

Status and Technological Aspects of Fresh Cheeses

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1.0 Introduction:

India has emerged today as the largest milk producer in the world with an annual production of 176.4 million tones in 2017-18 (DAHD, 2019). India is documented as the biggest and fastest growing market of milk and milk products in the world. The white revolution has transformed India's dairy industry. Now, the total amount of milk produced today is about seven times *i.e.* as compared to 25 million tones back in 1973-74. The annual world's milk production is around 811.9 million tones in 2017 and is growing at the rate of only 1.46 % while, India's milk production growing at around 6.65 % per annum (DAHD, 2019). This also indicated that more than 20% of the world's milk is produced in India and growing at the rate four times more than the global growth. About 35% of India's total milk production is processed. Most milk is sold through unorganised channels and consumed in a farm-fresh or unpasteurised state. The main value-added products include milk powder, dairy whitener, packaged milk, milk based sweets, butter, ghee, yoghurt, dahi, cheese, and ready-to drink milk products.

The marked scenario is changing fast. There has been a significant increase of middle class families and migration from rural areas to smaller developing towns. All this has resulted in the emergences of growing markets and demand in smaller towns across the country. The growing demand for milk and milk products is going to present greater and newer challenges to dairy sector. There is a need for multi-pronged action. The tasks involved today are much more complex than they were during the White Revolution. A developed Indian dairy sector by 2020 or even earlier is not a dream. It is a mission we can all take up and accomplish.

Cheese, the nature's wonder food and the classical example for fermentation technology. It is unquestionably advantageous over non-fermented dairy products with respect to nutritional attributes, as it contains rich amount of proteins in easily assimilable form and essential minerals in more absorbable form besides being the only concentrated and balanced milk food for lactose intolerant. The supremacy of cheese technology strongly lies

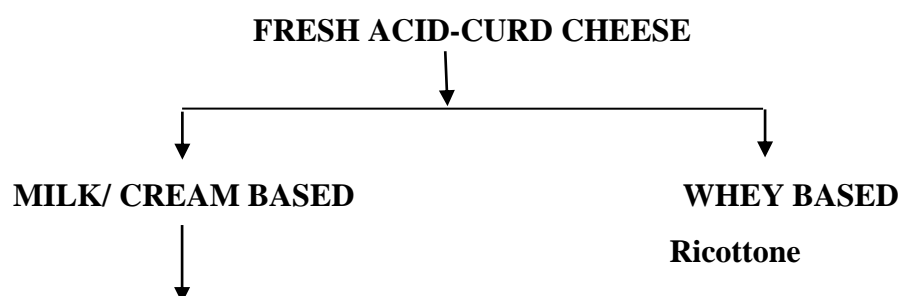
in the fact that it not only retains the original biological value of raw material, the milk but further enhances it by virtue of its bio-available beneficial microflora. Cheese has been well proved to have therapeutic, anticholesterolemic, anticarcinogenic and anticariogenic properties beyond their basic nutritive value. They contribute a variety to our gustative desire in terms of nutritional and intrinsic health attributes, as the microflora present produce simple compounds like lactic acid, amino acids and free fatty acids that are easily assimilable. Besides this, cheese is also a good source of vitamins, riboflavin, minerals and some of the cheese flora inhibits the growth of certain toxin-producing bacteria in the gastrointestinal tract (GIT). Hence, cheeses have been comes under as perfect food category. That is why the cheese production and consumption can be seen in almost all parts of the world in one form of the other. The famous saying “the best is much more important than being the biggest”, therefore, is appropriate and applicable to the cheese.

Cheese consumption and production has continued to increase over the past decades. The popularity of cheese is attributed to its great taste, availability of new and different varieties, convenience and versatility of use and nutritional value. The World cheese production is continually growing at 4.0% rate (Kumar, *et al.*2017). Also, the proportion of milk converted into cheese is increasing and is currently over 30%. This ascribed to increased milk production and greater demand for cheese. Cheese industry has been and is playing its part in the development of this demand in all countries of the world. India is one of the growing markets for cheese. During the last few years, Indian cheese market has grown steadily at 10 to 12 percent per annum in terms of volume and 16-17% per year in value terms (Jena, 2015). Per capita consumption of cheese in India is a mere 200 grams per year in contrast to the global average of 7 kg per annum. The average for urban India, however, is 700 grams per person and the country’s four metropolitan cities viz., Delhi, Mumbai, Chennai and Kolkata consume approximately 60% of all cheese sold in India (Jayadevan, 2013). With one of the largest consumer bases in the world, cheese could be a multi-million dollar industry in India. Currently, about one third of the milk produced in the U.S. each year is used in the manufacturing of cheese. Cheese contains a concentrated amount of almost all of the valuable nutrients found in milk. In 2017, the top three world cheese producers were: (1) United States of America with 5.16 million tons (2) Germany with 2.04 million tons, and (3) France with 1.94 million tons (<https://www.worldblaze.in/largest-cheese-producer-countries/>). According to a report (Global Industry Analysts, 2010), though the economic recession has put a check on the cheese consumption pattern across the world, more

