MINISTRY OF FOOD PROCESSING INDUSTRIES
GOVERNMENT OF INDIA

सत्यमेव जयते

Reading Material for

Cheese Production

Under PMFME Scheme

AATMANIRBHAR BHARAT

National Institute of Food Technology Entrepreneurship and Management
Deemed to be University (De-novo Category) under Section 3 of the UGC Act, 1956
An Autonomous Institution under Ministry of Food Processing Industries, Government of India
Plot no 97, Sector 56, HSIIDC, Industrial Estate, Kundli, Sonepat, Haryana – 131028
Website: www.niftem.ac.in, Email: pmfmecell@niftem.ac.in Contact: 0130-2281089

Contents

Chapter – 1: Raw Material

Chapter – 2: Processing and Machinery

Chapter – 3: Packaging

Chapter – 4: Food Safety Regulations and Standards

Chapter – 5: Cleaning, CIP and Effluent Treatment

Chapter – 1

Raw Material

1.1 Introduction

Milk is liquid secreted by the mammary glands of female mammals to nourish their young for a period beginning immediately after birth. The milk of domesticated animals is also an important food source for humans, either as a fresh fluid or processed into a number of dairy products such as butter and cheese (https://www.britannica.com). Milk is a nutritious choice as it provides nine essential nutrients our body needs. Milk contains essential nutrients like high-quality protein, calcium, vitamin D and more. These nutrients help our bodies function properly. For example: Protein helps build and repair muscle tissue Calcium and vitamin D helps build and maintain strong bones and teeth Milk also contains B vitamins, which can help your body convert food into energy.

1.2 Dairy Industry in India

India is leading milk producing country in the world, accounting for 19 percent of the global market share and expected to grow at compound annual growth rate (CAGR) of 14.8% between FY 2018 – 2023. As per fiscal year 2019, milk production in India amounted to about 187 million metric tons. As per FY – 2018, around 81% of the Indian dairy and milk processing market comes under unorganized sector, where milk is processed in unhygienic infrastructure, which affects the overall quality of milk and milk-based products. Consumption patterns of liquid milk at the farm level and less infrastructure for processing is the main reason for low value addition of milk. The demand for value added products especially traditional dairy products is increasing day by day and the dairy industry of the country is trying to meet the present demand.

Uttar Pradesh, Rajasthan and Gujarat are the major milk producing states in India. Uttar Pradesh is the largest milk-producing state, as it has the highest buffalo population and the second-highest cattle population in the country. Majority of the rural population in this state is engaged in livestock nurture and dairy farming. Gujarat holds several cooperative dairy unions, milk cooperative societies and private dairy plants, which play vital roles in the production of milk and milk-based products in the state.

1.3 Insight on value-added product

Apart from processed liquid milk, Indian dairy and milk processing industry generates revenue from several value-added products such as butter, curd, paneer, ghee, whey, flavoured milk, ultra-high temperature (UHT) milk, cheese, yogurt, dairy whitener and milk powder. During the FY 2016 – 2020, the market size of dairy ingredients is expected to grow by around 14%.

1.4 Export-import opportunities

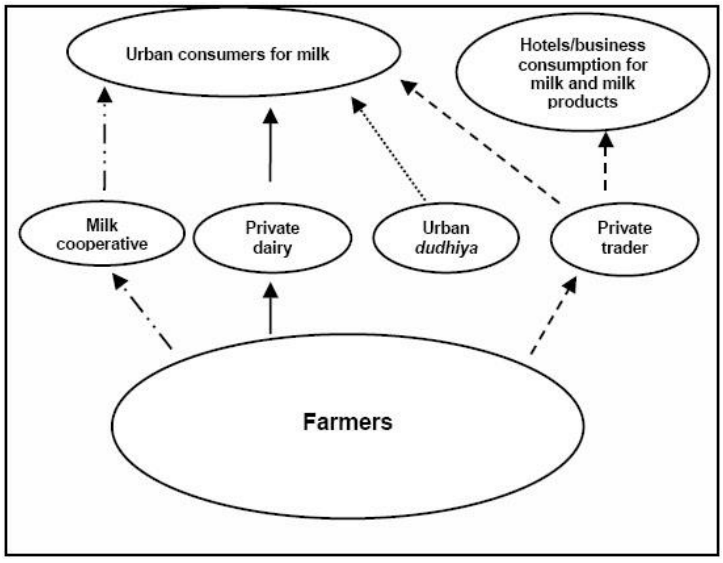
The export of dairy products from India has increased to countries like Bhutan, Afghanistan, Canada, Egypt, and the United Arab Emirates. India has also imported a significant number of dairy products from countries like France, New Zealand, Ireland, France, Ukraine, and Italy.

1.5 Key deterrents to the growth of the market

Despite having a significant livestock base of milch animals, India lacks in terms of good processing facility and availability of cold storages which results in wastage of dairy output. Lack of sufficient storage facilities and inefficient distribution channels are hampering the growth of the Indian dairy and milk processing industry.

Sufficient quantity and good quality of feed and fodder are required for proper animal rearing and milk production. Improper droughts and flood management affect the production of fodder in India. Deficiency of proper feed and fodder for milch animals, due to high usage of agricultural crop residues by producers of fibreboard, paper, and liquid fuels, affect its availability for dairy production and milk processing.

Dairy marketing channels in India



Reference: FAO

1.6 Need for Processing Milk

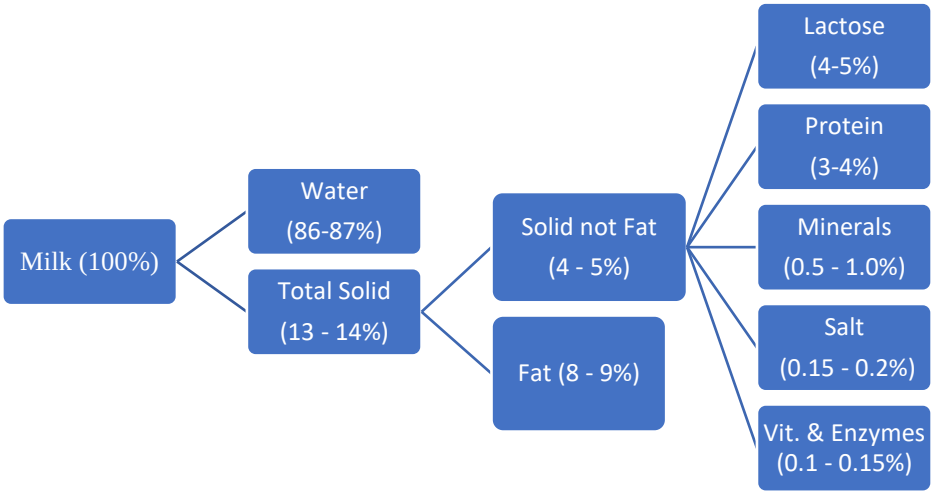
Milk is considered wholesome food mainly because of its high nutritive value. It has to be processed to;

- Increase the shelf life, because it is highly perishable.
- Prepare value added products like dahi, cheese, paneer, butter, ghee, AMF, flavoured milk, cheese, and yogurt, dairy whitener, milk powder etc. and many more dairy based products, for a good health.
- Make business out of it, create job opportunities, consequently building financially strong Nation.

1.7 Composition of Milk

Milk composition varies with species, breed (Holstein, Jersey), feed, and the stage of lactation. As per FSSAI, "Milk is a whole, fresh, clean lacteal secretion obtained by complete milking of one or more healthy milch animals excluding that obtained within 15 days before calving or 5 days after calving. Market milk must possess the pre-determined percentage of milk fat and SNF (Solid Not Fat)."

Milk of different classes and types must conform to the standards laid down by FSSAI. Mixed milk means a combination of the milk from cow and buffalo or any other milch animal. The combination also should at par with FSSAI standards.



