Dairy Product Processor
(Job Role)
Textbook for Class XII
Qualification Pack: FIC/Q2001, V1.0
Sector: Dairy Processing

विद्यया ऽ मृतमश्नुते

एन सी ई आर टी
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FOREWORD

The National Education Policy (NEP) 2020 envisions a future-ready education system that nurtures the potential of every learner by integrating vocational education into mainstream schooling from the foundational years. It emphasizes the importance of providing skill-oriented learning opportunities to help students make informed choices aligned with their aptitudes, interests, and aspirations. In this context, equipping learners with job-specific knowledge, competencies, and practical training becomes critical for enabling them to contribute effectively to the evolving world of work.

The National Curriculum Framework for School Education (NCFSE) 2023 further strengthens this vision by highlighting the role of vocational education in fostering self-reliance, employability, and lifelong learning skills among students. It underscores the need for structured, age-appropriate, and inclusive vocational training within schools, ensuring that every learner, irrespective of background, has access to credible and relevant sector-specific knowledge and entrepreneurial exposure.

The Ministry of Education, through the National Council of Educational Research and Training (NCERT), has taken significant steps to operationalize this vision, such as developing sector-specific textbooks and introducing qualification pack–aligned job roles in school curricula. These initiatives aim to provide comprehensive, up-to-date, and easily accessible skill training to students, parents, and educators alike, thereby bridging the gap between education and employability.

The Textbook on Dairy Product Processor (Job Role) for Class XII aligns with these national priorities, serving as a practical and insightful resource for students to acquire knowledge and skills related to dairy processing. This book will assist in translating the policy vision into effective vocational practices that empower learners to explore opportunities in both employment and entrepreneurship within the dairy sector.

I express my sincere appreciation to all contributors who have worked diligently towards developing this valuable resource. It is my hope that this publication will inspire learners to become skilled professionals and catalysts of change in shaping the future of India's dairy industry.

National Council of Educational Research and Training

ABOUT THE TEXTBOOK

This textbook, developed by PSSCIVE, NCERT, Bhopal, is designed to promote skill development and vocational education in dairy processing for Class XII under the Dairy Processing Sector. Aligned with NEP 2020, NCF-SE 2023, and National Occupational Standards, it covers fundamental concepts, operational processes, safety practices, and entrepreneurial opportunities for the Dairy Product Processor job role. Through a student-centered approach, it emphasizes experiential learning, combining practical job activities with classroom teaching. Developed by subject experts, industry professionals, and academicians, the content ensures learners acquire relevant competencies, industry-aligned skills, and knowledge, preparing them to become skilled, competent, and self-reliant professionals in the dairy processing sector, while maintaining quality, relevance, and adherence to industry standards.

The first unit introduces the production and technology of cultured and frozen dairy products, focusing on organized process planning, preparation of work areas, and systematic control of fermentation and freezing operations. It emphasizes the manufacture of curd, lassi, yoghurt, shrikhand, and similar products through proper culture selection, incubation management, and consistency control. Principles of production and ripening are explained along with monitoring temperature, acidity, and time to achieve uniform quality. Ice cream and frozen dessert manufacturing are covered, including formulation, processing steps, freezing, hardening, and storage. The unit also highlights sanitation, equipment inspection, preventive maintenance, and safety practices to ensure uninterrupted operations, while optional sessions introduce innovative dairy desserts, stressing hygienic production, quality assurance, and efficient coordination of manpower and materials.

The second unit focuses on the principles and practices of producing concentrated and dried dairy products, covering moisture removal, evaporation techniques, and control of heat-related quality changes. It explains the production of concentrated milks and discusses operating conditions required to maintain nutritional value and sensory properties. Milk powder manufacture by spray drying and roller drying is described with respect to feed preparation, atomization, drying processes, and powder collection systems. Product standards, regulatory requirements, and quality evaluation procedures receive special emphasis. The unit stresses appropriate storage conditions, packaging materials, and their applications to prevent deterioration, thereby ensuring shelf life, product safety, and efficient handling during transport and distribution.

The third unit deals with dairy industry by-products, outlining their global status, availability, and scope for effective utilization and value addition. It explains the processing and applications of skim milk and its derivatives, highlighting compositional requirements and quality standards. Whey and whey-based products are described in terms of recovery, concentration, drying, and use in food formulations. The unit further covers buttermilk and ghee residue, discussing characteristics, processing methods, packaging, and storage needs. Emphasis is placed on hygienic handling, waste reduction, sustainability, regulatory compliance, and economic utilization for strengthening overall efficiency.

The fourth unit explains food safety management systems in dairy plants, focusing on HACCP, good manufacturing practices, and hygiene requirements essential for safe production. It introduces principles of food safety systems and their implementation across operations. Hazard analysis, identification of critical control points, monitoring systems, documentation, and corrective measures are discussed to prevent contamination. Good manufacturing and hygiene practices, sanitation programs, cleaning-in-place systems, and equipment maintenance strategies are described in detail. Emphasis is also placed on team management, workforce training, supervision, record keeping, and disciplined shop-floor coordination to sustain quality assurance programs and regulatory compliance in competitive industrial environments.

This textbook is designed for Class XII students, focusing on the role of a Dairy Product Processor. It introduces milk and milk products, their composition, quality standards, and processing techniques. The book covers hygienic handling, common dairy operations, and modern methods for ensuring safety and quality. With practical examples, illustrations, and case studies, it provides students with essential knowledge and understanding to become skilled, responsible, and industry-ready dairy professionals.

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Unit 1

Fermented and Frozen Dairy Products

Fermented and frozen dairy products are important categories of value-added milk products prepared through controlled processing methods. In fermented dairy products, selected microorganisms, mainly lactic acid bacteria, convert lactose (milk sugar) into lactic acid. The formation of lactic acid results in coagulation of milk proteins and development of characteristic flavour, body and texture. Fermentation also improves digestibility and enhances the keeping quality of milk. Common fermented dairy products include curd, lassi, yoghurt and shrikhand.

Frozen dairy products are prepared by freezing a properly standardized and pasteurized milk mixture under controlled conditions. During freezing, the product develops desirable body, texture and palatability. Examples of frozen dairy products include ice cream and kulfi.

Thus, fermentation and freezing are important preservation and processing techniques in dairy technology, which help in better utilization of milk and production of diversified dairy products.

Objectives

- To understand manufacturing of fermented dairy products
- To learn processing steps of cheese and paneer
- To study manufacture of ice cream and frozen desserts
- To understand functional dairy products
- To learn standards and entrepreneurship aspects

SESSION 1 – CULTURED DAIRY PRODUCTS – CURD, CHAKKA AND SHRIKHAND

Introduction

With the development of microbiological and nutritional sciences in the late 19th century came the technology necessary to produce cultured dairy products on an industrial or commercial basis. Fermented milks had been made since early times, when warm raw milk from cows, sheep, goats, camels, or horses was naturally preserved by common strains

of Streptococcus and Lactobacillus bacteria. (The "cultures" were obtained by including a small portion from the previous batch.) These harmless lactic acid producers were effective in suppressing spoilage and pathogenic organisms, making it possible to preserve fresh milk for several days or weeks without refrigeration. Cultured products eventually became ethnic favorites and were introduced around the world as people migrated.

Central to the production of cultured milk is the initial fermentation process, which involves the partial conversion of lactose (milk sugar) to lactic acid. Lactose conversion is accomplished by lactic-acid–producing *Streptococcus* and *Lactobacillus* bacteria. At temperatures of approximately 32 °C (90 °F), these bacteria reproduce very rapidly, perhaps doubling their population every 20 minutes. Many minute by-products that result from their metabolic processes assist in further ripening and flavoring of the cultured product. Subsequent or secondary fermentations can result in the production of other compounds, such as diacetyl (a flavor compound found in buttermilk) and alcohol (from yeasts in kefir), as well as butyric acid (which causes bitter or rancid flavors).

1. Curd (Dahi)

Dahi is a fermented dairy product, produced by fermentation process by deliberately adding live, harmless, lactic acid producing bacteria in the form of bacterial culture to milk. Lactic acid bacteria added in the form of starter culture multiply and grow, produces lactic acid, acetic acid and carbon dioxide by utilizing lactose present in the milk. Some bacteria use the citric acid of milk to produce certain volatile organic compounds mainly diacetyl, which is mainly responsible for flavor of dahi. Judicious combination of acid producing and flavour producing microorganisms in the starter helps in the production of Dahi with a firm body and good flavour. Fermentation gives an acid taste to milk which is particularly refreshing in hot climate and also possess certain therapeutic values originally absent in milk. Hence fermented dairy products are playing a very important role in human diet in many regions of the world. Fermentation leads to partial breakdown of milk constituents particularly lactose and proteins and increases the digestibility of cultured milk products. In Vedic literatures also we could find many references about fermented milk products, some of the popular Indian fermented milk products are Dahi, Lassi, Shrikhand MishtiDoi and Raita.

Food safety and standards regulation (FSSR, 2011) defines: Dahi or curd means the product obtained from pasteurised or boiled milk by souring, natural or otherwise, by Dairy Products Technology 39 a harmless lactic acid culture or other harmless bacterial culture may also be used in conjunction with lactic acid bacteria cultures for souring. Dahi may contain added cane sugar. Dahi shall have the same minimum percentage of milk fat and milk solids-not-fat as the milk from which it is prepared

Table: Chemical Composition of Dahi

Components	Whole Milk Dahi (%)	Skim Milk Dahi (%)
Water	85 – 88	90 – 91
Fat	5 – 8	0.05 – 0.1
Protein	3.2 – 3.4	3.3 – 3.5
Lactose	4.6 – 5.2	4.7 – 5.3
Lactic Acid	0.5 – 1.1	0.5 – 1.1
Ash	0.7 – 0.75	0.7 – 0.75

Method of Preparation

Traditional Method

In traditional method of dahi preparation, milk is heated intensively to boil for 5 to 10 min and then it is cooled to room temperature. Thus boiled and cooled milk is added with previous day's curd or buttermilk, stirred and allowed undisturbed, to set, usually for overnight.

At halwai's shop the milk is considerably concentrated before being inoculated with starter culture. So that the total solid content of milk is increased, particularly increase in the protein content of milk results in custard like consistency of the dahi and keep the product from wheying off.

Selection of Raw Material

Production of cultured/fermented milk demands high quality raw materials with respect to physical, chemical and microbial standards

Filtration/Clarification

Fresh raw milk is heated to 35 to 40°C to aid clarification or filtration process then it is filtered to ensure the milk is free from extraneous matter.

Standardization

Fat is standardized based on type of product ranging from fat free to full fat and SNF level is increased by min. 2% than that of milk. It is common to boost the SNF content of the milk to about 12% with the addition of skim milk powder or condensed skim milk.

Increased SNF in turn increases the protein, calcium and other nutrients and resulted with improved body and texture, custard like consistency. Higher milk solids prevent wheying off of the product during storage.

Flowchart for Preparation of Dahi at Dairy Industries

Receiving of Milk
↓
Preheating (35 – 40°C)
↓
Filtration / Clarification
↓
Standardization
(Fat: 0 – 5%, SNF: 11 – 13%)
↓
Preheating (60°C)
↓
Homogenization (175 kg/cm^2)
↓
Pasteurization (95°C for 15 min)
↓
Cooling to 30°C
↓
Addition of Starter Culture (1 – 1.5%)
↓
Packaging
↓
Incubation (30 – 35°C for 8 – 10 hours)

↓

Dahi Formation

↓

Cooling and Storage (< 5°C)

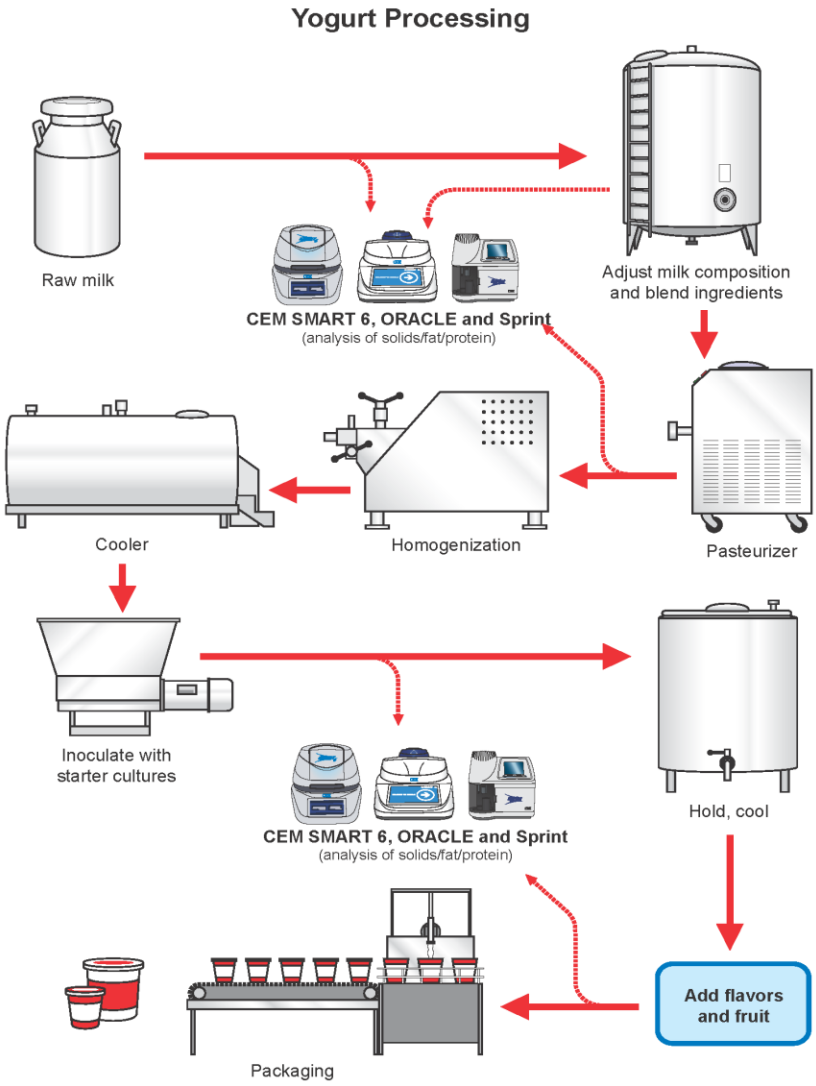


Fig: Preparation of Dahi

Packaging of Dahi

Dahi is packed in food grade polystyrene and polypropylene cups in 100g, 200g and 400g pack sizes. Various packaging machines of upto 400cups/min speed

are available to package cultural dairy products in different sizes. The packaged product should be stored at 1-4°C for extended shelf life.

Defects in Dahi

Sl. No.	Defect	Probable Cause	Remedy
1	Insufficient flavour	Low citrate level in milk; Low diacetyl content	Add 0.02–0.05% sodium citrate prior to the mix; Cool rapidly after culturing
2	Oxidized flavor	Copper contamination; Exposure to fluorescent light; Exposure to sunlight	Avoid usage of copper utensils; Protect product from direct exposure to sunlight/UV light
3	Yeast/cheesy	Contaminating yeast growth	Sanitation check
4	Rancid flavor	Lipolytic activity	Do not mix pasteurized and raw dairy ingredients prior to homogenization
5	Weak body	Insufficient heat treatment to the mix; Too low milk SNF; Severe agitation after fermentation	Heat treatment should be less than 85°C/30 min; Homogenize the dahi mix prior to fermentation; Increase the MSNF content to 11% by adding skim milk powder
6	Grainy texture	High acidity; Improper dispersion of skim milk powder	Rapidly cool the product to <5°C after attaining optimum acidity; Use in-line screen/filter

2. Chakka

Definition

Chakka is a fermented, intermediate dairy product obtained during the production of Shrikhand. Scientifically chakka can be described as strained dahi, in other words it is the curd mass obtained after removing whey from dahi, either by muslin cloth or basket centrifuge. Chakka is the base material for the production of shrikhand and shrikhandwadi.

FSSR, 2011 Definition for Chakka

Means a white to pale yellow semi-solid product of good texture and uniform consistency obtained by draining off the whey from the Yoghurt obtained by the lactic fermentation of cow's milk, buffalo's milk, skimmed milk and recombined or standardised milk which has been subjected to minimum heat treatment equivalent to that of pasteurisation. It shall have pleasant Yoghurt/Dahi like flavour. It shall not contain any ingredient foreign to milk. It shall be free from mouldness and free from signs of fat or water seepage or both. It shall be smooth and it shall not appear dry. It shall not contain extraneous colour and flavours.

Table: Standards for Chakka (FSSR, 2011)

Sl. No.	Components	Food Safety and Standards Regulations (2011) – Chakka	Skimmed Milk Chakka	Full Cream Chakka
1	Total Solids (%) (Minimum) on Dry Matter	30.0	20.0	28.0
2	Milk Fat (%) (Minimum) on Dry Matter	33.0 (Min)	5.0 (Max)	38.0 (Min)
3	Milk Protein (%) (Minimum) on Dry Matter	30.0	60.0	30.0
4	Titratable Acidity (%) as Lactic Acid (Maximum)	2.5	2.5	2.5
5	Total Ash on Dry Matter (%) (Maximum)	3.5	5.0	3.5

Chakka when sold without any indication shall conform to the standards of Chakka.

Traditional Method of Making Chakka

In traditional method, cow milk or buffalo milk or mixed milk is boiled thoroughly and cooled to room temperature (30°C) Fig. 2.2. Previous day curd is added to this milk at the rate of 1 to 1.5 %. Milk is left undisturbed overnight at room temperature to set firmly. It is then stirred and hung in a muslin cloth for 10 to

12 hrs to drain off whey. The curd mass obtained after removal of whey is called as chakka.

Flow diagram for traditional method of making Chakka

Whole Milk

↓

Boiling

↓

Cooling to 30°C

↓

Addition of Dahi (1.0 – 1.5%)

↓

Kept Undisturbed Overnight

↓

Dahi Formation (0.7 – 0.8% Acidity)

↓

Whey ← Stirred and Hung in Muslin Cloth (10 – 12 Hours)

↓

Chakka

3. Shrikhand

Shrikhand is a popular fermented, sweetened, indigenous dairy product having semi solid consistency with typical sweetish-sour taste. It is very popular in the state of Gujarat, Maharashtra and part of Karnataka. It is prepared by mixing chakka (Strained dahi), with sugar, color, flavor, spices and other ingredients like fruit pulp, nuts etc. to form soft homogenous mass.

Chakka is the intermediate product obtained during the production of shrikhand. It can be defined as a semi solid product obtained by draining off the whey from the curd prepared by acid fermentation of cow's/buffalo's/mixed/skimmed/standardized milk or reconstituted milk.

Food Safety and Standard Rules, 2011 Definition for Shrikhand

Shrikhand-means the product obtained from chakka or Skimmed Milk Chakka to which milk fat is added. It may contain fruits, nuts, sugar, cardamom, saffron and other spices. It shall not contain any added colouring and artificial flavouring substances.

Table: FSSAI (Food Safety and Standards Authority of India) Standards for Shrikhand

Sl. No.	Particulars	Shrikhand	Full Cream Shrikhand
1	Total Solids (% by mass, minimum)	58.0	58.0
2	Milk Fat (% on Dry Matter, minimum)	8.5	10.0
3	Milk Protein (% on Dry Matter, minimum)	9.0	7.0
4	Titratable Acidity (% lactic acid, maximum)	1.4	1.4
5	Sucrose (% on Dry Matter, maximum)	72.5	72.5
6	Total Ash (% on Dry Matter, maximum)	0.9	0.9

Traditional Method of Making Shrikhand

Traditionally shrikhand is prepared by boiling cow or buffalo or mixed milk and cooled to room temperature (30°C). Thus heated and cooled milk is then added with previous day dahi at the rate of 0.5 to 1 %. Milk is left undisturbed overnight at room temperature to set firmly. It is then stirred and hung in a muslin cloth for 10 to 12 hrs to drain off whey. The curd mass obtained after removal of whey is called as chakka. Chakka is then added with calculated amount (40-45% w/w) of sugar, color, flavour and other optional ingredients like fruits, nuts, spices, herbs and cooled to 10°C or less.

The yield of chakka produced traditionally is about 650g per 1000g of milk and yield of shrikhand is about 1.5 to 2.0 kg per kg of chakka.

The chakka obtained from whole milk/ standardized milk has smooth body, whereas the one obtained from skim milk is little rough and dry. This is majorly due to less fat in the curd. When whole milk is used for chakka making high fat losses occurs in whey thereby affecting the recovery of fat in chakka. Therefore it is preferred to use skim milk for chakka making and then mixing of cream or unsalted butter to adjust the fat in the finished product.

Shelf Life of Shrikhand

Due to both high acid and sugar levels, shrikhand has a fairly long shelf-life of 30-40 days at 8°C and 2-3 days at 30°C. The shelf-life depends largely on the initial level of contaminating Microorganisms particularly yeast and moulds. The shelf life of shrikhand can be increased by addition of potassium sorbate 0.05% or by thermization at 65°C for 10 minutes coupled with addition of 0.02% sorbic acid. For industrial purposes pasteurization of shrikhand at 650 C/10min and subsequent freezing can increase the shelf life upto 12 months at -180 C.

Innovations

Use of basket centrifuge or quarg separator for the production of Chakka - use of basket centrifuge increased the curd production to 80kg/hr and quarg separator has got the capacity to produce 2,500kg of curd per hour. This permits to scale up the production upto 8tonnes/day and minimizes the batch to batch variation with

Flow Chart: Industrial method of shrikhand manufacture

Skim milk (100 kg) of 9% T.S., 0.13% Lactic acid (LA), 6.7 pH

↓

Heat treatment 85°C for 30 min

↓

Cooling to 30°C

↓

Inoculation (*L. Lactis* + *L. Lactis var. diacetilactis* 1.0 to 1.5%)

↓

Incubate for 10 to 12 hr

↓

Dahi 0.9% LA & 4.6 pH

↓

Whey ← Basket Centrifuge 900 rpm for 90 min at 30°C

↓

Chakka 20 kg of 25% T.S. (T.S. in chakka is 5 kg)

↓

Titratable Acidity of 2.1 to 2.2%, pH 4.4 to 4.6

Planetary mixer (35 to 45 rpm for 40 min)

↓

Cream 80% fat 2.4 kg, Sugar @ 80% w/w of chakka, Cardamom @ 1 g/kg of chakka

Shrikhand

pH 4.4 to 4.6, TA 1.03 to 1.05%, Fat 5–6%, Protein 6.5–7%

Sucrose 40–43%, Ash 0.49–0.53%, T.S. 57–60%

↓

Packaging at room temperature and cold storage (<7°C)

Practical Exercise

Activity

CHECK YOUR PROGRESS

1. Demonstrate the preparation of curd (dahi) using boiled milk and starter culture under hygienic conditions.
2. Prepare chakka by draining whey from curd using a muslin cloth and observe the change in texture.
3. Prepare shrikhand by mixing chakka with sugar and flavouring agents, and note the consistency and taste.
4. Observe the effect of fermentation on milk by comparing fresh milk and curd in terms of taste, texture, and acidity.
5. Evaluate hygienic practices followed during preparation, including cleanliness of utensils, quality of milk, and storage conditions.

A. Multiple-Choice Questions (MCQs)

1. Curd (dahi) is produced by:
   a) Freezing
   b) Fermentation
   c) Evaporation
   d) Drying
2. The main bacteria involved in curd formation are:
   a) Salmonella and E. coli
   b) Streptococcus and Lactobacillus
   c) Yeast and mold
   d) Bacillus species
3. Chakka is obtained by:
   a) Freezing milk
   b) Adding sugar to curd
   c) Removing whey from curd
   d) Boiling milk repeatedly
4. Shrikhand is prepared by mixing chakka with:
   a) Salt and spices
   b) Sugar and flavoring agents

c) Water and yeast
d) Cream and salt

5. The ideal incubation temperature for dahi formation is around:
   a) 10°C
   b) 20°C
   c) 30–35°C
   d) 60°C

B. Fill in the Blanks

1. Lactic acid bacteria convert lactose into _____.
2. Dahi is formed by adding _____ culture to milk.
3. Chakka is a _____ product obtained after whey removal.
4. Shrikhand has a _____ taste (sweet/sour combination).
5. Fermentation improves the _____ of milk products.

C. True or False

1. Fermentation helps preserve milk by inhibiting harmful microbes.
2. Chakka is a final product and not used further.
3. Shrikhand is made directly from milk without fermentation.
4. Lactic acid formation lowers the pH of milk.
5. Fermented dairy products have better digestibility than fresh milk.

D. Subjective Questions

1. Define cultured dairy products and give examples.
2. Explain the role of lactic acid bacteria in curd formation.
3. Describe the traditional method of preparing dahi.
4. What is chakka? How is it prepared?
5. List the steps involved in the preparation of shrikhand.

SESSION 2 - FERMENTED DAIRY PRODUCTS AND CHEESE

Introduction

The word 'cheese' is derived from the Old English 'cese' which in turn was derived from the Latin 'caseus' which means correct or perfect thing. Cheese may be defined 'as the curd of milk separated from the whey and pressed into a solid mass'. This definition of cheese is satisfactory but too limited and vague from a technical standpoint. Therefore, a relatively complete definition is as follows:

Cheese is the curd or substance formed by the coagulation of milk of certain mammals by rennet or similar enzymes in the presence of lactic acid produced by added or adventitious microorganisms, from which part of the moisture has been removed by cutting, warming and pressing, which has been shaped in mould and then ripened (also unripened) by holding for some time at suitable temperatures and humidity.

The expansion of the numbers of types of cheese makes a simple definition of cheese difficult. Thus the definition, the curd produced from milk by enzyme activity and subsequent separation of whey from the coagulum does not cover whey cheese, lactic cheese, cream cheese and some of the cheeses produced by newer techniques, viz. ultrafiltration and reverse osmosis. The definition is, therefore, not universally acceptable.

Cheese is the fresh or matured solid or semi-solid product obtained:

a) By coagulating milk, skim milk or partly skimmed milk, whey, cream or butter milk or any combination of these materials, through the action of rennet or other suitable coagulating agents and by partially draining the whey resulting from such coagulation, or

b) By processing techniques involving coagulation of milk and/or materials obtained from milk (provided that the whey protein casein ratio does not exceed that of milk) and which give an end product which has similar physical, chemical or organoleptic characteristics as the product defined under (a).

According to the FSSR (2011), cheese means the ripened or unripened 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:

(i) 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.

(ii) 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.

(iii) Unripened cheese including fresh cheese is cheese which is ready for consumption shortly after manufacture.

Classification of Cheese

Several schemes to classify cheese have been proposed to assist international trade and to provide compositional and nutritional information. The basis for such classification

include 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 about 2000 names of cheeses. It is very difficult to classify the different cheeses satisfactorily, in groups. There are probably only about 18 types of natural cheeses. These are: 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: i) External – Camembert ii) Internal – Gorgonzola, Blue, Roquefort

4) Soft - Moisture > 47%

a) Unripened – Cottage

b) Ripened – Neufchatel

Cheese Manufacture

Cheese manufacture involves the controlled syneresis of the rennet milk coagulum, the expulsion of moisture being affected by:

i) acid development, the pH falling from 6.6 to about 5.0 as a result of lactic acid bacteria of the starter, chiefly Lactococcuslactis subsp. lactis and Lactococcus lactis subsp. cremoris,

ii) warmth, the temperature being raised to about 31°C for renneting and to about 38°C for scalding the curd, and especially

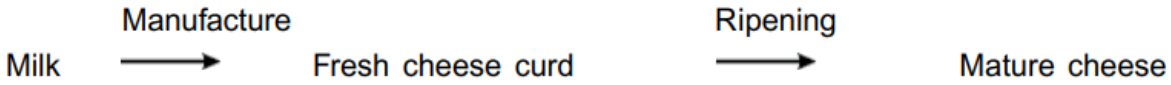
iii) repeated cutting of the curd and stirring

Table: Legal standards of cheese

Type of Cheese	Moisture (Maximum)	Milk Fat (on Dry Basis) – Minimum
Hard pressed cheese	39.0%	48.0%
Semi hard cheese	45.0%	40.0%

Semi soft cheese	52.0%	45.0%
Soft cheese	80.0%	20.0%
Extra hard cheese	36.0%	32.0%
Mozzarella cheese	60.0%	35.0%
Pizza cheese	54.0%	35.0%

Although some soft cheese varieties are consumed fresh, i.e. without a ripening period, the production of the vast majority of cheese varieties can be subdivided into two well -defined phases, manufacture and ripening.

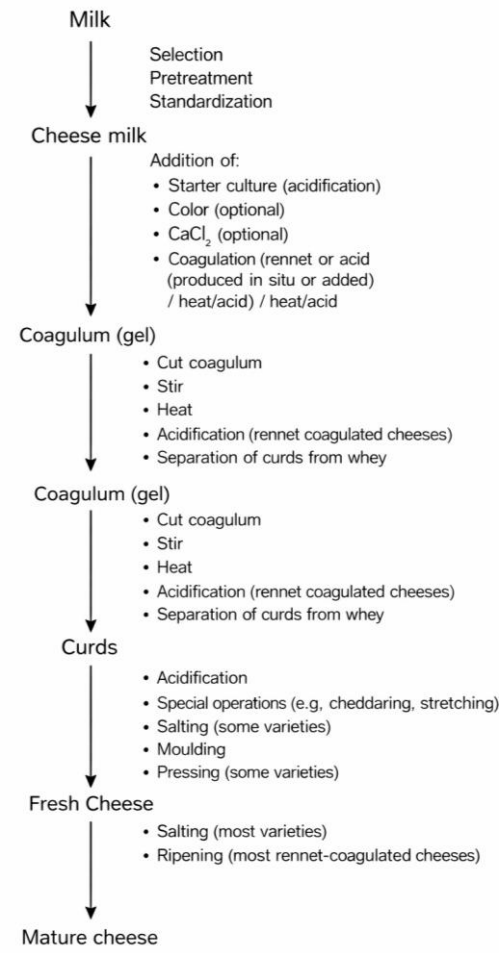


The manufacturing phase includes operations performed during the first 24 hours, though some steps like salting and dehydration may continue longer. While methods vary for different cheese types, the basic steps are common: acidification, coagulation, dehydration (cutting, cooking, stirring, pressing), shaping, and salting.

During dehydration, fat and casein are concentrated 6–12 times depending on the variety. The level of dehydration depends on these operations and milk composition. Moisture, salt, pH, and microflora then control biochemical changes during ripening, affecting flavor, aroma, and texture.

Thus, manufacturing steps largely determine cheese quality, while ripening develops its characteristic flavor and texture.

Flowchart of Cheese Manufacturing Process



Practical Exercise

Activity

CHECK YOUR PROGRESS

1. Demonstrate the preparation of simple cheese (paneer-type) by coagulating milk using an acid or enzyme and separating whey.
2. Observe the coagulation process by adding rennet or acid to milk and noting curd formation.
3. Perform cutting and heating of curd, and observe whey expulsion (syneresis).
4. Press and shape the curd into a solid mass and evaluate texture.
5. Evaluate hygienic practices followed during cheese preparation, including quality of milk, cleanliness of equipment, and storage conditions.

