Industrial Production of Cheese

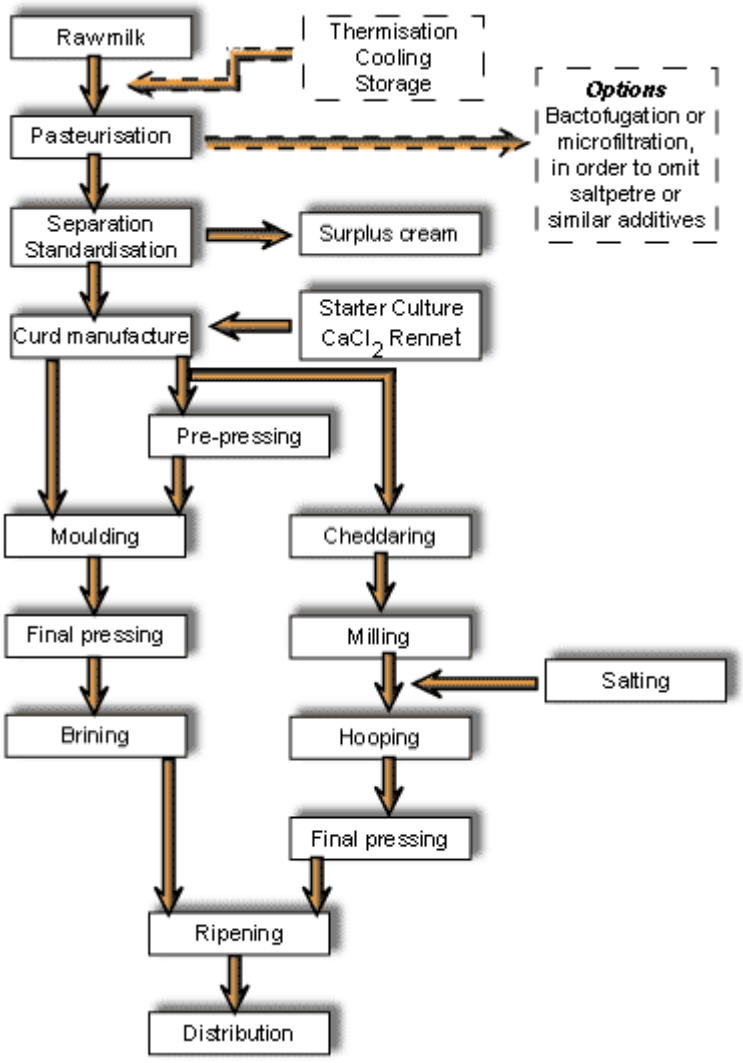
Cheese is a food product made from milk; it contains butterfat, lactose, the proteins albumin and casein, and the watery whey. Casein will coagulate to form a curd when it is acted upon by an acid or by the enzyme pepsin or renin. Though renin was initially obtained from calves stomachs, now a days it is obtained from fungi. Renin from fungi have become increasingly importantly in cheese manufacture. One fungus that is commercially important as a source of renin is the plant pathogen *Cryphonectria parasitica*.