1.8 Nutritional Value of Milk

Table: Nutritional values of milk

Nutritional Factor	Description	Energy Value
Protein	Milk protein is casein, a high-quality protein. All essential amino acids are present in Milk.	4.1 KC/g
Minerals	Milk contains phosphorus and calcium.	
Vitamins	Milk contains vitamins A, D, thiamine, and riboflavin.	
Fat	Milk fat is responsible of good flavor and physical properties. The fat content in cow milk is generally from 3.5 to 4.5 %	9.3 KC/g
Lactose	Lactose is the sugar component of milk and it supply energy.	4.1 KC/g

1.9 Selection of milk for Cheese

Selection of milk is one of the most important part in cheese making process. Cow milk is commonly used for making cheese all over the world, however buffalo milk can also be used for Cheese making with certain process modifications. The quality of raw milk used for cheese making determines the quality of resulting cheese. Rennet coagulation, starter growth and changes in texture during cheese ripening etc. all depends on the quality of the milk.

Milk quality is evaluated in terms of organoleptic test, chemical and microbiological aspects.

1.10 Composition of milk for cheese processing

Yield of the final product is one of the most important factors, which determines the profitability of any company. The composition, mainly casein and fat content determine the yield of cheese. Yield can be predicted by using the general equation;

$$Y = aF + bC$$

Where, Y is Yield

F is Fat content of milk

C is Casein content of milk

a and b are coefficients, depend on the composition of milk, the manufacturing procedure, equipment design and retention of fat and casein in the cheese

The equation shows, yield of cheese is linearly related with fat and casein content of milk. The greater contribution of casein is expected, as it forms the continuous paracasein sponge-like network that occludes the fat and serum phases, whereas fat on its own has very little water-holding capacity. Fat is occluded in the pores of the paracasein network of the cheese and

impedes syneresis. The occluded fat globules physically limit aggregation of the surrounding paracasein network and therefore reduce the degree of matrix contraction and moisture expulsion. Hence, as the fat content of the curd is increased, it becomes more difficult to expel moisture, and the moisture-protein ratio increases. However, if the moisture in non-fat substance is maintained constant (e.g., by process modifications such as reduction of curd particle size and slight elevation of the scald temperature), fat contributes less than its own weight to cheese yield (~ 0.9 kg/kg), owing to the fact that about 8-10% of the milk fat is normally lost in the whey.

1.11 Importance of raw milk storage temperature in cheese making

In India, normally milk is reaches factory in batches from different collection/chilling centres. At raw milk reception dock (RMRD), received milk is immediately chilled after basic organoleptic and quality tests and stored in insulated silos/tanks. Once the required volume is achieved, processing starts. Storing milk at refrigerated temperature for some hours results in some physico-chemical changes in milk, which include:

- Solubilization of casein and colloidal calcium phosphate which leads to increase in serum caseins, thereby increasing loss in whey.
- Growth of psychrotrophic bacteria which leads to release of enzymes like proteases and lipases.
- Increase in free fat levels owing to lipase action.

The increased serum casein level can be reversed by pasteurization and thus, the effect of cold storage is nullified but the production of proteases causes protein breakdown into peptides. Some of these peptides are soluble in the serum phase and do not coagulate during curd formation. They are lost in whey leading to a decrease in cheese yield. The reduced casein level has an effect of curd shattering and weak coagulum, thereby increasing fat loss in whey. The dual effect of losing casein and fat in whey reduces the cheese yield considerably.

1.12 Process alterations to prepare cheese from buffalo milk

1. Heating buffalo milk to a higher temperature: High heat treatment results in partial precipitation of colloidal calcium. Also, interaction of casein micelles with whey proteins prevents faster coagulation. The curd so formed holds more moisture, finally improving body and texture of the cheese.

2. Ripening of milk (acidification): In buffalo milk, acidity development is relatively slower due to its higher buffering capacity, so an elevated level of about 2% lactic culture is added.
3. Ripening temperature of milk: In case of buffalo milk, a Relatively lower ripening temperature (28°C) is more favourable for acidity development as compared to the higher temperature (30°C) in case of cow milk.
4. Cooking temperature: For buffalo milk, a lower cooking temperature for (37°C for 40-45 min) helps in retention of greater amount of moisture as compared to cow milk cheese (39-40°C for 60 min).
5. Cheddaring: During cheddaring, piling and re-piling of cheese blocks should be more frequent to ensure greater retention of moisture in case of buffalo cheese.
6. Pressure: Lower pressure should be applied on cheese block in case of buffalo milk cheese as compared to cow milk cheese.
7. Application of starter culture adjuncts and enzyme preparation: In order to accelerate the ripening of cheese further from buffalo milk application of starter adjuncts and exogenous enzyme preparations should be made.

Chapter – 2

Processing and Machinery

2.1 Introduction

Cheese is one of the oldest processed foods by mankind. It is believed that cheese originated accidently as a result of some activities of the nomadic tribes across rivers of Tigris and Euphrates, around 8000 years ago. Bags made of animal skin were used to store food items, particularly surplus milk. During warm climate, fermentation of milk sugar would result into curdling of milk

The swaying animals would have broken up the acid curd during journeys to produce curds and whey. The whey provided a refreshing drink on hot journeys, while the curds, preserved by the acid of fermentation. This activity gave rise to the assumption that cheese was evolved from fermented milks.

Cheese making was basically a farmhouse practice till 18th century. Scientific developments during the early 19th century have provided guidelines, which has a great impact on cheese making and ripening process. And hence, cheese making became an Art with Science. The cheese making process has undergone several developments in terms of mechanization and automation during the course of history. Several machines have been developed for continuous and mass production for different varieties of cheese with inline packaging.

Traditionally, cheese was kept for months or sometimes even years for ripening and development of typical texture and flavour. Scientific development and research have accelerated the cheese ripening process and to achieve the desired texture and flavour in a very less time.

According to the FSSR (2011), cheese means the ripened or unripen soft or semihard, hard and extra hard product, which may be coated with food grade waxes or polyfilm, and in which the whey protein/casein ratio does not exceed that of milk. Cheese is obtained by coagulating wholly or partly milk and/or products obtained from milk through the action of non-animal rennet or other suitable coagulating agents and by partially draining the whey resulting from such coagulation and/or processing techniques involving coagulation of milk and/or products obtained from milk which give a final product with similar physical, chemical and organoleptic

characteristics. The product may contain starter cultures of harmless lactic acid and/or flavor producing bacteria and cultures of other harmless microorganisms, safe and suitable enzymes and sodium chloride. It may be in the form of blocks, slices, cut, shredded or grated cheese. FSSR (2011) has also defined cheese on the basis of ripening as follows:

1. Ripened cheese is cheese which is not ready for consumption shortly after manufacture but which must be held for some time at such temperature and under such other conditions as will result in necessary biochemical and physical changes characterizing the cheese in question.
2. Mould ripened cheese is a ripened cheese in which the ripening has been accomplished primarily by the development of characteristic mould growth through the interior and/ or on the surface of the cheese.
3. Un-ripened cheese including fresh cheese is cheese which is ready for consumption shortly after manufacture. Cheese or varieties of cheeses shall have pleasant taste and flavour free from off-flavour and rancidity. It may contain permitted food additives and shall conform to the microbiological requirements prescribed in the regulation.

