UNIT IV

Chemistry and technology of Cheese

Cheese was prepared in Asia and in Europe several hundred years ago, at least before the birth of Jesus Christ. It is one of the oldest foods of mankind. Cheese is a dairy product derived from coagulation of milk protein 'casein'. It comprises of proteins and fats from milk of cows, buffaloes or the combination thereof. During the production of cheese, milk is usually acidified. The enzyme called rennet is added in order to cause the coagulation of milk. The solids are separated and pressed into the final form. The solid mass is ripened using different strains of microorganisms to produce ripened cheese. About 400 different types of cheese are produced using different ripening conditions.

Types of cheese:

There are numerous types of cheese, some of the important ones are as under:

Hard with no gas holes – Cheddar cheese
Hard with eye holes – Emmental cheese
Soft and unripened – Cambridge cheese
Soft and ripened – Coulommier cheese
Surface mould ripened – Cammembert cheese
Internal mould ripened – Roquefort cheese
Acid coagulated – Cottage cheese
High fat – Cream cheese

Preparation process

Receiving of milk

The high grade milk can yield high grade cheese. The quality of finished cheese depends upon the initial quality of the milk from which it is made.

Filtration/clarification

The purpose of filtration is to remove any visible dirt in milk so as to improve the aesthetic quality of the cheese make. The milk is usually pre-heated to 35-40°C for efficient filtration/clarification.

Standardization

In cheese making, the standardization referrers to adjustment of the casein/fat ratio in cheese milk to 0.68-0.70. The objective of standardization is to regulate the fat in the dry matter of cheese and to produce the maximum amount of cheese per kg of fat in the cheese milk

Pasteurization

The usual temperature-time employed for pasteurization of cheese milk is -63°C for 30 min or HTST-71°C for 15 sec. The advantages of pasteurization cheese milk are to destroy all pathogens and to produce a more uniform product of high quality.

Homogenization

The advantages of homogenization are (i) lower fat losses in whey and thereby a higher yield of cheese (ii) reduced fat leakage of cheese at elevated temperatures

Addition of calcium chloride

Excessive heat treatment causes the precipitation of a part of the calcium salts in milk. This results in slower renneting action and a weaker curd, which can be corrected by addition of 0.01 to 0.03 % calcium chloride to milk.

Adding starter (ripening)

Ripening or souring of milk refers to the development of acidity in milk from the time it is received in the cheese vat until renneting. In cheese milk, ripening is done by the addition of starter. The starter is the heart of cheese. A bad starter is almost certain to give low quality cheese. A good starter may make up for other defects such as contaminated milk. There are different kinds of cheese starters such as those producing acids, aroma etc. a cheddar cheese starter usually contains *Streptococcus lactis* or *Streptococcus* cremoris.

The usual time to add the starter is before all the milk has been received in the vat. The starter is added 0.5 to 1% of the milk, and the temperature at the addition time should be 30°C.

Addition of colour

Sometimes colour is also added during the preparation of cheese. Colour is usually added just before renetting. The usual amount is 30 to 200 mL or more (for buffalo milk) for 100 kg of milk.

Renneting

Adding rennet to milk in cheese making is commonly known as renneting or setting. Rennet is the crude preparation or extract from the abomasum. Rennet contains two principal enzymes viz., rennin and pepsin. Rennin is an extremely powerful clotting enzyme, which causes rapid clothing without much proteolysis. On the other hand, pepsin induces proteolysis, leading to bitterness in cheese.

Coagulation

This refers to liquid milk changing to a semisolid junket. The first signs of coagulation are that bubbles of air stirred into the milk and withdrawn shows small flakes of curd.

Cutting

This refers to the cutting of the firm coagulum into cubes of a specific size.

Cooking

This refers to the heating of curd cubes; it begins within 15 minute of cooking.

Drainage of whey

This refers to the removal of whey from the curd. When the curd cubes have been reduce to about one-half of their size at cutting, the acidity approaches a desirable limit and he cubes attain a desirable consistency (elastic feel when squeezed), stirring is stooped and the cubes are pitched.

Cheddaring

This refers to the combined operation of packaging, turning, piling and repiling the curd cubes

Packaging: after the bulk drainage of whey, the curd cubes are kept closely together in two heaps with a channel in between (for continuing the whey removal process). This is know as packing, and takes 5 to 15 minutes after dipping. It results in the formation of two long slabs of curd. These are cut with a cheese knife into blocks or strips 15-20 cm side.

Turning: as soon as the block (strips) of curd can be handled without breaking , they are rolled bottom-side up I the vat. This is called turning and is carried out every 15 minutes till the curd is ready for milling and salting.

Piling and repiling: within 30 to 45 minutes of packaging, blocks of curd are turned and laid one over another in twos or threes. This is called repiling. Then the position of the curd blocks is altered and this is known as repiling.

The cheddaring operation usually lasts two hours or more and is very important not only for moisture control but also for improving body and texture. After cheddaring, the curd becomes drier, more mellow and silky and changes from a sorbo rubber like material to one resembling chicken breast meat.

Milling

This refers to the mechanical operation of cutting the blocks of cheddared curd into small pieces with the help of cheese milk. The objective of milling is to promote the further removal of whey, to enable quick distribution of salt in the curd, and to prepare curd for pressing into final form.

Salting

This refers to the addition of common slat to the curd pieces. Salt in cheese affects flavour, body and texture, and keeping quality. Cheeses without salt are soft, ripen quickly and rapidly develop unpleasant flavours. The objective of salting are to further removal of whey,

hardening and shrinking of curd, retarding further formation of lactic acid, and to check undesirable fermentation.

Hooping

This refers to the curd being placed in hoops or moulds in which the cheese curd is pressed into its final shape.

