

# Cheese

Revised 2024

## Cheese

Over 600 varieties of cheese are listed and described in "Cheese Varieties" USDA Handbook No. 54 (1978), and over 70 U.S. Standards of Identity have been issued for varieties of natural and processed cheeses (Code of Federal Regulations CFR-21, Food and Drugs). Cheese is produced principally from milk of any species (raw, partially pasteurized (thermized), or pasteurized), together with or without certain enzymes, bacteria, salt, and color. Soft cheese, such as Bakers, Chevre, Cottage, Cream, Neufchatel, and Queso Fresco are not cured and are seldom warehoused. Virtually all other types, including semi-hard and hard, are "ripened" or cured. Curing through bacterial growth and enzymatic action results in the desired texture, body, and flavor in cheese. Cured cheese is referred to as natural cheese since curing is a "natural" biological process. Natural cheese may be stored for curing in the cheese factory, in warehouses operated by assemblers; it may be repackaged, used for pasteurized processed cheese, or it may be stored in refrigerated warehouses.

Storage of cheese for curing should be differentiated from storage of cheese for standby or distribution purposes. Natural cheese continually undergoes some biological activity, called curing. That process may affect its qualities, either positively or negatively. Temperatures, and humidity for storage or curing, normally are selected based on the history of the cheese during its manufacture and observed changes during the initial stages of ripening. The quality of the cheese resulting from this biological process is difficult to predict. Manufacturers and producers should stipulate the conditions for its storage and routinely monitor the quality.

A summary of the usual moisture, protein, fat, carbohydrate, and ash composition of common cheeses distributed globally is included in Table 1. Also included are thermal properties, including specific heat (above and below freezing) and latent heat of fusion, in English (British thermal units (Btu)/lb \* degrees Fahrenheit) and Metric units (kilojoules/kg \* degrees Kelvin (or Celsius)). Note: water has a specific heat capacity of approximately 1.0 Btu/lb\*°F or 4.18 kJ/(kg\*K).

Temperature control of cheese during storage (between 32 to 42°F or 0 to 5.56°C) is essential for quality. Freezing is typically not advised, as it changes the body and texture characteristics of the product. Storage temperatures above 50°F (10°C) do not only lead to body and texture defects, but aroma, taste, and flavor defects. Recommended storage temperatures for cheeses and primary modes of failure are included in Table 2.

**Table 1. Properties of common cheeses distributed globally**

	Camembert		Cheddar	
	English	Metric	English	Metric
Moisture, %	51.80	--	36.75	--
Protein, %	19.80	--	24.90	--
Fat, %	24.26	--	33.14	--
Carbohydrate, %	0.46	--	1.28	--
Fiber, %	0.0	--	0.0	--
Ash, %	3.68	--	3.93	--
Specific Heat Above Freezing	0.74 Btu/lb*°F	3.10 kJ/(kg*K)	0.66 Btu/lb*°F	2.77 kJ/(kg*K)
Specific Heat Below Freezing	0.80 Btu/lb*°F	3.34 kJ/(kg*K)	0.73 Btu/lb*°F	3.07 kJ/(kg*K)
Latent Heat of Fusion	74 Btu/lb	173 kJ/kg	53 Btu/lb	123 kJ/kg

	Cottage, Un-creamed		Cream	
	English	Metric	English	Metric
Moisture, %	79.77	--	53.75	--
Protein, %	17.27	--	7.55	--
Fat, %	0.42	--	34.87	--
Carbohydrate, %	1.85	--	2.66	--
Fiber, %	0.0	--	0.0	--
Ash, %	0.69	--	1.17	--
Specific Heat Above Freezing	0.89 Btu/lb*°F	3.73 kJ/(kg*K)	0.75 Btu/lb*°F	3.16 kJ/(kg*K)
Specific Heat Below Freezing	0.48 Btu/lb*°F	1.99 kJ/(kg*K)	0.70 Btu/lb*°F	2.91 kJ/(kg*K)
Latent Heat of Fusion	114 Btu/lb	266 kJ/kg	77 Btu/lb	180 kJ/kg