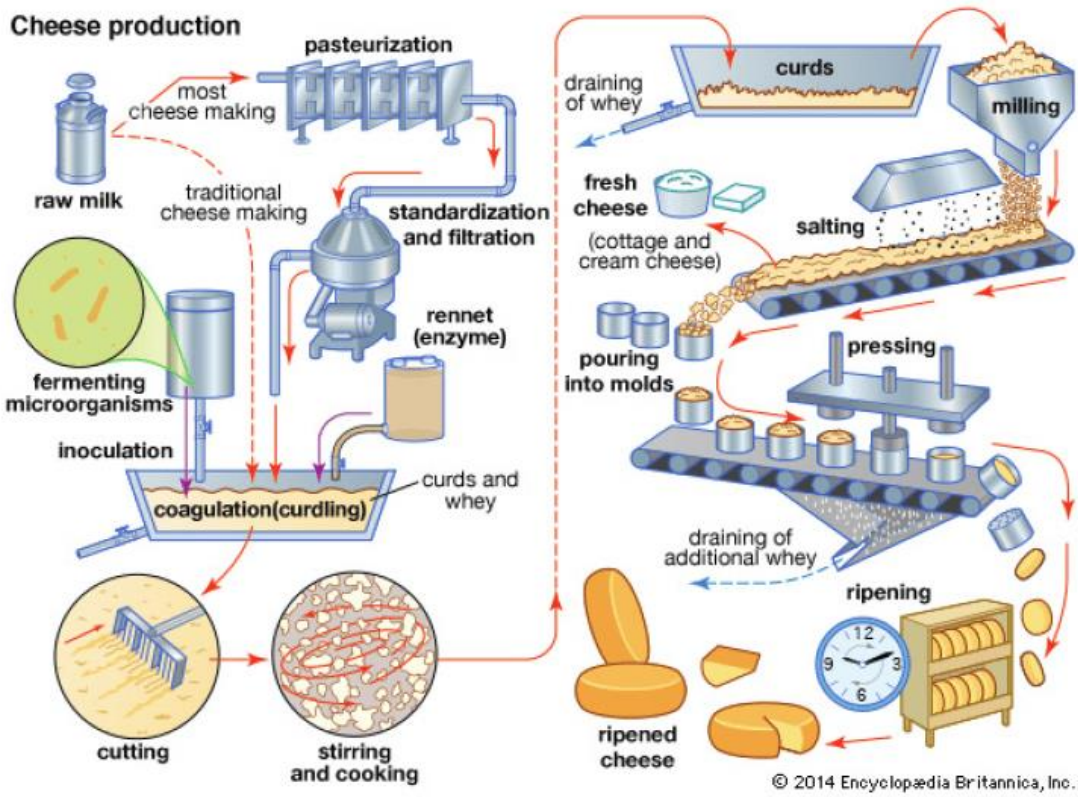
The coagulated curd is the newly formed cheese that separate from a watery fluid called whey. The cheese may be eaten in this form when freshly prepared (cottage cheese). Alternatively the cheese may be further drained of moisture, pressed or cooked (Gouda, cheddar cheese). Some cheeses may be processed with a characteristic bacterial or fungal flora, which will impart distinctive flavours during the ripening period. Fungi are used to process cheeses of two principal types- **1**. Those of the Camembert type, which are soft in texture and are covered on the outside with a rind formed through the agency of the mold; and **2**. Those semi hard cheeses of the Roquefort type, which have streaks and pockets lined with a blue-green mold.

In general te flow chart of cheese preparation is as follows:

1. **Standardise milk:** Milk is often standardised to optimise the protein to fat ratio to make a good quality cheese with high yield.
2. **Pasteurise or heat treat milk:** the milk may be pasteurised or mildly heat treated to reduce the number of spoilage organisms and improve the condition for the starter culture to grow.
3. **Cool milk:** Milk is cooled to bring it to the temperature needed for the starter bacteria to grow.
4. **Inoculation with starter and non-starter bacteria and ripen**: The starter culture and non-starter adjunct bacteria are added to the milk and held at 32^0 centigrade for 30 minutes to ripen.
5. **Add rennet and form curd**: The rennet is the enzyme that act on the milk protein to form the curd. After the rennet is added, the curd is not disturbed for approximate 30 minutes so that a firm coagulum forms.
6. **Cut curd and heat**: The curd is allowed to ferment until it reaches pH 6.4. The curd is then cut with cheese knives into small pieces and heated to 38^0 c. The heating separates the whey from curd.
7. **Drain whey**: The whey is drained from the vat and the curd makes a mat.
8. **Texture curd**: The curd mats are cut into sections and piled on top of each other and flipped periodically. This step is called cheddaring. Cheddaring helps to expel more whey, allows the fermentation to continue until pH of 5.1 to 5.5 is reached and allow the mats to knit together and form a tighter matted structure. The curd mats are then milled into smaller pieces.
9. **Dry salt or brine**: For cheddar cheeses, the smaller milled curd pieces are put back in the vat and salted by sprinkling dry salt on the curd and mixing the salt. In mozzarella, the curd is formed into loaves and the loaves are placed in a brine.
10. **Form cheese into blocks**: The salted curd pieces are placed in cheese hoops and pressed into blocks to form cheese.

