Ice cream Processing Technician

(Job Role)

Draft Study Material for Grade XI

Qualification Pack: FIC/Q2004
Sector: Food Processing

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NCERT

PSS Central Institute of Vocational Education

(a constituent unit of NCERT, Under Ministry of Education, Government of India)

Shyamala Hills, Bhopal- 462 002, Madhya Pradesh

FOREWORD

It is with great pleasure to introduce the textbook "Ice cream Processing Technician" for Grade XI. This comprehensive resource is the result of a collaborative effort between esteemed authors and the Ministry of Education, who have dedicated their expertise and support to the development of this invaluable learning tool.

In a time where knowledge and innovation reign supreme, the "Ice Cream Processing Technician" textbook stands tall as a guiding light, providing students with a comprehensive insight into the intricate world of ice cream production and utilization. Through the collaborative efforts of esteemed authors Dr. Rakesh Kumar Raman, Dr. Yogesh Khetra, Mr. Shafat Khan, Dr. Madhuresh Dwivedi, Dr. Preeti Dixit, and Dr. R. Ravichandran, this textbook seamlessly integrates their wealth of expertise and experiences, offering a panoramic view of the subject matter.

This textbook is not merely a compilation of facts; it is a journey through the intricacies of ice-cream processing, guided by the wisdom of experts. Crafted with meticulous detail, its content not only caters to the academic requisites of Grade XI students but also aims to cultivate within them a deep-seated reverence for the significance of dairy processing, particularly ice-cream production, within the broader landscape of agriculture and dairy industry.

I commend the Ministry of Education for their foresight and commitment to advancing education, as well as the National Council of Educational Research and Training (NCERT) and the Pandit Sunderlal Sharma Central Institute of Vocational Education (PSSCIVE) for their unwavering support in bringing this project to fruition.

As students embark on the exploration of "Ice cream Processing Technician" I am confident that they will find within its pages a wealth of knowledge that will not only enrich their academic journey but also inspire a passion for the fascinating world of ice cream production.

May this textbook ignite curiosity, foster discovery, and cultivate a lasting appreciation for the transformative power of ice cream in our interconnected world.

Director
National Council of Educational
Research and Training (NCERT), New Delhi

About the Textbook

The "Ice Cream Processing Technician" textbook offers a comprehensive approach to learning that combines theoretical knowledge with hands-on experience. By focusing on experiential learning, students are empowered to actively engage in the learning process, gaining practical skills that are directly applicable to their future careers in the ice cream industry.

Developed by a team of subject matter experts, industry professionals, and academicians, the textbook ensures that students receive a well-rounded education that aligns with the National Occupational Standards (NOSs) for the job role. This alignment guarantees that students acquire the necessary knowledge and skills outlined in the performance criteria of the Qualification Pack (QP) for Ice Cream Processing Technicians.

The content of the textbook covers a wide range of topics relevant to the ice cream industry, including food processing sector, Dairy Processing Industry, Ice-cream Processing Industry and Food Safety and Quality control measures, Through a student-centered approach, learners are encouraged to take an active role in their education, fostering critical thinking and problem-solving skills essential for success in the field.

Furthermore, the textbook goes beyond traditional classroom teaching by incorporating real-world examples, case studies, and industry insights. This multifaceted approach not only enhances the learning experience but also prepares students for the challenges and opportunities they may encounter in their careers as Ice Cream Processing Technicians.

By providing a comprehensive and well-structured curriculum, the textbook equips students with the knowledge, skills, and confidence to pursue diverse career paths within the ice cream industry, from production and quality control to entrepreneurship and innovation. Whether students aspire to work in large-scale manufacturing facilities, start their own ice cream businesses, or pursue further education and research, this textbook serves as a valuable resource for building a successful and rewarding career in the field of ice cream processing.

1. FIC/N2013: Prepare and maintain work area and process machineries for production of ice cream
2. FIC/N2014: Prepare for production of ice cream
3. FIC/N2015: Produce ice cream
4. FIC/N2016: Complete documentation and record keeping related to production of ice cream
5. FIC/N9001: Food safety hygiene and sanitation for processing food products

The textbook consists of five units. Unit 1: Introduction to Food Processing provides an overview of food processing, its types, and its significance, with a focus on the Indian food processing industry. Students learn about primary, secondary, and tertiary processing, and the journey of food from farmer to consumer. The unit discusses the current scenario, scope, challenges, and

opportunities in the Indian food processing industry. Students also explore sub-sectors like dairy, cereals, fruits, bakery, meat, beverages, and packaging, laying the foundation for understanding food processing.

Unit 2: Dairy Processing provides a comprehensive understanding of the dairy industry in India, focusing on milk processing and its various products. Students learn about the major milk-producing states, the workforce engaged in the dairy sector, and its contribution to the Indian GDP. They explore categories of milk and milk products, including composition and types of milk like full cream, toned, and skimmed. Practical sessions involve creating a project covering aspects like market players, packaging, and major milk products. They also learn about cleaning and maintenance of work areas, including methods, cleaning agents, and precautionary measures. Through this unit, students gain practical insights into the operations and management of dairy processing plants, essential for a career in the dairy industry.

Unit 3: Elements of Ice Cream Processing introduces the role of an Ice Cream Processing Technician and raw material requirements. Students learn about milk composition, nutritive value, and testing, as well as other ingredients like sugar, stabilizers, and flavors. Practical sessions involve demonstrations of technician duties, boiling and pasteurization of milk, and preparation of ingredients lists. Students also learn about production scheduling, food safety standards, and preparation of work areas and equipment. This unit provides essential skills for ice cream processing technicians.

Unit 4: Basics of Ice Cream Production covers the composition of ice cream, types of ice cream, and the production process. They learn about unit operations involved in ice cream production, including blending, pasteurization, and freezing. Practical sessions involve step-by-step demonstrations of these processes and video tutorials. Students also perform various processes to produce different types of ice cream, such as plain ice cream, frozen desserts, premium ice cream, and syrup ice cream.

Unit 5: Food Safety and Hygiene focuses on ensuring food safety, understanding hazards, and implementing safety management systems. Students learn factors affecting food safety and conduct quality testing of milk. They identify hazards, suggest removal measures, and check milk for adulteration and total soluble solids. They elaborate on Food Safety Management Systems (FSMS) and visit processing units to assess compliance. Additionally, they study Indian food safety laws, inspect packaging for related symbols, and understand their meanings. Students also learn about personal hygiene in ice cream processing, covering uniform wearing, hand washing, and workplace sanitation. Practical demonstrations emphasize these hygiene practices.

I hope this textbook will be useful for students, who will opt for this job role, as well as, teachers. Suggestions for improving this textbook are welcome.

Rakesh K. Raman

TEXTBOOK DEVELOPMENT TEAM

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We extend our heartfelt gratitude to the Ministry of Education, Govt. of India for their unwavering approval and support in the development of the textbook titled "Ice Cream Processing Technician" for Grade XI. Their commitment to advancing education has been instrumental in bringing this project to fruition.

We would like to express our sincere appreciation to the Director, National Council of Educational Research and Training (NCERT) for his invaluable support and guidance throughout the creation of this textbook.

We acknowledge the Joint Director, Pandit Sunderlal Sharma Central Institute of Vocational Education (PSSCIVE) for his insightful guidance, which has played a crucial role in shaping the content and structure of the textbook.

Our deepest gratitude goes to the distinguished authors who have contributed their expertise and knowledge to this textbook. Dr. Rakesh Kumar Raman, Dr. Yogesh Khetra, Mr. Shafat Khan, Dr. Madhuresh Dwivedi, Dr. Preeti Dixit, and Dr. R. Ravichandran have demonstrated a keen interest and dedication in the development of the "Ice Cream Processing Technician" textbook. Their diverse backgrounds and experiences have enriched the content and ensured its relevance to the field.

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Module 1 Overview of Food Processing

The food processing sector in India holds a prominent position, ranking high in terms of growth, production, consumption, and exports. This industry has experienced substantial expansion over the years due to various factors such as rapid urbanization, an evolving middle class with changing lifestyles, and an expanding consumer base. Consequently, the Indian food industry is on track for significant growth and continues to contribute extensively to global food trade annually. India boasts approximately 11.2 percent of the world's total arable land and has emerged as a leading producer of several food products. India is one of the world's largest producers of rice, wheat, milk, pulses and jute manufacturing; second in fruits and vegetables; and third in cereals. It is also the sixth largest food and grocery market in the world and recognized globally as a hub for premium products

Fig.1.1: A Typical Food Processing Unit

like Basmati rice, Darjeeling tea, and Alphonso mangoes.

The abundance of raw materials coupled with affordable labor costs creates immense potential for value addition within the food processing business. This sector has become highly lucrative due to its diverse range of opportunities across different segments. With such favorable conditions at hand, the availability of resources combined with a wide consumer base, the growth potential for this industry remains robust.

SESSION 1: FOOD PROCESSING

1. Food Processing

Food processing is the set of approaches and procedures used to convert food from its original form into another form that can be consumed by people or animals at home or by businesses in the food processing sector. Food processing typically transforms clean, harvested crops into appealing, marketable, and often long-lasting food products. Food processing benefits include food preservation, marketing, and distribution, as well as protection from hazardous and pathogenic chemicals, year-round availability of many foods, and consumer friendly preparation.

2. Objectives of Food Processing

The major objective of food processing is to transform the raw agricultural items or livestock into a consumable food item. It also includes turning surplus food into a form that can be stored and used during times when there is not enough food available. The key objectives of food processing are as follows:

2.1. Improve Food Safety: Food safety is a critical objective of food processing. Contaminated food can cause foodborne illnesses, which can have severe health consequences. Food processing techniques such as pasteurization, canning, and irradiation are used to eliminate harmful microorganisms and pathogens from food products.

2.2. Extend Shelf Life: Food processing also aims to extend the shelf life of food products by slowing down the spoilage process. This is achieved through techniques such as dehydration, canning, refrigeration, and freezing. These techniques help to preserve the nutritional value and freshness of the food product.

2.3. Improve Nutritional Value: Food processing can also be used to enhance the nutritional value of food products. For example, fortification involves adding nutrients such as vitamins and minerals to food products to improve their nutritional value. Food processing can also help to break down anti-nutrients that can hinder nutrient absorption.

2.4. Enhance Palatability: Food processing can also be used to enhance the sensory properties of food products such as taste, texture, and appearance. Techniques such as marinating, seasoning, and adding flavors are used to improve the taste of food products. Similarly, techniques such as freezing, whipping, and emulsifying are used to improve the texture of food products.

2.5. Aids in Food Transportation and Storage: Food processing helps in converting raw milk into powdered form, making it easier to transport and store for longer periods.

2.6. Enhances Convenience and Palatability: Food processing creates products like instant food, Ready-to-Eat/Cook foods, making meals more convenient and appealing to consumers.

2.7. Creates Attractive and Diverse Products: Raw materials are transformed into diverse and attractive products tailored to different needs and preferences.

2.8. Improves Quality: Processing enhances the quality of food products, ensuring they meet certain standards and are safe for consumption.

2.9. Ensures Year-Round Availability: Processed foods ensure a steady supply of food products throughout the year, regardless of seasonal variations.

2.10. Customizes Nutrition: Food processing allows for the customization of nutrition to meet specific dietary requirements, such as geriatric foods, infant foods, and sports nutrition for different demographics.

3. Levels of Food Processing

As we all know that the food is the basic need of all human beings and to eat food it has to be converted from its raw form into a form which we can consume. Therefore, the process of conversion of food to its consumable form is called food processing. All food groups like, cereals and grains; pulses, fruits and vegetables etc. available from the farm are subjected to various processes to make it edible. After harvest foods is first cleaned, sorted and graded after which depending on the food group different processing treatment are carried out. For example, apples that are harvested are washed, sorted according to size and graded according to their quality after which they are packed and transported. Chana/Bengal gram after harvesting is dehulled meaning outer hard skin is removed, it is cleaned, sorted, graded and packed. This dal is further cooked at home, and also further milled to make *besan,* this *besan* in turn is used in variety of snacks such as *bhujiya, chakli*, sweets etc. making industry.

Based on the level of processing as well as degree of interventions applied FAO (Food and Agriculture Organization), has classified the processed foods into three types viz. Primary, Secondary and Tertiary.

4. Primary Food Processing

Fig.1.2: Primary Food Processing

Primary processing is the conversion of raw materials to food commodities. Cleaning, grading sorting, milling are examples of primary processing. For example, de-husking of paddy to rice; washing, sorting and grading apples; de-scaling and cleaning of prawns etc.

5. Secondary Food Processing

Fig.1.3: Grading & Sorting

Secondary processing is further processing of primary processed food to add variety to meet the taste preferences of the consumer. For example, making ketchup and sauces from tomatoes jams and jellies from fruits, using flour to make bread, paneer, curd, cream from milk etc.

6. Tertiary Food Processing

Fig.1.4: From Dough to Biscuit (Tertiary Food Processing)

Tertiary food processing is processing of food at an industrial level for marketing purposes. Examples include instant noodles, bottled juices, ready to eat, ready to serve foods, bakery products, instant foods, etc.

Food processing provides more variety in foods and hence increases consumer choice. It also alters the texture, taste and nutritional value of food products to attract consumers. Food processing increases the shelf-life of the product and thus ensures food safety, availability and maximum utilization, reducing post-harvest losses. Surplus fresh produce can also be made into other food products using various processing techniques.

Practical Exercise

Activity

1. Demonstrate primary processing techniques such as cleaning, sorting, and grading of fruits and vegetables.
2. Showcase secondary processing by preparing a simple food item like fruit jam or paneer from milk.
3. Prepare samples of fortified food products to showcase how food processing can improve nutritional value. Compare fortified and non-fortified versions to demonstrate the impact on nutritional content.
4. Conduct a preservation experiment using different techniques such as canning, freezing, and dehydration. Compare the shelf life and quality of preserved food items over time.

CHECK YOUR PROGRESS

A. Multiple-Choice Questions (MCQs):

1. What is the primary objective of food processing?
   a) Enhancing shelf life
   b) Improving nutritional value
   c) Enhancing convenience
   d) All of the above

2. Which level of food processing involves further processing of primary processed foods to add variety?
   a) Primary processing
   b) Secondary processing
   c) Tertiary processing
   d) Quaternary processing

3. What is the main benefit of food processing in terms of consumer choice?
   a) Decreased shelf-life
   b) Reduced nutritional value
   c) Increased variety
   d) Limited availability

4. Which of the following is an example of tertiary food processing?
   a) Washing and sorting apples
   b) Making ketchup from tomatoes
   c) De-husking paddy to rice
   d) De-scaling and cleaning prawns

5. Food processing helps in reducing post-harvest losses by:
   a) Decreasing shelf-life
   b) Increasing food safety
   c) Limiting consumer choice
   d) Allowing surplus produce to be made into other food products

B. Fill in the Blanks

1. Primary processing involves _____ of raw materials to food commodities.
2. Secondary processing adds variety to primary processed food to meet _____ of the consumer**.**
3. Tertiary processing involves processing food at an _____ for marketing purposes.
4. Food processing increases the _____ of the product and ensures food safety.
5. Surplus fresh produce can be made into other food products using various _____.

C. True or False:

1. Food processing aims to transform raw agricultural items into edible forms.
2. Tertiary food processing involves further processing of primary processed food items.
3. Food processing enhances nutritional value but does not impact taste or texture.
4. Packaging plays a minor role in food processing for transportation and storage.
5. Food processing helps in reducing post-harvest losses by utilizing surplus fresh produce.

D. Subjective Questions

1. Discuss the role of the Indian food processing sector in the country's economic growth and global food trade, highlighting key factors driving its expansion.
2. Explain the major objectives of food processing and how they contribute to food safety, shelf life extension, and nutritional enhancement of food products.
3. Describe the levels of food processing and provide examples of primary, secondary, and tertiary processing techniques with reference to different food groups.

4. Evaluate the significance of dairy industry in India's agricultural landscape, considering its contribution to rural livelihoods, urban nutrition, and economic development.
5. Analyze the challenges faced by the Indian food processing industry despite its immense growth potential, and suggest strategies to overcome these challenges for sustainable development.

What have you learned?

After completing this Session, you will be able to:

1. Explain the multifaceted role of the Indian food processing industry in driving economic growth, ensuring food safety, and meeting consumer demand.
2. Describe the objectives of food processing and the importance of food processing techniques in enhancing food safety, shelf life, and nutritional value.
3. Identify the different levels of food processing and comprehend their significance in adding value to food products.
4. Discuss the pivotal role of the dairy industry in India, including its contribution to rural livelihoods, urban nutrition, and employment generation, as well as its potential for export growth and technological advancement.
5. Evaluate the challenges faced by the Indian food processing industry and propose solutions to promote sustainable growth, enhance food security, and minimize post-harvest losses.

SESSION: 2 SUB SECTORS OF FOOD PROCESSING

The food processing industry in India comprises several sub-sectors, each specializing in different aspects of food production, processing, and distribution. Some of the prominent sub-sectors are shown in Fig. 1.5.

Fig.1.5: Sub-sectors of food processing

Dairy Processing: Dairy processing involves the conversion of raw milk into a range of dairy products like milk powder, cheese, butter, yogurt, and flavored milk.

Fruit and Vegetable Processing: India is one of the largest fruits and vegetable producer globally. This sub-sector focuses on processing fresh fruits and vegetables into various products such as juices, canned fruits, frozen vegetables, pickles, jams, dried fruits, and juice concentrates. The major contributors to fruit production are mangoes, bananas, citrus fruits, guavas, and apples which account for approximately 75-80%.

