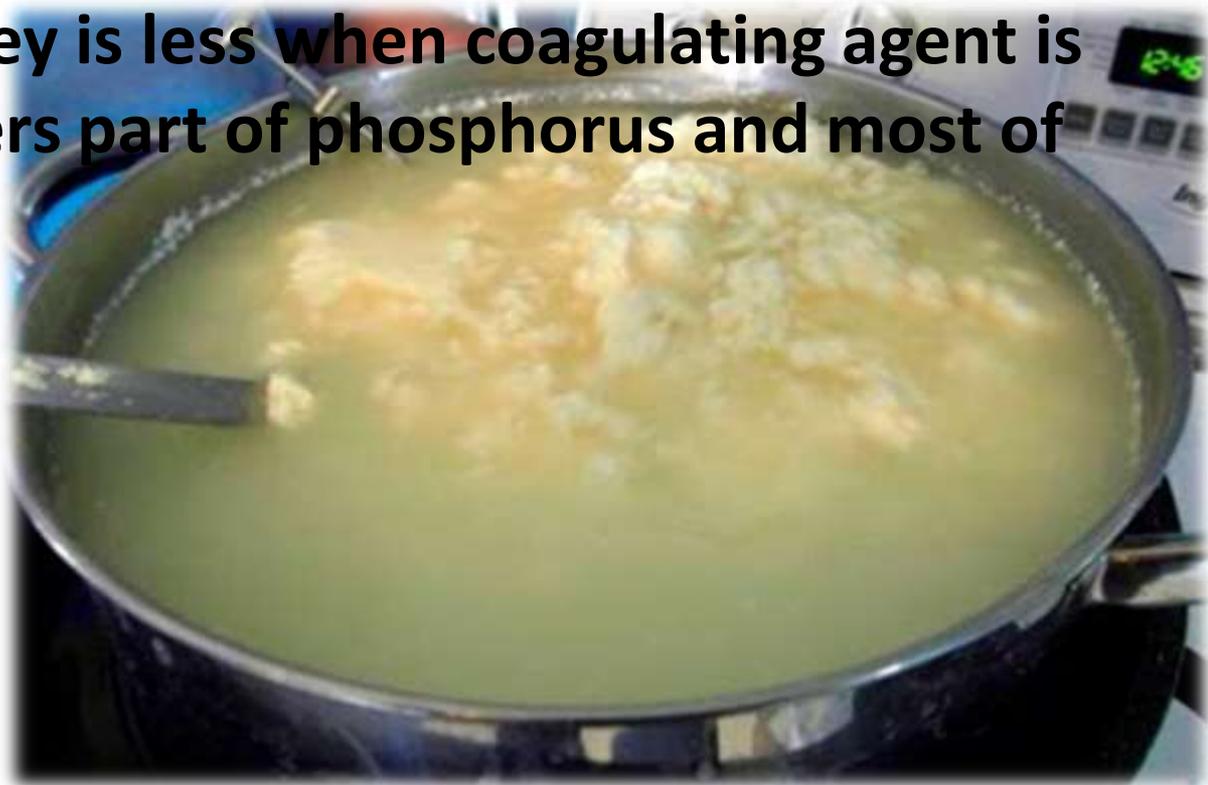


Physio-chemical properties and utilization of whey products

- **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 β -Lg slows down, but denaturation of α -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 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.