	Gouda		Limburger	
	English	Metric	English	Metric
Moisture, %	41.46	--	48.42	--
Protein, %	24.94	--	20.05	--
Fat, %	27.44	--	27.25	--
Carbohydrate, %	2.22	--	0.49	--
Fiber, %	0.0	--	0.0	--
Ash, %	3.94	--	3.79	--
Specific Heat Above Freezing	0.69 Btu/lb*°F	2.87 kJ/(kg*K)	0.72 Btu/lb*°F	3.03 kJ/(kg*K)

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Specific Heat Below Freezing	0.66 Btu/lb*°F	2.77 kJ/(kg*K)	0.67 Btu/lb*°F	2.82 kJ/(kg*K)
Latent Heat of Fusion	59 Btu/lb	138 kJ/kg	70 Btu/lb	162 kJ/kg

	Mozzarella		Parmesan, hard	
	English	Metric	English	Metric
Moisture, %	54.14	--	29.16	--
Protein, %	19.42	--	35.75	--
Fat, %	21.60	--	25.83	--
Carbohydrate, %	2.22	--	3.22	--
Fiber, %	0.0	--	0.0	--
Ash, %	2.62	--	6.04	--
Specific Heat Above Freezing	0.75 Btu/lb*°F	3.15 kJ/(kg*K)	0.62 Btu/lb*°F	2.58 kJ/(kg*K)
Specific Heat Below Freezing	0.59 Btu/lb*°F	2.46 kJ/(kg*K)	0.70 Btu/lb*°F	2.94 kJ/(kg*K)
Latent Heat of Fusion	78 Btu/lb	181 kJ/kg	42 Btu/lb	97 kJ/kg

	Processed American		Roquefort	
	English	Metric	English	Metric
Moisture, %	39.16	--	39.38	--
Protein, %	22.15	--	21.54	--
Fat, %	31.25	--	30.64	--
Carbohydrate, %	1.30	--	2.00	--
Fiber, %	0.0	--	0.0	--
Ash, %	5.84	--	6.44	--
Specific Heat Above Freezing	0.67 Btu/lb*°F	2.80 kJ/(kg*K)	0.67 Btu/lb*°F	2.80 kJ/(kg*K)
Specific Heat Below Freezing	0.66 Btu/lb*°F	2.75 kJ/(kg*K)	0.80 Btu/lb*°F	3.36 kJ/(kg*K)
Latent Heat of Fusion	56 Btu/lb	131 kJ/kg	57 Btu/lb	132 kJ/kg

	Swiss	
	English	Metric
Moisture, %	37.21	--
Protein, %	28.43	--
Fat, %	27.45	--
Carbohydrate, %	3.38	--
Fiber, %	0.0	--
Ash, %	3.53	--

Specific Heat Above Freezing	0.66 Btu/lb*°F	2.78 kJ/(kg*K)
Specific Heat Below Freezing	0.69 Btu/lb*°F	2.88 kJ/(kg*K)
Latent Heat of Fusion	53 Btu/lb	124 kJ/kg

**Table 2. Recommended storage conditions temperature and times for common cheeses distributed globally (65% relative humidity).**