A. Multiple-Choice Questions (MCQs)

1. Cheese is formed by:
   a) Freezing milk
   b) Coagulation of milk
   c) Drying milk
   d) Evaporation
2. The enzyme commonly used in cheese making is:
   a) Amylase
   b) Rennet
   c) Lipase
   d) Protease
3. The separation of liquid from curd in cheese making is called:
   a) Pasteurization
   b) Homogenization
   c) Syneresis
   d) Fermentation
4. Ripened cheese is:
   a) Ready immediately after production
   b) Stored at low temperature only
   c) Aged under controlled conditions
   d) Dried completely
5. Soft cheese generally has:
   a) Low moisture
   b) High moisture
   c) No fat
   d) High salt only

B. Fill in the Blanks

1. Cheese is obtained by coagulation of milk using _____ or similar enzymes.
2. The liquid removed from curd is called _____.
3. The process of moisture removal from curd is called _____.
4. Cheese ripening develops _____ and texture.
5. Lactic acid bacteria help in _____ of milk during cheese making.

C. True or False

1. Cheese can be made from milk, cream, or whey.

2. All cheeses are consumed immediately after production.
3. Ripening improves the flavor of cheese.
4. Cutting and heating of curd help remove moisture.
5. Cheese contains no microorganisms.

D. Subjective Questions

1. Define cheese and explain its basic composition.
2. Explain the role of rennet in cheese making.
3. Describe the steps involved in cheese manufacture.
4. Classify cheese based on moisture content.
5. What is the importance of ripening in cheese?

SESSION 3 -ICE CREAM AND FROZEN DESSERTS

Introduction

Ice cream is a frozen dairy product prepared by freezing a mixture consisting of dairy and non-dairy components such as milk, cream, skim milk powder, sweeteners, stabilizer, emulsifier, fruits, nuts, colour and flavour. All ice cream ingredients are mixed in a specific order and processed to form ice cream mix and this mix is then frozen under rapid agitation with incorporation of air. This process forms semi frozen slush of ice cream which is then hardened to freeze it further.

Ice cream is a product that falls under the broad category of frozen desserts. Frozen desserts other than ice cream are frozen custard, frozen confections, frozen yoghurt, ice milk, sherbets, water ice and mellorine type products. There are many varieties of ice cream available which may differ in flavour, colour, form or ingredients.

Definition and Standards

According to Food Safety and Standards Regulation 2011, India, ice cream, kulfi, chocolate ice cream or softy ice cream means the product obtained by freezing a pasteurized mix prepared from milk and/or other products derived from milk with or without the addition of nutritive sweetening agents, fruit and fruit products, eggs and egg products, coffee, cocoa, chocolate, condiments, spices, ginger and nuts and it may also contain bakery products such as cake or cookies

as a separate layer and/or coating. It may be frozen hard or frozen to a soft consistency; it shall have pleasant taste and smell free from off flavour and rancidity. It may contain food additives permitted in this regulation and it should also conform to the microbiological standards laid by the regulation.

Table: FSSAI standards for Ice cream

Requirement	Ice Cream	Medium Fat Ice Cream	Low Fat Ice Cream
Total Solid	Not less than 36.0 percent	Not less than 30.0 percent	Not less than 26.0 percent
Wt/Vol (g/l)	Not less than 525	Not less than 475	Not less than 475
Milk Fat	Not less than 10.0 percent	More than 2.5 percent but less than 10.0 percent	Not more than 2.5 percent
Milk Protein (Nx6.38)	Not less than 3.5 percent	Not less than 3.5 percent	Not less than 3.0 percent

Frozen Dessert/Frozen Confection means the product obtained by freezing a pasteurized mix prepared with milk fat and/or edible vegetable oils and fat having a melting point of not more than 37°C in combination and milk protein alone or in combination/or vegetable protein products singly or in combination with the addition of nutritive sweetening agents e.g. sugar, dextrose, fructose, liquid glucose, dried liquid glucose, maltodextrin, high maltose corn syrup, honey, fruit and fruit products, eggs and egg products, coffee, cocoa, chocolate, condiments, spices, ginger and nuts. The product may also contain bakery products such as cake or cookies as a separate layer or coating; it may be frozen hard or frozen to a soft consistency. It shall have pleasant taste and flavour free from off flavour and rancidity and may contain permitted food additives. It shall also conform to the microbiological requirements prescribed in the regulation. Total solids, weight /volume and other specifications for frozen desserts are same as for ice cream (The Food Safety and Standards Regulation, 2011).

Classification

Depending upon the commercial practices followed, the following classifications are used for different groups of ice cream and frozen products.

Plain Ice Cream: An ice cream in which the total amount of the colour and flavouring ingredients is less than 5% of the volume of the unfrozen ice cream. Examples are vanilla, coffee, maple and caramel ice cream.

Chocolate: Ice cream flavoured with cocoa or chocolate.

Fruit: Fruit Ice cream is made by adding various fruits at the time of freezing with or without additional fruit flavouring or colour. The fruits may be fresh, frozen, canned or preserved.

Nut: Ice cream containing nut meats, such as almonds, pistachio or walnut, with or without additional flavouring or color.

Ice Milk / Milk Ice: A product similar to ice cream containing 2 -7% fats and 12-15% MSNF, sweetened, flavoured and frozen like ice cream.

Ices: Made of fruit juices, sugar and stabilizer with or without additional fruits, color, flavouring or water and frozen to the consistency of ice cream. Usually contains 28 – 30% sugar, 15-20% overrun, and no dairy products.

Sherbets: Sherbet is a product made of fruit juices, sugar, stabilizer, and milk products. It is similar to an ice, except milk, either whole, skim, condensed, or powdered, or ice cream mix, is used in place of all or part of the water used in ices, sherbet contains 1% to 2% milk fat.

Sorbets: The composition of sorbets is similar to that of ices. Sorbets have a high sugar and fruit and fruit juice content (30 and 30 -50% respectively). Stabilizer and egg white are also added, and the product has an overrun of 20% or less. Exotic flavours are often included in sorbets.

Mousse: Ice cream containing whipped cream, sugar, colour and flavouring, and frozen without further agitation. Sometimes condensed milk is added to give better consistency.

Bisque: It is made by the addition of grape, nuts, macaroons, sponge cake or other bakery products with appropriate flavourings.

Custards: custard is ice cream cooked to custard before freezing. Frozen custards are also known as French ice cream or French custard ice cream. It contains whole egg or egg yolk in such a proportion that the total egg yolk solids should not be less than 1.4% of the weight of the finished frozen custard or less

than 1.12% for bulky flavoured products. Parfait is frozen custard with high fat content.

Cassata: This is made in a round mold, hinged so that it may be filled with ice cream and other frozen products. The confection is built up in layers of rich, variously flavoured ice cream, some with fruits, some with liqueurs, and sometimes with chocolate or nuts. Fingers or slices of sponge cake, sometimes soaked in liqueur, may be added. The cassata is frozen for several hours, and then turned out of the mold for serving.

Variegated or Rippled Ice Cream: Variegated ice cream is produced by injecting approximately 10% of a prepared base into the ice cream. Most popular flavours of variegated ice cream are chocolate, butter scotch, straw berry, pineapple and caramel.

Novelties: An ice cream novelty is defined as a unique single-serve portion – controlled product. Novelties include special combinations of ice cream with flavour and confections, cup items, and fancy molded items. They are usually produced by either extrusion or molding, and examples include coated ice cream bars (e.g. Mars), Coated ice cream bars on a stick (e.g. Magnum), ice cream cake, and ice cream logs (e.g. Vienetta), ice cream sandwiches, popsicles and fudgesicles.

Fanciful-Name Ice Cream: These products usually do not contain a single characterizing flavour, but the flavour is due to the mixture of several flavouring ingredients. Two or more distinct flavours are present in the same package.

Mellorine Type Products: Mellorine is a product similar to ice cream in which the butter fat has been replaced by a suitable vegetable or animal fat.

Soft Serve Ice Cream: Soft serve ice cream is a type of frozen dessert that is similar to, but softer than the ice cream. These products are sold as drawn from the freezer without hardening. It is generally lower in milk fat (3.6%) than ice cream (10-18%) and produced at a temperature of about -4°C compared to ice cream, which is stored at -15°C.

Ice Cream Ingredients

The selection of ingredients is the most important factor in manufacture of good quality ice cream. Ice cream ingredients are divided into two groups namely:

1) Dairy ingredients

2) Non - dairy ingredients

Dairy ingredients are used as a source of milk fat and milk solid not fat (MSNF) required for imparting a characteristic richness and flavour to ice cream. These ingredients also contribute to smoothness of texture and resistance to melting. Various products used as a source of milk fat and milk SNF are summarized in table 2. Milk fat imparts richness and mellows the flavour of ice cream. It tends to retard the rate of whipping. It contributes to smoothness of texture and contributes to body and melting resistance of the product. It does not lower the freezing point of mix. Milk solid not fat is high in food value, inexpensive and enhances palatability of ice cream. It increases viscosity and resistance to melting, but also lowers the freezing point of ice cream mix. Lactose adds slightly to the sweet taste and minerals tend to have a slightly salty taste. Proteins help to make ice cream more compact and smooth.

Non-dairy ingredients comprise sweeteners, stabilizers, emulsifiers, color, flavor, fruits and nuts etc. There are various sources and types of these ingredients. These ingredients have different role in manufacturing ice cream.

Table: List of Ingredients Used in Ice Cream Manufacturing

Dairy Ingredients		
Sources of Milk Fat	**Sources of Milk SNF**	**Combined Sources of Fat and SNF**
Butter	Skim milk powder	Cream
Anhydrous milk fat / butteroil	Whey protein concentrate	Sweetened condensed milk
	Whey powder	Whole milk
	Lactose powder	
Non-Dairy Ingredients		
Category	**Ingredients**	
Sweeteners (Natural)	Sucrose, Fructose, Glucose, Galactose, Maltose, Rhamnose, Lactose	

Sweeteners (Artificial)	Aspartame, Neotame, Sucralose, Saccharin, Acesulfame-K
Stabilizers	Gelatin, Guar Gum, Sodium alginate, Carboxy methyl cellulose, Pectin, etc.
Emulsifiers	Monoglycerides and diglycerides, Polysorbates, Polyglycerol esters
Others	Colour, flavour, fruits, nuts, chocolate and cocoa etc.

Practical Exercise

Activity

CHECK YOUR PROGRESS

1. Demonstrate the preparation of ice cream mix using milk, cream, sugar, and other ingredients under hygienic conditions.
2. Perform freezing of ice cream mix with continuous agitation and observe the incorporation of air (overrun).
3. Compare ice cream and frozen desserts based on ingredients such as milk fat and vegetable fat.
4. Observe the effect of ingredients (fat, sugar, stabilizers) on texture, smoothness, and melting quality.
5. Evaluate hygienic practices during preparation, freezing, and storage of ice cream.

CHECK YOUR PROGRESS

A. Multiple-Choice Questions (MCQs)

1. Ice cream is prepared by:
   a) Heating milk only
   b) Freezing a pasteurized mix
   c) Drying milk solids
   d) Fermenting milk
2. The incorporation of air during freezing is called:
   a) Pasteurization
   b) Homogenization
   c) Overrun
   d) Coagulation

3. Which of the following is a dairy ingredient in ice cream?
   a) Sugar
   b) Stabilizer
   c) Cream
   d) Colour
4. Frozen desserts differ from ice cream mainly in:
   a) Temperature
   b) Use of vegetable fat
   c) Colour
   d) Shape
5. Soft serve ice cream is usually served at about:
   a) -15°C
   b) -10°C
   c) -4°C
   d) 5°C

B. Fill in the Blanks

1. Ice cream is a _____ dairy product.
2. The process of incorporating air into ice cream is called _____.
3. Milk fat provides _____ and smooth texture to ice cream.
4. Stabilizers help improve _____ of ice cream.
5. Frozen desserts may contain _____ fat instead of milk fat.

C. True or False

1. Ice cream mix is pasteurized before freezing.
2. Overrun decreases the volume of ice cream.
3. Stabilizers help prevent ice crystal formation.
4. Frozen desserts and ice cream have identical composition.
5. Milk solids-not-fat improve the texture of ice cream.

D. Subjective Questions

1. Define ice cream and frozen desserts.
2. Explain the role of milk fat in ice cream.
3. List the different types of frozen desserts.
4. Describe the function of stabilizers and emulsifiers in ice cream.
5. Explain the difference between ice cream and frozen desserts.

SESSION 4 – FUNCTIONAL DAIRY PRODUCTS

Introduction

Functional foods are defined as foods or food ingredients that provide health benefits beyond the traditional nutrition they contain. These foods have beneficial effects on one or more target functions in the body beyond basic nutritional effects, resulting in improved health, well-being, or a reduced risk of diseases. Functional foods are consumed as part of a normal diet and are not taken in the form of pills, capsules, or other dietary supplements.

Natural valuable substances with altered properties of individual components can also form functional foods. These foods may be enriched with functional ingredients or may have modified bioavailability of one or more components. As a result, they provide health benefits beyond their traditional nutritional value.

Japan was the first country to recognize functional foods as a separate category. In 1991, it introduced the FOSHU (Foods for Specific Health Use) system to evaluate health claims. In India, the Food Safety and Standards Authority of India (FSSAI) issued a Gazette notification on 23 December 2016 regulating nutraceuticals, functional foods, and novel foods.

Table: Classification of Functional Foods with Descriptions and Examples

Category	Description	Examples
Conventional foods containing natural bioactive substances	Foods naturally rich in beneficial compounds	Oat beta-glucan, fruits and vegetables rich in lycopene and lutein
Foods enriched with bioactive substances	Foods in which specific components are added or modified	Margarine with phytosterol, calcium-fortified orange juice, folic acid-rich pomegranate, energy drinks with ginseng and guarana
Foods for special dietary use	Foods developed for specific nutritional needs	Gluten-free foods, lactose-free products, infant foods

Milk and Dairy Products as Functional Foods

Milk and dairy products are generally considered an excellent source of high-quality protein, calcium, vitamins (riboflavin, niacin, vitamin B6, vitamin B12), organic acids, and biologically active components. Because of these properties, dairy products are often regarded as functional foods.

1. Yogurt

Yoghurt is the most popular and widespread fermented milk product in the world. The word yoghurt or yogurt is derived from the Turkish word Jugurt. Yoghurt is a traditional food and beverage in the Balkans and the Middle East. However its popularity has now spread to Europe and many other parts of the world. The product is popular with different names in different countries.

Yougurt is an important example of a functional dairy product. It is usually made from milk (rarely from cream) that is inoculated with *Streptococcus thermophilus* and either *Lactobacillus acidophilus* or *Lactobacillus bulgaricus*. Yogurt is of Turkish origin.

Benefits of Yogurt

- Constipation
- Diarrheal diseases
- Colon cancer
- Inflammatory bowel diseases
- Allergies

The consumption of yogurt provides several health benefits and therefore it is widely recognized as an important functional dairy food.

Table: Requirements for yoghurt as per PFA

Product	Milk Fat	Milk solids not fat	Milk Protein	Sugar

(i) Yoghurt	–	Not less than 8.5 percent m/m	Not less than 3.2 percent m/m	–
(ii) Partly skimmed Yoghurt	Not less than 3.0 percent m/m	Not less than 8.5 percent m/m	Not less than 3.2 percent m/m	–
(iii) Skimmed Yoghurt	Not less than 0.5 percent m/m and not more than 3.0 percent m/m	Not less than 8.5 percent m/m	Not less than 3.2 percent m/m	–
(iv) Sweetened/Flavoured Yoghurt	Not less than 3.0 percent m/m	Not less than 8.5 percent m/m	Not less than 3.2 percent m/m	Not less than 6.0 percent m/m
(v) Fruit Yoghurt	Not less than 1.5 percent m/m	Not less than 8.5 percent m/m	Not less than 3.2 percent m/m	Not less than 6.0 percent m/m

TYPES OF YOGHURT

The types of yoghurt that are produced world-wide can be divided into various categories, and the sub-divisions are usually made on the basis of:

1. Legal / Standards/ Chemical composition: FAO/WHO (1973)

i. Full fat > 3% fat

ii. Medium fat 0.5 to 3% fat

iii. Low fat < 0.5%

iv. Balkan yoghurt – 4.5 to 10% fat

2. Method of production

i. Set yoghurt

ii. Stirred yoghurt

iii. Fluid yoghurt – diluted or stirred yoghurt (yoghurt with <11% T.S.)

3. Flavours

i. Naturalor plain yoghurt – traditional type with sharp, acidic taste

ii. Fruit yoghurt- addition of fruits & sweetening agents to plain yoghurt

iii. Flavoured yoghurt – in which synthetic flavouring & colouring agents are added.

4. Post –incubation processing

i. Pasteurized yoghurt

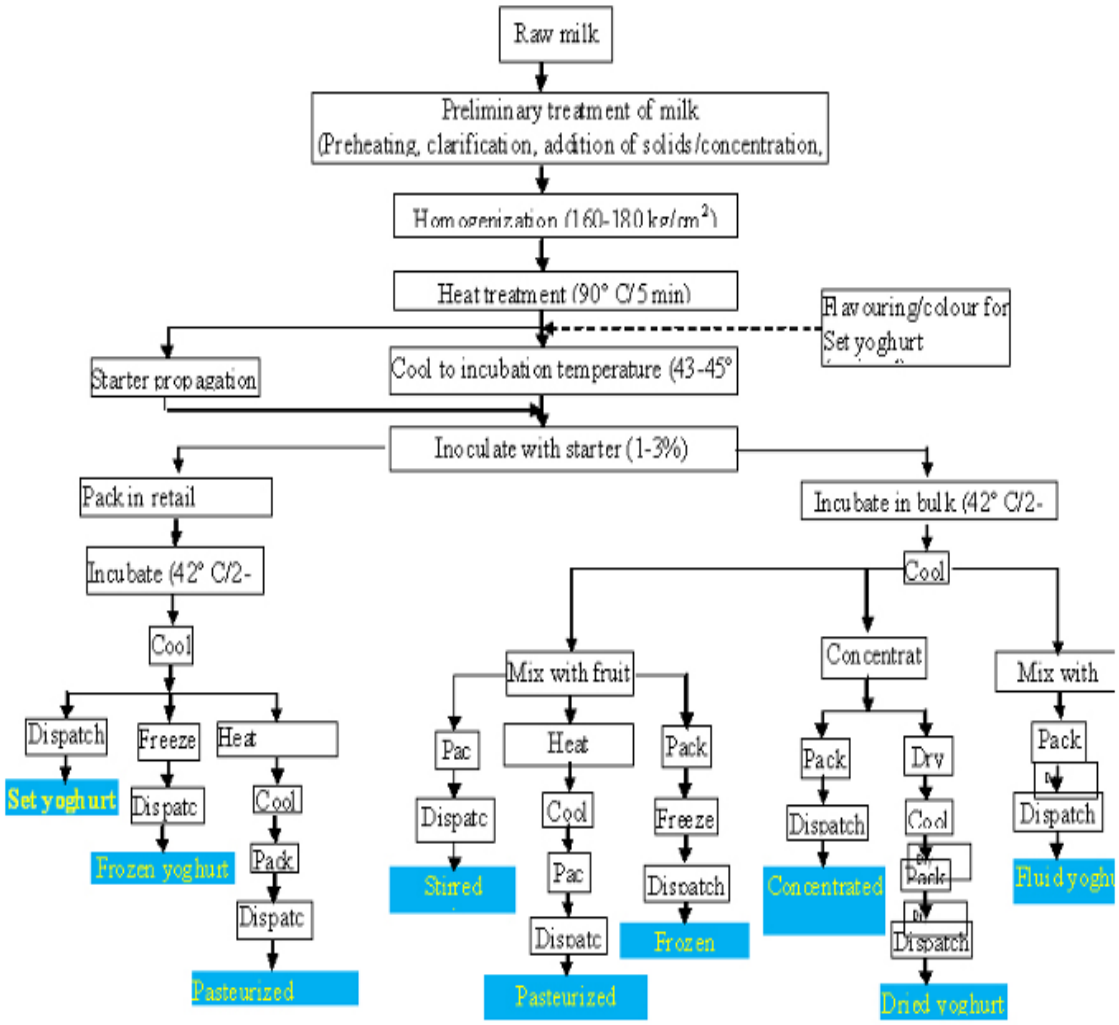
ii. Frozen yoghurt

iii. Dietetic yoghurts- may include less calorie yoghurt, low lactose yoghurt or vitamin/protein fortified yoghurt.

iv. Concentrated (>24% T.S.) and

v. Dried yoghurts (>90-94%).

Fig: Flowchart for Production of Yoghurt



Storage

All packaged retail units are packed in larger cartoon and stored in cold stores. The yoghurt must be stored at less than 5 C to ensure inhibition of growth starters and non-starter microorganism. If there are temperature fluctuations or temperature increases during storage, the growth of culture as well other microorganisms may take place and it will make the product sour or produce other defects. Hence, maintenance of temperature during storage is very important. The distribution of the finished product should always be through cold-chain. A good quality yoghurt has shelf-life of 2-3 weeks days at 5 C.

Table: Types of Probiotic Yoghurts

Name	Cultures Used
Acido-yoghurt	*L. bulgaricus* (LB) + *S. thermophilus* (ST) + 0.25% intestinal strain of *L. acidophilus*
Acidophilus yoghurt	(LB + ST) + *L. acidophilus* (final product contains about **30 million/ml** of *L. acidophilus*)
Acidophilus bifidus yoghurt	LB + ST + *L. acidophilus* + *B. bifidus*
Bioghurt	ST + *L. acidophilus* (or *S. lactis var. taette* + *L. acidophilus*)
Bifighurt	ST + *B. bifidus*
Biograde	ST + *L. acidophilus* + *B. bifidus*

Table: Nutritional Composition of Milk and yougurt per 100g

Constituent	Milk (Whole)	Milk (Skim)	Yoghurt (Full fat)	Yoghurt (Low fat)	Yoghurt (Low fat/fruit)
Water (g)	87.8	91.1	81.9	84.9	77.0
Energy value (kcal)	66	33	79	56	90
Protein (g)	3.2	3.3	5.7	5.1	4.1
Fat (g)	3.9	0.1	3.0	0.8	0.7
Carbohydrate (g)	4.8	5.0	7.8	7.5	17.9
Calcium (mg)	115	120	200	190	150
Phosphorus (mg)	92	95	170	160	120
Sodium (mg)	55	55	80	83	64
Potassium (mg)	140	150	280	250	210
Zinc (mg)	0.4	0.4	0.7	0.6	0.5

Table: PFA Standards for Yoghurt

Product	Milk Fat	Milk Solids Not Fat (SNF)	Milk Protein	Sugar
(i) Yoghurt	–	Not less than 8.5 % (m/m)	Not less than 3.2 % (m/m)	–
(ii) Partly Skimmed Yoghurt	Not less than 3.0 % (m/m)	Not less than 8.5 % (m/m)	Not less than 3.2 % (m/m)	–
(iii) Skimmed Yoghurt	Not less than 0.5 % (m/m) and not more than 3.0 % (m/m)	Not less than 8.5 % (m/m)	Not less than 3.2 % (m/m)	–
(iv) Sweetened Flavoured Yoghurt	Not less than 3.0 % (m/m)	Not less than 8.5 % (m/m)	Not less than 3.2 % (m/m)	Not less than 6.0 % (m/m)
(v) Fruit Yoghurt	Not less than 1.5 % (m/m)	Not less than 8.5 % (m/m)	Not less than 3.2 % (m/m)	Not less than 6.0 % (m/m)

2. Dahi

Since ancient times, surplus milk in India has been used to prepare various dairy products, the earliest being dahi (curd) produced by fermenting milk. Dahi (Sanskrit: *Dadhi*) is considered the oldest Indian fermented milk product and is similar to Western yoghurt. It is believed to have therapeutic properties and is traditionally used to treat gastrointestinal problems such as dyspepsia and dysentery. Dahi is commonly prepared and consumed in households, though recently commercial dairies have started large-scale production.

Definition of Dahi: According to PFA rules (2006), dahi or curd is a product obtained from pasteurized or boiled milk by souring with harmless lactic acid or bacterial cultures. It may contain added cane sugar, and its milk fat and solids-not-fat content must be the same as the milk used for preparation.

Standards for Dahi: As per Bureau of Indian Standards (1978), good quality dahi should have a pleasant flavour, clean acidic taste, firm body and texture, and uniform consistency with minimal whey separation.

Table: Specifications for dahi

Characteristics	Sweet dahi	Sour dahi
Acidity (% lactic acid)	0.7	1.0
Yeast and molds (per gram) Max.	100	100
Coliforms (per gram) Max.	10	10
Phosphatase test	Negative	Negative

Flow Chart for Preparation of Dahi

Raw milk

↓

Boiling

↓

Cooling to body temperature

↓

Addition of previous day's dahi (0.5–1.0%)

↓

Incubation at ambient temperature (6–10 h or overnight)

↓

Dahi

Flowchart for Household method of preparation of dahi

Raw milk

↓

Standardization (Fat 3–5% and SNF 10–12%)

↓

Pumped to multipurpose vat, preheated to 60°C

↓

Homogenization (176 kg/sq.cm)

↓

Heat treatment (80–90°C)

↓

Cooling (40–45°C)

↓

Inoculation of starter (1–2%)

↓

Filling of retail cups (200–500 g)

↓

Incubation at 37–42°C for 4–5 h

↓

Dahi sets in cups

↓

Remove dahi cups in crates from incubator

↓

Transfer to cold room and store till distributed

Table: Composition of Dahi

Characteristics	Cow milk	Buffalo milk
Moisture	85–88	82–85
Fat	3.5–4.5	6.0–8.0
Protein	3.0–3.5	3.5–4.0
Lactose	3.8–4.5	4.6–5.2
Ash	0.64–0.66	0.7–0.72
Lactic acid	0.5–1.0	0.5–1.1

Additives

Except sugar, no other additives are legally permitted in dahi. However, various additives such as starch,alginate, gelatin, CaCl2 and MgCl2 are frequently used to control the texture and also to reduce whey separation in dahi.

Nutritive and Therapeutic Value of Dahi

Dahi contains almost all the important nutrients of milk, with some changes due to heat treatment, microbial growth, and fermentation. Microorganisms predigest milk components, making dahi easier to digest. Protein digestibility increases due to softer curd formation, higher acidity, and release of peptides and amino acids, while lactose becomes easier to digest. Dahi also has higher levels of lactic acid, amino acids, fatty acids, bacterial cell mass, carbohydrates, and some vitamins, depending on the starter cultures used.

Dahi has long been recognized in Ayurvedic medicine for treating gastrointestinal disorders. Its benefits are mainly due to lactic acid and antibacterial substances**.** It can be safely consumed by lactose-intolerant people and helps reduce diarrhoea in children. Dahi is also believed to improve appetite and vitality**.** Probiotic dahi may have antidiabetic, anticarcinogenic, and antiatherogenic effects. Additionally, dahi is used in cosmetics as a soothing, cleansing, moisturizing, and beautifying agent.

MODIFIED DAHI - MISTI DAHI

Misti dahi is an indigenous sweetened fermented milk product popular in the eastern parts of the India. Misti dahi has creamish to light brown color, firm consistency, smooth texture, and pleasant aroma. Because of its brown colour

as a result of caramelization of sugar during heating, it is also called Lal Doi. At present no legal standards are available for the product.

Fig: Flow Diagram for the Manufacture of Misti Dahi

Buffalo Whole Milk

↓

Standardization

↓

Addition of cane sugar @14%

↓

Homogenization

↓

Addition of caramel

↓

Heat Treatment (90°C / 10 min)

↓

Inoculation with starter @2%

↓

Filling into pre-sterilized cups

↓

Incubation @ 41±1°C for 5–6 hr

↓

Misti Dahi

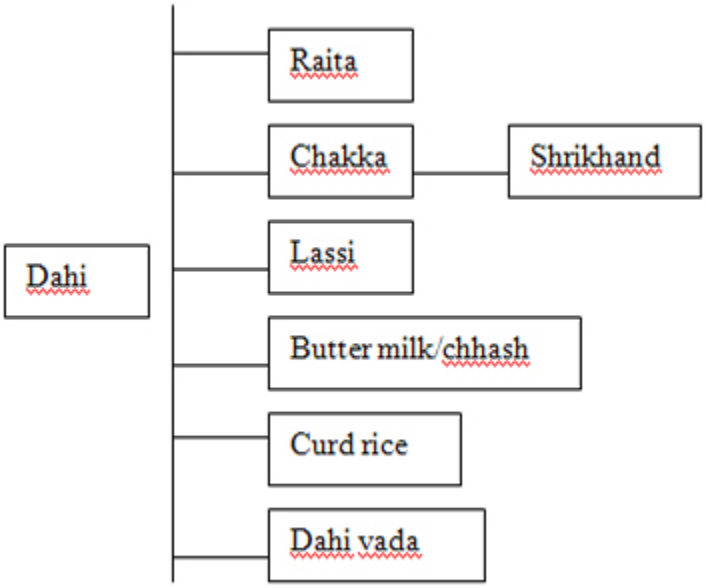
↓

Storage (6–8°C)

DAHI BASED PRODUCTS POPULAR IN INDIA

Dahi is consumed by large segments of our population either as apart of daily diet or as a refreshing beverage. The surplus dahi is used as the intermediate product and churned into makkhan (butter), while the liquid whey — chhach or mattha— is consumed as are freshing beverage or converted into kadhi, a spicy dish served hot with rice. Dahi is also used as a base for producing other products like shrikhand and lassi.

Flowchart: Dahi Based Products



3. Buttermilk

Drinking of butter after churning dahi in to country butter is a very common habit in India. This product has most of the fermented milk solids except fat which goes in butter.It also has mixed lactic acid bacteria, especially Lactococci and Leucostocs, which gives it a typical diacetyl flavour.

Manufacturing cultured butter milk on industrial scale involve selection of good quality raw material, standard cultures and optimized process of fermentation, packaging and storage.

True buttermilk is the fluid remaining after cream is churned into butter. If butter is made from sweet cream, its buttermilk has approximately the same composition as skim milk. Cultured butter milk is prepared by souring true butter milk or more commonly, skim milk with a butter starter culture that produces a desirable flavor and aroma.