Grains, Cereals and Pulses: India holds the prestigious title of being the largest global producer of various grains, including rice, wheat, corn, sorghum, and millets. The country has achieved a remarkable milestone with an estimated record-breaking food grain production of 330.5 MT. Amongst all segments within the food industry, grain processing takes center stage by contributing over 40% to its total value. This sector encompasses diverse activities such as transforming cereals and pulses into flakes, puffed cereals, ready-to-eat snacks, milling grains to produce flour and rice along with other related products.

Bakery and Confectionery: This sub-sector focuses on the production of bakery and confectionery products such as bread, cakes, cookies, chocolates, and candies.

Meat, Poultry and Sea Foods: Meat processing sector deals with processing meat and poultry products, including meat cuts, sausages, bacon, nuggets, and ready-to-eat meals. Furthermore, India ranks fifth in egg production globally and contributes in global broiler production. Fish and seafood processing involves cleaning, filleting, and packaging of various fish and seafood products, including canned fish, frozen seafood, and fish fillets.

India stands as the third largest producer of fish and second largest inland fish producer. Exportation plays a vital role in India's meat, poultry, and seafood industries. The sub sector is rapidly expanding and concomitantly contributing significantly to both domestic consumption and international trade, enriching the national economy with their remarkable performance.

Beverages Industry: The beverage industry primarily focuses on the production of various drinks and ready-to-drink (RTD) products. This includes a wide range of beverages such as bottled water, energy drinks, soft drinks, coffee, milk and dairy products, different types of alcohol, and nutritional beverages. The beverage industry holds a substantial share in the Indian food industry segment. The beverage industry plays an integral role within both domestic consumption and global markets, and its significance within the Indian economy continues to grow steadily.

Plantation Crops and Spices: Plantation crops, also referred to as cash crops, are perennial crops cultivated on a large scale with the aim of generating profit. Rubber, tea, coffee, cashew, oil palm, and coconut are among the significant plantation crops in India. These crops contribute approximately 5.0-6.0% to India's total export earnings. India is the world's leading producer and exporter of cashew kernels. India is renowned as the 'Home of Spices', occupying third place in terms of spice production worldwide and accounts for about 39.0% of global spice exports. The country cultivates approximately 63 different types of spices and condiments.

Ready-to-Eat and Convenience Foods: Ready-to-eat and convenience food sub-sector involves the production of pre-cooked or semi-cooked meals, snacks, and convenience food items that require minimal preparation before consumption. The rise in urban population has led to an increased demand for convenient food options, which in turn has driven the growth of the packaged food industry.

Food Packaging: Food packaging is a crucial sub-sector of the food processing industry that focuses on the design, production, and utilization of packaging materials and techniques to preserve and protect food products. It plays a vital role in maintaining the quality, safety, and shelf-life of food items from production to consumption.

Practical Exercise

Activity

1. Observe your home kitchen and prepare a chart on the following aspects:
   - Category food products available in your house (sectors wise)
   - Identify the food sector with major and least spending at your home.
   - Collect packaging material used for different food products (bakery, milk, fruits, frozen vegetables etc.).

Check Your Progress

A. Multiple-Choice Questions (MCQs):

1. India ranks third in global spice production and accounts for approximately what percentage of global spice exports?
   a) 25%
   b) 39%
   c) 50%
   d) 60%
2. What is the primary objective of food packaging in the food processing industry?
   a) Enhancing food taste
   b) Reducing food waste
   c) Extending shelf life
   d) Increasing food production
3. Ready-to-eat and convenience foods are popular among urban consumers due to:
   a) High nutritional value
   b) Minimal preparation required
   c) Low cost
   d) Complex cooking processes
4. Which of the following is not a beverage category produced by the beverage industry?
   a) Bottled water
   b) Energy drinks
   c) Canned fruits
   d) Nutritional beverages

B. Fill in the Blanks:

1. _____ processing involves the conversion of raw milk into a range of dairy products like cheese, butter, yogurt, and flavored milk.
2. India is one of the_____ fruits and vegetable producers globally, and the major contributors to fruit production are mangoes, bananas, citrus fruits and guavas.
3. Grains, cereals, and pulses processing contributes over _____ to the total value of the food industry.
4. Ready-to-eat and convenience foods involve the production of pre-cooked or semi-cooked meals, snacks, and convenience food items that require minimal _____ before consumption.
5. Food packaging plays a vital role in maintaining the quality, safety, and shelf-life of food items from production to _____.

C. True or False:

1. India is the largest global producer of various grains, including rice, wheat, and corn.
2. The beverage industry primarily focuses on the production of non-alcoholic drinks only.
3. Plantation crops like rubber and tea are not significant contributors to India's export earnings.
4. Meat, poultry, and seafood processing involve cleaning, filleting, and packaging of various fish and seafood products.
5. Ready-to-eat and convenience foods are primarily targeted at rural consumers.

D. Subjective Questions

1. Discuss the significance of food packaging in the food processing industry and its impact on food safety and consumer perception.
2. Discuss the processing techniques involved in dairy processing and fruit and vegetable processing, highlighting their unique challenges and opportunities.
3. Analyze the role of the beverage industry in the Indian food processing sector, considering its contribution to both domestic consumption and global markets.
4. Evaluate the potential market demand for ready-to-eat and convenience foods in urban areas and propose strategies for product innovation and market penetration.
5. Explore the export potential of Indian plantation crops and spices, discussing their economic importance and global market trends.

What have you learned?

After completing this Session, you will be able to:

1. Identify and describe various sub-sectors of the food processing industry in India.
2. Describe the processes involved in each sub-sector, including production, processing, and distribution of food products.
3. Explain the economic significance of each sub-sector and its contribution to India's agricultural and food industry landscape.
4. Recognize the market opportunities and challenges within each sub-sector and propose strategies for sustainable growth and development.
5. Demonstrate practical skills related to food processing techniques through hands-on activities and demonstrations.

SESSION 3: SIGNIFICANCE OF THE INDIAN FOOD PROCESSING AND DAIRY INDUSTRY

The Indian food processing industry has been growing rapidly, with an average annual growth rate of 8.3% over the past 5 years. In 2022, the market size reached a whopping US$ 866 billion, showing how important this industry is for the economy's growth. Looking ahead, the domestic food market is expected to grow by more than 47% from 2022 to 2027, reaching a staggering US$ 1,274 billion. In 2023, the food market already generated US$ 963 billion in revenue, and it is projected to keep expanding at a steady pace, with an anticipated growth rate of 7.23% between 2023 and 2027. This shows how significant the food industry is becoming in India's economic landscape.

The surge in the Indian food processing sector is driven mainly due to the increasing demand for convenience and growing concern on health and wellness. To meet the current demand of food materials and to address the consumers' expectation from processed foods, industrial food processing sector has emerged. The food processing sector in the country is mainly handled by the unorganized sectors. About, 42% of the output comes from the unorganized sector, 25% comes from the organized sector and the rest of it comes from the small-scale players. The small-scale food processing sector is a major source of employment and adds value to crops by processing.

3.1 Current Scenario of the Food Processing Industry

The food processing industry in India plays a vital role in the economy, contributing significantly to the GDP. It involves various sectors like fruits, vegetables, dairy, meat, cereals, and packaged foods. India ranks high globally in food production, processing, and consumption. It is the 6th largest market for food products worldwide, with 70% of sales volume. The sector is expected to grow steadily at around 11% annually, reaching $535 billion USD by 2025, driven by increased demand and health-conscious consumers.

Changing consumer preferences due to health concerns have led to a rise in demand for gluten-free, low-calorie, and organic products. Ready-to-Eat and Cook products are also gaining popularity, especially with the rise of E-commerce and online food delivery services. The Government, through the Ministry of Food Processing Industries (MoFPI), is increasing investments in this sector. The government is facilitating consumer awareness by improving labeling and encouraging eco-friendly packaging solutions, banning plastic packaging materials. These efforts aim to promote sustainable growth while meeting consumer needs and protecting the environment.

The Indian food processing industry is experiencing remarkable growth, driven by various factors such as rising per capita income, higher proportion of women in the workforce, nuclear family structures, urbanization, and changing lifestyles. With over half of the population under 30 years old, there is a growing demand for processed foods, especially among the youth. Increased awareness about health and nutrition is increasing the demand for healthier food options and functional foods. Government initiatives, including 100% Foreign Direct Investment (FDI), are supporting infrastructure development in food production, transportation, and processing, attracting significant investment.

3.2 Challenges and Opportunities in the Indian Food Processing Industry

Major challenges as shown in Fig. 1.6 in the food processing industry nationwide encompass deficiencies in raw material availability, subpar delivery standards, inconsistent seasonal supply of raw materials, insufficiently trained workforce, costly packaging materials, infrastructure limitations, and operational inefficiencies.

The principal obstacles in the food processing sector entail inadequate infrastructure, absence of a comprehensive national policy for Food Processing Industry (FPI), unclear food safety regulations and rigid international food laws hygiene concerns, and a shortage of skilled manpower further compound these challenges.

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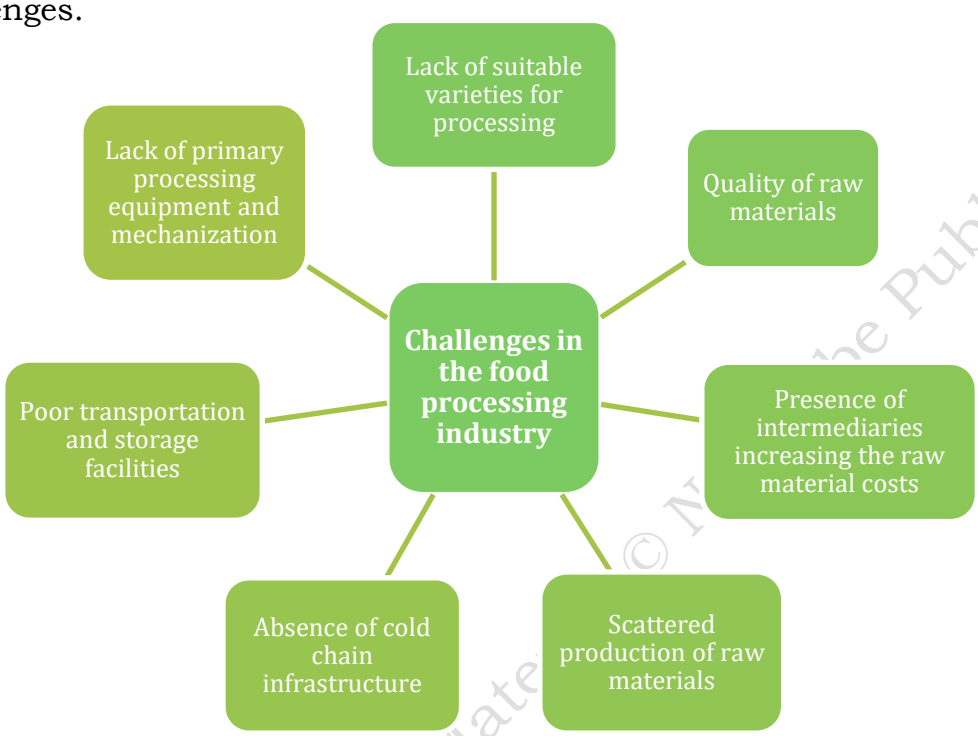


Fig.1.6: Challenges in the food processing industry

3.3 Opportunities and Future Outlook

The Indian food processing industry holds significant potential for improving the socio-economic conditions of rural communities. With its collaborative structure involving agriculture and industry, this sector offers numerous opportunities for growth and development as discussed below:

3.3.1 Favourable Agri-climatic condition

India boasts diverse agro-climatic conditions and substantial production bases, ranking second globally in arable land. This advantageous diversity enables simultaneous cultivation of a wide array of crops, including grains, fruits, vegetables, and herbs. Consequently, India stands as a leading producer of dairy products, fruits like banana, guava, papaya, mango, and grains such as rice, wheat, and certain millets. This abundance of raw materials facilitates robust investment opportunities in the food processing industry, both for domestic consumption and export.

3.3.2 Demographic Favorability

India hosts a significant portion of the world's youth population, offering a potential demographic dividend if appropriately skilled. The food processing sector demands various technical and specialized skills, and the quality of human resources significantly impacts performance. With a burgeoning population, rising disposable incomes, and evolving dietary habits, India's sizable market presents opportunities not only domestically but also globally for processed food items

3.3.3 FDI in Food Processing Sector

Foreign Direct Investment (FDI) is pivotal in fostering the growth of India's food processing industry. The country's liberalized FDI policies aim to attract investment across sectors, including food processing, through both automatic and government-approved routes. The inflow of FDI has been substantial, indicating investor confidence in the sector's potential for growth and development.

3.3.4 Urbanization and Changing Lifestyle

The food processing industry in India has witnessed rapid growth, aligning with the expansion of the middle class and evolving consumer preferences. Factors such as urbanization, technological advancements, industrialization, and shifts in lifestyle have contributed to this growth trajectory. Consequently, there's a need for increased utilization of agricultural production and significant changes in food delivery and marketing strategies to meet evolving consumer demands.

3.3.5 Demand for Functional Foods and Nutraceuticals

The prevalence of lifestyle diseases has spurred demand for functional foods and nutraceuticals in India. The country's market for these products has witnessed significant growth, driven by concerns about health and wellness. India's rich biodiversity, including medicinal plants, provides a vast resource for developing nutraceuticals. With growing global demand, India has the potential to capture a larger share of the global market through innovation and strategic positioning.

3.3.6 Government Initiatives to Promote Skill Development

Recognizing the potential of the food processing industry to generate employment and income in rural areas, the Government of India has prioritized it under the 'Make in India' program. Various initiatives have been undertaken to support the sector, including efforts to improve quality standards, increase access to formal credit for small and medium-sized businesses, and enhance skill development among the workforce. These initiatives aim to harness the industry's potential for economic growth and rural development.

3.3.7 Export Potential

India's diverse agricultural base provides a platform for food processing companies to tap into the global market.

3.3.8 Value Addition

There is a scope for adding value to agricultural produce through processing and reducing wastage.

3.3.9 Technology Adoption

Embracing advanced technologies will enhance productivity and competitiveness.

DAIRY INDUSTRY

The dairy industry in India plays a vital role in the country's economy and food security, contributing significantly to both rural livelihoods and urban nutrition. With a rich tradition of dairy farming dating back centuries, India has emerged as one of the largest milk producers globally, surpassing even the United States and European Union in total milk production.

Dairy farming in India is predominantly small-scale and traditional, with millions of rural households engaged in milk production. These farmers rear indigenous cattle breeds like Gir, Sahiwal (as illustrated in Fig. 1.7.), and Red Sindhi, as well as buffaloes, which are well adapted to local climatic conditions and provide high-quality milk.

Fig.1.7: a. Sahiwal Cow (Punjab *b. Gir cow (Gujarat)*

The dairy industry encompasses various activities, including milk production, processing, distribution, and marketing of dairy products. Milk is collected from individual farmers or dairy cooperatives and transported to processing plants where it undergoes pasteurization, homogenization, and packaging into various dairy products such as liquid milk, butter, ghee, yogurt, cheese, and ice cream.

One of the distinguishing features of the Indian dairy industry is the widespread presence of dairy cooperatives, most notably exemplified by the Amul cooperative movement in Gujarat. These cooperatives, spearheaded by organizations like the National Dairy Development Board (NDDB) and its flagship brand Amul, have played a crucial role in empowering dairy farmers, improving milk productivity, and ensuring fair prices for their produce.

The dairy industry also serves as a significant source of employment, particularly in rural areas, providing livelihoods to millions of farmers, milk vendors, transporters, and workers employed in processing plants and dairy outlets. Moreover, dairy products are an essential part of the Indian diet, providing valuable nutrients like protein, calcium, vitamins, and minerals. Milk and dairy products are consumed in various forms, both as standalone items and as ingredients in traditional Indian cuisine.

In recent years, the Indian dairy industry has witnessed significant modernization and technological advancements, with the adoption of mechanized milking techniques, cold chain infrastructure, and quality assurance measures to meet domestic demand and explore export opportunities.

The industry involves the transformation of milk into a variety of dairy products, liquid milk, UHT milk, flavoured milk, curd, flavoured and frozen yoghurts, probiotic dairy products, lassi, butter-milk, butter, *ghee*, *paneer*, cheese, *khoya*, cream, skimmed milk powder, dairy whitener, sweet condensed milk, ice cream, whey, A2 milk, organic milk, milk shake and dairy sweets. While liquid milk still dominates the Indian dairy sector, there is a growing interest in cheese, yoghurt, ice cream, dairy sweets, cream, whey, UHT milk, flavoured milk, curd, lassi, buttermilk, probiotic dairy products, and skimmed milk powder (SMP).

Indian dairy industry is a single largest agri-food commodity contributes 5% to India's national economy and employ more than 8 crore farmers directly. India ranks 1st in milk production worldwide. In 2021-22, the country produced a staggering 221.06 million tonnes of milk, registering an annual growth rate of 5.29%.

In the year 2021-22, the milk production has registered an annual growth rate of 5.29%. Top five major milk producing States are Uttar Pradesh, Rajasthan, Madhya Pradesh, Gujarat and Andhra Pradesh (2022-23).