	Temperature		Maximum storage period	Mode of failure <sup>1</sup>
	(°F)	(°C)		
Blue	32 to 34	0 to 1	3 months	Temp
Brie	32 to 34	0 to 1	2 months	Temp
Brick	32 to 34	0 to 1	3 months	Temp
Caciocavallo	32 to 34	0 to 1	6 months	Temp
Camembert	32 to 34	0 to 1	2 months	Temp
Cheddar	32 to 34	0 to 1	12 months	Temp
Chevre (fresh goat)	32 to 34	0 to 1	2 months	Temp
Colby/Colby-Jack	32 to 38	0 to 3	6 months	Temp
Cottage	32 to 34	0 to 1	3 weeks	Temp
Granular Cheese	32 to 40	0 to 1	12 months	Temp
Washed Curd Type Cheese	32 to 38	0 to 3	6 months	Temp
Cream, Hot Pack	32 to 34	0 to 1	4 weeks	Temp
Edam	32 to 34	0 to 1	6 months	Temp
Gorgonzola	32 to 34	0 to 1	3 months	Temp
Gouda	32 to 34	0 to 1	6 months	Temp
Grated, dried	32 to 40	0 to 4	12 months	Humidity
Manchego	32 to 38	0 to 3	12 months	Temp
Monterey Jack/Jack	32 to 38	0 to 3	12 months	Temp
Mozzarella, block pizza cheese	32 to 34	0 to 1	2 months	Temp
Mozzarella, fresh	32 to 34	0 to 1	2 months	Temp
Gruyere	32 to 34	0 to 1	12 months	Temp
Liederkrantz	32 to 34	0 to 1	3 months	Temp
Limburger	32 to 34	0 to 1	3 months	Temp
Parmesan	32 to 40	0 to 4	24 months	Humidity
Pasteurized Process Cheese	32 to 40	0 to 4	10 months	Temp

Pasteurized Process Cheese food	32 to 40	0 to 4	10 months	Temp
Pasteurized Process Cheese spread	32 to 40	0 to 4	6 months	Temp
Sliced Pasteurized Process cheese	32 to 40	0 to 4	6 months	Temp
Provolone	32 to 34	0 to 1	12 months	Temp
Queso Fresco (Latin American style)	32 to 34	0 to 1	2 months	Temp
Romano	32 to 40	0 to 4	12 months	Humidity
Roquefort	32 to 34	0 to 4	3 months	Temp
Stilton	32 to 34	0 to 1	8 months	Temp
Swiss	32 to 40	0 to 4	12 months	Humidity

<sup>1</sup>Recommendations are for storage, not for curing. Cheeses should only be stored for periods indicated; undesirable changes are likely with longer storage. Temperatures above 50°F (10°C) or below 30°F (-1°C) will cause undesirable changes.

## **Cheese packaging**

### **Paraffined, Waxed Cheese:**

Paraffined or waxed cheese is cheese dipped and coated with hot-melt paraffin-wax or wax compounds to provide a semi-flexible coating that protects against growth of mold, and loss of moisture and weight. Paraffin-wax coated cheese constitutes only a small portion, possibly 5% of all packaged cheeses. Among shapes of paraffin-wax coated granular, stirred curd, washed curd, or Cheddar cheese are midget longhorn, midget longhorn Colby, Daisy, and Cheddar. Frequently, consumer-size cuts or wedges are wax-coated. Some imported varieties of cheese are also wax-coated. Paraffined natural cheese in larger weight units may be stripped of the wax coating and sub-divided into consumer-size cuts, then either wrapped or wax-coated for retail sales.

Common defects that occur in paraffin-waxed cheese during storage are surface mold and rind rot. These defects may be caused by inappropriate conditions of waxing, abusive handling practices, the development of cracks or "checks" in the coating, or a combination of these. Paraffined-waxed cheese should be under regular surveillance by owners and by warehousemen for possible development of defects.

### **Rindless Natural Cheese:**

Rindless cheese describes a form of packaging, that eliminates the use of wax coatings, and includes many varieties, such as Cheddar, Colby, Swiss, Brick, and Muenster. Rindless Cheddar and Granular type Cheddar may be packed in 40 lb. (18 kg) units, up to 700 lb. (317 kg); Colby, 40 to 640 lb. (18 to 290 kg);

Swiss, 90 to 100 lb. (41 to 45 kg), and 200 lb. (91 kg); and Brick and Muenster, 5 to 20 lb. (3 to 9 kg). Protective films are selected for moisture, water vapor, and gas transmission properties. When it comes to gas transmission properties, CO<sub>2</sub> and O<sub>2</sub> are tightly pressed on and "annealed" by heat, vacuum, or shrink-wrapped.