11. **Store and age**: The cheese is stored in coolers until the desired age is reached. Depending on the variety, cheese can be of ages from several months to several years.
12. **Package**: Cheeses may be cut and packaged into blocks or it may be waxed.





Camembert Cheese

Camembert cheese was first made in the community of Camembert in North-western France. Milk is coagulated with renin, the curds are placed in hoops and allowed to drain overnight and then turned over to drain evenly. After 2-3 days, each cheese is rotted in salt and sprinkled with spores of *Penicillium camemberti*, a white mold. The layer of salt extracts the whey from the curd and forms a shiny cover of brine which flows away. The surface of the cheese becomes hardened after this extraction and forms a rind. During these initial stages, the cheese consists of sour curd surrounded by a salty rind, both of which inhibit the growth of bacteria and the fungus *Geotricum candidum*. The spores of *P. camemberti* germinates, the mycelia penetrate the rind and secrete proteolytic enzymes into the curd, so that the curd becomes soft and buttery and develops a mild flavour. The acidity also disappears, allowing the establishment of *Geotricum candidum* during the later stage of ripening. The ripening process required about 4 weeks and is carried out in ripening rooms held at 10-16^{0}c with a humidity of 86 to 88%.

Pasteurization at 63℃, 30min.

↓← Add Rice powder (1.0, 3.0, 5.0%)

Cooling at 32℃ and setting in vat

↓

Starter culture preparation DIP, KAZU (32℃, 60min)

↓

Injection Rennet (32℃, 60min)

↓

1st Whey Drainage (32℃→36℃, 20min)

↓

Molding

↓

2nd Whey Drainage (Room temperature overnight, pH 4.8)

↓

Salting solution (21%, 70 min)[a]

↓

Inoculating (*P. candidum* spore)

↓

1st Ripening, 12℃, 90~95% RH, 1 week

↓

2nd Ripening, 4℃, 2~4 weeks

[a]Brine salting (21% salt).

Roquefort Cheese

Roquefort Cheese originated in the sheep raising region surrounding Roquefort in Southern France. This cheese is made up from sheep's milk, while a similar one, blue cheese, is made in USA from cow's milk. The milk is curdled with renin at low temperature. Then the curd is broken into small masses and drained until it is rather dry and pieces no longer merge completely when placed together. The curd is heaped loosely in cheese hoops so that cracks and channels remain. It is then inoculated with bread crumbs containing spores of *Penicillium roqueforti*, which was grown on the bread. The curd is then maintained at a cool temperature of 18 to 20^0c and at a high humidity (80-90%). During the next 3-10 days, the ripening curd is periodically scraped, washed and salted. After the salting period, the cheese is perforated

with additional holes that provide adequate aeration for the fungus to grow along the many interfaces within the cheese. A two month ripening period is required and then the cheese is ready for sale. During its growth in the cheese, the fungus secretes protein and fat digesting enzymes. The pungent flavours characteristic of Roquefort cheese, results from the hydrolysis of fats and the liberation of high molecular weight fatty acids, and accompanying methyl-ketones and alcohols.

