Casein products:

1-The amount of casein in cow's whole milk varies according to the breed of cow and stage of lactation, but is generally in the range 24-29 g L-1. Casein contains 0.7-0.9% phosphorus, covalently bound to the protein by a serine ester linkage. Casein is consequently known as a phospho-protein.

-All the amino acids that are essential are present in casein in high proportions, with the possible exception of cysteine. Thus, casein may be considered as a highly nutritious protein.

2-Casein exists in milk in complex groups of molecules (sometimes referred to as calcium phospho-caseinate) that are called micelles. The micelles consist of casein molecules, calcium, inorganic phosphate and citrate ions, and have a typical molecular weight of several hundred million.

3-In terms of physical chemistry, the casein micelles may be considered to exist in milk as a very stable colloidal dispersion. The caseins, as proteins, are made up of many hundreds of individual amino acids, each of which may have a positive or a negative charge, depending on the pH of the [milk] system.

4-At some pH value, all the positive charges and all the negative charges on the [casein] protein will be in balance, the net charge on the protein will be zero. That pH value is known as the isoelectric point (PI) of the protein and is generally the pH at which the protein is least soluble. For casein, the PI is approximately 4.6 and it is the pH value at which acid casein is precipitated. In milk, which has a pH of about 6.6, the casein micelles have a net negative charge and are quite stable.

5-Although casein has been shown to consist of several individual casein components, referred to as αs1-, αs2-, β- and κ-casein, each having slightly different

properties (which are caused by small variations in their amino acid content), only the commercial product, contains all of these components.

Extraction of casein from milk

casein is precipitated from the skim milk that is produced after centrifugal separation of whole milk. The skim milk may be acidified to produce acid casein or treated with an enzyme, resulting in rennet casein. The precipitated casein curd is separated from the whey, washed and dried as shown in scheme below.

1-Separation

Casein is extracted from milk using the processes outlined in Figures 1. Whole cow's milk (with a typical fat content of 4.65% is first separated by means of centrifuges that produce cream (for the manufacture of butter or other milk fat products) and skim milk. Skim milk can thus be considered as the raw material from which casein products are made.

2-Precipitation

The operations involved in the precipitation of casein are shown below.

A-Precipitation by means of acidification can be considered in terms of simple chemistry as follows, R being the casein protein:

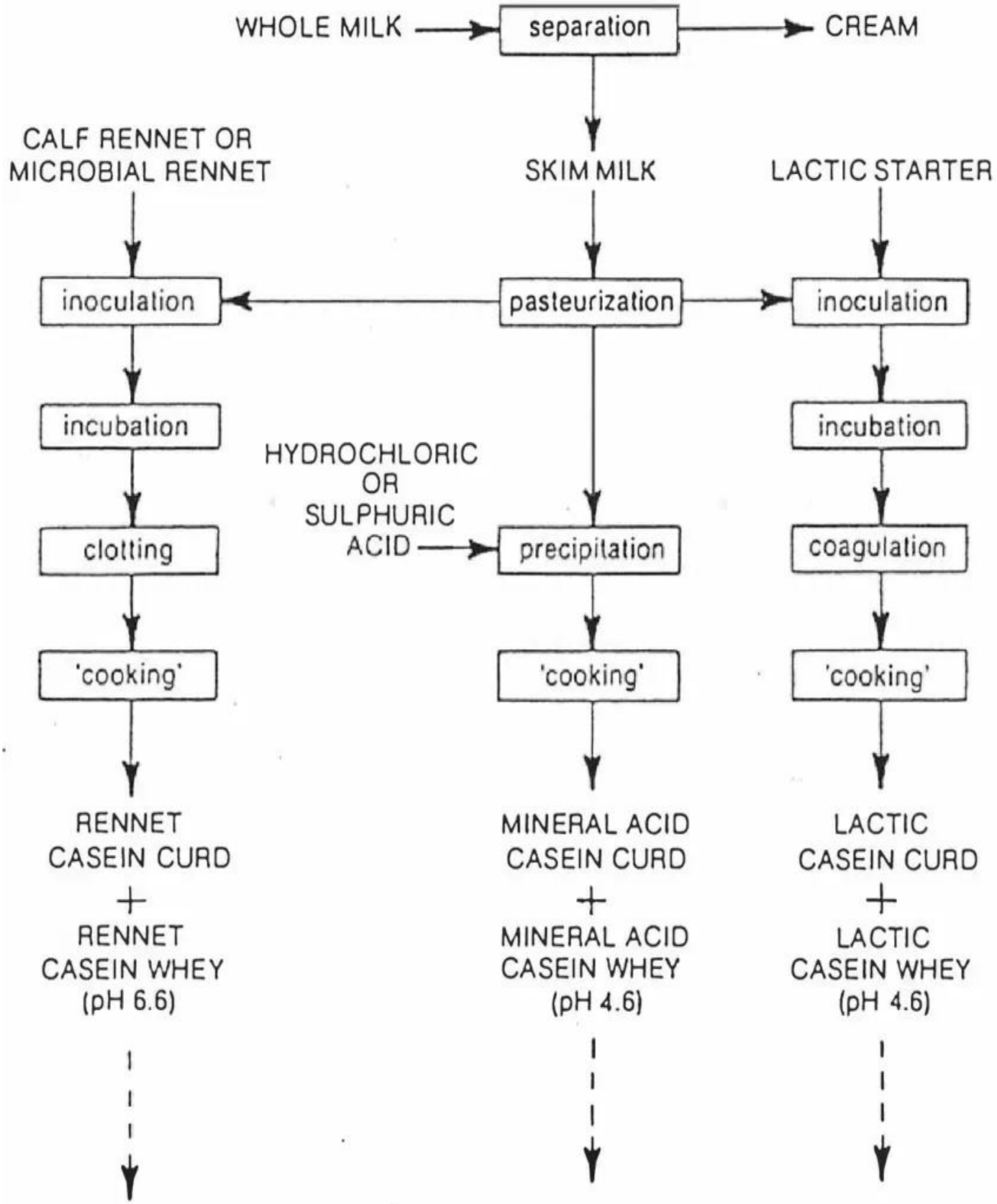
$H_2N\text{-}R\text{-}COO^- + H^+ \rightarrow + H_3N^+\text{-}R\text{-}COO^-$