Due to changing prices and quality competition between numerous small and large manufacturers, the market is incredibly fragmented. Due to this competition, it is frequently difficult for small firms to remain in the market. The processing facilities, which are operated by highly skilled technical employees, are owned by the farmers in India's dairy cooperatives. Many of the dairy

processing facilities have enormous capabilities, much exceeding those of the domestic and international private and corporate dairy processing facilities. The absence of suitable cold chain facilities is the main obstacle facing the dairy market. Dairy products require a continuous, dependable, and cost-effective cold chain infrastructure for storage and shipping because they are a perishable good with a short shelf life.

The Indian dairy industry represents a critical component of the country's agricultural and economic landscape, offering substantial opportunities for growth and development, though with challenges that need to be addressed to fully harness its potential.

Practical Exercise

Activity

1. Prepare a report on the contribution of the food processing sector to the Indian economy.
2. Make a chart on various revolutions of the Indian food processing industry.
3. Brainstorming on innovation and changing face of the food processing industry across the world.
4. Prepare a chart pertaining to SWOT analysis of the food processing industry of India.

Check Your Progress

A. Multiple-Choice Questions (MCQs)

1. What is the expected growth rate of the domestic food market in India from 2022 to 2027?
   a) 25%
   b) 47%
   c) 70%
   d) 11%
2. Which sector contributes approximately 70% of the sales volume in the Indian food market?
   a) Dairy
   b) Fruits and vegetables
   c) Cereals and grains
   d) Packaged foods
3. What is one of the main drivers of growth in the Indian food processing sector?
   a) Decreasing consumer demand
   b) Lack of technological advancements
   c) Rising demand for convenience and health-conscious products
   d) Decreasing government investments

4. Which organization spearheads the dairy cooperative movement in India?
   a) Ministry of Food Processing Industries
   b) National Dairy Development Board (NDDB)
   c) Food Safety and Standards Authority of India (FSSAI)
   d) Indian Dairy Association

5. What is the primary challenge faced by the dairy industry in India?
   a) Lack of skilled manpower
   b) Insufficient raw material availability
   c) Inadequate packaging materials
   d) Overproduction of dairy products

B. Fill in the Blanks

1. The Indian food processing industry is expected to reach $535 billion USD by _____.
2. Ready-to-Eat and Cook products are gaining popularity due to the rise of _____ and online food delivery services.
3. The absence of suitable cold chain facilities is a major obstacle facing the _____ market.
4. India ranks _____ in milk production worldwide.
5. The Indian dairy industry contributes _____ to India's national economy.

C. True or False

1. The Indian food processing industry contributes significantly to the GDP.
2. India ranks low globally in food production, processing, and consumption.
3. Changing consumer preferences have led to a decline in demand for processed foods.
4. The Government of India is not investing in infrastructure development in the food processing sector.
5. Lack of skilled manpower is one of the challenges faced by the dairy industry in India.

D. Subjective Questions

1. Discuss the main drivers of growth in the Indian food processing industry and their impact on the economy.
2. Explain the significance of dairy cooperatives in empowering dairy farmers and improving milk productivity in India.

3. Analyze the challenges faced by the Indian food processing industry and propose solutions to overcome them.
4. Evaluate the role of government initiatives in promoting growth and development in the food processing and dairy sectors.
5. Discuss the potential of the Indian food processing industry to contribute to rural development and employment generation.

What have you learned?

After completing this Session, you will be able to:

1. Discuss the significance of the Indian food processing and dairy industry in the country's economy and food security.
2. Identify the key drivers of growth and challenges faced by these industries.
3. Discuss government initiatives and policies aimed at promoting growth and development in the food processing and dairy sectors.
4. Analyze the potential opportunities and future outlook for the Indian food processing industry.
5. Evaluate the role of technology, innovation, and human resources in the sustainable development of these industries.

Module 2 | Overview of Dairy Processing Industry in India

SESSION 1: ORIGIN OF ICECREAM

1.1 Overview of dairy processing industry in India

India's dairy processing industry has ancient origins, with traditional methods evolving into modern practices. Today, the sector plays a vital role in India's economy, supported by a rich tradition of dairy farming. India is one of the world's largest producers of milk and milk products, deeply ingrained in its cuisine and cultural heritage. Over the past decade, the sector has seen impressive growth, with milk production increasing significantly. Uttar Pradesh, Maharashtra, and other states are major contributors to dairy production.

1.2 Major Products

India's dairy processing industry offers a diverse range of products, including liquid milk, butter, ghee, cheese, yogurt, ice cream, and flavored milk beverages as illustrated in Fig. 2.1. These cater to domestic and international markets, reflecting India's culinary diversity and consumer preferences. Dairy products, from basic milk to items like ice cream and cheese, play a significant role in this industry.

Fig.2.1: Varieties of Dairy Products

1.3 Key Players

The Indian dairy industry comprises cooperatives, private businesses, and government initiatives, with key players like the NDDB and *Amul* facilitating milk collection, processing, and distribution. This industry uniquely relies on numerous small-scale dairy farmers, uplifting rural livelihoods. Cooperatives such as NDDB and *Amul* have revolutionized farmer support across India, ensuring fair prices and poverty alleviation. India became the world's largest milk

producer over 15 years ago, with production exceeding 230.58 million tonnes during 2022-23. Despite its global prominence, India's milk trade remains minimal, with domestic consumption driving the market. Per capita milk availability stands at 459 grams per day, with annual industry growth at approximately 10%. The unorganized sector dominates, comprising 85% of the market share, engaging eight crore rural families. Major players like Amul, Mother Dairy, and others fiercely compete within the industry.

Do you Know about white revolution in India

The White Revolution, also known as Operation Flood, was a game-changer in India's dairy sector. Launched in 1970, it aimed to boost milk production and transform the country into a dairy powerhouse. Spearheaded by Prof. Verghese Kurien and the National Dairy Development Board (NDDB), this initiative revolutionized dairy farming through cooperative groups. The goal was simple yet ambitious: make India self-sufficient in milk production. And boy, did it deliver! Thanks to the White Revolution, milk productivity soared, meeting market demands and driving economic growth. But that's not all – it also sparked a surge in demand for dairy cattle and spurred the adoption of modern technology. The impact was monumental: India became self-reliant in milk solids, dairy businesses flourished, and infrastructure received a much-needed facelift. Plus, the revolution elevated the genetics of milking species through strategic cross-breeding. All in all, the White Revolution was a dairy dream come true, leaving a lasting legacy of progress and prosperity.

1.4 Ice Cream Processing Industry

The ice cream processing industry combines tradition with innovation to meet global consumer demands. It begins with selecting quality ingredients like milk, cream, sugars, and flavorings, which are blended in precise ratios. Technological advancements in pasteurization, homogenization, and freezing have revolutionized production. Pasteurization ensures safety by eliminating bacteria, while homogenization enhances creaminess. Freezing incorporates air for texture. Quality control is rigorous, ensuring each batch meets taste, texture, and safety standards. Packaging innovations reflect consumer preferences. In India, the organized sector holds 65% market share, with major brands like *Amul*, *Kwality Wall's*, and *Vadilal* dominating alongside regional favorites. You can see the market share of different ice cream brands in Table 2.1.

India's ice cream market offers a variety of flavors catering to diverse preferences. While prominent national brands such as *Amul, Mother Dairy, Kwality Wall's*, and *Vadilal* hold significant sway, smaller regional players like, *Arun* and *Naturals* etc. also garner appreciation among consumers. With the growing popularity of ice cream, the market continues to expand, giving rise to innovative and enticing flavor options.

Table 2.1: Market Share distribution of Ice Cream brands

Brand	Company	Market Share (%)
Amul	Gujarat Cooperative Milk Marketing Federation	12.8
Vadilal	Vadilal Industries	6.2
Mother Dairy	National Dairy Development Board	4.9
Arun	Hatsun Agro Products	4.5
Kwality Wall's	Hindustan Unilever Limited	3.9

Source: *Business Standards*

1.5 Global Trends

The global ice cream market is thriving, with numerous companies competing to satisfy the sweet cravings of consumers worldwide. Major players such as Unilever, Nestlé, McDonald's, Dreyer's, Lotte Group, General Mills, and others dominate the scene, offering a diverse range of products and flavors to cater to diverse tastes. Leveraging their extensive distribution networks and strong brand recognition, these multinational companies capture market share across the globe. With a growing demand for indulgent treats and frozen desserts, the global ice cream market was valued at USD 79.0 billion in 2021 and is expected to expand at a compound annual growth rate (CAGR) of 4.2% from 2022 to 2030. Factors driving this growth include rising demand for innovative flavors, types, and impulse ice creams, as well as increasing health consciousness among consumers, particularly for premium ice creams.

This growth is fueled by factors such as rising disposable incomes, changing consumer lifestyles, and the introduction of innovative flavors and formulations.

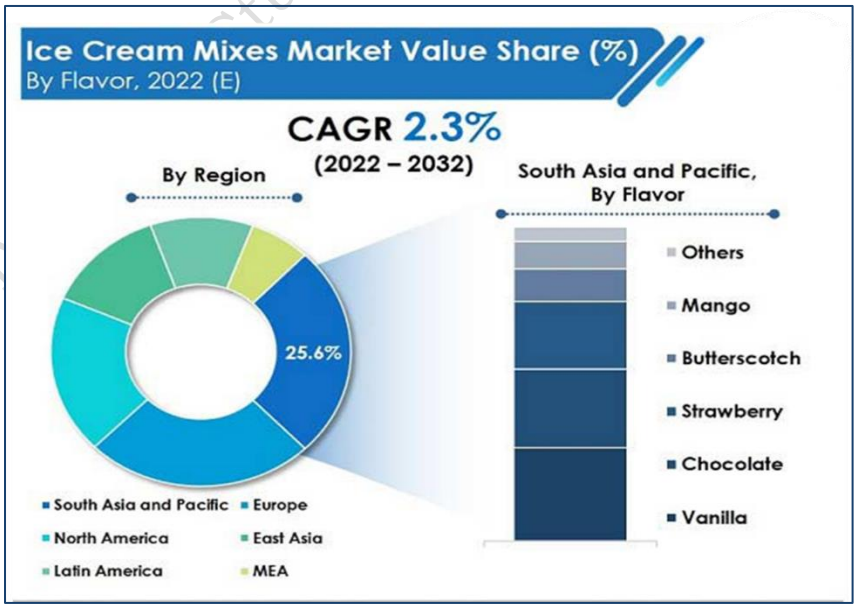


Fig.2.2: Global Market share (%) of Ice-cream

1.6 Origin of Ice Creams

Ice cream has a rich history spanning thousands of years, originating in ancient China with frozen mixtures of rice and milk. Persians enhanced these recipes with ingredients like vermicelli and rosewater before they spread to Europe and the Mediterranean. In Europe, ice cream gained popularity and later traveled to America with early settlers. Historical figures like Alexander the Great and Nero Claudius Caesar enjoyed early versions of frozen desserts. Marco Polo brought a recipe for water ices from the Far East, which eventually evolved into ice cream. In the 17th century, England and France both embraced similar frozen treats. The process of making ice cream evolved over time, with innovations like adding cream and using salt and ice for freezing. In 1851, *Jacob Fussel* started the first wholesale ice cream manufacturing operation in Baltimore, Maryland, revolutionizing the industry. Today, technological advancements like batch and continuous pasteurization processes have made ice cream production more efficient. The chronological evolution of Ice-cream is presented in Table 2.2.

Table 2.2: Ice-cream Origin: Timeline

Ancient Times	Frozen desserts have ancient origins across cultures. In China, a blend of rice and milk froze in the snow, akin to early ice cream. Persia enhanced the treat with additions like vermicelli and rosewater.
1st Century AD	Roman Emperor Nero enjoys a dessert made of snow flavored with fruit juices and honey.
Middle Ages	Marco Polo returns from the East with stories of frozen desserts, potentially introducing the concept to Europe.
16th Century	Catherine de' Medici introduces frozen desserts to the French court.
17th Century	Ice cream gains popularity in Europe, especially among the nobility.
18th Century	Ice cream's popularity surged with technological advances, becoming a status symbol among America's elite, featured even in presidential dinners, facilitated by the development of insulated ice houses.
1843	Nancy Johnson's churn innovation democratized ice cream. Industrialization widened access, and Italian immigrants brought gelato.
1874	Invention of Iceream Soda by Robert Green
Late 19th Century	To bypass religious objections, an ice cream vendor omitted carbonated water from sodas on Sundays, birthing the "Sunday." Renamed "Sundae" to avoid Sabbath associations, it became a tasty compromise, shaping the origin of the Ice Cream Sundae.
1904	Several Food Vendors claimed to have Ice-cream cone at the world fair at St. Louis,Missouri.
1921	Icecream was recognized as an essential food item.

1970	Prepackaged icecream sold through supermarkets, specialty icecream stores
Early 20th Century	Ice cream soda gained traction in soda shops and parlors, alongside the popularization of ice cream cones and banana splits.
20th Century	Ice cream's global popularity soars with its myriad flavors and variations. Technological innovations, such as the ice cream cone and soft serve, drive consumption. To accommodate dietary needs, gluten-free ice cream emerges, catering to those with gluten intolerance.
1980	Introduction of Premium and Super Premium Ice-cream relatively thicker comes under brands Ben &Jerry's and Haagen-Dazs
Present Day	Ice cream remains immensely popular with a vast array of flavors catering to diverse preferences.

Practical Exercise

Activity

1. Discuss the significance of the White Revolution in India's dairy industry
2. and its impact on rural livelihoods.
3. Compare and contrast the major players in the Indian ice cream market, including national and regional brands.
4. Explain the technological advancements in ice cream production and their role in enhancing efficiency and product quality.
5. Analyze the global trends in the ice cream industry, including key players, market value, and growth projections.
6. Trace the historical evolution of ice cream from ancient times to the present day, highlighting key milestones and innovations.

Check Your Progress

A. Multiple Choice Questions

1. What was the primary goal of the White Revolution in India's dairy sector?
   a) Increase milk production
   b) Boost cheese exports
   c) Improve butter quality
   d) Enhance yogurt production

2. Which of the following is NOT a major player in the Indian ice cream market?
   a) Amul
   b) Vadilal
   c) Mother Dairy
   d) Nestlé

3. What technological advancement has revolutionized ice cream production?
   a) Pasteurization
   b) Freezing
   c) Packaging
   d) Homogenization

4. What is the approximate market share of the organized ice cream sector in India?
   a) 50%
   b) 65%
   c) 75%
   d) 85%

5. What historical event is associated with the invention of the ice cream cone?
   a) World War I
   b) The Great Depression
   c) The St. Louis World's Fair
   d) The Industrial Revolution

B. Fill in the Blanks

1. The White Revolution in India aimed to make the country self-sufficient in _____ production.
2. The major players in the Indian ice cream market include Amul, Quality Walls, and _____.
3. Technological advancements in ice cream production have led to improved efficiency and product quality, such as advanced _____ processes.
4. The organized ice cream sector holds approximately _____% market share in India.
5. The invention of the ice cream cone is associated with the World's Fair in _____.

C. State True or False

1. The White Revolution in India aimed to make the country self-sufficient in cheese production.
2. Amul and Quality Walls are major players in the Indian ice cream market.
3. Technological advancements in ice cream production have not significantly impacted efficiency or product quality.
4. The unorganized ice cream sector holds the majority of the market share in India.
5. The invention of the ice cream cone is associated with the Industrial Revolution.

D. Subjective Questions

1. Discuss how the White Revolution has impacted India's dairy industry beyond milk production, focusing on its socio-economic effects on rural communities.
2. Compare marketing strategies of national and regional ice cream brands in India, considering product offerings, pricing, and distribution. Analyze their influence on consumer preferences.
3. Explain how technological advancements, like continuous freezing and flavor encapsulation, have transformed modern ice cream production, enhancing product quality and diversity.
4. Analyze emerging global trends in the ice cream market, including plant-based options and sustainable packaging. Discuss how industry leaders are adapting to maintain market relevance.
5. Explore the cultural evolution of ice cream consumption worldwide, highlighting its transition from luxury to commonplace indulgence and its role in shaping culinary identities.

What have you learned?

After completing this Session, you will be able to:

1. Understand the origins and evolution of ice cream throughout history.
2. Identify key players and initiatives in India's dairy sector, such as the National Dairy Development Board (NDDB) and Operation Flood (White Revolution).
3. Appreciate the diversity of ice cream flavors and brands available in India.
4. Gain insights into the global ice cream market, including major multinational companies and market trends.

SESSION:2 MILK AND MILK PRODUCTS

2.1 Milk and Milk Products

Ice cream can be manufactured using both dairy and non-dairy ingredients, each bringing its unique importance to the final product. Various sources of fat and solids-not-fat (SNF) can be employed in formulating the ice cream mix. However, the characteristics of the mix can vary depending on the composition and treatment of the dairy ingredients used. Before studying the chemistry and physical aspects of ice cream production, it's crucial to understand the composition and key operations involved in dairy processing plants, along with their cleaning and maintenance protocols. Understanding the composition of milk, its constituents, and the factors influencing them is vital due to milk's widespread use in developing the various dairy products and the challenges encountered during processing.

2.2 Composition of milk

Milk stands unparalleled in its nutritional value, comprising a blend of essential ingredients. According to the Food Safety and Standards Authority of India (FSSAI), "Milk" means the normal mammary secretion derived from complete milking of healthy milch animal, without either addition thereto or extraction therefrom, unless otherwise provided in these regulations and it shall be free from colostrum. Milk contains water, fat, protein, lactose, vitamins, and minerals, making it a complex substance. These components exist in three stages: fat-in-oil type emulsion, real solution colloid dispersion, and both. Milk's chemical makeup varies due to factors like species, breed, lactation stage, and geographical conditions. Below is Table 2.3 illustrating the diverse chemical compositions of milk from common milking animals.