importantly in the developing nations, the future outlook for global cheese market still remains bright with consumption of cheese projected to grow by more than 20% during 2008-2015. There are more than 3000 varieties of cheese is being produced throughout the world whereas only about 40 to 45 variants are marketed in India, presenting much room for the market's expansion (Jena, 2015). Fresh type varieties of cheeses are also prominent among the other types of cheeses.

Fresh acid-curd cheeses refer to those varieties produced by coagulation of milk, cream or whey via acidification or a combination of acid and heat, and which are ready for consumption once the manufacturing operations are complete (Guinee *et al.*, 1993). Quarg, cottage, cream, fromage-frais and ricotta are commercially the most important types under this category of cheese. Most fresh cheese is very versatile and particularly suitable for processing into fresh cheese preparations (cheese cakes and sauces, desserts). Annual world production of Fresh acid-curd cheeses amount to about 25% of total cheese production of 17.00 million tones (IDF, 2007) Fresh cheeses as a percentage of total cheese production are highest in the former USSR (60%), Eastern Europe (40-60%) and West Germany (45%). Per capita consumption as percentage of total cheese ranges from about 70% in Israel and Poland to 45% in Germany to 5-7% in Denmark. India too witnessed an impressive annual growth rate of cheese production of 10-12% percent (Jena, 2015), in which, most of cheese are comes under this category of cheese. In India, cheese production has been accelerating quite steadily, being 1000 tonnes in 1980 to 40000 tonnes in 2008, against the world production of 16 million tonnes (Kanawjia *et al.*, 2008).