Flow Diagram for Preparation of Cultured Buttermilk

Butter milk or skim milk or low fat milk

↓

Heat treatment 85°C / 20 min

↓

Cooling to 22°C

↓

Inoculate with 0.5–2.0% lactic starter

↓

Incubate 14–16 h at 22°C

↓

Agitate (break) curd at pH 4.6

↓

Packaging at 5°C

Table: Composition of Cultured Buttermilk

Item	Concentration
Total solid	10%
Fat	0.88%

Protein	3.3%
Ash	0.9%
Lactose	4.80%
Titratable acidity	0.80%
pH	4.5

Probiotics

Probiotic is derived from Greek and means pro-life. It is an opposite word of antibiotic and it means for life‘ or in support of life‘. Any microorganism and or substance which improve health can be called as probiotic. The term probiotic was coined by Lilly and Still well in 1965 who terms probiotics for growth promoting factors produced by microorganisms. Later on parker in 1974 used the term for organisms and substances‘ and Fuller in 1989 defined probiotic as a live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance. During the journey of science from1965 to till date, probiotic‘s definition has been revised several times. But at present, the definition given by WHO/FAO (2002) has been universally accepted and as per that probiotic is defined as — Live microorganisms which when administered in adequate amount confer a health benefit on the host.

Criteria for selection of probiotics:

The probiotic microorganisms are required to function in vivo in the body and hence any orally administered microbe need to withstand the adverse conditions in gastro-intestinal (GI) tract and establish in human GI tract. Further, it need to remain viable in the food product and hence it need to resist production conditions and remain viable in sufficient numbers till the end of shelf life of the product. The most important condition is that the culture should be safe for human consumption. Following is the list of criteria used for selection of strain of probiotic microorganism.

1. The source from where the culture is isolated. There is host specificity.

2. Capability of passage in live condition to gastro-intestinal tract.

- tolerance to gastric acids

- tolerance to low pH

- tolerance to digestive enzymes

- tolerance to lysozyme

3. Capability of persistence in live condition in gastro-intestinal tract.

- tolerance to bile salts

- resistance to lower surface tension

- tolerance to phenolic compounds

- resistance to peristalsis

4. Ability of intestinal implantation

- production of exopolysaccharides

- hydrogen bonding

- surface structures

- non-specific ionic bridges

- surface hydrophobicity

5. Tolerance to production conditions

- resistance to temperature

- resistance to salt

- resistance to sugar

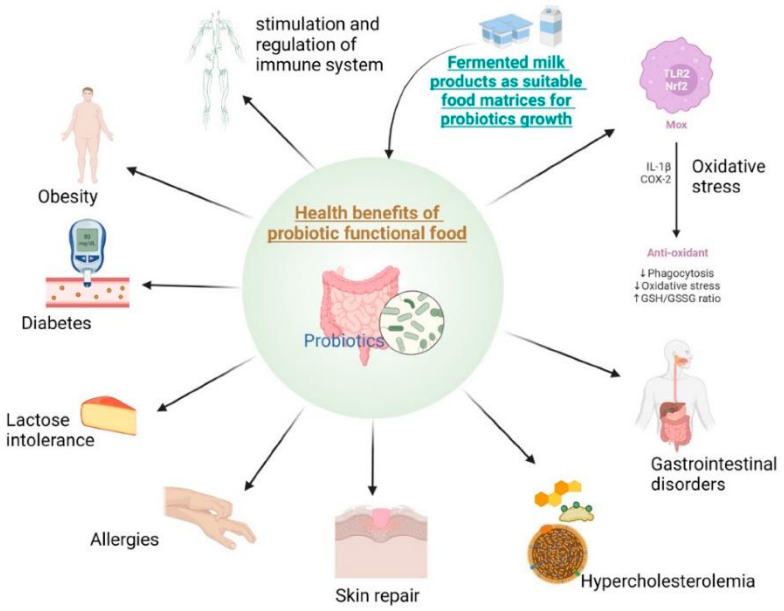


Fig: Health Benefits of Probiotics

PREBIOTIC

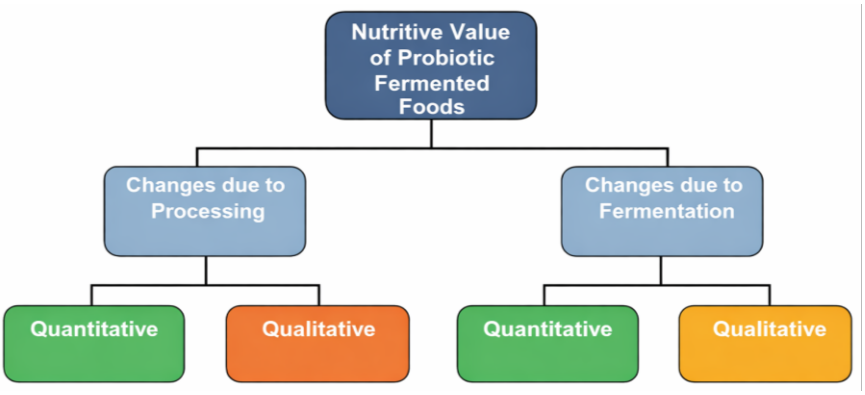
A prebiotic is a selectively fermented ingredient that causes beneficial changes in the composition and activity of gastrointestinal microflora, improving host health. The combination of probiotics and prebiotics is called synbiotics.

Prebiotics occur naturally in foods such as leek, asparagus, chicory, Jerusalem artichoke, garlic, onion, wheat, banana, oats, and soybean. They are metabolized by beneficial gut microbes, helping improve probiotic survival and gut microbiota balance.

SYNBIOTICS

A synbiotic has been defined as a mixture of probiotics and prebiotics that beneficially affects the host by improving the survival and implantation of live microbial dietary supplements in the gastrointestinal tract. Prebiotics and synbiotics are much newer concepts than probiotics, and as such information on their health-promoting properties is more sparse. Nevertheless, the beneficial outcomes are likely to be similar to those of probiotics, with the chance that these are more enhanced, given the issues of reduced survivability.

Fig: Changes in Nutritive Value of Probiotic Fermented Foods



Therapeutic Value of Probiotic Foods

The therapeutic effects of probiotics can be classified as reducing disease risk, prevention of diseases, supportive therapy, and curative therapy. Health effects of probiotics are strain-dependent and must be confirmed through reliable clinical trials before health claims are made.

1. Role in Gastrointestinal Tract

Lactic Acid Bacteria (LAB) are normal inhabitants of the gastrointestinal tract. They inhibit intestinal pathogens, regulate intestinal microflora, and help control diarrhoea, gastric acidity, constipation, and inflammatory bowel disease.

2. Role in Cardiovascular Diseases

Some probiotic organisms help lower cholesterol levels and assist in controlling cardiovascular diseases.

3. Bioactive Peptides from Fermented Milk

Fermented milks produce bioactive peptides such as opiates (sleep inducers), ACE inhibitors (antihypertensive), platelet aggregation inhibitors, antibacterials, digestive regulators, and immunomodulators.

4. Anticarcinogenic Activity

Certain LAB show anti-tumor properties, reduce tumor proliferation in animal studies, and are particularly effective against colon cancer by regulating intestinal microflora.

5. Immunostimulating Effects

Probiotics strengthen immunity by increasing antibodies, macrophage activity, NK-cell activity, T-cell and B-cell responses, and gamma-interferon production, while preventing the translocation of harmful bacteria.

6. Support for AIDS Patients

Fermented milks and Lactobacilli may inhibit tumor development, reverse immunosuppression caused by carcinogens, reduce symptoms of AIDS, and help control secondary infections.

7. Delaying Ageing

Fermented milks provide higher calcium availability, vitamin D support, and high protein, which help reduce bone loss and improve immunity and lactose digestion.

8. Hepatic Encephalopathy Control

Probiotics may reduce ammonia levels in blood by suppressing enzymes that convert urea to ammonia.

9. Other Benefits

Probiotic foods may help in preventing food allergies, improving lactose intolerance, controlling urinary tract infections, degrading toxins, reducing depression, and improving protein nutrition.

Current research is investigating probiotics for diarrhoea control, allergy prevention, reduction of cancer-promoting enzymes, treatment of infections, autoimmune diseases, respiratory infections, and improvement of oral health.

Practical Exercise

Activity

CHECK YOUR PROGRESS

1. Demonstrate the preparation of yoghurt using milk and starter cultures under hygienic conditions.
2. Prepare dahi at household level and observe fermentation time, texture, and taste.

3. Prepare cultured buttermilk using skim milk and starter culture, and record changes in flavour and acidity.
4. Compare functional dairy products (yoghurt, dahi, buttermilk) in terms of nutritional value and digestibility.
5. Evaluate hygienic practices during preparation, storage, and handling of functional dairy products.

A. Multiple-Choice Questions (MCQs)

1. Functional foods are those that:
   a) Provide only basic nutrition
   b) Provide health benefits beyond nutrition
   c) Are used as medicines only
   d) Are taken as supplements
2. Yoghurt is prepared using:
   a) Yeast
   b) Mold
   c) Streptococcus thermophilus and Lactobacillus
   d) Viruses
3. Probiotics are:
   a) Harmful bacteria
   b) Chemical additives
   c) Beneficial live microorganisms
   d) Enzymes
4. Buttermilk is obtained by:
   a) Freezing milk
   b) Churning cream or fermenting skim milk
   c) Boiling milk
   d) Drying milk
5. Prebiotics are:
   a) Live bacteria
   b) Digestive enzymes
   c) Non-digestible food ingredients that support beneficial microbes
   d) Vitamins

B. Fill in the Blanks

1. Functional foods provide _____ benefits beyond basic nutrition.
2. Yoghurt is made using _____ and Lactobacillus bacteria.
3. Probiotics help improve _____ health.

4. The combination of probiotics and prebiotics is called _____.
5. Buttermilk has a characteristic _____ flavour due to lactic acid bacteria.

C. True or False

1. Functional foods are consumed as part of a normal diet.
2. Probiotics are harmful to human health.
3. Dahi is an ancient fermented dairy product.
4. Prebiotics help in the growth of beneficial gut bacteria.
5. Functional dairy products have no therapeutic value.

D. Subjective Questions

1. Define functional foods and give examples.
2. Explain the role of probiotics in human health.
3. Describe the preparation of yoghurt.
4. What is dahi? Explain its nutritional and therapeutic value.
5. Explain the preparation and importance of buttermilk.

Unit 2

Concentrated and Dried Dairy Products: Principles and Practices

The main purpose of concentrating and drying milk is to reduce its volume and increase its shelf life. Water can be removed from milk by evaporation. During evaporation, some volatile substances, including dissolved gases, may also be removed. Evaporation is usually done under reduced pressure — hence, decreased temperature — to prevent damage caused by heating. Water can also be removed by a membrane process called as reverse osmosis, i.e., high pressure is applied to a solution to pass its water through a suitable membrane. A different method of concentrating is by freezing.

UHT Processing (Ultra High Temperature Processing)

UHT processing is a method of heat treatment in which milk is heated to a temperature of 135–150°C for 2–5 seconds and then rapidly cooled. This process destroys harmful microorganisms and spores, making the milk commercially sterile.

Advantages:
- Long shelf life (3–6 months)
- No refrigeration required before opening

Flowchart:
Milk → Preheating → Homogenization → UHT Treatment → Aseptic Packaging

Automation in Dairy Plants

Automation in dairy plants involves the use of advanced control systems to manage processing operations efficiently. Modern dairy industries use PLC (Programmable Logic Controller)-controlled systems and automatic pasteurizers to ensure precision and hygiene.

Benefits:
- Reduced labour requirement
- Consistent product quality

Smart Sensors & Quality Control

Smart sensors are used in dairy plants to monitor and control product quality during processing. These sensors help in real-time measurement and ensure safety standards.

Sensors are used for:
• Temperature
• pH
• Fat content

Digital monitoring systems help in maintaining accuracy and improving efficiency in dairy operations.

Cold Chain Logistics

Cold chain logistics refers to the maintenance of low temperature throughout the storage and transportation of milk and dairy products to preserve quality and prevent spoilage.

Importance:
It ensures freshness, safety, and extended shelf life of milk during transport.

Example:
Milk → Chilling Center → Processing Plant → Retail

SESSION–1

PRINCIPLES AND PRODUCTION OF CONCENTRATED MILK
INTRODUCTION

Condensed milk was developed in the 19th century and commercialized by Gail Borden in 1856.

Objectives of Milk Concentration

The concentration of milk is carried out mainly to reduce the water content of milk. The objectives of concentrating milk are:

- To reduce the volume and weight of milk for easier transportation and storage.
- To increase the keeping quality and shelf life of milk products.

- To reduce packaging and storage costs.
- To prepare milk for the manufacture of dried milk products such as milk powder.
- To obtain products with higher total solids content suitable for various food preparations.

Methods of Milk Concentration

Milk can be concentrated by several methods depending on the technology used:

1. **Evaporation**
   Evaporation is the most commonly used method for concentrating milk. In this process, water is removed by heating milk under reduced pressure (vacuum) so that evaporation occurs at a lower temperature, thereby minimizing heat damage to milk constituents.
2. **Reverse Osmosis**
   Reverse osmosis is a membrane process in which pressure is applied to separate water from milk through a semi-permeable membrane.
3. **Freeze Concentration**
   In freeze concentration, water is removed from milk by freezing and separating ice crystals, which contain relatively pure water, leaving behind concentrated milk solids.

Comparison of Methods:

Reverse osmosis and freeze concentration give better quality as they use low temperature, while evaporation is economical but may cause slight nutrient loss.

Principle:

Evaporation – removal of water under vacuum.

Reverse osmosis – separation using semi-permeable membrane.

Freeze concentration – removal of water by freezing.

Table: FSSAI Standards for Evaporated Milk

No.	Product	Milk Fat	Milk Solids	Milk Protein in Milk Solids Not Fat
(i)	Evaporated Milk	Not less than 8.0% (m/m)	Not less than 26.0% (m/m)	Not less than 34.0% (m/m)
(ii)	Evaporated Partly Skimmed Milk	Not less than 1.0% (m/m) and not more than 8.0% (m/m)	Not less than 20.0% (m/m)	Not less than 34.0% (m/m)
(iii)	Evaporated Skimmed Milk	Not more than 1.0% (m/m)	Not less than 20.0% (m/m)	Not less than 34.0% (m/m)
(iv)	Evaporated High Fat Milk	Not less than 15.0% (m/m)	Not less than 27.0% (m/m)	Not less than 34.0% (m/m)

Table: FSSAI Standards for Sweetened Condensed Milk

No.	Product	Milk Fat	Milk Solids	Milk Protein in Milk Solids Not Fat
(i)	Sweetened Condensed Milk	Not less than 9.0% (m/m)	Not less than 31.0% (m/m)	Not less than 34.0% (m/m)
(ii)	Sweetened Condensed Skimmed Milk	Not more than 1.0% (m/m)	Not less than 26.0% (m/m)	Not less than 34.0% (m/m)
(iii)	Sweetened Condensed Partly Skimmed Milk	Not less than 3.0% (m/m) and not more than 9.0% (m/m)	Not less than 28.0% (m/m)	Not less than 34.0% (m/m)
(iv)	Sweetened Condensed High Fat Milk	Not less than 16.0% (m/m)	Not less than 30.0% (m/m)	Not less than 34.0% (m/m)

Condensed Milk

Condensed milk is milk from which part of water has been removed, with or without addition of sugar. They are intended for use as such or for pre-condensing the fluid milk or fluid milk by–product preparatory to the manufacture of dried milk products. Condensed milk products are widely used in bakery, confectionery and dessert preparations due to their high solids content and extended shelf life.

The term 'condensed milk' is commonly used when referring to full cream sweetened condensed milk whereas the term Evaporated milk refers to unsweetened concentrated milk, whereas condensed milk generally refers to sweetened condensed milk. Skimmed milk products are known as sweetened condensed skim and unsweetened condensed skim milk respectively.

Sweetened Condensed Milks

Sweetened condensed milks are milk products which can be obtained by the partial removal of water from milk with the addition of sugar, or by any other process which leads to a product of the same composition and characteristics. The fat and/or protein content of the milk may have been adjusted, only to comply with the compositional requirements by the addition and/or withdrawal of milk constituents in such a way as not to alter the whey protein to casein ratio of the milk being adjusted.

Sweetened condensed milk should contain not less than 9.0 percent milk fat, and not less than 31 per cent milk solids and 40.0 per cent cane sugar.

They may be

1. Sweetened condensed milk
2. Sweetened condensed skimmed milk
3. Sweetened condensed partly skimmed milk
4. Sweetened condensed high-fat milk

Evaporated Milks

Evaporated milks are milk products which can be obtained by the partial removal of water from milk by heat, or by any other process which leads to a product of the same composition and characteristics. The fat and/or protein content of the milk may have been adjusted, only to comply with the compositional requirements by the addition and/or withdrawal of milk constituents in such a way as not to alter the whey protein to casein ratio of the milk being adjusted.

They may be:

1. Evaporated milk

2. Evaporated skim milk

3. Evaporated partly skimmed milk

4. Evaporated high-fat milk

5. Evaporated Filled Milk: Evaporated filled milk is a prepared blend of skim milk, vegetable oil, stabilizers and vitamins

Manufacture of Sweetened Condensed Milk

Sweetened condensed milk is milk that is concentrated by evaporation, to which sucrose is added to form an almost saturated sugar solution, after which it is packed. The high sugar concentration is primarily responsible for the keeping quality of the product and for its fairly long shelf life, even after the can has been opened, although it may eventually become moldy.

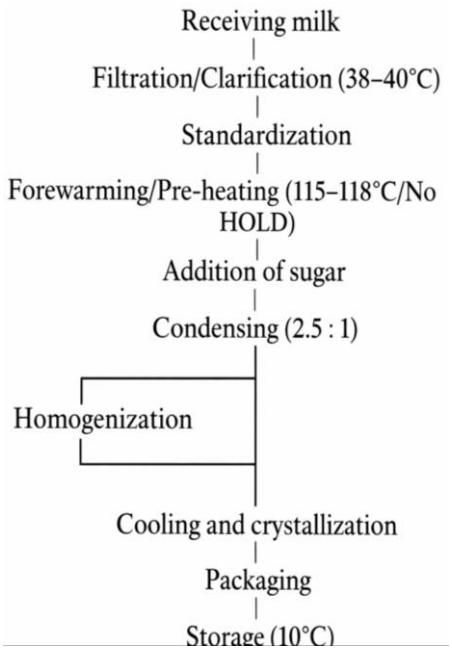
Main Steps:

1. **Selection of Milk:**
   Fresh, sweet milk without off-flavors or sediments is selected. It is clarified, filtered, and cooled if not used immediately.

2. **Standardization of Milk:**
   Milk is standardized to:
   - Achieve the desired fat: SNF (solids-not-fat) ratio.
   - Maintain the correct ratio of sugar to milk solids.
   - Ensure the required total solids in the final product.
3. **Correction of Fat Content:**
   - Fat deficiency is corrected by adding cream.
   - Fat excess is corrected by adding skim milk.

4. **Forewarming (Pasteurization):**
   Standardized milk is heated (often 85–115°C depending on process conditions) to destroy microorganisms, inactivate enzymes, and control viscosity and stability.
5. **Homogenization:**
   Sometimes done at low pressure (2–6 MPa) to reduce creaming and improve product consistency.
6. **Addition of Sugar:**
   Sugar is added mainly for preservation. Usually refined sucrose is used because it inhibits microbial growth and gives good flavor. A sugar ratio of about 62.5% in the water phase helps prevent microbial spoilage.
7. **Sugar Quality and Handling:**
   Sugar should be refined, free from invert sugar, and stored in dry sealed containers to prevent contamination or fermentation.
8. **Method of Adding Sugar:**
   Sugar is often added as a 65% syrup during condensation rather than before heating to reduce instability and age thickening.

Flow Diagram: Manufacture of Sweetened Condensed Milk



Manufacture of Evaporated Milk

Main Steps

1. **Inspection of Milk:**
   Milk is inspected by smell, taste, and sight and tested using acidity test, microscopic count, MBR test, alcohol test, and phosphate test. Milk quality affects heat stability and viscosity of the final product.

2. **Standardization:**
   Milk is standardized to the desired fat: SNF ratio in holding tanks before processing.
3. **Addition of Casein Stabilizers:**
   Stabilizers such as disodium phosphate or sodium citrate may be added to prevent heat coagulation during sterilization.
4. **Fore-warming (Preheating):**
   Milk is heated to increase heat stability, inactivate enzymes, and destroy microorganisms.

5. **Condensing:**
   Fore-warmed milk is concentrated in a vacuum pan or evaporator to the required solids level. The concentration is checked using a Baumé hydrometer.
6. **Homogenization:**
   Milk is homogenized (about 140–175 kg/cm² first stage and 35 kg/cm² second stage) to prevent creaming and improve emulsion stability. Homogenization increases viscosity.
7. **Cooling, Storage and Filling:**
   The product is cooled, stored, and filled into tins.
8. **Sterilization:**
   Filled and sealed tins are sterilized with steam under pressure to destroy bacteria and provide long shelf life and proper consistency.

Flow Diagram: Manufacture of Evaporated Milk

A. *Flow diagram of manufacture*

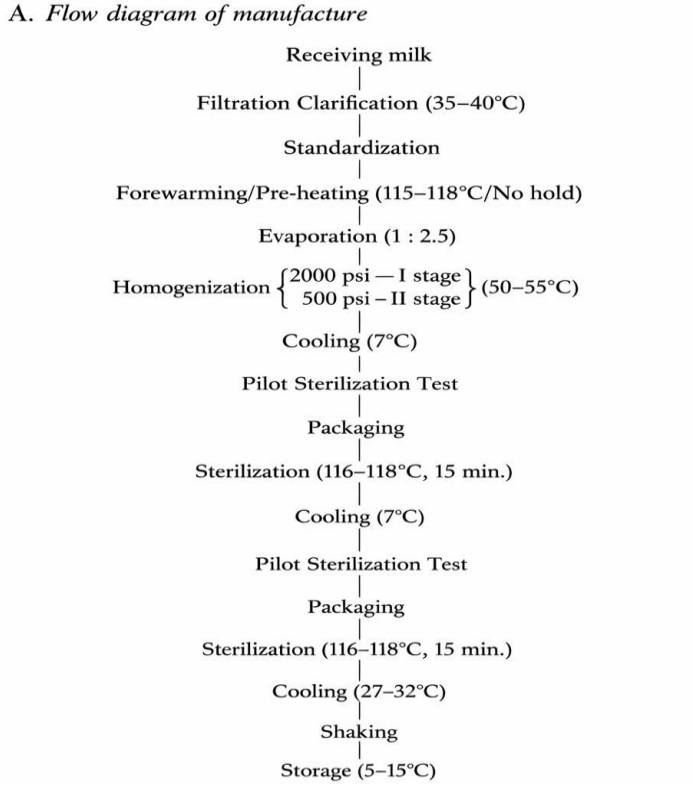


Table: Difference Between Evaporated Milk and Sweetened Condensed Milk

Feature	Evaporated Milk	Sweetened Condensed Milk
Sugar addition	No sugar added	Sugar added
Preservation method	Preserved by sterilization	Preserved by high sugar concentration
Taste	Slightly cooked flavor	Sweet taste
Shelf life	Long due to sterilization	Long due to high sugar content
Common uses	Beverages, cooking	Desserts, confectionery

Advantages of Condensed Milk

- Condensed milk has a longer shelf life compared to fresh milk.
- The reduced volume makes transportation and storage easier.
- It provides a convenient ingredient for bakery and confectionery products.

- The product is microbiologically stable due to reduced water content or high sugar concentration.
- It requires less storage space compared to liquid milk.

Disadvantages of Concentration and Drying:

- Heat damage to nutrients
- High cost of spray and freeze drying
- Stickiness and caking of powder
- Moisture absorption during storage

Practical Exercise

Activity

CHECK YOUR PROGRESS

1. Demonstrate the concentration of milk using simple heating (evaporation) and observe reduction in volume.
2. Prepare sweetened condensed milk (demonstration) by adding sugar to concentrated milk and observe changes in consistency.
3. Compare different methods of concentration (evaporation, reverse osmosis, freezing) based on temperature and product quality.
4. Observe the effect of sugar addition on preservation and shelf life of condensed milk.
5. Evaluate hygienic practices during milk handling, heating, and storage of concentrated milk products.

A. Multiple-Choice Questions (MCQs)

1. The main purpose of milk concentration is to:
   a) Increase water content
   b) Reduce volume and increase shelf life
   c) Change color of milk
   d) Increase acidity
2. Evaporation of milk is usually done under:
   a) High pressure

b) Atmospheric pressure
c) Reduced pressure (vacuum)
d) No heat

3. Reverse osmosis works on the principle of:
   a) Heating
   b) Freezing
   c) Membrane separation
   d) Fermentation
4. Sweetened condensed milk is preserved mainly by:
   a) Freezing
   b) High sugar concentration
   c) Drying
   d) Cooling
5. Evaporated milk differs from condensed milk because it:
   a) Contains more sugar
   b) Is fermented
   c) Does not contain added sugar
   d) Is dried

B. Fill in the Blanks

1. Removal of water from milk is called _____.
2. Evaporation is carried out under _____ pressure.
3. Reverse osmosis uses a _____ membrane.
4. Sweetened condensed milk contains high _____ content.
5. Evaporated milk is preserved by _____.

C. True or False

1. Concentration reduces the volume of milk.
2. Freeze concentration uses high temperature.
3. Sugar acts as a preservative in condensed milk.
4. Evaporated milk contains added sugar.
5. Concentrated milk has longer shelf life than fresh milk.

D. Subjective Questions

1. Define milk concentration and explain its objectives.
2. Describe the principle of evaporation in milk concentration.
3. Explain reverse osmosis and freeze concentration.

4. What is sweetened condensed milk?
5. Differentiate between evaporated milk and condensed milk.

SESSION 2 - PRODUCTION OF MILK POWDER: SPRAY DRYING AND ROLLER DRYING

Definition

Dried milk or milk powder is a dairy product obtained by removing most of the water from milk by heat or other suitable drying methods. The final product generally contains 5 percent or less moisture. Whole milk, skim milk, or partially skimmed milk may be used as the raw material for drying. The dried product prepared from whole milk is known as Dried Whole Milk or Whole Milk Powder (WMP), while the product obtained from skim milk is called Dried Skim Milk or Skim Milk Powder (SMP), also referred to as Non-Fat Dry Milk (NFDM). Different dried milk products are classified and named according to their composition and method of manufacture.

Objectives of Production

The main objectives of drying milk and milk products are as follows:

1. Reduction of moisture content to decrease the bulk of the product and thereby save storage space and packaging costs.
2. Reduction in transportation cost due to the decreased volume and weight of the dried product.
3. Improvement of storage life because the low moisture content limits microbial growth and spoilage.
4. Provision of a versatile ingredient that can be used in the manufacture of various food products.
5. Preservation of the natural properties of the original milk as much as possible during processing.

Composition

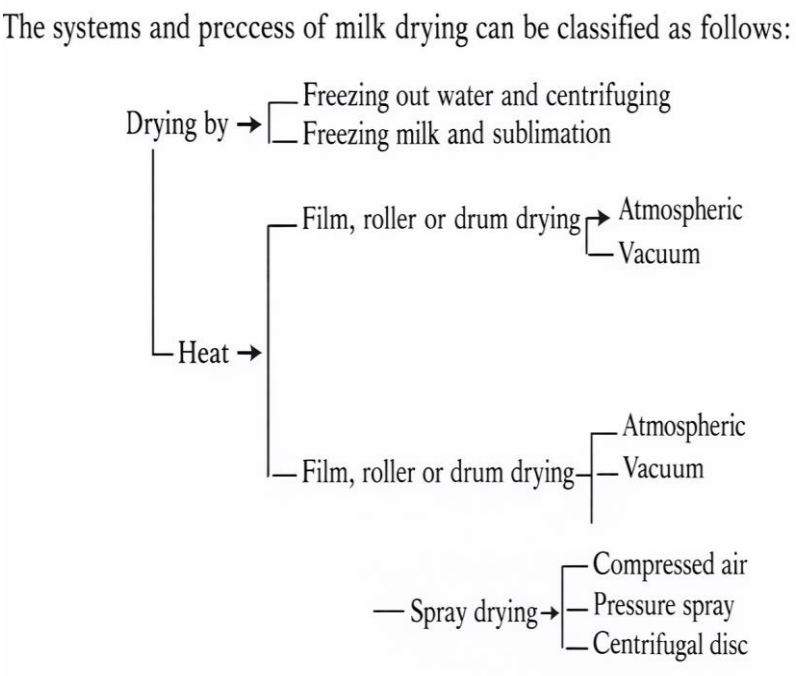
The average percentage composition of whole milk powder and skim milk powder.

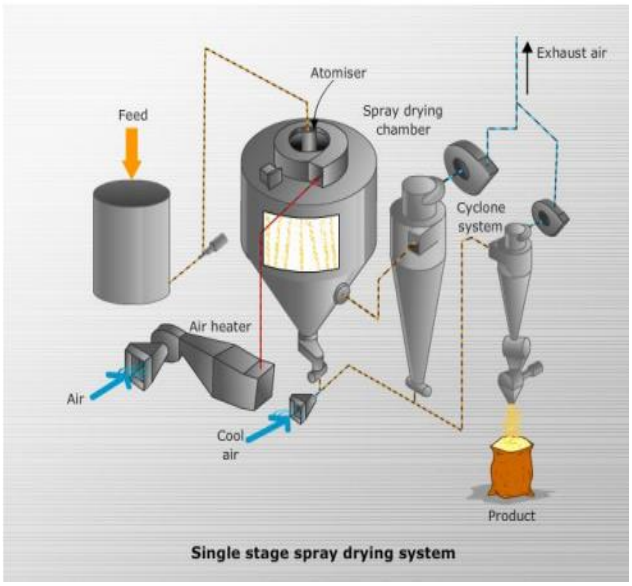
Table: Composition of Dried Milks

Type of Dried Milk	Moisture (%)	Fat (%)	Protein (%)	Lactose (%)	Ash (%)
Whole Milk Powder	2.0	27.5	26.4	38.2	5.9
Skim Milk Powder	3.0	0.8	35.9	52.3	8.0

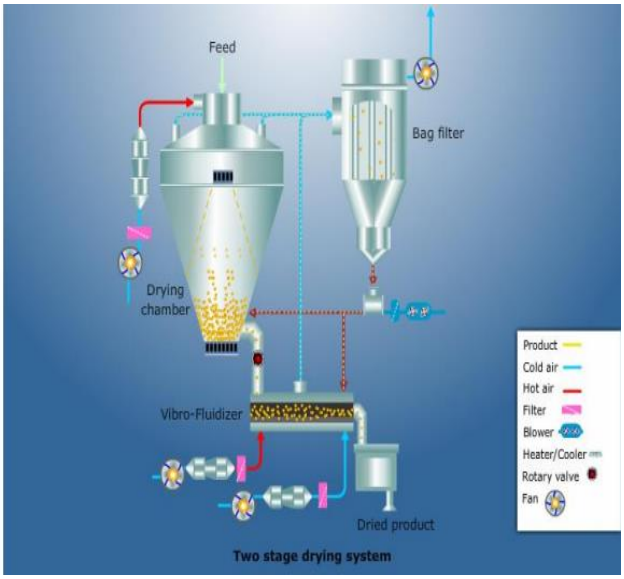
Source: Hall and Hedrick (1971), Drying of Milk and Milk Products.

