Draft Study Material

Dairy Product Processor

(JOB ROLE)

Qualification Pack: FIC/Q2001, V1.0

GRADE – XI

Sector: Dairy Processing

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MODULE 1 OPERATIONAL PLANNING, WORK AREA MAINTENANCE, AND PRODUCTION ORGANIZATION

Fig 1.1: Applications of Operational Planning Across Key Business Functions

The dairy industry in India plays a crucial role in the nation's food economy, with milk production ranking among the highest globally. Rising urbanization, improved purchasing power, and evolving food habits have increased consumer demand for traditional and fat-rich dairy products such as ghee, butter, khoa, paneer, curd, shrikhand, and a wide variety of regional milk-based sweets. These products are deeply rooted in Indian culinary culture and contribute significantly to household consumption as well as organized retail markets.

India's large livestock population and well-established milk procurement systems ensure a continuous supply of raw milk for processing. The presence of skilled workers, traditional processing expertise, and growing investments in refrigeration, packaging, and quality-control technologies have strengthened this sector. Standardization of manufacturing practices and compliance with food safety regulations are further enhancing product consistency and market reach.

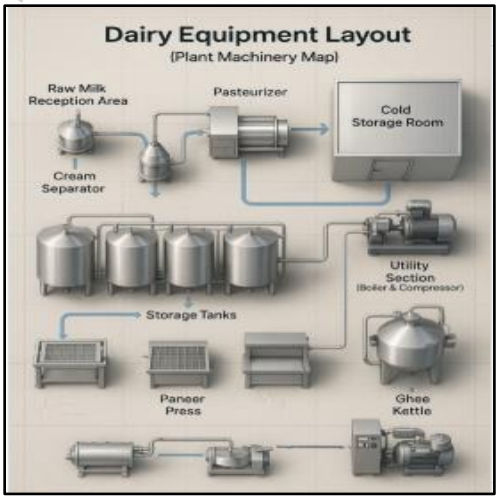

Figure 1.2: Industrial Dairy Processing Equipment and Plant Interior Setup

The abundance of milk resources, combined with expanding domestic demand and opportunities for value addition, makes this segment highly attractive for commercial growth. With increasing interest in branded and premium dairy foods, the production of indigenous and fat-rich dairy products is expected to expand steadily, supporting rural livelihoods and contributing to the overall development of the food processing industry.

SESSION 1: PRODUCTION PLANNING AND WORKFLOW DESIGN

1. Introduction

Production in any industry requires proper planning and organization. Products such as food items and consumer goods are produced through systematic decisions about what to produce, how much to produce, and how the work should be carried out. Production planning helps in organizing resources like materials, machines, manpower, and time so that production is smooth, timely, and cost-effective. Along with this, workflow design ensures that production activities are arranged in a logical sequence, allowing easy movement of materials and workers. A well-planned workflow reduces delays, wastage, and effort, and improves efficiency and safety. Understanding production planning and workflow design is important for students of dairy product processing, as these concepts support efficient and hygienic operations in dairy plants.

Fig 1.3: Stages in the Dairy Processing and Production System

2. Purpose and Scope of Production Planning

The primary purpose of production planning is to ensure that all production activities are seamless, efficient, and cost-effective. It behaves like a roadmap guiding the entire production process from early demand forecasting to final delivery of products to customers.

Objectives of Production Planning

Production planning in modern manufacturing systems has several objectives:

1. **Ensure Uninterrupted Production Flow:** Production planning anticipates variations in demand and allocates resources in a manner that prevents unscheduled stoppages or idle time.
2. **Meet Customer Demand on Time:** By using forecasting data and historical trends, production planning helps organizations fulfill customer orders within the intended delivery schedule.
3. **Optimize Utilization of Resources:** Planning ensures that materials, machines, labor, and finances are used in the most economical way to avoid waste and inefficiencies.
4. **Reduce Production Costs:** Efficient planning minimizes excess inventory, improves labor productivity, and reduces manufacturing overhead.
5. **Maintain Quality Standards:** Integrating quality checkpoints into the production plan ensures consistency and compliance with industry standards.
6. **Avoid Overproduction or Underproduction:** Proper planning helps produce only the required quantity of goods. It prevents making too much stock, which increases storage cost, and also avoids shortages that can disappoint customers.

3. Production Planning Process

Production planning is not a single activity but a systematic process consisting of several interrelated steps.

3.1 Demand Forecasting

Demand forecasting involves estimating future customer requirements based on past sales data, market trends, seasonal variations, and customer behavior. Accurate forecasting helps avoid shortages or excess inventory.

3.2 Capacity Planning

Capacity planning determines the production capacity required to meet forecasted demand. It includes evaluating machine capacity, labor availability, working hours, and plant limitations.

3.3 Material Requirement Planning

Material Requirement Planning calculates the quantity and timing of raw materials, components, and sub-assemblies needed for production. Modern industries use computerized MRP systems integrated with ERP software.

3.4 Routing

Routing determines the exact path and sequence of operations through which a product must pass. It specifies machines, workstations, tools, and methods required for each operation.

3.5 Scheduling

Scheduling assigns time frames for each production activity. It ensures that tasks are completed in the correct order and within the planned time.

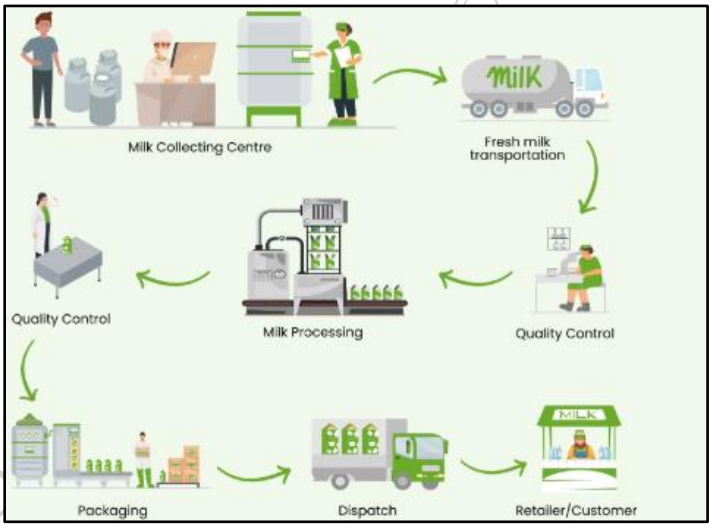

Fig 1.4: Milk Supply Chain and Processing Flow from Collection to Retail

3.6 Dispatching

Dispatching involves issuing work orders and instructions to start production activities. It ensures that materials, tools, and workers are available at the right place and time.

3.7 Follow-up and Control

Follow-up monitors production progress and identifies deviations from the plan. Corrective actions are taken to address delays, breakdowns, or quality issues.

4. Workflow Design

Workflow design refers to the systematic arrangement of tasks, machines, workstations, and movement paths to ensure smooth and efficient production flow.

Importance of Workflow Design

- Reduces material handling time and cost
- Minimizes unnecessary movement and delays
- Improves worker safety and comfort
- Enhances supervision and control
- Reduces chances of contamination or defects
- Increases overall productivity

Modern workflow design also considers ergonomics, automation, and digital monitoring systems to improve efficiency and worker well-being.

5. Types of Workflow Layouts

5.1 Linear (Straight-Line) Layout

All production activities are arranged in a straight line. Materials move from one process to the next without backtracking. This layout is suitable for mass production.

5.2 U-Shaped Layout

Machines are arranged in a U-shape, allowing easy supervision and communication. It reduces walking distance and is suitable for small to medium production units.

5.3 Functional (Process) Layout

Similar machines are grouped together. Products move between departments based on processing requirements. This layout is flexible but may increase material movement.

Table 1: Comparison of Workflow Layouts

Layout Type	Key Features	Advantages	Limitations
Linear	Straight-line flow	High efficiency, simple control	Less flexible
U-shaped	Compact arrangement	Easy supervision, reduced movement	Limited expansion
Functional	Grouped processes	High flexibility	More material handling

Source: Adapted from *Operations Management* (Heizer, Render & Munson, 2024)

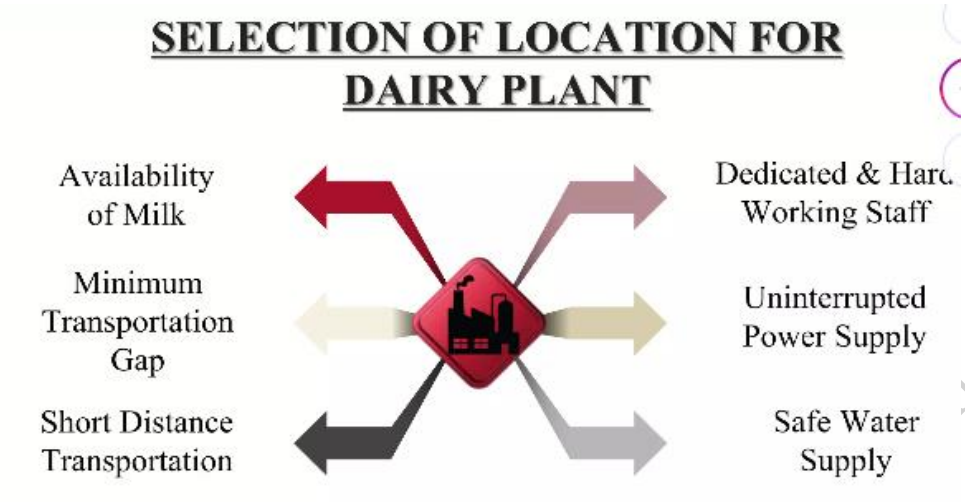

Fig 1.5: Factors Influencing Site Selection for a Dairy Processing Plant

6. Summary

Production planning and workflow design are essential elements of operational planning. Production planning ensures efficient use of resources, timely production, and cost control, while workflow design ensures smooth movement of materials and coordination of activities. Together, they improve productivity, quality, safety, and sustainability in modern production systems.

PRACTICAL EXERCISES

(Activity)

1. Visit a small manufacturing unit or observe a production process through a video.
2. Identify the steps involved in production planning.
3. Draw a simple workflow diagram.
4. List the type of workflow layout used.
5. Suggest improvements to reduce delays or wastage.

CHECK YOUR PROGRESS

1. Multiple-Choice Questions (MCQs)

1. Production planning mainly focuses on:
   a) Advertising products
   b) Organizing resources for production
   c) Selling finished goods
   d) Reducing customer demand

2. Workflow design helps in:
   a) Increasing wastage
   b) Improving material flow
   c) Delaying production
   d) Increasing accidents

3. Routing in production planning refers to:
   a) Cost calculation
   b) Sequence of operations
   c) Product pricing
   d) Packaging

4. Which layout is most suitable for mass production?
   a) Functional
   b) Circular
   c) Linear
   d) Random

5. Demand forecasting helps in:
   a) Ignoring customers
   b) Planning production quantity
   c) Increasing waste
   d) Reducing quality

2. Fill in the Blanks

1. Production planning ensures _____ use of resources.
2. _____ forecasting estimates future customer demand.
3. Routing decides the _____ of operations.
4. Scheduling fixes the _____ for production activities.
5. Workflow design reduces unnecessary _____ of materials.

3. True or False

1. Production planning helps reduce production costs.
2. Poor workflow design improves efficiency.
3. Scheduling is a part of production planning.
4. Functional layout provides high flexibility.
5. Workflow design has no impact on worker safety.

4. Subjective Questions

1. Define production planning and explain its objectives.
2. Describe the steps involved in the production planning process.
3. Explain the importance of workflow design in production systems.
4. Compare different types of workflow layouts.
5. How do modern technologies improve production planning?

SESSION 2: WORK AREA PREPARATION AND MACHINE MAINTENANCE

1. Introduction

A safe, clean, and well-organized work area is essential for efficient production in any industry. Before starting production activities, the work area must be properly prepared to ensure smooth operations and prevent accidents. In dairy and food processing units, maintaining cleanliness and order is especially important to ensure hygiene and product safety.

Fig. 1.6: Industrial Dairy Processing Equipment and Plant Interior

Along with work area preparation, proper machine maintenance plays a vital role in uninterrupted production. Machines and equipment must function correctly to produce quality products and avoid delays. Regular inspection, cleaning, lubrication, and repair of machines help in improving efficiency, reducing breakdowns, and extending the life of equipment. For students of dairy product processing, understanding work area preparation and machine maintenance is important for maintaining safe, hygienic, and efficient dairy plant operations.

2. Work Area Preparation

Work area preparation refers to the activities carried out to make the workplace ready for production. It ensures that the work environment is clean, safe, and suitable for performing production tasks.

2.1 Activities Involved in Work Area Preparation

- Cleaning floors, walls, and work surfaces
- Ensuring proper lighting and ventilation

- Arranging machines and equipment systematically
- Keeping passages and exits clear
- Availability of safety equipment such as gloves, masks, and fire extinguishers

2.2 Importance of Work Area Preparation

- Prevents accidents and injuries
- Improves efficiency and speed of work
- Maintains hygiene and cleanliness
- Reduces chances of product contamination
- Creates a comfortable working environment

In dairy plants, proper work area preparation helps maintain food safety standards and prevents microbial contamination.

3. Machine Maintenance

Machine maintenance refers to the regular inspection, cleaning, servicing, and repair of machines to keep them in good working condition. Proper maintenance ensures smooth operation and prevents sudden machine failure during production.

3.1 Types of Machine Maintenance

Preventive Maintenance

Preventive maintenance is carried out before machine failure occurs. It includes routine inspection, lubrication, cleaning, and replacement of worn-out parts.

Corrective Maintenance

Corrective maintenance is done after a machine breaks down. It involves repairing or replacing faulty components to restore machine operation.

3.2 Importance of Machine Maintenance

- Reduces machine breakdowns
- Increases machine life
- Ensures consistent product quality
- Minimizes production delays
- Improves worker safety

In dairy processing units, proper maintenance of equipment such as pasteurizers, separators, and filling machines is essential for hygienic production.

4. Safety Measures in Work Area and Maintenance

Safety is a major concern during work area preparation and machine maintenance.

Important safety measures include:

- Wearing protective clothing such as gloves, caps, and aprons
- Switching off machines before maintenance
- Using proper tools for repair and servicing
- Reporting faults immediately
- Following safety instructions and warning signs

5. Summary

Work area preparation and machine maintenance are essential for safe and efficient production. A clean and organized work area improves productivity and reduces accidents, while regular machine maintenance ensures smooth operation and prevents breakdowns. Together, they support quality production and hygienic practices in dairy processing units.

PRACTICAL EXERCISES

(Activity)

1. Observe a workshop or dairy processing area.
2. List activities involved in preparing the work area.
3. Identify machines used and note their maintenance needs.
4. Prepare a simple maintenance checklist.
5. Suggest safety measures to improve the work environment.

CHECK YOUR PROGRESS

1. Multiple-Choice Questions (MCQs)

1. Work area preparation mainly helps in:
   a) Increasing waste
   b) Improving safety and efficiency
   c) Delaying production
   d) Increasing cost
2. Machine maintenance is required to:
   a) Decorate machines
   b) Prevent breakdowns
   c) Reduce production
   d) Increase accidents

3. Preventive maintenance is done:
   a) After breakdown
   b) Before breakdown
   c) Only once
   d) Never
4. Which of the following improves workplace safety?
   a) Cluttered floors
   b) Proper lighting
   c) Poor ventilation
   d) Damaged tools
5. Machine maintenance helps in improving:
   a) Machine damage
   b) Product quality
   c) Production delays
   d) Waste generation

2. Fill in the Blanks

1. A clean work area reduces the risk of _____.
2. _____ maintenance is done before machine failure.
3. Machine maintenance increases machine _____.
4. Safety equipment should always be _____ in the work area.
5. Proper maintenance ensures smooth _____ operations.

3. True or False

1. Work area preparation improves safety.
2. Machine maintenance is not important for product quality.
3. Preventive maintenance reduces breakdowns.
4. Safety measures should be ignored during maintenance.
5. Clean work areas reduce contamination risks.

4. Subjective Questions

1. What is work area preparation? Explain its importance.
2. Describe different activities involved in work area preparation.
3. Explain the types of machine maintenance.
4. Why is machine maintenance important in dairy processing units?
5. List safety measures followed during machine maintenance.

SESSION 3: ORGANIZING TOOLS, MATERIALS AND MANPOWER FOR PRODUCTION

1. Introduction

Efficient production depends not only on proper planning and well-maintained machines but also on effective organization of tools, materials, and manpower. In any production unit, especially in dairy and food processing plants, disorganized tools, improper material handling, or poor manpower allocation can lead to delays, wastage, accidents, and reduced product quality.