2.2 Classification of Cheese

There are around more than 2000 varieties of cheese around the world and it is very difficult to classify and group them. To assist Internal trade and to provide compositional and nutritional information, cheese has been classified on the basis of age, type of milk, country of origin, ripening process/agents, important compositional varieties, like moisture and fat, general appearance, texture and rheological qualities. However, none of the above schemes is complete in itself. There are probably only about 18 types of natural cheeses, such as Cheddar, Gouda, Edam, Swiss, Brick, Herve, Camembert, Limburger, Parmesan, Provolone, Romano, Roquefort, Sapsago, Cottage, Neufchatel, Trappist, Cream and Whey cheeses. Such a grouping, though informative, is imperfect and incomplete. These can also be classified on the basis of their rheology, and according to the manner of ripening as shown below:

1. Very hard (grating) - Moisture < 35% on matured cheese and ripened by bacteria, e.g. Parmesan, Romano.
2. Hard - Moisture < 40%
    a) Ripened by bacteria, without eyes: Cheddar
    b) Ripened by bacteria, with eyes: Swiss

3. Semi-hard - Moisture 40-47%

a) Ripened principally by bacteria: Brick.

b) Ripened by bacteria and surface microorganisms: Limburger

c) Ripened principally by blue mould:

4. Soft - Moisture > 47%

a) Un-ripened – Cottage

b) Ripened – Neufchatel

2.3 Legal standard of cheese

Type of Cheese	Moisture Content (maximum) %	Milk Fat Content on Dry Basis (minimum) %
Hard pressed cheese	39	48
Semi hard cheese	45	40
Semi soft cheese	52	45
Soft cheese	80	20
Extra hard cheese	36	32
Mozzarella cheese	60	35
Pizza cheese	54	35

2.4 Composition and nutritional value of cheese

Cheese is one of the nutritious dairy products. The nutritional value depends on many factors such as animal species and breed, stage of lactation, fat content, manufacturing and ripening process. In general, cheese contains relatively small amounts of the water-soluble constituents whey proteins, lactose, and water-soluble vitamins.

Table: Composition of cheese

Variety	Moisture	Fat	Protein	Ash (salt-free)	Salt	Calcium	Phosphorous	Energy (Calorie/100g)
Cheddar	37.5	32	25	2	1.5	0.86	0.6	398
Mozzarella	54	18	22.1	2.3	0.7	-	-	290
Cottage (un-creamed)	79.5	0.3	15.0	0.8	1.0	0.1	0.15	200

2.5 Standardization of Milk

Standardization of milk in terms of protein/casein levels is done to minimize the impacts associated with a seasonality on milk quality such as variable protein/casein contents which result in poor curd-forming properties and in variations in yield and consistency of the final produced cheeses. Furthermore, standardisation of milk protein to higher-than-normal levels enables increased plant throughput without installation of extra cheese vats. Protein standardization may be achieved by: use of low-concentrated retentate (LCR) produced by UF or Reverse Osmosis (RO) of cheese milk; enrichment of casein by MF; or addition of phosphor casein powder (PC) or milk protein concentrate (MPC), typically followed by cheese manufacture using conventional equipment. Standardization of cheese is normally done to a casein/fat ratio of 0.70:1.0.

2.6 Heat treatment of milk

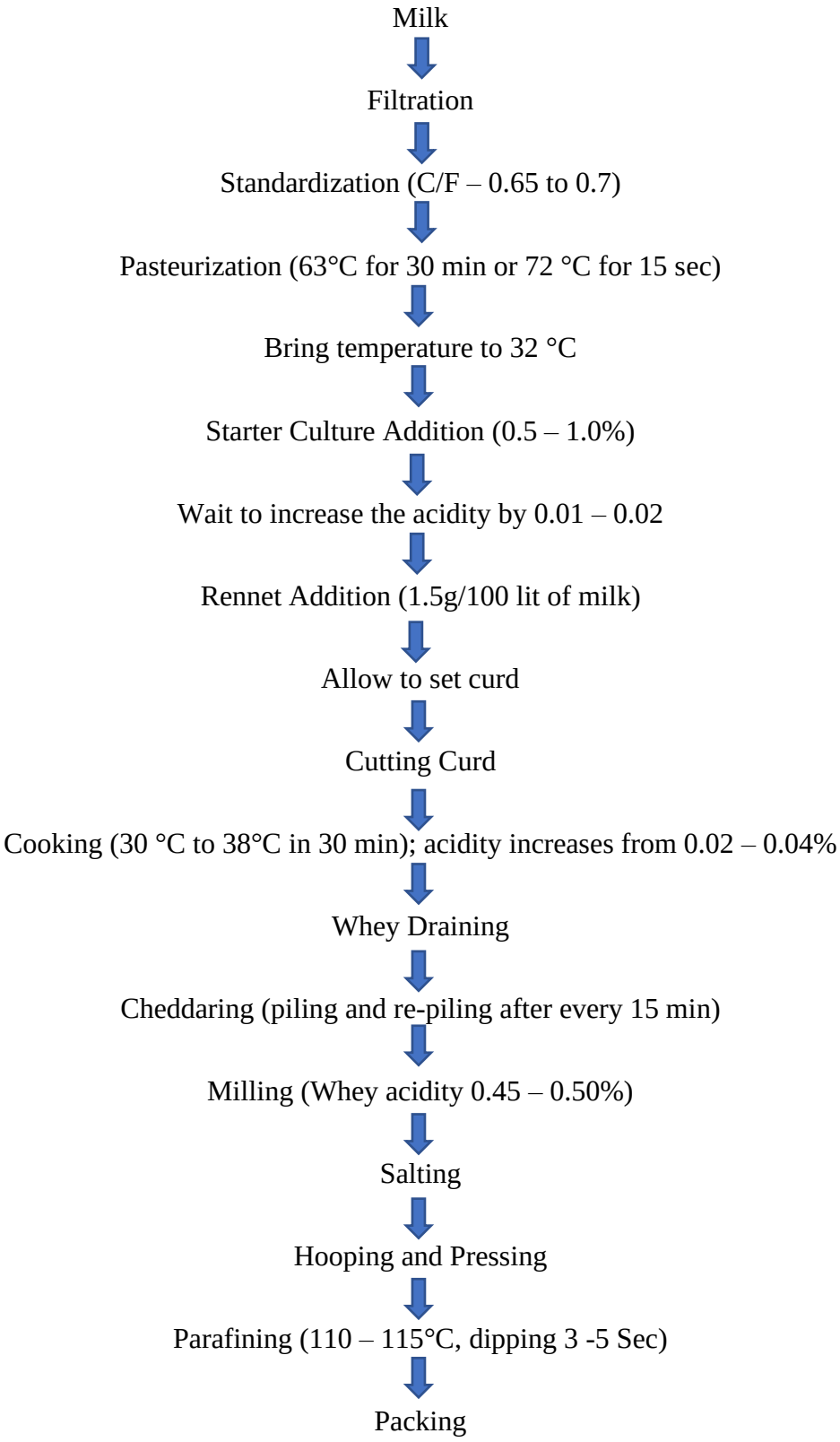
Milk used for cheese making is given heat treatments like thermization, pasteurization, etc. Heat treatment denatures whey proteins and results in their inclusion in the gel and thereby increase yield of cheese. The degree of whey protein denaturation determines the extent of their recovery in cheese. Thermization is done when milk is to be stored for long before making cheese. As discussed in the previous section, cold storage of milk leads to production of enzymes like proteases and lipases. Thermization prevents growth of psychrotrophs in milk, prevents casein solubilization and thus increases cheese yield. Pasteurization of milk (72 Deg. C, 15 s) denatures whey proteins to a lower level and thus the cheese yield is only slightly increased. The severe the heat treatment, more is the resultant increase in cheese yield.

Heat treatment eliminate pathogenic bacteria, to minimise damage to caseins by proteolytic bacteria on storage or to incorporate heat-denatured whey proteins in curd, thereby improving cheese yield.

2.7 Addition of CaCl2

Addition of CaCl2 at the rate of 0.02% in cheese milk is a common practice. This results in strengthening the curd, making it less susceptible to shattering at the time of cutting and stirring. This reduces the chances of fat and protein loss in whey and thus increases cheese yield.

