



Wisconsin Center for Dairy Research

Storage Temperatures Necessary to Maintain Cheese Safety

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Dean Sommer

Wisconsin Center for Dairy Research



A copy of the Article published in **Food Protection Trends** (October, 2006) that served as the basis of this presentation can be found at:

<http://www.cdr.wisc.edu/news/pdf/storage%20temps%20full.pdf>





If the dairy ingredients used are not pasteurized, the cheese is cured at a temperature of not less than 35 °F for at least 60 days.

Storage Temperatures Necessary to Maintain Cheese Safety

Goal: Allow cheeses which do not normally support the growth of pathogens to be stored/displayed at temperatures up to 50°F, & possibly higher



A. Conduct a literature search on the microbiological safety of selected cheeses at various storage temperatures.

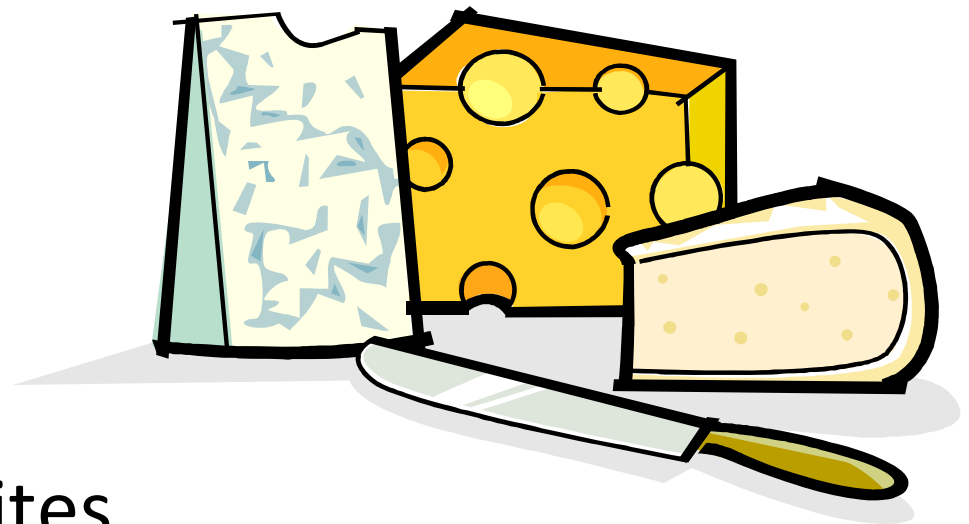
B. Determine cheese properties/parameters which allow for increased storage temperatures (pH, water activity, moisture level, salt level, culture activity)

Storage Temperatures Necessary to Maintain Cheese Safety

- Manufacture of cheeses must be done under the proper conditions GHP, GMP, HACCP principles and according to CFR requirements. The cheese must have active cultures, and storage and display temperatures do not exceed 30°C (86°F)

Safety Factors Inherent in Cheese

- Reduced moisture
- Lower water activity
- Low pH (lactic acid)
- Salt
- Competing flora
- Biochemical metabolites
- Bacteriocins



Safety Factors in Cheese Manufacture

- Highly regulated - farm to plant
- Good manufacturing practices
- HACCP
- Heat treatments
- Hurdle technology



Cheese Related Foodborne Outbreaks

- Variety/volume cheese consumed
- Foodborne outbreaks/diseases incidence very low

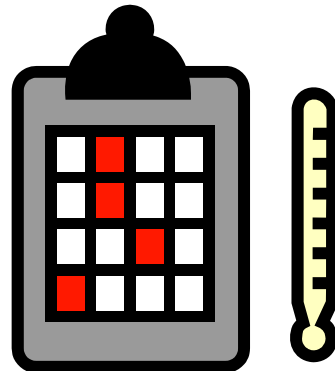


Cheese Categories (Moisture)

- Fresh soft - Queso Fresco, etc.
- Soft unripened ($> 50\% \text{H}_2\text{O}$) - Cottage, Cream, Ricotta
- Soft ripened ($> 50\% \text{H}_2\text{O}$) - Brie, Camembert, Feta, Mozzarella
- Semi-soft ($> 39\text{-}50\% \text{H}_2\text{O}$) - Blue, Brick, Monterey Jack, Muenster
- Hard ($< 39\% \text{H}_2\text{O}$) - Cheddar, Colby, Parmesan
- Pasteurized Process