Table 2.3: Composition of milk of different breeds

	Components				
Species	**Water (%)**	**Fat (%)**	**Protein (%)**	**Lactose (%)**	**Minerals (%)**
Cow's Milk	87	3.7	3.2	4.8	0.7
Buffalo Milk	81	7.9	4.5	4.8	0.7
Goat Milk	88	4.1	3.5	4.4	0.8
Sheep Milk	82	6.5	5.4	5.1	0.9
Camel Milk	87	3.3	3.5	4.8	0.8
Donkey Milk	90	1.5	1.7	6.0	0.9

These values are approximate and can vary depending on various factors such as breed, diet, and individual characteristics of the animals.

2.3 Types of milk

Various types of milk are available to cater to different dietary preferences and requirements. These varieties are defined by the FSSAI based on their fat and Solid Not Fat (SNF) content. Full cream milk, with its high fat content, offers a rich and creamy texture. Toned milk, on the other hand, has a lower fat content compared to full cream milk, making it a lighter option. Double toned milk contains even less fat than toned milk, while skimmed milk has the least amount of fat, making it suitable for individuals seeking a low-fat or fat-free option. Each type of milk offers a distinct taste and nutritional profile, catering to the diverse preferences of consumers. Let's explore some of the popular varieties of milk in greater detail (Table 2.4).

Table 2.4: Types of Milk (Standards as per FSSAI)

S. No.	Class of Milk	Minimum Milk Fat (per cent, m/m)	Minimum Milk Solids-not-Fat (SNF) (per cent, m/m)
1.	Buffalo Milk	5.0	9.0
2.	Cow Milk	3.2	8.3
3.	Goat or Sheep Milk	3.0	8.0
4.	Camel Milk	2.0	6.0
5.	Mixed Milk	4.5	8.5
6.	Standardized Milk	4.5	8.5
7.	Toned Milk	3.0	8.5
8.	Double Toned Milk	1.5	9.0
9.	Skimmed Milk	Not more than 0.5	8.7
10.	Full Cream Milk	6.0	9.0

2.3.1 Buffalo Milk

Buffalo milk is characterized by its richness, containing a minimum of 5.0% milk fat and 9.0% milk solids-not-fat (SNF). It is known for its creamy texture and high nutritional value.

2.3.2 Cow Milk

Cow milk is the most commonly consumed type of milk and must contain a minimum of 3.2% milk fat and 8.3% milk solids-not-fat (SNF). It is prized for its versatility and balanced flavor profile.

2.3.3 Goat or Sheep Milk

Goat or sheep milk is similar to cow milk but may have a slightly different taste. It must contain a minimum of 3.0% milk fat and 8.0% milk solids-not-fat (SNF). It is often preferred by individuals with lactose intolerance.

2.3.4 Camel Milk

Camel milk is gaining popularity for its unique taste and potential health benefits. It contains a minimum of 2.0% milk fat and 6.0% milk solids-not-fat (SNF), making it lower in fat compared to other types of milk.

2.3.5 Mixed Milk

Mixed milk is a blend of different types of milk, often used in commercial dairy products. It must contain a minimum of 4.5% milk fat and 8.5% milk solids-not-fat (SNF), providing a balance of flavors and nutrients.

2.3.6 Standardized Milk

Standardized milk undergoes a process to adjust the milk fat content to a specific level. It must contain a minimum of 4.5% milk fat and 8.5% milk solids-not-fat (SNF), ensuring consistency in fat content.

2.3.7 Toned Milk

Toned milk is obtained by adding skim milk powder and water to adjust the fat content. It must contain a minimum of 3.0% milk fat and 8.5% milk solids-not-fat (SNF), providing a lighter option compared to full cream milk.

2.3.8 Double Toned Milk

Double toned milk undergoes further fat reduction compared to toned milk. It must contain a minimum of 1.5% milk fat and 9.0% milk solids-not-fat (SNF), making it an even lighter option.

2.3.9 Skimmed Milk

Skimmed milk is produced by removing almost all the fat from whole milk. It must contain not more than 0.5% milk fat and 8.7% milk solids-not-fat (SNF), offering a low-fat or fat-free option for health-conscious consumers.

2.3.10 Full Cream Milk

Full cream milk is the richest and creamiest type of milk, containing a minimum of 6.0% milk fat and 9.0% milk solids-not-fat (SNF). It is prized for its indulgent taste and creamy texture, often used in desserts and rich dairy products.

❖ Milk has been categorized into the following heads based on the type of heat processing and utilization pattern:

(a) **Pasteurised Milk:** Pasteurization is a thermal process utilized to eliminate pathogenic microorganisms in milk while preserving its essential nutrients and properties. The most common method, High Temperature Short Time (HTST), involves heating milk to a minimum temperature of 71.7°C for 15 to 25 seconds, followed by rapid cooling to below 6°C. This process ensures milk safety and extends its shelf life. However, it may result in minor losses of certain vitamins and minerals.

(c) **Sterilised Milk:** Sterilized milk undergoes intense heat treatment to eliminate almost all bacteria. After pre-heating to about 50°C and homogenization, the milk is filled into glass bottles, tightly sealed for sterility. In a steam chamber, temperatures of 110-130°C are applied for 10-30 minutes. Following sterilization, cooling methods like cold water tanks or sprays are employed. This rigorous thermal process alters taste, color, and slightly reduces nutritional content, particularly B-group vitamins and vitamin C.

(d) **Homogenised milk**: Homogenization of milk involves subjecting the liquid to high-pressure forces, typically ranging from 1000 to 2500 psi, to pass through narrow apertures. This mechanical process occurs in multiple passes, exerting pressure to disrupt fat globules further. This disruption results in their uniform dispersion within the milk matrix, preventing cream separation. Homogenization enhances light scattering due to increased dispersed fat globules, improving milk's palatability and visual appeal. Widely adopted in the dairy industry, it ensures the uniformity and stability of milk products.

(e) **Evaporated milk**: Evaporated milk, a concentrated sterilized dairy product, is produced through standardization, heat treatment, and evaporation under reduced pressure at temperatures typically between 60°C and 65°C. This process concentrates the milk to twice its original concentration. After evaporation, homogenization is applied to prevent separation during storage, followed by cooling. The condensed milk is then canned, sealed, and subjected to a final cooling phase before labeling and packing. This process ensures the safety and quality of evaporated milk while preserving its flavor and nutrients.

(f) **Condensed milk**: Condensed milk, a concentrated dairy product with added sugar for preservation, is produced similarly to evaporated milk. The process involves standardization, followed by heat treatment at 110-115°C for 1-2 minutes. After homogenization, sugar is added, and the mixture is evaporated at low temperatures (55-60°C), resulting in up to three times the milk's original concentration. The condensed milk is rapidly cooled to 30°C before packaging, ensuring quality preservation while enhancing sweetness and texture.

(g) **Dried Milk or Milk Powder**: Powdered milk, or dried milk, is produced by evaporating water from milk using heat. Before drying, the milk undergoes homogenization, heat treatment, and pre-concentration. Spray drying is the most common method, where concentrated milk is sprayed into a chamber with hot air. The droplets lose water rapidly, forming fine powder particles. Skimmed milk powder easily mixes with water, while whole milk powder, with its higher fat content, presents reconstitution challenges.

(h) **Flavoured milk:** Flavored milk represents a rapidly expanding segment within the dairy industry, characterized by diverse flavor profiles and consistencies tailored to accommodate various demographics and preferences. Available in long-life (e.g., Ultra Heat Treated or sterilized) or fresh forms, flavored milk offerings encompass a spectrum of flavors and

textures. Typically derived from reduced-fat milk variants with an approximate fat content of 1%, popular flavors include chocolate, strawberry, and banana. This market evolution reflects a nuanced understanding of consumer tastes and preferences, driving innovation and growth within the dairy sector.

2.4 Categories of milk products (*paneer, curd, butter, ice cream, khoa & ghee*)

Milk products are broadly categorized into six segments based on their nature of processing as depicted in Fig.2.3.

Fig.2.3: Categorizations of Dairy Products based on nature of Processing

Fermented Dairy Products

Fermentation of dairy involves the conversion of lactose into lactic acid by specific bacterial cultures, leading to the development of characteristic flavors, textures, and enhanced shelf life. Examples include curd, yogurt, kefir, and cultured buttermilk, which undergo controlled fermentation processes.

2.4.1 Traditional Indian Dairy Products

Traditional Indian dairy products encompass a diverse range of culturally significant dairy foods prepared using age-old techniques and recipes. Examples include *Khoa*, *Burfi*, *Kunda* and various regional specialties like chhana-based sweets.

2.4.2 Fat-Rich Dairy Products

Fat-rich dairy products are characterized by a high-fat content, contributing to their creamy texture and rich flavor profile. Examples include *ghee*, cream, butter, and butter oil etc.

2.4.3 Condensed and Dried Milk

Condensed and dried milk products are obtained by concentrating milk through evaporation and, in the case of condensed milk, sweetening with sugar. These products offer prolonged shelf life and versatility in culinary applications. Dried milk involves the production of different types of milk powder i.e. spray or roller dried milk powder.

2.4.4 Ice Cream and Frozen Desserts

Ice cream and frozen desserts are dairy-based treats made by freezing a mixture of milk, cream, sugar, and flavorings. These products range from traditional ice cream to frozen yogurt, gelato, and sorbet, offering a wide variety of textures and flavors.

2.4.5 Dairy By-Products

Dairy by-products encompass secondary products derived from dairy processing, such as whey, casein, and lactose. These by-products often have specialized uses in food manufacturing, pharmaceuticals, and animal feed industries due to their nutritional and functional properties.

Practical Exercise

Activity

1. Choose at least two types of milk (e.g., full cream, toned, skimmed) and prepare small batches of ice cream using each type.
2. Note down observations on taste, texture, and consistency for each batch.
3. Share your findings with the class, discussing how the composition of milk affects the final product.

Check Your Progress

A. Multiple-Choice Questions (MCQs):

1. Which of the following dairy products undergoes a thermal process to eliminate pathogenic microorganisms while preserving essential nutrients?
   a. Butter
   b. Curd
   c. Ice cream
   d. Pasteurized milk

2. Which type of milk has the highest fat content?
   a. Skimmed milk
   b. Double toned milk
   c. Toned milk
   d. Full cream milk

3. What is the minimum milk fat content required for toned milk?
   a. 1.5%
   b. 3.0%
   c. 4.5%
   d. 6.0%

4. Which of the following dairy products involves the addition of sugar and heat treatment at high temperatures?
   a. Butter
   b. Condensed milk
   c. Evaporated milk
   d. Skimmed milk

5. What is the primary purpose of homogenization in milk processing?
   a. To eliminate bacteria
   b. To increase fat content
   c. To prevent cream separation
   d. To add flavor

B. Fill in the Blanks

1. Skimmed milk is produced by removing almost all the _____ from whole milk.
2. Evaporated milk is produced through standardization, heat treatment, and evaporation under reduced pressure at temperatures typically between 60°C and _____°C.

3. Characteristics of the ice-cream mix can vary depending on the composition and treatment of the _____ ingredients used.
4. Milk fermentation involves the conversion of lactose into _____ acid by specific bacterial cultures, leading to the development of characteristic flavors, textures, and enhanced shelf life.
5. Dried milk, or milk powder, is produced by evaporating water from milk using _____.

C. True or False

1. Homogenization of milk involves subjecting the liquid to high-pressure forces to pass through narrow apertures, resulting in uniform dispersion of fat globules.
2. Sterilized milk undergoes a rigorous thermal process that eliminates almost all bacteria, including pathogenic microorganisms, altering taste and color while slightly reducing nutritional content.
3. Double toned milk has a higher fat content compared to full cream milk.

D. Subjective Questions

1. Discuss the importance of pasteurization in dairy processing. Explain the process and its effects on milk safety and shelf life.
2. Compare and contrast the nutritional profiles of full cream milk, toned milk, and skimmed milk.
3. Describe the process of making ice cream, including the role of each ingredient.

What have you learned?

After completing this Session, you will be able to:

1. Identify the composition and types of milk, including their nutritional profiles.
2. Understand the processes of pasteurization, sterilization, and homogenization in dairy processing.
3. Describe the production and characteristics of various dairy products, such as ice cream, condensed milk, and powdered milk.

SESSION 3: UNITS OF A DAIRY PROCESSING PLANT

Dairy processing plants comprise various units working in harmony to transform milk into a range of products. These units, from milk reception to packaging, collaborate to ensure product quality and safety. At the heart of the operation lies the processing unit, where milk undergoes pasteurization, homogenization, and standardization to meet regulatory standards and consumer preferences.

Other units, including packaging, refrigeration, and wastewater treatment, contribute to plant efficiency and sustainability. Understanding these units unveils the intricate processes involved in dairy production, showcasing the dedication and innovation within the industry.

3.1 Milk reception area

3.1.1 Receiving and Storage Unit

The receiving and storage unit, positioned at the beginning of the dairy processing chain, is tasked with receiving raw milk from dairy farms and ensuring its safe storage until processing. It operates by accepting raw milk from tanker trucks or other transport vessels and then conducting comprehensive quality testing to assess milk composition, safety, and adherence to regulatory standards. Following the testing phase, the raw milk is temporarily stored in silos or tanks equipped with temperature control mechanisms. This storage method helps to maintain freshness and prevent bacterial growth, ensuring the integrity of the milk until it undergoes further processing.

Various tests assess raw milk for safety and quality, including checks for foreign materials, temperature, acidity, fat content, and more as tabulated in Table 2.5. The quality of raw milk determines the quality of milk products, highlighting the need for quick "Platform Tests" to ensure suitability for processing.

Table 2.5: Platform Test

S. No.	Name of Platform test	Purpose
1.	Organoleptic Test	To determine quality from external appearance of milk
2.	Alcohol test	To determine abnormal milk such as mastitis milk
3.	Total Solid and SNF test	To determine the total solids in the milk
4.	Test with Lactometer	To determine if any adulteration with water is there based on specific gravity
5.	Freezing test	To determine whether water is added and to determine the density
6.	Sediment test	To determine the extent of visible dirt in the milk
7.	Clot on Boiling Test (COB)	To determine the maximum heat stability of milk
8.	Dye reduction test or Resazurin test	To determine the extent of bacterial contamination and its growth in milk

3.2 Milk Processing Area

3.2.1 Filtration and Clarification Unit

Focused on purifying raw milk, this unit removes impurities and solid particles that might compromise product quality and safety. Its functions include mechanical filtration, which eliminates debris, dirt, and foreign matter from the raw milk. Additionally, it employs centrifugal clarification to separate cream from milk, ensuring uniform fat distribution in subsequent processing stages (Fig.2.4). Further refining milk, it utilizes filtration techniques like microfiltration or ultrafiltration to remove microorganisms or contaminants, enhancing the overall purity and safety of the product.

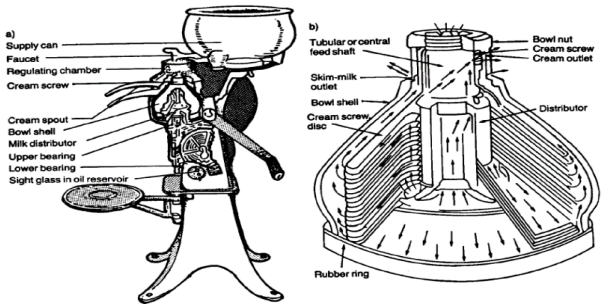


Fig. 2.4: Cutaway diagram of (a) Hand operated Milk Separator (b) bowls showing pathways of milk and

3.2.2 Pasteurization Unit

Pasteurization, a critical step in milk processing, aims to destroy harmful bacteria while preserving the nutritional integrity of the milk. This process involves heat treatment of the milk to predetermined temperatures and durations, such as HTST or UHT, to achieve pathogen eradication. Following pasteurization, rapid cooling is implemented to halt heat-induced alterations and maintain product quality.

Pasteurization methods are categorized based on time and temperature relationships:

- **High Temperature Short Time Treatment (HTST):** Milk is heated to 72°C (161°F) for 15 seconds using metal plates or heated pipes. This method is typically used for milk labeled "pasteurized."
- **Low Temperature Long Time Treatment:** In this process, milk is heated to 63°C (145°F) for at least 30 minutes in a vat pasteurizer. This method is common in the ice cream industry.
- **Ultra-Pasteurization (UHT):** Milk is heated to 140°C (284°F) for 4 seconds, extending its shelf life significantly. This method sterilizes milk rather than pasteurizing it, allowing for storage without refrigeration for several months. UHT processing involves spraying milk or juice into a chamber filled with high temperature steam under pressure. After reaching 140°C, the fluid is cooled instantly in a vacuum chamber and packed in a pre-sterilized airtight container. Milk labeled "ultra-pasteurized" or "UHT" has undergone this method.

3.2.3 Homogenization Unit

Homogenization ensures consistent milk texture and prevents cream separation by dispersing fat globules uniformly. The illustrative diagram of Homogeniser is presented in Fig. 2.5. It involves applying high pressure (typically ranging from 1000 to 3000 psi) to force milk through small apertures, breaking down fat globules and enhancing texture and mouth feel. This process yields stable milk with smaller fat globules (0.2-2 μm), crucial for cream, ice cream, and milk-based drinks. A homogenizer achieves this by forcing milk through tiny apertures under high pressure.