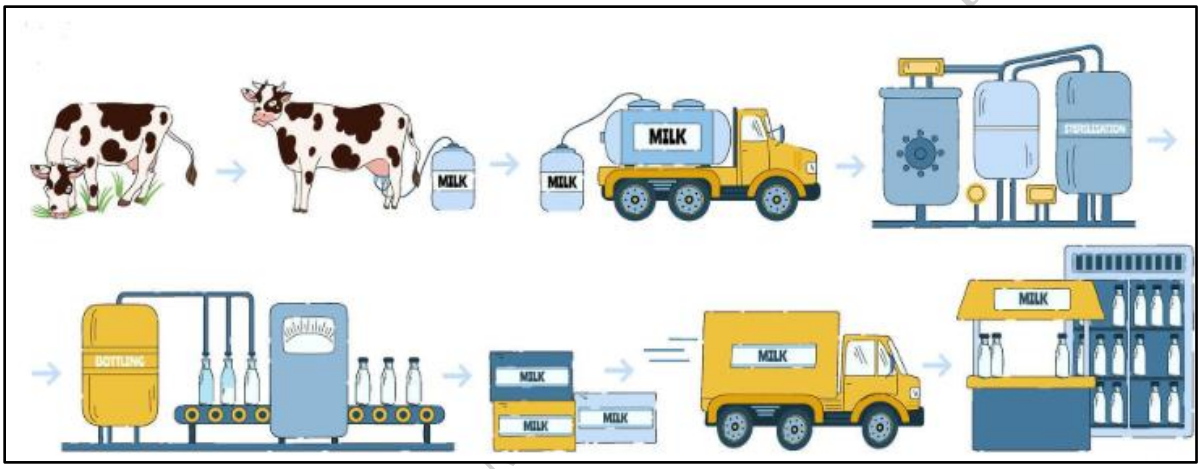

Fig. 1.7: Milk Production and Processing Workflow from Farm to

Products

Organizing tools, materials, and manpower ensures that the right resources are available at the right place and at the right time. Proper organization improves work efficiency, reduces confusion, enhances safety, and supports smooth production flow. For students of dairy product processing, understanding how to organize these resources is essential for maintaining hygiene, productivity, and quality in dairy plant operations.

2. Organizing Tools

Tools are essential for carrying out various production and maintenance activities. Proper organization of tools ensures that work is carried out smoothly without unnecessary delays.

2.1 Methods of Organizing Tools

- Tools should be cleaned after use
- Tools should be stored in designated places

- Tool racks, cabinets, or shadow boards should be used
- Damaged or worn-out tools should be repaired or replaced
- Tools should be easily accessible to workers

2.2 Importance of Organizing Tools

- Saves time during production
- Reduces loss or damage of tools
- Improves workplace safety
- Increases efficiency and productivity

In dairy plants, proper tool organization helps maintain hygiene and prevents contamination during processing.

3. Organizing Materials

Materials include raw materials, semi-finished products, packaging materials, and finished goods. Proper material organization is essential for smooth production flow.

3.1 Material Organization Practices

- Materials should be stored in clean and dry conditions
- Proper labeling of materials should be done
- Adequate quantity should be maintained to avoid shortages
- FIFO (First-In, First-Out) method should be followed
- Materials should be protected from damage and contamination

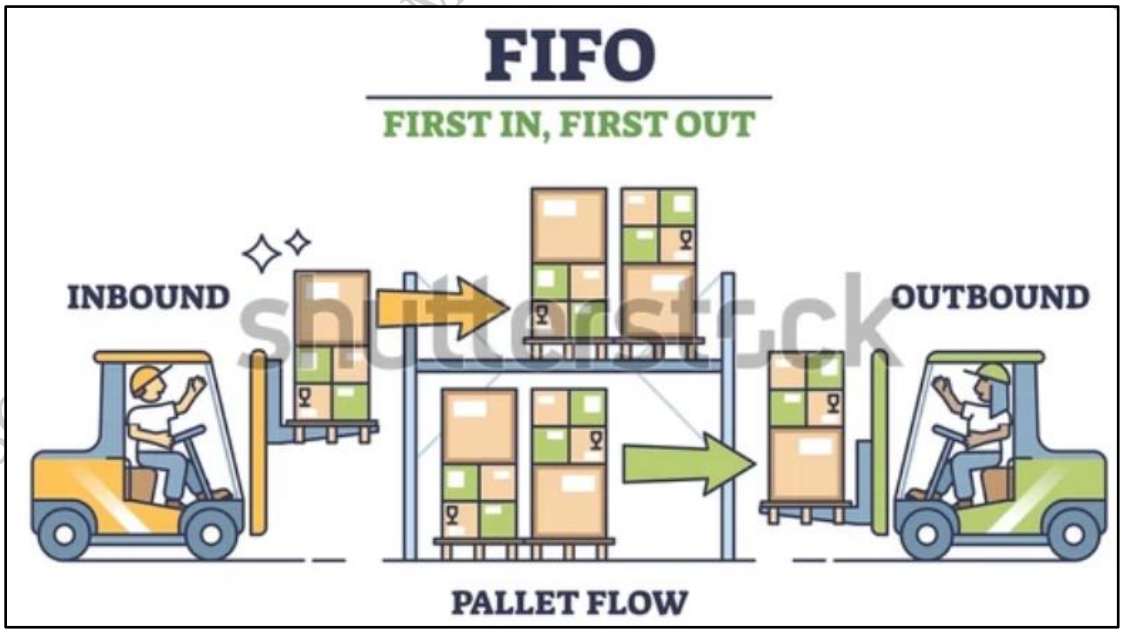

Fig. 1.8: FIFO (First-In, First-Out) Pallet Flow System in Warehouse Operations

3.2 Importance of Organizing Materials

- Prevents material wastage
- Reduces production delays
- Maintains product quality
- Ensures smooth workflow

In dairy processing units, correct storage of milk, ingredients, and packaging materials is important to maintain quality and safety standards.

4. Organizing Manpower

Manpower refers to the workforce involved in production activities. Proper organization of manpower ensures that tasks are completed efficiently and safely.

4.1 Manpower Organization

- Assign workers according to their skills and experience
- Provide proper training and instructions
- Maintain balanced workload
- Ensure clear communication among workers
- Follow hygiene and safety practices

4.2 Importance of Organizing Manpower

- Improves productivity
- Reduces errors and rework
- Enhances teamwork
- Improves worker satisfaction and safety

In dairy plants, trained and well-organized manpower is essential for maintaining hygiene and handling equipment safely.

5. Summary

Organizing tools, materials, and manpower is a key part of efficient production management. Proper tool organization saves time and improves safety, effective material management reduces wastage and delays, and good manpower organization increases productivity and quality. Together, these practices support smooth, hygienic, and efficient operations in dairy processing units.

PRACTICAL EXERCISES

(Activity)

1. Observe a dairy processing unit or workshop.
2. Identify how tools are stored and organized.
3. List materials used and note their storage methods.
4. Observe manpower allocation for different tasks.
5. Suggest improvements for better organization.

CHECK YOUR PROGRESS

1. Multiple-Choice Questions (MCQs)

1. Proper organization of tools helps in:
   a) Increasing delays
   b) Saving time
   c) Increasing wastage
   d) Reducing safety
2. Organizing manpower mainly helps in:
   a) Increasing confusion
   b) Reducing productivity
   c) Improving efficiency
   d) Increasing waste
3. Which of the following improves material safety?
   a) Improper storage
   b) Clear labeling
   c) Overcrowding
   d) Poor handling
4. In dairy plants, proper organization mainly helps to:
   a) Increase contamination
   b) Reduce hygiene
   c) Maintain quality and safety
   d) Delay production

2. Fill in the Blanks

1. Proper tool organization saves _____.
2. FIFO stands for _____.
3. Materials should be stored in _____ and dry conditions.
4. Assigning work based on skills improves _____.
5. Organized manpower reduces _____ during production.

3. True or False

1. Tool organization improves workplace safety.
2. Poor material storage improves product quality.
3. FIFO method helps reduce material wastage.
4. Manpower organization increases errors.
5. Proper organization supports smooth production flow.

4. Subjective Questions

1. Explain the importance of organizing tools in production.
2. Describe methods of organizing materials in a dairy plant.
3. What is manpower organization? Explain its importance.
4. How does proper organization improve productivity?
5. Explain the role of organization in maintaining hygiene in dairy processing units.

MODULE 2 MARKET MILK – PRODUCTION, PROCESSING, QUALITY ASSESSMENT, AND HYGIENE

Milk is a cornerstone of India's food industry and a vital source of nutrition, widely consumed across households. India is the world's largest producer and consumer of milk, contributing about 30–31% of global milk production, with annual output exceeding 220 million tonnes, according to Government of India and NDDB estimates. Growth of the organized dairy sector is driven by rising consumer incomes, rapid urbanization, changing dietary habits, improved cold chain infrastructure, expansion of dairy herds, and supportive government policies. Market milk plays a key role in ensuring nutritional security, supporting rural livelihoods, and generating employment through value-added dairy processing.

SESSION 1: MILK STANDARDIZATION AND HEAT/PROCESS TREATMENTS

1. Milk Standardization

Milk standardization in the dairy industry is the systematic adjustment of milk components to comply with legal regulations or to achieve specific compositional targets, ensuring safety, consistency, and suitability for consumer use. This process typically involves modifying the butterfat content by blending whole milk with skim milk (milk from which most fat has been removed) or by separating cream through centrifugation. The result is milk tailored to precise fat percentages, such as full-cream, toned, or skim milk, meeting diverse consumer preferences while maintaining adherence to quality and regulatory standards.

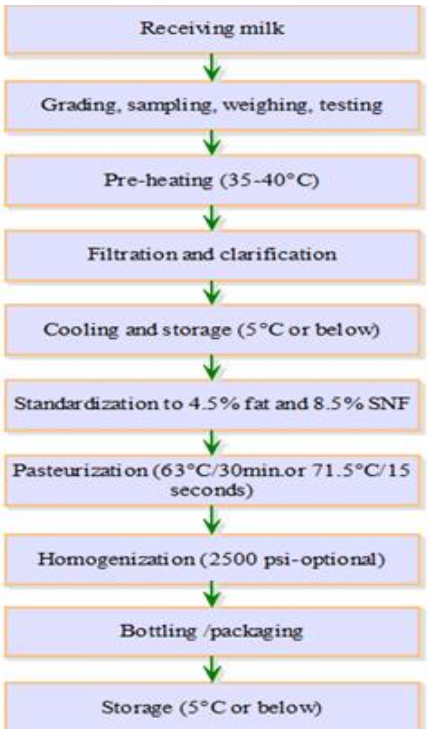

Fig. 2.1: Flow diagram for preparation of standardized milk

Goals of Milk Standardization

In the dairy industry, standardization is done with a few key goals in mind to ensure high-quality milk products for consumers. These goals include:

- **Meeting Legal Standards**: Adjusting milk to follow the rules and regulations set for different dairy products, ensuring they are safe and suitable for sale.
- **Consistent Quality for Consumers**: Creating milk with a uniform taste, texture, and fat content so that customers get the same reliable product every time.
- **Cost-Effective Production**: Making the process efficient for dairy producers. For example, adding skim milk increases the amount of milk available for sale, while removing cream allows it to be used for making other products like butter, table cream, or other dairy items, adding value and reducing waste.

2. Methods of Calculation

In the dairy industry, standardizing milk or cream for making products involves figuring out the right amounts of ingredients with known compositions to mix together. This ensures the final product has the desired quality and meets specific standards. The calculations can be done using two main methods:

Pearson's Square Method: A simple and visual way to calculate the proportions of ingredients, like milk and cream, to achieve the target fat content. It uses a square diagram to balance the components effectively.

Algebraic Equations: A mathematical approach where equations are set up based on the composition of ingredients to determine the exact quantities needed for standardization.

Pearson's Square Method

The Pearson's Square Method is a simple and practical way to calculate the proportion of two ingredients required to obtain a mixture of a desired fat percentage. It is commonly used in the dairy industry for standardization of milk and cream.

Steps of the method:

1. Draw a square and write the desired fat percentage in the centre.
2. On the left-hand corners of the square, write the fat percentage of the two ingredients to be mixed. The higher percentage is placed at the top left and the lower percentage at the bottom left.

3. Subtract the number in the centre from each of the numbers on the left-hand corners and write the differences at the diagonally opposite right-hand corners.
4. The numbers on the right side represent the parts of each ingredient to be taken for mixing.
   - The number at the upper right corner corresponds to the parts of the ingredient at the lower left.
   - The number at the lower right corner corresponds to the parts of the ingredient at the upper left.
5. Adding the two numbers on the right-hand side gives the total number of parts in the finished mixture.

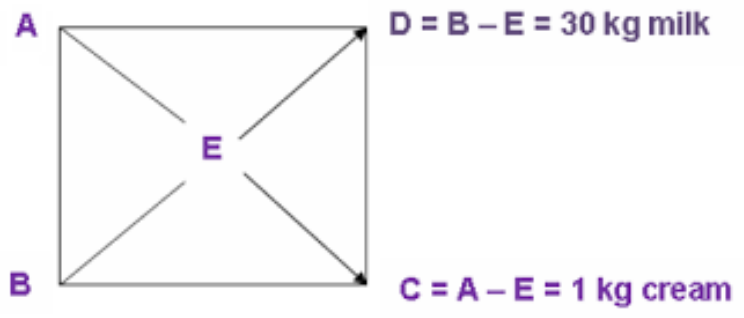

Fig. 2.2: Pearson's Square Diagram

- **Algebraic Equation**

  Problem:

  Prepare 600 kg of milk containing 3.0% fat and 8.6% SNF. You are provided with whole milk having 5.2% fat and 9.2% SNF, skim milk powder (SMP) having 1.0% fat and 96.0% SNF, and water. Calculate the amount of whole milk, SMP, and water required.

  Solution:

  Let:
  Whole milk = X kg
  SMP = Y kg
  Water = Z kg

  1. Mass Balance:

  X + Y + Z = 600

  2. Fat Balance:

  Fat in final milk = 600 × 0.03 = 18 kg
  0.052 X + 0.010 Y = 18

3. SNF Balance:

SNF in final milk = 600 × 0.086 = 51.6 kg

0.092 X + 0.960 Y = 51.6

Step 1: Solve Fat and SNF Equations

From fat equation:

0.052 X + 0.010 Y = 18

From SNF equation:

0.092 X + 0.960 Y = 51.6

Solving these equations simultaneously gives:

X ≈ 342.1 kg

Y ≈ 21.0 kg

Step 2: Calculate Water

Z = 600 − X − Y = 600 − 342.1 − 21.0 ≈ 236.9 kg

Answer:

Whole milk = 342.1 kg

SMP = 21.0 kg

Water = 236.9 kg

Check:

Fat = (0.052 × 342.1) + (0.010 × 21.0) = 18.0 kg → 18/600 = 3.0%

SNF = (0.092 × 342.1) + (0.960 × 21.0) = 51.6 kg → 51.6/600 = 8.6%

3. Methods of Standardization

Standardization of milk can be carried out in different ways depending on the equipment and accuracy required. The commonly used methods are as follows:

1. Batch Standardization

The most common method of standardization used in dairies involves mixing milk and cream in appropriate proportions in a tank. The mixture is then thoroughly agitated to achieve uniform composition. However, this method has a drawback, as it requires more time for proper mixing, testing, and making the final adjustments to reach the desired standard.

2. Continuous Standardization

In this method, an inline sampler is connected with a testing device. The system automatically samples milk, measures the fat content and displays the result at regular intervals, usually every 20 seconds. This allows quicker and more uniform standardization compared to the batch process.

3. Automatic Standardization

This method is an advanced form of continuous standardization. Here, the separator is replaced with a microprocessor or controller unit, which is linked to the sampler and tester. The system automatically regulates the cream and skim milk flow to achieve the desired fat level. It saves time and labour and provides greater accuracy than other methods.

4. Tri-Process Machine

The tri-process machine is designed to carry out clarification, separation and standardization of milk in a single unit. Its construction is similar to that of a cream separator but with additional control features. The machine is fitted with external valves on the discharge lines of cream and skim milk, and a precise needle valve is attached to the cream outlet to regulate the flow. A bypass line is also provided to connect the cream discharge line with the skim milk discharge line. This ensures better control and efficiency in standardization.

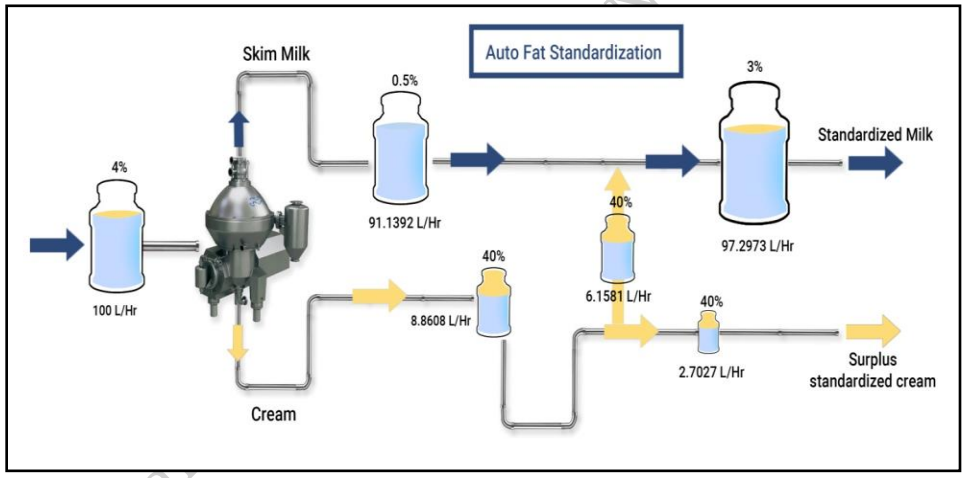

Fig. 2.3: Flowchart for Milk Standardization Methods

Table: Types of Heat/Process Treatments

Treatment	Time-Temperature	Purpose	Advantages	Limitations
Boiling	~100°C, few min	Household use	Simple, low cost	Cooked flavor, nutrient loss (~15% vitamin C)
LTLT Pasteurization	63°C, 30 min	Small-scale dairies	Preserves flavor	Slow, high energy use

HTST Pasteurization	72°C, 15 sec	Commercial dairies	Efficient, minimal nutrient loss	Needs plate heat exchangers
UHT	135–150°C, 2–5 sec	Long-life milk	Shelf-stable 3–6 months	Slight cooked flavor, costly packaging
Sterilization	110–115°C, 15–20 min	Canned milk	Shelf life up to 1 year	Nutrient loss (~25% thiamine)
Thermization	57–68°C, 15–30 sec	Pre-treatment	Reduces spoilage bacteria	Not pathogen-eliminating
Homogenization	1500–2500 psi	Prevents cream separation	Enhances texture	Not a microbial treatment

Source: **FSSAI Regulations, 2023**

2. Heat Treatments and Pasteurization

Milk is highly perishable and can easily become contaminated with harmful microorganisms. To make milk safe for consumption and to increase its shelf life, it is necessary to subject it to heat treatment**.** Heat treatment is a process in which milk is heated to a specific temperature for a certain period to destroy pathogenic and spoilage-causing microorganisms, while retaining its nutritional and sensory qualities.

