

## SHOULD CHEESE BE REFRIGERATED?

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*Cheeses are one of the oldest types of prepared foods. Cheesemaking provided mankind with the means of concentrating and preserving milk at a time when refrigeration was unknown and principles of food preservation were vague empirical concepts at best. Cheeses were included in the diet of early Egyptians and Greeks. Indeed, cheese is mentioned in Greek mythology, including one variety made from the milk of tigers. That cheese must have had real gusto, but pity the poor tiger milkers. Rome imported cheeses from England, France, the Alpine areas and even Asia, all without the benefit of refrigeration.*

### *General Principles*

Displays of cheeses out of refrigeration should be conditional upon ambient temperature limits and adequate stock rotation. Display temperatures should not exceed 78°F, and product should not be exposed to localized heat sources, such as sunlight, refrigeration condensers, etc. Effective stock rotation is a must, but is rarely a problem, since most promotions last only a few days.

Mass display should be limited to products in original packages - that is packages of food products filled and sealed under good manufacturing or food handling practices. Thus, delicatessen sales of opened blocks or loaves of cheese should maintain cheese in opened packages under refrigeration, in an enclosure which prevents handling or sampling by curious shoppers.

Some cheese packages bear the statement "Refrigerate after opening", reflecting concern that once a product is exposed to the environment, it should be kept cold to minimize the growth of spoilage organisms that may be introduced into the product.

Often, shippers for products displayed out of refrigeration may bear the statement, "Store under refrigeration" or "Keep refrigerated." Such instruction reflect manufacturers programs to control distribution conditions so that

when weeks or months elapse between manufacture and store display, product will remain at optimum quality.

### *Reasons for Out-of-Refrigeration Display*

A major incentive for removing cheese from refrigeration is sales promotion. Attractive mass display of any product, strategically positioned and priced to motivate consumer purchase is a proven technique for increasing sales. The removal of cheese from the confines of refrigerated display cases is essential to this sales strategy.

Foodservice operations may need to have cheese conveniently at hand during food preparation. Buffet food service may include a variety of cheeses or items which incorporate cheese, some of them at ambient temperatures.

### *Technology of Natural Cheeses*

Natural cheeses are fermented foods. Conversion of milk to cheese includes inoculation with very high numbers of harmless lactic culture microorganisms. These lactic organisms multiply as fermentation of the lactose to lactic acid proceeds. Consequently, the pH decreases. The milk is clotted with rennet or acid and the curds separated from the whey under controlled processing conditions. Some natural cheeses are sold freshly manufactured but many are cured or aged, again under controlled conditions for many months or even years.

During the manufacture of semi-soft, hard, and very hard cheeses, the cheese is subjected to relatively long exposure to ideal incubation temperatures for spoilage microorganisms. For example, Cheddar and related varieties are maintained at 88-102°F during manufacture and are formed or hooped at temperatures in the 90's. Cheeses may remain at warm temperatures during overnight pressing, cooling gradually thereafter.

Many Cheddar-type cheeses are cured or aged at temperatures up to 60°F. Swiss cheese is held for a period of four to eight weeks at a temperature of 72°-74°F to develop the characteristic eyes and flavor of Swiss cheese. If storage of Cheddar or Swiss cheeses at room temperature had any in-

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herent detrimental effect on the safety of the cheeses, then neither Cheddar nor Swiss cheeses would be safe to consume.

The safety of natural cheeses is "built in" by proper management of the fermentation process. There are two main keys to proper control of cheese fermentation. First, the lactic culture utilized in manufacture must exhibit vigorous fermentation activity. A vigorous lactic fermentation has been demonstrated to inhibit the growth of spoilage microorganisms and pathogens and to inhibit, as well, toxin production by Staphylococci. Second, the fermentation during cheese manufacturing must be carefully controlled to be neither too rapid nor too slow. The key analytical tool is pH measurement, particularly pH of the cheese 24 hours after manufacture. Such freshly made cheddar and related cheese must exhibit a pH of 5.4 or less. Aged cheese may have a pH exceeding 5.4, resulting from chemical changes in constituents.

#### Display Conditions for Natural Cheeses

Guidelines for the storage of natural cheeses are primarily related to the moisture content of the cheese. Although salt, pH, and gross composition exert some effect, moisture content is by far the most significant determinant of how well a cheese will withstand temperature stress.

For the purpose of assessing susceptibility to temperature stress, natural cheese can be divided into four groups - soft cheeses, semi-soft cheeses, hard cheeses, and hard grating cheeses.

Soft cheeses include cottage, bakers, neufchatel, cream, mozzarella and ricotta. Soft cheeses have moisture contents exceeding 50 percent. They spoil readily when temperature stressed. Spoilage may be either organoleptic (flavor) or microbiological. They should always be refrigerated at temperatures of 40°F or less.