Cured bulk units of rindless natural cheese are sub-divided (usually in rooms pressurized with filtered air to minimize mold contamination) into smaller units such as 2 to 5 or 10 lb. (1 to 3 or 5 kg) loaves, or into slices, and packaged under vacuum or in atmospheres of CO<sub>2</sub> or N<sub>2</sub> in film pouches; or in shrink-wrap films to minimize the occlusion of air and to protect against mold growth.

Rindless natural cheese made from raw or unpasteurized milk is biologically more active at any given temperature than when made from fully pasteurized milk. Thus, in this case, the gas generation from rindless natural cheese may be more rapid, can be dissipated through the film, and bulging of the package may occur.

If temperature abuse occurs, "weeping", "sweating" or "syneresis" (moisture exudation) of cheese may occur. The leached whey may collect in any fold or loose area of packaging. If a white film, "haze", or spots of white crystals appear on the surfaces of cheese it indicates the formation of calcium lactate crystals. This can be particularly evident in slices and shreds. Customers often think it is mold, although both are harmless; calcium lactate crystals are very undesirable which is one of the reasons temperature control is so important.

### **Mold-Ripened Cheeses (Blue or Bleu, Roquefort, Gorgonzola, Stilton, Camembert, Brie):**

Mold-ripened cheeses are especially susceptible to quality deterioration if not properly refrigerated. These cheeses tend to soften, undergo syneresis, and may develop unwanted surface mold when held at warmer storage conditions. The rate at which these quality defects will appear varies with storage temperature and will likely occur within only a few days if stored at 45 to 50°F (7 to 10°C).

### **Pasteurized Process Cheeses**

#### **Pasteurized Processed Cheese, Cheese Foods, and Cheese Spreads:**

These soft cheeses are prepared by comminuting and mixing certain cheese, or cheeses, emulsifying salts and other ingredients (e.g., butter, whey) while heating for not less than 30 seconds at 150°F (68°C) or the equivalent. This results in a homogeneous plastic mass, some of which is packaged in loaf form, but most of which is molded or cast in slice or sandwich size, then packaged in 4 oz to 5 lb. (113 gram to 2.3 kg) flexible, semi-rigid or rigid units. Pasteurized Processed Cheese, Cheese Foods, and Cheese Spreads have legal regulations (CFR 21) for moisture, fat, and ingredients. According to type, they may contain ingredients such as fruits, vegetables, and meats. Processed Cheese Foods and Spreads contain more moisture and less fat than Processed Cheese. Processed Cheese products properly packaged are relatively stable in storage at 30 to 34°F (-1 to 1°C).

**Cold-pack Cheese, Club Cheese, and Cold Pack Cheese Food:**

These soft cheeses are comminuted or reduced to spreadable form without the aid of heat and may be made from certain cheeses or their blends. Cold-pack Cheese Food may also include certain fruits, vegetables, meats, and other ingredients; and is packaged in rigid or semi-rigid institutional and consumer-size units. Cold-pack Cheese is less stable (more perishable) than Pasteurized Processed Cheeses. With added mold inhibitors (legally permissive sorbic acid or Na or Ca propionates), the shelf life may be prolonged. Cold-pack Cheese products should be stored at 30 to 34°F (-1 to 1°C) and kept under routine surveillance, particularly for mold spoilage.

**Grated Cheese and Cheese Products:**

A number of dried forms of cheese are produced mainly for use as condiment and flavor, in consumer-size packages, or in larger bulk quantities for use as ingredients in food product manufacture. These products are relatively stable unless their moisture contents are too high; or they are stored in atmospheres of high relative humidity, especially if inadequately packaged. Grated and dried to 18% moisture or less, these cheeses may commonly be packed in non-moisture proof containers. If these grated cheeses are stored at refrigeration temperatures (40°F/4.4°C), and then exposed to warm moist air, condensation may occur within the containers. This can cause the cheese to become caked and lumpy or to become moldy. Care should be taken to ensure that the relative humidity during tempering (warming) of the cheese does not exceed the relative humidity under which the cheese has been stored.