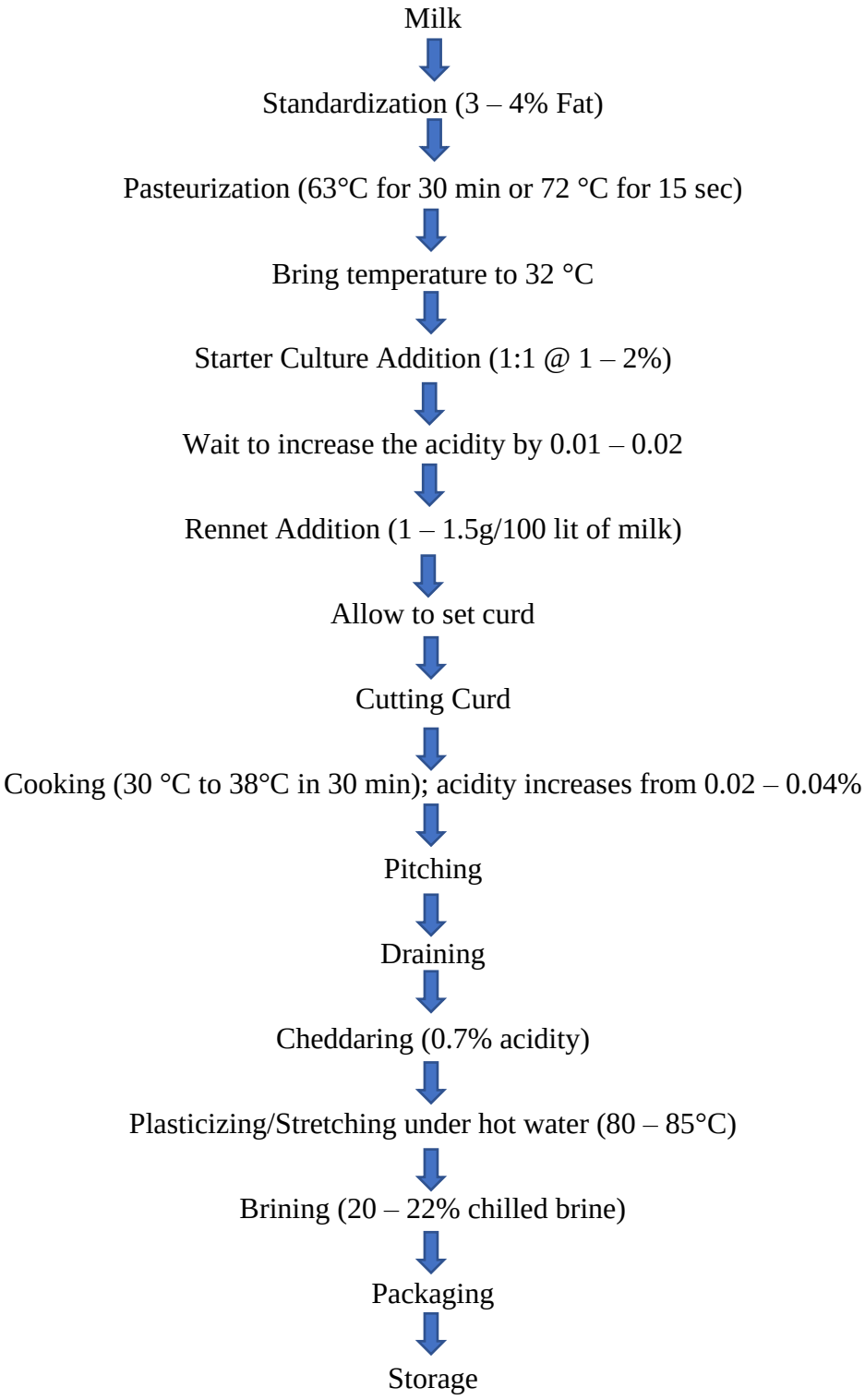
2.8 Flow chart for Cheddar Cheese



2.9 Composition of Cheddar cheese made from cow and buffalo milk

Constituent %	Cheddar Cheese from Cow Milk	Cheddar Cheese from Buffalo Milk
Moisture	37	34.75
Fat	32	33.33
Protein	25	25.32
Lactose	2.1	1.94
Salt	1.5	1.37
Salt in moisture	4.0	3.93
Ash	3.7	4.66
Calcium	0.725	0.84
Phosphorous	0.495	0.48
pH	5.2 – 5.4	5.2

2.10 Flow chart for Mozzarella Cheese



2.10 Composition of Cheddar cheese

Constituent %	Mozzarella Cheese
Fat	18
Moisture	54
Total Solid	46
Protein	22
Salt	O.7
Ash	2.3
pH	5.2

2.11Cheese Processing Machinery

a) Complete line: Milk reception and pasteurization

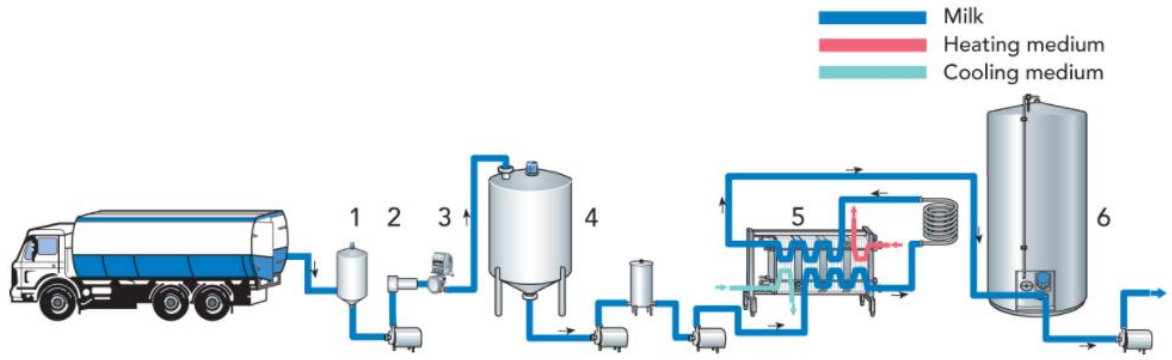


Fig. Milk reception and pasteurization unit – Tetrapak Handbook: a) Air eliminator, b) Filter, c) Milk meter, d) Intermediate storage tank, e) Thermization/pasteurization and cooling, f) Silo tank

b) OO Vat or double O Vat: It is also called multipurpose Vat, and is mounted with agitator with drive to control the agitator speed. Here heated milk at required temperature is received and addition of starter culture is done.

c) Horizontal enclosed cheese making machine with combined stirring and cutting tools and hoisted drain system:

1. Combined cutting and stirring tool
2. Strainer for whey drain
3. Frequency controlled motor
4. Jacket for heating
5. Manhole cover
6. CIP Nozzle

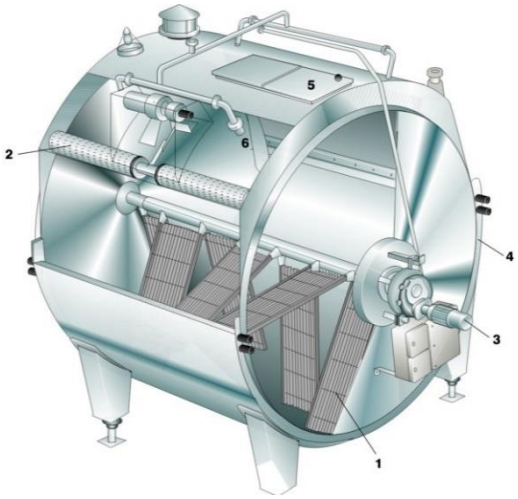


Fig. Tetrapak Automatic Cheese making machine

Chapter – 3

Packaging

3.1 Introduction

Packaging refers to a protective wrapper or container to protect from contamination, improving shelf-life, communicating through consumer, storage and shipment. Any material to be used for packaging natural cheeses must:

a) afford general protection such as physical damages
b) maintain the moisture contained
c) give an appealing appearance to consumer
d) protect from micro-organisms and
e) provide oxygen transmission barrier

Packaging of cheese is mainly done to protect the cheese at the time of storage and transportation. Traditionally, cloth was used with wood to give support and protection, but the invention of polymers or plastics has revolutionized cheese packaging. Cheese manufacturing is now-a-days highly mechanized and at the same time, many developments are taking place in the area of cheese packaging also. Cheese is packaged mainly in two forms:

a) Packaging cheese for storage and ripening (bulk packaging)
b) Packaging for consumers (retail packaging).

