February 2021

Cheese and Varieties
Part I: What is Cheese?

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.

What is cheese?

Cheese is believed to have been discovered about 8000 years ago in the area of modern-day Iraq when milk was stored in the stomach of a ruminant animal by nomads, and agitated and heated during daily travel, thus clotting the milk and separating out the cheese curds from the whey. The oldest archaeological evidence of cheesemaking is from 7000–year old fragments of pottery dotted with tiny holes found in central Poland (1,2).

Cheese is defined as a ripened or unripened product made by coagulation of the proteins in milk, skimmed or partly skimmed milk, cream, whey cream or buttermilk, or a combination of these liquid streams, and with a concentration of the proteins from the source material (2). The manufacture involves dehydration and often fermentation, both of which have the ultimate goal of increasing the shelf-life of milk. A soft cheese curd is obtained (Figure 1) by coagulation of the milk proteins through the action of rennet or another suitable coagulating agent, and by partially draining the whey after milk coagulation. Through the action of lactic acid bacteria (LAB), that may be added as starter cultures, the lactose in the cheese curd is fermented to its constituent sugars, galactose and glucose, and ultimately to lactic acid to reduce the pH from 6.7 of the original milk to a value typically from 4.5 to 6.0, depending upon the cheese variety. Some cheeses, e.g. Paneer or Queso Blanco, are not fermented with cultures.

Finer curd cutting, higher curd warming temperatures, and higher curd pressures expel more liquid whey from the cheese curds and decrease the water content of the final cheese (Figure 1).

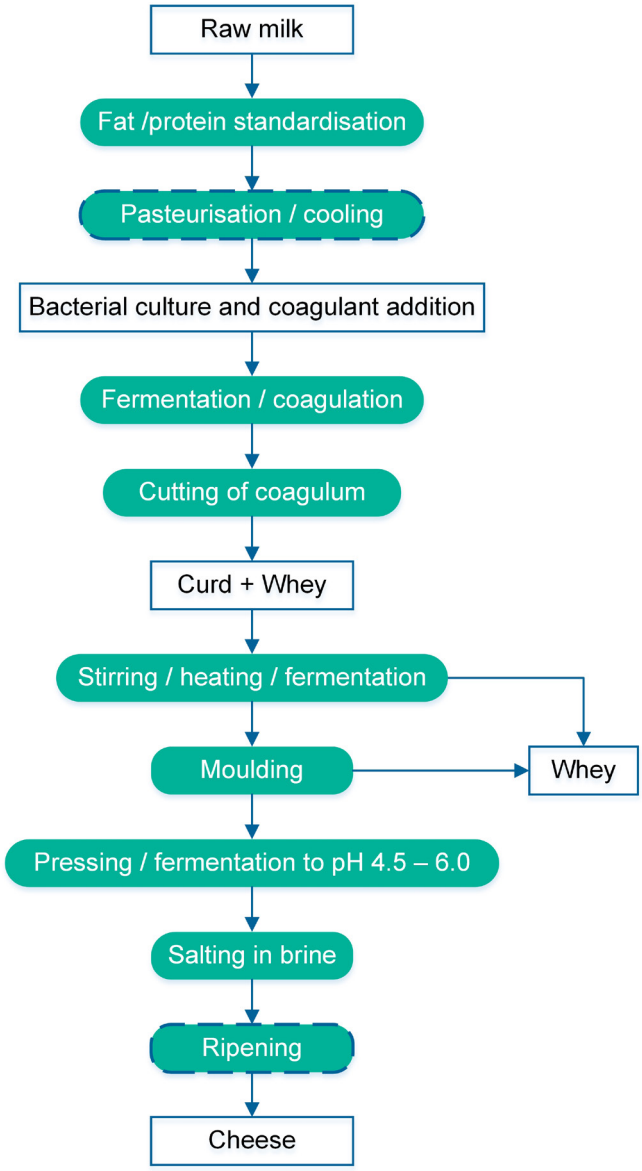

Figure 1

Typical cheese manufacturing process (the example given is for a brined cheese process; process steps in dotted lines are optional, depending upon the variety; green boxes are process steps; raw materials, intermediate and final products are without colour).