Temperature Issues

- Date marking mandate
- Storage temperature



FDA/USDA Evaluation of Foods

Date marking exemptions:

- Asiago
- Blue
- Brick
- Cheddar
- Colby (< 40 % H₂O)
- Edam
- Feta
- Gorgonzola
- Gouda
- Gruyere
- Limburger
- Monterey Jack
- Muenster
- Parmesan
- Pasteurized Process
- Provolone
- Reggiano
- Romano
- Sapsago
- Swiss/Emmentaler

FDA/USDA Risk Categories

High → soft unripened cheeses

Moderate → fresh soft cheeses

soft ripened cheeses

semi-soft cheeses

Very low → hard cheeses

pasteurized process cheeses

Literature Research

- Approx. 20 cheese varieties
- Various pathogens — L. monocytogenes
S. aureus
E. coli
Salmonella
Y. enterocolitica
C. botulinum
A. hydrophils
C. jejuni
P. aeruginosa

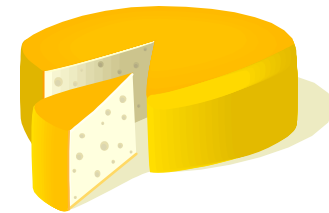
CDR Conclusions from Research

- Less than 50% moisture
- Active lactic acid cultures
- Traditional levels salt, pH, fat

- Do not allow pathogens growth in cheeses
- Higher storage temperatures lead to significant bactericidal activity

Recommendations for Cheeses

- Pasteurized or heat-treated ($> 63^{\circ}\text{C}$ / $> 16\text{ sec}$) milk
- Good hygienic practices
- Good manufacturing practices
- Operating HACCP systems
- Active lactic acid cultures
- FDA CFR specifications



Following Cheeses

- Should be considered exempt from refrigeration requirements
- During aging, storing, shipping and display
- Maximum temperature of 30⁰ C (86⁰ F)
- ***For Safety Purposes Only***

Cheeses

- Asiago (medium and old)
- Cheddar
- Colby
- Feta
- Monterey Jack
- Muenster
- Parmesan
- Pasteurized Process Cheese
- Provolone
- Romano
- Swiss/Emmentaler



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- Scientific information indicates some cheeses may be safe when displayed at room temperature.
- FDA Memo ⇒ “storage and display of wheels, rolls, or wedges of hard or semi-soft cheese which still retain the original, undisturbed wax or cloth packaging has been accepted practice in retail food establishments to date, provided no breaks, cracks, punctures, etc. of the protective covering have occurred.”
- Conference recommended that FDA work with stakeholders on scientific issues and product assessments related to food safety to determine that certain cheeses do not need temperature control for safety.
- We didn't break down a door, but we opened a window.

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- Request FDA to consult with National Advisory Committee on Microbiological Criteria for Foods on the science ... (to allow) ..., as a minimum, the Tier 1 cheeses (Asiago (med/old), Cheddar, Colby, Provolone, Romano, and Swiss/Emmentaler) be classified as non-Potentially Hazardous Food / Time/Temperature Control for Food Safety food at storage temperatures not to exceed 30°C (86°F).

Interaction Table From 2005 Food Code

Table A. Interaction of pH and a_w for control of spores in food heat-treated to destroy vegetative cells and subsequently packaged.

a_w Values	pH Values		
	4.6 or less	> 4.6 – 5.6	> 5.6
0.92 or less	Non-PHF*/non-TCS**	Non-PHF/non-TCS	Non-PHF/non-TCS
> 0.92 – 0.95	Non-PHF/non-TCS	Non-PHF/non-TCS	PA***
> 0.95	Non-PHF/non-TCS	PA	PA

* PHF means “Potentially Hazardous Food”

** TCS means “Time/Temperature Control for Safety Food”

*** PA means “Product Assessment Required”

Source: FDA

Application of Interaction Tables - Parmesan Cheese

- **Parmesan Cheese:**
 - $a_w = 0.68 - 0.76$
 - $\text{pH} = 6.5$
 - curd heated to $\sim 130^\circ\text{F}$ & cured 2-3 years, then packaged
- **Ambient storage desired & no history of related illness**
- **The food is heat-treated/cured & packaged**
- **Locate the cheese's a_w (0.68 – 0.76) in the correct line and pH (6.5) in the correct column**
- **They intersect at “Non-PHF/Non-TCS”**
 - No temperature control is required