2.0 Major Fresh Acid-curd Cheese Varieties



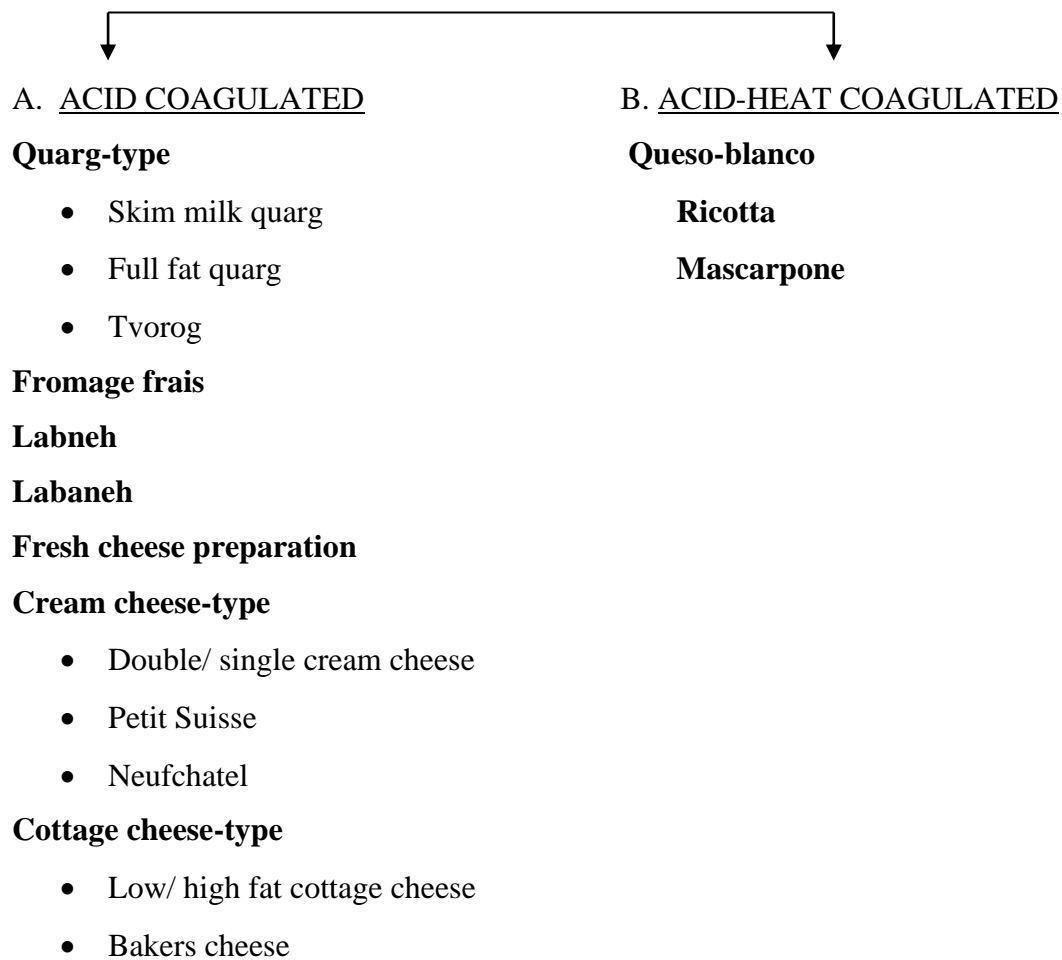


Fig. Fresh acid-curd cheeses

Table: Proximate composition of different varieties of fresh cheeses

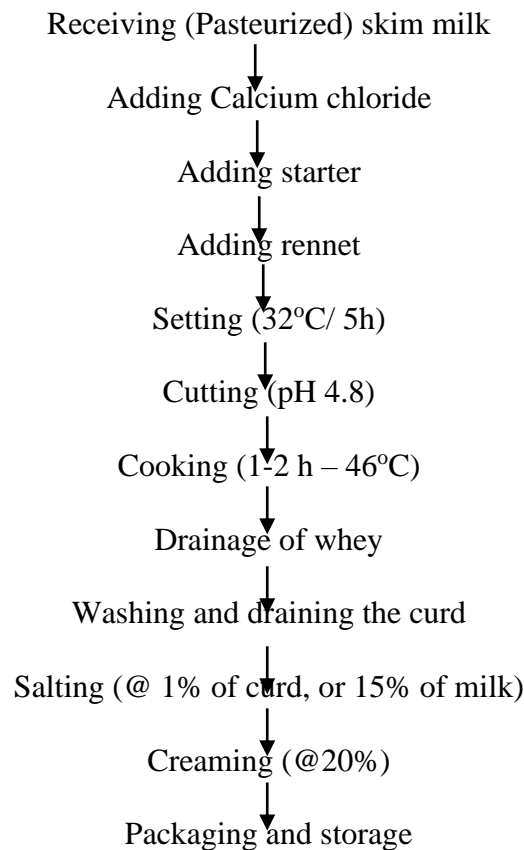
Variety	Dry matter	Fat	Protein	% w/w lactose	Salt	Ca (mg/100g)	pH
Cream cheese							
Double	40	30	8-10	2-3	0.75	80	4.6
Single	30	14	12	3-5	0.75	100	4.6
Neufchetal	35	20	10-12	2-3	0.75	75	4.6
Labneh	25	11.6	8-4	4.3	--	--	4.2
Quarg							
Skim milk	18	0.5	13	3-4	--	120	4.5
Full fat	27	12	10	2-3	--	100	4.6
Cottage cheese							
Low fat	21	2	14	--	--	90	4.8
Creamed	21	5	13	--	--	60	4.8
Fromage frais							
Skim milk	14	1	8	3.5	--	0.15	4.4
Queso blanco	49	15	23	1.8	3.9	--	5.4
Ricotta							
Whole milk	28	13	11.5	3.0	--	200	5.8
Part skim	25	8	12	3.6	--	280	5.8
Ricottone	18	0.5	11	5.2	--	400	5.3

(Source:Kumar *et al.*, 2010)

2.1 Cottage Cheese:

Cottage cheese is a soft unripened mildly acid cheese. Although its specific origin is unknown, the name 'cottage' implies that the cheese was originally produced on family farms. The first industrial production of cottage cheese was in the USA.