Flow Diagram of Milk Drying Systems





Single stage spray drying system



Two stage drying system

Drying Milk by Cold Treatment

(a) Drying milk by freezing and sublimation.

This freeze-drying method, which seems to have been developed by 1945, consists of:

(i) freezing the product, and

(ii) supplying heat, so that moisture is removed by sublimation (without passing through the liquid phase) by maintaining a vacuum in the vaporizing chamber.

(b) Merits and demerits of freeze-drying process

Merits.
(i) Can be designed for continuous operation;
(ii) there is an almost complete absence of air throughout the drying cycle;
(iii) moisture content of the finished product can be reduced to extremely low values;
(iv) heat damage to protein stability, flavour, solubility and colour of the finished product is minimal.

Demerits.
(i) The plant is complicated;
(ii) operating costs are rather high (five to ten times that of conventional heat-drying, according to one estimate).

Flow Diagram of Drum Drying System

Milk concentrate
↓
Adjustable pump
↓
Feeding
↓
Drying drum
↓
Scraper
↓
Grinder
↓
Sifter
↓
Dried product

Spray-Drying System

A. Principle

The basic principle of spray drying consists of atomizing the milk, preferably pre-heated and concentrated, to form a spray of very fine droplets (fog-like mist). These droplets are directed into a large, suitably designed drying chamber, where they come in intimate contact with a stream of hot air.

Because of their large surface area, the droplets lose moisture almost instantaneously and dry into fine powder, which is continuously removed from the chamber.

B. Advantages and Disadvantages (over roller-drying system)

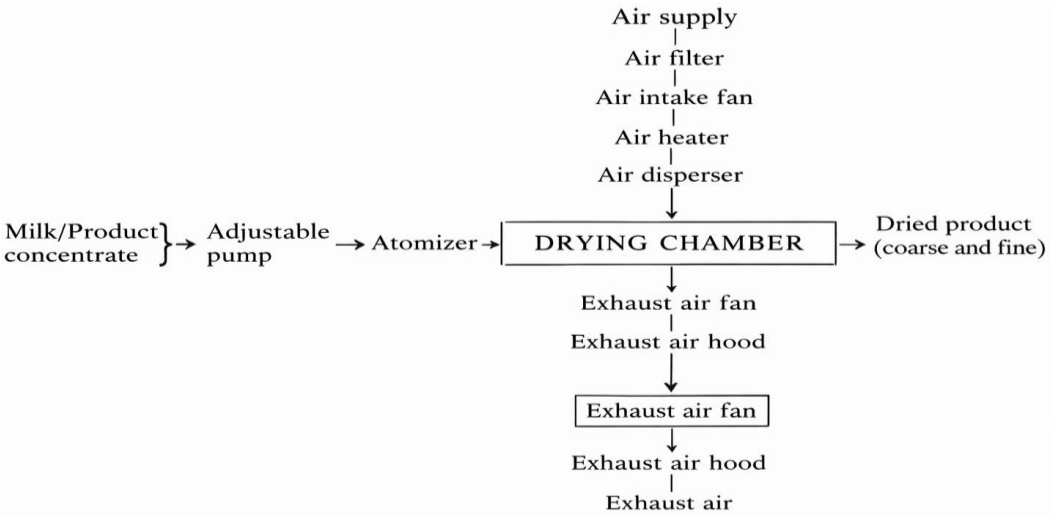
(a) Advantages

(i) Produces milk powder which is superior in appearance, flavour and solubility (and therefore commands a higher market price);
(ii) most economical when large quantities of milk are handle**d**.

(b) Disadvantages

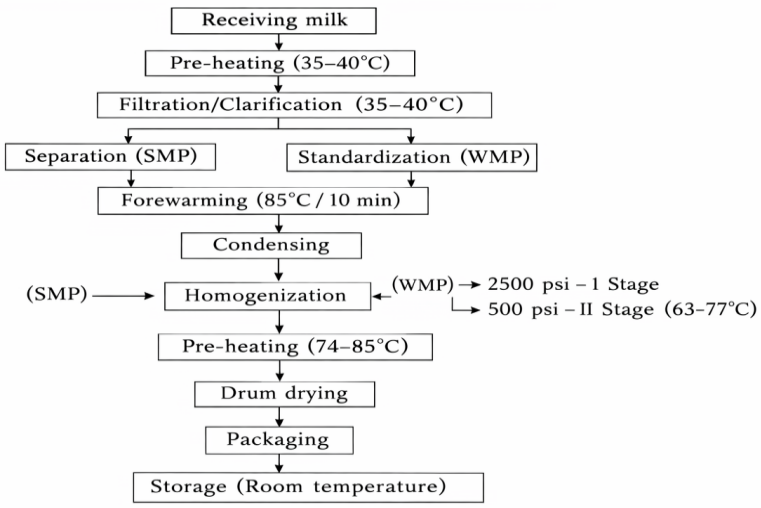
(i) Requires large capital investment in plant and buildings;
(ii) the plant is comparatively complicated.

Flow diagram of spray drying system

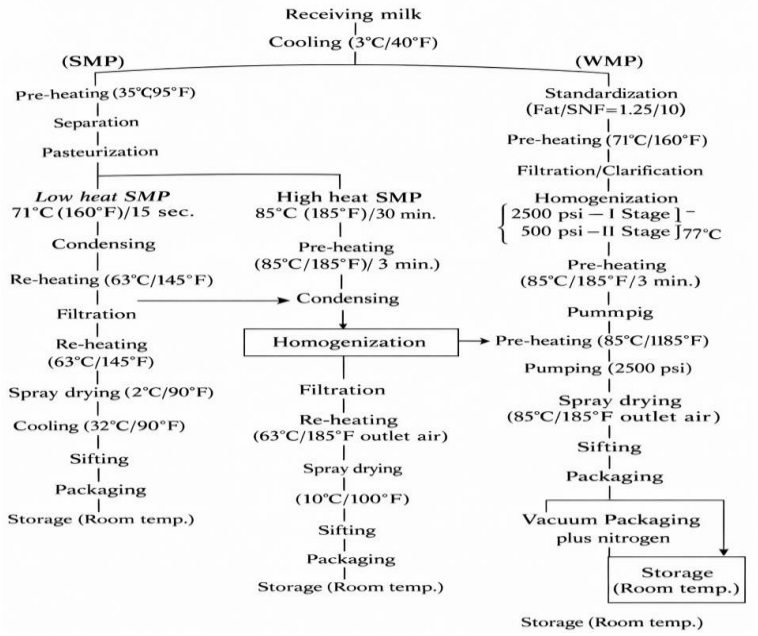


Method of Manufacture by Drum Process of Whole Milk Powder (WMP) and Skin Milk Powder (SMP)

A. *Flow diagram* – combined for WMP and SMP



A. ***Flow diagram = combined for WMP and SMP*** (Adapted from Hall and Hedrick)



Packaging

Before packaging, the sheets of roller-dried milk must be reduced to powder form. This is usually carried out using a simple brush-type sifter, which is relatively inexpensive in design and helps reduce processing costs. If a very fine powder is required, a ball mill may be used.

In the case of spray-dried powder, it is generally sufficient to remove any coarse particles by passing the powder through a screen sifter.

Hand packaging is undesirable, as it is difficult to avoid dust formation, wastage, manual contact and general inconvenience. Therefore, powder-filling machines are normally used, the type depending on the nature and size of the container.

Semi-automatic single-head machines may be used for filling large containers, whereas fully automatic multi-head rotary machines are employed for the rapid filling of small containers.

Storage

High storage temperatures negatively affect the quality and shelf life of dried milk and milk products; therefore, temperatures below 24°C (75°F) are recommended. To maintain maximum quality, dried milk products should be kept in sealed, moisture-proof, and vapor-proof packages and stored in a cool, dark, and dry environment. In regions with warm climates, refrigerated storage is preferable for long-term preservation. During retail distribution, the product should remain in its original packaging to protect its quality.

Dried Milk Products

Introduction

Dried milk products are produced for purposes similar to other dried foods. The main objective is to reduce the bulk of the product, thereby saving storage space, lowering packaging and transportation costs, and improving the shelf life of the product.

During the past two decades, many milk products and by-products have been successfully converted into dried forms, and additional products are expected in the future. However, several challenges related to production, handling, and storage still remain. These issues are being addressed through extensive research conducted worldwide, with the primary aim of preserving the natural properties of the original raw material as much as possible.

Buttermilk Powder

Dried buttermilk or buttermilk powder may be prepared from sweet, sour or high-acid buttermilk.

(a) Composition

Composition of Buttermilk Powder

Type of Buttermilk	Moisture (%)	Fat (%)	Protein (%)	Lactose (%)	Ash (%)	Lactic Acid (%)
Sweet	2.8	5.3	34.3	50.0	7.6	–
Sour (Acid)	4.8	5.7	37.6	38.8	7.4	5.7

Source: Fundamentals of Dairy Chemistry by Webb and Johnson (1974).

(b) Food and Nutritive Value

Both sweet and sour (acid) buttermilk powders are rich in protein, lactose and minerals, while acid buttermilk powder also contains a higher level of lactic acid**.**

Flow Diagram of Manufacture of Buttermilk Powder

Sweet / Sour Buttermilk
↓
Cooling (about 5°C)
↓
Storage in Stainless Steel Tanks
↓
Pre-heating (32–49°C)
↓
Condensation / Concentration
↓
Further Heating (about 85°C for 15 s)
↓
Concentration to 40–45% Solids
↓
Reheating (71–79°C)
↓
Drying (Spray or Drum Drying)
↓

Grinding and Packaging

↓

Buttermilk Powder

Packaging and Storage

Dried buttermilk is usually packed in kraft paper bags with plastic (polythene) liners or in fibre drums with or without plastic liners. It is generally stored at room temperature.

Keeping Quality

The storage life of sweet buttermilk powder is relatively short, usually about 1 to 3 months. However, some commercial samples have been reported to possess a shelf-life of more than one year at room temperature.

Uses

(i) Sweet/cream buttermilk powder may be used for enriching the nutritive value of prepared foods, bread, etc.; it can also be used in ice cream.

(ii) Sour cream buttermilk powder is intended mainly for animal and poultry feeding.

(iii) High-acid buttermilk powder is used for special purposes; under Indian conditions it may also be used for reconstitution into a "lassi" beverage.

Whey Powder

Dried whey or whey powder presents several production and storage difficulties. The high lactose content of whey solids creates problems during the manufacture of dried whey. When heated, lactose tends to become sticky, which complicates the drying process. In addition, the powder may absorb moisture from the surroundings, leading to caking of the product.

(a) Composition

The average chemical composition of whey powder

Table: Composition of Whey Powder

Type of Whey	Moisture (%)	Fat (%)	Protein (%)	Lactose (%)	Ash (%)	Lactic Acid (%)
Cheddar cheese whey (sweet)	4.5	0.9	12.9	73.5	8.0	2.3
Cottage cheese whey (acid)	3.2	0.0	13.0	66.5	10.2	8.6

Source: Fundamentals of Dairy Chemistry by Webb and Johnson (1974).

(b) Food and Nutritive Value

Both sweet and acid whey powders are fairly high in protein, minerals and lactose. In addition, whey powder contains valuable nutrients derived from milk.

However, because of the high lactose content, the drum drying of whey may lead to the formation of a sticky mass. Various processing methods have been developed to overcome this problem. One common method involves removing part of the whey proteins before drying. Whey is concentrated, lactose is crystallized, and then dried.

(c) Packaging and Storage

Dry whey is usually packed in containers lined with suitable moisture-proof materials to prevent moisture absorption and caking during storage.

Ice Cream Mix Powder

Dried ice cream mix, also known as ice cream mix powder, has gained popularity in India in recent years. Several dairy factories are now producing it on a regular basis.

Table: Composition of ice cream mix powder

Moisture	Fat	Serum solids	Sugar	Stabilizer + emulsifier
1.0 to 2.5	25.0 to 29.0	25.0 to 30.0	37.0 to 42.0	0.5 to 1.2

Source: *Drying of Milk and Milk Products* by Hall and Hedrick (1971).

Food and Nutritive Value:
Ice cream mix powder is rich in fat, protein, and sugars (including sucrose and lactose), making it a high-energy food product.

Method of Manufacture:
The ice cream mix is prepared in the usual manner by proper selection of ingredients; the percentages of fat and serum solids (milk-solids-not-fat), sugar, stabilizer and emulsifier, and total solids, are standardized to ensure proper composition of the dry product; the mix is made, pre-heated to 65–71°C (150–168°F) and homogenized at 2500 psi in the first stage and 500 psi in the second. The prepared mix is heated to 82–88°C (180–190°F) for 5–10 minutes, spray-dried to a coarse particle with 2–2.5 per cent moisture, cooled at once to 32–38°C (90–100°F), sifted, and packaged.

Packaging and storage. Normally ice cream mix powder is packed in bags with polythene liners or in fibre drums with or without polythene liners, preferably small-sized. It may be stored at room temperature or in a cooled room (10–15°C/50–60°F) with or without gas-flushing.

Keeping quality. Keeping quality: Ice cream mix powder with low moisture has a shelf life of more than 2 years at room temperature. The product, when gas-packed in 2 per cent oxygen level in the container, is expected to have a shelf-life of 6–12 months at 10–15°C. Browning, oxidation and staleness are common defects that develop during storage.

Uses. For reconstitution ice cream mix to be frozen into ice cream.

(Dried) Infant Milk food

Introduction: Infant milk food is prepared to provide proper nutrition when mother's milk is not sufficient.

Table: Composition of milks used for infant feeding

Species	Water	Fat	Protein	Lactose	Solids-not-fat	Calcium
Human	86.4	4.6	1.2	6.9	9.0	0.03

Cow	86.7	4.5	3.4	4.9	8.8	0.13
Buffalo	83.7	6.5	3.8	5.1	8.8	0.30
Goat	86.8	4.5	3.6	4.4	8.7	0.13
Sheep	81.6	7.5	5.6	4.4	10.9	0.20

Note: It will be observed from Table that human milk is characterized by a lower protein and calcium content (both of which contribute towards the formation of soft-curd, which is easily digestible) and a higher lactose content. Other milks are generally modified for infant feeding by dilution with water and the addition of sugar. For the past few decades, modified cow milk has been successfully dried into infant milk powder, under modern conditions in India, investigations were undertaken jointly by the Central Food Technological Research Institute, Mysore, and Amul Dairy, Anand, in 1957, and a standardized process was evolved for the commercial production of Amul infant (baby) food from buffalo milk in 1960 by the Roller Process. Since 1967, Amulspray babyfood has been in the market.

Composition of some infant foods

Brand Name	Moisture	Fat	Protein	Carbohydrate*	Ash
Amul	3.0	18.0	22.0	52.0	5.0
Glaxo	2.9	26.5	24.9	38.5	5.6
Lactogen	3.0	19.0	21.6	50.8	4.8
Nestogen	3.3	12.0	20.2	60.0	4.7
Vijayaspray	—	19.0	22.0	50.0	—
Parag	—	18.0	24.0	49.0	—

Includes sucrose, dextrose or dextrins, maltose or lactose.

Method of manufacture (Amul)

(a) Principle.

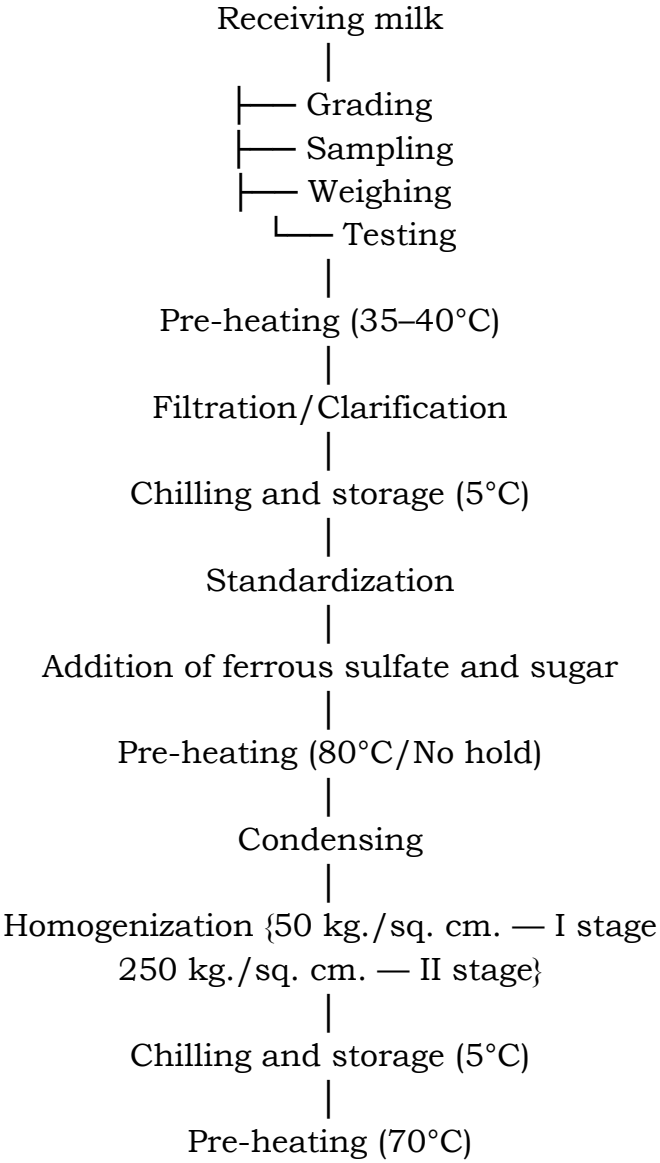
The successive steps in the production of Amul babyfood are:

(i) reduction of the fat content of buffalo milk to 2.5 per cent;

(ii) addition of buffer salts are added to improve digestibility and reduce curd hardness

(iii) addition of sugar (sucrose) so as to reduce the protein content to about 22 per cent and the fat content to about 18 per cent in the dried product;
(iv) concentration;
(v) homogenization;
(vi) drying;
(vii) fortification with amino-acids, vitamins and minerals; and
(viii) packaging in tin-cans under inert gas (nitrogen).

Flow Diagram for Production of Fortified Milk Powder



|
Drying (Roller or Spray)
|
Grinding and sifting
|
Fortification with amino-acids, vitamins and minerals
|
Gas packing
|
Storage

Practical Exercise

Activity

CHECK YOUR PROGRESS

1. Demonstrate preparation of milk powder (model/demo) using spray drying concept and observe formation of fine powder.
2. Study the spray drying process by observing atomization and drying of milk droplets.
3. Compare spray drying and roller drying methods in terms of product quality, cost, and efficiency.
4. Observe packaging methods for milk powder and note precautions to avoid moisture absorption.
5. Evaluate storage conditions required for maintaining quality and shelf life of dried milk products.

A. Multiple-Choice Questions (MCQs)

1. Milk powder is obtained by:
   a) Freezing milk
   b) Removing water from milk
   c) Adding sugar
   d) Fermenting milk
2. Spray drying works on the principle of:
   a) Freezing
   b) Atomization and hot air drying
   c) Fermentation
   d) Filtration

3. Roller drying involves:
   a) Spraying milk into air
   b) Drying milk on heated drums
   c) Freezing milk
   d) Using membranes
4. Milk powder generally contains moisture:
   a) More than 20%
   b) About 10%
   c) 5% or less
   d) 50%
5. The main advantage of spray drying is:
   a) Low cost
   b) Better flavour and solubility
   c) Simple equipment
   d) No heating required

B. Fill in the Blanks

1. Removal of water from milk to form powder is called _____.
2. Spray drying produces fine _____ particles.
3. Roller drying uses heated _____ for drying milk.
4. Milk powder should be stored in _____ and moisture-proof containers.
5. Low moisture content improves _____ life of milk powder.

C. True or False

1. Milk powder has longer shelf life than liquid milk.
2. Spray drying produces inferior quality powder than roller drying.
3. Freeze drying involves sublimation of ice.
4. High storage temperature improves milk powder quality.
5. Packaging prevents moisture absorption in milk powder.

D. Subjective Questions

1. Define milk powder and explain its types.
2. Describe the principle of spray drying.
3. Explain the roller drying method.
4. What are the objectives of milk drying?
5. Explain the importance of packaging and storage in milk powder.

SESSION 3- STANDARDS, STORAGE AND PACKAGING

Indian Standards

Table: Standards of different classes of milks in India

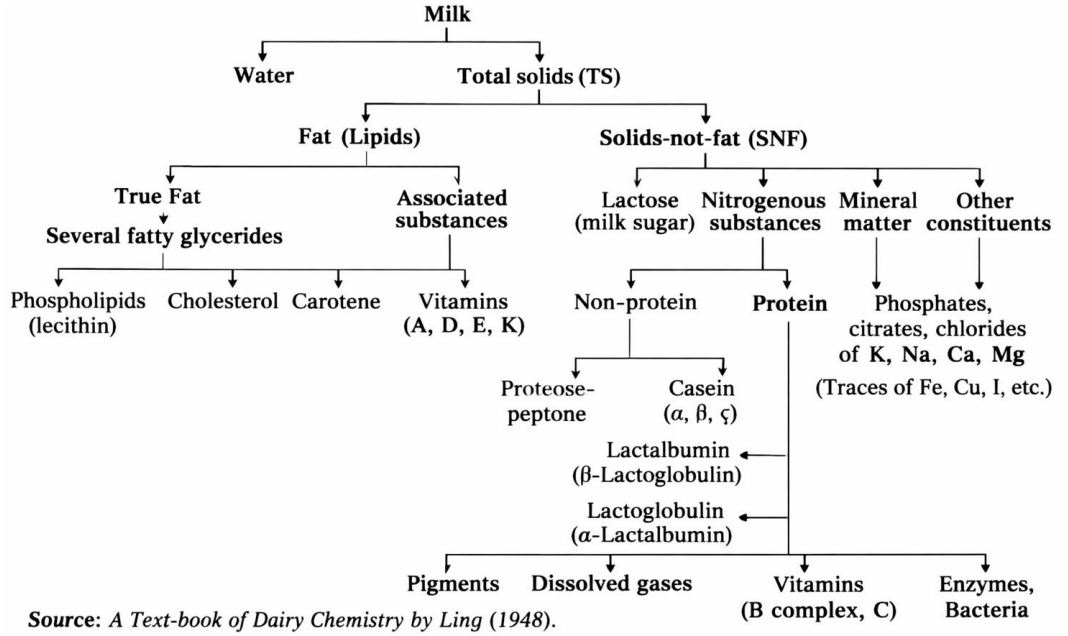
Class of milk	Designation	Locality	Minimum % MF	Minimum % MSNF
Buffalo milk	Raw, pasteurized, boiled, flavoured and sterilized	Assam; Bihar; Chandigarh; Delhi; Gujarat; Maharashtra; Haryana; Punjab; Uttar Pradesh; West Bengal	6.0	9.0
-do-	-do-	Andhra & Nicobar; Andhra Pradesh; Dadra & Nagar-Haveli; Goa; Daman & Diu; Kerala; Himachal Pradesh; Lakshadweep; Tamil Nadu; Madhya Pradesh; Manipur; Karnataka; Nagaland; NEFA; Orissa; Pondicherry; Rajasthan; Tripura; Chandigarh; Haryana; Punjab	5.0	9.0
Cow milk	-do-	Andhra & Nicobar; Bihar; Dadra & Nagar-Haveli; Delhi; Gujarat; Goa; Daman & Diu; Himachal Pradesh; Kerala; Madhya Pradesh; Tamil Nadu; Karnataka; Manipur; Nagaland; NEFA; Pondicherry; Rajasthan; Tripura; Uttar Pradesh; West Bengal; Lakshadweep	4.0	8.5
-do-	-do-	Andhra & Nicobar; Bihar; Dadra & Assam; Haryana;	3.5	8.5

		Delhi; Gujarat; Goa; Daman & Diu; Himachal Pradesh; Kerala; Madhya Pradesh; Tamil Nadu; Karnataka; Manipur; Nagaland; NEFA; Pondicherry; Rajasthan; Tripura; Uttar Pradesh; West Bengal		
Goat or sheep milk	Raw, pasteurized, boiled			

Table: Chemical composition of milk of different species

Name of species	Water	Fat	Protein	Lactose	Ash
Ass	90.0	1.3	1.7	6.5	0.5
Buffalo	84.2	6.6	3.9	5.2	0.8
Camel	86.5	3.7	4.0	5.4	0.8
Cat	84.6	3.8	9.1	4.9	0.8
Cow (foreign)	86.6	4.6	3.4	4.9	0.7
Dog	75.4	9.6	11.2	3.1	0.7
Elephant	67.8	19.6	3.1	8.8	0.7
Ewe	79.4	8.6	6.7	4.3	0.8
Goat	86.5	4.5	3.5	4.7	0.9
Guinea-pig	82.2	5.5	8.5	2.9	0.8
Human	87.7	3.8	1.9	6.8	0.2
Llama	86.5	3.2	3.9	5.6	0.8
Mare	89.1	1.6	2.7	6.1	0.5
Porpoise	41.1	45.8	11.2	1.3	0.6
Reindeer	68.2	17.1	10.4	2.3	1.5
Seal	30.6	49.8	9.5	3.4	0.9
Whale	70.1	19.6	9.5	—	1.0

Flowchart: Milk Constituents



Source: *A Text-book of Dairy Chemistry by Ling (1948).*

Factors Affecting Composition of Milk

(a) Milk differs widely in composition. All milks contain the same kind of constituents, but in varying amounts. Milk from individual cows shows greater variation than mixed herd milk. In the dairy industry greater uniform blends than in general, milk fat shows the greatest daily variation, then comes protein, followed by ash and sugar.

The factors affecting the composition of milk are:

(i) Species. Each species yields milk of a characteristic composition.

(ii) Breed. In general, breeds producing the largest amount of milk yield milk of a lower fat percentage.

(iii)Individuality. Each cow tends to yield milk of a composition that is characteristic of the individual.

(iv) Interval of milking. In general, a longer interval is associated with more milk with a lower fat test.

(v) Incomplete milking. If the cow is not completely milked, the test is normal, if not, it is usually lower.

(vi) Frequency of milking. Whether a cow is milked two, three or four times a day, it has no great effect on the fat test.

(vii) Irregularity of milking. Frequent changes in the time and interval of milking result in lower tests.

(viii) Day-to-day variation. May show variations for the individual cow.

(ix) Disease and abnormal conditions. These tend to alter the composition of milk, especially when they result in a fall in yield.

(x) Stage of milking. Foremilk is low in fat content (less than 1 per cent), while strippings are highest (close to 10 per cent). The other milk constituents are only slightly affected on a fat-free basis.

(xi) Stage of lactation. The first secretion after calving (colostrum) is very different from milk in its composition and general properties. The change from colostrum to milk takes place within a few days.

(xii) Yield. For a single cow, there is a tendency for increased yield to be accompanied by a lower fat percentage, and vice versa.

(xiii) Feeding. Has temporary effect only.

(xiv) Season. The percentages of both fat and solids-not-fat are influenced.

Flow Diagram for Manufacture, Packaging and Storage of Pasteurized Milk

Receiving milk
[Grading, Sampling, Weighing, Testing]

|

Pre-heating (35–40°C)

|

Filtration/Clarification

|

Cooling and Storage (5°C or below)

|

Standardization

|

Pasteurization (63°C/30 mts or 72°C/15 sec)

|

Homogenization (2500 psi)

|

Bottling/Packaging

|

Storage (5°C or below)

Conclusion:

Concentrated and dried dairy products increase shelf life, reduce volume, and improve convenience. Different methods are selected based on cost, quality, and use.

Practical Exercise

Activity

CHECK YOUR PROGRESS

1. Study the standards of different types of milk (buffalo, cow, goat) and compare their fat and SNF content.
2. Observe milk composition (fat, protein, lactose, ash) using charts or laboratory data.
3. Demonstrate pasteurization of milk and record temperature and time conditions.
4. Study packaging methods used for milk (bottles, pouches, cartons) and their advantages.
5. Evaluate storage conditions required for maintaining milk quality and preventing spoilage.

A. Multiple-Choice Questions (MCQs)

1. The minimum fat percentage in buffalo milk (in many regions) is:
   a) 3.0%
   b) 4.0%
   c) 5.0%
   d) 6.0%
2. Pasteurization of milk is commonly done at:
   a) 50°C
   b) 63°C for 30 minutes
   c) 100°C
   d) -5°C
3. The major component of milk is:
   a) Fat
   b) Protein
   c) Water
   d) Lactose
4. Homogenization helps to:
   a) Kill bacteria
   b) Prevent cream separation
   c) Increase sugar
   d) Remove water
5. Milk should be stored at:
   a) Room temperature
   b) Below 5°C
   c) 50°C
   d) -20°C

B. Fill in the Blanks

1. SNF stands for _____.
2. Pasteurization helps to destroy _____ in milk.
3. Milk is mainly composed of _____.
4. Homogenization reduces _____ size.
5. Milk should be stored at _____ temperature to maintain quality.

C. True or False

1. Milk composition is the same for all species.
2. Fat content varies more than other components in milk.
3. Pasteurization increases microbial growth.
4. Proper storage increases shelf life of milk.
5. Packaging helps protect milk from contamination.

D. Subjective Questions

1. Explain the standards of milk in India.
2. Describe the composition of milk from different species.
3. List the factors affecting the composition of milk.
4. Explain the process of pasteurization.
5. Discuss the importance of packaging and storage of milk.

Unit 3

Dairy Industry: By-products

Definition

A dairy by-product is a product of commercial value obtained during the manufacture of a primary dairy product. (However, what is currently a by-product may become the main product in the future.)

During the manufacture of different dairy products, the inevitable problem of utilization of by-products is encountered. Because of their unique and important nutrients available in the by-products, they have to be utilized in a proper manner considering the welfare of the general masses. Improper utilization of dairy by-products leads to wastage of valuable nutrients, which is undesirable, especially in developing countries facing malnutrition. The profitability of the dairying can be greatly improved by economically utilizing the dairy by-products and it can be considered as a prerequisite to profitable dairy business. With the advancement in technology, the scope is wide open for creating newer channels of utilization of the by-products arising from dairy processing.

In India, the dairy industry generates large quantities of by-products due to high milk production and widespread traditional processing (e.g., ghee, paneer). With the unorganised sector handling 80-85% of milk, many by-products remain underutilized or wasted, leading to environmental pollution and lost economic value. Proper utilization can reduce waste, improve dairy profitability, support rural livelihoods, and enhance nutritional security.