**Frozen Storage****Frozen Storage of Cheese:**

Recommended procedures for frozen storage of cheese vary, and certain varieties should not be frozen. A high-moisture cheese, such as Bakers, Cottage, Cream, Ricotta, and Neufchatel will be damaged when frozen, through the shattering of curd, and change in texture. Some dairy operators consider it feasible to freeze un-creamed Cottage cheese curd and Bakers cheese for later mixing with fresh cheese, but not without some possible adverse effects when milk supplies are short. Other types of cheese such as Camembert and Brie, or Brick, Cheddar, and Mozzarella may be frozen, but only with considerable care.

During the freezing process, cheese should pass through the temperature range 28 to -10°F (-2.2 to -23°C) as quickly as feasible and be maintained at or below that temperature consistently to minimize the formation of large ice crystals (which disrupt the cheese body and texture). Frozen storage for short intervals of a few months appears more successful than for long periods.

Tempering of thawed cheese such as Cheddar and Swiss, especially through the range 28 to 30°F (-2.2 to -1°C) over a period of 10 days, is believed to aid in restoring affected properties of the cheese. Mozzarella cheese can be frozen and stored at 0 to -20°F (-18 to -29°C) for 1 year without negative effects if the cheese is tempered for 10 to 20 days after thawing. Rates of freezing and thawing pallet-

loads of Mozzarella cheese, applied in well-operated warehouses are suitable for obtaining good quality cheese. Storage of frozen cheese for subsequent use as an ingredient in foods or in-process cheese products should be thoroughly evaluated.

Freezing of cheeses with textures like Cheddar cheese may result in body and texture changes, such as the development of "pastiness" or "oiliness." Because recommended procedures for freezing many kinds of cheeses are unavailable, the owners of the cheese should be required to assume total responsibility for the conditions of storage and thawing and the quality of the final product. With the large increase in the production of low-fat cheese, frozen storage of this product is being encountered. While little or no definitive data are available for frozen storage of low-fat cheese, it is safe to assume that the same storage conditions be used for full-fat cheese.

### **Frozen Storage of Cheddar Cheese for Use in Pasteurized Process Cheese:**

Studies have shown that 5-pound (2.25-kilogram) blocks of pasteurized processed American cheese may be manufactured from previously frozen conventionally manufactured barrel Cheddar cheese or stirred curd Cheddar cheese. Previously frozen cheese may be processed alone or in blends with cheese that has never been frozen.

Barrel Cheddar cheese to be placed in frozen storage should contain a minimum fat content of 50% of the solids (MFB). Proper acid development is critical; pH should be 5.2 to 5.4. Moisture content should be 34 to 36%. Cheese should be aged 60 to 90 days before freezing for greatest utility by the manufacturer.

To freeze the cheese, it should be placed in a 0°F (-18°C) room with good circulation. It is estimated that a 550-pound (250-kilogram) barrel will freeze in 35 days. Exact times for complete freezing have not been ascertained either for individual barrels or palletized barrels.

The maximum length of frozen storage time for which hard data is available is 2 years. A longer frozen storage time may be possible but records documenting longer frozen storage times are not complete.

To thaw the cheese for processing, the storage area temperature should be raised to 32°F (0°C), and barrels should be separated slightly if possible. Under normal warehouse conditions, thawing should take an estimated 42 days with constant air circulation and exchange. Thawed cheese should be shipped at 32°F (0°C). Cheese may be tempered for processing under operating conditions normal to the particular plant.

The storage temperatures and freezing and thawing rates described above have been shown to yield good quality pasteurized process cheese on a commercial scale under commercial operating conditions. Processing of the previously frozen cheese can be accomplished by normal cooking times and temperatures, equipment, and emulsifying salts in use for conventional process cheese-making. Properly wrapped, sealed, cooled, and stored process cheese manufactured from previously frozen

cheese that had been handled as described above has taste quality, melting characteristics, and shelf life equivalent to conventionally manufactured process cheese.

