

Dairy
technology3
(Fermented Milks
and By-Products)
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- PRACTICAL LESSON 6, FOR
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Casein Production



Introduction

- Casein is the major protein in cows' milk, and comprises about 80 % of the total protein content of which the rest, some 20 %, are the whey or serum proteins.

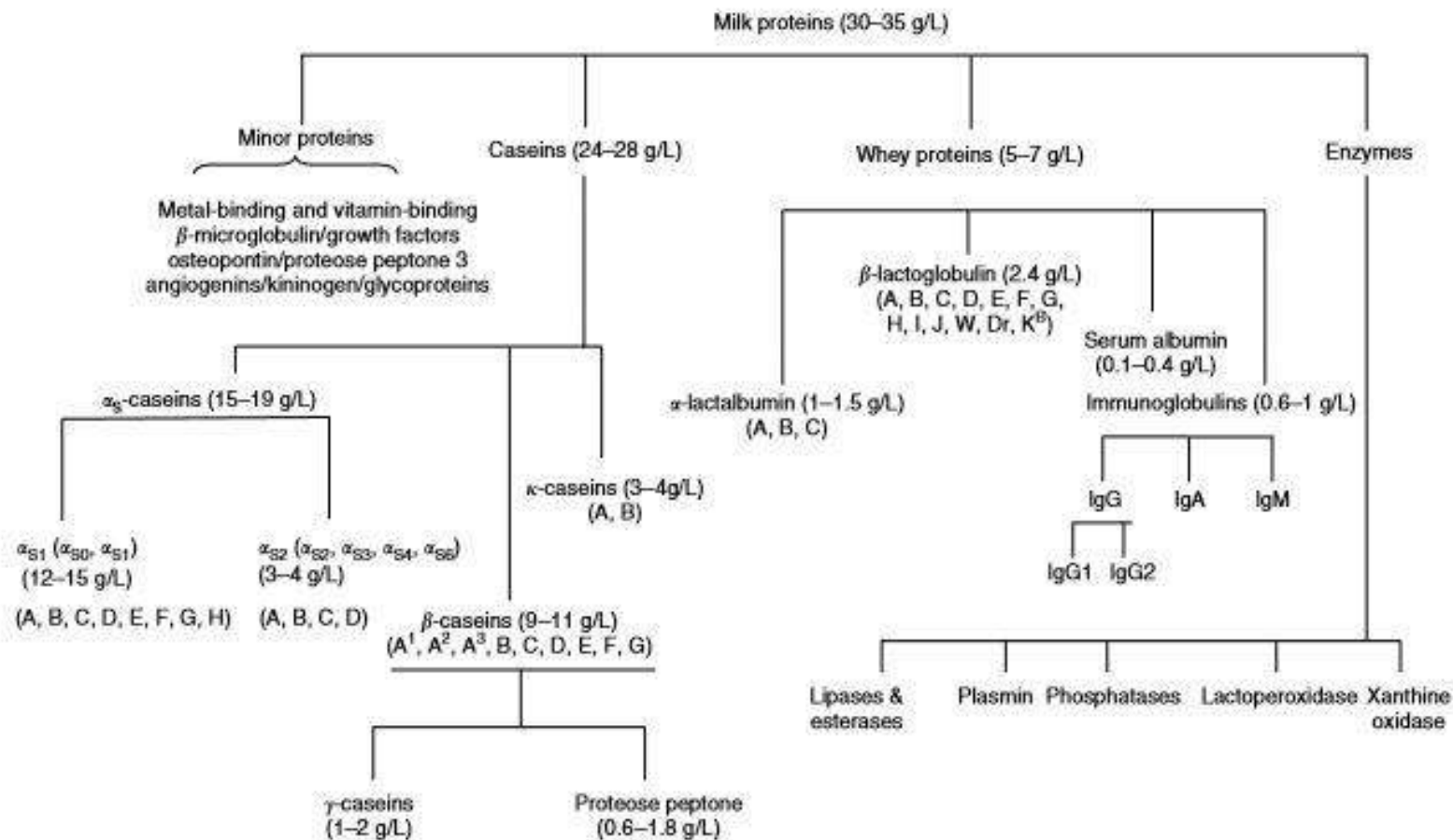


FIGURE 26.1 Distribution of fractions, and approximate concentrations and genetic variants of the major proteins in bovine milk. (Adapted from Ref. 3.)