Table: By-products of Indian Dairy Industry

Main product	**By-product**
Cream	Skim milk
Butter	Buttermilk
Ghee	Lassi Ghee residue
Chhana / Paneer	Whey
Cheese	Whey
Casein	Whey

Table: By-products of Western Dairy Industry

Main product	By-product
Cream	Skim milk
Butter	Buttermilk
Cheese	Whey
Casein	Whey

SESSION-1 STATUS AND SCOPE OF DAIRY BY-PRODUCTS

India is the world's largest milk producer, with recent estimates indicating production of 247.87 million tonnes annually during 2024-25 (as per Basic Animal Husbandry Statistics 2025, Department of Animal Husbandry and Dairying, Government of India). This accounts for about 25% of global milk output, with most consumed domestically.

India contributes less than 1% to global dairy trade. The per capita availability of milk stands at around 485 grams per day. The dairy sector engages over 80 million rural families and grows at about 4-6% annually in volume, supported by strong domestic demand. Leading milk-producing states include Uttar Pradesh (15.66%), Rajasthan (14.82%), Madhya Pradesh (9.12%), Gujarat (7.78%), and Maharashtra (6.71%).

In dairy processing, about 40-50% of milk is converted into main products like butter, ghee, cheese, paneer, curd, and milk powder. This generates significant by-products such as skim milk, whey, buttermilk, and ghee residue. Traditional products (e.g., ghee and butter) account for a large share of milk use, while value-added items like cheese and yoghurt contribute to by-product generation in the organised sector.

Status of Dairy By-Products Dairy by-products are rich in nutrients like proteins, lactose, minerals, and vitamins. Their utilization varies between organised and unorganised sectors (the latter handling about 80-85% of milk).

- **Skim Milk and Skim Milk Powder (SMP)**: Produced during cream separation for butter/ghee. SMP production is around 770,000 tonnes annually (2025 estimates from USDA reports), with forecasts for slight increase in coming years. It is widely used in reconstituted milk, sweets, ice cream, bakery products, and exports.

- **Whey**: Generated from cheese, paneer, and chhana making (sweet or acid whey). Estimated annual production is around 0.8-1 million tonnes. Much is used in animal feed or beverages in the organised sector, but often underutilized or discarded in unorganised areas. India imports whey protein concentrates to meet demand in nutrition and sports products.
- **Buttermilk**: Obtained from butter churning. It is utilized in traditional drinks like lassi, chaach, and fermented products, or as animal feed.
- **Ghee Residue**: A solid by-product from ghee clarification, rich in proteins and used in sweets or animal feed.

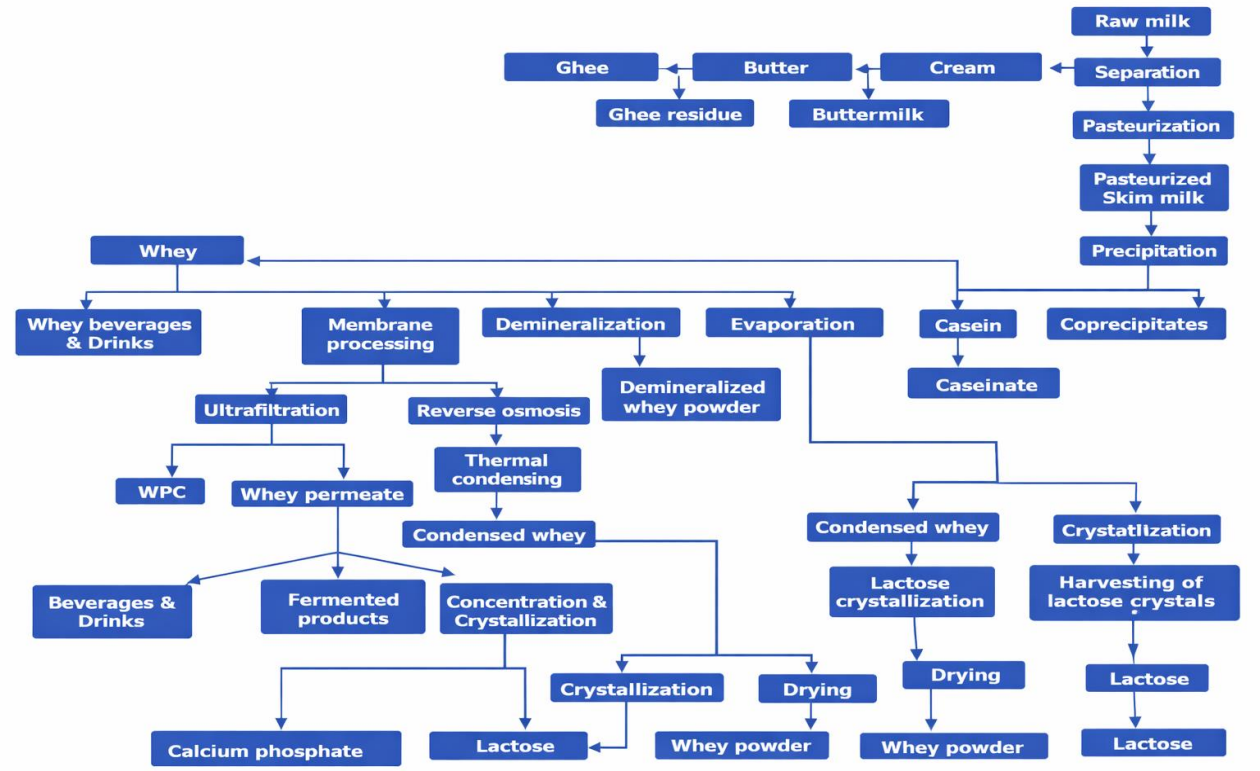
In the unorganised sector, many by-products face underutilization, leading to waste and environmental concerns. Organised processing (cooperatives and private dairies) recovers and values them better.

Scope of Dairy By-Products There is considerable scope for improved utilization and value addition of dairy by-products:

- **Economic Benefits**: Proper utilization can increase dairy profitability by 20-30% through conversion into high-value items like whey protein isolates/concentrates (growing demand in health foods, sports nutrition, and functional beverages).
- **Nutritional and Industrial Applications**: Whey and lactose in infant formula, dietary supplements, pharmaceuticals, and bakery; skim milk in low-fat products; buttermilk in probiotics and fermented foods; casein from skim milk in food and industrial uses.
- **Export Potential**: Growing exports of SMP, casein, and whey products to neighbouring countries (e.g., Middle East, Bangladesh) and ethnic markets.
- **Opportunities and Challenges**: Advances in technology (e.g., ultrafiltration, membrane processing, spray drying) enable better recovery and new products. Government schemes promote value addition and clean production. Challenges include poor infrastructure in rural/unorganised sectors, seasonal surpluses, environmental pollution from waste, and need for awareness/training among producers. With rising health consciousness, urban demand for protein-rich/functional foods, and organised sector expansion, by-products offer high growth potential in sustainable dairy development.
- Future Trends: Rising demand for functional and protein-rich foods (e.g., sports nutrition, supplements) is driving value addition in whey protein and casein. Technology adoption (ultrafiltration, membrane processing) in

organised dairies reduces imports (e.g., whey protein) and boosts exports of SMP and casein. Government schemes support this shift toward sustainable, high-value by-product use.

- **Nutritional and Environmental Importance** Dairy by-products are nutrient-dense: Whey provides high-quality proteins (including BCAAs for muscle health), skim milk offers low-fat protein and calcium, buttermilk contains probiotics for gut health, and ghee residue is rich in proteins and antioxidants. Environmentally, better utilization prevents pollution (e.g., whey disposal increases water BOD/COD levels) and promotes a circular economy (waste to wealth), aligning with sustainable dairy development.



Dairy-byproducts

Table: Important By-products from the Dairy Industry and Their Utilization

S. No.	Main Product	By-Product	Processing Method	Products Made / Utilization (Common in India)
1	Cream	Skim Milk	Pasteurization	Flavoured milk, reconstituted milk

			Sterilization	Sterilized flavoured milk
			Fermentation	Cultured buttermilk, probiotic drinks
			Concentration	Plain and sweetened condensed skim milk
			Drying	Skim milk powder (SMP) – used in sweets, ice cream, bakery, reconstituted milk (production ~0.77-0.79 million tonnes in 2025-26)
			Coagulation	Cottage cheese, paneer-like products, edible casein
2	Butter	Buttermilk	Fermentation	Lassi, chaach, cultured buttermilk drinks
			Concentration and Drying	Dried buttermilk – used in bakery products, animal feed
			Fermentation and Concentration	Condensed buttermilk
3	Cheese, Casein, Chhana, Paneer	Whey	Fermentation	Whey beverages, probiotic drinks
			Concentration	Whey protein concentrate (WPC), whey paste, lactose, condensed whey
			Drying	Dried whey powder – used in infant formula, sports nutrition, bakery (India imports whey protein to meet demand)
			Coagulation	Ricotta cheese or whey-based cheese

4	Ghee	Ghee Residue	Processing (drying/mixing/fat extraction)	Sweetmeats (burfi, peda), toffee, sweet paste, energy bars, snacks, bakery fillings, cookies, chocolates (production ~0.2 million tonnes/year; often underutilized)

Proper utilization of dairy by-products is essential for increasing profitability, reducing waste and ensuring sustainable dairy development.

Practical Exercise

Activity

CHECK YOUR PROGRESS

1. Identify different dairy by-products (skim milk, whey, buttermilk, ghee residue) from various dairy processes.
2. Observe the utilization of by-products in preparing products like lassi, paneer, and whey beverages.
3. Compare organised and unorganised sectors in terms of by-product utilization and wastage.
4. Study the nutritional value of dairy by-products such as whey and skim milk.
5. Evaluate environmental impact of improper disposal of dairy by-products and suggest solutions.

A. Multiple-Choice Questions (MCQs)

1. A dairy by-product is:
   a) The main dairy product
   b) A waste material
   c) A product obtained during manufacture of main product
   d) A synthetic product
2. Whey is obtained during the production of:
   a) Butter
   b) Cheese and paneer

c) Ghee
d) Ice cream

3. Skim milk is obtained from:
   a) Cheese making
   b) Cream separation
   c) Butter churning
   d) Drying
4. Buttermilk is a by-product of:
   a) Ghee making
   b) Butter churning
   c) Cheese making
   d) Milk drying
5. Proper utilization of dairy by-products helps to:
   a) Increase waste
   b) Reduce profitability
   c) Improve economic value
   d) Decrease nutrition

B. Fill in the Blanks

1. Dairy by-products are rich in _____ like proteins and minerals.
2. Whey contains high-quality _____.
3. Skim milk is low in _____ content.
4. Improper disposal of whey can cause _____ pollution.
5. Utilization of by-products improves _____ of dairy industry.

C. True or False

1. Dairy by-products have no nutritional value.
2. Whey is often underutilized in unorganised sectors.
3. Proper utilization reduces environmental pollution.
4. Buttermilk can be used as a beverage.
5. Dairy by-products cannot be converted into value-added products.

D. Subjective Questions

1. Define dairy by-products and give examples.
2. Explain the importance of utilizing dairy by-products.
3. Describe the status of dairy by-products in India.
4. List the major dairy by-products and their uses.

5. Discuss the environmental impact of improper disposal of by-products.

SESSION-2

SKIM MILK AND ITS BY-PRODUCTS

Skim milk is a by-product obtained during the manufacture of cream. It is rich in solids-notfat content and has high nutritional value. In dairy plants, it is mostly utilized either in standardization for the manufacture of main dairy products or preserved by removing moisture in spray dried form. The skim milk when utilized in either of these two forms or consumed as liquid is not considered a by-product. It is regarded as a by-product only when it is either not economically utilized or utilized for derived by-products like casein and related products, coprecipitates, protein hydrolysates etc.

Skim Milk and Its By-Products

Skim milk is a valuable by-product obtained during the manufacture of cream by centrifugal separation of whole milk. It is rich in solids-not-fat (SNF), containing high-quality proteins (about 3.4–3.5 %), lactose (about 4.8–5 %), minerals (especially calcium and phosphorus) and B-complex vitamins. Skim milk has high nutritional value and serves as an important source of protein for human consumption.

Utilization Trends The use of skim milk has changed over the years. Earlier, a large part was fed to livestock. Today, skim milk is mainly used in two ways:

- For standardisation of milk fat in main dairy products (toned milk, flavoured milk, curd).
- Preserved by spray drying to make skim milk powder (SMP).

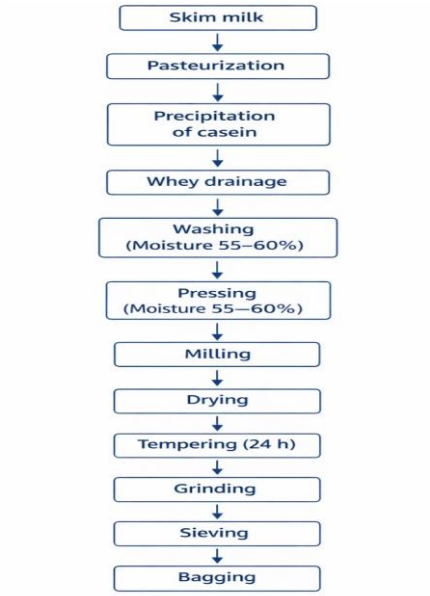
Skim milk is not treated as a by-product when used in these forms. It becomes a by-product only when it is not used economically or is processed into derived products like casein, caseinates, co-precipitates or milk protein hydrolysates.

Skim Milk Powder (SMP) SMP is the most common form of preserved skim milk. It is made by spray drying pasteurised skim milk. It has low moisture (3–4 %) and long shelf life. SMP is used in reconstituted milk, sweets, ice cream, bakery products and infant formula. In India, SMP production is around 770,000 tonnes (2025) and is expected to reach about 790,000 tonnes in 2026. Almost all SMP is used in the country.

Casein and Caseinates Casein is the major protein in skim milk (80 % of milk proteins). It is obtained by acid or enzyme precipitation.

- Industrial uses: paper, textile, paint, leather and adhesives.
- Edible uses: imitation cheese, nutritional bars, sports nutrition and infant formula.

Global production is about 1 million tonnes per year. Major producers are New Zealand, Ireland, France and the Netherlands. The USA is the biggest importer. In India, edible casein is now produced in modern plants and exported. Caseinate production is still limited due to high cost.



Basic principle of casein manufacture

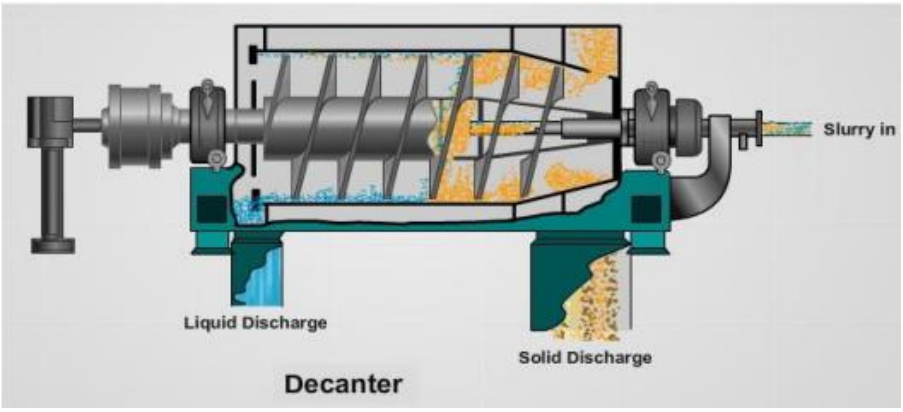


Fig: Drying, tempering and grinding

Co-precipitates Co-precipitates are made by precipitating casein and whey proteins together using heat and acid. They give higher yield and better nutrition than plain casein. However, they are not widely produced in India because of poor solubility.

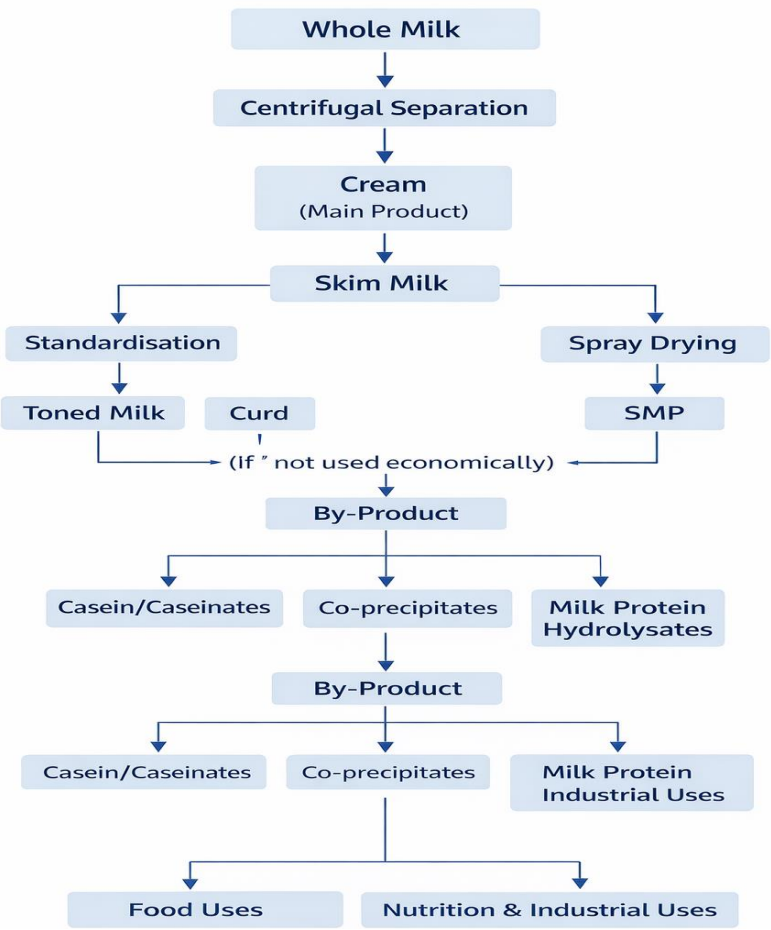
Milk Protein Hydrolysates These are made by enzymatic hydrolysis of casein or whey proteins. They are predigested and easy to absorb. They are used in infant formula, medical nutrition, sports drinks and allergy-friendly foods. The global market is growing rapidly (USD 1.1 billion in 2024 to USD 2.2 billion by 2034). In India, demand is rising in functional foods.

Skim milk and its by-products offer great opportunity in the Indian dairy industry. Proper use increases profit, reduces waste and supports nutrition.

Table: Key Derived By-Products from Skim Milk

By-Product	Production Method	Main Uses	India/Global Status (2025)
Skim Milk Powder (SMP)	Spray drying	Reconstituted milk, sweets, ice cream	India: ~770,000 tonnes (2025)
Casein & Caseinates	Acid/enzyme precipitation	Imitation cheese, nutrition bars	Global: ~1 million tonnes; India exporter
Co-precipitates	Heat + acid/alkali	Bakery, nutritional foods	Limited commercial use
Milk Protein Hydrolysates	Enzymatic hydrolysis	Infant formula, sports nutrition	Growing market in India

Flowchart: Skim Milk Utilization Pathway



Key Features of Skim Milk By-Products

- High nutritional value (protein, calcium, vitamins).
- Increases dairy profitability.
- Supports functional foods and sports nutrition.
- Helps reduce waste and pollution.
- Growing scope in India through modern plants and government schemes.

Table: By-products, their principle of utilization and names of food products made

By-product	Principle of Utilization / Processing Method	Food Products Made / Common Utilization in India
Skim Milk	Pasteurization	Flavoured milks, reconstituted milk
	Sterilization	Sterilized flavoured milk

	Fermentation	Cultured buttermilk, probiotic drinks, acidophilus milk
	Fermentation and Concentration	Concentrated sour skim milk
	Concentration	Plain condensed skim milk, sweetened condensed skim milk, low-lactose condensed skim milk
	Drying	Dried skim milk / Skim milk powder (SMP) – used in sweets, ice cream, bakery, reconstituted milk
	Coagulation	Cottage cheese, edible casein
Buttermilk	Fermentation	Lassi, chaach, cultured buttermilk drinks, probiotic beverages
	Fermentation and Concentration	Condensed buttermilk
	Concentration and Drying	Dried buttermilk – used in bakery products, animal feed
	Coagulation	Soft cheese or similar products
Whey	Fermentation	Whey beverages, probiotic drinks
	Concentration	Whey protein concentrate (WPC), whey paste, lactose, plain/sweetened condensed whey
	Drying	Dried whey powder – used in infant formula, sports nutrition, bakery, functional foods (high demand; often imported)
	Coagulation	Ricotta cheese or whey-based cheese
Ghee Residue	Processing (drying, mixing, fat extraction)	Traditional sweetmeats (burfi, peda), toffee, sweet paste, energy bars, snacks, bakery fillings, cookies, chocolates

Table: Composition of some by-products (percentage)

Name of by-product (from cow milk)	**Water**	**Fat**	**Protein**	**Lactose**	**Ash**
Skim milk	90.6	0.1	3.6	5.0	0.7
Buttermilk (sweet cream)	91.0	0.4	3.4	4.5	0.7
Lassi	96.2	0.8	1.4	1.2	0.4

Ghee residue (sweet-cream butter)	9.7	61.4	24.8	—	4.1
Chhana whey	93.6	0.5	0.4	5.1	0.4
Cheese whey	93.1	0.3	0.9	4.9	0.6
Acid-casein whey	93.1	0.1	1.0	5.1	0.7

Practical Exercise

Activity

CHECK YOUR PROGRESS

1. Demonstrate separation of cream from milk to obtain skim milk and observe its composition.
2. Prepare skim milk powder (concept/demo) using spray drying and observe differences from liquid skim milk.
3. Prepare casein (demonstration) by acid precipitation from skim milk and study its texture.
4. Compare skim milk and whole milk in terms of fat content and nutritional value.
5. Evaluate utilization of skim milk by-products in foods like bakery products, beverages, and nutritional supplements.

A. Multiple-Choice Questions (MCQs)

1. Skim milk is obtained during:
   a) Cheese making
   b) Cream separation
   c) Butter churning
   d) Drying
2. Skim milk is rich in:
   a) Fat
   b) Water only
   c) Solids-not-fat (SNF)
   d) Sugar only
3. Skim milk powder is produced by:
   a) Freezing

b) Fermentation
c) Spray drying
d) Filtration

4. Casein is obtained by:
   a) Freezing milk
   b) Acid or enzyme precipitation
   c) Drying milk
   d) Boiling milk
5. Milk protein hydrolysates are produced by:
   a) Heating
   b) Enzymatic hydrolysis
   c) Freezing
   d) Filtration

B. Fill in the Blanks

1. Skim milk contains very low _____ content.
2. The major protein in milk is _____.
3. Skim milk powder has low _____ content and long shelf life.
4. Co-precipitates contain both _____ and whey proteins.
5. Milk protein hydrolysates are used in _____ nutrition.

C. True or False

1. Skim milk is rich in protein and minerals.
2. Skim milk contains high fat content.
3. Casein has industrial as well as edible uses.
4. Milk protein hydrolysates are difficult to digest.
5. Skim milk by-products help reduce waste and increase profit.

D. Subjective Questions

1. Define skim milk and explain its composition.
2. Describe the uses of skim milk in the dairy industry.
3. Explain the production of skim milk powder.
4. What is casein? Mention its uses.
5. Explain milk protein hydrolysates and their importance.

SESSION-3

WHEY AND ITS BY-PRODUCTS

Whey is the greenish translucent liquid obtained as a by-product during the manufacture of cheese, casein, chhana, paneer, chakka and co-precipitates. Until recently, whey was considered one of the major disposal problems of the dairy industry due to its high organic matter content (6–7% total solids) in the form of protein, lactose, fat, minerals and water-soluble vitamins. Its disposal causes serious environmental pollution because of very high biological oxygen demand (BOD) of 40,000 mg/kg or more. This makes whey an economical burden when disposed of as waste.

The quantity of whey produced is often too small in many plants to justify economical utilization. The low total solids content of whey has also led to a lack of interest in its processing compared to other fluid by-products. High processing and handling costs result in a large amount of whey being disposed of as raw whey. In small plants, options are limited to municipal treatment, spreading on farmlands for nutrient value, or feeding to livestock. Acid whey (e.g., from cottage cheese or paneer) is particularly difficult to utilize due to high mineral content (0.7–0.8%), low pH and salty flavour. Neutralization is possible but increases cost and adds sodium ions, altering whey characteristics.

Despite these challenges, whey is a valuable source of precious nutrients such as lactose, whey proteins, minerals and vitamins. Utilization in the human food chain is now preferred due to economic opportunities. Whey serves as the base material for nutritional products like whey protein concentrates (WPC), lactose, whey drinks and dietetic beverages. However, a significant portion of whey production—especially from small plants—still remains unutilized or disposed of as raw whey.

Nutritional Characteristics of Whey By-products

Condensed whey

Condensed whey contains whey constituents in more concentrated form. Whey solids in the form of condensed whey is a cheap source of high-quality proteins and carbohydrate and the fat is generally removed by centrifugation. Sweetened condensed whey contains sugar equal to the weight of solids in whey which is a source of energy.

Whey powder

Whey powder is the dried form of whey that contains relatively high concentration of all whey constituents including lactose and protein. In the presence of moisture, lactose and protein readily participate in the maillard reaction. This interaction may result in a decrease in protein quality, which is accompanied or followed by undesirable colour changes. During drying, high heat denatures whey proteins, destroying some bioactive compounds, such as the amino acid cystine. Acid whey powder from Cottage cheese and related products contains approx. 65 percent lactose, 12 percent protein, 6 percent lactic acid, 2.5 percent moisture and large quantities of calcium; in fact, all of the calcium that originally existed in the milk. Furthermore, acid whey powder contains the vitamin B complex, vitamin C, and the natural milk fermentation flavour compounds, like diacetyl.

Because of low concentrations of sodium, potassium and chloride, but high lactose and high-quality whey proteins contents, demineralised whey powder at 90% demineralization level is eminently appropriate for the preparation of infant formulae for meeting the nutritional requirements of infants.

Table: Essential mineral content in acid and sweet whey powder

Minerals	WHO Recommended Daily Intake (Adult Male)	Acid Whey Powder (mg/100g)	Sweet Whey Powder (mg/100g)
Calcium	500 mg	2,054 mg	796 mg
Zinc	22 mg	6.31 mg	1.97 mg
Magnesium	300 mg	199 mg	176 mg
Phosphorus	—	1,348 mg	932 mg

Source:

- *World Health Organization, 1974*
- Potosi and Orr, 1976

Table: Key Characteristics and Challenges of Whey

Aspect	Details

Source	Cheese, casein, chhana, paneer, chakka, co-precipitates
Appearance	Greenish translucent liquid
Total Solids	6–7% (protein, lactose, fat, minerals, water-soluble vitamins)
BOD (Biological Oxygen Demand)	Very high (40,000 mg/kg or more) – causes environmental pollution
Mineral Content	0.7–0.8% – causes salty flavour and restricts many applications
pH (Acid Whey)	Low – makes utilization difficult
Main Disposal Methods (Small Plants)	Municipal treatment, farmland spreading, livestock feeding
Major Problems	High processing/handling cost, low solids, small quantity, salty taste
Valuable Nutrients	Lactose, whey proteins, minerals, vitamins
Preferred Modern Use	Human food chain: WPC, lactose, whey drinks, dietetic beverages

Key Features of Whey Utilization

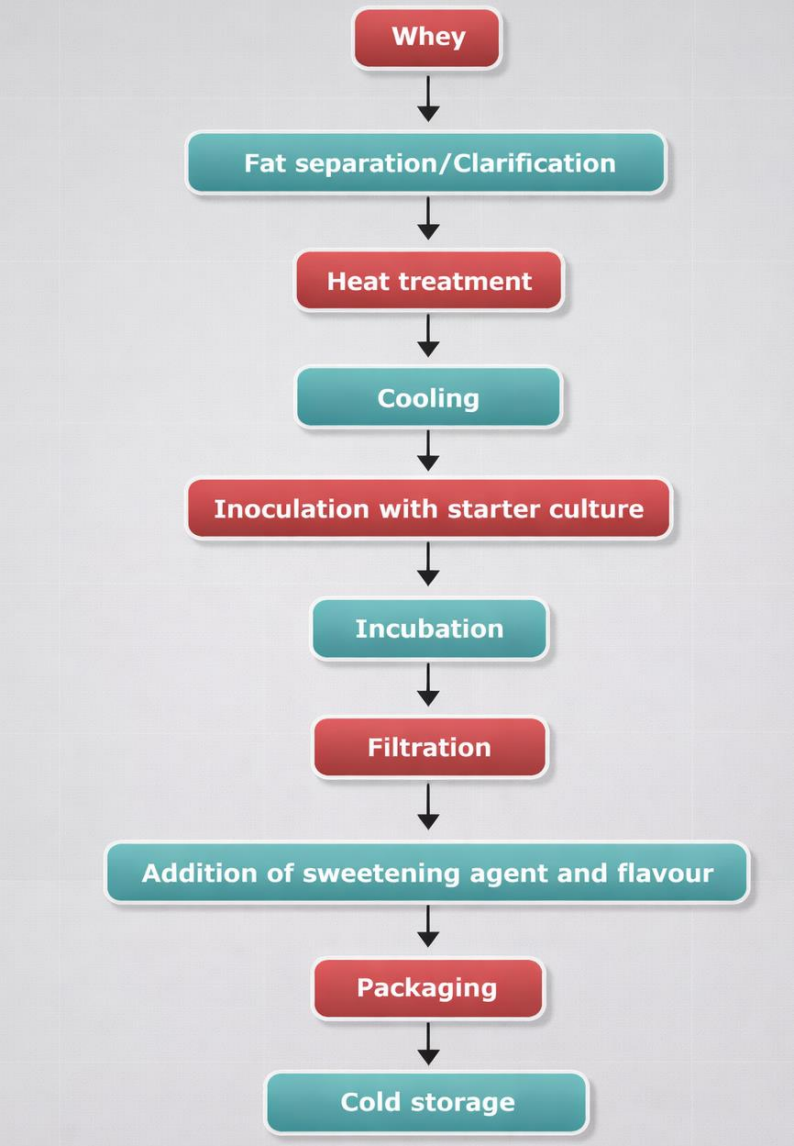
- **Environmental Concern**: High BOD leads to pollution if discharged untreated.
- **Economic Challenge**: Processing cost often exceeds value in small plants.
- **Acid Whey Difficulty**: High minerals and low pH limit use; neutralization adds cost and sodium.
- **Nutritional Value**: Rich in high-quality whey proteins and lactose for human nutrition.
- **Current Status**: Large amount still disposed as raw whey, especially from small-scale units.
- **Scope for Improvement**: Growing interest in value-added products like whey protein concentrates and beverages.
- **Human Food Preference**: Favoured now for economic and nutritional benefits over animal feed or waste disposal.

Whey Drinks

Whey can be utilized for the preparation of a variety of beverages such as plain, carbonated, alcoholic and fruit-flavoured drinks. These beverages have been developed and marketed in many countries due to their potential for utilizing whey solids and nutrients. Among these, drinks prepared by blending whey with fruit juices are the most common.