3.2 Bulk Packaging of Cheese

For bulk packaging of cheese, it is either paraffined or vacuum packed in flexible film. For waxing, the cheese can be lifted by means of suction and half immersed in wax and then other half can be immersed. For vacuum packaging, there are now available vacuum packaging machines, gas flushing machines, over wrapping machines and vacuum skin packaging machines. Paraffining is now completely replaced by film packaging as it causes considerable loss of cheese while removing paraffin. Many cheap and easy-to-apply films are now available.

3.3 Film packaging

This has become synonymous with rindless cheese. In the latter, green cheeses of uniform size and shape are ripened in bags made of plastic films. The wrapped cheese may be placed in a

wooden box or jig to preserve its shape. If the cheese is made and ripened in the conventional way, it may be cut into retail portions and wrapped by such method as the cryovac.

3.4 Desirable properties of films for packaging

a) The film must be strong so that it does not tear or change its property when rubbed against a sharp point.

b) It should be easily applied and sealed.

c) It must be impervious to water vapor and oxygen.

d) When the film is in contact with cheese, it should not change its inherent properties.

e) The material must be chemically inert and non-toxic for humans. Plastic film packaging of cheese is applicable to varieties except such extreme types as cottage (which has very high moisture content) and as Parmesan (which is very low in moisture). There are many advantages and few disadvantages of film packaging which are summarized as follows:

Merits

i) It affords a considerable saving in labour.

ii) It protects the cheese from attacks by molds, insects, rodents and fault-inducing microorganisms.

iii) It is easily applied and the method can be readily mechanized.

iv) There is practically no loss of moisture and of weight in the cured cheese (In traditional ripening the loss may be 3 to 7%, even up to 12 %).

v) The method permits and is suitable for packaging small quantities, which make handling and retail trade easier.

vi) The method is most easily used for rectangular blocks.

vii) It is cheap and convenient.

viii) Humidity control is unnecessary during ripening and storage.

ix) More cheese can be stored in a given volume.

x) Turning is unnecessary during ripening.

xi) It permits rindless curing, so that whole of the cheese can be eaten. (When rind is formed as in traditional method, the loss can be as high as 10%).

Demerits

i) Not all technical problems in film packaging have been solved. (For example, failure to obtain a perfect seal and to remove all air may result in mould growth).

ii) The moisture content of the cheese at packaging must be less than for traditional packaging and must be carefully standardized. Failure to do so may lead to the growth of taint-producing organisms.

iii) The ripening process in some cheeses (such as Camembert) may be affected.

iv) The film does not always give the same mechanical protection to cheese as traditional methods.

v) The most careful attention to detail is necessary in film packaging.

3.5 Retail Packaging of Cheese

Retail packaging is an important aspect which affects not only the shelf life of cheese but also its marketability. Cheese is available in the form of slices, cubes, tubs, paper board cartons with foil overwraps, etc. These are available in different retail sizes like 100 g, 200 g etc. With the developments taking place in packaging technology, cheese packaging is also revolutionized. Active packaging and modified atmosphere packaging are being used for retail cheese packaging.

3.6 Storage of Cheese

After completion of the post-processing treatments like bandaging and dressing, the cheeses are kept in the ripening room. This starts the process of ripening. For some varieties of cheese like Cheddar and Parmesan, ripening and storage are the same while for others like Camembert and Roquefort, ripening and storage are two different processes as they need altered temperature and humidity in both the processes. Storage is inevitably, a continuation of the ripening process (except changing temperature and humidity for some varieties) so that all the considerations which apply to the ripening period apply equally to the storage period.

30.2 Shelves for Ripening/Storage of Cheese In traditional practice, wood was used as the material for construction of shelves. But it has many disadvantages like it gives shelter to pests and is an excellent medium for the growth of molds and other microorganisms, once it is wet. So, wooden shelves need lot of care and maintenance. The easiest materials to clean are glass and stainless steel. 30.3 Factors Affecting Ripening and Storage The two most important

factors controlling ripening and storage are temperature and humidity. Thus, the ripening or storage rooms should have means for controlling these two factors.

a) Temperature: It is necessary to control the temperature during storage and maintain uniform temperature as almost all biochemical reactions are temperature-dependent. Higher temperature accelerates ripening but jeopardizes the quality of cheese as it results in the growth of undesirable microorganisms. For cheeses of Cheddar and related varieties, temperature of 5-7°C is ideal but 8-12°C is considered economically best. Temperature higher than 18°C should be strictly avoided.

b) Relative Humidity: The relative humidity is the amount of water vapour present, and expressed as percentage of that required to saturate the gas. Higher humidity leads to mold growth, accelerated ripening and surface bacterial taints. Lower humidity results in cracking, shrinking, distortion and retardation of ripening in addition to excessive loss of weight. The correct humidity for ripening depends on the type of cheese. Soft cheese requires a higher humidity (95%) than open-textured hard cheese (85%) and these again require greater humidity than close-textured hard cheese (80%). Further, mold ripened cheese require higher humidity than other varieties of cheese

c) Storage Conditions for some of the Cheese Varieties Cheeses of the Cheddar family (Cheddar, Cheshire, etc.) are ripened at lower temperatures of about 4-8°C, and a relative humidity (RH) lower than 80%. The ripening time may vary from a few months up to 8–10 months or even 12 months. Other types of cheese like Emmental are first stored in a green cheese room at 8–12°C for some 3–4 weeks followed by storage in a fermenting room at 22–25°C for some 6–7 weeks. After that the cheese is stored for several months in a ripening store at 8–12°C. The relative humidity in all rooms is normally 85–90%. Smear-treated types of cheese – Tilsiter, Havarti and others – are typically stored in a fermenting room for some 2 weeks at 14–16°C and a RH of about 90%, during which time the surface is smeared with a special cultured smear mixed with a salt solution. Once the desired layer of smear has developed, the cheese is normally transferred to the ripening room at a temperature of 10–12°C and a RH of 90% for a further 2–3 weeks. Eventually, after the smear is washed off and cheese is wrapped in aluminium foil, it is transferred to a cold store, 6–10°C and about 70–75% RH, where it remains until distributed. Other hard and semi-hard types of cheese, Gouda, Edam, may first be stored for a couple of weeks in a green cheese room at 10–12°C and a RH of some 75%. After that a ripening period of about 3–4 weeks may follow at 12–18°C and 75–80% RH.

Finally, the cheese is transferred to a storage room at about 10–12°C and a relative humidity of about 75%, where the final characteristics are developed.

3.7 Factors Controlling the Loss of Moisture in Cheese

The primary factors which control the loss of moisture in cheese are temperature, moisture content, size and shape of the cheese and RH of air. The rate of loss of moisture rises sharply with temperature. With storage at 5, 10 and 15°C, the losses in 6 months were found to be 4.4, 6.4 and 8.7%, respectively. Higher the moisture content, higher will be the rate of loss and more is the free moisture. The smaller the cheese, the more rapid the losses of moisture as a proportion of that initially present. The higher the RH of the air in the cheese storage room, slower will be the rate of moisture loss. Other factors that influence the loss of moisture during storage are type and quality of the wax or film applied to the outside of the cheese and type of cheese.

3.8 Distribution of Cheese

Distribution of cheese from manufacturer to distributor/retailer should be done under strict conditions of appropriate temperature. For cheese varieties, which continue to ripen in the storage period, it is important to maintain the temperature for ripening during distribution also. For example, Cheddar cheese should be distributed at the temperature of 5-8°C. Refrigerated and insulated vehicles are used for this purpose.