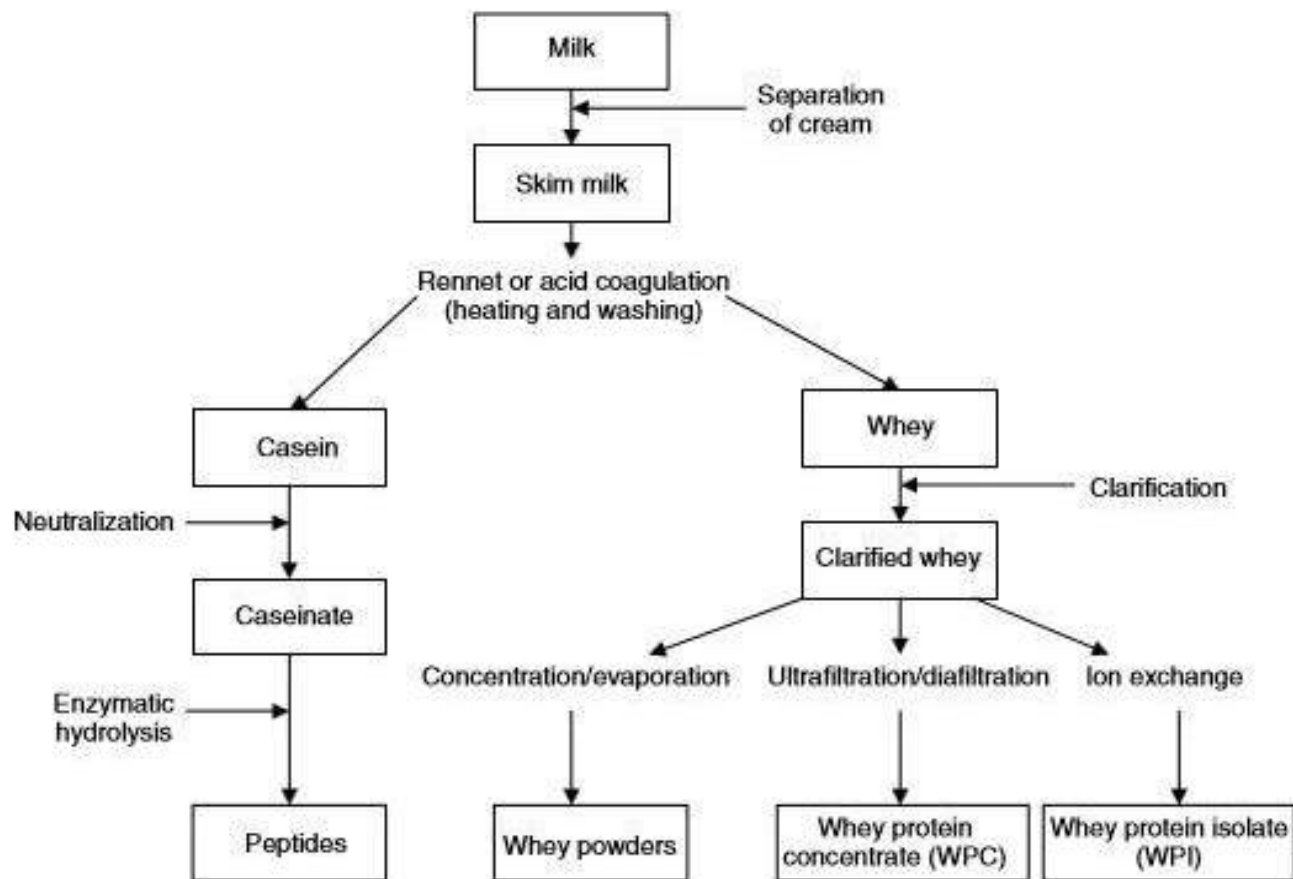


FIGURE 26.8 Outline of principal processes used for the manufacture of casein and whey proteins products.

TYPES OF CASEIN

Casein is usually divided into the following types:

In addition to these two main types, there are other commercially available casein products of importance, such as:

Rennet casein, obtained by enzymatic precipitation

Acid casein, obtained by acidifying skim milk to the isoelectric point (pH 4.6 – 4.7).