The practice of freezing Cheddar cheese for use in pasteurized process cheese was initiated by the United States Department of Agriculture (USDA) in the 1980s when additional storage space, over the conventional cooler storage, was needed. Since stocks of surplus cheese have dwindled, the USDA is no longer holding Cheddar cheese in frozen storage.

## Storage Problems and Considerations

### Loss of Weight in Cheese during Storage:

Different varieties of cheese contain different concentrations of moisture. Loss of moisture from the cheese in storage rooms will depend on the relative humidity and the kind of packaging used. Loss is minimized when the cheese is packaged in wrappers with low moisture vapor transmission (MVT) rates. Paraffin-wax coating on cheese has only fair MVT protective properties. Certain un-waxed cheeses, for which the absence of a coating is essential for curing, may continually lose weight during storage.

### Cheese Mites:

Cheese in contaminated, fractured, or otherwise damaged wrappers or containers is subject to infestation and damage by mites such as *Acarus siro L.* and *Tyrophagus putrescentiae*. The hatching of eggs and completion of the life cycle through the adult stage may occur in a few weeks at temperatures of 40 to 60°F (4.4 to 15.5°C), and relative humidity greater than 65%. Development of mites is greatly inhibited at temperatures and humidity less than these. Mite-infested cheese should not be accepted for storage. Infestation is mostly the result of poor sanitation. Once the infestation occurs, the mites can survive on porous surfaces of shelves, pallets, walls, and cartons. To help prevent infestation, it is suggested to use good sanitation practices in the warehouse, use smooth surfaced shelves and walls, be sure the wrappings or coatings (wax) are completely sealed without cracks or holes, and do not reuse old cartons.

If an infested cheese is discovered, it should be photographed, isolated, and destroyed, with documentation. To eliminate an infestation, remove all products from the storage room and release a methyl bromide bomb, making sure the room is sealed for 24 hours. It would be advisable to check with your local Department of Health or Occupational Safety and Health office for safety precautions before using methyl bromide. Fumigation with methyl bromide must be done by a licensed fumigator or pest control officer. The room must be sealed before using the bomb. Protective clothing must be worn, and proper procedures must be followed before, during, and after, when reentering the room.

### Fungi and Mycotoxins:

Mold on cheese is considered to be a contaminant, and disagreeable, except where beneficial types are used to develop desired qualities, as in Blue, Roquefort, Stilton, Gorgonzola, etc. Mold spores, from which mold grows, are widely spread, and special care must be used to exclude them and prevent their growth on cheese. Mold may grow either inside or outside the cheese coating or wrapper. Mold will grow slowly, even at 34°F (1.1°C). Mold inhibitors, where permissible in cheese standards, are reasonably effective and must be declared on ingredient labels.

In the past several years, concern has developed because certain foodstuffs such as cereal grains, nuts, and oilseeds have been found to contain mycotoxins resulting from the growth of contaminating fungi, which, when fed, have been found responsible for extensive mortality in livestock and poultry. Some mycotoxins are carcinogenic. It is well established that certain fungi in cereal grains have been responsible for extensive numbers of deaths in humans in France and Russia. Some foods with 15% moisture or more will support mold growth, and possible toxin production. Toxicity of identified toxin extracts from foods and feeds (including cheese) fed to animals and poultry has been established. Considering the possible hazard implied in the presence of any unidentified mold, conditions must be maintained in refrigerated warehouses to prevent mold growth. Rooms, walls, ceilings, pallets, and racks should be reasonably clean, frequently inspected, and well-maintained when used for cheese storage. Porosity in walls and ceilings should be sealed with aluminum paint or another sealant. Circulation of air around pallets, and all room areas, sufficient to eliminate "dead" spots, is essential. Production of aflatoxin by aspergilli on cheese is impossible at temperatures below 50°F (10°C). Formation of other mycotoxins by molds such as *Penicillium* species is greatly reduced at 40°F (4.4°C) or lower.

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GCCF is indebted to Dr. Stephanie Clark, New Mexico State University, and Dr. Charles H. White, Mississippi State University, for the review and revision of this topic.