Chapter – 4

Food Safety Regulations and Standards

4.1 Registration and Licensing of Food Business

All Food Business Operators in the country will be registered or licensed in accordance with the procedures laid down

Registration of Petty Food Business

a. Every petty Food Business Operator shall register themselves with the Registering Authority by submitting
b. An application for registration in Form A under Schedule 2 of these Regulations along with a fee as provided in Schedule 3.
c. The petty food manufacturer shall follow the basic hygiene and safety requirements provided in Part I of Schedule 4 of these Regulations and provide a self-attested declaration of adherence to these requirements with the application in the format provided in Annexure-1 under Schedule 2.
d. The Registering Authority shall consider the application and may either grant registration or reject it with reasons to be recorded in writing or issue notice for inspection, within 7 days of receipt of an application for registration.
e. In the event of an inspection being ordered, the registration shall be granted by the Registering Authority after being satisfied with the safety, hygiene and sanitary conditions of the premises as contained in Part II of Schedule 4 within a period of 30 days.
f. If registration is not granted, or denied, or inspection not ordered within 7 days as provided in above sub regulation (3) or no decision is communicated within 30 days as provided in above sub regulation (4), the petty food manufacturer may start its business, provided that it will be incumbent on the Food Business Operator to comply with any improvement suggested by the Registering Authority even later.
g. Provided that registration shall not be refused without giving the applicant an opportunity of being heard and for reasons to be recorded in writing.
h. The Registering Authority shall issue a registration certificate and a photo identity card, which shall be displayed at a prominent place at all times within the premises or vehicle or cart or any other place where the person carries on sale/manufacture of food in case of Petty Food Business.

i. The Registering Authority or any officer or agency specifically authorized for this purpose shall carry out food safety inspection of the registered establishments at least once in a year. Provided that a producer of milk who is a registered member of a dairy Cooperative Society registered under Cooperative Societies Act and supplies or sells the entire milk to the Society shall be exempted from this provision for registration.

4.2 Hygienic, Sanitary and Good Manufacturing Practices (GMP/GHP)

In addition to Part-II, the dairy establishment in which dairy-based food is being handled, processed, manufactured, stored, distributed and ultimately sold by the food business operator, and the persons handling them should conform to the sanitary and hygienic requirement, food safety measures and other standard as specified below.

1. Sanitary requirements

a. Facilities for the hygienic handling and protection of raw materials and of non-packed or non-wrapped dairy products during loading and unloading, transport & storing including Bulk Milk cooling facilities.
b. Special watertight, non-corrodible containers to put raw materials or dairy products intended for human consumption. Where such raw materials or dairy products are removed through conduits, these shall be constructed and installed in such a way so as to avoid any risk of contamination of other raw materials or dairy products;
c. A waste water disposal system which is hygienic and approved;
d. Facilities for cleaning & disinfecting of tanks used for transporting dairy products and raw milk. These containers have to be cleaned after every use.
e. The occupier of a dairy establishment shall take appropriate measures to avoid cross-contamination of dairy products in accordance with the cleaning program as specified in point 9.1 of Part II.
f. Where a dairy establishment produces food stuffs containing dairy products together with other ingredients, which have not undergone heat treatment or any other treatment having equivalent effect, such dairy products and ingredients shall be stored separately to prevent cross-contamination.
g. The production of heat-treated milk or the manufacture of milk-based products, which might pose a risk of contamination to other dairy products, shall be carried out in a clearly separated working area.

h. Equipment, containers and installations which come into contact with dairy products or perishable raw materials used during production shall be cleaned and if necessary disinfected according to a verified and documented cleaning programme.

i. Equipment, containers, instruments and installations which come in contact with microbiologically stable dairy products and the rooms in which they are stored shall be cleaned and disinfected according to a verified and documented. Food Safety management programme drawn up by the owner/occupier of the dairy establishment.

j. Disinfectants and similar substances used shall be used in such a way that they do not have any adverse effects on the machinery, equipment, raw materials and dairy products kept at the dairy establishment. They shall be in clearly identifiable containers bearing labels with instructions for their use and their use shall be followed by thorough rinsing of such instruments and working equipment with potable water, unless supplier's instructions indicate otherwise.

2. Personal hygiene requirements

a. The Food Business Operator shall employ those persons only in such an establishment to work directly with and handle raw materials or dairy products if those persons have proved to the occupier's satisfaction by means of a medical certificate, on recruitment, that there is no medical impediment to their employment in that capacity.

b. Persons working directly with and handling raw materials or dairy products shall maintain the highest standards of personal cleanliness at all times. In particular they shall

- wear suitable, clean working clothes and headgear which completely encloses their hair;
- wash their hands at least each time work is resumed and whenever contamination of their hands has occurred; e.g., after coughing / sneezing, visiting toilet, using telephone, smoking etc.
- Cover wounds to the skin with a suitable waterproof dressing. No person with injury on hand, even with dressing, shall be placed in any product making/handling section.
- avoid certain hand habits - e.g., scratching nose, running finger through hair, rubbing eyes, ears and mouth, scratching beard, scratching parts of bodies etc. that are potentially hazardous when associated with handling dairy products, and might lead to food contamination through the transfer of bacteria from the employee to

product during its preparation. When unavoidable, hands should be effectively washed before resuming work after such actions

3. Sanitary requirements for storage

a. Immediately after procuring, raw milk shall be placed in a clean place, which is suitably equipped so as to prevent any kind of contamination.

b. The cans/ containers made up of mild steel metal and plastic material used for storage and transportation of milk and milk products shall not be allowed.

c. If raw milk is brought to the dairy plant by a producer or farmer then it shall be ensured that he brings it within four hours of milking and it shall be cooled as soon as practicable to a temperature of 4ºC or lower and maintained at that temperature until processed.

d. Where raw milk is collected daily from a producer, it shall be cooled immediately to a temperature of 4ºC to 6ºC or lower and maintained at that temperature until processed;

e. When the pasteurization process is completed, pasteurized milk shall be cooled immediately to a temperature of 4ºC or lower. Subject to Paragraph 7 below, any dairy product not intended to be stored at ambient temperature shall be cooled as quickly as possible to the temperature established by the manufacturer of that product as suitable to ensure its durability and thereafter stored at that temperature.

f. Where dairy products other than raw milk are stored under cooled conditions, their storage temperatures shall be registered and the cooling rate shall be such that the products reach the required temperature as quickly as possible.

g. The maximum temperature at which pasteurized milk may be stored until it leaves the treatment establishment shall not exceed 5ºC.

4. Wrapping and packaging

a. The wrapping and packaging of dairy products shall take place under satisfactory hygienic conditions and in rooms provided for that purpose.

b. The manufacture of dairy products and packaging operations may take place in the same room if the following conditions are satisfied:

- The room shall be sufficiently large and equipped to ensure the hygiene of the operations;
- the wrapping and packaging shall have been brought to the treatment or processing establishment in protective cover in which they were placed immediately after manufacture and which protects the wrapping or packaging from any damage

during transport to the dairy establishment, and they shall have been stored there under hygienic conditions in a room intended for that purpose;

- the rooms for storing the packaging material shall be free from vermin and from dust which could constitute an unacceptable risk of contamination of the product and shall be separated from rooms containing substances which might contaminate the products. Packaging shall not be placed directly on the floor;
- packaging shall be assembled under hygienic conditions before being brought into the room, except in the case of automatic assembly or packaging, provided that there is no risk of contamination of the products;
- packaging shall be done without delay. It shall be handled by separate group of staff having experience in handling and product wrapping and
- immediately after packaging, the dairy products shall be placed in the designated rooms provided for storage under required temperature.

c. Bottling or filling of containers with heat-treated milk and milk product shall be carried out hygienically.

d. Wrapping or packaging may not be re-used for dairy products, except where the containers are of a type which may be re-used after thorough cleaning and disinfecting.

e. Sealing shall be carried out in the establishment in which the last heat-treatment of milk or liquid milk-based products have been carried out, immediately after filling, by means of a sealing device which ensures that the milk is protected from any adverse effects of external origin on its characteristic. The sealing device shall be so designed that once the container has been opened, the evidence of opening remains clear and easy to check.