Whey-based beverages also include products made from deproteinated milk serum, fermented dairy-type beverages, and flavoured milk-type drinks containing whey or its components. Fermented whey beverages such as soft drinks, whey wine, beer-like products and low-alcohol beverages are considered economical methods for converting whey into value-added products through microbiological processes.

However, alcoholic whey beverages like whey beer and whey wine have limited commercial importance. Whey-based liqueurs may gain importance in the future. Although whey drinks are rich in proteins and nutrients, their market value is still limited and they are generally produced on a small scale. Certain technological problems may arise during processing, especially when additional ingredients are used. Flavour losses may also occur during UHT processing, particularly in direct heating systems.



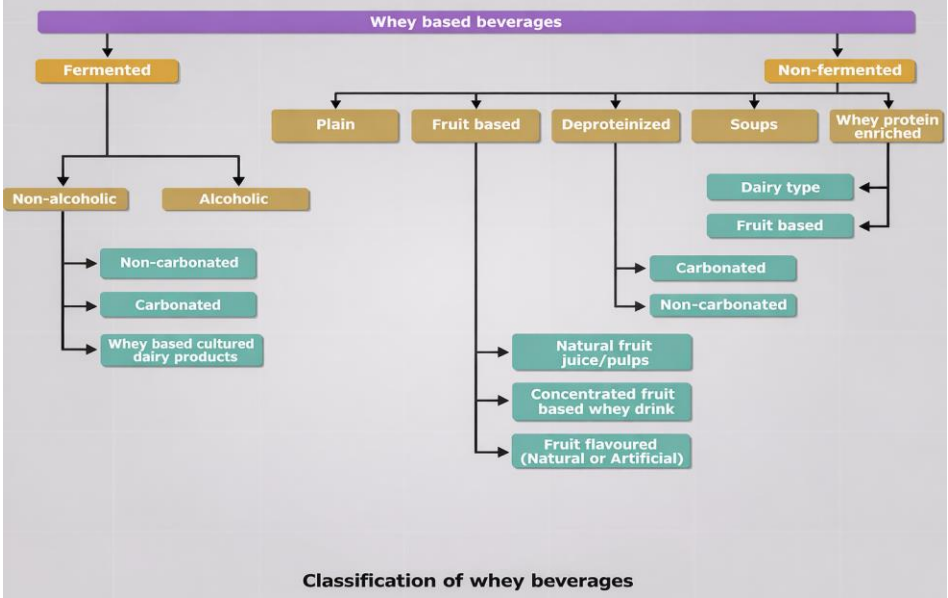
Flow diagram for production of whey based fermented

Concentrated and Dried Whey

Drying of whey is an important method for increasing its shelf life and reducing its weight and volume. This helps in lowering transportation and storage costs. The production of whey powder ensures that no by-product residues remain after processing.

However, the process has certain limitations. It requires expensive equipment and high energy input. Compared to products like whey protein concentrates, dried whey has a relatively lower market value. A major part of the energy

consumption (more than 50%) occurs during the evaporation stage. Therefore, the efficiency of evaporators plays a crucial role in the economic production of whey powder.



Classification of whey beverages

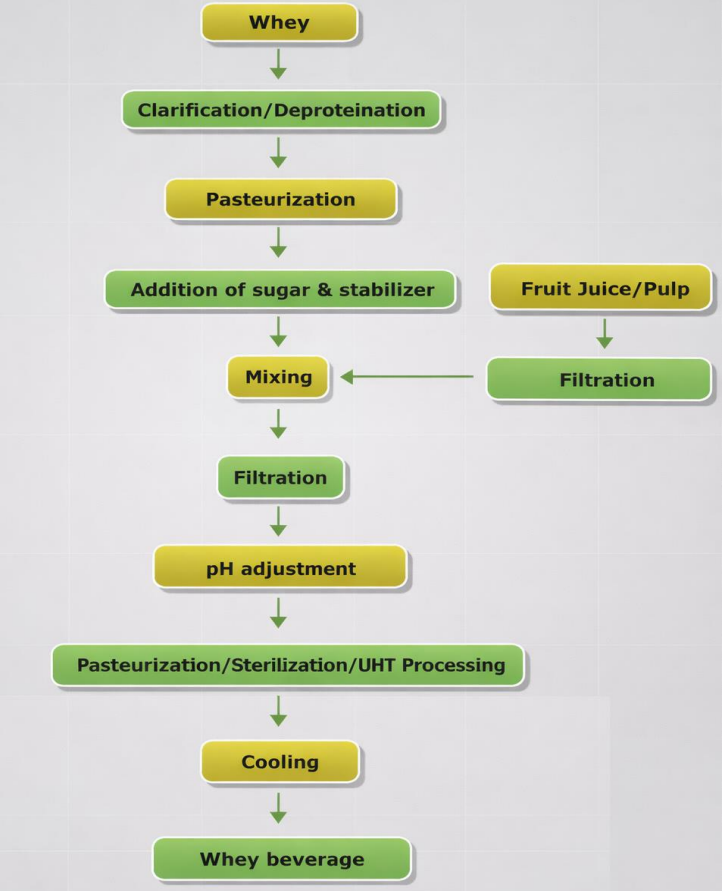
Ultrafiltration Processing of Whey

Ultrafiltration (UF) is commonly used for the separation of whey proteins to produce whey protein concentrates (WPC). These concentrates are highly functional and widely used in the food industry as substitutes for non-fat dry milk and other protein ingredients.

The UF process produces two fractions:

- Whey protein concentrate (retentate)
- Permeate containing lactose and minerals

Although UF technology has been in use for many years, its adoption has been limited due to certain constraints. The process is economically feasible mainly for large-scale operations, as the product yield is relatively low. Additionally, the permeate generated during the process creates disposal problems similar to those associated with raw whey.

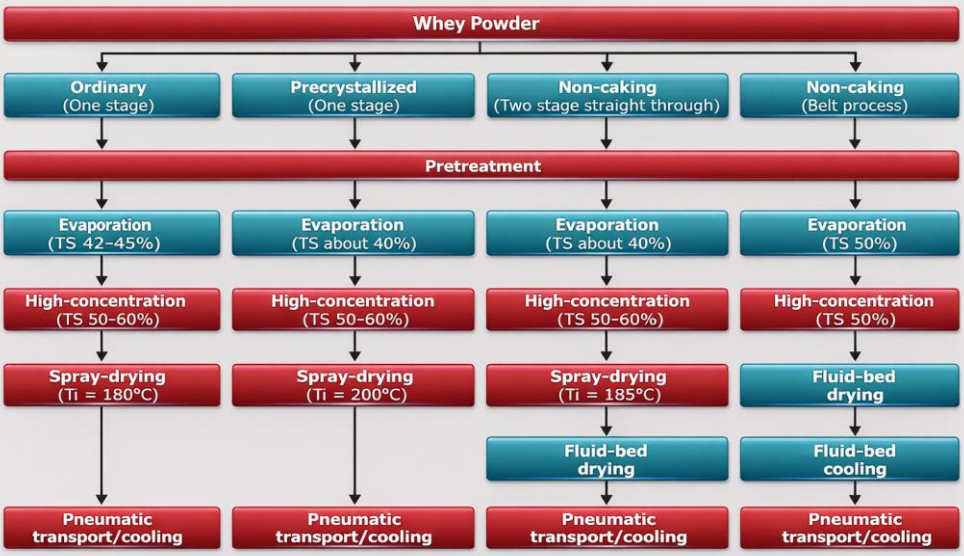


Flow diagram for production of fruit whey beverage

Demineralized Whey

Demineralized whey is produced by removing minerals using processes such as ion-exchange and electrodialysis. This improves the quality and suitability of whey for use in value-added products, especially in infant foods and specialized formulations.

Despite its advantages, the process has several limitations. It requires high capital investment and operational costs. The disposal of effluents generated during processing also poses environmental challenges. Therefore, the economic viability of demineralized whey depends on its utilization in high-value products.



Different processes for the manufacture of whey powder

Practical Exercise

Activity

CHECK YOUR PROGRESS

1. Observe whey obtained during paneer or cheese preparation and note its colour, taste, and composition.
2. Prepare a whey-based beverage by mixing whey with fruit juice and evaluate flavour and acceptability.
3. Compare sweet whey and acid whey based on pH, mineral content, and usability.
4. Study drying of whey (demo/concept) to understand production of whey powder.
5. Evaluate environmental impact of whey disposal and suggest methods for its proper utilization.

A. Multiple-Choice Questions (MCQs)

1. Whey is obtained during:
   a) Milk pasteurization
   b) Cheese and paneer production

c) Milk drying
d) Cream separation

2. Whey contains:
   a) Only water
   b) High fat only
   c) Lactose, proteins, minerals and vitamins
   d) No nutrients
3. The major environmental problem caused by whey is:
   a) Low temperature
   b) High BOD
   c) Low fat
   d) Low lactose
4. Whey protein concentrate (WPC) is obtained by:
   a) Fermentation
   b) Ultrafiltration
   c) Freezing
   d) Boiling
5. Demineralized whey is mainly used in:
   a) Animal feed only
   b) Infant food and special products
   c) Fuel production
   d) Packaging

B. Fill in the Blanks

1. Whey is a _____ liquid obtained during dairy processing.
2. Whey contains high-quality _____ proteins.
3. High BOD of whey causes _____ pollution.
4. Ultrafiltration separates whey into _____ and permeate.
5. Whey powder is produced by _____ process.

C. True or False

1. Whey has no nutritional value.
2. Whey disposal can cause environmental pollution.
3. Whey can be used to prepare beverages.
4. Ultrafiltration is used to concentrate whey proteins.
5. Demineralized whey has no industrial use.

D. Subjective Questions

1. Define whey and explain its composition.
2. Describe the problems associated with whey disposal.
3. Explain the production and uses of whey powder.
4. What is whey protein concentrate (WPC)?
5. Describe the preparation and importance of whey beverages.

SESSION-4

BUTTERMILK AND GHEE RESIDUE

Buttermilk

Buttermilk is an important by-product obtained during manufacture of butter. In addition, a substantial amount of lassi (sour buttermilk) is also produced during the manufacture of makkhan directly from fermented milk (curd). Sweet cream buttermilk (SCBM) is almost similar in composition to skim milk except for their high amount of phospholipids and milk fat globular membrane proteins.

Types of Buttermilk

a) Sweet cream buttermilk obtained by churning of fresh/ pasteurized cream with little or no developed acidity

b) Sour buttermilk obtained by churning naturally sour milk or cream

c) Desi buttermilk (lassi) obtained by churning of curd (dahi) during the manufacture of makkhan.

Table: Average gross composition and physico-chemical properties of sweet cream buttermilk and skim milk (obtained from buffalo milk)

Comparison of Characteristics of Skim Milk and Sweet Cream Buttermilk

Characteristic	Skim Milk	Sweet cream Buttermilk
T.S. (%)	10.38	9.88
Fat (%)	0.09	0.59
Total proteins (%)	4.27	3.73
Lactose (%)	5.20	4.81
Ash (%)	0.82	0.75
Total phospholipids (mg %)	8.65	78.56
Titratable acidity (% LA)	0.16	0.12
pH	6.69	6.86
Curd tension (g)	66.85	18.84
Relative viscosity (cP at 30°C)	1.64	1.80

Source: Pal & Mulay (1983).

Table: Difference between sweet cream buttermilk and skim milk

Aspect	Buttermilk	Skim Milk
Fat content	Higher (can be reduced by centrifugation)	Very low
Proteins	Contains FGMP (fat globule membrane proteins), unique and aid emulsification	Lacks FGMP
Phospholipids	~9× higher; includes lecithin, sphingomyelin, cephalin	Much lower
Fatty acids	Mainly long-chain (e.g., palmitic acid); ~40% saturated, rest unsaturated	Lower levels of such fatty acids
Functional properties	Good emulsifier; antioxidant activity; helps prevent lipid oxidation	Limited functional properties
Applications	Useful in dairy processing and food stabilization	More limited applications

Buttermilk Powder

Buttermilk can be preserved by drying it into powder using the same process as skim milk powder—pasteurization, evaporation, and spray or roller drying. Buttermilk powder must contain at least 4.5% fat, 30% protein, and not more than 5% moisture, with no added chemicals or non-buttermilk ingredients. It

has higher phospholipid and lipid content than skim milk powder. Sweet cream buttermilk also shows better heat stability, making it suitable for high-temperature processing.

Buttermilk powder is a cream-colored product with a mild dairy flavor. Spray-dried powder has better solubility than roller-dried. Its composition is similar to skim milk powder but includes additional fat globule membrane proteins and higher lipid (especially phospholipid) content. It has lower bulk density and is less free-flowing due to higher fat. The shelf life is 6–9 months and is limited by fat oxidation, which can be reduced by keeping moisture low and avoiding light and metals.

Utilization of Buttermilk

The uses of sweet cream buttermilk are somewhat similar to those of skim milk. It is valued in the food industry because of its emulsifying capacity and its positive impact on flavor. Commercially produced buttermilk is mostly sweet cream buttermilk. It is a desirable component of bakery products to improve their flavor and texture, the condensed and dried forms being the most convenient ones. High phospholipids content in dried buttermilk makes it a good functional ingredient in food formulations. Casein made from buttermilk is different in many respects from skim-milk casein. For most purposes, it is less desirable than casein from skim milk. But for casein paints, it is especially suitable if used in paste form without being dried. Buttermilk as such and in condensed form is also used as animal feed and dried buttermilk is added in the formulation of their mixed feeds.

Dahi: Incorporation of sweet cream buttermilk into whole milk produces a soft body due to changes in casein charge, presence of phospholipids and MFGM material, and free fat. Addition of 1–2% skim milk powder improves body. It can also be used for cultured buttermilk and lassi.

Yoghurt: Total solids are increased to 14–16%. Buttermilk powder can replace up to 50% of skim milk powder in low-fat yoghurt with acceptable quality. Addition up to 4.8% gives a soft, smooth product and reduces syneresis.

Cheese: Buttermilk with skim milk can be used for low-fat cheese. It improves texture due to high water-holding capacity of phospholipids but may produce a softer body. It also increases yield, improves flavour, texture, and biological value, and reduces cost and waste.

Indian traditional dairy products

Channa: Buffalo milk channa is hard and greasy, but addition of sweet cream buttermilk (SCBM) improves quality and is suitable for products like rasogolla and sandesh.

Paneer: Replacing skim milk with SCBM in buffalo milk increases paneer yield (~1%) without affecting quality. Buttermilk solids can also be used to make good quality paneer from low-fat milk.

Basundi: Replacement of buffalo milk solids with SCBM affects quality at 100% replacement, but up to 25% replacement is acceptable.

Chakka & Shrikhand: Replacement of skim milk with SCBM (up to 50%) improves flavour, body, and texture of chakka. Shrikhand made from SCBM with 15% total solids is comparable to control.

Frozen products: Buttermilk powder can replace skim milk solids in ice cream, improving product quality.

Beverages: Buttermilk is widely used as a refreshing drink in plain or spiced forms. It can be blended with fruit juices or pulps (e.g., apple, mango, litchi) to improve flavour, texture, and quality.

Probiotic drinks: The growing interest worldwide in probiotic foods led the researchers to find all possible ways of developing health foods and buttermilk is no exception. Various workers have developed buttermilkbased probiotic drinks with different probiotic bacteria. Rodas et al, (2002) developed probiotic buttermilk by adding the probiotic strain of Lactobacillus reuteri at a rate of 1%.

Sour buttermilk: Obtained during butter manufacture; not preferred for direct consumption but can be converted into casein or used for paneer making, giving higher yield and comparable quality and shelf life.

Desi buttermilk (chhach): Used as a refreshing beverage, flavoured with salt and spices; also used in products like karhi and rabri. Industrial use is limited due to lack of proper collection and variation in quality.

Buttermilk powder: Can partly replace skim milk powder in baked goods, ice cream, pudding, sauces, beverages, and chocolates; improves flavor, browning,

water binding, viscosity, and emulsification; also useful in products like khoa, kheer, rabri, gulabjamun, and rasogolla.

Utilization of Buttermilk Powder: Buttermilk powder can replace partly skim milk powder for incorporation into baked goods, ice cream, Pudding, sauces, beverages and chocolates. In baked goods it provides desirable flavor, help to incorporate air into product, aid in the development of browning as the product is baked and preserve freshness by binding water. In pudding, sauces and beverages, buttermilk powder is used to absorb water and increase their viscosity. In chocolate it provides the beneficial emulsifying ability.

Great scope lies in the effective use of buttermilk or buttermilk solids in the manufacture of some of our popular indigenous Indian dairy products, e.g., khoa, kheer, rabri and gulabjamun. The dried buttermilk can replace the SMP in the manufacture of gulabjamun mix powder. Because of high lecithin content in buttermilk, it may improve the textural properties of rasogolla.

Ghee Residue

Introduction

Ghee-residue is a by-product of the ghee manufacturing industry. It is a partially charred (burnt), light to dark brown, moist residue obtained on the cloth strainer after ghee is filtered. During ghee manufacture, the solids-not-fat (SNF) present in cream or butter appear as small particles known as ghee-residue. It is obtained after molten ghee is either strained through bag filters or muslin cloth, or separated by continuous centrifugal clarifiers.

The yield of ghee-residue varies with the method of ghee preparation. This variation is due to differences in the non-fatty serum constituents of the raw materials used. The average yield is highest in the direct creamery (DC) method (about 12%), followed by the creamery butter (CB) and desi butter (DB) methods (about 3.7%).

Ghee-residue, especially that obtained from creamery butter, contains a high level of phospholipids (17.39% of its total fat). These phospholipids act as good emulsifiers and are useful in products where mixing of fat and aqueous phases is required.

The keeping quality of all types of ghee-residue clarified at 120°C is about 3 months. Its shelf life can be increased to more than 4 months by pressing it into cake form.

Table: Chemical composition and yield of ghee-residue (Hand pressed)

Source of ghee-residue	Average % fat of source	Moisture (%)	Fat (%)	Protein (%)	Lactose (%)	Ash (%)	Yield (kg/100 kg source)
From buffalo milk							
Desi butter	77.0	13.4	33.4	32.8	15.4	5.2	1.6
Creamery butter (unsalted)	85.0	5.7	65.0	25.5	Trace	3.8	1.2
Sweet cream	67.0	4.1	63.2	18.0	12.3	2.4	7.7
Sour cream	67.0	8.0	38.8	41.6	7.3	4.3	5.1
Washed sweet cream	71.0	1.7	80.8	16.2	Trace	1.3	3.5

Recovery of Ghee from Ghee-Residue

In dairy plants, attempt is made to recover as much ghee as possible from ghee-residue. Two methods of recovery of ghee from ghee-residue are adopted.

Pressure technique

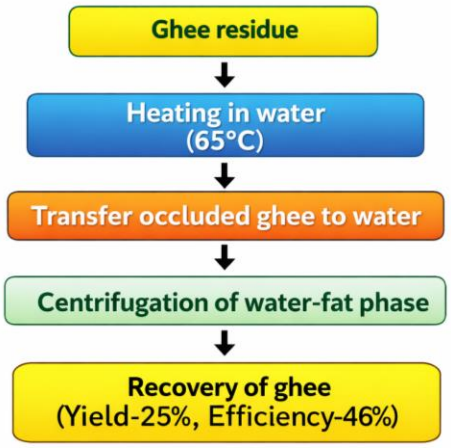
This consists of subjecting the heated ghee-residue (65-70oC) to a limited pressure in hand screw or hydraulic press. This method gives a yield of about 45% (extraction efficiency of about 67%). This method is simple, efficient, more practical, economical and requires no electricity or sophisticated equipment.

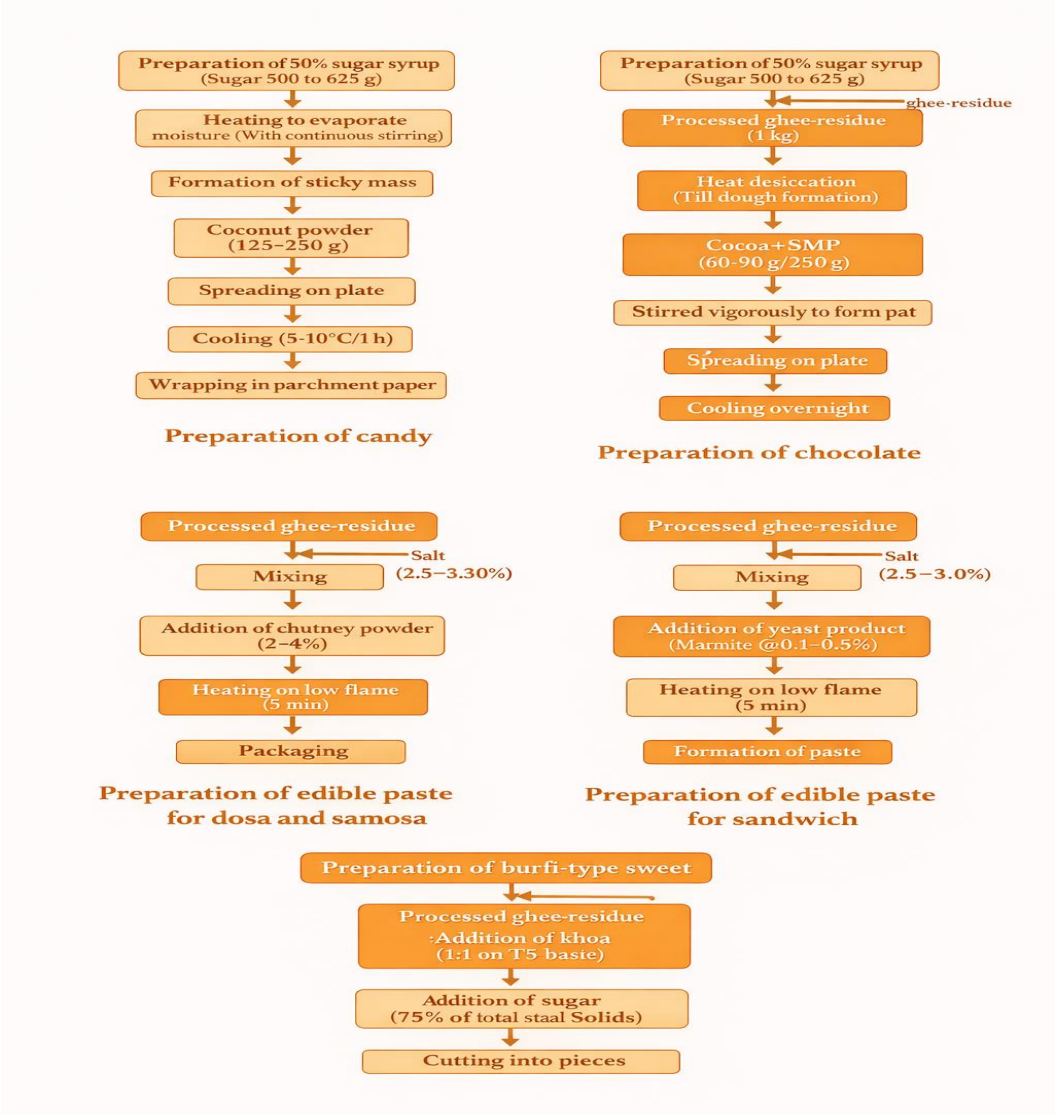
Centrifugation process

This consists of heating ghee-residue in water (65oC) due to which fat entrapped within the residue matrix melts and oozes out, and collects as the top layer above soak water. Ghee is subsequently recovered by centrifuging the water-fat phase. The method yields 25% ghee (46% efficiency).

Alternatively the released fat at the surface of water is recovered by solidification by cooling either by adding ice/cold water or leaving it in a cold store (5-10oC) over night.

Flowchart: Recovery of ghee by Centrifugation process





Conclusion: Proper utilization of dairy by-products is essential for improving profitability, reducing environmental pollution, and ensuring sustainable development of the dairy industry.

Practical Exercise

Activity

CHECK YOUR PROGRESS

1. Demonstrate preparation of buttermilk by churning cream or curd and observe its taste and composition.

2. Prepare a buttermilk-based beverage (spiced or fruit-based) and evaluate flavour and acceptability.
3. Observe buttermilk powder (demo/concept) and compare it with skim milk powder.
4. Study ghee residue obtained during ghee preparation and note its colour, texture, and composition.
5. Demonstrate recovery of ghee from ghee residue using simple heating and pressing/centrifugation methods.

A. Multiple-Choice Questions (MCQs)

1. Buttermilk is obtained during:
   a) Cheese making
   b) Butter churning
   c) Milk drying
   d) Cream separation
2. Sweet cream buttermilk is obtained from:
   a) Sour milk
   b) Fresh cream
   c) Paneer
   d) Whey
3. Buttermilk powder is produced by:
   a) Freezing
   b) Fermentation
   c) Drying (spray/roller)
   d) Filtration
4. Ghee residue is obtained during:
   a) Milk pasteurization
   b) Ghee preparation
   c) Cheese making
   d) Milk drying
5. One method of recovering ghee from residue is:
   a) Fermentation
   b) Centrifugation
   c) Freezing
   d) Filtration

B. Fill in the Blanks

1. Buttermilk contains high _____ content and phospholipids.

2. Sweet cream buttermilk is similar to _____ milk in composition.
3. Buttermilk powder has a shelf life of about _____ months.
4. Ghee residue contains significant amounts of _____ and protein.
5. Ghee can be recovered from residue using _____ or centrifugation.

C. True or False

1. Buttermilk has no nutritional value.
2. Buttermilk powder has better solubility when spray dried.
3. Ghee residue contains useful nutrients.
4. Buttermilk can be used in bakery and dairy products.
5. Ghee residue cannot be utilized further.

D. Subjective Questions

1. Define buttermilk and explain its types.
2. Describe the composition and properties of buttermilk.
3. Explain the preparation and uses of buttermilk powder.
4. What is ghee residue? How is it formed?
5. Describe methods of recovery of ghee from ghee residue.

Unit 4

Food Safety and Team Management (FSMS: HACCP, GMP)

Introduction

Food safety is an essential requirement in the food and dairy industry, ensuring that food is safe for consumption and free from contamination at all stages, from production to distribution. It is achieved through a systematic approach known as the Food Safety Management System (FSMS), which integrates various preventive and control measures. Key components of FSMS include Good Manufacturing Practices (GMP) and Hazard Analysis and Critical Control Points (HACCP). GMP provides the basic guidelines for hygiene, sanitation, equipment maintenance, and proper handling of food materials, while HACCP focuses on identifying potential hazards and controlling them at critical stages of processing to prevent risks before they occur.

Effective team management is equally important for the successful implementation of food safety systems. A well-trained and organized team ensures that all safety practices are properly followed. Clear roles and responsibilities, regular training, and proper communication help maintain high standards of hygiene and safety. Strong leadership, continuous monitoring, and a collective sense of responsibility among workers contribute to a positive food safety culture, ultimately ensuring the production of safe and high-quality food products.

FSMS is based on Prerequisite Programs (PRPs), HACCP principles, and management system elements, which together ensure effective control of food safety hazards.

SESSION-1

INTRODUCTION TO FOOD SAFETY MANAGEMENT SYSTEM

Food safety is a global concern, not only because of the importance for public health but also because of its impact on international trade. Globalisation of food production and procurement makes food chains longer and more complex and increases the risk of food safety incidents. Effective and harmonized food safety systems shall manage and ensure the safety and suitability of food in each link of the supply chain. For this reason ISO developed the standard for food safety management systems ISO 22000 which applies to all organizations in the food chain and thus ensures integrity of the chain. ISO 22000 is a generic food safety

management system standard. It defines a set of general food safety requirements that apply to all organizations in the food chain. If an organization is part of the food chain, ISO 22000 wants it to establish a food safety management system (FSMS). It then wants it to use this system to ensure that food products do not cause adverse human health effects. Since ISO 22000 is a generic food safety management standard, it can be used by any organization directly or indirectly involved in the food chain. It applies to all organizations in the food chain. It doesn't matter how complex the organization is or what size it is, ISO 22000 can help ensure the safety of its food products.

Definition and Terminology

Control (noun)

To state wherein correct procedures are being followed and criteria are being met.

Control (verb)

To take all necessary actions to ensure and maintain compliance with criteria established in the HACCP plan.

Control measure

Any action and activity that can be used to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

Corrective action

Any action to be taken when the results of monitoring at the CCP indicate a loss of control.

Critical control point (CCP)

A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

Critical limit

A criterion which separates acceptability from unacceptability.

Deviation Failure

to meet a critical limit.

End products

Product that will undergo no further processing or transformation by the organization.

Flow diagram

A systematic representation of the sequence of steps or operations used in the production or manufacture of a particular food item.

Food safety hazard

Biological, chemical or physical agents in food, or condition of food, with potential to cause an adverse health effect.

Food safety policy

Overall intentions and direction of an organization related to food safety as formally expressed by top management.

HACCP plan

A document prepared in accordance with the principles of HACCP to ensure control of hazards which are significant for food safety in the segment of the food chain under consideration.

HACCP

A system which identifies, evaluates and controls hazards which are significant for food safety.

Hazard analysis

The process of collecting and evaluating information on hazards and conditions loading to their presence to decide which are significant for food safety and therefore should be addressed in the HACCP plan.

Hazard

A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect. It is the potential to cause harm; risk on the other hand is the likelihood of harm (in defined circumstances, and usually qualified by some statement of the severity of the harm).

Monitor

The act of conducting a planned sequence of observations or measurements of control parameters to assess whether a CCP is under control.

Operating limits

Criteria more stringent than critical limits that are used by an operator to reduce that risk of contamination, eg., if a certain chemical concentration is required to control a hazard, the operating limit is generally set above the minimum concentration needed to ensure effective treatment.

Operational prerequisite programme (OPRP)

Identified by the hazard analysis as essential in order to control the likelihood of introducing food safety hazards (and/ or the contamination or proliferation or food safety hazards in the product (s) or in the processing environment.

Prerequisite programme (PRP)

Basic condition and activities that is necessary to maintain a hygienic environment throughout the food chain suitable for production, handling and provision of safe end products and safe food for human consumption.

Risk

An estimate of the likely occurrence of a hazard.

Severity

The seriousness of a hazard (if not properly controlled)

Step

A point, procedure, operation or stage in the food chain including raw materials, from primary production to final consumption.

Validation

Verification focused on collecting and evaluating scientific and technical information to determine if the HACCP plan, when properly implemented, will effectively control the hazards.

Verification

The use of methods, procedures or test, in addition to those used in monitoring, those determine if the HACCP system complies with the HACCP plan and/ or whether the plan needs modification.

ISO 22000, Food safety management systems – Requirements

ISO 22000, Food safety management systems – Requirements for any organization in the food chain, was first published in 2005. The standard provides international harmonization in the field of food safety standards, offering a tool to implement HACCP (Hazard Analysis and Critical Control Point) throughout the food supply chain.