- **Source: FDA**

TABLE 3. Summary of data on cheeses reviewed, and compositional calculations (21, 68, 75)

Cheese Type	Typical % H ₂ O	CFR Limit % H ₂ O	A _w	Typical pH	Typical % NaCl	Typical % Aqueous NaCl	% FDM **	Active Culture	Age at sale (days)	Other Inherent characteristics	Pathogen Kill†
Asiago	32-34	35	0.93	5.2-5.5	1.9-2.2	5.75	45	Thermophile	180-365	A/S Temp*	Ah, Cj, Ec, Lm, P, Sa, Sta, Ye
Cheddar	38	39	0.95	5.2	1.7	4.47	52	Mesophile	15-1,000	A/S Temp*	Lm, Sa, Sta, Ye
Colby	39	40	0.95	5.2	1.7	4.36	52	Mesophile	15-80	A/S Temp*	Ec, Lm, Sta, Ye
Feta	53	NA	0.95	4.5	3.0	5.66	29-52	Mesophile	7-90	A/S Temp*	Lm
Monterey Jack	38-42	44		5.25	1.7	4.05-4.47	52	Mesophile	15-150	A/S Temp*	Lm
Mozzarella	45-52	45-52		4.9-5.4	1.6	3.07-3.56	52	Thermophile	5-150	Hot water/steam treatment	Lm kill cook/stretch Lm, Sa growth
Muenster	43	46	0.98	5.2	1.8	4.18	52	Thermophile	10-150	A/S Temp*	Lm
Parmesan	31	32	0.92	5.4	2.6	8.38	38	Thermophile	300-600	A/S Temp* Aged ≥300d High temp curd cook Lipase activity	Lm
Process (sliceable)	40		0.92	5.6	2.2	5.50	50	None	14-180	A/S Temp* Heated ≥150°F/≥30 sec	Clb, Ec, Lm, Sa, Sta
Provolone	42.5	45	0.91	5.2	1.8	4.24	45	Thermophile	15-150	A/S Temp*	Lm
Romano	33.5	34	0.92	5.3	2.2	6.57	40	Thermophile	150-180	A/S Temp*	Lm
Swiss / Emmentaler	38	41	0.97	5.6	1.2	3.16	43	Thermophile	61-300	A/S Temp*	Ah, Cj, Ec, Lm, Pa, Sa, Sta, Ye
Brick	43	44		5.3	1.6	3.72	52	Mesophile	7-50	A/S Temp*	Ec, Lm
Blue	43	46	0.97	6.0	2.5	5.82	52	Mesophile	61-240		Lm

* A/S Temp => Increased pathogen kill at elevated aging/storage temperatures.

** %FDM=> Percent fat in dry matter.

† Ah – *Aeromonas hydrophila*, Cj – *Campylobacter jejuni*, Clb – *Clostridium botulinum*, Ec – *Escherichia coli* O157:H7, Lm – *L. monocytogenes*,

P – *Pseudomonas aeruginosa*, Sa – *Salmonella* sp., Sta – *Staphylococcus aureus*, Ye – *Yersinia enterocolitica*.

Pasteurized Process (21CFR133.169)