#### SOFT CHEESES Refrigeration Essential

Variety	Max. Moisture
Cottage	80
Bakers	(80)
Neufchatel	65
Cook (Koch)	80
Cream	55
High Moisture Jack	50 (44 minimum)
Low Moisture	
Mozzarella, Scamorze	52 (45 minimum)
Low Moisture Park Skim	
Mozzarella, Scamorze	52 (45 minimum)
Mozzarella, Scamorze	60 (52 minimum)
Part Skim	
Mozzarella, Scamorze	60 (52 minimum)
Ricotta	(70)

Semi-soft cheeses include surface ripened Brie, and Camembert, mold-ripened Blue and Gorgonzola, and others - Edam, Monterrey, and Muenster. These varieties have moisture contents ranging from 44-52 percent. Although such cheeses are capable of withstanding moderate temperature stress, they should be refrigerated. Flavor deterioration result from prolonged temperature stress.

#### SEMI-SOFT CHEESES Refrigeration Desirable

Variety	Max. Moisture
Surfaced Ripened	
Brie	(50)
Camembert	(50)
Brick	44
Limburger	50
Mold Ripened	
Blue	46
Gorgonzola	46
Roquefort	45
Other Varieties	
Edam, Gouda	45
Monterrey, Monterrey Jack	44
Muenster, Munster	46

Hard cheeses include Cheddar, Colby and Swiss cheeses and have moisture contents of 36-43 percent. Generally, hard cheeses that are to be cured or aged are manufactured to contain less moisture than mild flavored hard cheeses which may be marketed three months or less after manufacture.

#### HARD CHEESES Refrigeration Optional

Variety	Max. Moisture
Cheddar	39
Colby	40
Swiss	41

Hard cheeses readily withstand short-term out-of-refrigeration display, at temperatures of 78°F or less. Good control over ambient temperature is essential, since high temperatures can result in unsightly oiling off of liquified milk fat. Good stock rotation is a must. Out-of-refrigeration display exceeding one week should be avoided.

#### HARD GRATING CHEESES, GRATED CHEESES Refrigeration Unnecessary

Variety	Max. Moisture
Parmesan	32
Romano	34
Grated	(18)

The fourth group, hard grating cheeses can be displayed out of refrigeration for extended periods, as can grated cheeses. The moisture content of hard grating cheeses is 34 percent or less while the moisture content of grated cheeses is usually about 18 percent. Consistent with these low-moisture contents, such cheeses can withstand extended out-of-refrigeration display although they will exhibit oiling-off if subjected to temperature stress in excess of 80°-85°F.

#### Process Cheeses and Related Products

Processed cheeses and related products are manufactured by comminuting, mixing and heating blends of natural cheese and in some types, other dairy ingredients. Emulsifying salts are incorporated to impart a smooth,

homogenous body and texture. The heat treatments are sufficient to render processed cheeses microbiologically inert, although very low populations of heat resistant organisms are present in some production lots.

Pasteurized process cheeses and related products can be divided into four product groups - process cheese, cheese foods, cheese spreads, and cheese products. Process cheeses are manufactured exclusively from cheeses without any optional dairy ingredients. The moisture content of pasteurized process cheeses is limited to 1 percent greater than the maximum moisture allowed in the natural cheese or cheese blends from which they are manufactured. Pasteurized process cheese foods must have a moisture content not exceeding 44 percent, contain at least 51 percent cheese and therefore may contain up to 49 percent optional dairy ingredients. Pasteurized process cheese spreads must also contain 51 percent cheese but may exhibit a moisture content within the range 44-60 percent. Most pasteurized process cheese spreads on the market contain 52 percent moisture or less.

Pasteurized process cheese products are those products that are all dairy, are pasteurized, but do not fall within the requirements of the three standards just summarized. Presently, there is no federal standard for pasteurized process cheese products although proposals for such a standard have been filled with or proposed by FDA.

The minimum requirements for pasteurization of process cheese and similar products set forth in the Code of Federal Regulations specify heating the product to a temperature of at least 150°F for 30 seconds. This time/temperature combination would not adequately pasteurize milk. However, the same temperature has been proven effective for cheese because the pH of natural Cheddar cheese and most other natural cheeses is much lower than that of milk. Also, the emulsifying salts used in processing as well as added salt increase the level of electrolyte, thereby increasing the lethality of this heat treatment to microorganisms. Therefore, pasteurization of cheese at this time/temperature is considered adequate by FDA and other agencies.

The usual practice in the process industry is to heat the blended ingredients to a temperature substantially above 150°F, usually from 160°F to 170°F, for a period of three to five minutes. Consequently, the heat treatments used in pasteurization of cheese for the manufacture of process cheese and process cheese products are far in excess of that required to kill pathogenic organisms including Salmonella and enterotoxigenic Staphylococci. Moreover these products are packaged and sealed with heat—usually at temperatures not lower than 160°F. Such heat treatment just preceding hot filling and immediate package closure imparts a longer keeping quality than would be the case if minimum heat treatments had been applied for the destruction of pathogens.