Dressing

This refers to the arrangement of the cheese cloth before and after pressing. Large cheese hoops are lined with cloth before they filled with cheese curd for pressing,

Pressing

This refers to the operation of forcing the particles of milled and salted curd in the hoops into the smallest possible space.

Drying

This is done for rind formation in cheese. It involves, (i) taking the cheese out of the hoop. Care is taken to see that the cheese removed from the hoop is neat, clean, uniform in size and regular in shape. (ii) keeping the cheese in a drying room, where the temperature is maintained at 12 to 16°C and the average relative humidity at 50% for a few days. The cheese is turned at 24 hour intervals so that both, ends and sides of the cheese can dry and form the desired rind.

Paraffining

This refers to the operation of dipping the cheese for a few seconds in a bath of melted paraffin, whereby a thin coating of paraffin is applied to the surface of the cheese. The objectives of paraffining are to reduce loss of moisture during curing, to prevent extensive mould growth and to protect it against insects.

Curing

The curing/ripening/maturing of cheese refers to the storage of cheese for at least 2 to 3 months at a given low temperature (0-16°C), during which its physical, chemical and bacteriological properties are profoundly changed resulting in the development of a characteristic flavour, body and texture.

Fermented Milk Products

Fermented milk refers to those milks which have made by employing selected micro-organisms to develop the characteristic flavour and/or body and texture. Fermentation is defined as the metabolic process in which chemical changes are brought about on an organic substratum,

whether protein, carbohydrate, or fat, through the action of enzymes liberated by specific living microorganisms.

1. Acidophilus milk

This type of fermented milk is produced by development in milk of a culture of *Lactobacillus acidophilus* under the conditions existing in the intestinal tract will replace undesirable putrefactive fermentations with a beneficial lactic fermentation.

Preparation

Skim, whole, or partly defatted milk may be used. Milk containing more than 1% fat should be homogenized. Acidophilus milk can simple be made with added sugar or honey, or with tomato or carrot juice. Fresh milk is heated to 115°C for 15 minutes to obtain sterile milk. The addition of 1% of glucose or honey, or 5% tomato juice helps to hasten the fermentation, but is not essential. The milk is cooled to 38-40°C and inoculated with 3-5% inoculums. The inoculated milk is mixed thoroughly and incubated at 28-40°C until the milk coagulates. The coagulum is slowly broken up a cooled to 10°C. Five to 10% lactose or dextrin may be added if desired. The milk is stirred until smooth, packaged and stored at 5°C unit used.

2. Yoghurt

Turkish yoghurt, Egyptian leben, Armenian matzoon and Indian dahi are all similar products. Originally yoghurt was made from boiled concentrated whole milk, but most modern methods of manufacture use whole or partly defatted milk containing small amounts of skim milk powder or concentrate. The fat content in yoghurt may vary from 0 to 5% and the solids content from 9 to 20%.

Two microorganisms, *Lact. bulgaricus* an *Str. thermophilus* growing together symbiotically, are responsible for the lactic fermentation of yoghurt. In some countries, it contains lactose fermenting yeast. Leuconostoc strains, *Str. diacetilactis* and *Lact. acidophilus* are also added to improve the flavour of the yoghurt.

The method of culture control is very important in yoghurt manufacture, and for this reason stock (mother) cultures are best maintained individually, rather than mixed. The optimum pH and temperature for growth of *Str. thermophilus* is 6.8 and 38°C, respectively; *str. thermophilus* cultures normally attain acidities of 0.85 to 0.9%, whereas *Lact. bulgaricus* reaches acidities of 1.20 to 1.5%.

Preparation

Skim milk powder/concentrate is added to while or partly defatted milk to increase the solids-not-fat content by 2-3% to a total of approximately 12%. The mix is pre-heated to 60°C and homogenized single stage at 2000-2500 psi. Stabilizers are frequently added to the mix but are not essential and excessive amounts are to be avoided. The mix is heated in a vat to 85°C for 30 minutes and then cooled to 43-44°C, inoculated with 2% bulk starter and stirred briefly to

ensure proper mixing. The mix is then packaged, care being taken that the temperature does not fall below 41°C during the filling operation. The time interval between inoculation and filling should not exceed 45 minutes. Yoghurt is inoculated in the package without further agitation at 41-42°C for about 3 hours, till a titratable acidity of 0.75% is reached. It is then placed under refrigeration to cool to 5-7°C; approximately 8 hours are required, at which time the product is ready for distribution. A final acidity of 0.9% is desired in the product.

3. Buttermilk

Buttermilk is the liquid left behind after churning butter out of cream. It also refers to a range of fermented milk drinks. This fermented dairy product also known as cultured butter milk is produced from cow's milk which has a characteristic sour taste caused by lactic acid bacteria. It is made using one of two species of bacteria either *Lactococcus lactis* or *Lactobacillus bulgaricus* which creates more tartness.

The tartness of buttermilk is due to the acidity in the milk. The acidity is primarily due to lactic acid produced by lactic acid bacteria, while fermenting lactose. As the bacteria produces lactic acid, the pH of the milk decreases and casein, the primary milk protein coagulates causing the curdling of the milk. This process makes buttermilk thicker than plain milk. The cultured buttermilk appears to be more viscous than traditional buttermilk as it contains more lactic acid.

Buttermilk prepared in the traditional way is considered beneficial to health as it contains probiotic microbes. The probiotic nature of buttermilk is said to beneficial to the gut and improve immunity when taken regularly. Buttermilk contains vitamins, potassium, calcium and traces of phosphorus. It is a favorite traditional drink during summer, as it is soothing to the stomach and alleviates minor stomach upsets. In India, flavouring ingredients such as asafoetida, coriander leaves, ginger, curry leaves and salt are mixed with buttermilk to enhance its digestion-aiding properties.