Different methods of pasteurization are used depending on the desired processing and shelf life:

1. Plate Heat Exchanger
2. High Temperature Short Time
3. Homogenizer

1. Plate Heat Exchanger

Plate heat exchangers (PHEs) are widely used in the dairy industry for pasteurization and sterilization of milk. They consist of thin, corrugated metal plates stacked together with gaskets to direct the flow of fluids. This creates turbulence, which improves heat transfer and reduces fouling.

The corrugated plates provide a large surface area and a self-cleaning effect, making PHEs more efficient and lighter than shell-and-tube heat

exchangers. Heat transfer in PHEs is analysed using energy and mass balance, along with simple mathematical models. Steady-state models help determine flow rates and temperatures of hot and cold fluids, which are used to design and optimize the exchanger for efficient operation.

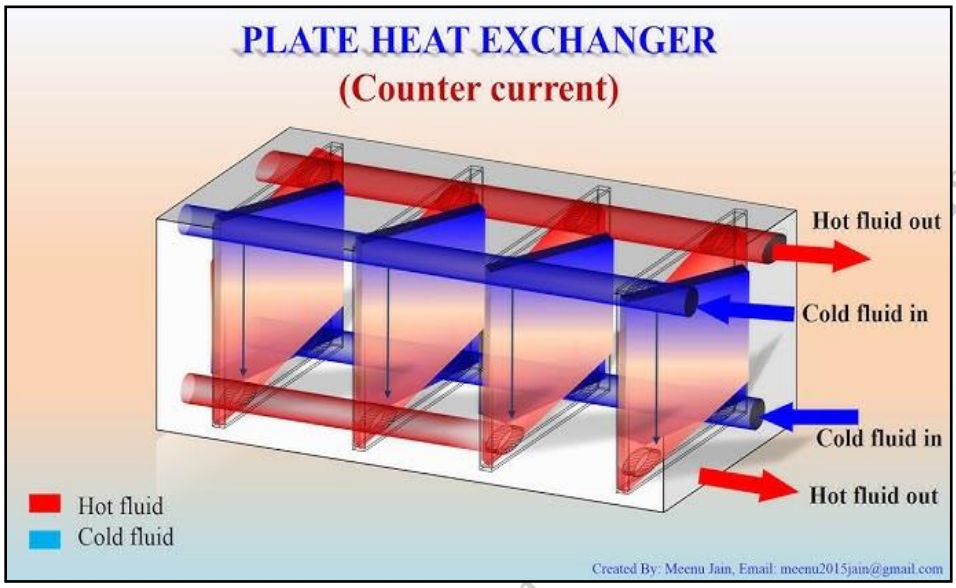

Fig. 2.4: Plate Heat Exchanger Diagram

2. HTST – High-Temperature Short-Time Pasteurization

High-Temperature Short-Time (HTST) pasteurization is widely used in the dairy industry to ensure the safety and quality of milk. In this process, milk is heated to 72°C for 15 seconds in a holding tube and then cooled rapidly. Plate heat exchangers (PHEs) are used to achieve efficient heat transfer and meet industrial cleaning and sanitation standards.

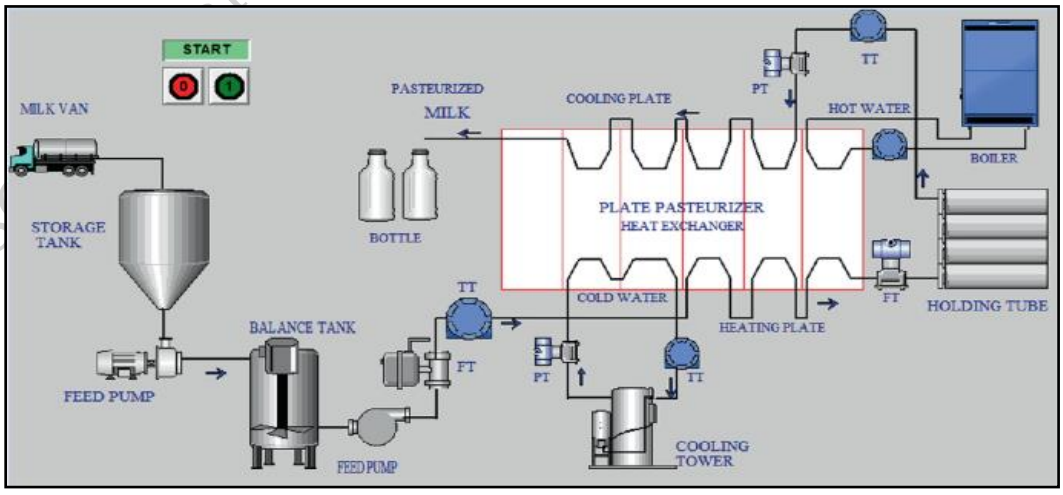

Fig. 2.5: HTST Pasteurization Flowchart

3. Homogenizer

Homogenization is a process in the dairy industry that uses mechanical force to break down milk fat globules into tiny particles, typically 2 micrometers or smaller, spreading them evenly throughout the milk. This technique mainly aims to stop or slow the formation of a cream layer on top of full-cream milk by making the fat globules much smaller than their natural size, which ranges from 2 to 12 micrometers. A single milliliter of milk contains about 3 to 4 billion fat globules. Long ago, pasteurized milk was often left unhomogenized, allowing some cream to rise to the surface to highlight its rich, full-cream nature. Nowadays, homogenization gives milk a smoother, fuller taste and is commonly used for sterilized, evaporated, or condensed milk, as well as cream, to ensure a consistent texture and quality.

Table: Purpose of homogenization in different products

Product	Benefits of Homogenization
Milk, cream, condensed milk	Prevention of cream separation; improvement in flavor; increased whitening
Coffee cream	Power increase in viscosity; increased whitening
Yoghurt	A more stable gel
Ice cream mix	Reduced fat separation during freezing; higher overrun
Whole milk powder	Lower free fat content in powder; better flowability
Cheese (soft types)	Increased cheese yield; superior flavor

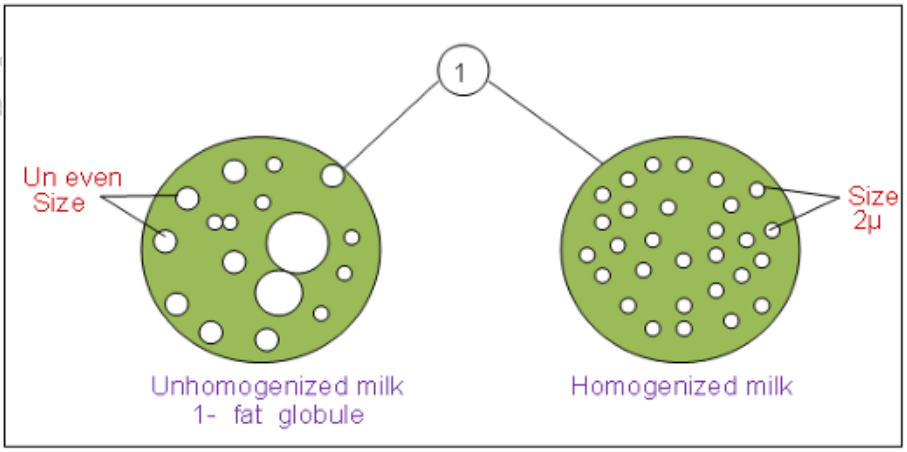

Fig. 2.6: Effect of homogenization on fat in milk

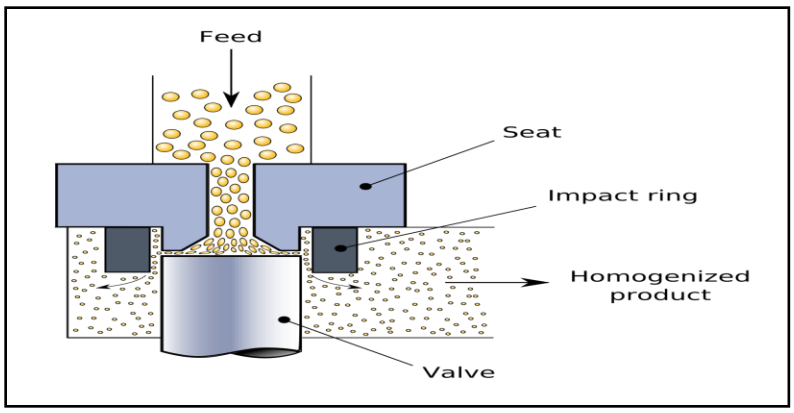

Fig. 2.7: Homogenizer Diagram

PRACTICAL EXERCISES

Activities

1. Standardize milk to a specific fat level using a lab separator and verify with a milk analyzer.
2. Calculate proportions for toned milk using Pearson's Square with raw milk and skim milk.
3. Process milk with high-temperature short-time pasteurization and compare its flavor and color with low-temperature long-time pasteurization.
4. Blend buffalo milk with cow milk and adjust fat and solids-not-fat to meet toned milk standards.
5. Store pasteurized milk in a refrigerator and ultra-high-temperature milk at room temperature, observing quality changes over five days.

CHECK YOUR PROGRESS

A. Multiple-Choice Questions:

1. The main purpose of milk standardization is to ensure:
   a) Higher fat content
   b) Consistent composition
   c) Better color
   d) Longer shelf life

2. HTST pasteurization involves:
   a) 63°C for 30 minutes
   b) 72°C for 15 seconds
   c) 135°C for 2 seconds
   d) 100°C for 5 minutes

3. Plate heat exchangers are primarily used in:
   a) LTLT pasteurization
   b) HTST pasteurization
   c) Homogenization
   d) Cream separation
4. Pearson's Square method is used to calculate:
   a) Heating times
   b) Blending proportions
   c) Microbial counts
   d) Packaging needs
5. UHT milk is typically stored at:
   a) ≤4°C
   b) Ambient temperature
   c) 10–15°C
   d) Frozen

B. Fill in the Blanks

1. Standardization adjusts _____and _____ in milk.
2. HTST uses a _____ heat exchanger for efficiency.
3. Pearson's Square aids _____calculations.
4. UHT milk shelf life is _____ months at ambient temperature.
5. Rapid _____ to ≤4°C prevents recontamination.

C. True or False

1. Pasteurization eliminates all microorganisms.
2. Plate heat exchangers recover 90–95% heat.
3. Pearson's Square is limited to two-component blends.
4. Homogenization improves texture by reducing fat globules.
5. High heat treatments cause no nutrient loss.

D. Subjective Questions

1. Why is milk standardization important in dairy processing? Explain its role in ensuring quality and meeting consumer needs.
2. Describe the process of cream separation and how Pearson's Square method is used to standardize milk. Provide a simple example.
3. Discuss the principles and objectives of heat treatments in dairy processing, focusing on their impact on milk safety and shelf life.
4. Explain the role of plate heat exchangers (PHEs) in HTST pasteurization. Include a simple sketch or description of a PHE setup.
5. Compare the effects of LTLT, HTST, and UHT pasteurization on milk quality, including flavor, nutritional value, and shelf life.

E. What Have You Learned?

1. Understand the concept and importance of milk standardization in dairy processing.
2. Learn to apply methods like Pearson's Square for standardizing milk.
3. Explore different types of pasteurization and their effects on milk safety and quality.
4. Understand the role of plate heat exchangers in efficient milk processing.
5. Gain hands-on experience through practical exercises in standardization and heat treatments

SESSION 2: TYPES OF MARKET MILK AND THEIR PROCESSING TECHNIQUES

1. Market Milk

Market milk refers to fluid milk that is processed, standardized, heat-treated, packaged, and distributed under strict hygienic conditions for direct consumption. Advanced processing technologies ensure safety, quality, and compliance with standards set by the Food Safety and Standards Authority of India (FSSAI). Techniques like pasteurization, homogenization, and fortification enable milk to meet diverse consumer needs and global benchmarks. India's dairy industry thrives due to its vast dairy animal population, skilled workforce, cooperative networks (e.g., Amul, Mother Dairy etc.), and government initiatives, fostering both nutritional benefits and economic growth.

Fig. 2.8: Distribution of Packaged Market Milk through Organized Supply Chain

2. Classification

Table: Comparison of Different Milk Types

Milk Type	Fat Content (% by weight)	SNF Content (% by weight)	Description
Full Cream Milk / Whole Milk	≥ 6.0	≥ 9.0	Rich and creamy milk, suitable for children and general consumption
Standardized Milk	4.5	≥ 8.5	Uniform composition milk for regular daily use
Toned Milk	3.0	≥ 8.5	Popular and affordable milk with balanced nutrition
Double Toned Milk	1.5	≥ 9.0	Low-fat milk for health-conscious consumers
Skimmed Milk	≤ 0.5	≥ 8.7	Almost fat-free milk, high in proteins
Flavoured Milk	As per base milk	As per base milk	Milk with permitted flavors, sweeteners, and stabilizers
Fortified Milk	As per base milk	As per base milk	Milk fortified with vitamins A (2000 IU/L) and D (400 IU/L)

Source: Food Safety and Standards Authority of India (FSSAI). *Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2011 (as amended up to 2022).*

Table: Standards for Different Types of Milk

Type of Milk	SNF (Minimum %)	Fat (Minimum / Maximum %)	Description
Skimmed Milk	8.7	≤ 0.5 (Maximum)	Nearly fat-free milk, suitable for low-fat diets
Double Toned Milk	9.0	1.5 (Maximum)	Low-fat milk, ideal for health-conscious consumers
Toned Milk	8.5	3.0 (Maximum)	Commonly consumed milk in India with balanced nutrition

Standardized Milk	8.5	4.5	Milk standardized for regular daily consumption
Full Cream Milk	9.0	6.0 (Minimum)	Rich and creamy milk, suitable for children and general use

Source: *Food Safety and Standards Authority of India (FSSAI). Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2011, amended up to 2022.*

3. Processing Techniques for Different Types of Market Milk

Processing includes reception, clarification, standardization, heat treatment, homogenization, cooling, and packaging, customized for each milk type.

Table: Composition and Processing Standards for Market Milk Types (as per FSSAI)

Milk Type	Fat Content (%)	SNF Content (%)	Key Processing Steps	Considerations
Whole / Full Cream Milk	≥ 6.0	≥ 9.0	Reception → Clarification → Standardization → HTST Pasteurization → Homogenization (optional) → Cooling → Packaging	Homogenization prevents cream separation; light-protective packaging recommended
Standardized Milk	4.5	≥ 8.5	Reception → Clarification → Standardization → HTST Pasteurization → Cooling → Packaging	Inline fat/SNF monitoring for compliance
Toned Milk	3.0	≥ 8.5	Reception → Clarification → Standardization (cream removal + skim/SMP addition) → Homogenization (optional) → HTST → Cooling → Packaging	Affordable; thorough blending required

Double Toned Milk	1.5	≥ 9.0	Reception → Clarification → Cream separation → Skim/SMP addition → HTST → Cooling → Packaging	Low-fat milk; vitamin fortification recommended
Skimmed Milk	≤ 0.5	≥ 8.7	Reception → Clarification → Cream separation → SNF adjustment → HTST / UHT → Cooling → Packaging	Protein-rich; vitamin fortification recommended

4. Packaging, Storage, and Cold Chain Management

Milk, a highly perishable product, needs proper packaging to stay fresh, with options like pouches, bottles, and cartons used worldwide. Plastic packaging is lightweight and cost-effective, but requires proper recycling and waste management to reduce environmental impact. The hot climate and poor transport infrastructure cause significant waste, making good packaging crucial for success in the dairy business. Essentially, packaging protects milk and extends its shelf life for easy transport.

Purpose of Packaging

Packaging for dairy products like milk:

i) **Protects**: Keeps milk safe during storage and transport, extending shelf life.

ii) **Informs**: Shares product details like quality, ingredients, and manufacturer.

iii) **Attracts**: Eye-catching designs boost sales.