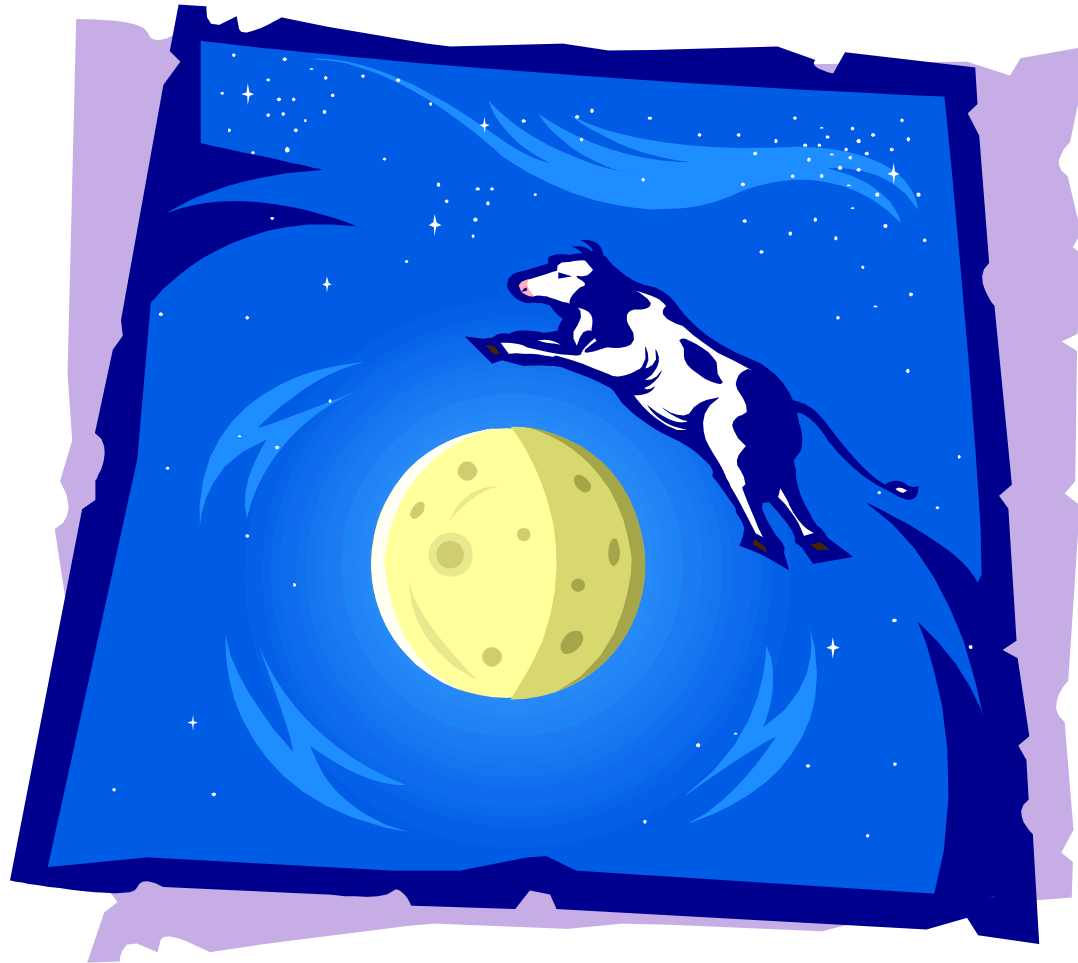
Pasteurized process cheese is a soft to semi-soft cheese that does not support *L. monocytogenes* growth and that causes gradual death at all temperatures (25, 27). Pasteurized processed cheese and related products have an excellent safety record in the United States (39). During the past 50 years, very few disease outbreaks have been attributed to contaminated pasteurized process cheese products (27). The combined effects of pH, moisture, and salt in standardized process cheese may inhibit vegetative pathogen growth in a way

similar to the mechanism of inhibition for *Clostridium botulinum* (73, 74). If a pasteurized processed cheese is intended for use at ambient temperature, pH, water activity (a_w), moisture content, and antimicrobials should be appropriately adjusted to inhibit botulinum toxin formation (3). During manufacture, the product is heated for ≥ 30 s at a temperature of ≥ 65.6°C, this is sufficient to eliminate vegetative organisms but not the spores of *Clostridium botulinum*. As a formulated safe product with regard to *C. botulinum*, the combinations of moisture, salt, and pH act as multiple hurdles to inhibit botulinum growth and toxin production (42, 73).

While studying pathogen survival in pasteurized process cheese slices, Glass et al. (27) reported that populations of *Salmonella* serotypes and *E. coli* O157:H7 decreased by an average of 1.3 and 2.1 log CFU/g, respectively, by 36 h. *Salmonella* serotypes decreased an additional 0.6 log CFU/g during the remaining 60 h. Populations of *L. monocytogenes* also decreased, although to a lesser extent, exhibiting approximately 0.6 log CFU/g reduction in 96 h. *S. aureus* levels remained relatively constant during the testing period and were below levels that support detectable enterotoxin production. At 30°C, the pasteurized process cheese slices

Support

- National Cheese Institute
- Wisconsin Center for Dairy Research
- Wisconsin Milk Marketing Board
- Dairy Management Inc.



Questions?