The technology of manufacture this cheese is as follows:



(Source: Tiwari, 1996)

a) Cottage cheese is a highly perishable product despite all sanitary precautions in manufacture and adequate storage facilities. The more common flavour defects observed in this cheese are acid, high-acid, sour, bitter, fermented, coarse, flat, feed, rancid, metallic, oxidized, unclean, fruity Foreign, chemical, medicinal, Garlic, onion, Stale, Malty, Musty, Salt (high), Unclean Yeasty, Vinegary etc. whereas more common body & texture defects of cottage cheese are Too firm, elastic, rubbery Gelatinous Mealy, grainy, dry, caseinaceous Pasty, putty, doughy Weak, soft, mushy, over stabilized dressing

2.2 Cream Cheese or Neufchatel Cheese

Cream cheese is a soft, unripened cheese made from cream, coagulated either by microbial development of lactic acid (aided by milk-coagulating enzymes) or by direct acidification. This is followed by collection of the formed soft curd by centrifugation or pressing in cloth bags. This cheese is creamy-white in colour, has a fine, smooth, spreadable texture, and a full rich cream-like flavour with a slight acidic taste. The product has a shelf-life of 3 months at 8°C and most popular in North America.

Cream cheese is generally made from a cream base that contains 12 to 20% milk fat; the fat content of the finished cheese may vary from the typical minimum of 30% to as high as 40%. The moisture content will vary in inverse proportion.

Neufchatel is a similar cheese made from whole milk of high fat content and hence has a correspondingly lower milk fat content (20-25%) in the final product.

In recent years, a US manufacturer has developed a direct acidification process for converting cream or milk base into cream cheese or Neufchatel cheese. Glucono-delta-lactone (GDL) and phosphoric acid are the acidulants used for coagulating the milk protein. Gluconic acid is formed, when GDL is added to an aqueous system such as the cream or milk base; the resulting pH decrease induces the clotting of casein. Milk or cream is usually preacidified with phosphoric acid. The GDL requires heating of the milk for its conversion to gluconate.

Defects in Cream Cheese:

Flavour: Cream cheese should have a full, rich, clean mild acidic flavour in accordance with the high percentage of milk fat present (30 to 40%). The lower fat content cream cheese of the Neufchatel type may have a moderate acid taste. A sweet, cream-like flavour is generally preferred over a distinct acid flavour in cream and Neufchatel cheese.

The more common flavour defects in various types of cream cheese are flat (lacking flavour, sour or too high acid, metallic, an unclean after taste, and yeasty).

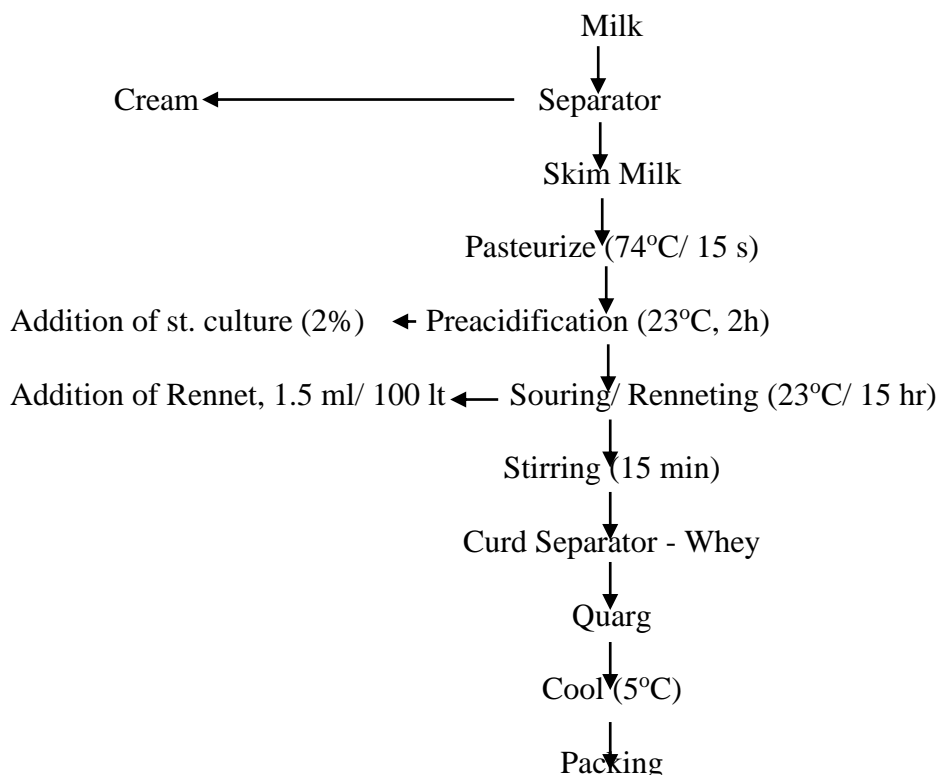
Body and Texture: Cream cheese should have a soft body, yet be sufficiently firm to retain its shape at serving temperature. The texture should be somewhat buttery, silky-smooth, and simultaneously provide excellent spreading and slicing properties.

