.



STRATEGY: INCREASE STRETCHING TEMPERATURE OF CURD FOR MOZZARELLA

Storage Time: Can extend shelf-life by about 3-6 months

Pros: Involves a relatively simple adjustment to the cooker/stretcher temperature. Uses existing equipment, although could be a benefit to using waterless systems.

Cons: More fat loss occurs when increasing stretching temperature.

A current CDR research project is finding that when making LMPS Mozzarella, higher stretching temperatures for the curd can inactivate or destroy most residual rennet. By destroying these enzymes, the proteolytic activity of the cheese is greatly decreased, resulting in a longer performance shelf life. A downside is that by increasing the cook temperature, more fat is lost in the cooker water. Some early research at CDR indicates the waterless cookers may help reduce fat losses when increasing stretching temperatures. CDR research indicates that increasing the curd temperature from typical values around 130-140°F up to 150-160°F helped to extend the shelf life by 3-6 months depending on the specific curd temperature used. Another option is to produce processed Mozzarella by adding some emulsifying salts in the process, which also helps to control functionality and reduce fat losses.

CDR IS HERE TO HELP

This is a very difficult time for the dairy industry. CDR staff have done detailed research on extending the shelf-life on a number of specific cheese varieties including Cheddar, Block Gouda, LMPS Mozzarella, Cream and Mascarpone cheeses. Please reach out to CDR for help and technical advice on your specific variety. There are also many resources and information on the **CDR website:** www.cdr.wisc.edu

If you are a Wisconsin manufacturer or member of the CDR Industry team, you can access the CDR Insider, which includes additional in-depth resources and articles on a wide variety of topics. More information: www.cdr.wisc.edu/about/cdrindustryteam

Contact: CDR Cheese Staff: www.cdr.wisc.edu/cheese/staff/Cheese

FAQ

STRATEGIES TO PROPERLY STORE OR EXTEND THE SHELF LIFE OF CHEESE

Webinar CDR COVID-19 Toolkit: Extending Cheese Shelf Life, Wednesday, April 8, 2020

Questions related to Freezing/Super Chilling

1. Have you seen lactate crystals when freezing?
Yes, but only in gas flushed packages of aged Cheddar. We believe there was some temperature fluctuations in the freezing cycle that allowed for moisture (ice) accumulations at the cheese surface and drying in certain areas of the cheese. We have not seen calcium lactate crystals in vacuum sealed cheeses unless they are already there.

2. Are the effects of freezing minimized if the cheese is frozen in converted forms like shreds, slices, cubes?
The faster you freeze cheese the better and smaller pieces freeze faster. Previous studies indicated that shredded cheese melts less but stretches more after freezing. The concern with slices is they are likely to become brittle, due to more surface area and thus more moisture migration.

3. Was the Mozzarella super chilled immediately after it was made?
No, 2 weeks later. Same for the HPP treatment.

4. Is there any reason why you didn't hold it (Mozzarella) at like 25° or 28° vs 32°F?
We did not go too low for fear of freezing and ice crystal formation. Cycling of the coolers and temperature variability adds to this risk. The freezing temperature of the cheese will depend on the salt content, proteolysis, and dissolved solutes in the cheese.

5. Has CDR had any experience freezing shredded Mozzarella without IQF and the best time to freeze/utilize that product for best performance?
Yes, all of our experience is without IQF. In IQF Mozzarella additives such as sodium phosphates or citrates are often added to rapidly chelate the calcium and this allows for faster hydration of the casein. We normally have to age the Mozzarella for maybe a week to allow sufficient calcium loss from casein and hydration of the casein in non-IQF process. Loss of calcium and hydration allows for better stretch characteristics. This is vital for frozen pizza or entrée use where little time is given during baking to allow for the necessary reactions to occur. Without the hydration of the casein the moisture would be free to form large ice crystals and could damage the cheese and the cheese would not stretch and would burn when baked. Could the calcium and moisture equilibration occur after thawing and holding the cheese under refrigeration for a week? Yes.

6. We have found that natural cheese that has been frozen then eventually used for process cheese does not emulsify. It creates a pudding-like mass. Can you discuss any tips to make frozen cheese play nice in process cheese?
We never froze any of the recent Cheddar for processing projects. In general, frozen cheese should be allowed to thaw completely before processing. It's possible that extreme temperature differences between frozen cheese and other ingredients at refrigeration or room temperature would not be conducive to even heating and mixing in the process cheese. The superchilled cheese stored was always given at least a day in the 4°C cooler after shredding before making process cheese. All the refrigerated ingredients were given an hour or two to come up to room temp before processing.

7. Have we done any work with freezing Cream Fraiche? Sour Cream?
We do not think that freezing of Sour Cream is a good idea, it will likely destabilize the texture and result in a very poor texture after thawing, much like we saw with Mascarpone. Lots of different fat levels possible in Cream Fraiche but likely issues with this product too, we suggest caution.

8. Has work been done with super chilling flavored Cheddars? And mixed milk cheeses?
No, but superchilling would be much better than freezing and I would never freeze a cheese with added condiments. And mixed milk cheeses? Superchilling would be just as beneficial for any cheese made from any milk. Frozen goat curd works good for Chevre cheese. Sheep milk has been frozen regularly and used to make cheese.