Co-precipitate, made by heating skim milk to a high temperature and then precipitating the casein/whey protein complex, usually with calcium chloride.

Pre-Production

- In order to produce high quality casein, the raw material, skimmed milk, must be in good quality. If lactose is converted into lactic acid by bacteria, the quality of casein will be affected because of increasing of acidity.
- Excessive heating on milk before precipitation or manufacturing process is not only cause undesirable color of casein but also reduce to yield.

1-RENNET CASEIN

- Rennet casein production is obtained by coagulation of skim milk with rennet at 30°C.
- First, as in the case of cheese production, the casein micelles are converted into gel, and whey is separated from casein, washed with water, after the washing, water is removed then dried and ground.
- When casein is treated with rennet, casein is completely rennet-converted and casein becomes rennet casein.

- Proteolytic coagulation is described as two stages:
- In first step, rennin enzyme affects casein between the 105-106 chain by hydrolysis and casein breaks to κ -casein and macropeptides.
- In second stage, casein micelles are oxidized with Ca^{2+} ions and become rennet casein.
- To obtain rennet casein for used food production, skim milk pasteurized at 72°C is cooled to 30°C .

- Rennet and calcium chloride are added, for coagulation in 15-20 minutes. Rennet is diluted with 200 ml of water before adding skim milk.
- Formed curd is cut and heated to 60-65°C.
- The enzyme is deactivated by heating. Heating takes about 30 minutes.
- After separating whey, curd is washed with water at a temperature of 45-60°C (washing process is done in 2 or 3 stages), drained, pressed, crushed and dried with hot air to 12% moisture content.

- Dried casein is milled and packed to form granules at a size of 0,5-1,0 mm.
- Produced rennet casein must be white or slightly yellowish in color.
- A darker color is a sign of poor quality and is caused by the high lactose content of the product.

- Rennet casein consists of an insoluble structure of calcium para-caseinate.
- According to results, typical flavor of rennet casein consists of hexanoic acid, indole, guaiasol and p-cresol. Casein has its own character; an unpleasant stale flavor and animal / wet dog smell

WASHING METHODS

■ BATCH WASHING

Washing takes place in two or three stages at a temperature between 45 and 60 °C.

■ CONTINUOUS WASHING

- Drainage of whey takes place before the casein passes through two or three washing tanks with agitators.
- De-wheying is normally done in a decanter centrifuge to reduce consumption of wash water.
- After leaving the washing stages, the water/casein mixture goes through another decanter to discharge as much water as possible before final drying.

- Washing takes place in countercurrent, which uses water more economically than concurrent washing.
- The concurrent system uses one litre of water per litre of skim milk, whereas only about 0.3 – 0.4 litre of water per litre of skim milk is needed in countercurrent washing.
- The number of washing stages is dependent on the requirements on the product. Two stages is the minimum.

2- Acid Casein

- Acidification can be achieved by:
 - Mineral acid (hydrochloric HCl, sulfuric -H₂SO₄, nitric -HNO₃ acid etc.)
 - Organic acids (citric, lactic acid etc.)
 - Ion-exchange
 - Addition of CO₂ at high pressure

Biological Acidification – Lactic Acid Casein

- For the production of lactic acid casein, skim milk at pH 6,6 is pasteurized at 72°C for 15 s. Mesophilic, non-gas starter bacteria (eg *Streptococcus lactis* 0,5%, *Streptococcus cremoris* 0,5%, *Lactococcus lactis sub-species cremoris* 0,1-0,2%) are inoculated at 22-27°C to pasteurized milk.

- Lactic acid bacteria ferment lactose during the incubation period (14-16 h) to reduce pH 4,6 and casein coagulate.
- Very rapid incubation affects quality, accelerates proteolysis and reduces the amount of product obtained. This clot-curd is called "soft gel-coagulum".
- In addition to lactic acid, compounds such as diacetyl ($\text{CH}_3\text{COCOCH}_3$), acetone ($\text{CH}_3\text{CHOHCOCH}_3$) and benzoin ($\text{C}_6\text{H}_5\text{COCHOHC}_6\text{H}_5$) are formed with lactose fermentation.
- These compounds do not cause serious problems because of the small amount.

