

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 out 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 $40\pm 2^\circ\text{F}$ (some companies use lower temperatures like $32\text{-}36^\circ\text{F}$). Storing cheese at colder than normal temperatures ($<40^\circ\text{F}$) can slow down proteolysis and breakdown of the cheese body. Research at CDR has demonstrated that holding cheese at temperatures around $30\text{-}32^\circ\text{F}$ 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