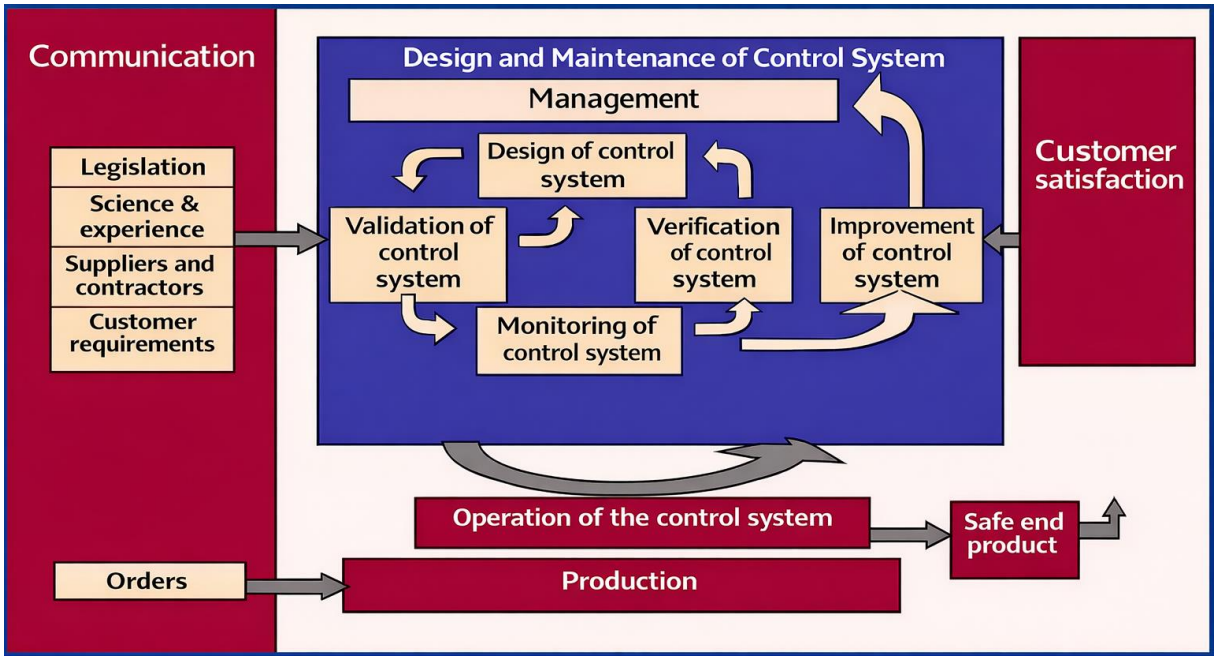


Fig: Process module of the standard ISO 22000:2005

Use of FSMS (ISO 22000)

- Primary producers: Dairy Farms, Ranches, Fisheries, Dairies
- Processors: Dairy, Fish, Meat, Poultry, Feed
- Manufacturers of Soups, Snacks, Breads, Cereals, Dressings, Beverages, Seasonings, Packaging, Frozen food, Canned food, Confectionery, Dietary supplements
- Food service providers: Grocery stores, Restaurants, Cafeterias, Hospitals, Hotels, Resorts, Airlines, Cruise ships, Seniors lodges, Nursing homes
- Other service providers for Storage service providers, Catering service providers, Logistics service providers, Transportation, Distribution, Sanitation, Cleaning

• Product suppliers: Suppliers of tools, utensils, equipment, additives, ingredients, raw materials, cleaning agents, sanitizing agents, packaging materials, other food contact materials.

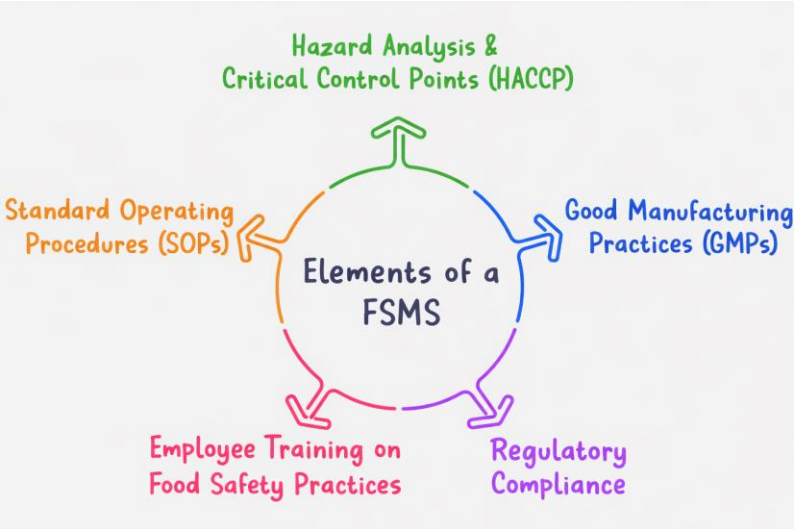


Fig: Elements of a food safety system

Goal of ISO 22000

The goal of ISO 22000 is to control and reduce to an acceptable level, any safety hazards identified for the end products delivered to the next step of the food chain. An end product is defined as a product that will not undergo any further processing or transformation by the organization. The standard combines the following generally-recognized key elements to ensure food safety at all points of the food chain:

• Requirements for good manufacturing practices or prerequisite programs

• Requirements for HACCP according to the principles of the Codex Alimentarius (an international commission established to develop food safety standards and guidelines)

• Requirements for a management system

• Interactive communication between suppliers, customers and regulatory authorities.

ISO 22000:2005 specifies requirements for a food safety management system where an organization in the food chain needs to demonstrate its ability to control food safety hazards in order to ensure that food is safe at the time of human consumption. It is applicable to all organizations, regardless of size, which are involved in any aspect of the food chain and want to implement systems that consistently provide safe products. The means of meeting any requirements of ISO 22000:2005 can be accomplished through the use of internal and/ or external resources. ISO 22000: 2005 specifies requirements to enable an organization.

- To plan, implement, operate, maintain and update a food safety management system aimed at providing products those, according to their intended use, are safe for the consumer,

- To demonstrate compliance with applicable statutory and regulatory food safety requirements,

- To evaluate and assess customer requirements and demonstrate conformity with those mutually agreed customer requirements that relate to food safety in order to enhance customer satisfaction,

- To effectively communicate food safety issues to their suppliers, customers and relevant interested parties in the food chain,

- To ensure that the organization conforms to its stated food safety policy,

- To demonstrate such conformity to relevant interested parties and

- To seek certification or registration of its food safety management system by an external organization, or make a self-assessment or self-declaration of conformity to ISO 22000:2005.

ISO 22000:2005 is fully compatible with ISO 9001:2000, so it is suitable for the development of a fully integrated, risk-based management system. This also means that organizations with an existing management system should find it fairly easy to expand its scope to include ISO 22000. ISO 22000 was the first in a new family of standards related to food safety namely:

- ISO/ TS 22004:2005 provides guidance on the application of ISO 22000:2005.

- ISO 22005:2007 provides requirements for the design and implementation of a feed and food traceability system.

• ISO/ TS 22003:2007 set requirements for bodies providing audit and certification of ISO 22000.

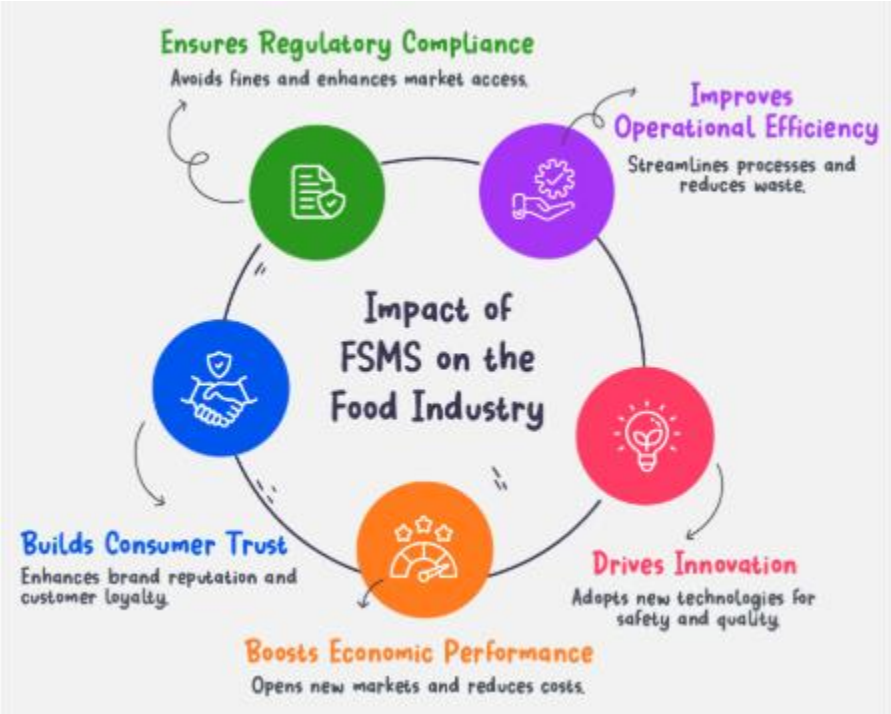


Fig: Impact of Food Safety Management System (FSMS) on the Food Industry

Documentation, Traceability and Recall in FSMS

1. Documentation System

A well-structured documentation system is essential for the effective implementation of FSMS and ISO 22000.

- Food Safety Manual
- Standard Operating Procedures (SOPs)
- Work instructions
- Records and logs (CCP monitoring, cleaning, etc.)
- Internal and external audit reports

2. Traceability System

Traceability is the ability to track food products through all stages of production, processing, and distribution.

- Helps in identifying the source of contamination
- Ensures transparency in the food supply chain
- Facilitates quick corrective actions

3. Product Recall System

A product recall system is a procedure to withdraw unsafe or contaminated food products from the market.

- Protects consumer health
- Prevents foodborne illness outbreaks
- Maintains company reputation

Practical Exercise

Activity

CHECK YOUR PROGRESS

1. Identify food safety hazards (biological, chemical, physical) in a dairy processing unit.
2. Prepare a simple flow diagram for a dairy product (e.g., milk or curd) and identify Critical Control Points (CCPs).
3. Demonstrate Good Manufacturing Practices (GMP) such as personal hygiene, equipment sanitation, and safe handling.
4. Study documentation records like SOPs, monitoring logs, and cleaning records used in FSMS.
5. Evaluate traceability and recall system by tracing a food product from production to distribution.

A. Multiple-Choice Questions (MCQs)

1. FSMS stands for:
   a) Food Safety Monitoring System
   b) Food Safety Management System
   c) Food Standard Maintenance System
   d) Food Safety Manufacturing System

2. HACCP is mainly used to:
   a) Increase food production
   b) Identify and control food safety hazards
   c) Improve packaging
   d) Reduce cost
3. GMP refers to:
   a) Good Marketing Practices
   b) Good Manufacturing Practices
   c) General Management Process
   d) Global Monitoring Program
4. A Critical Control Point (CCP) is:
   a) Final product
   b) Storage area
   c) Step where hazard can be controlled
   d) Cleaning process
5. ISO 22000 is related to:
   a) Quality control only
   b) Food safety management system
   c) Packaging standards
   d) Transport system

B. Fill in the Blanks

1. HACCP stands for _____ Analysis and Critical Control Points.
2. GMP ensures proper _____ and hygiene in food processing.
3. A _____ limit separates acceptable from unacceptable conditions.
4. Traceability helps track food through the _____ chain.
5. Product recall helps protect _____ health.

C. True or False

1. FSMS ensures food safety at all stages of production.
2. HACCP focuses only on final product testing.
3. GMP includes hygiene and sanitation practices.
4. Traceability helps identify the source of contamination.
5. Product recall is not necessary in food safety systems.

D. Subjective Questions

1. Define Food Safety Management System (FSMS).

2. Explain the importance of HACCP in food safety.
3. Describe Good Manufacturing Practices (GMP).
4. What is a Critical Control Point (CCP)?
5. Explain the importance of traceability in food safety.

SESSION-2

PRINCIPLES AND IMPLEMENTATION OF HACCP

Introduction

HACCP is a system that relies on process controls to minimize food safety risks in the food processing industry. It is useful to think of HACCP as a preventative food safety system and not a traditional quality control inspection system. HACCP is an international food safety system that deals with the control of factors affecting the ingredients, product and processing of food. It is widely recognized by scientific authorities and international organizations as the most effective approach available for producing safe food. The goal of HACCP is to identify biological, chemical and physical hazards and to include preventive measures throughout the process which would stop these hazards before they begin. These measures would, in turn, prevent unsafe food from reaching the consumer. Significant hazards for a particular food product are identified after a review of all the processing steps and use of scientific information. The steps at which these hazards can be controlled are identified and critical limits, such as process temperatures and hold times, at key process steps are set. Monitoring procedures are implemented to evaluate conformance with these critical limits. Should the process fall outside these limits, pre-planned corrective actions are taken to prevent the potentially defective product from entering the commerce stream. In addition, the HACCP system relies on extensive verification and documentation to assure that food safety has not been compromised during any step. Thus, HACCP provides a structure for assessing risks or what could go wrong and for putting the controls in place to minimize such risks.

History of HACCP

The Pillsbury Company encountered this dilemma in the 1960's while fulfilling food production contracts with the US Army and NASA. NASA had very stringent microbiological acceptance criteria, as it could not risk illness of astronauts during space missions. It was clear that product testing alone could not guarantee food safety, and a better system was required.

HACCP is a preventive system in which food safety is designed into the product and the process. It is a system of product design and process control that effectively controls identified hazards without relying on product testing. The HACCP system was developed in the 1960s, published in 1971 in the USA, endorsed by FAO/WHO Codex Alimentarius Commission in 1985, and later became mandatory in meat and poultry plants, with full implementation in processing plants by January 2000.

HACCP and Food Regulation

The US Food and Drug Administration (FDA) applied HACCP-based principles in low-acid food canning regulations in the 1970s. In 1995, HACCP was made mandatory for fish and seafood products, and in 2001 for juice processing and packaging plants. A voluntary HACCP program was also introduced in 2001 for Grade A fluid milk and milk products under the NCIMS program. The FDA further implemented pilot HACCP programs for other food processing and retail sectors.

HACCP has also been implemented by the USDA, with mandatory application in meat and poultry processing plants in 1998. It is widely adopted in countries such as Europe, Canada, Australia, and New Zealand, and is a priority program under Codex Alimentarius. In India, food quality control is enforced through systems like PFA, AGMARK, and FPO. The Bureau of Indian Standards (BIS) has introduced HACCP certification, and organizations like Mother Dairy, Punjab Cooperative Milk Federation, and APEDA-supported units have implemented it. However, there is a need to extend HACCP to the unorganised sector, which accounts for 70–80% of food production and processing in India.

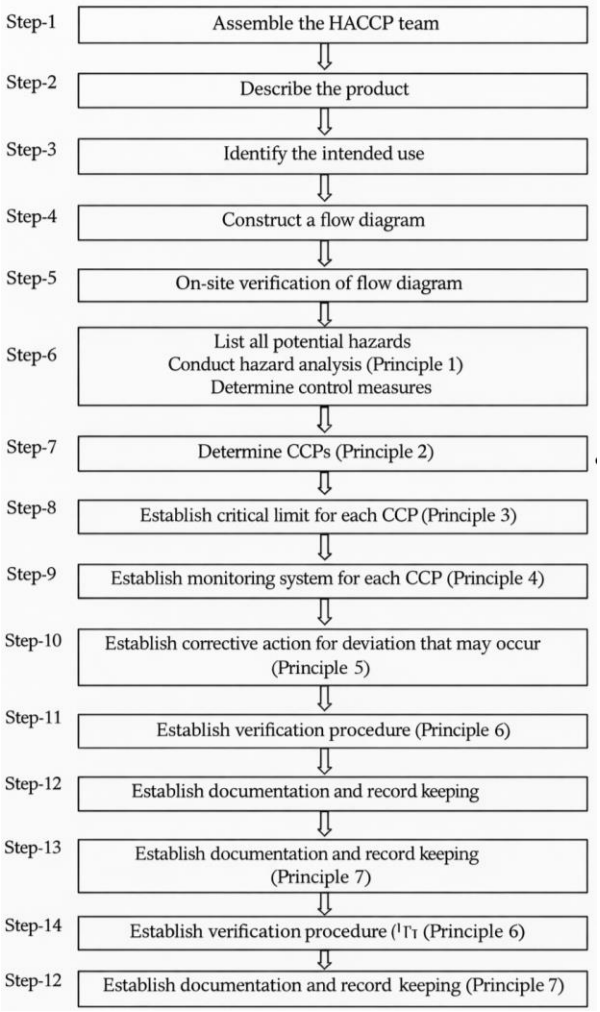
Steps and Principles of HACCP Concepts

The HACCP concept is based on the seven principles of the Codex Alimentarius as laid down in Article 5 of Regulation (EC) 852/2004 on food hygiene. It must be regularly reviewed and updated to reflect changes in products, manufacturing processes, and new scientific knowledge related to food safety risks. Before applying HACCP, the food sector should follow Codex General Principles of Food Hygiene, relevant Codes of Practice, and food safety legislation, along with strong management commitment.

During HACCP application, consideration is given to raw materials, ingredients, manufacturing practices, processing methods, end-use of the product, consumer

groups, and food safety data. The system focuses on control at Critical Control Points (CCPs), and if no CCP is identified for a hazard, the process should be redesigned. HACCP should be applied separately to each operation, and flexibility is required depending on the size and nature of the operation. The system must be reviewed and updated whenever changes occur in product, process, or any step.

Flowchart: HACCP 12-step implementation process



The HACCP team should have knowledge, experience and attributes to correctly:

- Identify potential food hazards.
- Evaluate the existing system and data in a logical manner,

• Assign levels of severity and risk to identified hazards.

• Analyze problems and recommend controls, criteria and procedures for monitoring and verification to bring lasting solutions to recurring problems, recommend appropriate corrective actions when deviations occur.

• Communicate both within the team and with people across all levels of the dairy.

• Predict the success of the HACCP plan.

• It is necessary to have right blend of people in the HACCP team. The team should normally have five to eight people depending on the size of the organization and complexity of operations.

Product description

The product description contains such information as product characteristics, product composition, Storage requirements, placing on the market. The dairy should describe its product(s). The description should include the major raw materials, food ingredients, preservation and packing materials used and their impact on food safety. This can also include a brief description of how the process occurs and/ products are made and stored. It would be useful if hazards that may exist either in ingredients or in packing material are identified. A description of the method of distribution includes type of transport and any special consideration to maintain product safety. For example, ice cream is described as a frozen ready to eat product containing both pasteurized and unpasteurized components. The skim milk powder, butter, sugar and water are pasteurized while the flavourings, nuts and chocolate are added without further heat processing. Air is also whipped into the product at freezing. Separate HACCP plan should be made for each product. But if two or more products have the identical raw material, ingredients, process operations, packaging, storage and distribution, they can be clubbed together in one HACCP plan.

Identify intended use

This intended use should be based on the expected uses of the product by the end user or consumer. It should be indicated how the product is to be used including if it is to be fully cooked before consumption, what preparations will be needed, what will be serving requirements, shelf life, etc. If consumer has special consideration such as infant or geriatrics it should be made clear so that necessary emphasis may be given to safeguard their special interest. For

instance ice cream is consumed without further processing by general population including high risk groups but infant milk food is meant for infants and is given special consideration.

Construct a process flow diagram

The HACCP team constructs a detailed process flow diagram for each product indicating critical steps of control. Each step within the specified area of operation is analyzed for the particular part of the operation under consideration to produce the flow diagram. When applying HACCP system to a given operation, consideration is given to steps preceding and following the specified operation. The process flow diagram is used as the basis of the hazard analysis and should therefore contain sufficient technical detail for the study to progress. Each step within the specified area of operation should be analyzed for the particular part of the operation under consideration to produce the flow diagram.

On-site verification of process flow diagram

When the process flow diagram is complete, it is verified by the HACCP team at site to confirm the processing operation against the flow diagram during all stages and hours of operation and amend the flow diagram where appropriate. This is partly an in office exercise and partly on site activity. In office exercise includes dissecting the process stage and discussing the implications of process parameters and then they are verified at the site. The verification of the flow diagram at site is done by actually walking through the plant to check the accuracy and completeness and make sure that the steps listed on the diagram describe what really occurs in producing the product. It would be useful if a plant layout is also available because a bad layout may provide avenues for cross contamination from raw material to products, facilities to products and persons to product. This should also form part of on-site verification.

Conduct hazards analysis (principle 1)

When the process flow diagram is completed and verified, the HACCP team conducts a hazard analysis and lists all the biological, chemical and physical hazards that may be reasonably expected to occur at each step from primary production, processing, manufacture and distribution until the point of consumption. When conducting the hazard analysis, consideration must be given to the impact of raw materials, ingredients, manufacturing practices, role of manufacturing processes to control hazards, likely end-use of the product, consumer populations at risk and epidemiological evidence relative to food safety. The team should then identify in the HACCP plan which hazards are of

such nature that their elimination or reduction to acceptable levels is essential to the production of safe food. The team must then consider what preventative measures, if any, exist which can be applied for each hazard. Preventive measures are those action and activities that are required to eliminate hazards or reduce their impact or occurrence to acceptable levels. More than one preventive measure may be required to control a specific hazard(s) and more than one hazard may be controlled by a specified preventative measure.

Identify the critical control points (principle 2)

A critical control point is a point/procedure where a food safety hazard can be prevented, eliminated or reduced to acceptable levels. The identification of a CCP in the HACCP system is facilitated by the application of a decision tree. All hazards that may be reasonably expected to occur, at each step, should be considered. If a hazard has been identified at a step where control is necessary for safety and no preventive measure exists at that step, or any other, then the product or process should be modified at that step, or at any earlier or later stage, to include a preventive measure. Application of the decision tree determines whether the step is a CCP for the identified hazard. For the identification of CCP's, a decision tree can be used.

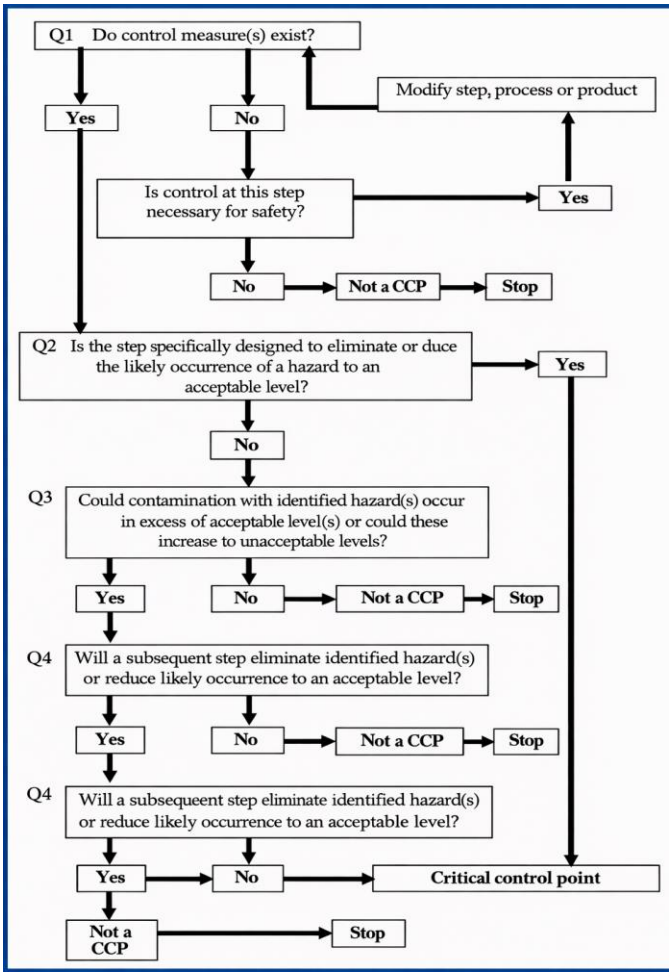


Fig: Example of decision tree to identify CCPs (answer questions in sequence)

Establish critical limits for each CCP (principle 3)

Since the critical control points define the boundaries between safe and unsafe products, it is vital that they are specified at the correct levels and validated at each criterion. The HACCP team should therefore fully understand the criteria governing safety at each CCP in order to set the appropriate critical limits. Critical limits much be specified for each preventive measure. In some cases more than one critical limit will be elaborated at a particular step. Criteria often used include measurements of temperature, time, moisture level, pH, and available chlorine and sensory parameters such as visual appearance and texture.

Establish a monitoring system for each CCP (principle 4)

Monitoring is one of the most important aspects of the HACCP system. It is the scheduled measurement of a CCP relative to its critical limits. The monitoring procedures must be able to detect loss of control at the CCP and provide information in time for corrective action to regain control of the process. Data derived from monitoring must be evaluated by a designated person with knowledge and authority to carry out corrective actions when indicated. If monitoring is not continuous, then the frequency of monitoring must be sufficient to ensure that the CCP is under control. Most monitoring procedures for CCPs will need to be done rapidly because they relate to on line processes and there will not be time for lengthy analytical testing. Physical and chemical measurements are often preferred to microbiological testing because they may be done rapidly and can often indicate the microbiological control of the product. All records and documents associated with monitoring CCPs must be signed by the person(s) doing the monitoring and by a responsible reviewing official of the company.

Establish corrective actions (principle 5)

Specific corrective actions must be developed for each CCP in the HACCP system in order to deal with deviations when they occur. The actions must ensure that the CCP has been brought under control. Actions taken must also include proper disposition of the non conforming product. Deviation and product disposition procedures must be documented in the HACCP record keeping. Corrective action should also be taken when monitoring results indicate a trend towards loss of control at a CCP. Action should be taken to bring the process back into control before the deviation leads to a safety hazard.

Establish verification procedures (principle 6)

The HACCP system should include verification procedures to provide assurance that HACCP system is being complied with on day to day basis. This can be done most effectively by using audit method. Monitoring and auditing methods, procedures and tests, including random sampling and analysis, can be used to determine if the HACCP system is working correctly. The frequency of verification should be sufficient to confirm that the HACCP system is working effectively. For examples of verification activities include

- Review of the HACCP system and its records,
- Review of deviations and product dispositions,
- Confirmation if CCPs are under control,

- Validation of established critical limits.

Establish record keeping and documentation (principle 7)

Efficient and accurate record keeping is essential to the application of a HACCP system. Records need to be kept of all areas which are critical to product safety to demonstrate that the HACCP system is in compliance with the documented system. Documentation of HACCP operation at all steps should be included and assembled in a HACCP plan. Records are useful in providing a basis for analysis of trends as well as for internal investigation of any food safety incidents which may occur. It is extremely useful to allocate a unique reference number to each HACCP record. The types of records that might be retained are as follows:

- HACCP plan,
- Modification to HACCP plan,
- CCP monitoring records,
- Deviations and associated corrective action,
- Training records,
- Audit records,
- HACCP system

Flowchart: Example of a worksheet

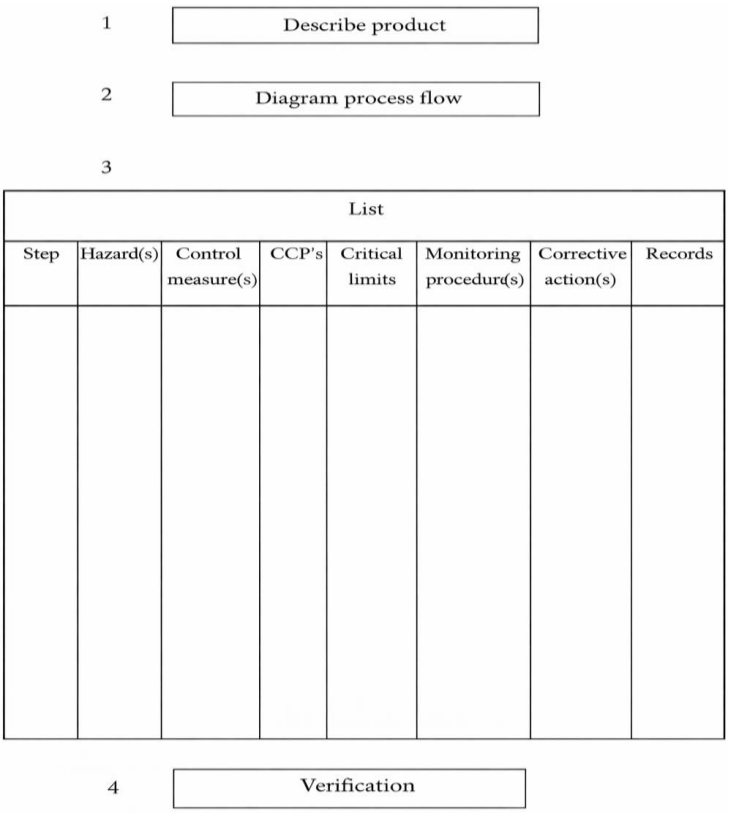


Table: Safety colours

Safety colour	Meaning or purpose	Examples of use	Contrasting colors (if required)	Symbol colors
Red	Stop or prohibition	Stop signs identification and colors of emergency shutdown devices prohibition signs	White	Black
Yellow	Caution, risk of danger	Indication of hazards (fire, explosion, radiation, chemical, etc.) Warning signs identification of dangerous thresholds, passages, obstacles	Black	Black
Blue	Mandatory action	Obligation to wear personal safety equipment Mandatory signs	White	White

Green	Safety condition	Identification of safety showers, first aid posts and rescue points Emergency exit sign	White	White

The Codex General Principles of Food Hygiene has recommended a Hazard Analysis and Critical Control Point (HACCP) based approach as a means to enhance food safety and has indicated how to implement the principle 1. The HACCP concept was developed in the 1960's as a system to ensure the safety of food products. The HACCP can be defined as a system which identifies, evaluates and controls hazards which are significant for food safety. Its introduction signaled a shift in emphasis from end product testing to preventive control at all stages of food production. The HACCP system was initially developed for use by food processors for preventing food-borne hazards. However, the application of the HACCP system has been expanding to form a basis for regulated food control and as a standard for international food trade. It is being promoted internationally as a preventive system of hazard control that is considered to be the most effective and efficient way to ensure food safety. It is an action oriented programme to identify and reduce food-borne diseases. The Principles of the HACCP system set the basis for the requirements for the application of HACCP, while the guidelines for the application provide general guidance for practical application. Since the publication of the decision tree by Codex, its use has been implemented many times for training purposes. In many instances, while this tree has been useful to explain the logic and depth of understanding needed to determine CCPs, it is not specific to all food operations, e.g., slaughter and therefore it should be used in conjunction with professional judgment and modified in some cases.

Practical Exercise

Activity

CHECK YOUR PROGRESS

1. Identify potential hazards (biological, chemical, physical) in a food processing operation.
2. Prepare a HACCP flow diagram for a selected food product and verify it on-site.

3. Identify Critical Control Points (CCPs) using a decision tree approach.
4. Establish critical limits and monitoring procedures for each CCP.
5. Develop corrective actions and record-keeping formats for HACCP implementation.