casein micelle acid casein

(pH = 6.6) (pH = 4.6)

Colloidal dispersion Insoluble particles v

B- In the case of enzyme coagulation of casein, there is no change in the pH of the milk. Instead, the addition of a specific enzyme, chymosin, which is found in the stomach of newborn calves, specifically cleaves a highly charged portion from the κ-casein, called glycomacropeptide. That action causes the cleavage of the κ-casein to para-κ-casein & glycomacropeptide) to lose its considerable power in stabilizing the micelles in milk, and the result is the formation of a three-dimensional gel network or clot of the casein in the presence of calcium ions. This reaction is essential in the manufacture of virtually all cheese types and in the production of rennet casein.


WHOLE MILK
separation
CREAM
CALF RENNET OR MICROBIAL RENNET
SKIM MILK
LACTIC STARTER
inoculation
pasteurization
inoculation
incubation
incubation
HYDROCHLORIC OR SULPHURIC ACID
clotting
precipitation
coagulation
'cooking'
'cooking'
'cooking'
RENNET CASEIN CURD
+
RENNET CASEIN WHEY (pH 6.6)
MINERAL ACID CASEIN CURD
+
MINERAL ACID CASEIN WHEY (pH 4.6)
LACTIC CASEIN CURD
+
LACTIC CASEIN WHEY (pH 4.6)

The processes involved in the precipitation of casein are shown in Figure above -1-1-Precipitation by means of acidification can be considered as follows, R being the casein protein:

$H_2N\text{-}R\text{-}COO^- + H^+ \rightarrow + H_3N^+\text{-}R\text{-}COO^-$

casein micelle acid casein

(pH = 6.6) (pH = 4.6)

Colloidal dispersion Insoluble particles

-In the case of enzyme coagulation of casein, there is no change in the pH of the milk. Instead, the addition of a specific enzyme, chymosin, which is found in the stomach of newborn calves, specifically cleaves a highly charged portion from the κ-casein, called glycomacropeptide. That action causes the remainder of the κ-

casein (now called para-κcasein) to lose its considerable power in stabilizing the micelles in milk, and the result is the formation of a three-dimensional gel network or clot of the casein in the presence of calcium ions. This reaction is essential in the manufacture of virtually all cheese types and in the production of rennet casein.

3- When the casein has been precipitated, the mixture is heated (a process known in the dairy industry as cooking). Heating of the precipitated casein causes the particles to shrink and separate moisture (whey) and also to agglomerate together to form clumps of curd.

4-The curd is then separated from the whey and washed several times with water in vats prior to mechanical dewatering by pressing or centrifuging.

5-Drying and dry processing of casein, the dewatered curd, with a moisture content of about 55%, is dried by means of hot air using either fluidized bed driers with multiple decks or pneumatic-conveying ring driers to produce a dry casein having a moisture content of 10-12%. The warm, un- milled casein is then subjected to several dry processing steps including cooling (usually by air conveying), tempering or conditioning to ensure that moisture is distributed evenly between large and small particles.

6- milling, selecting (to produce coarse, medium and fine mesh particles), blending (to ensure uniformity) and bagging.

Production of Sodium Caseinate:

The Water-soluble derivatives of acid caseins, produced by reaction with alkalis, are called caseinates.