Packages show:

- ✓ Product name and description
- ✓ Manufacturer's details
- ✓ Additives, nutrition facts, weight, and batch number

Table: Different types of Packaging Materials

Material	Details	Advantages	Disadvantages/Notes
Glass	**Types**: Transparent, Opaque **Features**: Reusable, non-reactive, good barrier	Provides clear visibility, excellent barrier properties	Heavy, breakable, less used now
Plastics	**Types**: - **LDPE**: Early films had pin-holes; double-layer improved - **LLDPE**: Stronger, better sealing, puncture-resistant **Benefits**: Protects from microbes, controls humidity	Flexible, lightweight, effective protection	Early LDPE had wastage issues due to pin-holes
Laminates	**Description**: Multiple film layers **Examples**: Polyethylene/paper, polyethylene/aluminum foil **Use**: Enhances durability	Improved strength, grease resistance, better barriers	Used for enhanced product safety

Aseptic Packaging

Aseptic packaging is an advanced technique where milk or other dairy products are sterilized and packed in sterile containers under germ-free conditions. The packages are then hermetically sealed to ensure the product remains fresh for up to 6 months without refrigeration, even at room temperature. This method is ideal for ultra-high temperature (UHT) milk, which is heated to kill all bacteria and spores, ensuring safety and a long shelf life.

Table: Tetra Pak Layers in Aseptic Packaging

Layer	Function
Outer Polyethylene	Keeps the package dry and protects it from external moisture.
Paper	Provides structural strength and stability to the package.

Polyethylene	Acts as a binding layer to hold the structure together.
Aluminum Foil	Forms a barrier against light and oxygen, preventing spoilage.
Adhesive Polymers	Glues the aluminum foil to the inner polyethylene layer.
Inner Polyethylene	Creates a liquid-tight seal to keep the milk fresh and safe.

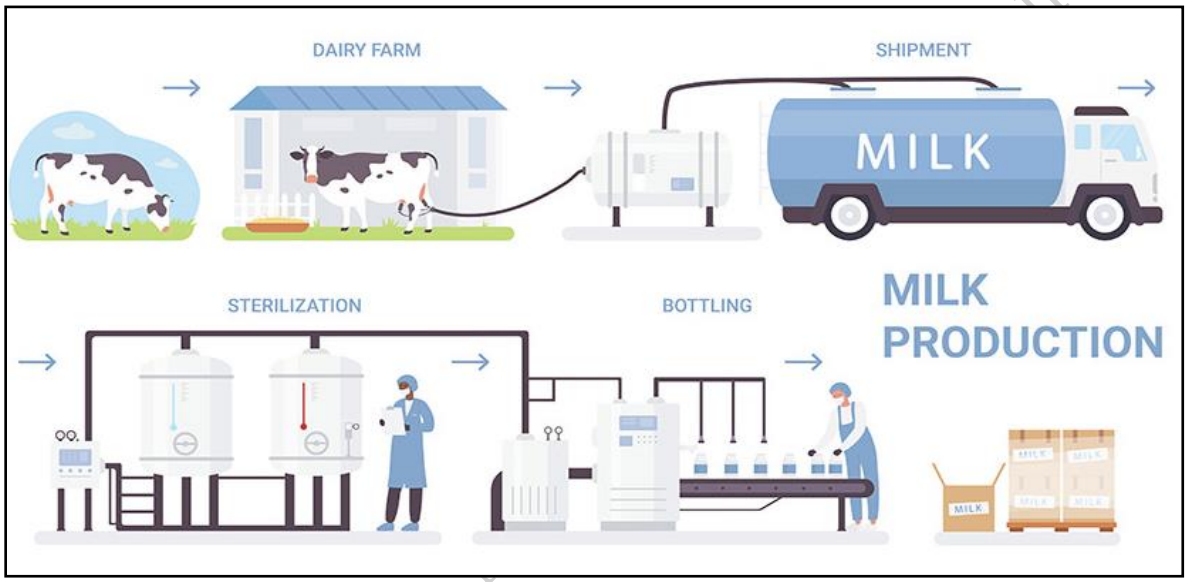

Fig. 2.9: Cold Chain Management Diagram

PRACTICAL EXERCISES

Activities

1. Compare the fat and SNF content of whole milk and toned milk using a milk analyzer and record the differences.
2. Simulate the standardization process for toned milk using a model separator and calculate the proportions of cream and skim milk.
3. Perform HTST pasteurization on a milk sample and observe the changes in texture and flavor compared to raw milk.
4. Prepare a small batch of flavored milk by adding a heat-stable flavor and evaluate its taste and stability.
5. Study the layers of a Tetra Pak carton and create a diagram illustrating their functions in aseptic packaging.

CHECK YOUR PROGRESS

A. Multiple-Choice Questions

1. Market milk is defined as fluid milk that is processed for:
   a) Cheese production
   b) Direct consumption
   c) Animal feed
   d) Butter making
2. The minimum fat content of full cream milk as per FSSAI standards is:
   a) 3.0%
   b) 4.5%
   c) 6.0%
   d) 1.5%
3. Which processing technique prevents fat separation in milk?
   a) Pasteurization
   b) Homogenization
   c) Fortification
   d) Clarification
4. Aseptic packaging is most suitable for which type of milk?
   a) Toned milk
   b) UHT milk
   c) Skimmed milk
   d) Standardized milk
5. The primary purpose of packaging in the dairy industry is to:
   a) Reduce costs
   b) Protect milk during transport
   c) Increase milk production
   d) Enhance milk flavor

B. Fill in the Blanks

1. Market milk is processed and distributed under strict _____ conditions to ensure safety.
2. _____ adjusts the fat and SNF content of milk to meet consumer needs.
3. HTST pasteurization involves heating milk at _____ °C for _____ seconds.
4. _____ packaging allows milk to remain fresh for up to 6 months without refrigeration.
5. The _____ layer in Tetra Pak provides a barrier against light and oxygen

C. True or False

1. Whole milk has the highest fat content among all milk types.
2. Clarification removes impurities from milk during processing.
3. Plastic packaging is not effective for milk storage due to pin-holes. (Modern double-layer LDPE and LLDPE address this issue).
4. Fortified milk contains added vitamins like A and D.
5. Cold chain management is unnecessary for UHT milk.

D. Subjective Questions

1. Explain the role of cooperative networks like Amul in the success of India's dairy industry.
2. Describe the differences between whole milk and skimmed milk in terms of composition and processing techniques.
3. Discuss the steps involved in the processing of toned milk and their importance in meeting FSSAI standards.
4. Explain the advantages of aseptic packaging over traditional packaging for milk products.
5. Compare the processing techniques of HTST pasteurization and UHT treatment, focusing on their impact on shelf life and nutritional value.

E. What Have You Learned?

1. Understand the definition and significance of market milk in the dairy industry.
2. Learn about the different types of market milk and their specific fat and SNF content.
3. Explore the processing techniques such as standardization, pasteurization, and homogenization.
4. Gain insights into packaging materials and the importance of aseptic packaging for milk shelf life.
5. Appreciate the role of cold chain management in maintaining milk quality during distribution.

SESSION 3: QUALITY CONTROL, ASSURANCE, AND HYGIENIC HANDLING PRACTICES

Introduction

Milk is a nutritious food packed with proteins, vitamins, and minerals that support growth and health. Market milk refers to the milk available in shops or dairies for drinking or making products like curd and cheese. Ensuring its safety and quality is essential to prevent illness and maintain its goodness.

1. Ensuring Safety and Quality in Milk Production

Food safety ensures that milk does not cause illness when consumed. Quality ensures it tastes good, looks appealing, and retains its nutritional value. Milk can become unsafe due to contamination by bacteria, chemicals, or foreign objects if not handled properly.

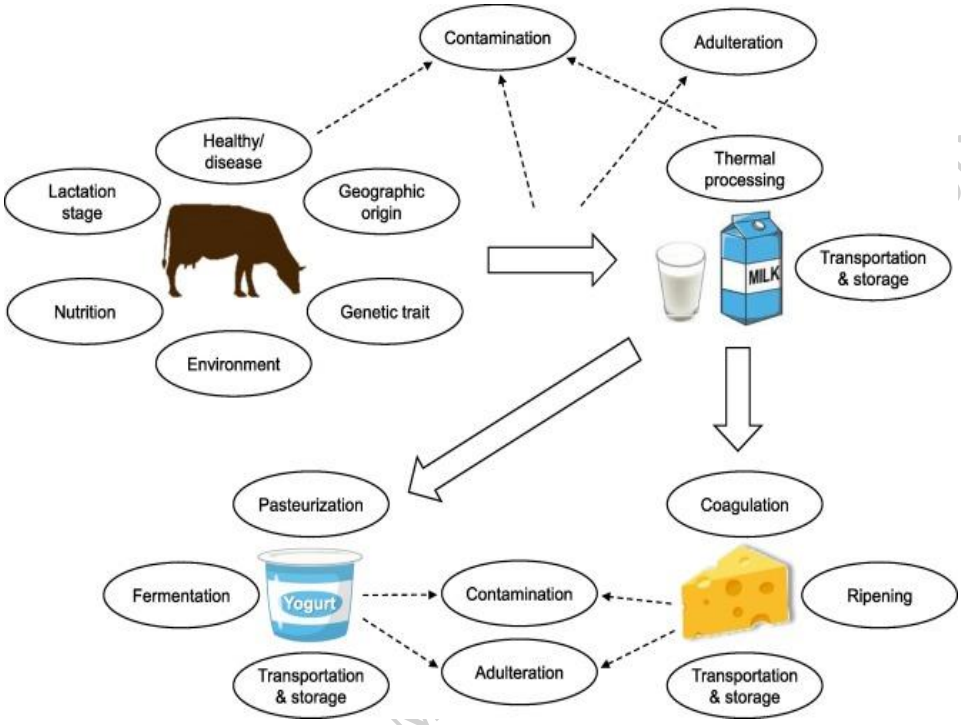

Fig. 2.10. Flowchart of Milk Processing and Potential Contamination

- **Two approaches are used for food safety:**
  - ✓ **Traditional Approach**: This involves testing milk after production. If unsafe, it is discarded. This method is reactive and does not prevent issues early.
  - ✓ **Science-Based Approach**: This proactive method monitors every step of milk production to prevent problems before they occur, ensuring safer milk.

  The science-based approach is like building a strong house with good materials to avoid issues, while the traditional approach is like fixing leaks after they happen.

- **Hazards in Milk**

  Milk can face three types of hazards that affect its safety and quality:

1. **Biological Hazards**: These are living organisms such as bacteria, viruses, or parasites.

   Examples-
   - ✓ *Staphylococcus aureus* from dirty udders or *Mycobacterium tuberculosis*, which can cause serious illnesses.
   - ✓ Some bacteria spoil milk, making it sour, while others cause diseases like food poisoning.
   - ✓ Sources include cow feces, dirty water, or unclean hands during milking.

2. **Chemical Hazards**: These are non-living contaminants like antibiotics, pesticides, or toxins.

   Examples-
   - ✓ Antibiotics from treated cows can remain in milk if withdrawal periods are not followed.
   - ✓ Pesticides from farms or toxins like aflatoxin from contaminated feed can harm consumers.
   - ✓ These can cause health issues over time.

3. **Physical Hazards**: These are foreign objects like dirt, hair, glass, or metal.

   Examples-
   - ✓ Sources include unclean farms, storage areas, or broken equipment.
   - ✓ These can cause injury when consumed.

   Preventing these hazards requires clean farms, healthy cows, and careful handling at every stage.

Contaminants in Milk and Milk Products

Contaminants are unwanted substances that make milk unsafe. They are classified into two types:

- **Infectious Contaminants**: These cause diseases and include bacteria, viruses, or parasites.

  Examples
  - ✓ bacteria causing brucellosis or typhoid, often from dirty udders, water, or insects.
  - ✓ Prevention involves cleaning equipment, pasteurizing milk, and storing it at low temperatures.

- **Non-Infectious Contaminants**: These do not spread diseases but affect safety or quality.

Examples

- ✓ chemicals from drugs, heavy metals from pollution, or added water that dilutes milk.
- ✓ In countries like India, small-scale farmers may add water, reducing milk quality.

Milk-borne illnesses arise when harmful germs grow in milk. Boiling or pasteurizing milk eliminates these risks.

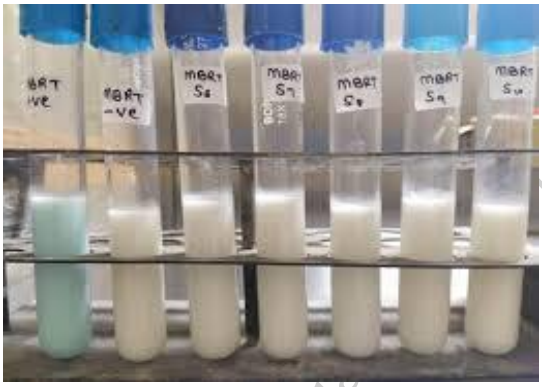

Fig. 2.11: Microbiological Testing Setup

Table: Quality Assurance and Control

Quality assurance	Quality control
Involves planning to ensure milk meets safety and quality standards consistently. It is a promise that milk is safe and wholesome.	Involves testing and checking milk to identify and fix problems.

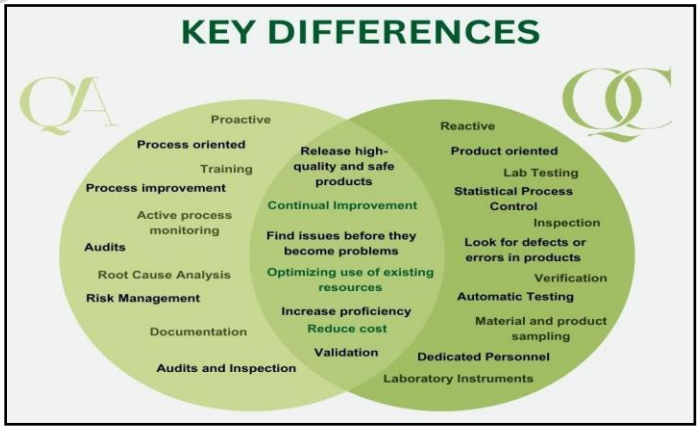

Fig. 2.12:

Quality checks occur at multiple stages:

Farm: Use clean equipment, milk healthy cows, and cool milk immediately.
Collection Centers: Test milk from different farmers for quality.
Dairy Factory: Process milk hygienically to produce safe products.
Marketing: Government authorities inspect milk to ensure it meets standards.

Indicators of Quality Milk:

Appearance: White, no lumps or particles.
Smell: Fresh, not sour.
Acidity: pH between 6.5 and 6.7.
Density: 1.028–1.032 g/cm³, indicating no added water or removed cream.
Freezing Point: Below -0.517°C.
Bacterial Count: Low, indicating cleanliness.

Testing Methods for Milk Quality

Several simple tests ensure milk meets quality standards:

Table: Milk Quality Testing Methods

Test Name	Description
Density Test	Checks if water was added (lowers density) or cream removed (increases density).
Organoleptic Test	Uses sight, smell, and taste to assess milk; quality milk is creamy white with a mild smell and no off-taste.
Clot-on-Boiling Test	Boiling milk reveals high acidity or colostrum if it curdles, indicating it is unfit for processing.
Alcohol Test	Mixing milk with alcohol checks protein stability; clotting indicates high acid or salts.
Titratable Acidity Test	Measures acid levels from bacterial activity; fresh milk has low acidity.
Bacterial Counts	Tests like total plate count or somatic cell count assess cleanliness and udder health.

Milk Quality Standards and Regulations

Governments enforce standards to protect consumers from health risks associated with contaminated or adulterated milk. In India, the Food Safety and Standards Authority of India (FSSAI) sets rules that align with

international standards, such as those in the European Union and the United States. These regulations ensure milk safety and quality from production to consumption.

Table: Milk Quality Standards and Grading

Category	Description
Raw Milk	Must be cooled to 8°C quickly, with aerobic bacteria within limits prescribed by FSSAI for raw milk at collection.
Pasteurized Milk	Heat-treated to eliminate harmful germs, with no fecal coliforms (Pasteurization destroys pathogenic microorganisms but does not eliminate all microorganisms)
Grading	
- Grade A	Top-quality milk for drinking, produced under sanitary conditions.
- Grade B	Used for products like cheese or butter, with slightly lower standards.
- Grade C	Lowest grade, not for direct consumption.

- **Hazard Analysis and Critical Control Points (HACCP)**
  HACCP is a scientific system to ensure milk safety by identifying and controlling hazards throughout production. It is widely used globally to meet export standards.

  Seven Principles of HACCP:
  ✓ Identify hazards (e.g., bacteria during milking).
  ✓ Determine critical control points (e.g., cooling milk).
  ✓ Set critical limits (e.g., cool to below 6°C).
  ✓ Monitor these points regularly.
  ✓ Take corrective actions if limits are exceeded.
  ✓ Verify the system works.
  ✓ Keep detailed records.

  HACCP prevents problems proactively, unlike traditional methods, ensuring milk is safe for consumption and export.

Hygienic Handling Practices

Table: Hygienic Handling Practices for Market Milk

Stage	Hygienic Handling Practices
Farm	Wash cow udders, use clean milking equipment, cool milk to 4–6°C within two hours.