The body and texture defects of cream cheese may be listed as: coarse, crumbly, excessively smooth (slick), grainy (gritty), sticky, hard, and too soft (lacking viscosity). Most of these defects are easily recognized upon close observation of the product.

2.3 Quarg and Related Cheese

Quarg is a cheese of major commercial significance in Germany where the annual per capita consumption is highest. It is a soft, natural, unripened homogenous, white cheese with a smooth mouthfeel, soft body and a clean, refreshing, mildly acidic flavour. The product is shelf-stable for 2-4 weeks at $<8^{\circ}\text{C}$ (Jelen and Renz-Schauen, 1989). It is sometimes loosely referred to as chakka in India. Also it is referred to as Tvorog in some European countries. In the manufacture of quarg, several processing (hydrocolloid, addition, heating, homogenization and/ or aeration) and addition of various materials (species, herbs, fruit, cream, sugar, other fresh fermented milk products of different fat levels) to quarg give rise to a range of quarg-based products such as half-fat (20% FDM) and full fat (40% FDM) quarg and savoury quarg's, shrikhand dairy desserts and fresh cheese preparations (Patel *et al.*, 1986; Guinee, 1990). Ultrafiltration is now being used on a large scale for the commercial production of quarg (Patel *et.al.*,1986, kumar,*et al.* 2010).

Flow diagram of method of manufacture of Quarg



(Source: Walstra, 1999)

The other varieties like Labneh, ymer and fromage-frais are quite similar to quarg. These products are versions of concentrated, natural stirred-curd yoghurt which represent the interface between the classical fresh cheeses and yoghurt with different compositional, textural and flavour attributes.

Defects in Quarg Cheese:

Flavour: Due to its relatively high moisture (82%) and low protein (14%) levels, the shelf-life of quarg is limited to two to four weeks at <8°C because of microbial growth, syneresis and off-flavour.

The more common flavour defect of quarg cheese is bitterness. Other flavour defects in such cheeses are flat, sour, or too high acid, unclean, metallic and yeasty.

Body and Texture: The most common body & texture defects of quarg cheese is development of grainy texture. Other defects which are notified are sticky, hard, too soft, coarse, crumbly, and excessively smooth etc.

2.4 Ricotta Cheese:

Ricotta cheese, was traditionally produced in Italy from cheese whey. It is a soft, cream coloured, unripened cheese, with a sweet-cream and somewhat nutty-caramel flavour and a delicate aerated-like texture. This cheese, now enjoying more widespread popularity, in particular in North America, where it is produced mainly from whole or partly skimmed bovine milk or whey/ skim mixtures (Kosikowski, 1982; Cleay and Nilson, 1983 Kumar et.al (2010).

Ricotta cheese because of its relatively high pH, high moisture and open manner of moulding and cooling is very susceptible to spoilage by yeasts, mold and bacteria, and hence a relatively short-life of 1-3 weeks at 4°C. Excellent quality Ricotta cheese produced by using ultrafiltration. (Maubois and Kosikowski (1982).

Ricotta cheese has many applications, including a base for whipping dairy dessert, use in confectionary fillings and cheese cakes and as a base for products such as cream cheese and processed cheese (Kosikowski, 1982, Kumar, et.al 2010).

The more common flavour defects observed in this cheese are acid, high-acid, sour, bitter, fermented, coarse, flat, rancid, metallic, oxidized, unclean, fruity etc.

2.5 Queso Blanco:

Queso Blanco is white, semi-soft cheeses, generally produced in central and south America and it is being consumed as fresh: however, some cheeses may be held for period of 2 weeks to 2 months before consumption.

In Latin America, Queso blanco covers many white cheese varieties which differ from each other by the method of production (i.e. acid/ heat or rennet coagulated), composition, size, shape and region of production like Queso del Cincho, Queso del Pais and Queso Llanero (acid/ heat coagulated), and Queso de Matera and Queso Pasteurizado (Rennet coagulated).