4.3 Packaging and Labelling

The packaging design and materials shall provide protection for products in order to prevent contamination, damage and accommodate required labelling as laid down under the FSS Act and the Regulations there under. Only food grade packaging materials shall be used as primary packaging material. Packaging materials like aluminium, tin and plastic shall conform to the Indian standards as mentioned under the FSS Regulations from time to time. The food packaging materials shall be inspected before use to avoid using damaged, defective or contaminated packaging, which may lead to contamination of the product.

- The wrapping and packaging of dairy products shall take place under satisfactory hygienic conditions and in rooms provided for that purpose.

- The rooms for storing the packaging material shall be free from vermin and from dust which could constitute an unacceptable risk of contamination of the product and shall be separated from rooms containing substances which might contaminate the products. Packaging shall not be placed directly on the floor.
- Packaging shall be done without delay followed by labelling. If it is not the case, appropriate procedure shall be applied to ensure that no mix-ups or mislabelling could occur. It shall be handled by separate group of staff having experience in handling and product wrapping and immediately after packaging; the dairy products shall be placed in the designated rooms provided for storage under required temperature.
- Packaging material/wrapping materials shall be protected from external environment/contamination during transport and storage. Facilities shall be established for safe and hygienic storage of packing materials at the dairy plant."
- Wrapping or packaging may not be re-used for dairy products, except where the containers are of a type which may be re-used after thorough cleaning and disinfecting.
- "Packaging of milk and milk products shall be carried after processing. The packages should be designed so as to ensure they are tamper proof and are not easily damaged during general handling /operation. Once the packages are opened it should be easily identifiable and cannot be duplicated against a fresh/unopened package".
- The ink used for printing of primary food packaging should be of food grade quality. This should comply with **IS 15495** standards or other international standards for use in food packaging and printing.

4.4 Coding and Labelling of Packaging Material

Fluid milk: The caps of the milk bottles /pouch/tetrapack shall clearly indicate the nature of the milk contained in them. The indication may be either in full or by abbreviation shown below:

i) Buffalo milk may be denoted by the letter 'B'.
ii) Cow milk may be denoted by the letter 'C'
iii) Goat milk may be denoted by the letter 'G'
iv) Standardized milk may be denoted by the letter 'S'
v) Toned milk may be denoted by the letter 'T'
vi) Double toned milk may be denoted by the letter 'DT'
vii) Skimmed milk may be denoted by the letter 'K'
viii) Pasteurised milk may be denoted by the letter 'P; followed by the class of milk. For example, Pasteurised Buffalo milk shall bear the letters 'PB '.

ix) Alternatively, suitable indicative colours of the packs/caps/bags shall be indicative of the nature of milk contained in them, the classification of colours being displayed at places where milk is sold\stored or exhibited for sale, provided that the same had been simultaneously intimated to the concerned Designated Officer, and information disseminated through the local media

4.5 Exemptions from labelling requirements

Where the surface area of the package is not more than 100 square centimetres, the label of such package shall be exempted from the requirements of list of ingredients, Lot Number or Batch Number or Code Number, nutritional information and instructions for use, but this information shall be given on the wholesale packages or multi piece packages, as the case may be.

1. The date of manufacture' or 'best before date' or 'expiry date' may not be required to be mentioned on the package having surface area of less than 30 square centimetres but this information shall be given on the wholesale packages or multipiece packages, as the case may be;
2. In case of liquid products marketed in bottles, if such bottle is intended to be reused for refilling, the requirement of list of ingredients shall be exempted, but the nutritional information specified in regulation.
3. “To make a fluid not below the composition of toned milk or skimmed milk (as the case may be) with the contents of this package, add (here insert the number of parts) of water by volume to one part by volume of this condensed milk or desiccated (dried) milk”.
4. In case of food with shelf-life of not more than seven days, the 'date of manufacture may not be required to be mentioned on the label of packaged food articles, but the 'use by date' shall be mentioned on the label by the manufacturer or packer.
5. In case of multi piece packages the particulars regarding list of ingredients, nutritional information, Date of manufacture/ packing, best before, expiry date labelling of irradiated food and, vegetarian logo/non vegetarian logo, may not be specified.

4.6 Date of manufacture or packing

The date, month and year in which the commodity is manufactured, packed or pre-packed, shall be given on the label:

Provided that the month and the year of manufacture, packing or pre-packing shall be given if the “Best Before Date” of the products is more than three months:

Provided further that in case any package contains commodity which has a short shelf life of less than three months, the date, month and year in which the commodity is manufactured or prepared or pre-packed shall be mentioned on the label.

Best Before and Use By Date

i) the month and year in capital letters up to which the product is best for consumption, in the following manner, namely:

"BEST BEFORE ..... MONTHS AND YEAR

OR

"BEST BEFORE ..... MONTHS FROM PACKAGING

OR

"BEST BEFORE .....MONTHS FROM MANUFACTURE

(Note: — blank be filled up)

ii) In case of package or bottle containing sterilised or Ultra High Temperature treated milk, soya milk, flavoured milk, any package containing bread, dhokla, bhelpuri, pizza, doughnuts, khoa, paneer, or any un-canned package of fruits, vegetable, meat, fish or any other like commodity, the declaration be made as follows

"BEST BEFORE ……DATE/MONTH/YEAR"

OR

"BEST BEFORE.....DAYS FROM PACKAGING"

OR

"BEST BEFORE ……..DAYS FROM MANUFACTURE"

Note:

(a) blanks be filled up

(b) Month and year may be used in numerals (c) Year may be given in two digits

(iii) On packages of Aspartame, instead of Best Before date, Use by date/recommended last consumption date/expiry date shall be given, which shall not be more than three years from the date of packing;

(iv) In case of infant milk substitute and infant foods instead of Best Before date, Use by date/ recommended last consumption date/expiry date shall be given, Provided further that the declaration of best before date for consumption shall not be applicable

4.7 Documentation and Record Keeping

Every organization has to maintain records of raw material procurement, production processes, and sales. This is to ensure that the business runs effectively and is profitable. Listed below are some reasons why there is a need for documentation:

1. It gives detailed knowledge about running the business.
2. It helps to control product quality.
3. It helps to keep track of the money invested in the business.
4. It helps to identify the separate costs of raw material or product ingredients.
5. It helps to identify the production cost of a particular process.
6. It helps to make sure that all the quality assurance practices were followed during the production.
7. It helps to make sure that the production equipment is running smoothly/effectively.
8. It works as an evidence for legal procedures.
9. It helps to set an appropriate product price.
10. It helps to take corrective measures at the right time.

4.8 How to Keep Records?

Every food processing organization follows a more or less similar way of keeping records. Production records keep a log of the following:

- The quantity and type of raw materials received
- The quantity and type of ingredients used during processing
- The processing conditions in which production took place (e.g., the temperature set or the air pressure applied)
- The product quality produced

Product quality can be maintained only when:

- The same quantity and quality of ingredients and raw materials are mixed in every batch
- A standard formulation is used for every batch
- Standard process parameters are applied for every batch

Every batch of food is given a batch number. This number is recorded in:

- Stock control books (where raw material procurement is noted)
- Processing logbooks (where production process is noted)
- Product sales records (where sales and distribution are noted)

The batch number must correlate with the product code number, which is printed on labels. This helps the processor to trace any fault found in a batch back to the raw material used or the production process.