Transport	Use clean, refrigerated tanks to maintain low temperatures.
Processing	Pasteurize milk to kill germs, pack in sterile containers.
Storage	Refrigerate milk below 5°C at home or in stores.
Personal Hygiene	Wash hands, wear clean clothes, ensure no sick individuals handle milk.

These steps prevent contamination and maintain milk quality.

Economic Benefits

High-quality milk reduces waste, improves public health, and supports trade, including exports, which bring economic benefits. Safe milk lowers healthcare costs by reducing foodborne illnesses and enhances consumer trust.

Milk is a valuable food, but it requires careful handling to remain safe and nutritious. From clean farms to proper storage, every step matters. By following quality control, assurance, and hygienic practices, the dairy industry ensures milk is a wholesome product for all.

Table: Common Defects Table Visualization

Defect	Icon	Description	Causes	Remedies
Off-Flavour (Sour)	Sour smell	Sour, unpleasant taste/smell	Microbial growth, inadequate pasteurization, storage >4°C, contamination	HTST pasteurization (72°C, 15 sec), cold chain (≤4°C), CIP hygiene
Rancidity	Spoiled fat	Bitter/soapy taste from fat breakdown	Lipase activity, high storage temperatures, psychrotrophic bacteria	Cool to ≤4°C, pasteurize to inactivate lipase, clean equipment
Coagulation/ Curdling	Curdled texture	Clots or curdling, unfit for use	High acidity, under-pasteurization, contaminated milk	Test pH (6.6–6.8), ensure HTST, segregate milk lots
Cream Separation	Layered milk	Cream layer on top	No/inadequate homogenizatio, temperature fluctuations	Homogenize (1500–2500 psi), store at ≤4°C

Discoloration	Yellowish tint	Yellowish/brownish milk	Overheating (UHT), light exposure, Maillard reaction	Use HTST, light-protective packaging, control UHT (135–150°C)
Adulteration	Water drop	Diluted milk, low fat/SNF	Added water/starch, poor standardization	Use lactometer (1.028–1.032 g/ml), FSSAI-compliant testing

PRACTICAL EXERCISES

Activities

1. Perform an organoleptic test of raw and pasteurized milk and record differences in color, smell, and taste.
2. Carry out a clot-on-boiling (COB) test on milk samples and note which ones curdle.
3. Use a lactometer to measure the density of a milk sample and check for adulteration with water.
4. Demonstrate hand washing and equipment cleaning before handling milk and explain why it matters.
5. Create a flowchart showing possible contamination points in milk from farm to consumer.

CHECK YOUR PROGRESS

A. Multiple-Choice Questions

1. Which of the following is a biological hazard in milk?
   a) Glass pieces
   b) Antibiotics
   c) Staphylococcus aureus
   d) Pesticides

2. The pH of good-quality milk is:
   a) 5.0–5.5
   b) 6.5–6.7
   c) 7.5–8.0
   d) 4.0–4.5

3. Which test is used to check protein stability in milk?
   a) Alcohol test
   b) Density test
   c) Organoleptic test
   d) Freezing point test

4. HACCP is mainly used to:
   a) Add flavors to milk
   b) Identify and control hazards
   c) Increase fat content
   d) Remove water from milk

5. Which layer of the supply chain ensures milk reaches safely to consumers?
   a) Farm only
   b) Transport only
   c) Marketing and government checks
   d) None of the above

B. Fill in the Blanks

1. The three main types of hazards in milk are _____, and _____.
2. The _____ is used to check if milk has high acidity or colostrum.
3. The normal density of milk is _____, which indicates no added water.
4. _____ is a scientific system used to identify and control hazards in milk production.
5. Cooling milk quickly to _____ prevents the growth of harmful bacteria.

C. True or False

1. Contaminants in milk can be infectious or non-infectious.
2. Antibiotic residues in milk are an example of a biological hazard.
3. Milk should always be stored at temperatures below 5°C.
4. Grade C milk is the highest quality and used for drinking.
5. Organoleptic testing checks milk using sight, smell, and taste.

D. Subjective Questions

1. Explain the difference between quality control and quality assurance in milk.
2. What are the main hazards in milk? Give one example of each type.
3. Describe two simple tests used for checking milk quality at collection centers.

4. How does HACCP improve the safety of milk compared to traditional testing methods?
5. Write short notes on hygienic handling practices of milk at the farm level.

E. What Have You Learned?

1. Milk quality can be affected by biological, chemical, and physical hazards.
2. Contaminants can be infectious (bacteria, viruses) or non-infectious (chemicals, adulterants).
3. Quality assurance ensures safety by planning, while quality control identifies problems through testing.
4. Common tests for milk quality include density, organoleptic, clot-on-boiling, alcohol test, and titratable acidity.
5. HACCP is a preventive system to ensure food safety by monitoring every step.
6. Hygienic handling—from clean farms to cold storage—keeps milk safe and nutritious.

MODULE 3 PRODUCTION OF INDIGENOUS AND FAT-RICH DAIRY PRODUCTS

Milk is a nutritious but highly perishable commodity and therefore requires processing to improve its safety, shelf life and economic value. In India, a substantial proportion of milk is converted into indigenous dairy products such as ghee, butter, khoa, paneer and chhana, which hold nutritional, cultural and commercial importance. Many of these products are rich in milk fat, contributing to their characteristic flavour, texture and energy value. With the growth of organised dairying, traditional practices are now supported by scientific processing, hygienic handling and proper packaging to ensure consistent quality. This unit introduces the production, quality parameters and significance of major indigenous and fat-rich dairy products in the Indian dairy sector.

SESSION 1: OVERVIEW AND IMPORTANCE OF INDIGENOUS AND FAT-RICH DAIRY PRODUCTS

1. Introduction

Today, indigenous and fat-rich dairy products occupy an important place in both household consumption and the commercial dairy sector. Advances in processing technology, quality control, and packaging have enabled these traditional products to be manufactured on a large scale while maintaining their characteristic taste and nutritional value. Standardized methods and strict hygienic practices help ensure product safety, uniformity, and longer shelf life. Therefore, a sound understanding of the production, quality parameters, and storage of indigenous and fat-rich dairy products is essential for students and professionals involved in dairy science and food processing.

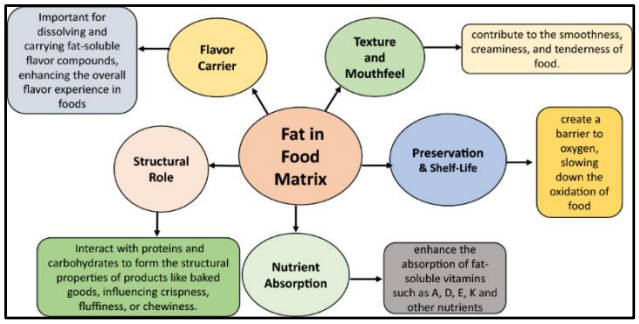

Fig. 3.1: Importance of Fat in Food Structure, Flavor, and Nutrition

2. Indigenous Dairy Products

Indigenous dairy products are traditional milk products that originated in India and were developed through indigenous knowledge and practices. These products are prepared from milk, cream, butter, or khoa by applying processes such as heating, fermentation, and coagulation

Examples of Indigenous Dairy Products:

- Ghee
- Khoa and khoa-based sweets
- Paneer
- Chhana
- Curd and fermented products

3. Fat-Rich Dairy Products

Fat-rich dairy products are products that contain a high proportion of milk fat. Milk fat improves the taste, mouthfeel, and calorific value of dairy products and also carries fat-soluble vitamins.

Fig. 3.2: Fat-Rich Dairy Products

Examples of Fat-Rich Dairy Products:

- Cream
- Butter
- Ghee
- Khoa

4. Importance of Indigenous and Fat-Rich Dairy Products

- Utilization of surplus milk
- Extension of milk shelf life
- High energy and nutritional value

- Cultural and religious significance
- Employment generation in rural and small-scale dairy units
- Significant contribution to the dairy economy

5. Scope in the Indian Dairy Industry

A major portion of milk produced in India is converted into indigenous dairy products. These products are manufactured at household, cottage, and industrial levels. Standardization and mechanization of traditional processes have improved product quality and expanded market reach.

PRACTICAL EXERCISES

(Activity)

- Visit a local dairy plant, sweet shop, or view an online virtual tour of indigenous dairy product processing.
- Identify the main types of indigenous and fat-rich dairy products and their purpose (e.g., nutritional/cultural use).
- Create a simple diagram of categorization workflow (milk → indigenous/fat-rich products).
- Observe how hygiene is maintained during production/display/storage.
- Make a list of equipment used for key products (e.g., karahi for khoa, clarifier for ghee).

CHECK YOUR PROGRESS

1. Multiple-Choice Questions (MCQs)

1. What is the primary method for preparing indigenous dairy products?
   a) Freezing
   b) Heating/concentration/fermentation
   c) Homogenization
   d) Carbonation
2. Which is NOT a fat-rich dairy product?
   a) Butter
   b) Ghee
   c) Paneer
   d) Cream
3. The Main role of fat in these products?
   a) Adds water
   b) Improves flavor/texture
   c) Reduces calories
   d) Increases acidity

4. Production level of indigenous products in India?
   a) Only industrial
   b) Household/cottage/industrial
   c) Only household
   d) Imported
5. Cultural significance example?
   a) Ghee in rituals
   b) Cream in beverages
   c) Khoa in exports
   d) Curd in industry

2. Fill in the Blanks

1. Indigenous products use methods like heating, _____, and coagulation.
2. Fat-rich examples: cream, butter, ghee, _____.
3. These products utilize _____ milk.
4. They provide high _____ value.
5. Manufactured at household, _____, industrial levels.

3. True or False

1. Indigenous products originated in India.
2. Fat carries water-soluble vitamins.
3. They extend milk shelf life.
4. Only organized sector produces them.
5. They generate rural employment.

4. Subjective Questions

1. Define indigenous dairy products with two examples.
2. List four fat-rich products and their importance.
3. Explain three benefits of these products for Indian dairy economy.
4. Describe scope of standardization in indigenous products.
5. Draw a simple diagram showing milk flow to indigenous/fat-rich products and label stages.

SESSION 2: CREAM, BUTTER, AND GHEE – PRODUCTION AND QUALITY PARAMETER

1. Cream

1.1 Definition

Cream is the fat-rich portion of milk obtained by separation due to the difference in density between milk fat and skim milk.

1.2 Methods of Cream Separation

- Natural creaming – fat rises to the surface when milk is kept undisturbed
- Mechanical separation – "centrifugal cream separator is used".

1.3 Composition of Cream

Cream contains milk fat, small amounts of protein, lactose, minerals, and water. The fat content varies depending on the type of cream.

Fig. 3.3: Butter Formation During Cream Churning Process

2. Butter

2.1 Definition

Butter is a fat-rich dairy product obtained by churning cream, which results in aggregation of fat globules and separation of buttermilk.

2.2 Method of Butter Production

- Standardization and pasteurization of cream
- Cooling and ageing
- Churning of cream
- Separation of butter granules from buttermilk
- Washing and working of butter

2.3 Types of Butter

- White butter (makkhan)
- Table butter
- Salted butter

2.4 Quality Parameters of Butter

- Clean and pleasant flavor
- Uniform color
- Firm and smooth texture
- Absence of rancidity

PRACTICAL EXERCISES

(Activity)

- Visit a local dairy plant or view an online virtual tour focusing on cream and butter production.
- Identify the main sections for cream separation and butter making and their purpose.
- Create a simple diagram of linear workflow layout for butter production.
- Observe how hygiene is maintained at different stages (e.g., CIP cleaning).
- Make a list of equipment used in each section (e.g., separator, churner).

CHECK YOUR PROGRESS

1. Multiple-Choice Questions (MCQs)

1. Cream is separated based on:
   a) Color difference
   b) Density difference
   c) Taste difference
   d) Temperature difference
2. Natural creaming method relies on:
   a) Centrifugation
   b) Fat rising to surface
   c) Filtration
   d) Heating
3. Butter is produced by:
   a) Boiling cream
   b) Churning cream
   c) Freezing cream
   d) Fermenting cream
4. Which is NOT a step in butter production?
   a) Ageing cream
   b) Washing butter
   c) Homogenizing buttermilk
   d) Churning
5. White butter is also called:
   a) Table butter
   b) Makkhan
   c) Salted butter
   d) Yellow butter

2. Fill in the Blanks

1. Cream is the _____ portion of milk.
2. Mechanical separation uses _____ separator.
3. Butter results from aggregation of _____ globules.
4. Cream is cooled and _____ before churning.
5. Butter quality requires absence of _____.

3. True or False

1. Cream composition includes only fat.
2. Mechanical separation is faster than natural creaming.
3. Butter churning separates buttermilk.
4. Salted butter has no salt added.
5. Firm texture is a butter quality parameter.

4. Subjective Questions

1. Define cream and explain two separation methods.
2. Describe step-by-step butter production process.
3. List three types of butter with one feature each.
4. Explain four quality parameters of butter.
5. Draw a simple diagram of cream separation to butter workflow and label parts.

SESSION 3: KHOA-BASED PRODUCTS (BURFI, PEDA, GULAB JAMUN, ETC.)

1. Khoa

1.1 Definition

Khoa is a concentrated dairy product obtained by continuous heating of milk with constant stirring until most of the moisture is evaporated.

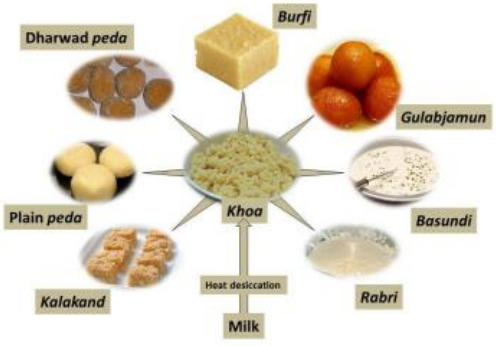

Fig. 3.4: An illustration showing a variety of heat desiccated (khoa-based) sweets of Indian sub-continent

1.2 Types of Khoa

- Pindi – hard and compact
- Danedar – granular texture
- Dhap – soft and moist

1.3 Importance of Khoa

- Base material for many indigenous sweets
- High nutritional and calorific value
- Improved shelf life compared to milk

2. Khoa-Based Products

2.1 Burfi

Burfi is prepared by cooking khoa with sugar and flavoring agents, followed by setting and cutting.

2.2 Peda

Peda is prepared by heating khoa with sugar until a dough-like consistency is obtained and shaping into discs.

2.3 Gulab jamun

Gulab jamun is prepared from khoa-based dough, deep-fried, and soaked in sugar syrup.

3. Quality Parameters

- Uniform color
- Soft and smooth texture
- Pleasant taste and aroma
- Free from spoilage

PRACTICAL EXERCISES

(Activity)

- Visit a local sweet shop, dairy plant, or view an online virtual tour of khoa/sweet production.
- Identify the main sections/steps for khoa preparation and khoa-based products and their purpose.
- Create a simple diagram of linear workflow layout for burfi production.
- Observe how hygiene is maintained at different stages (e.g., utensil cleaning, worker gloves).
- Make a list of equipment used in each section (e.g., karahi, gas stove, molds).

CHECK YOUR PROGRESS

1. Multiple-Choice Questions (MCQs)

1. Khoa is obtained by:
   a) Fermentation
   b) Continuous heating/stirring
   c) Coagulation
   d) Churning
3. Which khoa type is granular?
   a) Pindi
   b) Danedar
   c) Dhap
   d) Burfi khoa
4. Burfi preparation involves:
   a) Deep frying
   b) Cooking khoa with sugar
   c) Soaking in syrup
   d) Pressing
5. Peda is shaped into:
   a) Squares
   b) Discs
   c) Balls
   d) Sheets
6. Main quality parameter for khoa products?
   a) Hard texture
   b) Uniform color
   c) High moisture
   d) Sour taste

2. Fill in the Blanks

1. Khoa removes most _____ from milk.
2. Pindi khoa is _____ and compact.
3. Gulab jamun is _____ fried.
4. Khoa is base for _____ sweets.
5. Quality requires pleasant _____ and aroma.

3. True or False

1. Khoa has shorter shelf life than milk.
2. Danedar khoa has granular texture.
3. Burfi is set after cooking.
4. Gulab jamun uses paneer dough.
5. Smooth texture is undesirable in peda.

4. Subjective Questions

1. Define khoa and list its three types with features.
2. Describe preparation of burfi, peda, and gulab jamun.
3. Explain importance of khoa in sweets.
4. List four quality parameters for khoa products.
5. Draw a simple diagram of khoa to gulab jamun workflow and label parts.

SESSION 4: CHHANA, PANEER, AND RELATED PRODUCTS – PREPARATION AND PACKAGING

1. Chhana

1.1 Definition

Chhana is a heat-acid coagulated dairy product obtained by adding acid to hot milk followed by drainage of whey.

1.2 Method of Chhana Preparation

- Heating of milk
- Addition of acid
- Coagulation of milk proteins
- Drainage of whey

2. Paneer

2.1 Definition

Paneer is a pressed, non-fermented fresh cheese obtained by acid coagulation of milk followed by pressing into blocks.