In general, Queso blanco-type cheeses are creamy, high salted and acid in flavour, the texture and body resembles those of young high-moisture cheddar and the cheese has good slicing properties.

Sensory Characteristics and Utilization:

One of the properties of acid-coagulated Queso blanco is its melt resistance due to inclusion of whey protein which makes the cheese suitable for use in deep-fried snack foods such as cheese sticks in batter.

The texture and hence the sliceability, of Queso Blanco is influenced by the moisture content and the age of the cheese. Major volatile compounds contributing to the flavour and aroma of this type of cheese include acetaldehyde, acetone, ethyl, iso-propyl and butyl alcohols and formic, acetic, propionic and butyric acids.

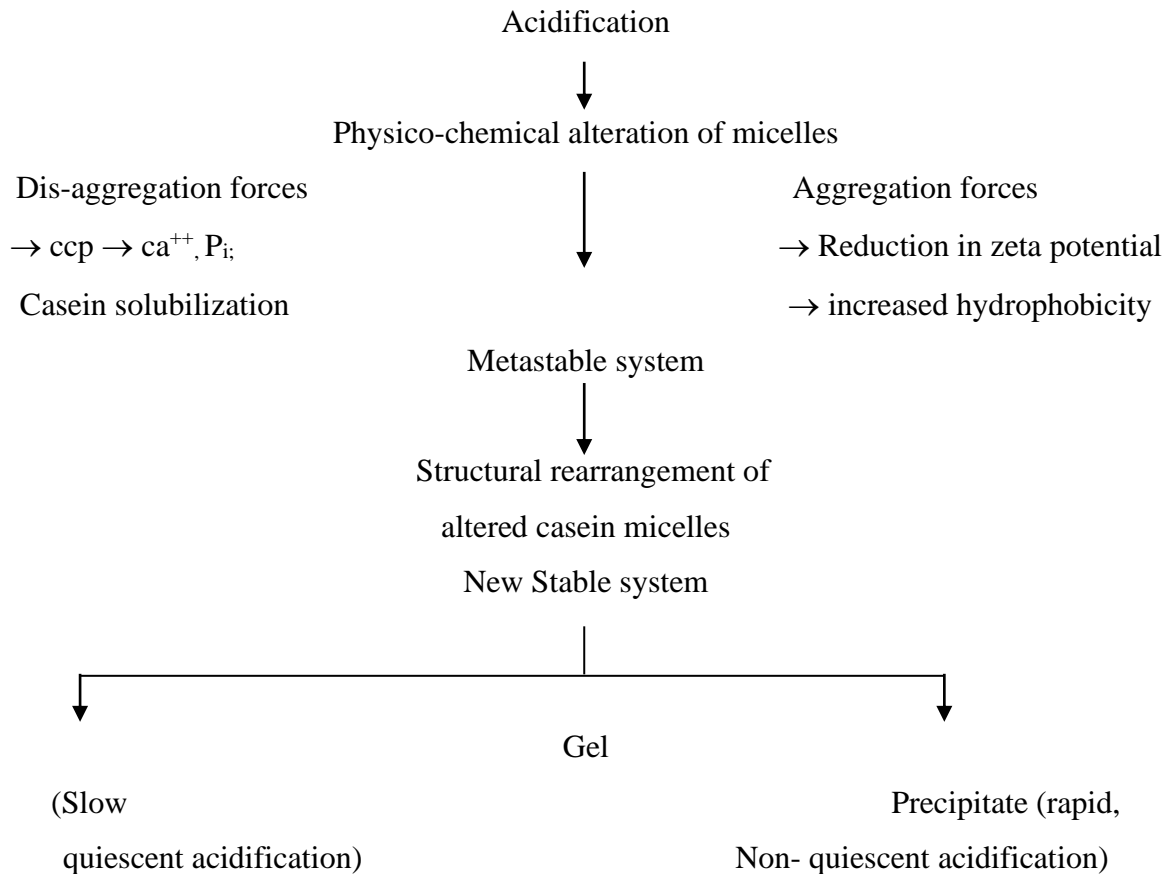
Technological changes on acidification for manufacture of Fresh acid-curd cheese varieties:

Sudden acidification, by adding an inorganic or organic acid, produces flocculation of the casein at pH 4.6 in the form of a more or less granular precipitate which separates from the whey, on the other hand progressive acidification, effected either by in situ lactic acid production or by hydrolysis of gluconic acid delta lactone, leads to the formation of a smooth, homogenous coagulum completely filling the original volume of the milk.