FAQ

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9. Dean Sommer said there have been good results with superchilling shredded cheeses, but has the CDR had any experience freezing shredded Mozzarella without IQF and the best time to freeze/utilize that product for best performance?
See answer to question 5.

10. Are temperature recorders in different areas of the super cooler helpful to catch variability of temperature and cycling? Was humidity an issue?
The cheese was in a package so no issue about humidity in the product, not a factor in the cooler.

11. For Blue cheese, would you superchill after the mold development or is it ok to start at day 1 of storage?
I would superchill after mold development. Superchilling does not prevent the open texture from slightly collapsing over prolonged storage. While molds are acid tolerant, I am not sure what prolonged exposure could do to their activity. I presume it would be less after superchilling.

12. Have you looked at pallet quantities of cheese as it relates to freezing and thawing? Was your work done on block quantities or pallet quantities for freezing and thawing?
The CDR worked with 40lb blocks. Pallets can be done but depends on airflow. Need to have air circulation. It is hard to control at exact temperature in a cooler, don't want to risk freezing. That is why I would not recommend supercooling to less than 27°F as you could get freezing for some cheese types.

Questions related to High Pressure Processing (HPP)

1. Can you do HPP and superchill?
Yes, you can.

2. What happens to the water during HPP and how is that handled?
You are not squeezing water out of the cheese. The water in the cheese doesn't get released. If it did, it will get re-absorbed during cooling. No free water gets squeezed out of the cheese. The cheese is packaged so it is protected from the water medium. After HPP, more water binding takes place especially in young cheeses due to calcium shift. After HPP we don't see free, expressible water.

The water in the HPP chamber itself is re-used again. It is only a media where the HPP treatment is taking place. The water itself is HPP treated too.

3. What will be the impact on freezing after 30-40 days of shred? Food safety concerns? Functionality concerns? Physical characteristics concerns during thaw like balling up?
For 30-40 day shreds, the surface area is too large; maybe drying will take place. Will need anti-caking agents, use the minimum. Anytime you use anticaking, there will be functionality issue because of anticaking agent.

No food safety concerns. May need to use IQF – fast freezing.

Cheddar shreds – Freezing could cause calcium lactate crystals if old cheese. concerned with moisture migrations during freezing and thawing in the package. Functionality issues. Risk of balling up.

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4. What was the age of the cheese when pressure treated?
Age of cheese – 4 days for Cheddar. Age of cheese needs to be selected for the purpose of the cheese. if you need intact casein, then do Cheddar cheese early. If you want some ripening or flavor development to occur, then you wait. Also have used HPP at lower pressures, that accelerated ripening. If trying to accelerate ripening do it early. We have done Mozzarella at 2 weeks.
LMPS Mozzarella (Reduced salt) – HPP 2 weeks
Block Gouda, both stirred-curd and milled-curd (Reduced salt) – HPP 1 month
Cream cheese – HPP 1 week
Mascarpone – HPP 1 week
Cheddar for processing – HPP at 4 days
Low-Fat Cheddar – HPP at 1 week (50-400 MPa)
Low-Na Cheddar cheese, UF Retentate – HPP at 1 day (500 MPa)
Regular, reduced and low-Na Cheddar – HPP at 1 week (405 MPa)

5. Is there any difference in oiling off of super chilled, HPP, or a combination of the two when it was used on pizza?
There were no differences in oiling off between superchilled, HPP, combo when the cheeses were baked on pizzas.

6. So would applying HPP to our cheese decrease the need of anti-caking when it's shredded?
No. 12 month cheese was soft. We need anti-caking agents.

7. What mechanisms are at work improving shelf life of Mozzarella during HPP? Is it just enzyme and micro reduction?
Yes, you need to use at least 600 MPa to inactivate rennet (much but not all of its activity). HPP doesn't kill all bacteria at that pressure (600 MPa) and depends on the cheese itself (moisture, salt, pH, etc). Different bacteria are killed at different pressure levels. Solubilization of calcium occurs immediately during HPP treatment.

Question related to High Temperature Processing

1. For the high heat milk treatment extension method for CCFM, what is the impact on yield?
We didn't do any yield measurements. In general, there could be an increase in yield due to incorporation of some extra denatured whey proteins as well as a possible increase in moisture content.

Increasing the HTST temperature is a great point. High fat and high protein. You do not want to denature too much protein, but from a past involvement in fluid milk 7 days extra could be achieved on shelf life with increasing the HTST temperature from 165 to 175°f.

CDR has seen an extension in shelf life with an increase in the HTST temperature.

2. With waterless cooker, what was the impact on fat loss at 190°F? Hoping it is much less if we are using waterless cooker.
We found there was 3-4% more fat losses compared to 140°F. Fat may possibly be re-incorporated back with the proper strategy or processing approach.

Other Questions

1. What is the best way to add the salt on cheese? Add it all at once or divide it into 2 or 3 stages?
3 applications – 5-10 mins apart. For Parmesan, you need slower rate.

2. For Cheddar and MJ type of cheese what would be the shelf life increase if we go from 40 to 32°F?
Additional 6 months could be possible.

3. Are there ingredients to prevent large ice crystal formation in frozen cheese?
No, not likely possible to add gums/stabilizers due to cheese standards (they are common in ice cream for this purpose). Suggest rapid freezing to a low temperature and limit freeze/thaw cycling.