Sample Paneer Processing Record:

Paneer Processing Record		
Date:		Batch No:
Processing	**Parameters**	**Value**
Milk	Fat %	
	SNF %	
	Ratio of SNF to Fat	
	TS%	
	Acidity % LA (= ºN x 0.9/100)	
	Coliform count per gram	
Processing	Qty of Milk (kg)	
	Heat Treatment ºC (90 ºC)	
	Time taken for heating in minutes	
	Coagulation Temp. ºC (70 ºC)	
	Time taken for cooling in minutes	
	Temp of Citric solution ºC (70 ºC)	
	Concentration of Coagulants (2%)	
	Qty of citric acid used per litre of milk (1.65 gr/L)	
	Quantity Coagulants (82.5 ml/L milk)	
	Dipping time	
	Hooping Temp ºC	
	Load in kg of Pressing	

	Time of Pressing in min.	
	Temp of Chilled Water ºC	
	Soaking Time in min.	
	Temp of Paneer after Soaking ºC (40 ºC)	
	Drying Temp. ºC	
	Drying Time	
	Temp. After Drying in ºC	
	pH of Whey	
Paneer	Moisture %	
	Acidity % LA	
	Fat %	
	Fat on Dry matter %	
	Qty in kg	
	Yield %	
	SPC per gram	
	Coilform per gram	
	Colour	
	Texture	
	Flavour & Taste	
	Friability	
	No of 200g pack made	
	Actual yield in kg	
	Handling losses in %	

Production Supervisor Production Manager

Chapter – 5

Cleaning and CIP

5.1 Tanker Washing

The main objective of this unit is to clean the tankers properly after unloading or before uploading milk or any other dairy ingredients to avoid microbial and bacterial growth.

Stepwise washing operation:

- Circulate Caustic solution for 15min. (1 – 1.5%) at 70 – 75^{0}C.
- Flush out Caustic with water.
- Circulate with hot water for 15min. (80 – 85^{0}C)
- Allow temperature to cool down
- Get QA clearance

5.2 Crate Washing:

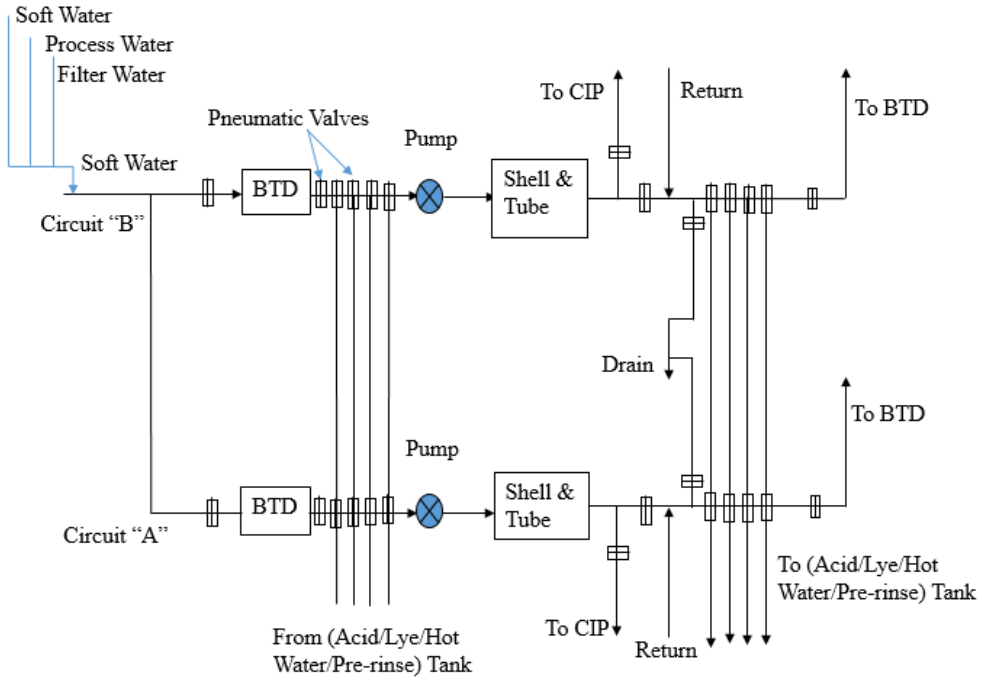
Normally a semi-automatic crate washer is used for cleaning the crates. The washer cleans the crates in stages

Solid waste removal – Manually

1. Pre-rinse
2. Hot water and caustic solution
3. Final rinsing

5.3 CIP of raw milk tank, multipurpose tank etc.

- Flush Silo with necessary water
- Clean (by brushing) the door of the manhole and sampling point with soap oil and water.
- Circulate Caustic solution for 20min. (1 – 1.5%) at 70 – 75^{0}C.
- Flush out Caustic with water.
- Circulate with acid for 20min. (0.6 – 1.0%) at 60 – 65^0
- Circulate with hot water for 20min. (80 – 85^{0}C)
- Allow temperature to cool down



A two station CIP Circuit (model)

5.4 Effluent Treatment Plant (ETP)

ETP is a 24 hrs. continuous process. It takes hazardous outlet from all the process as inlet, treat it in three stages (Primary, Secondary and Tertiary stage) to reach the environmental standard. The outlets of the plant namely solid waste and treated water are respectively disposed in field and used for irrigation purpose in plant to develop green belt.

Effluent Sources:

1. CIP: Caustic and Nitric Acid
2. Backwash: Water
3. Tanker wash: Caustic and Nitric Acid
4. Boiler: Water
5. Caret wash: Caustic

Stepwise description of ETP functioning:

1) Screen chamber: Raw effluent from the plant is received by screen chamber and suspended particles are removed here.

2) Collection and equalization tank: After the screening the effluent enters the collection and equalization tank, where it is neutralized with hydrochloric acid and the effluent is made homogeneous.
3) Holding tank: It only meant for storage when excess amount of effluent is discharged from plant during CIP
4) Dissolved Air Floatation (DAF): The neutralized effluent from collection and equalization tank is received here and aluminum sulphate (a non-ferric alum) is added. The suspended and emulsified solids are separated here.
5) Buffer tank: It is an over flaw storage tank
6) Up blow Anaerobic Suspended Sludge Blanket (UASSB) Reactor (I&II): 12% to15% of the total volume of this tank is filled with biomass. It receives the effluent from DAF from the bottom of the tank. There are two types of bacteria present here.
    a. Acetogenesis: - It converts the large chain molecule to small chain molecule and produces amino acid.
    b. Methenogenesis: - It converts to methane gas, and hence organic load decreases
7) Hopper bottom tank: It is just a tank to control the escaped microbes from UASSBR and again recirculate it.
8) Aeration tank: In this tank aerobic microbes are developed
9) Lamella clarifier: It is used for solid settling purpose i.e., the solid liquid separation takes place here
10) Secondary clarifier: Here the aerobic culture is settled and again circulated to aeration tank to maintain the amount.
11) Treated water tank: Here the treated water from secondary clarifier or lamella clarifier is collected.

5.5 Plant Performance and Monitoring:

- Carryout regular monitoring program involving maintenance of record and analysis of effluent sample.
- ETP assistants have to collect samples at different stages of treatment system in presence of ETP in-charge for analysis.
- ETP in-charge has to do the analysis and record the result also report the result to EHS-engineer and EHS-officer. EHS-engineer and EHS-officer both will assess the performance of the plant based on laboratory analysis report and instruct the ETP in-charge and assistants about the action to be taken in case of any deviation from normal.

- The treated effluent has to be analyzed on daily basis and the results are recorded

5.6 Environmental Management System (EMS): Implementation and operation

2. **Level-1:** EMS manual; describes the core elements of the EMS and their interactions. It outlines the structure of the document used in the EMS in line with-ISO 14001-2004 manual also describe the procedures elaborately how various requirements of ISO 14001-2004 are implemented.
3. **Level-2:** Documents; the filled formats which conveys the data that affects the environment. Ex – Operational control process, environmental management programs, emergency procedures, monitoring and management plans, training plan etc.
4. **Lavel-3:** Formats; used for recording and conveying data effecting the environment