- Then the lactic clot is washed and dried by heating in plate heat exchangers at 50-55°C, removing whey.
- Occasionally, the presence of gas-producing Leuconostoc spp or Streptococcus diacetylactis bacteria in starter cultures lead to gas-curd, which makes it easier to heat, wash and dry.
- In addition, it has been stated that the presence of excess gas have a negative effect on casein production.

Mineral Acidification-Acid Casein

- In the case of acid casein production, skim milk's at 25-32°C pH value is reduced to 4,3-4,6 by the addition of dilute hydrochloric or sulfuric acid (0,5-1,4N) and it is waited for about 2 minutes until a smooth casein clot is obtained. All the remaining processes are carried out as in production of lactic casein. Acid caseins are insoluble form in the water.

Co-precipitates

- Co-precipitate contains practically all the protein fractions of milk.
- Following the addition of small quantities of calcium chloride or acid to the skim milk, the mixture is heated to 85 – 95 °C and held at that temperature for a period of 1 – 20 minutes to allow interaction between the caseins and the whey proteins.

- Precipitation of the proteins from the heated milk is then effected by controlled addition of either calcium chloride solution (to produce high-calcium co-precipitate) or diluted acid (to produce medium-calcium or low-calcium co-precipitate, depending upon the amount of acid added and the pH of the resulting whey).

- The curd is subsequently washed and either dried to produce granular, insoluble co-precipitates or dissolved in alkali as described for the methods for the manufacture of caseinates to produce soluble or “dispersible” co-precipitates.

Uses of casein:

- Casein is used in many industries as mentioned in the following table

Food Category	Casein product	Use level* %	Function
Baked Products	Casein, caseinates	1-25	Nutrition, water binding
Cheese products	Rennet casein, acid casein, caseinates	2-25	Fat and water binding, texture, matrix formation
Fermented milk Products	Caseinate, co-precipitate	-	Emulsifier, stabilizer, water binding, viscosity building
Coffee whiteners	Sodium caseinate	1-10	Fat emulsification
Beverages	Caseinate	-	Nutrition, stabilizer, emulsifier, stabilizer,
Confectionery	Caseinates, co-precipitate, acid casein	1-25	Texture, foam stabilizer
Dietary preparations	Caseinate	-	Nutritive value
Cultured products	Sodium caseinate	2-3	Fat emulsifier, stabiliser
High fat powders	Sodium caseinate	Up to 10	Fat emulsifier
Ice cream	Sodium caseinate	1-5	Texture, Stabiliser
Infant foods	Rennet casein, acid casein	1-25	Nutrition
Instants breakfasts	Sodium caseinate	2-30	Nutrition
Meat products	Sodium caseinate, co-precipitate	3-20	Nutrition, fat emulsifier, water binding, texture, structure formation
Nutritional food bars	Casein, caseinates	10-20	Nutrition, texture
Pasta and snacks	Casein, caseinates	5-20	Nutrition, texture

Pharmaceuticals	Casein, caseinates, hydrolysed casein	5-95	Nutrition
Soups and gravies	Sodium caseinate	5-20	Nutrition, thickener
Sports drinks	Sodium caseinate	2-10	Nutrition
Whipped toppings	Sodium caseinate	5-10	Film former, fat emulsifier, stabiliser, bodying agent
Desserts	Caseinate	-	Emulsifier, stabilizer, foam stabilizer
Extruded foods	Caseinate, rennet casein, acid casein	-	Texture, nutritive value, emulsifier
Photoresist for Photo-engraving Processes	Caseinate	-	Light-induced cross-linking by Cr^{3+}
Glues	Caseinate	-	Thickener, structure formation; water resistance of the glue
Paints	Caseinate, Acid Casein	-	Thickener, emulsifier, structure formation; to keep the pigment particles
Plastics	Rennet casein	-	structure formation; plastics in the form of buttons, buckles, imitation tortoiseshell (cobs and hairclips), imitation ivory (knife handles and piano keys), fountain pen barrels, shoehorns, dominoes, novelties
Cements	Acid casein	-	Joint in wallbord

References

- Bylund, G., 2003. *Dairy processing handbook*. Tetra Pak Processing Systems AB.