2.2 Method of Paneer Preparation

- Heating and coagulation of milk
- Whey separation
- Pressing into blocks
- Cooling and cutting

3. Packaging and Storage

- Packaging in food-grade plastic materials.
- Storage under refrigeration
- Vacuum packaging to increase shelf life

PRACTICAL EXERCISES

(Activity)

1. Visit a local dairy plant, paneer shop, or view an online virtual tour of chhana/paneer production.

2. Identify the main sections for coagulation, pressing, and packaging and their purpose.
3. Create a simple diagram of linear workflow layout for paneer production.
4. Observe how hygiene is maintained at different stages (e.g., sanitized surfaces, whey disposal).
5. Make a list of equipment used in each section (e.g., coagulation vat, press, packaging machine).

CHECK YOUR PROGRESS

1. Multiple-Choice Questions (MCQs)

1. Chhana is coagulated by:
   a) Rennet
   b) Heat-acid
   c) Bacteria
   d) Salt
2. Paneer is:
   a) Fermented cheese
   b) Pressed fresh cheese
   c) Fried product
   d) Concentrated milk
3. First step in chhana preparation?
   a) Draining whey
   b) Heating milk
   c) Pressing
   d) Packaging
4. Paneer shelf life increases by:
   a) Vacuum packaging
   b) Open air storage
   c) Heating
   d) Freezing only
5. Acid used for coagulation?
   a) Sulphuric
   b) Citric/lactic
   c) Nitric
   d) Hydrochloric

2. Fill in the Blanks

1. Chhana is obtained by draining _____.
2. Paneer involves _____ after coagulation.
3. Store paneer under _____.
4. Coagulation occurs on adding _____ to hot milk.
5. Use _____ packaging for longer shelf life.

3. True or False

1. Chhana requires pressing.
2. Paneer is fermented.
3. Heat milk before acid addition.
4. Refrigeration is optional for storage.
5. Vacuum packaging reduces shelf life.

4. Subjective Questions

1. Define chhana and describe its preparation method.
2. Explain paneer production steps.
3. Compare chhana and paneer (two differences).
4. Describe packaging/storage methods.
5. Draw a simple diagram of milk to paneer workflow and label parts.

MODULE 4 MANAGEMENT OF DAIRY PLANT OPERATIONS AND PRODUCTION SYSTEM

Modern dairy plants operate in a highly regulated and competitive environment where efficiency, product safety, and sustainability are critical to success. This unit introduces learners to the comprehensive management of dairy plant operations and integrated production systems, emphasizing how raw milk is transformed into safe, high-quality products through well-planned processes and coordinated activities. It explores plant layout and workflow design to ensure smooth movement of materials, personnel, and finished goods while minimizing losses and operational bottlenecks.

The unit further examines production planning, scheduling, and process control techniques that help achieve consistent output, cost effectiveness, and timely fulfillment of market demand. Special attention is given to equipment maintenance programs, cleaning-in-place systems, and sanitation protocols that are essential for preventing contamination, extending machinery life, and complying with food safety regulations. Documentation, workforce supervision, quality assurance systems, and regulatory requirements are also discussed to highlight their role in maintaining operational discipline and ensuring sustainable, compliant, and efficient functioning of modern dairy processing facilities.

SESSION 1: INTRODUCTION TO DAIRY PLANT OPERATIONS AND WORKFLOW LAYOUT

1. Introduction

The dairy industry is an important part of the agricultural sector. It processes raw milk and converts it into safe and nutritious products such as curd, butter, cheese, paneer, and ghee. To ensure high-quality products, dairy plants follow a systematic set of operations. These include receiving the milk, testing it for quality, chilling it, processing it, packaging it, and finally distributing it to consumers.

Each step in dairy plant operations must be carried out under clean and hygienic conditions. This helps maintain product quality, improve efficiency, and ensure the safety of both workers and consumers.

A key element of dairy plant management is the *workflow layout.* This refers to the physical arrangement of equipment and the sequence in which different activities are performed. A well-planned layout reduces unnecessary movement of materials, minimizes contamination risks, and helps in smooth, continuous working. Depending on the size and capacity of the plant, different layouts—such as *linear, L-shaped, or U-shaped* may be used.

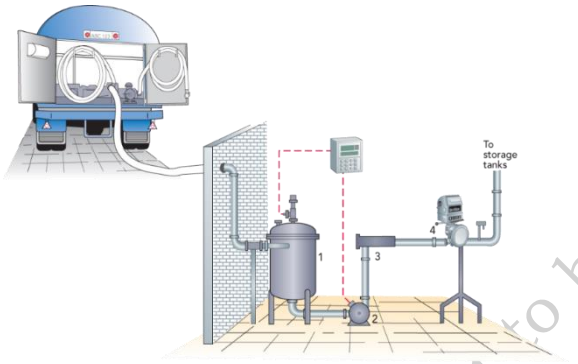

Fig. 4.1:

Understanding the structure and flow of operations in a dairy plant is important for students interested in dairy technology, food processing, or agricultural engineering. Modern dairy plants are designed with a focus on *safety, hygiene, efficiency, and sustainability* to meet the growing demand for quality dairy products.

2. Purpose and Scope of Dairy Plant Operations

The main objectives of dairy plant operations are:

- To receive and test raw milk for quality and safety
- To process milk using methods such as pasteurization
- To produce value-added products like butter, curd, paneer, and cheese
- To package and store products under hygienic conditions
- To minimize waste and ensure environment-friendly practices

3. Main Sections of a Dairy Plant

A dairy plant is divided into several functional areas. Each section has a specific role in transforming raw milk into safe, high-quality dairy products.

3.1 Milk Reception Dock

The Milk Reception Dock is the first and one of the most important sections of a dairy plant. This is the point where raw milk arrives from farmers, dairy cooperatives, or village collection centers. Milk is usually transported in stainless-steel cans or insulated tankers to maintain cleanliness and temperature during transit.

When the milk reaches the reception dock, it is first weighed to record the quantity received. After this, samples are taken for quality testing. These tests help check the fat and SNF (Solids-Not-Fat) content, freshness, acidity, temperature, and any signs of contamination or adulteration. Common tests done at this stage include the lactometer test, clot-on-boiling test (COB), and organoleptic evaluation (smell, color, appearance).

Only the milk that meets the required quality standards is accepted. If the milk fails to pass the tests, it is rejected to ensure safety and prevent spoilage of the entire batch. Accepted milk is then filtered to remove dust or foreign particles and pumped into the chilling section for rapid cooling. Proper handling at the reception dock is essential because it determines the overall quality of the final dairy products.

3.2 Chilling Section

The Chilling Section is a crucial part of a dairy plant, as it helps maintain the quality and safety of milk before processing. Raw milk is highly perishable and can quickly spoil due to the growth of bacteria if not handled properly. To prevent this, milk must be cooled rapidly to about 4°C immediately after reception.

Purpose of Chilling

- Slows down bacterial growth and enzymatic activity
- Preserves freshness and natural flavor of milk
- Extends shelf life before processing or transportation

Equipment Used

- Plate Chillers: Milk flows between cold metal plates through which chilled water or coolant circulates. Heat is transferred from milk to the cooling medium, quickly lowering its temperature.
- Bulk Milk Coolers (BMC): Large insulated tanks equipped with a cooling system that maintains milk at a uniform low temperature. They are commonly used in collection centers and dairy plants.

Process

- Milk is pumped from the reception dock into chilling tanks or coolers.
- The temperature is reduced to 4°C or slightly lower, depending on storage requirements.
- Milk is continuously stirred during chilling to ensure even cooling and prevent cream from separating.

Temporary Storage

- After chilling, milk can be stored in bulk storage tanks for a short period before it is processed. During storage, temperature and hygiene are closely monitored to prevent contamination. Proper chilling ensures that milk retains its nutritional quality, taste, and safety, which is essential for producing high-quality dairy products.

3.3 Processing Section

This section makes milk safe for consumption and suitable for making other products.

The Processing Section is a critical area of a dairy plant where raw milk is treated to make it safe for consumption and suitable for manufacturing other dairy products. The main processes include pasteurization, homogenization, separation, and standardization. These processes ensure milk is hygienic, nutritious, and has a longer shelf life.

3.3.1 Pasteurization

Pasteurization is the process of heating milk to a specific temperature for a short time to destroy harmful bacteria and pathogens without affecting its nutritional value or taste.

- **Standard method:** Milk is heated to 72°C for 15 seconds (known as High-Temperature Short-Time, HTST method) and then rapidly cooled to 4°C.

Fig. 4.2:

- **Purpose:**
  - Kills disease-causing microorganisms such as *Salmonella* and *E. coli*
  - Reduces spoilage by slowing down microbial growth
  - Makes milk safe for consumption and suitable for storage

Pasteurized milk must be handled carefully to avoid recontamination.

3.3.2 Homogenization

Homogenization is a mechanical process that breaks fat globules into smaller, uniform particles so that they remain evenly distributed in milk.

- Purpose:
  - Prevents cream from rising to the top
  - Gives milk a smooth and consistent texture
  - Improves taste and appearance
- Process: Milk is forced through very fine nozzles at high pressure, breaking large fat globules into tiny particles.

3.3.3 Separation and Standardization

Separation and standardization are processes used to adjust the fat content in milk according to different product requirements.

Separation:

- Milk is placed in a centrifugal separator, which spins at high speed.
- The heavier part (skimmed milk) is separated from the lighter fat (cream).

Standardization:

- Fat content of milk is adjusted to produce different types:
  - Full-cream milk: 6–6.5% fat
  - Toned milk: 3% fat
  - Skimmed milk: 0.5–1% fat

This ensures consistency in the quality of milk supplied to consumers and used for making dairy products like butter, cheese, and paneer.

3.4 Product Manufacturing Section

In this section, milk is converted into various dairy products. Examples:

- Butter is made by churning cream.
- Paneer is made by curdling milk.
- Curd is produced by adding bacterial cultures.
- Cheese and ghee require specific machinery and controlled conditions.

3.5 Packaging Section

Processed milk and products are packed using pouch-filling machines, bottle fillers, or carton sealers. Proper packaging protects the product from contamination and makes transportation easier.

3.6 Cold Storage and Dispatch

Packed dairy products are stored in cold rooms or freezers to maintain freshness. After storage, products are loaded into refrigerated vehicles and sent to markets or retailers.

4. Workflow Layout in a Dairy Plant

The workflow layout refers to how different sections are arranged and how milk moves from one stage to another. A good layout ensures:

- Efficient movement of milk and products
- Minimum handling and delays
- Reduced contamination risks
- Better supervision and safety

4.1 Types of Workflow Layouts

- **Linear Layout:** All sections arranged in a straight line; suitable for large plants.
- **L-Shaped Layout:** Requires less space; common in medium-sized plants.
- **U-Shaped Layout:** Allows easy supervision; ideal for small plants.

4.2 Importance of a Good Workflow Layout

A proper layout results in:

- Smooth product flow
- Lower chances of contamination
- Reduced labor effort and cost
- Higher productivity
- Better hygiene and safety

5. Factors to Consider in Plant Layout Design

When designing a dairy plant layout, the following factors are important:

- Size and processing capacity of the plant
- Type of dairy products to be made
- Availability of water, electricity, steam, and other utilities
- Ventilation and waste disposal systems
- Space for future expansion
- Compliance with hygiene and safety standards

6. Summary

Dairy plant operations involve a series of well-organized steps, from receiving milk to processing, packaging, and dispatch. Each section plays a vital role in maintaining quality and safety. A good workflow layout helps improve efficiency, reduce contamination, and ensure smooth functioning of the plant. Understanding these processes is essential for students interested in dairy technology, food processing, or agricultural engineering.

PRACTICAL EXERCISES

(Activity)

- Visit a local dairy plant or view an online virtual tour.
- Identify the main sections of the plant and their purpose.
- Create a simple diagram of a linear workflow layout.
- Observe how hygiene is maintained at different stages.
- Make a list of equipment used in each section.

CHECK YOUR PROGRESS

1. Multiple-Choice Questions (MCQs)

1. What is the ideal temperature for storing raw milk in chilling tanks?
   a) 10°C
   b) 4°C
   c) 8°C
   d) 2°C
2. Which process kills harmful microorganisms in milk?
   a) Homogenization
   b) Pasteurization
   c) Standardization
   d) Cooling
3. Homogenization is used to:
   a) Increase fat content
   b) Boil the milk
   c) Break fat particles for even mixing
   d) Chill the milk
4. What is the first step in dairy plant operations?
   a) Processing
   b) Packaging
   c) Dispatch
   d) Milk Reception

5. Which layout is common in large-scale dairy plants?
   a) U-shaped
   b) L-shaped
   c) Linear
   d) Circular

2. Fill in the Blanks

1. Milk is chilled to _____ to prevent bacterial growth.
2. _____ is the process that kills germs by heating milk.
3. In a dairy plant, milk is first received at the _____ dock.
4. _____ machines are used to fill milk into packets.
5. Cream is removed from milk using a _____.

3. True or False

1. Pasteurization increases the shelf life of milk.
2. A U-shaped layout is ideal for very large dairy plants.
3. Standardization is done to adjust milk's fat content.
4. Homogenization adds vitamins to milk.
5. Cold storage is needed even after packaging.

4. Subjective Questions

1. What is the purpose of pasteurization in milk processing?
2. Describe the different sections of a dairy plant.
3. Explain the importance of a good workflow layout in a dairy plant.
4. Draw a simple diagram of a linear layout and label its parts.
5. List any four factors that should be considered while designing a dairy plant layout.

SESSION 2: PRODUCTION PLANNING, SCHEDULING, AND PROCESS MANAGEMENT

1. Introduction

In today's competitive industrial world, every successful product that reaches the customer has gone through a carefully designed and well-managed production process. Whether it is a smartphone, a packet of biscuits, a pair of shoes, or an automobile, it is not created by chance. It is the result of effective production planning, scheduling, and process management. These are the backbone of efficient manufacturing systems, ensuring that the right product is made, in the right quantity, at the right time, and at the lowest possible cost—without compromising on quality. Production planning is the

process of deciding in advance what to produce, how to produce it, when to produce it, and how much to produce. It involves selecting the materials, equipment, workforce, and methods needed for production. It also ensures that resources are used efficiently and waste is minimized. A good production plan helps in managing inventory, meeting customer demands, reducing production costs, and ensuring timely delivery of goods.

Once the production plan is ready, the next step is scheduling. Scheduling is about setting the exact time and sequence in which different production tasks should be carried out. It includes assigning work to different machines or workstations, deciding the order of operations, and allocating time for each task. Proper scheduling prevents delays, avoids overloading of machines or workers, and helps in meeting delivery deadlines. For example, in a bakery, the dough must be prepared before it goes into the oven, and the oven must be preheated in time. Such coordination requires good scheduling. Process management is the overall approach to controlling and improving the various activities involved in production. It includes monitoring each step of the production process, ensuring that everything is running smoothly, and making improvements where necessary. It also involves identifying any problems or bottlenecks and finding ways to solve them. Good process management leads to higher productivity, better quality, reduced costs, and increased customer satisfaction.

In industries, these three elements—planning, scheduling, and process management—work together like the parts of a well-oiled machine. If any part is weak or missing, it can lead to production delays, poor product quality, increased costs, or even failure to deliver the product. This is why industries invest a lot of effort and technology into managing their production systems effectively.

With the use of modern tools like computer software, automation, and data analysis, production planning and scheduling have become more accurate and efficient. Industries now use tools like ERP (Enterprise Resource Planning) and MRP (Material Requirements Planning) systems to manage production operations smoothly.

In this chapter, you will learn the basic concepts and importance of production planning, types of production systems, steps involved in scheduling, and key principles of process management. You will also understand how industries use these systems to ensure productivity, efficiency, and competitiveness in today's market. By the end of this chapter, you will be able to appreciate how products are made and how each step is carefully controlled to deliver quality goods to consumers.

2. Production Planning

Production planning refers to the process of determining what to produce, how much to produce, when to produce, and where to produce. It involves forecasting demand, arranging raw materials, labor, machines, and other resources to meet production targets efficiently. The main goal of production planning is to ensure that production runs smoothly without interruptions, delays, or excess inventory.

Proper planning helps reduce costs, avoid production bottlenecks, and meet customer demands on time. It also helps in resource allocation, budgeting, and improving overall operational efficiency.

2.1 Steps in Production Planning

The production planning process usually involves the following steps:

- **Forecasting demand:** Estimating the quantity of products required by customers.
- **Capacity planning:** Determining the production capacity needed to meet demand.
- **Material requirement planning:** Calculating the raw materials and components required.
- **Routing:** Deciding the sequence of operations for production.
- **Scheduling:** Setting the time frame for production activities.
- **Dispatching:** Issuing orders to start production.

3. Production Scheduling

Production scheduling is a detailed plan that specifies when and where each part of the production process will take place. It is the allocation of resources like machines, labor, and materials over time to ensure products are completed on schedule. While production planning focuses on overall goals, scheduling deals with the day-to-day or hour-to-hour activities.

Scheduling helps in minimizing idle time, preventing delays, and improving workflow coordination.

3.1 Types of Scheduling

There are several types of scheduling used in industries:

- **Forward scheduling:** Production starts as soon as possible and continues forward.
- **Backward scheduling:** Production is scheduled backward from the due date to ensure timely completion.

- **Finite scheduling:** Schedules are created based on limited resource availability.
- **Infinite scheduling:** Assumes unlimited resources and schedules without constraints.

