February 2021

Cheese and Varieties
Part II: Cheese Styles

Scientific excellence
Industry applicability
Strategic networking
Global influence

Series summary

Cheese is a ripened or unripened product made by coagulation of the proteins in milk through the action of rennet or another coagulant. Dehydration, often fermentation by lactic acid bacteria (LAB) and salt addition during cheese manufacture increase its shelf-life. Cheese contains the main milk protein casein, milk fat, the mineral calcium phosphate, about 36-43% water, lactic acid and 1.5% salt for a hard cheese. Coagulum cutting size, curd heating conditions and pressing influence moisture content and texture. Often ripening by enzymes from milk, rennet, LAB and partly ripening microorganisms occurs to develop flavour and texture.

Major classes of cheeses

Cheese can be classified into different groups based on the type of milk, heat treatment, the coagulation type, curd preparation, the water content, fat content, or the method and extent of ripening (Table 1 and Figure 1). This results in countless varieties of cheeses.

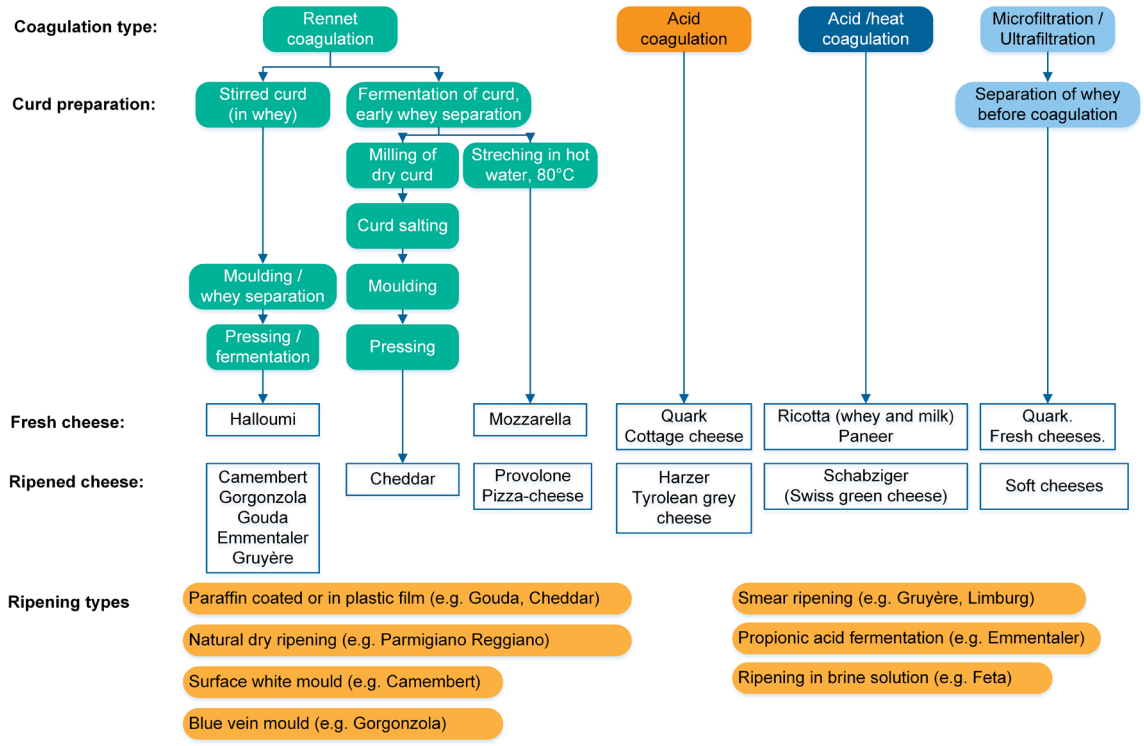
According to firmness		According to milkfat content	
MFFB %	Designation	FDM%	Designation
< 51	Extra hard	≥ 60	High fat
49–56	Hard	45 – < 60	Full fat
54–69	Firm /Semi-hard	25 - < 45	Medium fat
> 67	Soft	10 - < 25	Partially skimmed
		<10	Skimmed

MFFB (%): moisture on a fat-free basis: $\frac{Weight\ of\ moisture\ in\ the\ cheese}{weight\ of\ cheese - weight\ of\ fat\ in\ the\ cheese} * 100$

FDM (%): fat in dry matter: $\frac{weight\ of\ fat\ in\ the\ cheese}{weight\ of\ cheese - weight\ of\ water\ in\ the\ cheese} * 100$

Figure 1

Classification of cheese according to coagulation, curd preparation and ripening. (Membrane filtration technologies such as microfiltration and ultrafiltration can also be used for other cheeses as described in the main text).



Classes of cheese according to moisture content on a fat-free basis

The firmness of cheese is dictated by four main mechanisms: moisture on a fat-free basis (MFFB), fat content, the extent of calcium phosphate mineral solubilisation, and the extent of casein protein hydrolysis (proteolysis, ripening), all of which, at higher levels, will cause the cheese to soften. Calcium solubilisation and proteolysis are mechanisms that may take weeks or months to be manifested.

Extra-hard cheeses: include e.g. Parmesan, Parmigiano Reggiano and Grana Padano (the latter two of these are made from raw milk) and are distinguished by having the lowest moisture content at around 32% (w/w) or 41% MFFB (Table 1). Extra-hard cheeses are often consumed in grated form.

Hard cheeses: include Cheddar, Gruyère, Emmentaler, or Manchego. Moisture content is around 36–43% or 49–56% MFFB.

Firm/Semi-hard cheeses: include Appenzeller, Maasdam, Gouda, Colby or Havarti. These have a higher moisture content than hard cheese, and 54–69% MFFB (Table 1).