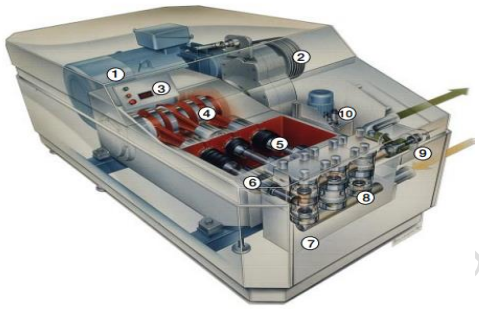


Fig. 2.5.: Open section of a

1. Man drive motor
2. V-Belt Transmission
3. Pressure indication
4. Crank case
5. Piston
6. Piston seal cartridge
7. Solid Stainless-steel pump block
8. Valves

3.2.4 Separation Unit

This unit specializes in separating milk into its constituent components, such as cream and skim milk, enabling tailored processing and product formulation. It employs centrifugal separation to partition milk into cream and skim milk fractions based on density disparities. Additionally, it adjusts the fat content in dairy products by blending cream and skim milk in varying proportions.

3.2.5 Evaporation and Concentration Unit

Evaporation processes serve to remove water from milk, concentrating its solids content for the production of condensed or powdered milk products. A typical Milk evaporation unit is presented in Fig. 2.6. These processes involve applying heat and vacuum conditions to evaporate water from milk, resulting in concentrated dairy solutions. The milk is then evaporative concentrated to the desired solids content for condensed milk production, followed by homogenization and packaging. Alternatively, spray drying or roller drying techniques are employed for the production of powdered milk, where concentrated milk is atomized into fine droplets and rapidly dried to form powder particles.

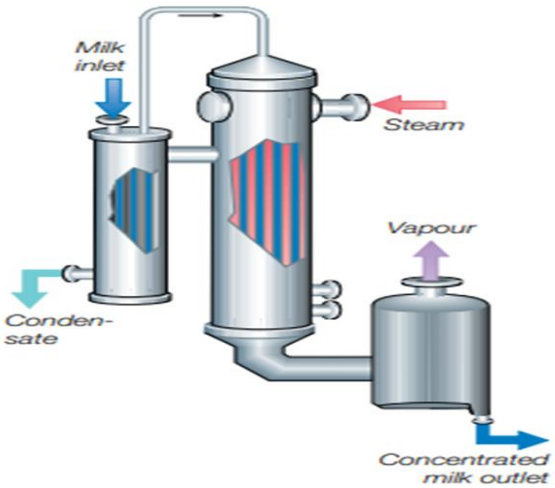


Fig.2.6: Single Effect Falling Film Evaporator

3.2.6 Packaging and Storage Unit

In the final stage of dairy processing, finished products are packaged to ensure their preservation and readiness for distribution to consumers. This involves automated filling and sealing of dairy products into containers, cartons, or pouches, utilizing hygienic packaging materials and techniques. Additionally, labeling, coding, and batch identification systems are applied for traceability and regulatory compliance. Packaged dairy products are then stored in controlled environments, maintaining optimal temperature and humidity conditions to extend shelf life and preserve product freshness.

3.3 MILK PRODUCT SECTIONS

3.3.1 Powder section

In the powder section of the dairy industry, the process begins with concentration, aimed at removing a significant portion of the water content from liquid milk. This step typically increases the total solids content to around 50-60%, effectively extending the shelf life of the milk and reducing shipping costs by minimizing volume. Subsequent to concentration, drying is employed to further reduce the moisture content of the concentrated milk. This step is crucial for achieving the desired powder consistency and stability. The final moisture content of the dried milk powder typically ranges from 2-5%, ensuring optimal preservation and flow properties.

Evaporation serves as an integral process within the powder section, facilitating the concentration of milk solids. By boiling off water from the concentrated milk and subsequently evaporating it, the total solids content is significantly increased. This concentration process is controlled to achieve specific total solid levels, typically reaching concentrations of 30-50%.

Finally, spray drying is utilized to transform the concentrated milk into powdered form. Through atomization, the concentrated milk is dispersed into fine droplets, which are then rapidly dried using hot air. This process ensures uniform drying and results in milk powder with desirable characteristics such as excellent solubility and extended shelf life. The final product typically contains around 95-98% total solids, with minimal moisture content to maintain stability during storage and transportation.

3.3.2 Ice cream section

In the ice cream production section, several essential steps and processes are involved to create high-quality frozen treats. A typical industrial unit of ice-cream is depicted in Fig. 2.7.

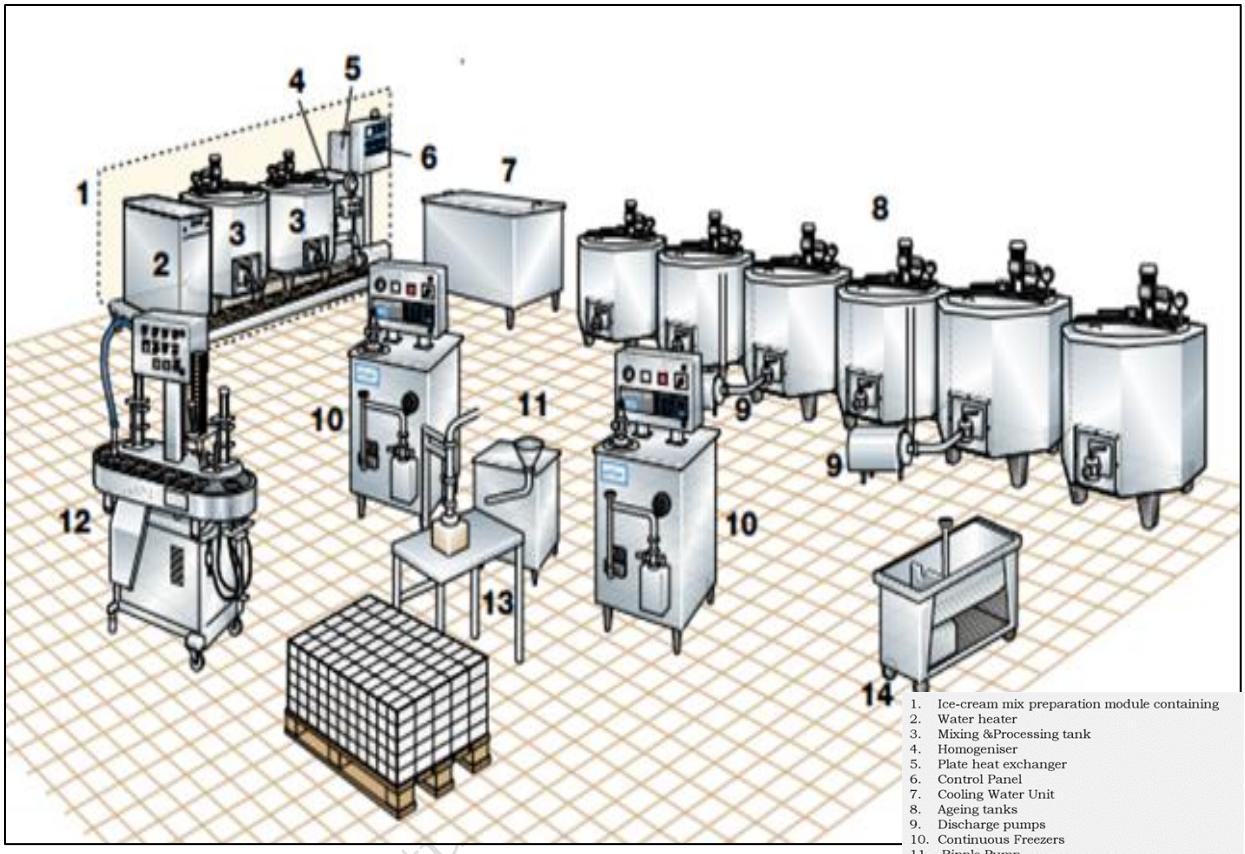


Fig. 2.7: Ice-cream Processing Unit

3.3.3 *Ingredients Selection*

The choice of ingredients is crucial for the overall quality of the ice cream. Dairy ingredients like sweet cream, sweet milk, and various powders contribute to the desired fat and milk solids content. Non-dairy ingredients such as sweeteners, stabilizers, emulsifiers, flavors, colors, fruits, and nuts are also carefully selected based on availability, flavor impact, and cost.

3.3.4 Mix Preparation

Ingredients are blended to form the ice cream base. The blending process varies depending on the temperature and type of ingredients used. Cold batching is preferred for liquid milk-based ingredients, while warmer temperatures are suitable for fat-containing ingredients. Special care is taken to prevent over-churning of cream into butter during mixing.

3.3.5 Pasteurization

The ice cream mix undergoes pasteurization to ensure safety by eliminating harmful microorganisms. Pasteurization involves heating the mix to specific temperatures and durations according to regulatory standards.

3.3.6 Homogenization

To achieve a smooth texture, the mix undergoes homogenization to break down fat globules. This process enhances the consistency of the final product by reducing fat droplet size to less than 1 mm.

3.3.7 Cooling

After pasteurization and homogenization, the mix is rapidly cooled to a specific temperature to prepare it for freezing.

3.3.8 Aging

The cooled mix is aged to allow for the recrystallization of fat crystals and hydration of stabilizers. This aging process typically ranges from 3 to 16 hours, during which the mix is stored in a refrigerated vat with intermittent agitation.

3.3.9 Freezing

After aging, the ice cream mix is churned and frozen in specialized continuous freezers. These machines rapidly freeze the mix while incorporating air to create the characteristic light and airy texture of ice cream. Operating at temperatures between -5°C to -8°C (23°F to 17.6°F), approximately 50% of the water in the mix is converted to ice during freezing, contributing to the final product's structure and stability. Continuous freezers are essential equipment in ice cream production facilities, ensuring consistent quality and texture.

3.3.10 Flavor and Ingredient Addition

Once frozen, various flavorings, colors, and additional ingredients are added to create different ice cream varieties, enhancing the sensory experience.

3.3.11 Packaging

The final ice cream is packaged in containers suitable for storage and distribution. Common packaging materials include plastic tubs, paperboard cartons, and aluminum foil wrappers. These materials are chosen for their ability to protect the ice cream from temperature fluctuations, maintain freshness, and prevent leakage. Additionally, packaging must be designed to meet regulatory requirements and ensure consumer safety.

3.4 Equipment used in dairy processing industry

In the dairy processing industry, various specialized equipment plays a crucial role in the production of dairy products. Here are some of the key pieces of equipment commonly used:

3.4.1 Milk Silos/Storage Tanks

Milk silos, fundamental to dairy processing facilities, serve as reservoirs for storing raw milk upon arrival from farms (Fig. 2.8). These vessels are engineered with essential features to safeguard the milk's integrity prior to processing. Here are key technical aspects of milk silos:

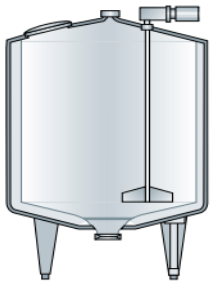


Fig 2.8: A Typical Storage Tank

- ***Material*:** Milk silos predominantly utilize food-grade stainless steel, renowned for its resistance to corrosion and ease of sanitation, ensuring optimal hygiene standards for milk storage.
- ***Capacity:*** Milk silos exhibit varying capacities tailored to the scale of dairy operations, ranging from compact tanks accommodating a few hundred liters to expansive silos capable of holding thousands of liters of milk.
- ***Insulation*:** To preserve milk freshness, silos are often outfitted with insulation systems to counteract temperature fluctuations. This insulation is pivotal in regulating internal temperatures, safeguarding the milk's quality during storage.
- ***Temperature Control*:** Equipped with sophisticated temperature control mechanisms like refrigeration units or cooling jackets, milk silos uphold the desired storage temperature. This stringent temperature control inhibits bacterial proliferation and sustains milk freshness prior to processing.
- ***Agitation System*:** Some milk silos integrate agitation systems to thwart stratification and ensure uniform milk mixing. This agitation mechanism fosters consistency and homogeneity, particularly in larger storage tanks.
- ***Cleaning System*:** Given the paramount importance of hygiene, milk silos are equipped with automated cleaning systems to ensure thorough sanitation between batches. These systems employ hot water and cleaning agents to eradicate any residues and bacteria, maintaining impeccable hygiene standards within the tank.

3.5 Pasteurizer

Pasteurizers are indispensable equipment in dairy processing, ensuring milk safety by eliminating harmful bacteria while retaining its nutritional properties. They come in various types, each with distinct components and technical specifications. A complete setup of milk pasteurizer unit is illustrated in Fig.2.9.

Types of Pasteurizers

1. **Plate Heat Exchangers:** Plate heat exchangers utilize a series of metal plates to heat milk rapidly and efficiently. Milk flows between alternating plates, while hot water or steam circulates on the opposite side, transferring heat to the milk. This method ensures uniform heating and minimizes thermal damage to the milk.

2. **Scraped Surface Heat Exchangers:** Scraped surface heat exchangers employ rotating blades or scrapers to maintain constant agitation and prevent milk from overheating or burning during the pasteurization process. This type of pasteurizer is ideal for viscous or heat-sensitive products.

Components of a Pasteurizer

1. ***Heat Exchanger*:** The heat exchanger is the core component responsible for transferring heat to the milk. In plate heat exchangers, this consists of a series of plates with narrow gaps for efficient heat transfer. In scraped surface heat exchangers, it includes a rotating drum or cylinder with scraper blades.

2. ***Heating System*:** Pasteurizers are equipped with heating systems such as steam coils or hot water jackets to provide the necessary heat energy for pasteurization.

3. ***Temperature Control System:*** A precise temperature control system ensures that the milk reaches and maintains the required pasteurization temperature for the specified duration. This system may include sensors, controllers, and safety mechanisms to monitor and regulate temperature fluctuations.

4. ***Cooling System*:** After pasteurization, milk must be rapidly cooled to prevent over-processing and preserve its quality. Pasteurizers are equipped with cooling systems, such as chilled water or refrigerant, to achieve rapid cooling and maintain product freshness.

5. ***Automation and Control Panel*:** Modern pasteurizers often feature advanced automation and control panels for seamless operation and monitoring.

These panels allow operators to set and adjust pasteurization parameters, monitor process variables, and ensure compliance with regulatory standards.

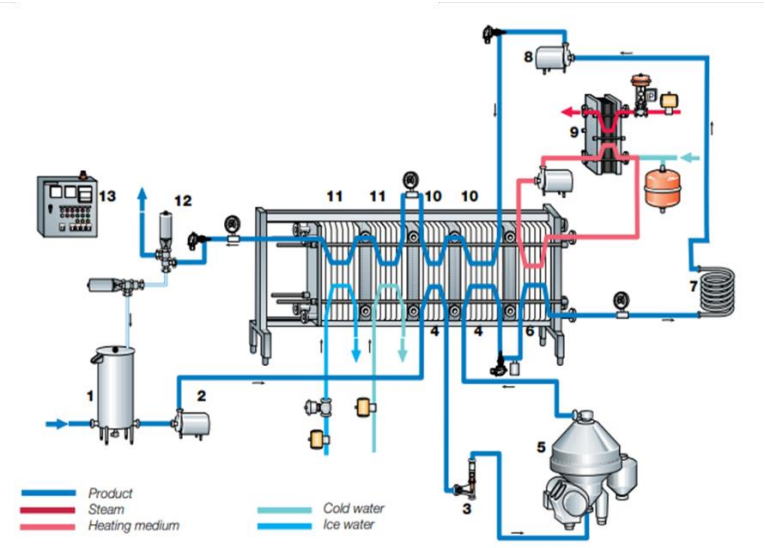


Fig. 2.9: Milk Pasteuriser Unit

Pasteuriser Plant consist of

1. Balance tank
2. Feed Pump
3. Flow Controller
4. Regenerative Preheating Sections
5. Centrifugal clarifier
6. Heating Section
7. Holding tube
8. Booster Pump
9. Hot Water heating system
10. Regenerative cooling Sections
11. Cooling Sections
12. Flow diversion valve
13. Control panel

Pasteurization involves heating milk to temperatures between 63°C to 72°C (145°F to 161°F), with the duration ranging from 15 seconds to 30 minutes, depending on regulatory standards. Pasteurizers can handle diverse flow rates, from small-scale batches to high-capacity continuous systems. Components are typically made from food-grade stainless steel for hygiene and durability, meeting strict food safety regulations.

3.6 Homogenizer

Homogenizers are used to achieve uniform dispersion of fat globules in milk, ensuring product consistency and preventing cream separation. High-pressure homogenization processes break down fat globules to smaller sizes, enhancing texture and mouthfeel.

i. Milk Homogenizer

Homogenizers are essential equipment in dairy processing, utilized to achieve uniform dispersion of fat globules in milk, thereby ensuring product consistency and preventing cream separation. Here are the complete details about milk homogenizers, including technical specifications:

- **Function:** Homogenizers work by subjecting milk to high-pressure forces, which break down fat globules into smaller sizes. This process ensures uniform distribution of fat throughout the milk, enhancing texture, mouthfeel, and overall product quality. By preventing cream separation, homogenizers contribute to the stability and shelf life of dairy products.

Components

1. **High-pressure Pump:** The heart of the homogenizer, responsible for generating the necessary pressure to break down fat globules. This pump typically operates at pressures ranging from 1000 to 1500 bar.
2. **Homogenizing Valve:** Where the milk is forced through small apertures at high pressure, resulting in fat globule disruption and dispersion. The size and configuration of the valve influence the degree of homogenization achieved.
3. **Pressure Gauge:** Monitors and regulates the pressure within the homogenization chamber, ensuring consistent performance and product quality.
4. **Cooling System:** Homogenizers may incorporate cooling systems to dissipate heat generated during the homogenization process, preventing milk from overheating.