3.3 Benefits of Production Scheduling

Effective scheduling ensures timely product delivery, balanced workload, better machine utilization, and reduced work-in-progress inventory. It also helps managers monitor progress and identify bottlenecks early.

4. Process Management

4.1 Understanding Process Management

Process management involves designing, monitoring, and controlling production processes to achieve consistent quality and efficiency. It focuses on how production activities are performed, aiming for optimization and continuous improvement.

Process management includes defining workflows, setting standards, tracking performance, and implementing changes when necessary. It ensures that every step in production is well-organized and contributes to the final output.

4.2 Key Elements of Process Management

- **Process design:** Creating the best possible production process considering available technology and resources.
- **Process control:** Monitoring production activities to ensure adherence to standards.
- **Process improvement:** Identifying inefficiencies and implementing changes to improve quality, speed, or cost.
- **Quality management:** Ensuring that the output meets customer expectations and regulatory requirements.

4.3 Tools Used in Process Management

Industries use various tools like flowcharts, Gantt charts, statistical process control (SPC), and to manage and improve processes.

5. Integration of Planning, Scheduling, and Process Management

For a production system to be effective, planning, scheduling, and process management must work together seamlessly. Production planning sets the goals, scheduling arranges the execution timeline, and process management ensures the activities are performed efficiently and with quality control.

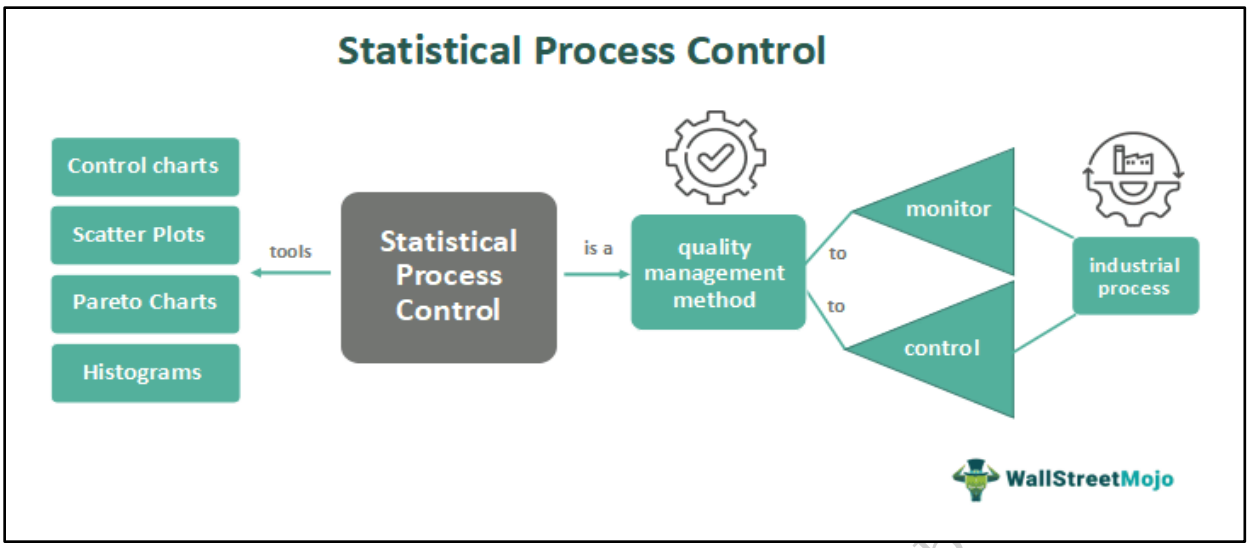

Fig. 4.3:

Together, these functions help industries reduce costs, improve productivity, maintain customer satisfaction, and adapt quickly to changing market demands.

6. Summery

Production planning, scheduling, and process management are essential concepts in manufacturing and service industries. They ensure that resources are used efficiently, products are made on time, and quality standards are maintained. Understanding these concepts prepares students for careers in management, engineering, and entrepreneurship.

PRACTICAL EXERCISES

(Activity)

1. Visit a small manufacturing unit (if possible) or watch an online video of a production line and observe how production planning and scheduling are done.
2. Prepare a simple weekly production plan for a product of your choice, including raw materials, manpower, and machinery requirements.
3. Create a basic schedule chart for completing a school project, assigning time slots for each task.
4. Identify the steps involved in a process at home (like preparing a meal) and list how process management can make it more efficient.
5. Discuss with classmates or family members examples where poor planning or scheduling caused delays or problems and suggest improvements.

CHECK YOUR PROGRESS

1. Multiple-Choice Questions (MCQs)

1. What is the primary goal of production planning?
   a) Increase product prices
   b) Ensure smooth production without delays
   c) Hire more employees
   d) Reduce customer demand
2. Production scheduling mainly focuses on:
   a) Overall business strategy
   b) Long-term resource allocation
   c) Daily or hourly allocation of resources
   d) Marketing products
3. Which of the following is a step in production planning?
   a) Advertising products
   b) Forecasting demand
   c) Selling products
   d) Packaging
4. Backward scheduling means scheduling production:
   a) From the start date forward
   b) From the due date backward
   c) Without any schedule
   d) Based on unlimited resources
5. Process management helps in:
   a) Ignoring quality standards
   b) Improving production efficiency and quality
   c) Delaying production
   d) Increasing costs

2. Fill in the Blanks

1. Production planning helps in the efficient use of _____.
2. _____ scheduling starts from the due date and plans backward.
3. Process management involves monitoring and _____ production activities.
4. A _____ chart is a useful tool for scheduling production tasks.
5. Material requirement planning is part of _____ planning.

3. True or False

1. Production scheduling deals with long-term business goals.
2. Process improvement is an important part of process management.

3. Forward scheduling plans production starting from the delivery date backward.
4. Production planning includes forecasting demand.
5. Efficient scheduling can reduce machine idle time.

5. Subjective Questions

1. Define production planning and explain its importance in manufacturing.
2. Describe the difference between production planning and production scheduling.
3. What are the key steps involved in production planning?
4. Explain the role of process management in maintaining product quality.
5. How does effective scheduling improve productivity in a production system?

SESSION 3: EQUIPMENT MAINTENANCE, CLEANING-IN-PLACE (CIP), AND SANITATION PROTOCOLS

1. Introduction

In modern industries such as food processing, pharmaceuticals, dairy, and beverages, maintaining high standards of hygiene and operational efficiency is extremely important. One of the key aspects that ensures this is proper equipment maintenance, effective cleaning procedures, and strict sanitation protocols. These practices are not only necessary for the quality and safety of the final product but also help in extending the lifespan of equipment, reducing downtime, and complying with health and safety regulations.

Equipment is the backbone of any industrial operation. Whether it's a pasteurizer in a milk processing plant, a conveyor belt in a packaging unit, or tanks and pipes in a beverage factory, each piece of equipment must operate smoothly and efficiently. Regular maintenance ensures that equipment performs at its best, preventing unexpected breakdowns that could halt production or lead to unsafe conditions. Preventive maintenance includes checking, cleaning, lubricating, repairing, and replacing parts before they fail. When done regularly, it can reduce long-term costs and prevent accidents or contamination.

In addition to maintenance, cleaning plays a crucial role in industrial environments, especially where food and beverages are processed. Traditional

cleaning methods involve dismantling equipment and manually washing each part, which can be time-consuming and labor-intensive. To overcome this challenge, industries now use Cleaning-in-Place (CIP) systems. CIP is a method of cleaning the interior surfaces of equipment such as pipes, tanks, and valves without disassembly. It involves circulating cleaning solutions through the system under controlled conditions, making the process faster, more effective, and less dependent on manual labor. Sanitation protocols go hand-in-hand with cleaning and maintenance. While cleaning removes visible dirt and residues, sanitation involves using chemicals or heat to kill microorganisms that can cause spoilage or illness. In food-related industries, maintaining a sanitary environment is not optional – it is a legal and ethical responsibility. Poor sanitation can lead to contamination, product recalls, legal issues, and harm to consumer health. Therefore, industries follow strict sanitation schedules and protocols that include cleaning frequency, sanitation chemicals, contact times, and personal hygiene practices for workers.

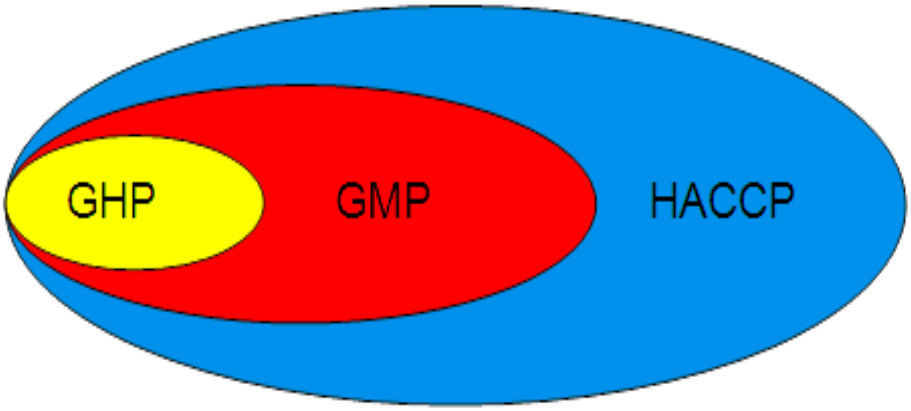

Fig. 4.4: Relation between Good manufacturing Practices (GHP), good hygiene practices GMP and hazard analysis and critical control points HACCP

Understanding and applying proper maintenance, cleaning-in-place methods, and sanitation protocols not only enhances product quality but also builds trust among consumers and regulatory authorities. These practices support the goals *of Good Manufacturing Practices (GMP) and Hazard Analysis and Critical Control Points (HACCP)* – both of which are essential in ensuring food safety and product integrity.

This chapter aims to introduce students to the essential concepts, procedures, and significance of equipment maintenance, CIP, and sanitation in industrial settings. It will cover the types of maintenance practices, how

CIP systems function, types of cleaning agents, sanitation methods, and the importance of following standard operating procedures (SOPs). By the end of this chapter, students will have a clear understanding of how these practices contribute to a safe, efficient, and compliant industrial environment.

1. **Equipment Maintenance**

   Equipment maintenance refers to the regular inspection, cleaning, repair, and servicing of tools and machines used in food preparation and processing. Maintenance ensures that the equipment functions smoothly, minimizes downtime, and prolongs the lifespan of machines (Food Safety and Standards Authority of India - FSSAI, 2021).

   Types of Maintenance

   Preventive Maintenance: This involves scheduled servicing of equipment before any problem arises. It includes lubrication, adjustments, and replacement of worn-out parts to avoid failure.

   Example: Oiling moving parts of a mixer regularly to prevent rusting.

Fig. 4.5:

Corrective Maintenance: This is performed after equipment fails. It involves diagnosing the fault and repairing it to bring the equipment back to working condition.

Example: Replacing a damaged motor in a filling machine.

Predictive Maintenance: This uses data and sensors to predict when equipment might fail. It is common in advanced automated systems.

Example: Vibration sensors detecting imbalance in a centrifuge before breakdown.

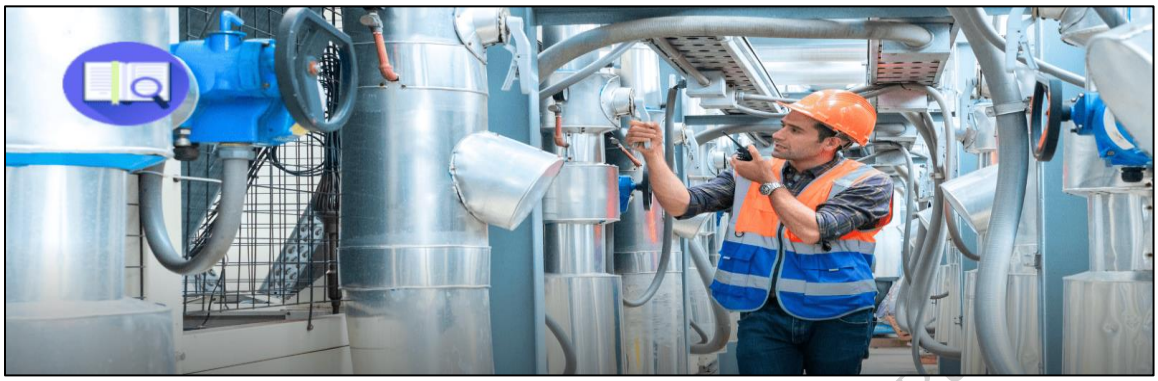

Fig. 4.6:

1.2 Importance of Equipment Maintenance

- Ensures food safety and hygiene
- Prevents unexpected equipment failure
- Reduces operational costs in the long term
- Increases efficiency and productivity
- Complies with legal and industry standards (FSSAI, 2021)

2. Cleaning-in-Place (CIP)

Cleaning-in-Place (CIP) is a method of cleaning the interior surfaces of pipes, vessels, equipment, and process systems without disassembling them. It is commonly used in industries like dairy, beverage, and pharmaceuticals where hygiene is critical (Food Processing Skill Sector Council - FICSI, 2020).

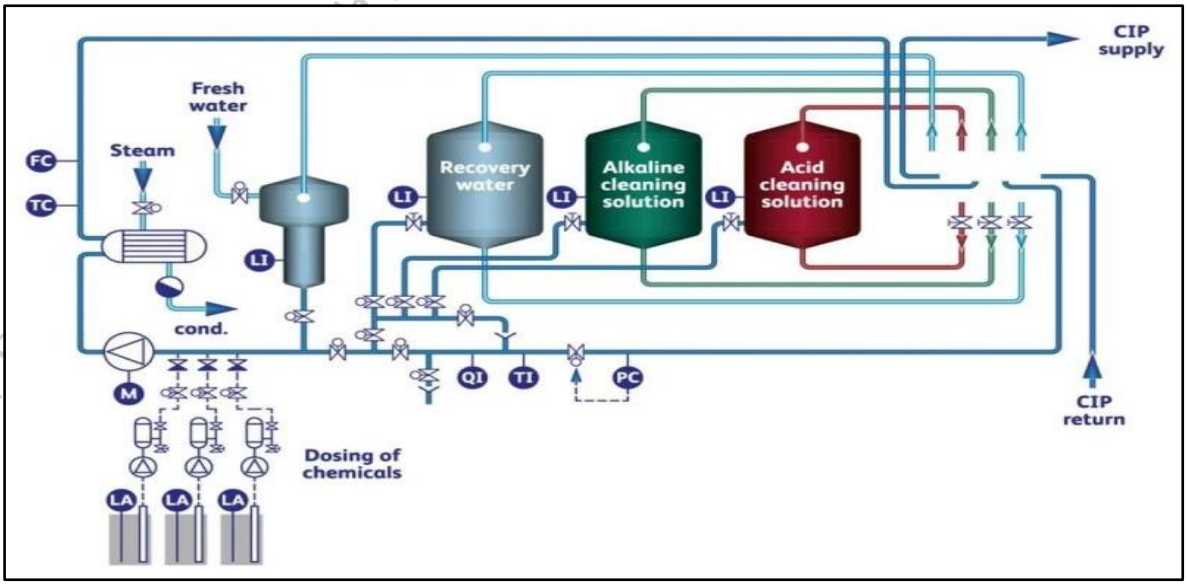

Fig. 4.7: CIP system in dairy plant

CIP uses a combination of water, cleaning agents, and heat to remove food residues, biofilms, and microorganisms from internal equipment surfaces.

2.1 Basic Steps in CIP

A typical CIP cycle includes the following steps:

1. **Pre-rinse**: Removes loose soil and food particles with warm water.
2. **Cleaning Solution Wash**: Uses an alkaline or acidic detergent to remove grease, protein, and mineral deposits.
3. **Intermediate Rinse**: Flushes out the cleaning agent with water.
4. **Sanitizing Rinse**: Uses a sanitizing solution (e.g., chlorine or hot water) to kill microbes.
5. **Final Rinse (if needed)**: Removes sanitizer residues.

2.3 Advantages of CIP

- Saves time and labor compared to manual cleaning
- Ensures consistent and thorough cleaning
- Reduces risk of contamination
- Can be automated for better control and monitoring

3. Sanitation Protocols

3.1 Sanitation

Sanitation refers to all measures taken to ensure cleanliness and hygiene in food handling environments. It includes cleaning surfaces, disinfecting equipment, pest control, and personal hygiene of workers. Proper sanitation helps in controlling the spread of bacteria, viruses, and other contaminants that can cause foodborne illnesses (World Health Organization -WHO, 2020).

3.2 Steps in an Effective Sanitation Protocol

1. **Dry Cleaning**: Removal of dry waste, such as flour or crumbs.
2. **Wet Cleaning**: Application of water and detergent to wash surfaces.
3. **Rinsing**: Washing off detergent and loosened dirt.
4. **Disinfection/Sanitization**: Use of chemicals or hot water to kill microbes.
5. **Drying**: Ensuring surfaces and equipment are properly dried to prevent microbial growth.

3.3 Personal Hygiene and Safety

Workers play a major role in maintaining sanitation. Key personal hygiene practices include:

- Wearing clean uniforms and hairnets
- Regular handwashing with soap

- Not handling food when sick
- Using gloves when necessary

4. Summery

Maintaining clean and properly functioning equipment is essential for any industry that values product quality, safety, and efficiency. Equipment maintenance ensures machines operate smoothly and last longer, while Cleaning-in-Place (CIP) provides an effective and time-saving way to clean internal surfaces without disassembly. Sanitation protocols further protect the production environment by eliminating harmful microorganisms and enforcing personal hygiene standards. Together, these practices form the foundation of a safe and hygienic production system, helping industries meet legal regulations, prevent contamination, and gain consumer trust.