When process cheese and process cheese products deteriorate, they do not, as a rule, exhibit microbiological spoilage. Instead, they exhibit the results of lipid oxidation. As is true with all foods containing fat, eventually there is a tendency for oxidized flavors to develop no mat-

ter how they are packaged. Cheese products that have received the kind of treatment mentioned above and that are packaged while hot in sealed plastic or glass containers have a shelf life by Kraft standards in excess of 150-270 days. Even when Kraft process cheese type products reached the "Best when purchased by" date stamped on the package, they are still suitable for consumption for many weeks thereafter if they have been handled in a reasonable manner.

For pasteurized process cheese and related standard products there need be no hesitation in permitting out-of-refrigeration display at temperature of 78°F or less. Proper stock rotation is again a must and although we believe that a two week display is completely safe, a one week stock turnover is recommended to sales representatives and customers.

Pasteurized process cheese products are presently not a well defined class of products. Consequently, no general recommendation can or should be made on out-of-refrigeration storage or display. However, there is no reason to conclude that they cannot be handled and displayed in a manner similar to other pasteurized process cheese types.

#### *Concerning Mold on Cheese*

Despite continuing advancement in cheese packaging technology and the use of antimycotic substances, moldy cheese continues to be a common occurrence. Moldy cheese does not present a serious health hazard. The commonest cheese mold - the green or blue-green penicillia and white "dairy mold" are not toxin producers. In the unlikely event that mold on cheese is a toxin-producing mold, profuse growth is required before significant toxin production occurs. This remote risk can be eliminated by trimming moldy cheese to a depth of 1/3 in. below the deepest mold growth penetration. This recommendation does not, of course, apply to mold ripened cheeses such as Blue, Gorgonzola, Roquefort and Stilton.

Mold growth under refrigerated conditions presents no known health risk. Common toxigenic molds cannot grow well, if at all, at refrigerated temperatures. The scientific literature records no instance whatsoever wherein growth of toxigenic molds on cheese under refrigerated conditions resulted in toxin production.

#### *Definition of "Potentially Hazardous Food"*

A definition that has caused considerable confusion and misunderstanding in the evaluation of out-of-refrigeration display of cheeses and other foods is that contained in the 1976 FDA Food Service Sanitation Manual for "Potentially Hazardous Food."

"Potentially Hazardous Foods" means any food that consists in whole or in part of milk or milk products, eggs, meat, poultry, fish, shellfish, edible crustacea, or other ingredients, including synthetic ingredients, in a form capable of supporting rapid and progressive growth of infectious or toxigenic microorganisms. The term does not include clean, whole, uncracked, odor-free shell eggs or foods which have a pH level of 4.6

or below or a water activity ( $a_w$ ) value of 0.85 or less."

We believe that natural cheese, properly manufactured via a vigorously controlled lactic fermentation is *not* "in a form capable of supporting rapid and progressive growth of infectious or toxigenic microorganisms." Similarly, pasteurized process cheese and related products that have been subjected to the pasteurization conditions previously described and which have been hot filled and sealed are *not* "in a form capable of supporting rapid and progressive growth of infectious or toxigenic microorganisms."

It is important, of course, that both types of products be in the original, sealed, package. Accordingly, an appropriate legend on the package such as "Refrigerate after opening", is recommended even though the surface of cheeses are not a particularly hospitable environment for pathogens.

#### Conclusion

Whether or not any cheese should be refrigerated depends upon moisture content and cheese type. Pasteurized process cheeses and related standardized products readily withstand out-of-refrigeration conditions. Natural cheeses may not require refrigeration if they contain a relatively

low proportion of moisture. Soft or semi-soft cheese must be refrigerated whether or not they are in intact packages. Hard or hard grating cheeses need not be refrigerated but should not be subjected to temperature stress which could cause oiling off. Open packages of any cheese should be refrigerated. Mold on cheese presents little or no health risk, but moldy cheese should be trimmed and the trimmings discarded.

The definition for "Potentially Hazardous Food" doesn't offer clear guidance on whether to refrigerate cheeses. The definition requires adequate knowledge and proper interpretation of what constitutes those conditions which will support the growth of pathogens and information on whether contamination with pathogenic microorganisms has or may have occurred.

#### PROCESS CHEESES AND RELATED PRODUCTS

Refrigeration optional, except for cheese products for which no general recommendations can presently be made.

Type	Max. Moisture
Pasteurize Process:	
Cheese	40-42
Cheese Food	44
Cheese Spread	60 (44 minimum)
Cheese Product	(60) ?

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