Soft cheeses: Full fat soft cheeses have a moisture content of about 50–65% and above 67% MFFB (Table 1). These have a soft texture, which becomes viscous and creamy with ripening. Camembert is a typical soft cheese.

Classes of cheese according to ripening, or technological and microbial characteristics

Cheese ripening by rennet and lactic acid bacterial enzymes (with and without support of plasmin): Paraffin-coated Gouda–type cheeses ripen through the action of the residual plasmin enzyme found naturally in milk and by residual chymosin retained in the cheese curd after its addition to milk, as well as by enzymes from the starter culture, from non-starter lactic acid bacteria (NSLAB) inoculated into the cheese from the manufacturing environment, and from adjunct cultures, if used. Citrate fermentation by specific LAB forms diacetyl resulting in a buttery flavour and carbon dioxide resulting in pea-sized eyes. Cheddar cheese in plastic film ripens in a similar way by the action of these enzymes, but without citrate fermentation. For naturally dry-ripened extra–hard cheeses, NSLAB from the raw milk, partly from the natural whey cultures and from the cheese manufacturing environment mainly contribute to the ripening, as well as lipolysis by the indigenous milk lipase (Figure 1). All these ripening mechanisms also apply selectively for most of the following cheese groups.

Cheese with propionic acid fermentation: The most commonly known cheese in this category is Emmentaler. Other Swiss-type cheeses are Comté fruité, Maasdam, Jarlsberg, and Grevé. Propionic acid bacteria (PAB) ferment the lactic acid formed by the starter culture fermentation (or if no starter culture has been added the dominant culture) during the first 24 hours of cheesemanufacture. In the weeks after manufacture, the PAB form CO2, propionic acid and acetic acid. The CO2 forms the typical large round holes (eyes) of 1–5 cm in diameter. Propionic acid together with other flavour compounds contribute to the sweet-nutty taste of Swiss–type cheeses. Ripening time can be from 4 weeks (Maasdam) to more than 12 months (long-ripened traditional Emmentaler Switzerland made from raw milk).

Cheese with surface mould: Common varieties include Camembert and Brie. Mould is added to the milk or sprayed onto the cheese surface and develops a characteristic fluffy white appearance after a few weeks. A typical mould is Penicillium camemberti. Surface mould contains a highly proteolytic system whereby the cheese is ripened by the mould from the outside to the cheese interior. The mould metabolises lactic acid and breaks down the protein to amino acids, and further to ammonia and other flavour compounds. Lactic acid consumption and ammonia both raise the pH, partly solubilising the casein protein matrix, and causing increased precipitation of calcium phosphate near the surface, which all help to soften the interior cheese texture.

Cheese with internal blue mould: Typical varieties include Gorgonzola, Stilton, Roquefort, and Danablu. The cheese is spiked to create air holes to facilitate the growth of blue mould, typically Penicillium roqueforti. The growth of mould on the inside of the spiked air passages is evident in ripened cheese due to the requirement by mould for oxygen.

Smear-ripened cheese: Gruyère, Beaufort and Limburger are examples of this class of cheese. A de-acidifying, proteolytic and salt-tolerant mixed bacterial-yeast culture is applied to the surface to additionally ripen the cheese from the outside towards the interior, and to protect the cheese surface against spoilage.

The surface is periodically wiped with a salt solution to create a viscous surface smear. Humidity in the ripening rooms is kept high at 85–95% RH and at temperatures of 8–15°C. Important smear microorganisms are Brevibacterium linens, Debaryomyces hansenii, Kluyveromyces lactis, Geotrichum candidum and Yarrowia lipolytica. Microbial communities in cheese smear are extremely diverse, (1) list 42 yeast species and 115 bacterial species. Ripening time can be from 5 weeks (French Munster) to more than 12 months (Gruyère made from raw milk in Switzerland; Beaufort made from raw milk in France).

Pasta filata cheese: Mozzarella and Provolone are typical examples. After coagulation, whey separation, and curd fermentation for e.g. 3 hours, these cheese varieties are immersed in hot water at around 60°–80°C and stretched, a process called the pasta filata step ("spun paste"). The pasta filata step decreases proteolysis in the finished cheese by partial inactivation of cultures and enzymes due to the high heat treatment, resulting in a more elastic and curdy texture. The step more fully integrates fat into the casein protein matrix as well, such that it does not destabilise and form free surface oil when heated on a pizza. It must be noted that traditional Mozzarella is a fresh cheese with a moisture content of 55% or higher, and is made from buffalo milk, and now also from cows' milk. The appearance is white, the mild flavour is milky, and the cheese is sold immersed in salted whey or salted water. By comparison, what is known as low-moisture Mozzarella in the US, and Mozzarella in Australia, New Zealand and many other countries has a distinctly more cheese–like flavour, although still mild by comparison to Cheddar. This cheese is ripened for several weeks before shredding as a food ingredient, typically for the pizza industry and can be referred to as pizza cheese.

White brined cheese: Brined-type white cheeses are particularly popular in the Balkans, the Middle East, the Mediterranean region, North Africa, and Eastern Europe and include a large number of varieties such as Feta, Turkish Beyaz peynir, Domiati and Halloumi. These cheeses typically have a very high sodium chloride concentration (2.2–3.4%) due to the length of time they are immersed in brine. If made from sheep and goats' milk, these cheeses have a whiter colour compared to cheese made from bovine milk.

Fresh cheese: Examples include cottage cheese, cream cheese, and fromage frais. Ripening time is very short (days), resulting in less lactose hydrolysis and thus a higher amount of residual lactose retained in the cheese. Cottage cheese is usually sold and consumed within about three weeks.

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