What does cheese contain?

Cheese contains the main milk protein casein, milk fat, the mineral calcium phosphate, as well as a small portion of lactose, whey, and other micro constituents, such as salt. Whey proteins, the remainder of the lactose and some of the soluble minerals are found in the liquid whey. The composition of full fat hard cheeses is around 25–30% protein, 30–35% fat, and the remainder being mostly water. Softer cheeses contain higher amounts of water and/or fat. Endogenous milk minerals make up around 1% of the cheese weight, the most predominant of which is calcium phosphate. Cheese also contains added sodium chloride, the amount of which varies considerably depending upon the variety of cheese, and which can exceed the calcium phosphate concentration.

Cheese typically contains only milk, usually a bacterial culture to ferment lactose, a clotting agent, calcium chloride (if pasteurised milk is used) to aid in the milk casein gelation, and salt to limit growth of pathogenic bacteria and to selectively promote growth of secondary starter cultures and flavour development. Raw or pasteurised bovine milk is used to make most cheese varieties, with buffalo, goat, and sheep milk to a lesser extent. The traditional clotting agent is calf rennet containing the enzyme chymosin. However, rennet substitutes of fungal origin *(Rhizomucor miehei, R. pusillus and Cryphonectria parasitica)*, plant origin (e.g. from the thistle Cynara cardunculus), or fermentation-produced chymosin from *Escherichia coli, Kluyveromyces lactis or Aspergillus niger* with the inserted gene to express chymosin, are also used. The latter represents 70-80% of the world rennet market (3). Lactic acid bacterial starter cultures ferment lactose, and impact upon texture and flavour development during cheese ripening. Secondary non-starter cultures are either adventitious or are added selectively to aid in development of flavour. Salt can be added in dry form to milled or stirred cheese curd particles, such as commonly practiced in the manufacture of cheeses such as Cheddar or Monterey Jack, respectively. For many other cheeses, the entire cheese is immersed in a brine solution typically containing 10–25% (w/w) sodium chloride.

What is cheesemaking process?

Fresh cheeses, such as Cottage cheese or high-moisture Mozzarella, are ready for consumption a few days after manufacture. Ripened cheeses are typically stored from 3 weeks (e.g. Camembert) up to 3 years (e.g. Parmigiano Reggiano) or longer develop their flavour through the specific ripening methods, and are effectively lactose-free in most ripened cheese varieties (4). The breakdown of proteins to peptides and further to amino acids and flavour active compounds is one of the main ripening mechanisms. Controlled lipolysis is also a major contributor to flavour, e.g. in Feta, Emmentaler, Parmigiano Reggiano and North American Romano. The metabolism of milk-indigenous citrate also contributes to flavour and small eyes (holes) in many cheeses, such as Edam and Gouda.

Milk is clotted to reduce the moisture content in the manufacture of cheese, and for other groups of cheeses, this is done without rennet by milk acidification to around pH 4.6 using starter cultures (e.g. quark, cottage cheese), mineral acids (e.g. hydrochloric acid) or organic acids (e.g. lactic acid), or by combined heating-acidification of milk (Paneer, Queso Blanco) or a milk-whey mixture (Ricotta), which additionally coagulates the whey proteins. Microfiltration and ultrafiltration are membrane filtration techniques that can also be used to increase the solids (protein and fat) portion of milk, thus decreasing water content, prior to cheese manufacture. This is a useful method to standardise the protein-to-fat ratio in milk prior to cheesemaking, to remove some of the serum (water phase) directly from milk, or to remove some of the lactose to control the pH of the cheese after fermentation.

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. This results in countless varieties of cheeses.

For more information, read IDF Factsheet 18/2021 - Cheese and Varieties Part II: Cheese Styles.

Acknowledgements

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