Influence of acidification on milk

Milk (Stable casein colloidal system-micelles)





(Source: Guinee, 1995)

In the course of acidification the following changes occur in milk protein system i.e. casein which leads to development of coagulum:

- (a) The ionization of the acidic functional groups of the casein like aspartic, glutamic and phosphoserine residues is reduced. Consequently, the zeta (surface) potential is reduced which eventually decreases the sequestering capacity of α_s - and β -caseins.
- (b) Solubility of calcium salts in water increases, resulting in progressive displacement of the calcium and the inorganic phosphate of the micelle into the aqueous phase and hence demineralization of the micelle. This tends to cause disaggregation/ disorganization of the micelles into their micellar sub-units. Total demineralization of the micelle occurs at a pH of less than 5.0.
- (c) At isoelectric pH i.e. 4.6 the charges are neutralized and hydration is significantly reduced, rendering the caseins insoluble.

The changes as above, due to acidification result in formation of a coagulum consisting of insoluble protein network, which encloses the whole of the aqueous phase in its meshes. The Junction point of the network are the sub-micelles, totally demineralised and to some extent.

modified in their structure. The intermolecular linkages involved in the formation of this network are electrostatic and hydrophobic in nature. This explains the very great fragility of lactic coagulum. The nature and characteristics of lactic gel are principally decided by:

- (1) Factors inherent in milk, particularly the protein concentration and
- (2) Factors inherent in the conditions of acidification, particularly temperature, rate of acidification, and pH at the end of acidification/ fermentation.

Structural changes:

It is evident from electro-microscopic studies, the quiescent acidification of milk from pH 6.6 to 4.6 is accompanied by a number of concerted structural changes which are pH, related. For fresh or pasteurized milk, acidified at 20-30°C, these may briefly given as follows:

- At pH value > 5.6 no major changes are observed; the individual micelles retain their shape, dimensions and integrity.
- At the pH of maximum casein dissociation (\sim pH 5.5), the micelles become more porous as a consequence of casein dissociation.
- On further reduction of pH to 5.2 i.e. where practically all CCP is solubilized, smaller particles, in addition to the original micelles, become increasingly more visible.
- At pH \sim 5.2, gelation commences with the formation of casein aggregates which appear as relatively large corpuscular structures.
- On further pH reduction, the casein rich areas contract and the aggregates touch to form short dangling pieces of network which, as the isoelectric point is approached, tough and crosslink to give a three-dimensional particulate gel network which extends, more or less continuously, throughout the serum phase.

The structural parameters of a gel are affected by various factors like milk composition (level of fat and protein), processing parameters (heat and homogenization treatments of the milk) and conditions of gel formation (incubation temperature, rate of acidification, addition of rennet, final pH value, etc.). These factors determine the magnitude of the physico-chemical changes which eventually regulate structure formation.

Various methods have been employed to assess the rheological characteristics of fresh acid-curd products. Viscometric studies have been used to measure viscosity and stress (T) as a function of shear rate (Y) for soft fresh cheese. In order to obtain more accurate information on the rheological characteristics of visco-elastic systems, such as soft fresh

cheeses, instruments like Den Otter and Bohlin Rheometers; low-shear 20 Son oscillatory viscometer have been used, which minimizes structural damage to the gel.

Conclusion:

Due to effective implementation of white revolution in our country, India became a largest milk production in the world. About 35% of total milk production is being processed in our country. The main value-added products include milk powder, dairy whitener, packaged milk, milk based sweets, butter, ghee, yoghurt, dahi, cheese, and ready-to drink milk products.

Cheese consumption and production has continued to increase over the recent years. The popularity of cheese is attributed to its great taste, availability of new and different varieties, convenience and versatility of use and nutritional value. The World cheese production is continually growing at 4.0% rate. Also, the proportion of milk converted into cheese is increasing and is currently over 30%. India is one of the growing markets for cheese. During the last few years, Indian cheese market has grown steadily at 10 to 12 percent per annum in terms of volume and 16-17% per year in value terms

Fresh type varieties of cheeses are also prominent among the other types of cheeses. India too witnessed an impressive annual growth rate of cheese production of 10-12% percent (Jena, 2015), in which, most of cheese are comes under this category of cheese. So, more and more innovation and upgradation of such types of cheese is required so that India could also export some amount of such cheeses.

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