Technical Details

1. **Operating Pressure:** Typically ranges from 1000 to 1500 bar (14,500 to 21,750 psi).
2. **Homogenization Temperature:** Generally maintained below 65°C (149°F) to prevent thermal damage to the milk.
3. **Homogenization Efficiency:** Determines the degree of fat globule reduction, typically achieving sizes below 2 µm for optimal homogenization.
4. **Flow Rate:** Varies based on the capacity of the homogenizer, ranging from a few hundred liters per hour to several thousand liters per hour.
5. **Material:** Components are often constructed from durable materials such as stainless steel to ensure hygiene and longevity.

3.7 Milk Chiller

Milk chillers are indispensable refrigeration units in dairy processing, specifically designed to rapidly cool milk to desired temperatures post-pasteurization. Here's an overview of milk chillers:

- **Function:** After pasteurization, milk must be promptly cooled to preserve its freshness and quality while inhibiting bacterial growth. Milk chillers achieve this by rapidly reducing the temperature of the milk to the desired level, ensuring optimal storage conditions until further processing or packaging.

Components

1. **Refrigeration System:** Comprising compressors, condensers, evaporators, and refrigerant, the refrigeration system is responsible for extracting heat from the milk and maintaining low temperatures within the chiller.
2. **Cooling Coils/Tanks:** Milk chillers feature cooling coils or tanks through which milk flows, allowing efficient heat exchange with the refrigerant to facilitate rapid cooling.
3. **Temperature Control Unit:** Equipped with temperature sensors and controllers, the temperature control unit regulates and maintains the desired milk temperature, ensuring consistency and precision in cooling operations.
4. **Insulation:** Milk chillers are insulated to minimize heat transfer and maintain stable internal temperatures, optimizing energy efficiency and cooling performance.

Technical Details

1. **Cooling Capacity:** Milk chillers are available in various capacities, ranging from small-scale units suitable for artisanal dairies to large-scale systems capable of chilling thousands of liters of milk per hour.
2. **Temperature Range:** Milk chillers typically operate within a temperature range of 1°C to 4°C (34°F to 39°F), ensuring optimal storage conditions to preserve milk freshness and quality.
3. **Energy Efficiency:** Modern milk chillers are designed for energy efficiency, incorporating features such as variable speed compressors, heat recovery systems, and optimized refrigeration cycles to minimize energy consumption.
4. **Material:** Components of milk chillers are often constructed from corrosion-resistant materials such as stainless steel or food-grade plastics, ensuring hygiene and durability in dairy processing environments.

3.8 Freezer

Freezers are utilized in dairy processing for freezing various products such as ice cream or frozen desserts. Continuous freezers are commonly used to rapidly freeze ice cream mixtures while incorporating air to achieve the desired texture. Continuous freezers operate by continuously circulating the ice cream mixture through a freezing chamber while incorporating controlled amounts of air. This dynamic process results in the formation of small ice crystals and the creation of a smooth, creamy texture characteristic of high-quality ice cream.

Components

1. **Freezing Chamber:** The core component where the ice cream mixture is rapidly cooled to freezing temperatures. It typically contains rotating blades or dashers to ensure uniform freezing and incorporation of air.
2. **Refrigeration System:** Comprising compressors, condensers, and evaporators, the refrigeration system maintains low temperatures within the freezing chamber, facilitating the rapid freezing of the ice cream mixture.
3. **Air Incorporation System:** Controlled air injection mechanisms regulate the amount of air introduced into the ice cream mixture during freezing, crucial for achieving the desired texture and overrun (air content) in the final product.
4. **Control Panel:** Advanced control panels allow operators to monitor and adjust freezing parameters such as temperature, pressure, and air incorporation rate, ensuring consistent product quality and adherence to specifications.

3.9 Spray Dryer

Spray dryers are used for producing powdered dairy products like milk powder or whey powder (Fig. 2.10). Spray dryers utilize a process known as atomization, where liquid milk is transformed into tiny droplets through high-pressure nozzles or rotary atomizers. These droplets are then exposed to hot air within a drying chamber, where moisture evaporates, leaving behind dry powder particles.

Components

1. **Atomization System:** Spray dryers use high-pressure nozzles or rotary atomizers to convert liquid milk into droplets for drying. Various atomization techniques, including pressure nozzles and rotary atomizers, are employed to achieve desired droplet sizes and distribution.
2. **Drying Chamber:** Atomized milk droplets encounter hot air here, promoting rapid moisture evaporation and powder particle formation. Temperature ranges from 150°C to 200°C (302°F to 392°F), efficiently removing moisture while preserving dairy proteins and nutrients.
3. Air Heating System and Air Flow Rate: This system supplies heat energy to evaporate moisture from milk droplets, often through electric heaters or gas-fired burners. Controlled airflow in the drying chamber maintains optimal drying conditions, ensuring uniform powder formation and preventing agglomeration.

4. Powder Collection System: Collects the dried powder particles as they exit the drying chamber, often employing cyclones or bag filters to separate the powder from the drying air.

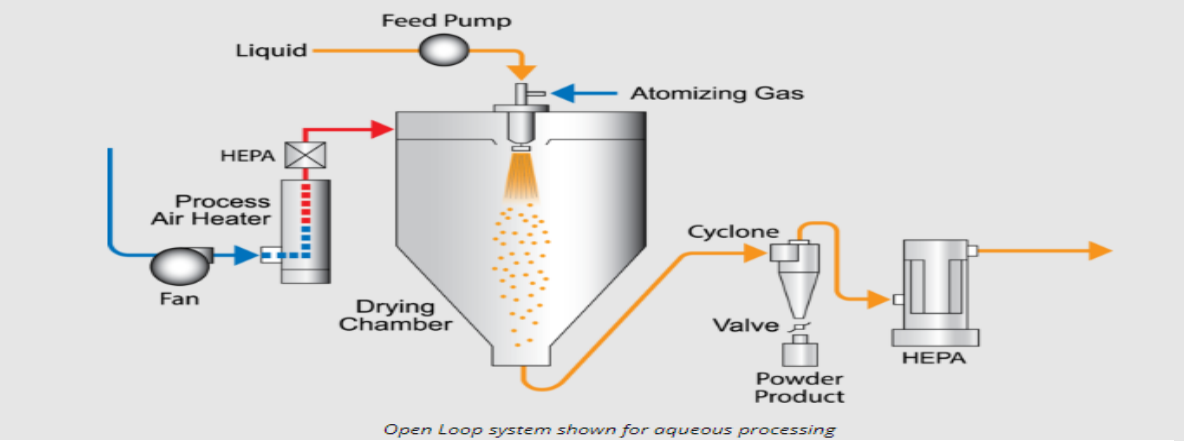


Fig. 2.10: Spray drying Unit

Benefits

1. Enables the production of powdered dairy products with extended shelf life and improved stability compared to liquid forms.
2. Maintains the nutritional integrity of dairy proteins and other components through gentle drying processes.
3. Facilitates efficient processing of large volumes of liquid milk, allowing for increased productivity and scalability in dairy operations.

3.10 Packaging Equipment

Packaging equipment is used for the final step of the dairy processing chain, where finished products are packaged for distribution to consumers. This equipment includes machines for filling, sealing, and labeling containers such as cartons, bottles, or pouches, ensuring product safety and quality during transit.

Each of these pieces of equipment plays a critical role in the efficient and hygienic production of dairy products, contributing to the overall quality and safety of the final products.

Practical Exercise

Activity

1. Demonstrate understanding of the units and processes involved in a dairy processing plant by creating a virtual simulation.
2. Analyze the efficiency and effectiveness of each unit within the simulation to identify areas for improvement and optimization in dairy processing operations.

Check Your Progress

A. Multiple-Choice Questions (MCQs):

1. What is the purpose of pasteurization in dairy processing?
   a) To increase the fat content of milk
   b) To decrease the shelf life of milk
   c) To destroy harmful bacteria in milk
   d) To enhance the color of milk

2. Which of the following tests is used to determine the maximum heat stability of milk?
   a. Alcohol test
   b. Sediment test
   c. Clot on Boiling Test (COB)
   d. Freezing test

3. What is the function of a homogenization unit in dairy processing?
   a) To separate cream from milk
   b) To standardize the fat content of milk
   c) To ensure uniform texture by dispersing fat globules uniformly
   d) To remove impurities and solid particles from milk

4. Which method of pasteurization involves heating milk to 72°C (161°F) for 15 seconds?
   a) HTST (High Temperature Short Time)
   b) UHT (Ultra High Temperature)
   c) LTLT (Low Temperature Long Time)
   d) Vat pasteurization

5. What is the purpose of the separation unit in dairy processing?
   a) To concentrate milk by removing water
   b) To separate milk into cream and skim milk
   c) To homogenize the fat content of milk
   d) To pasteurize milk

B. Fill in the Blanks:

1. The…… unit in a dairy processing plant is responsible for receiving raw milk from dairy farms.
2. ……. ensures consistent milk texture by dispersing fat globules uniformly throughout the milk.
3. Pasteurization involves heating milk to specific temperatures and durations……. to destroy harmful bacteria while preserving its nutritional integrity.

C. True or False:

1. The main purpose of the filtration and clarification unit in a dairy processing plant is to separate cream from milk.
2. Homogenization ensures consistent milk texture by dispersing fat globules uniformly, resulting in larger fat globules for better cream separation.
3. Ultra-Pasteurization (UHT) involves heating milk to 140°C for 4 seconds, allowing for storage without refrigeration for several months.

   The separation unit in a dairy processing plant separates milk into two components: cream and whey.
4. Spray drying is a process used in the ice cream section of a dairy processing plant to concentrate milk solids.

D. Subjective Questions

1. Discuss the importance of pasteurization in dairy processing. How does pasteurization ensure both product safety and nutritional integrity?
2. Explain the role of homogenization in dairy processing. How does homogenization affect the texture, stability, and quality of dairy products?
3. Describe the process of spray drying and its applications in the dairy industry and what are its advantages over other drying methods?

What have you learned?

After completing this Session, you will be able to:

1. Understand the essential units of a dairy processing plant
2. Explain the processes involved in milk reception, pasteurization, homogenization, and standardization, and their significance in dairy production.
3. Identify the different tests conducted on raw milk and their purposes, such as organoleptic tests, alcohol tests, and sediment tests.

SESSION 4. PERFORM CLEANING AND MAINTENANCE OF WORK AREA

Cleanliness in the dairy industry is crucial for food safety and quality. Rigorous cleaning protocols prevent contamination and maintain hygienic conditions, mitigating the risk of bacterial growth and spoilage. Effective sanitation practices uphold regulatory compliance, safeguard consumer health, and maintain product integrity from production to consumption.

4.1 Cleaning Materials/Agents

4.1.1 Detergents

Grease, grime, and residue are removed from surfaces using detergents approved for use on food. They are intended to decompose and eliminate both organic and inorganic pollutants, and they are available in several forms, including liquids, foams, and powders.

4.1.2 Sanitizers/Disinfectants

Microorganisms such as bacteria, viruses, and molds are eliminated or their growth is inhibited by the use of disinfectants and sterilizers. They are essential for sanitizing tools and surfaces that come into touch with food.

Although a range of chemicals are effective against the most common foodborne pathogens, there are a few that are most frequently used.

a) **Hypochlorites**
Chlorine combined with an inorganic compound, such as calcium or sodium, produces hypochlorites. Household bleach is a good example of a cleaning chemical that uses hypochlorites to disinfect surfaces and other materials.

b) **Quaternary Ammonium Compounds**
Quaternary ammonium compounds, commonly known as quats, are complex chemicals composed of nitrogen bound to multiple alkyl chains. In contrast to other disinfectants, quats can be applied over a relatively large temperature range. Unlike hypochlorites, which require a clean surface, quats are effective on surfaces that have light soil.

c) **Peroxyacetic Acid (PAA)**
Peroxyacetic acid works by disrupting the chemical bonds within the cell membranes of bacteria and other microorganisms. Often combined with hydrogen peroxide, PAA works well in cold conditions, making it ideal for refrigeration units in food processing environments. PAA is also effective for biofilm removal, which is a common challenge in food processing plants. Compared to hypochlorites, PAA is more effective, less corrosive, and more environmentally friendly because it breaks down into acetic acid, oxygen, and water.

d) **Degreasers**
These are specialist cleaners used to get rid of oil and grease from machinery and surfaces. They are especially crucial in settings where oils and fats are handled.

e) **Acid Cleaners**
On surfaces and equipment, mineral deposits, scale, and rust are removed with acidic cleaning solutions. They are frequently utilized in regions with hard water or high mineral buildup.

f) **Alkaline Cleaners**

Protein and organic residues can be effectively removed by alkaline cleansers. They are employed in dairy processing facilities to clean surfaces and equipment.

In the food/dairy industry, alkaline cleaning agents play a crucial role in maintaining cleanliness and sanitation. Here are some common alkaline cleaning agents used:

1. Caustic Soda (Sodium Hydroxide): Caustic soda is a strong alkaline agent that effectively removes fats and proteins. It is commonly used in CIP (Clean-in-Place) systems and bottle washing applications1.
2. Caustic Potash (Potassium Hydroxide): Similar to caustic soda, caustic potash is another strong alkaline cleaner used for removing fats and proteins. It is also employed in CIP systems and bottle washing1.
3. Phosphate, Silicate, or Carbonate Salts: These moderately alkaline detergents are used for various cleaning purposes in the food industry. They help break down dirt, grease, and food residues1

(g) Solvent Cleaners

Heavy-duty machinery and equipment are cleaned with solvent-based cleansers, particularly when oil and grease are difficult to remove with other cleaning solutions.

(h) Enzyme Cleaners

Protein and other organic pollutants are broken down by enzyme-based cleansers. They work well to get rid of tenacious organic residues.

Steam and Hot Water: Hot water and steam at high temperatures work well to remove dirt and debris from surfaces and equipment. They work especially well for cleaning machinery and conveyor belts.

Rinse Water: After cleaning, surfaces and equipment are rinsed with clean, drinkable water to get rid of any last traces of cleaning solution.

4.2 Cleaning Equipment and Tools

4.2.1 Bristle Brushes

Bristle brushes are used to clean and agitate surfaces. They are available in a variety of sizes and forms. They are made for certain jobs, such conveyor belt brushes or tanks cleaning brushes.

4.2.2 Pressure Washers

Water jets with high pressure are used to clean surfaces of obstinate dirt and debris. Large food processing facilities frequently employ them.

4.2.3 Sponges and Scrub Pads

Soft sponges and abrasive scrub pads are used for manual scrubbing of equipment and surfaces. Abrasive pads are effective for removing tough residues.

4.2.4 Mops and Buckets

Mops are used to clean floors and walls. They are often made of materials that can be laundered and sanitized. Buckets are used for carrying water and cleaning solutions.

4.2.5 Squeegees

Squeegees are used to remove excess water and cleaning solutions from floors and walls. They are essential for maintaining a dry, slip-free work environment.

4.2.6 Cleaning Cloths and Towels

These are used for wiping and drying surfaces. They should be made of materials that are easy to clean and sanitize.

4.2.7 Dilution Systems

These systems are used to accurately dilute cleaning agents to the required concentration, ensuring effective cleaning without waste or excess chemical use.

4.2.8 Personal Protective Equipment (PPE)

Workers should wear appropriate PPE, including gloves and safety goggles, when handling cleaning agents and using cleaning equipment.

4.3 Methods of Cleaning

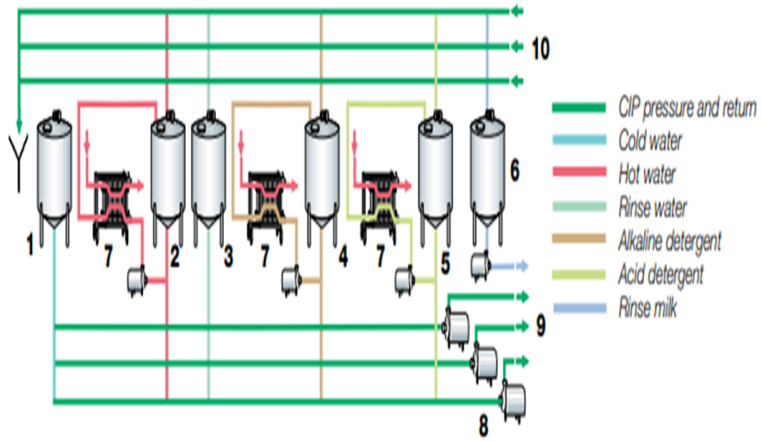
Effective cleaning is essential in food processing to ensure product quality and safety, as well as prevent cross-contamination. Tailoring cleaning supplies, agents, tools, and equipment to the facility's needs and the types of food processed is vital. Adhering to food safety guidelines requires proper cleaning protocols and schedules. Cleaning techniques focus on preserving product safety, preventing contamination, and maintaining cleanliness.

4.3.1 Cleaning-in-Place (CIP)

Without disassembling them, pipelines and equipment can be cleaned in-situ using CIP, an automated cleaning technique. A typical CIP system is illustrated in Fig.2.11. It is frequently used to clean tanks, pipes, pumps, and other equipment in food and beverage processing facilities. In CIP, a predetermined cleaning solution is pumped through the pipelines and equipment.

This cleaning solution is often a blend of water and detergent.

- **Thorough Rinse:** Rinse the equipment again to remove the detergent and loosened residues.
- **Inspect:** Take a closer look at the surfaces to ensure they are clean and free from any remaining debris.



