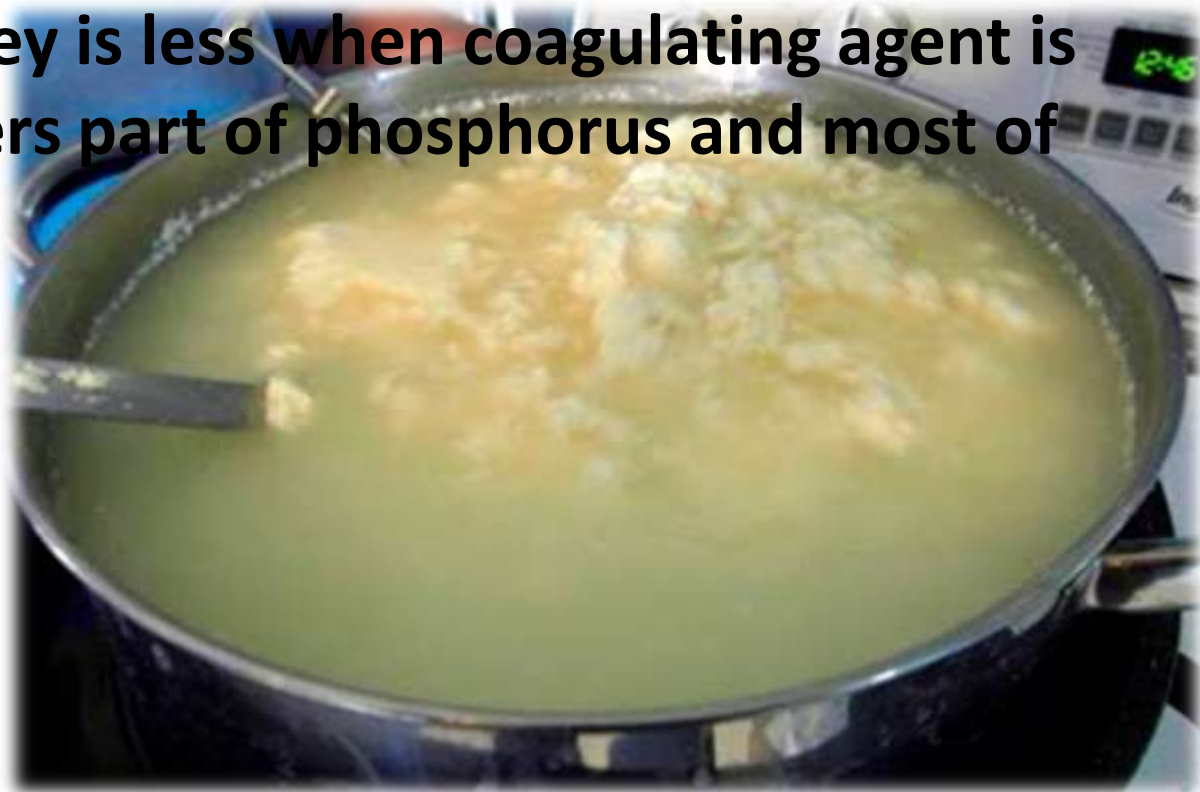


# Physio-chemical properties and utilization of whey products



- **Whey produced from rennet-coagulated cheeses and casein is sweet whey, whereas production of acid casein and fresh acid cheeses (Ricotta or Cottage) yields acid whey.**
- **When we use rennet, most part of calcium and phosphorus of casein complex remain with curd.**
- **Ash content of whey is less when coagulating agent is acid, which transfers part of phosphorus and most of calcium to whey.**



## Based on acidity, whey conveniently classed into groups

Sweet whey

- Titratable acidity, < 0.20%, pH 5.8-6.6

Medium acid whey

- Titratable acidity, 0.20-0.40%, pH 5.0-5.8

Acid whey

- Titratable acidity greater than 0.40%, pH<5.0

- **Whey is a multi component solution of various water-soluble milk constituents in water; dry matter of whey consists primary of lactose, protein and various minerals.**
- **Fat content of freshly separated liquid whey may be up to 0.5-1% depending on type of milk and efficiency of cheese-making operation.**
- **Fat content of most acid whey is negligible.**
- **Proximate composition of various whey has variations due to pretreatment of cheese milk (heating, centrifugation, cultures used, mechanical handling, use of processing aids such as yellow color); and whey handling and pretreatment processes (pasteurization, pre concentration, recovery of casein fines).**



- **Lactose** constitutes about 4.4 -4.9% of whey.
- Lower lactose content is usually found in acid whey due to fermentation (lactose is converted to lactic acid).
- Most valuable whey component is whey protein, constituting approx. 0.7% of whey (about 9-11% of dry matter).
- Whey may contain about 0.2-0.3% non protein nitrogen (principally inorganic compounds, urea etc): this is sometimes included with true whey protein and reported as total whey protein ( $N \times 6.38$ ).
- In manufacture of channa and paneer, high heat treatment is given to milk resulting in varying degree of whey protein precipitation along with product. Mainly there will be heat non-coagulable whey proteins and its total protein content will be substantially lower.

- **Minerals** constitute third major component of dry matter of whey, which contribute electrical conductivity of whey.
- In addition to lower pH and higher lactic acid, acid cheese whey shows substantially higher calcium and phosphorus content caused by solubilization of calcium-phosphate complex of casein micelle at acid pH range.
- Calcium removal from casein micelle does not occur during rennet clotting at pH 6.0 or higher; so milk calcium is retained in cheese rather than lost in sweet whey.

# PHYSICAL PROPERTIES

## Colour:

- **Whey is the greenish translucent liquid.**
- **Greenish color of most traditional whey systems is caused by water-soluble and heat-stable riboflavin.**
- **Riboflavin is sensitive to light as well as to ionizing radiation and whey systems exposed to these conditions will show fade green color.**

## Flavour:

- **According to McGugan et al. (1979), increasing concentration of whey were added to skim milk “brothiness” was first noted when 20% whey was added, and diacetyl, bitterness and sweetness at 40% addition.**
- **Volatile acidity, non-volatile acidity, saltiness and astringency were only noted in 100% whey.**

## Surface tension:

- Surface tension of cheese whey vary between 40,000 and 84,000 N/m, increasing with increasing total solids, and decreasing with temperature.

## Viscosity:

- Viscosity characteristics of whey and concentrated whey are important, in terms of evaporation efficiency, lactose hydrolysis, which might be expected to function more efficiently if applied to concentrates.

Viscosity of whey at different temperatures (Viscosity in cP)

Temperature	Viscosity
10°C	1.71
20°C	1.26
40°C	0.82
80°C	0.68



## Heat stability:

- Individual proteins in whey have wide range of denaturation temperature (65 -75 C).
- With higher TS, denaturation of  $\beta$ -Lg slows down, but denaturation of  $\alpha$ -La increases.
- Increased lactose concentration reduced denaturation of both proteins, perhaps as result of formation of heat induced complexes.
- Increased calcium contents, up to  $0.4 \text{ mg ml}^{-1}$  tended to slow denaturation.
- Rate of denaturation of both proteins was slower at pH 4 than at pH 9.
- Changes occurring in proteins at these temperatures may partly explain improvement in flux commonly obtained holding whey at 55 C before ultrafiltration.

# Solubility:

- Solubility of lactose is only about 20 g/100 g water at room temperature and 60 g/100 g water at 60°C.
- Whey concentration to more than about 36 -38% total solids results in formation of crystalline lactose.