(A^x)

Cows', goats', or ewes' milk, or a mixture of two or three milk types

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Raw milk, thermization (*c.*62°C × 15 s) or pasteurization (*c.*72°C × 15 s)

↓

Addition of rennet

Addition of LAB (optional)

Addition of Penicillium roqueforti (optional)

↓

Coagulation, cutting, and stirring

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Molding

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Whey drainage for *c.*10–48 h. No pressure is applied, but molds are turned frequently

↓

Brine-salting or dry-salting for 24–48 h

↓

Piercing of the cheeses (optional)

↓

Ripening (in general at *c.*10°C, *c.*85–95% relative humidity, for some varieties in caves)

[x]Times, temperatures, etc., depend upon the variety

(B)

Pasteurized cows' milk (*c.*73°C × 40 s)

↓

Inoculation with LAB (mesophilic + thermophilic starter culture, *c.*10^6 cfu mL^{-1} of cheese milk)

↓

Inoculation with *Penicillium roqueforti*

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Addition of liquid calf rennet

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Coagulation at 30-34°C

↓

Cutting of the coagulum (size of curd: *c.*2.0-2.5 cm)

↓

Stirring

↓

Molding

↓

Whey drainage, no pressure is applied, held at 18°C for 10 h with four turns

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Salting (*c.*200 g of salt spread over each cheese), 22°C for 40 h

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Ripening at 4–6°C for 83 days, 85%–90% relative humidity

Cheeses are pierced after 12 and 20 days.

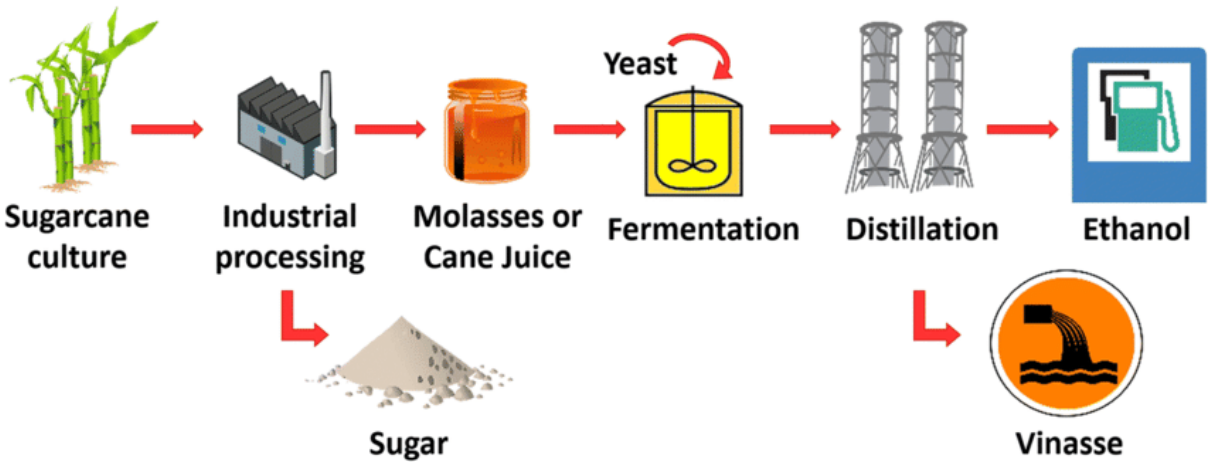
Industrial Production of Ethanol

Ethanol can be used as a solvent or for other industrial processes, or as a fuel for automobiles. This alcohol can be derived from petroleum by chemical means, or obtained as an end product of the alcoholic fermentation carried out by yeasts (*Saccharomyces cerevisiae*).

Ethanol can be readily derived from the fermentation of plant materials having sugars or polysaccharides that can be readily hydrolysed, such as, sugarcane, sugar beet, corn, cassava etc. In addition, by-products of crop processing such as molasses or sulphite liquor (aqueous material left from the manufacture of pulp from the wood) may also be used. Production of industrial alcohol from sulphite liquor may be carried out using the Ekstrom process.