1. Cold Water Tank
2. Hot Water tank
3. Rinse Water tank
4. Alkaline detergent Tank
5. Acid Detergent Tank
6. Rinse Milk Tank
7. Plate heat exchanger for heating
8. CIP Pressure Pumps
9. CIP Pressure lines
10. CIP return lines

Fig. 2.11: General diagram of a CIP

- **Sanitize or Disinfect:** Apply a sanitizing solution or disinfectant to kill any remaining bacteria or pathogens. This step is crucial for food safety.
- **Dry:** Finally, allow the equipment to dry completely before using it again.

4.3.2 Cleaning-out-of-Place (COP)

Equipment and component parts are taken out of their original locations and cleaned individually using the COP manual or semi-automated cleaning technique. Equipment components that are difficult to clean on-site are frequently cleaned using this technique. Parts of the equipment are disassembled in COP and put in a special cleaning room. They are cleaned by hand or by machine with a mix of brushing, scrubbing, soaking, and rinsing. This technique makes it possible to clean each component more thoroughly.

- **Advantages:** Equipment with sophisticated parts or difficult-to-reach places that are not accessible in CIP benefits greatly from the usage of COP. It guarantees a thorough cleaning procedure for every part.

4.3.3 Sterilizing-in-Place (SIP)

Sterilization in place (SIP) is a technique that is usually applied after CIP. It is necessary in sectors of the economy where aseptic food production and the pharmaceutical industry depend on perfect sanitation. In SIP, the cleaned equipment or system is exposed to steam or another sterilizing agent, which

raises the temperature to a point where germs are killed or rendered inactive. The sterilizing procedure is meticulously regulated to adhere to precise temperature and duration specifications.

- **Advantages:** SIP ensures that equipment and systems are not only cleaned but also sterilized, which is crucial for processes where product sterility is essential.

4.4 Maintenance

Maintenance is crucial for ensuring machinery, equipment, and facilities operate effectively and last long. Different maintenance procedures serve distinct purposes. The four main types are: preventive, predictive, corrective, and proactive.

i. **Preventive Maintenance:** In order to stop equipment from breaking down or deteriorating, preventive maintenance is a proactive strategy that includes routinely scheduled inspections, cleaning, lubrication, and small repairs. Its aim is to prolong the operational life of equipment and maintain it in good functioning order. The duties involved in preventive maintenance are completed on a daily, weekly, monthly, or yearly basis.

ii. **Predictive Maintenance:** Predictive maintenance uses condition monitoring and data to forecast when equipment may break. It entails utilizing technologies like as sensors, data analytics, and machine learning to spot possible problems early on and schedule maintenance or repairs accordingly. Based on real-time data and analysis, predictive maintenance is event-driven and may take place on an irregular basis.

iii. **Corrective Maintenance:** Reactive or breakdown maintenance are other terms for corrective maintenance, which is the process of fixing equipment only after it has broken down. In essence, it is the process of mending objects that break or malfunction. There is no set schedule for corrective maintenance; it is done as needed.

iv. **Scheduled Maintenance:** Preventive and corrective maintenance are both included in the broad phrase "scheduled maintenance," which refers to the practice of carrying out particular maintenance operations according to a predetermined timetable. It might entail regular cleaning, adjustments, and inspections. Scheduled maintenance is done at prearranged, frequently preplanned periods.

The type of maintenance that is selected is determined by various criteria, including the industry's specialized requirements, equipment criticality, and cost considerations. To maximize asset performance and dependability while efficiently controlling maintenance expenses, numerous companies combine various maintenance techniques.

4.5 Precautionary measures during cleaning and sanitization

To ensure safety, remember to follow important precautions while carrying out these procedures.

a. **Personal Protective Equipment (PPE):** To prevent exposure to cleaning agents and any risks, wear the proper personal protective equipment (PPE), such as gloves, safety goggles, aprons, and respiratory protection when needed.

b. **Training and Education workshops:** Make certain that staff members have received adequate training on sanitization and cleaning techniques, as well as how to handle tools and cleaning solutions.

c. **Ventilation:** To minimize exposure to fumes and to guarantee sufficient airflow, make sure the cleaning area has enough ventilation.

d. **Chemical Handling:** It is important to follow the manufacturer's directions when handling and diluting cleaning chemicals. Keep chemicals in their original containers; unless otherwise advised, never combine dissimilar substances.

e. **Labeling and Identification:** It is important to clearly mark spray bottles and containers with their contents to avoid using the incorrect cleaning solution by accident.

f. **Read Safety Data Sheets (SDS):** familiarity with cleaning agent Safety Data Sheets (SDS). They include crucial details regarding risks, safe handling, and action to take in an emergency.

g. **Lockout/Tagout:** Observing lockout/tagout protocols to guarantee that machinery is turned off and that energy sources are isolated to prevent unintentional starts are important when cleaning equipment.

h. **Check for Allergies and Sensitivities:** providing alternate solutions or safety precautions, as well as sensitizing staff members to any allergies or sensitivities they may have to specific allergens or cleaning products.

i. **First Aid Kit:** Maintaining a well-stocked first aid kit in the cleaning area and making sure staff members are aware of where it is and how to use it.

j. **Safe Handling of Equipment:** To avoid mishaps or injuries during the cleaning and sanitization process, use the equipment as designed and according to safety regulations.

k. **Color-Coding:** To avoid cross-contamination, think about labeling cleaning supplies and instruments with colored tape. For instance, employing green for kitchen cleaning and red for restroom cleaning.

l. **Proper Dilution:** Make that cleaning products are diluted appropriately, adhering to suggested guidelines, to prevent harmful or inefficient over- or under-dilution.

m. **Testing and Validation:** To make sure that the cleaning and sanitization procedures satisfy quality and regulatory requirements, test and confirm their efficacy on a regular basis.

n. **Controlled Disposal:** When disposing of spent cleaning supplies, such as gloves, cloths, and cleaning solution waste, dispose of them properly by adhering to the rules and recommendations for the disposal of hazardous waste, as applicable.

o. **Emergency Procedures:** In the event of mishaps, chemical exposure, or other cleaning and sanitization-related issues, clearly define emergency protocols.

p. **Documentation:** Keep detailed records of all cleaning and sanitization operations, including the people engaged, the dates, and the cleaning products used.

4.6 Disposal of waste

In the food industry, efficient waste management is vital for environmental sustainability and minimizing ecological impact. Fig.2.12 illustrates the standard symbol used in the food industry to represent disposable items. Below are common procedures employed for waste disposal:

1. Reduce, Reuse, and Recycle (the Three R's):

- **Reduce:** Minimize waste generation by optimizing processes and avoiding excess production.
- **Reuse:** Repurpose materials whenever possible to extend their lifespan.

- **Recycle:** Separate recyclable materials (such as cardboard, clean plastic, metal, and paper) for sale to recyclers.

Fig.2.12: Symbolic representation of different Icons

2. Food Waste

- **Animal Feed:** Convert food waste into animal feed, which can be sold to goat farms, chicken farms, etc.
- **Composting:** Compost organic waste to create nutrient-rich fertilizer.
- **Anaerobic Digestion:** Use anaerobic digestion to produce energy-rich biogas and digestate. Biogas can be used for heating or converted into electricity, while digestate serves as a soil conditioner.

3. Wastewater Treatment Plant (WWTP) Sludge

- **Recycling/Reusing:** Top food manufacturers recycle WWTP sludge through land application, anaerobic digestion, or composting.

4. Cardboard Boxes

- Flatten cardboard boxes and sell them to recyclers.
- Reuse cardboard boxes for temporary storage before retail distribution.

5. Packaging Separation

- Use waste technologies (like "jet shredders") to separate film, carton, and foodstuffs for separate recycling.

6. Zero Landfill Program

- To achieve zero landfill waste, implement these sustainable waste management practices:
  - **Waste Segregation:** Sort waste at the source into hazardous, non-organic, organic, and recyclable categories.
  - **Reduce Food Waste:** Employ efficient manufacturing methods, maintain accurate inventory records, and donate excess food to food banks.
  - **Composting:** Convert organic waste like food scraps and expired ingredients into nutrient-rich soil to minimize landfill volume.
  - **Recycling:** Establish recycling procedures for metals, glass, plastic, and cardboard to conserve resources and reduce environmental impact.
  - **Waste-to-Energy:** Consider waste-to-energy solutions for non-compostable or non-recyclable waste, generating electricity from garbage.
  - **Wastewater Treatment:** Install appropriate equipment for treating wastewater from food processing, ensuring compliance with legal discharge limits.
  - **Proper Chemical Handling:** Adhere to safety protocols and regulations for handling and disposing of hazardous chemicals, using authorized channels for disposal.

Implementing these practices will promote responsible waste management and benefit both the environment and the ice cream making industry.

7. Sanitary Landfill for Residue

Sanitary landfills are where waste that cannot be burned or composted can be disposed of. Make that the rules governing the landfill are being followed.

8. Food Product Recovery

Establish protocols for extracting consumables and materials from the waste stream that could be recovered. This can reduce food waste and increase productivity.

9. Packaging Waste Reduction: Reduce overpackaging and use environmentally friendly packing options to cut down on packaging waste.

4.7 Employee Training

Employees should receive training on correct trash disposal techniques, such as recycling techniques, handling hazardous products, and waste segregation.
In the food processing industry, which includes the ice cream production industry, proper waste disposal is crucial to minimizing environmental effect, adhering to legal requirements, and advancing sustainability. Adopting ethical waste management techniques can save costs and enhance the public's opinion of your company in addition to helping the environment.

Practical Exercise

Activity

Design a comprehensive cleaning protocol for a dairy processing plant, covering materials, methods, equipment, and precautions. Submit a detailed plan outlining cleaning agent, procedures, tools, PPE requirements, and precautionary measures.

Check Your Progress

1. Multiple-Choice Questions (MCQs):

1. Which chemical is commonly used in the food industry for sanitizing tools and surfaces?
   a) Sodium chloride
   b) Quaternary ammonium compounds
   c) Acetic acid
   d) Hydrogen peroxide
2. What is the primary purpose of alkaline cleaning agents in dairy processing?
   a) Removing oil and grease
   b) Disinfecting surfaces
   c) Breaking down protein and organic residues
   d) Removing mineral deposits and rust
3. What is the primary advantage of Cleaning-in-Place (CIP) over Cleaning-out-of-Place (COP)?
   a) COP is more cost-effective
   b) CIP requires less water
   c) COP provides better cleaning of equipment
   d) CIP allows cleaning without disassembling equipment
4. Which precautionary measure is crucial during cleaning and sanitization to prevent chemical exposure?
   a) Proper ventilation
   b) Wearing multiple layers of gloves
   c) Mixing different cleaning chemicals
   d) Storing chemicals in unmarked containers

B. Fill in the Blanks

1. _____ is a commonly used detergent for removing oil and grease from machinery and surfaces.
2. In the food industry, _____ are used to clean and agitate surfaces.
3. _____ are used for manual scrubbing of equipment and surfaces.
4. Personal Protective Equipment (PPE) includes gloves, safety goggles, aprons, and _____.
5. Cleaning-in-Place (CIP) allows cleaning pipelines and equipment without _____.

C. True or False

1. Peroxyacetic acid (PAA) is less corrosive than hypochlorites.
2. Quaternary ammonium compounds (quats) are effective on surfaces with heavy soil.
3. Enzyme-based cleansers are used to remove oil and grease from machinery.
4. Cleaning-in-Place (CIP) involves disassembling equipment for cleaning.
5. Sterilizing-in-Place (SIP) is necessary in sectors where product sterility is not essential.

D. Subjective Questions

1. Explain the importance of proper cleaning and maintenance in the dairy industry, particularly regarding food safety and quality.
2. Describe the differences between Cleaning-in-Place (CIP) and Cleaning-out-of-Place (COP) methods. When would you use each method, and what are their advantages and disadvantages?

What have you learned?

After completing this session, you will be able to:

1. Understand the importance of proper cleaning and maintenance in the dairy industry for food safety and quality.
2. Differentiate between various cleaning materials, agents, and methods used in food processing facilities.
3. Identify key precautions and safety measures necessary during cleaning and sanitization processes to ensure a hygienic work environment and prevent contamination.

Module 3 | Elements of Ice Cream Processing

As we explore into the intricacies of ice cream production, it's crucial to understand the foundational elements that shape every scoop. From the creamy richness to the smooth texture, each aspect of ice cream processing contributes to the final product that delights our taste buds. In this chapter, we will explore the key components and processes that transform simple ingredients into the beloved frozen treat we all adore. From the dairy base to the sweeteners and flavorings, every ingredient plays a vital role in crafting the perfect scoop. Additionally, we'll understand the science behind freezing and churning, two fundamental steps that give ice cream its characteristic texture and consistency.

SESSION-1: ICE CREAM PROCESSING TECHNICIAN PROCESSING

1.1 Ice Cream Processing Technician: Job Description

An Ice Cream Processing Technician plays a crucial role in the production of high-quality ice cream products. This position involves a combination of technical skills, attention to detail, and adherence to strict food safety standards. Ice cream processing technicians work in manufacturing facilities, ensuring that the production process runs smoothly and efficiently to meet consumer demand.

1.2 Responsibilities of an Ice Cream Processing Technician

a. **Operating Machinery:** Ice cream processing technicians are responsible for operating various machinery and equipment used in the production process. This includes mixers, pasteurizers, freezers, and packaging machines. They must be proficient in operating these machines safely and efficiently.

b. **Quality Control:** Ensuring the quality of the final product is a primary responsibility. Ice cream processing technicians monitor the production process closely to maintain consistent quality standards. This involves conducting regular checks on ingredients, monitoring temperature and consistency, and performing sensory evaluation as well to ensure the ice cream meets quality specifications.

c. **Ingredient Handling:** Ice cream recipes require precise measurements of ingredients. Technicians are responsible for accurately measuring and adding ingredients according to the recipe specifications. This includes handling dairy products, flavorings, sweeteners, and stabilizers while adhering to strict hygiene standards to prevent contamination.

d. **Cleaning and Sanitizing:** Maintaining cleanliness and sanitation throughout the production area is essential for food safety. Ice cream processing technicians are responsible for cleaning and sanitizing equipment, surfaces, and utensils pre and post production regularly to prevent cross-contamination and ensure compliance with food safety regulations.

e. **Troubleshooting:** When issues arise during the production process, such as equipment malfunctions or ingredient shortages, ice cream processing technicians must troubleshoot and resolve them promptly. This may involve adjusting machine settings, coordinating with maintenance staff for repairs, or finding alternative solutions to maintain production schedules.

f. **Documentation:** Keeping accurate records is vital for traceability and quality assurance. Ice cream processing technicians document production activities, including ingredient usage, batch numbers, temperature logs, and any deviations from standard procedures. This documentation helps track product quality and facilitates compliance with regulatory requirements.

g. **Safety Compliance:** Safety protocols are paramount in food manufacturing environments. Ice cream processing technicians must follow all safety procedures, including wearing appropriate protective gear, handling hazardous materials safely, and adhering to equipment operating guidelines to prevent accidents and injuries.

h. **Team Collaboration:** Ice cream production is often a team effort involving multiple departments such as production, quality assurance, and maintenance. Ice cream processing technicians collaborate with colleagues to coordinate production schedules, address quality issues, and implement process improvements.

i. **Continuous Improvement:** Ice cream processing technicians actively participate in process improvement initiatives, providing insights for enhancing productivity, reducing waste, and improving product consistency.

j. **Adherence to Regulations:** Ice cream processing technicians must comply with regulatory requirements governing food safety, sanitation, and labeling. This includes understanding and following Good Manufacturing Practices (GMP), Hazard Analysis and Critical Control Points (HACCP) principles, and relevant food safety regulations enforced by government agencies.

Practical Exercise

Activity

1. Create a step-by-step guide for cleaning and sanitizing an ice cream production machine, including the required cleaning materials, techniques, and safety precautions.

Check Your Progress

A. Multiple-Choice Questions (MCQs):

1. What is the primary responsibility of an Ice Cream Processing Technician?
   a) Operating machinery
   b) Marketing ice cream products
   c) Managing customer complaints
   d) Conducting financial audits

2. Why is quality control important in ice cream production?
   a) To increase production speed
   b) To maintain consistent quality standards
   c) To reduce cleaning time
   d) To minimize safety risks

3. What is one of the key duties of an ice cream processing technician regarding ingredients?
   a) Discarding unused ingredients
   b) Using ingredients without measuring
   c) Accurately measuring and adding ingredients
   d) Reusing ingredients from previous batches

B. Fill in the Blanks

1. Ice cream processing technicians are responsible for_____ equipment to prevent contamination.
2. Accurate _____ of ingredients are essential for producing high-quality ice cream.
3. Ice cream processing technicians must adhere to strict to _____ prevent accidents and injuries.

C. True or False:

1. Ice cream processing technicians are responsible for cleaning and sanitizing equipment.
2. Accurate measurement and handling of ingredients are important in ice cream production.

D. Subjective Questions

1. Describe the importance of quality control in ice cream production and how it contributes to the overall success of the manufacturing process.

What have you learned?

After completing this Session, you will be able to:

1. Understand the key responsibilities of an Ice Cream Processing Technician, including operating machinery, quality control, ingredient handling, and cleaning.
2. Recognize the importance of adhering to regulations such as Good Manufacturing Practices (GMP) and Hazard Analysis and Critical Control Points (HACCP) in ensuring food safety and quality.