PRACTICAL EXERCISES

Activities

1. Equipment Inspection Practice: Select a small equipment or tool in your lab (e.g., blender, milk can, or valve) and prepare a checklist to inspect its cleanliness, wear and tear, and lubrication.
2. Demonstrate a Basic CIP Procedure: Perform a simple Cleaning-in-Place activity using water, cleaning solution, and a closed-loop container system. Record the steps.
3. Make a Sanitation Schedule: Design a weekly sanitation schedule for a small dairy unit, listing tasks, responsible persons, cleaning agents, and frequency.
4. Identify Cleaning Agents: Collect labels from common cleaning and sanitizing agents used in food processing. Classify them into acid, alkali, and disinfectant types.
5. Personal Hygiene Demonstration: Demonstrate proper handwashing and use of protective clothing (e.g., gloves, apron, cap) before handling food-processing equipment.

CHECK YOUR PROGRESS

1. Multiple Choice Questions (MCQs)

1. What is the main purpose of equipment maintenance?
   a) Decoration
   b) Reduce electricity cost
   c) Prevent breakdown and ensure efficiency
   d) Increase weight of equipment

2. CIP stands for:
   a) Cleaning Inside Parts
   b) Clean-In-Person
   c) Cleaning-in-Place
   d) Central Inspection Process

3. Which of the following is a sanitizing agent?
   a) Sugar
   b) Sodium hypochlorite
   c) Milk
   d) Starch

4. What is done during preventive maintenance?
   a) Equipment is discarded
   b) Equipment is repaired only after failure
   c) Regular inspection and repair before failure
   d) Equipment is painted only

5. Which of the following is *not* a benefit of CIP?
   a) Saves time
   b) Requires disassembly of equipment
   c) Ensures consistent cleaning
   d) Reduces human error

2. Fill in the Blanks

1. _____ maintenance helps prevent equipment breakdown before it happens.
2. CIP stands for _____.
3. _____ removes microorganisms after visible dirt is cleaned.
4. _____ is used to remove mineral deposits in dairy equipment.
5. _____ protocol includes steps for hand hygiene and protective clothing.

3. True or False

1. CIP requires dismantling the equipment completely.
2. Sanitation only removes visible dirt.
3. Regular maintenance reduces the chance of equipment failure.
4. Sanitizers can be both chemical and heat-based.
5. Cleaning is not necessary if sanitation is done properly.

4. Subjective Questions

1. Define equipment maintenance and explain its importance in food processing units.

2. Describe the steps involved in a standard Cleaning-in-Place (CIP) process.
3. Differentiate between cleaning and sanitation with suitable examples.
4. Explain any three types of cleaning agents used in food industry.
5. Why is personal hygiene considered important in sanitation protocols? Illustrate with examples.

GLOSSARY

1. **Adulteration**: The practice of adding inferior or harmful substances such as water, starch, or chemicals to milk, reducing its quality and safety.
2. **Aseptic Packaging**: A packaging method in which sterilized milk is packed in sterile containers under hygienic conditions to extend shelf life without refrigeration.
3. **Batch Pasteurization (LTLT)**: A pasteurization method where milk is heated to 63°C for 30 minutes to destroy pathogenic microorganisms.
4. **Biological Hazards**: Living organisms such as bacteria, viruses, and parasites that can contaminate milk and cause foodborne diseases.
5. **Bulk Milk Cooler (BMC)**: An insulated refrigerated tank used to rapidly cool and store raw milk at around 4°C to prevent spoilage.
6. **Butter**: A fat-rich dairy product obtained by churning cream, resulting in the separation of butter granules and buttermilk.
7. **Butterfat**: The fat portion of milk that contributes to richness, flavor, and energy value in dairy products.
8. **Chhana**: A heat-acid coagulated dairy product obtained by adding acid to hot milk followed by drainage of whey.
9. **Chilling**: The rapid cooling of milk to about 4°C immediately after reception to slow microbial growth.
10. **Cleaning-in-Place (CIP)**: A method of cleaning the internal surfaces of dairy equipment such as pipes and tanks without dismantling them.
11. **Clarification**: The process of removing visible impurities such as dirt, hair, and sediments from milk using filters or centrifugal force.
12. **Cold Chain**: A temperature-controlled supply chain that maintains dairy products at low temperatures from production to consumption.
13. **Colostrum**: The first milk produced after calving, rich in proteins and antibodies, unsuitable for commercial milk processing.
14. **Contamination**: The presence of harmful biological, chemical, or physical substances in milk or dairy products.
15. **Cream**: The fat-rich portion of milk separated by natural creaming or centrifugal separation.
16. **Cream Separator**: A centrifugal machine used to separate cream and skim milk based on density differences.
17. **Corrective Maintenance**: Maintenance carried out after equipment failure to restore normal operation.
18. **Critical Control Point (CCP)**: A stage in food processing where control can be applied to prevent or eliminate food safety hazards.

19. **Curd**: A fermented dairy product produced by the action of lactic acid bacteria on milk.
20. **Dairy Plant Layout**: The physical arrangement of equipment and work areas in a dairy plant to ensure smooth workflow and hygiene.
21. **Dairy Product Processor**: A trained professional responsible for processing milk into safe, quality dairy products following hygienic practices.
22. **Density Test**: A quality test used to detect adulteration of milk by measuring its density using a lactometer.
23. **Dispatching**: Issuing instructions and releasing materials and equipment to start production activities.
24. **Double Toned Milk**: Low-fat milk containing about 1.5% fat and 9.0% SNF, suitable for health-conscious consumers.
25. **Emulsification**: The uniform distribution of fat globules in milk to prevent cream separation.
26. **Equipment Maintenance**: Regular inspection, servicing, and repair of machines to ensure efficient and safe operation.
27. **Fat-Rich Dairy Products**: Dairy products containing a high proportion of milk fat, such as cream, butter, ghee, and khoa.
28. **Fermentation**: A biological process in which microorganisms convert lactose into lactic acid, improving shelf life and flavor.
29. **FIFO (First-In, First-Out)**: A material handling method where older stock is used before newer stock to reduce spoilage.
30. **Food Safety**: Practices that ensure food does not cause harm to consumers when prepared and consumed.
31. **Food Safety and Standards Authority of India (FSSAI)**: The statutory body responsible for regulating food safety and standards in India.
32. **Fortification**: The addition of vitamins or minerals, such as vitamins A and D, to milk to improve nutritional value.
33. **Ghee**: A clarified fat-rich dairy product obtained by heating butter or cream to remove moisture and milk solids.
34. **Good Manufacturing Practices (GMP)**: Guidelines that ensure dairy products are consistently produced and controlled according to quality standards.
35. **Hazard Analysis and Critical Control Points (HACCP)**: A systematic preventive approach to identify, evaluate, and control food safety hazards.
36. **Heat Treatment**: The process of heating milk to destroy harmful microorganisms and extend shelf life.
37. **Homogenization**: A mechanical process that breaks down milk fat globules to prevent cream separation and improve texture.

38. **HTST Pasteurization**: High-Temperature Short-Time pasteurization where milk is heated to 72°C for 15 seconds.
39. **Hygienic Handling**: Safe practices followed during milk collection, processing, storage, and distribution to prevent contamination.
40. **Indigenous Dairy Products**: Traditional Indian dairy products such as ghee, khoa, paneer, and chhana.
41. **Khoa**: A concentrated milk product obtained by continuous heating and evaporation of milk.
42. **Lactometer**: An instrument used to measure the density of milk and detect adulteration.
43. **Market Milk**: Fluid milk processed and packaged for direct consumption under hygienic conditions.
44. **Milk Reception Dock**: The area where raw milk is received, weighed, tested, and accepted or rejected.
45. **Milk Standardization**: Adjustment of fat and SNF content in milk to meet legal and consumer requirements.
46. **Over-Processing**: Excessive heating or handling of milk leading to loss of nutrients and cooked flavor.
47. **Packaging**: The process of enclosing milk or dairy products in protective materials to ensure safety and shelf life.
48. **Paneer**: A pressed, non-fermented fresh cheese obtained by acid coagulation of milk.
49. **Pasteurization**: Heat treatment used to destroy pathogenic microorganisms in milk.
50. **Perishable Foods**: Foods like milk and dairy products that spoil quickly if not stored properly.
51. **Physical Hazards**: Foreign materials such as glass, metal, or plastic that may contaminate food.
52. **Predictive Maintenance**: Maintenance based on monitoring equipment condition to predict failures before they occur.
53. **Quality Assurance**: Planned activities to ensure milk consistently meets safety and quality standards.
54. **Quality Control**: Testing and inspection activities to identify defects in milk and dairy products.
55. **Rancidity**: Development of unpleasant flavors in fat due to oxidation or enzyme activity.
56. **Receiving and Storage Unit**: Area where milk is accepted and temporarily stored under controlled temperature.
57. **Refrigeration**: Cooling process used to slow microbial growth and extend shelf life.

58. **Sanitation**: Measures taken to maintain cleanliness and eliminate microorganisms in processing environments.
59. **Sanitizers**: Chemicals or heat treatments used to destroy harmful microorganisms after cleaning.
60. **Scheduling**: Assigning time frames for production activities to ensure timely completion.
61. **Separation**: The process of dividing milk into cream and skim milk using centrifugal force.
62. **Shelf Life**: The length of time a dairy product remains safe and acceptable for consumption.
63. **Skimmed Milk**: Milk with most of the fat removed, containing less than 0.5% fat.
64. **SNF (Solids-Not-Fat)**: Milk components other than fat, including proteins, lactose, and minerals.
65. **Standardized Milk**: Milk adjusted to a uniform fat and SNF content for regular consumption.
66. **Sterilization**: Heat treatment that destroys almost all microorganisms to extend shelf life.
67. **Toned Milk**: Milk with reduced fat content (about 3.0%) made by adding skim milk or water.
68. **Traceability**: The ability to track milk and dairy products through all stages of production and distribution.
69. **UHT Treatment**: Ultra-High Temperature processing where milk is heated to about 135–150°C for a few seconds.
70. **Workflow Layout**: Logical arrangement of machines and processes to ensure smooth production flow.

Abbreviations

°C : Degrees Celsius
BMC : Bulk Milk Cooler
B. cereus : *Bacillus cereus*
CCP : Critical Control Point
CCPs : Critical Control Points
CIP : Cleaning-in-Place
COB : Clot-on-Boiling
COP : Cleaning-out-of-Place
E. coli : *Escherichia coli*
FAO : Food and Agriculture Organization
FIFO : First-In, First-Out
FBOs : Food Business Operators
FDI : Foreign Direct Investment
FSMS : Food Safety Management System
FSS Act : Food Safety and Standards Act, 2006
FSSAI : Food Safety and Standards Authority of India
g : Gram
g/L : Grams per litre
GDP : Gross Domestic Product
GHP : Good Hygienic Practices
GMP : Good Manufacturing Practices
HACCP : Hazard Analysis and Critical Control Points
HTST : High-Temperature Short-Time Pasteurization
kg : Kilogram
L : Litre
LDPE : Low-Density Polyethylene
LLDPE : Linear Low-Density Polyethylene
LTLT : Low-Temperature Long-Time Treatment
MoFPI : Ministry of Food Processing Industries
MRP : Material Requirement Planning
MSNF : Milk Solids-Not-Fat
MT : Metric Tonne
NDDB : National Dairy Development Board
PHE : Plate Heat Exchanger
ppm : Parts per million
QC : Quality Control
QA : Quality Assurance

SNF : Solids-Not-Fat
SMP : Skim Milk Powder
SPC : Statistical Process Control
SOP : Standard Operating Procedure
TPC : Total Plate Count
UHT : Ultra-High Temperature
WHO : World Health Organization

Answer Key

Module 1: Operational Planning, Work Area Maintenance, and Production Organization

Session 1: Production Planning and Workflow Design

A. Multiple Choice Questions

1. (b) Organizing resources for production
2. (b) Improving material flow
3. (b) Sequence of operations
4. (c) Linear
5. (b) Planning production quantity

B. Fill in the Blanks

1. efficient
2. Demand
3. sequence
4. time frame
5. movement

C. State True or False

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

Session 2: Work Area Preparation and Machine Maintenance

A. Multiple Choice Questions

1. (b) Improving safety and efficiency
2. (b) Prevent breakdowns
3. (b) Before breakdown
4. (b) Proper lighting
5. (b) Product quality

B. Fill in the Blanks

1. accidents
2. Preventive
3. life
4. available
5. production

C. State True or False

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

Session 3: Organizing Tools, Materials, and Manpower for Production

A. Multiple Choice Questions

1. (b) Saving time
2. (c) Improving efficiency
3. (b) Clear labeling
4. (c) Maintain quality and safety

B. Fill in the Blanks

1. time
2. First-In, First-Out
3. clean
4. efficiency
5. errors

C. State True or False

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

Module 2: Market Milk – Production, Processing, Quality Assessment, and Hygiene

Session 1: Milk Standardization and Heat/Process Treatments

A. Multiple Choice Questions

1. (b) Consistent composition
2. (b) 72°C for 15 seconds
3. (b) HTST pasteurization
4. (b) Blending proportions
5. (b) Ambient temperature

B. Fill in the Blanks

1. fat and SNF
2. plate
3. blending
4. 3–6
5. cooling

C. State True or False

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

Session 2: Types of Market Milk and Their Processing Techniques

A. Multiple Choice Questions

1. (b) Direct consumption
2. (c) 6.0%
3. (b) Homogenization
4. (b) UHT milk
5. (b) Protect milk during transport

B. Fill in the Blanks

1. hygienic
2. Standardization
3. 72, 15
4. Aseptic
5. Aluminum foil

C. State True or False

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

Session 3: Quality Control, Assurance, and Hygienic Handling Practices

A. Multiple Choice Questions

1. (c) Staphylococcus aureus
2. (b) 6.5–6.7

3. (a) Alcohol test
4. (b) Identify and control hazards
5. (c) Marketing and government checks

B. Fill in the Blanks

1. biological, chemical, and physical
2. Clot-on-boiling test
3. 1.028–1.032 g/cm³
4. HACCP
5. 4–6°C

C. State True or False

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

Module 3: Production of Indigenous and Fat-Rich Dairy Products

Session 1: Overview and Importance

A. Multiple Choice Questions

1. (b) Heating/concentration/fermentation
2. (c) Paneer
3. (b) Improves flavor/texture
4. (b) Household/cottage/industrial
5. (a) Ghee in rituals

B. Fill in the Blanks

1. fermentation
2. *khoa*
3. surplus
4. energy
5. cottage

C. State True or False

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

Session 2: Cream, Butter, and Ghee

A. Multiple Choice Questions

1. (b) Density difference
2. (b) Fat rising to surface
3. (b) Churning cream
4. (c) Homogenizing buttermilk
5. (b) Makkhan

B. Fill in the Blanks

1. fat-rich
2. centrifugal
3. fat
4. aged
5. rancidity

C. State True or False

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

Session 3: *Khoa*-Based Products

A. Multiple Choice Questions

1. (b) Continuous heating/stirring
2. (b) Danedar
3. (b) Cooking *khoa* with sugar
4. (b) Discs
5. (b) Uniform color

B. Fill in the Blanks

1. moisture
2. hard
3. deep
4. indigenous
5. taste

C. State True or False

1. False
2. True

3. True
4. False
5. False

Session 4: Chhana and Paneer

A. Multiple Choice Questions

1. (b) Heat-acid
2. (b) Pressed fresh cheese
3. (b) Heating milk
4. (a) Vacuum packaging
5. (b) Citric/lactic

B. Fill in the Blanks

1. whey
2. pressing
3. refrigeration
4. acid
5. vacuum

C. State True or False

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

Module 4: Management of Dairy Plant Operations and Production Systems

Session 1: Dairy Plant Operations and Workflow Layout

A. Multiple Choice Questions

1. (b) 4°C
2. (b) Pasteurization
3. (c) Break fat particles for even mixing
4. (d) Milk Reception
5. (c) Linear

B. Fill in the Blanks

1. 4°C
2. Pasteurization
3. reception
4. filling
5. separator

C. State True or False

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

Session 2: Production Planning, Scheduling, and Process Management

A. Multiple Choice Questions

1. (b) Ensure smooth production without delays
2. (c) Daily or hourly allocation of resources
3. (b) Forecasting demand
4. (b) From the due date backward
5. (b) Improving production efficiency and quality

B. Fill in the Blanks

1. resources
2. Backward
3. controlling
4. Gantt
5. production

C. State True or False

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

Session 3: Equipment Maintenance, CIP, and Sanitation

A. Multiple Choice Questions

1. (c) Prevent breakdown and ensure efficiency
2. (c) Cleaning-in-Place
3. (b) Sodium hypochlorite
4. (c) Regular inspection and repair before failure
5. (b) Requires disassembly of equipment

B. Fill in the Blanks

1. Preventive
2. Cleaning-in-Place

3. Sanitization
4. Acid
5. Sanitation

C. State True or False

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