Ethanol is produced by continuous fermentation. Hence large fermenters are used for continuous manufacturing of ethanol. Large volume of storage tanks of molasses provide continuous supply and store fresh molasses from sugar producing section during fermentation process. The molasses from the tanks are diluted with water to obtain the sugar concentration of 10-15%. The acidic nature of molasses support the growth of Yeast during break up of sucrose, thus acids are added to maintain the pH between 4 -5. SA yeast culture tank is maintained with nutrition supply of manganese and ammonium phosphate or sulphates. The acidic condition favours the yeast to produce catalytic enzymes invertase and zymase. Diluted and treated molasses and yeasts are transferred to fermentation chamber made up of stainless steel and fitted with heating coils so that 20-30^{0}ctemperature is maintained. The process of fermentation takes 30 -70 hours. Final temperature of 35^{0}c is attained at the end of the process. During fermentation process, yeast produces CO_2 as by-product.

The product liquid is fed to Beer Still to perform distillation, solid and slurry mass is separated leaving the alcohol and water. The concentration of alcohol now is 8 -10%. The slurry is called slop and used as cattle feed and fertiliser. As aldehydes are not allowed in consumable beers, thus aldehydes present in the solution are removed by aldehyde column. Mixture of ethanol and water comes from the middle and bottom section of the column. The middle stream is fed to rectification column to produce rectified spirit, having 95% ethanol. Rectified spirit is further made to absolute alcohol by anhydrous Still using benzene as third component.



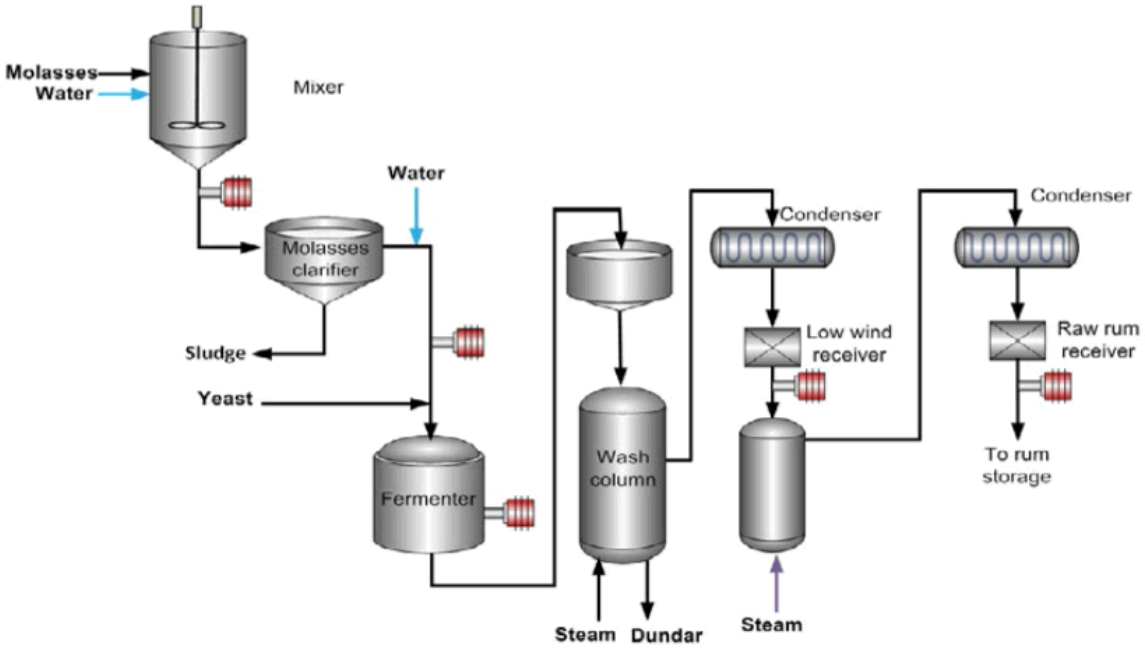


Figure 2: Ethanol production from molasses using fermentation process.