A. Multiple-Choice Questions (MCQs)

1. HACCP is a:
   a) Quality testing system
   b) Preventive food safety system
   c) Packaging system
   d) Storage system
2. HACCP focuses on controlling:
   a) Only final product
   b) Hazards in food processing
   c) Packaging design
   d) Marketing
3. A Critical Control Point (CCP) is:
   a) Storage area
   b) A step where hazard can be controlled
   c) Final product
   d) Cleaning process
4. Monitoring in HACCP is used to:
   a) Increase production
   b) Check compliance with critical limits
   c) Reduce cost
   d) Improve packaging
5. HACCP was first developed by:
   a) WHO
   b) NASA and Pillsbury Company
   c) FAO
   d) ISO

B. Fill in the Blanks

1. HACCP stands for _____ Analysis and Critical Control Points.
2. HACCP is a _____ system to ensure food safety.
3. A _____ limit separates safe and unsafe conditions.
4. Monitoring helps detect loss of _____ at CCP.
5. Corrective actions are taken when there is a _____ from limits.

C. True or False

1. HACCP relies only on end product testing.
2. HACCP identifies hazards before they occur.
3. CCPs are important for controlling food safety hazards.
4. Monitoring is not required in HACCP.
5. HACCP requires proper documentation and verification.

D. Subjective Questions

1. Define HACCP and explain its importance.
2. Describe the history and development of HACCP.
3. Explain the concept of hazard analysis.
4. What is a Critical Control Point (CCP)?
5. Describe the role of monitoring in HACCP.

SESSION-3

GOOD HYGIENE AND MANUFACTURING PRACTICES (GMP & GHP)

Introduction to Good Hygiene Practices

Safe food originates from its source, the farm. At this stage Good Agricultural Practices (GAP) are applied to ensure food safety. Subsequent to the farm, Good Manufacturing Practices (GMP) ensure products are consistently produced and controlled according to quality standards at the various stages of processing, storage and transportation till food reaches consumers. General Principles of Food Hygiene apply to both GAP and GMP through the implementation of Good Hygiene Practices (GHP). GHP recommends a HACCP-based approach to reduce risks Good Hygiene Practices aim to implement the essential principles of food hygiene applicable throughout the food chain (including primary production through to the. final consumer), to achieve the goal of ensuring that food is safe and suitable for human consumption. This unit illustrates the application of GHP to achieve food safety goals.

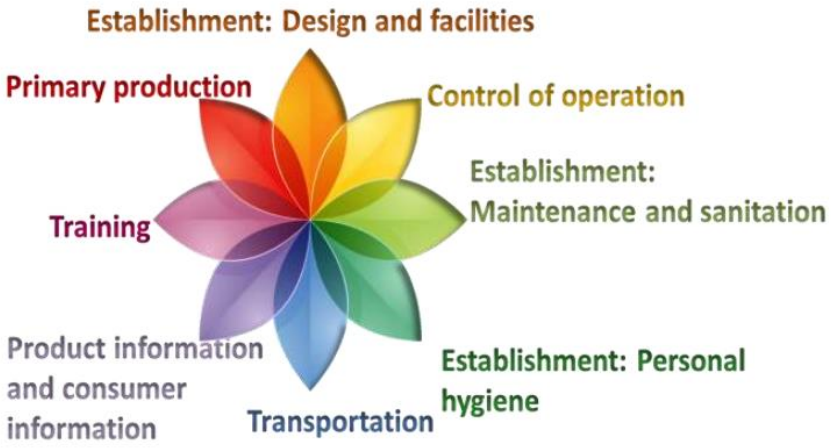


Fig: Main categories in GHP implementation

Building and equipment

Location of premises

Appropriate location of building and equipment reduce the likelihood of introducing a hazard which may adversely affect the safety of food, or its suitability for consumption, at later stages of the food chain. This may help control many hazard factors that may not be in your control once the building and equipment are already set up.

Prevent contamination by locating premises away from areas that:

- Are polluted
- Contain industrial activities nearby
- Prone to flooding or pest infestation
- Make it difficult to remove waste efficiently

Situate / install equipment to allow

- Adequate maintenance and cleaning outside and inside
- Correct functioning

Fig: Toxic fumes, dust can contaminate food.

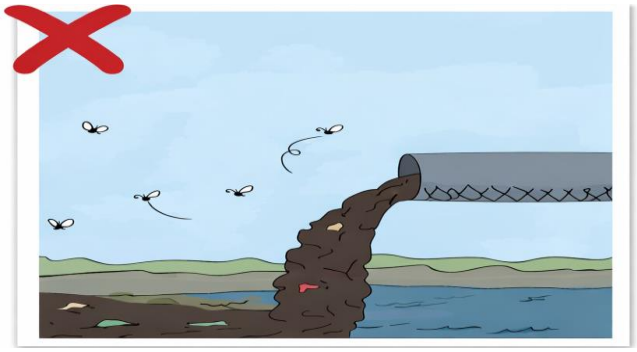


Fig: Areas where wastes cannot be efficiently removed pose a threat to food

Work surface

To avoid build-up of micro-organisms and dirt or food, working surface should be

- easy to clean,
- maintain and
- disinfect, and
- made of inert (non-reactive) material

Design and layout of premises

Attention to

• good hygienic design and construction,

• appropriate location and the provision of adequate facilities,

• from the initial stages itself, is necessary to enable hazards to be effectively controlled.

It may be difficult to change the layout and basic design later when the operations are functional.

Internal design and layout of food establishments should permit good food hygiene practices, including protection against cross-contamination between and during operations by foodstuffs.

Layout

Internal design and layout of food establishments should

• permit good food hygiene practices, and

• protect against cross-contamination between and during operations by foodstuffs.

Windows

Windows should be

• easy to clean,

• constructed to minimize the build-up of dirt

• and where necessary,

• be fitted with removable and cleanable insect-proof screens

Equipment

Clean and nontoxic materials

Equipment and containers that come into contact with food should

• allow for adequate cleaning, disinfection and maintenance to avoid contamination of food.

• Have no toxic effect in intended use

Movable and detachable

Equipment and containers that come into contact with food should

• be movable and

• allow disassembly

for maintenance, cleaning, disinfection, and monitoring.

Monitoring food characteristics

Equipment used to cook, heat treat, cool, store or freeze food should

• be designed to achieve the required food temperatures as rapidly as necessary

• allow temperatures to be monitored and controlled and where necessary,

• have effective means of controlling and monitoring humidity, air-flow and any other characteristic likely to have a detrimental effect on the safety or suitability of food.

Facilities for food operations

Depending on the nature of the food operations, adequate facilities should be available for

• heating, cooling, cooking,

• refrigerating and freezing food,

• storing refrigerated or frozen foods,

• monitoring food temperatures, and

• when necessary,

• controlling ambient temperatures to ensure the safety and suitability of food.

Waste

Containers for waste, by-products and inedible or dangerous substances, should be

• specifically identifiable,

• suitably constructed and,

• where appropriate,

• made of impervious material. Dangerous substances Containers used to hold dangerous substances should

• be identified and,

• where appropriate, be lockable

• to prevent malicious or accidental contamination of food.

• to prevent malicious or accidental contamination of food.

Facilities

Water

• Water supply should – be adequate – of potable (drinking) quality with appropriate facilities for its storage, and distribution.

• Control temperature whenever necessary to ensure the safety and suitability of food.

• Non-potable water (for use in, for example, fire control, steam production, refrigeration and other similar purposes where it would not contaminate food), shall have a separate system.

• Non-potable water systems shall be identified and shall not connect with, or allow reflux into, potable water systems.

• Adequate drainage and waste disposal should be provided and designed, avoiding risk of contamination to food and potable water supply.

Personnel changing and washing facilities

• Personnel hygiene facilities should be available to ensure that an appropriate degree of personal hygiene can be maintained and to avoid contaminating food.

• Where appropriate, facilities should include:

– adequate means of hygienically washing and drying hands

– wash basins

– supply of hot and cold (or suitably temperature controlled) water;

– lavatories of appropriate hygienic design; and

– adequate changing facilities for personnel.

Lighting and ventilation

• Adequate means of natural or mechanical ventilation should be provided, in particular to:

– minimize air-borne contamination of food, for example, from aerosols and condensation droplets;

– control ambient temperatures;

– control odours which might affect the suitability of food; and

– control humidity, where necessary, to ensure the safety and suitability of food.

• Where necessary, lighting should not be such that the resulting colour is misleading. The intensity should be adequate to the nature of the operation.

• Ventilation systems should be designed and constructed so that air does not flow from contaminated areas to clean areas and, where necessary, they can be adequately maintained and cleaned.

-enable food to be effectively protected from contamination and deterioration during storage (e.g. by temperature and humidity control).

Control of operations

Controling process inputs and operations in terms of

• correct temperature,

• pressure,

• humidity

• water activity (aw)

• pH levels

• contamination (extraneous material, aflatoxin, pesticide residues)

reduces the risk of unsafe food by taking preventive measures to assure the safety and suitability of food at an appropriate stage in the operation by controlling food hazards. Assurance activities in a food safety management system have the objective to provide evidence that products and processes are

within set specifications. Examples of assurance activities are sampling, validation, verification, documentation.

Management of microbiological food safety is largely based on good design of processes, products and procedures. Finished product testing may be considered as a control measure at the end of the production process. However, testing gives only very limited information on the safety status of a food. If a hazardous organism is found it means something, but absence in a limited number of samples is no guarantee of safety of a whole production batch. Finished product testing is often too little and too late.

Therefore most attention should be focussed on management and control of the hazards in a more proactiveway by implementing an effective food safety management system.

Table: Examples of measurements and records that can be used for building the history of safe product in food safety management

Where and what .		Activities and record
Suppliers	Efficacy of their food safety management system	Compliance to an agreed standard of food safety management certification and efficiency of control measures records
Factory/Process steps	Raw materials (including packaging material)	Monitoring or verification results on contamination of pathogens, spoilage or indicator organisms based on a priori risk rating applied to supplier and raw materials.
	Storage	Temperature, atmosphere, storage time
	CCP monitoring results (e.g. heat process)	Holding time and temperature
	Process parameters	Time to acidification, pH drop, cooling time, etc.
	Semi-finished product	Occasionally microbial testing as verification: sampling plan and results.
Prerequisite programs	Factory environment	Test results on hygiene or pathogens from swab samples, product residues, or air quality
	Cleaning	Results from verification of efficiency (visual inspections, microbiological tests, ATP-test, etc.)
Verification of finished products	Microbial tests	Sampling plan and microbiology results
	Intrinsic properties	Verification results on pH, a$_w$, preservative conetration etc.

After factory release, during product shelf-life	Extrinsic properties of finished products	Verification results on modified atmosphere, storage temperature etc.
After factory release, during product shelf-life	Extrinsic properties of finished products	Verification results on modified atmosphere, storage temperature, in-market supply-chain testing and product durability and stability testing

Source: Relevance of microbial finished product testing in food safety management, Marcel H. Zwietering et al, Food Control

Practical Exercise

Activity

CHECK YOUR PROGRESS

1. Observe hygiene practices in a food processing unit, including cleanliness of premises, equipment, and personnel.
2. Evaluate the layout of a food establishment and identify areas prone to contamination.
3. Demonstrate proper hand washing and personal hygiene practices required in food handling.
4. Inspect equipment and work surfaces for cleanliness, material suitability, and ease of maintenance.
5. Assess waste disposal and water supply systems to ensure they meet hygiene standards.

A. Multiple-Choice Questions (MCQs)

1. GHP stands for:
   a) General Handling Practices
   b) Good Hygiene Practices
   c) Global Health Program
   d) Good Handling Procedures
2. GMP ensures:
   a) Only product testing
   b) Proper manufacturing and quality control
   c) Packaging design
   d) Marketing
3. Work surfaces in food processing should be:
   a) Rough and porous
   b) Easy to clean and non-reactive

c) Wooden only
d) Painted

4. Non-potable water is used for:
   a) Drinking
   b) Food preparation
   c) Fire control and similar purposes
   d) Cleaning utensils
5. Proper ventilation helps to:
   a) Increase contamination
   b) Control temperature and humidity
   c) Reduce food quality
   d) Increase moisture only

B. Fill in the Blanks

1. GMP ensures proper _____ and control of food production.
2. GHP focuses on maintaining _____ in food processing.
3. Equipment should be made of _____ materials.
4. Water used in food processing should be of _____ quality.
5. Waste containers should be _____ and properly identified.

C. True or False

1. Good hygiene practices reduce food contamination.
2. Equipment should be difficult to clean.
3. Proper layout prevents cross-contamination.
4. Finished product testing alone ensures food safety.
5. Personal hygiene is important in food safety.

D. Subjective Questions

1. Define Good Hygiene Practices (GHP).
2. Explain the importance of GMP in food processing.
3. Describe the design and layout requirements of food premises.
4. Explain the importance of water quality in food safety.
5. Discuss the role of personal hygiene in preventing contamination.

SESSION-4

TEAM MANAGEMENT IN FOOD SAFETY

Introduction

Team management is a fundamental component in the effective implementation of Food Safety Management Systems (FSMS), including HACCP, GMP, and GHP. In modern food industries, especially dairy processing, food safety is achieved through a systematic and coordinated effort involving personnel at all organizational levels. It is not limited to individual responsibility but requires a multidisciplinary team approach.

A well-organized food safety team ensures proper hazard identification, implementation of control measures, monitoring of Critical Control Points (CCPs), and continuous system improvement. Effective team management also supports compliance with international standards such as ISO 22000, promotes accountability, and strengthens food safety culture within the organization. Thus, teamwork, leadership, and communication are essential to ensure safe production, processing, and distribution of food products.

The HACCP system requires a multidisciplinary team with expertise in processing, microbiology, quality control, and engineering. Therefore, effective team management is essential for the successful design, implementation, and maintenance of HACCP-based food safety systems.

Importance of Team Management in Food Safety

Team management plays a vital role in ensuring the efficiency and reliability of food safety systems. Its importance can be summarized as follows:

- Ensures systematic implementation of FSMS, HACCP, and GMP principles
- Facilitates coordination between production, quality control, and sanitation departments
- Enables early identification, evaluation, and control of biological, chemical, and physical hazards
- Enhances decision-making and problem-solving in food safety issues
- Promotes a strong food safety culture and regulatory compliance
- Minimizes risks of contamination, product recalls, and public health hazards

Food Safety Team

A food safety team is a multidisciplinary group of competent and trained individuals with expertise in different areas of food processing and safety with

multidisciplinary knowledge responsible for developing, implementing, maintaining, and updating the food safety management system.

Table: Composition of Food Safety Team

Position	Role and Responsibility
Production Manager	Supervises processing operations and ensures process control
Quality Control Officer	Monitors product quality, safety standards, and compliance
Microbiologist	Identifies and evaluates microbiological hazards
Maintenance Engineer	Ensures proper functioning and hygiene of equipment
Sanitation Supervisor	Implements cleaning, sanitation, and hygiene practices
Store/Raw Material Officer	Ensures safe storage and handling of raw materials

Responsibilities of Food Safety Team

The food safety team is responsible for the effective functioning of the food safety system. Major responsibilities include:

- Conducting hazard analysis (biological, chemical, physical)
- Developing, implementing, and updating HACCP plans
- Identification and monitoring of Critical Control Points (CCPs)
- Establishing critical limits and corrective actions
- Maintaining proper documentation and record keeping
- Conducting verification and validation of the system
- Ensuring compliance with national and international food safety regulations (ISO, Codex, FSSAI)
- Providing technical support and training to staff

Role of Team Leader

The food safety team leader is responsible for overall coordination and effectiveness of the FSMS.

Key Responsibilities:

- Leading the development and implementation of FSMS
- Assigning roles and responsibilities to team members
- Ensuring effective communication within the organization
- Organizing training and awareness programs
- Reviewing HACCP plans and system performance
- Reporting to top management regarding food safety issues

Training and Awareness

Training is an essential prerequisite for effective team management and successful implementation of food safety systems.

- Training on personal hygiene and sanitation practices
- Awareness of HACCP principles and CCP monitoring
- Training on GMP, GHP, and SOPs
- Regular refresher and skill development programs
- Evaluation of employee competency and performance

Communication in Food Safety

Effective communication is necessary to ensure proper coordination and timely action.

- Clear communication of instructions and procedures
- Reporting deviations, hazards, and corrective actions
- Coordination between departments (production, QC, maintenance)
- Documentation and record sharing for traceability
- Communication with external stakeholders (suppliers, regulators)

Food Safety Culture

Food safety culture reflects the commitment of an organization toward food safety.

- Strong leadership and commitment from top management
- Active participation of all employees

- Awareness and accountability at every level
- Encouragement of safe practices and ethical responsibility
- Continuous improvement through audits and feedback

Monitoring and Supervision

Monitoring ensures that food safety practices are properly implemented and maintained.

- Regular inspection of processing operations
- Monitoring of Critical Control Points (CCPs)
- Internal audits and system review
- Verification of records and procedures
- Implementation of corrective and preventive actions

Flowchart: Team Management in Food Safety System

Challenges in Team Management

Despite its importance, effective team management may face several challenges:

- Lack of technical knowledge and training
- Poor communication and coordination
- Resistance to change and new practices
- Inadequate management support and resources
- Lack of proper documentation and monitoring

Conclusion

Team management is a critical element in ensuring food safety in the dairy and food industry. A competent food safety team, supported by effective leadership, proper training, and clear communication, ensures the successful implementation of FSMS, HACCP, and GMP systems. This integrated approach not only ensures regulatory compliance but also guarantees the production of safe, high-quality food, thereby protecting consumer health and enhancing industry credibility.

Practical Exercise

Activity

CHECK YOUR PROGRESS

1. Identify roles of different team members in a food safety team (production, QC, microbiology, maintenance, sanitation).
2. Simulate formation of a food safety team and assign responsibilities for HACCP implementation.
3. Observe communication flow between departments in a food processing unit.
4. Evaluate training programs related to hygiene, HACCP, and GMP practices.
5. Assess monitoring and supervision activities such as CCP checks, audits, and record verification.

A. Multiple-Choice Questions (MCQs)

1. Team management in food safety helps to:
   a) Increase cost
   b) Ensure coordination and safety
   c) Reduce production only
   d) Eliminate workers
2. A food safety team should be:
   a) Single person
   b) Multidisciplinary
   c) Temporary
   d) Untrained

3. The role of the team leader is to:
   a) Ignore safety issues
   b) Coordinate and supervise FSMS
   c) Only monitor production
   d) Handle packaging
4. Training in food safety is important for:
   a) Increasing profit only
   b) Improving employee knowledge and skills
   c) Reducing staff
   d) Avoiding documentation
5. Communication in food safety ensures:
   a) Confusion
   b) Proper coordination and action
   c) Delay in work
   d) No monitoring

B. Fill in the Blanks

1. A food safety team consists of _____ members from different fields.
2. The team leader ensures proper _____ and communication.
3. Training improves employee _____ and awareness.
4. Monitoring includes checking _____ control points.
5. Food safety culture promotes _____ and responsibility.

C. True or False

1. Team management is not important in food safety.
2. A multidisciplinary team improves food safety systems.
3. Communication is essential for effective coordination.
4. Training is not required for HACCP implementation.
5. Monitoring helps maintain food safety standards.

D. Subjective Questions

1. Define team management in food safety.
2. Explain the importance of a food safety team.
3. Describe the roles and responsibilities of team members.
4. What is the role of a team leader in FSMS?
5. Explain the importance of training and communication in food safety.

Glossary

1. Fermentation: Conversion of lactose into lactic acid by microorganisms.
2. Lactic Acid Bacteria (LAB): Bacteria that ferment milk sugar into lactic acid.
3. Curd (Dahi): Fermented milk product formed by bacterial action.
4. Starter Culture: Microorganisms added to initiate fermentation.
5. Chakka: Semi-solid product obtained after removing whey from curd.
6. Shrikhand: Sweetened product made from chakka.
7. Whey: Liquid separated from curd.
8. Cheese: Product obtained by coagulation of milk.
9. Rennet: Enzyme used for coagulation of milk.
10. Syneresis: Removal of whey from curd.
11. Ripening: Ageing process in cheese for flavor development.
12. Ice Cream: Frozen dairy product made from milk and cream.
13. Overrun: Air incorporation during ice cream freezing.
14. Stabilizers: Substances improving texture of ice cream.
15. Emulsifiers: Agents that mix fat and water uniformly.
16. Functional Foods: Foods providing extra health benefits.
17. Probiotics: Beneficial live microorganisms.
18. Prebiotics: Substances that promote good bacteria.
19. Synbiotics: Combination of probiotics and prebiotics.
20. Buttermilk: Liquid obtained after churning butter.
21. Concentration: Removal of water to reduce milk volume.
22. Evaporation: Removal of water by heating under reduced pressure.
23. Condensed Milk: Milk with reduced water content.
24. Spray Drying: Process of converting milk into powder using hot air.
25. Roller Drying: Drying milk on heated rollers.
26. Milk Powder: Dried form of milk with low moisture.
27. Reverse Osmosis: Membrane process for removing water from milk.
28. Shelf Life: Duration for which product remains safe and usable.
29. Packaging: Process of protecting product for storage and transport.
30. Hygroscopic: Ability of powder to absorb moisture from air.
31. By-products: Secondary products obtained during dairy processing.
32. Skim Milk: Milk with fat removed.
33. Whey Products: Products obtained from whey processing.
34. Whey Protein: Protein extracted from whey.
35. Buttermilk (Industrial): Product from butter production or fermentation.
36. Ghee Residue: Solid left after clarification of butter into ghee.
37. Value Addition: Process of increasing product value by processing.

38. Utilization: Effective use of dairy by-products.
39. Food Safety: Practices to ensure food is safe for consumption.
40. HACCP: Hazard Analysis and Critical Control Point system for food safety.
41. Hazard: Biological, chemical, or physical contamination risk.
42. Critical Control Point (CCP): Step where hazard can be controlled.
43. GMP (Good Manufacturing Practices): Guidelines for safe production.
44. GHP (Good Hygiene Practices): Cleanliness practices in food handling.
45. Sanitation: Maintenance of cleanliness in processing environment.
46. Cleaning-in-Place (CIP): Automated cleaning of equipment without dismantling.
47. Contamination: Presence of harmful substances in food.
48. Personal Hygiene: Clean habits followed by workers.
49. Team Management: Coordination and supervision of workers.
50. Record Keeping: Maintaining documentation of processes and safety checks.
51. Diacetyl: A flavour compound produced during fermentation, responsible for buttery aroma in dairy products.
52. Overrun : The amount of air incorporated into ice cream during freezing.
53. Rennet : An enzyme used to coagulate milk during cheese making.
54. Syneresis : The process of expulsion of whey from curd.
55. Functional Foods : Foods that provide health benefits beyond basic nutrition.
56. Bioactive Compounds : Components in food that have positive effects on health.
57. Probiotics : Live beneficial microorganisms that improve gut health.
58. Prebiotics : Non-digestible food ingredients that promote growth of beneficial bacteria.
59. Synbiotics : Combination of probiotics and prebiotics.
60. Standardization : Adjustment of fat and SNF content in milk.
61. Shelf Life : The period during which a product remains safe and suitable for consumption.
62. Contamination : Presence of harmful substances or microorganisms in food.
63. Hazard : Any biological, chemical or physical agent that can cause harm

Abbreviations

°C : Degrees Celsius
LAB : Lactic Acid Bacteria
SNF : Solids-Not-Fat
MSNF : Milk Solids-Not-Fat
TS : Total Solids
TA : Titratable Acidity
pH : Potential of Hydrogen
ST : Streptococcus thermophilus
LB : Lactobacillus bulgaricus
RO : Reverse Osmosis
FSSR : Food Safety and Standards Regulations
FSSAI : Food Safety and Standards Authority of India
PFA : Prevention of Food Adulteration
HACCP : Hazard Analysis and Critical Control Points
CCP : Critical Control Point
CCPs : Critical Control Points
GMP : Good Manufacturing Practices
GHP : Good Hygienic Practices
CIP : Cleaning-in-Place
FSMS : Food Safety Management System
FAO : Food and Agriculture Organization
WHO : World Health Organization

Answer Key

UNIT 1

Fermented and Frozen Dairy Products

SESSION 1: CULTURED DAIRY PRODUCTS – CURD, CHAKKA AND SHRIKHAND

A. Multiple Choice Questions

1. (b) Fermentation
2. (b) Streptococcus and Lactobacillus
3. (c) Removing whey from curd
4. (b) Sugar and flavoring agents
5. (c) 30–35°C

B. Fill in the Blanks

1. lactic acid
2. starter
3. semi-solid
4. sweet-sour
5. digestibility

C. True or False

1. True
2. False
3. False
4. True
5. True

SESSION 2: FERMENTED DAIRY PRODUCTS AND CHEESE

A. Multiple Choice Questions

1. (b) Coagulation of milk
2. (b) Rennet
3. (c) Syneresis
4. (c) Aged under controlled conditions

5. (b) High moisture

B. Fill in the Blanks

1. rennet
2. whey
3. dehydration
4. flavour
5. fermentation

C. True or False

1. True
2. False
3. True
4. True
5. False

SESSION 3: ICE CREAM AND FROZEN DESSERTS

A. Multiple Choice Questions

1. (b) Freezing a pasteurized mix
2. (c) Overrun
3. (c) Cream
4. (b) Use of vegetable fat
5. (c) -4°C

B. Fill in the Blanks

1. frozen
2. overrun
3. richness
4. texture
5. vegetable

C. True or False

1. True
2. False
3. True

4. False
5. True

SESSION 4: FUNCTIONAL DAIRY PRODUCTS

A. Multiple Choice Questions

1. (b) Provide health benefits beyond nutrition
2. (c) Streptococcus thermophilus and Lactobacillus
3. (c) Beneficial live microorganisms
4. (b) Churning cream or fermenting skim milk
5. (c) Non-digestible food ingredients

B. Fill in the Blanks

1. health
2. Streptococcus thermophilus
3. gut
4. synbiotics
5. diacetyl

C. True or False

1. True
2. False
3. True
4. True
5. False

UNIT 2

Concentrated and Dried Dairy Products

SESSION 1: PRINCIPLES AND PRODUCTION OF CONCENTRATED MILK

A. Multiple Choice Questions

1. (c) Reduce moisture content
2. (c) Reduce heat damage to milk

3. (c) Sugar
4. (c) Sterilization
5. (c) Dried milk powder

B. Fill in the Blanks

1. water
2. boiling
3. 40–45
4. storage
5. cooked

C. True or False

1. True
2. False
3. True
4. False
5. True

SESSION 2: PRODUCTION OF MILK POWDER (SPRAY AND ROLLER DRYING)

A. Multiple Choice Questions

1. (c) Remove almost all moisture
2. (c) 5%
3. (c) Spray drying
4. (c) Atomization
5. (d) Inferior product quality

B. Fill in the Blanks

1. shelf
2. concentrated
3. potable
4. film
5. minimal

C. True or False

1. True

2. False
3. True
4. False
5. True

SESSION 3: STANDARDS, STORAGE AND PACKAGING

A. Multiple Choice Questions

1. (c) Safety and quality
2. (c) Prevent microbial growth
3. (b) Moisture absorption
4. (c) Multi-layer laminated pouches
5. (c) Bakery and confectionery

B. Fill in the Blanks

1. Standards
2. cool
3. pathogenic
4. contamination
5. nutritional

C. True or False

1. False
2. True
3. True
4. False
5. True

UNIT 3

Dairy Industry: By-products

SESSION 1: STATUS AND SCOPE OF DAIRY BY-PRODUCTS

A. Multiple Choice Questions

1. (b) Whey

2. (b) Skim milk
3. (b) High Biochemical Oxygen Demand
4. (c) India
5. (a) Protein supplements and animal feed

B. Fill in the Blanks

1. cream
2. 9–10
3. butter churning
4. 30–50
5. value-added

C. True or False

1. True
2. False
3. True
4. False
5. False

SESSION 2: SKIM MILK AND ITS BY-PRODUCTS

A. Multiple Choice Questions

1. (c) Cream removal
2. (c) Skim milk powder
3. (c) Fine, uniform powder
4. (b) Bakery, confectionery, infant formula
5. (b) Moisture ≤ 4–5%

B. Fill in the Blanks

1. proteins
2. spray drying
3. coarse
4. bakery
5. 45–50

C. True or False

1. True
2. False
3. True
4. False
5. True

SESSION 3: WHEY AND ITS BY-PRODUCTS

A. Multiple Choice Questions

1. (b) Cheese or paneer production
2. (b) Sweet whey
3. (c) >90% protein
4. (c) Crystallization
5. (b) Prevent BOD/COD discharge

B. Fill in the Blanks

1. coagulation
2. 9–10
3. ultrafiltration
4. 90
5. nutraceuticals

C. True or False

1. True
2. False
3. True
4. True
5. True

SESSION 4: BUTTERMILK AND GHEE RESIDUE

A. Multiple Choice Questions

1. (b) Churning cream or butter
2. (b) Bakery, confectionery, animal feed
3. (b) 0.5–1%
4. (a) Lactic acid bacteria
5. (b) Taste, texture, digestibility

B. Fill in the Blanks

1. churning
2. milk solids residue
3. probiotic
4. bakery
5. environmental

C. True or False

1. False
2. True
3. True
4. False
5. True

UNIT 4

Food Safety and Team Management

SESSION 1: INTRODUCTION TO FSMS

A. Multiple Choice Questions

1. (c) Protect consumer health
2. (c) Salmonella
3. (c) FSSAI
4. (c) Chemical hazards
5. (b) Preventive control

B. Fill in the Blanks

1. harm
2. perishable

3. physical
4. prevention
5. microbial

C. True or False

1. False
2. True
3. True
4. True
5. False

SESSION 2: HACCP

A. Multiple Choice Questions

1. (b) Hazard Analysis and Critical Control Points
2. (b) Preventive control
3. (b) Pasteurization
4. (c) 72°C
5. (b) Codex Alimentarius Commission

B. Fill in the Blanks

1. preventive
2. CCP
3. maximum
4. corrective
5. traceability

C. True or False

1. False
2. True
3. True
4. False
5. True

SESSION 3: GMP & GHP

A. Multiple Choice Questions

1. (b) Manufacturing conditions
2. (c) Stainless steel
3. (a) First In First Out
4. (c) GHP
5. (b) Sealed doors and windows

B. Fill in the Blanks

1. Manufacturing
2. hygiene
3. food
4. microbial
5. inventory

C. True or False

1. True
2. False
3. True
4. True
5. True

SESSION 4: TEAM MANAGEMENT

A. Multiple Choice Questions

1. (c) All employees
2. (c) Food Safety Team Leader
3. (b) New employees
4. (b) SOP displays
5. (c) Human error

B. Fill in the Blanks

1. shared
2. Food Safety

3. refresher
4. documentation
5. incidents

C. True or False

1. False
2. True
3. True
4. True
5. True