SESSION-2: RAW MATERIALS USED FOR ICE CREAM PRODUCTION

As we move forward to Session 2 of Unit-3, let us explore the general practices of ice-cream production, the raw materials used, ice-cream formulation strategies and the role of ingredients used.

2.1 Definition and Classification of Ice-cream

According to FSSAI, "Ice Cream" is an icy or frozen dessert prepared from milk or other dairy products that may contain other permissible ingredients such as sugar, stabilizers, emulsifiers, and flavors. It needs to have a minimum milk fat level of 10%.

2.2 Raw materials required for ice cream production

Ice cream production involves two main types of ingredients: dairy and non-dairy. ingredients

- **Dairy Ingredients:** These form the creamy, rich base of traditional ice cream recipes and typically include: Milk, Cream, Skim Milk Powder, Butter fat, Milk Solids etc.
- **Nondairy Ingredients**: These ingredients provide flavor, texture, and stability to ice cream, catering to dietary preferences and expanding flavor options. They include: Sweeteners, Emulsifiers, Stabilizers, Flavoring Agents and other inclusions including Nuts, fruits, candies and chocolate chips etc.

2.2.1 Dairy Ingredients

- **Milk:** Milk serves as the base ingredient in ice cream, providing a creamy texture. Options include whole milk for richness, low-fat milk for a balance between creaminess and lower fat content, and skim milk for a lighter, fat-free option.

- **Fat:** The fat content greatly influences the texture and flavor, with higher fat content resulting in a fuller, creamier taste. Cream and butter are the main sources of fat in ice cream, lending it a rich and creamy texture. These dairy-derived ingredients provide indulgent mouthfeel, enhancing the overall luxuriousness of the frozen dessert.

In India, ice cream is categorized based on fat content and type of ingredients used, following national standards i.e. FSSAI. Variants include those with milk fat or vegetable fat, typically ranging from 10-15% fat content. The classification includes various categories, such as non-fat ice cream (less than 0.5% fat), low-fat ice cream (2.0% fat), reduced-fat ice cream (2.0-10.0%), and standard, premium, and super-premium ice cream (greater than 10% fat).

2.3 Milk solids not fat (MSNF)

Milk solids not fat encompass milk proteins, milk sugar, and minerals, often referred to as serum solids. They provide essential nutrition and contribute to ice cream's body and texture, without adding fragrance. Milk sugar enhances sweetness, while proteins aid in compacting and smoothing ice cream. It's advisable to maximize MSNF content for improved texture, although excessive amounts may cause texture issues. MSNF increases viscosity and resistance to melting, while lactose adds sweetness and minerals contribute a slightly salty taste. The MSNF content varies inversely with fat content, typically ranging from 7.5-8.0% in high-fat ice cream to 14.0% in low-fat variants. Indian regulations mandate a minimum of 10.7% SNF, ensuring a balanced composition. Exceeding optimal MSNF levels may lead to a "sandiness" defect, necessitating careful management based on production turnover.

2.4 Other dairy Ingredients

Other ingredients such as buttermilk, casein, whey protein, and lactose play essential roles in ice cream production, contributing to its body, texture, and sweetness. Buttermilk adds tanginess and richness, enhancing flavor complexity. Casein and whey protein help improve the structure and stability of the ice cream, preventing crystallization and ensuring a smooth consistency. Lactose, a natural sugar found in dairy, contributes sweetness to the ice cream, balancing its flavor profile. Collectively, these ingredients work synergistically to create a well-rounded and satisfying frozen dessert experience.

2.5 Non-Dairy Ingredients

2.5.1 Sugar and Sweeteners

In ice cream production, sugar plays a crucial role by adding sweetness and contributing to a soft texture. It achieves this by reducing the freezing point of the mixture. Typical sugars utilized are sucrose, corn syrup, and glucose.

SWEETENERS: While a sweet ice cream is generally desired by the public, sweeteners should be used in moderation, not only for optimum palatability, but also for handling properties.

Role of sweeteners in Ice cream

- Enhances sweetness and creamy flavor, improving product acceptance.
- Boosts viscosity and total solids (TS), enhancing body and texture.
- Lowers freezing point, requiring lower temperatures for proper hardening.
- Economical source of total solids in the mix, but excessive sweetness can overshadow desired flavors.
- Optimal sugar levels vary: 14-16% for plain ice cream, 17-18% for fruit and chocolate variants.
- High sugar levels may slow down mix whipping process.

Types of Sweetening ingredients used in Ice cream and Frozen desserts

- Sugar (Sucrose) or sugar syrup
- Dextrose
- Invert sugar (in paste or syrup form)
- Corn syrup, Dried corn sugar, Glucose syrup, Dried glucose syrup
- Maple syrup, Maple sugar
- Honey
- Brown sugar Intense sweeteners (viz., Saccharin, Aspartame, Acesulfame-K, Sucralose, Stevioside, etc.)

2.6 Stabilizers

Stabilizers are utilized to prevent the formation of excessively large ice crystals in ice cream, especially during storage. Their impact on food value or flavour is negligible due to their minimal quantities. Some frequently used stabilisers include Locust bean gum (LBG), Guar gum, Sodium alginate, Carrageenan, and Sodium carboxy methyl cellulose (Na – CMC). Some of the stabilisers and emulsifiers image is presented in Fig. 3.1.

2.7 Emulsifiers

These ingredients are utilized primarily to ensure consistent whipping and create a smoother, softer texture in ice cream. Emulsifiers, such as lecithin and mono- and diglycerides, are vital for maintaining the desired texture and preventing the formation of ice crystals.

Fig. 3.1: Examples of Stabilisers and Emulsifiers

2.8 Flavor and Color

Flavorings are essential for enhancing ice cream's taste and appearance, contributing to its overall appeal. Common flavor options include vanilla extract, cocoa powder, fruit purees, chocolate chips, and various other choices. Vanilla and chocolate remain popular choices, but there's a growing interest in experimenting with different flavorings like fruits, nuts, and spices to create unique and delightful ice cream varieties.

2.8.1 The type of flavorings utilized in ice cream and frozen desserts include:

a) Natural flavorings: Non-citrus fruit, citrus fruit, tropical fruit, natural flavors from botanicals, spices, cocoa and chocolate, coffee, natural flavorings from vanilla beans and nuts.

b) Synthetic flavorings: These include aromatic chemicals and imitation flavors.

c) Liqueur flavorings: Alcohol, whiskey and other distilled beverages, fruit brandy distillate and brandy flavor essence and fruit liqueurs. The last category (c) is prevalent in countries abroad.

2.8.2 Colorings

Ice cream should possess an appealing color that corresponds to its flavor profile. While fruit ice cream may require additional coloring due to the subtle

effect of added fruit, chocolate ice cream typically achieves its desired color from cocoa. Synthetic colorants are commonly used, with Annatto color being one of the few vegetable-based options. Permitted colorings for ice cream include erythrosine, Allura red, caramel, and Brown HT including others.

Practical Exercise

Activity

1. Create a unique ice cream flavor by selecting ingredients. Make a small batch at home, taste and evaluate. Adjust the recipe based on feedback and try again for improvement.

Check Your Progress

A. Multiple-Choice Questions (MCQs)

1. What is the minimum milk fat level required for ice cream according to FSSAI?
   a) 5%
   b) 8%
   c) 10%
   d) 15%

2. Which of the following is NOT a dairy ingredient commonly used in ice cream production?
   a) Milk
   b) Cream
   c) Skim Milk Powder
   d) Corn Syrup

3. What role do stabilizers play in ice cream production?
   a) Adding sweetness
   b) Enhancing texture
   c) Improving color
   d) Increasing fat content

4. Which type of flavorings is derived from botanicals, spices, and vanilla beans?
   a) Natural flavorings
   b) Synthetic flavorings
   c) Liqueur flavorings
   d) Artificial flavorings

5. What is the primary purpose of emulsifiers in ice cream production?
   a) Adding color
   b) Enhancing flavor
   c) Preventing the formation of ice crystals
   d) Increasing sweetness

B. Fill in the Blanks:

1. The minimum milk fat level required for ice cream according to FSSAI is _____.
2. In ice cream production, sugar plays a crucial role by adding sweetness and contributing to a soft texture by reducing the_____of the mixture.
3. Some frequently used stabilizers include_____.
4. Ice cream should possess an appealing color that corresponds to its _____.

C. True or False:

1. Ice cream production involves two main types of ingredients: dairy and non-dairy.
2. The fat content in ice cream greatly influences its texture and flavor, with higher fat content resulting in a fuller, creamier taste.
3. Stabilizers are used in ice cream to promote the formation of excessively large ice crystals, especially during storage.
4. Emulsifiers are primarily used in ice cream to ensure consistent whipping and create a smoother, softer texture.
5. Synthetic colorants are commonly used in ice cream, with Annatto color being one of the few vegetable-based options.

D. Subjective Questions

1. How do dairy ingredients contribute to the texture and flavor of ice cream?
2. Explain the role of stabilizers and emulsifiers in ice cream production.

What have you learned?

After completing this Session, you will be able to:

- Identify the main categories of ingredients used in ice cream production, including dairy and non-dairy components.
- Understand the role of each ingredient category in influencing the texture, flavor, and overall quality of ice cream.
- Explain the significance of adhering to regulatory standards and classifications for ice cream production, such as fat content and ingredient types.

SESSION: 3 IDENTIFICATION OF PRODUCTION REQUIREMENT

Before commencing ice cream production, it's crucial to establish a comprehensive schedule to ensure smooth operations and adherence to quality standards. This involves several key steps, including:

1. ***Identification of Production Requirements:*** Assessing production requirements involves determining the quantity and variety of ice cream to be produced. Factors such as market demand, seasonal trends, and inventory levels must be considered to ensure optimal production planning.

2. ***Product-Related Information:*** Understanding the raw materials required for ice cream production, their treatment processes, and the desired quality attributes of the final product are essential considerations. This includes sourcing high-quality dairy ingredients, flavorings, stabilizers, and inclusions to meet consumer preferences and regulatory standards.

3. ***Process-Related Topics:*** Planning the production process involves evaluating plant capacity, selecting compatible components and equipment, ensuring efficient process control, and availability of heating and cooling media. Additionally, scheduling regular cleaning and maintenance of processing equipment is essential to prevent contamination and ensure product safety.

4. ***Cost Management*:** Efficiently managing production expenses while preserving quality by optimizing resource use, reducing waste, and sourcing affordable ingredients and packaging materials.

5. ***Regulatory Compliance*:** Ensuring adherence to legal food production regulations by meeting defined standards, using approved components, and maintaining documentation to demonstrate compliance with food safety guidelines.

By diligently preparing a production schedule that encompasses these factors, ice cream manufacturers can streamline operations, meet consumer demand, and deliver high-quality products that comply with regulatory requirements.

Process/ Product Flowchart for Ice Cream Manufacturing

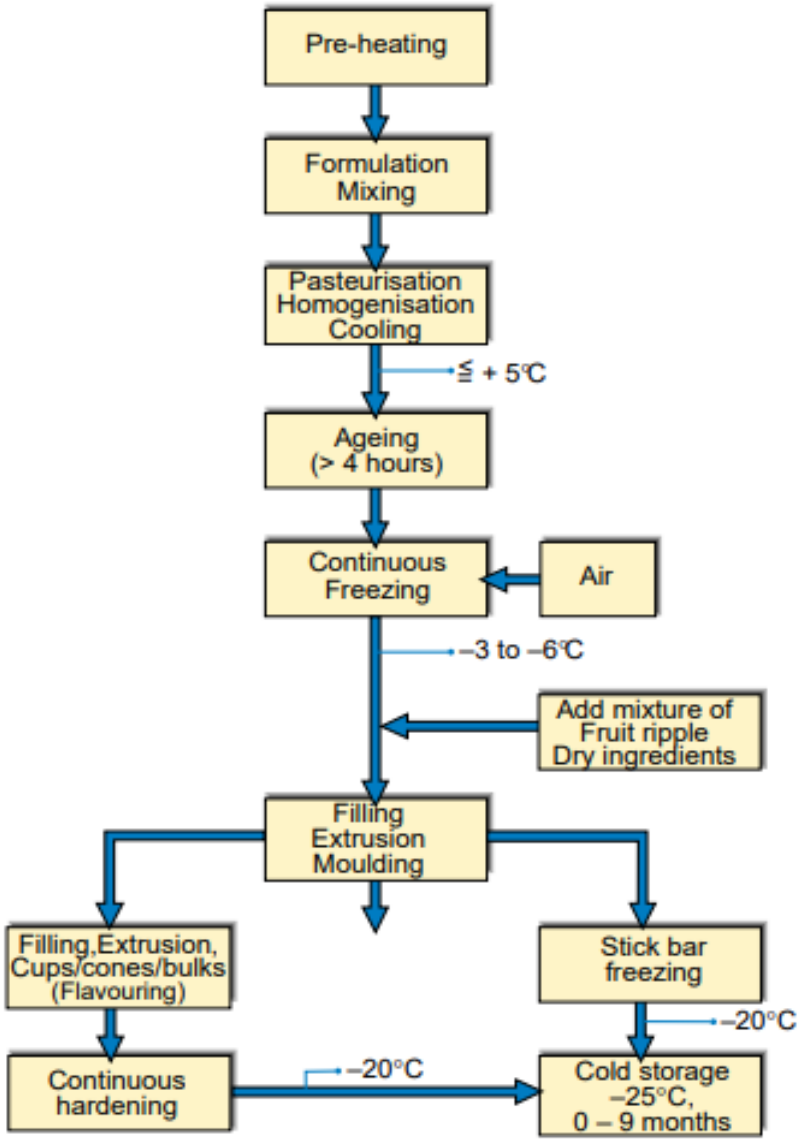


Fig.3.2: Flow diagram for Ice-cream making Process

The process of making ice cream involves a series of operations, as depicted in Figure 3.2 with a typical flow chart.

1. ***Selection of ingredients***

Selecting the right ingredients is crucial for preparing high-quality ice cream with the desired taste and texture. Factors such as the fat content of milk and cream should align with the desired ice cream style. Fresh dairy products are

essential for optimal flavor and texture. The type of sugar affects sweetness and freezing point depression, so it must be balanced for the right sweetness without crystal formation.

Stabilizers and emulsifiers, such as guar gum and lecithin, maintain texture and prevent separation. The quality of flavorings, whether natural or artificial, significantly impacts taste. Natural flavors and high-quality components offer a more authentic experience. Inclusions like chocolate chips, fruit chunks, and nuts add texture and flavor variety, requiring careful consideration of type and quantity.

Overrun, or the air introduced during freezing, influences texture and volume and should be controlled based on the desired outcome. Water content, colorants, and preservatives should be selected and managed carefully. Dietary concerns, allergen management, regulatory compliance, quality control, and supplier relationships all influence ingredient selection.

2. Figuring the mix

In ice cream production, calculations are vital for achieving the desired taste, texture, and consistency. This involves determining the ideal mix composition based on factors like fat content, sweetness level, and flavor profile. Stabilizers and emulsifiers are carefully selected to maintain texture and ensure proper blending of fat and water.

After creating the initial mixture, extensive testing, including sensory evaluation and laboratory analysis, is conducted to make necessary adjustments for flavor and texture. The scaled-up production involves large-scale equipment to blend ingredients accurately.

3. Ice-cream Mix Pasteurization

During pasteurization, the ice cream mixture is heated to a specific temperature, typically around 71.7°C (161°F), and held at this temperature for 15 to 25 seconds. This heating process is crucial for food safety as it effectively eliminates harmful bacteria and deactivates enzymes that could affect the quality of the ice cream. Following pasteurization, the mixture undergoes rapid cooling to bring the temperature down quickly while maintaining the desired consistency.

4. Ice-cream Mix Homogenization

Homogenization of the mixture involves passing it through high-pressure valves, effectively breaking down fat globules into smaller particles. This process ensures uniform distribution of fat throughout the ice cream, resulting in a smoother texture and minimizing fat separation after freezing.

5. ***Cooling and ageing the mix***

he mixture is then transported to a holding tank and left to cooled and mature simultaneously. This aging stage, which normally lasts 4 to 12 hours, takes place at refrigerator temperatures. The flavors merge and develop during this time, resulting in a more well-rounded and pleasant taste. Furthermore, aging improves the texture and general quality of the ice cream.

6. ***Freezing the mix***

The mixture is placed to the churn or freezer when it has aged sufficiently. This stage includes adding air to the mixture to obtain the desired overflow. The amount of overrun has an effect on the final texture. During this phase, flavorings such as vanilla extract or cocoa powder are added, as well as any additions such as cookie bits or fruit pieces.

During the freezing process, the mixture is rapidly cooled to around -29°C or lower. This rapid cooling allows ice crystals to develop, which gives ice cream its distinctive texture. The liquid is constantly stirred while it freezes to retain a smooth and creamy consistency. This agitation helps to prevent the production of huge ice crystals, resulting in a pleasing mouthfeel.

7. ***Packaging of ice cream***

Once the ice cream has attained the desired consistency, it is ready for packaging. The finished product is packed into various containers, such as cartons, tubs, or waffle cones for ice cream cones. The packaging is well engineered to protect food safety, prevent freezer burn, and retain the ice cream's flavor.

8. ***Storage of ice cream***

Packaged ice cream is kept in refrigerators at controlled temperatures ranging from -29°C to -40°C. Maintaining these low temperatures is crucial to preventing thawing and refreezing, which can have a negative influence on texture and taste. Proper storage conditions are critical for maintaining product quality. Following storage, ice cream is distributed to retailers such as grocery stores, ice cream shops, and restaurants.

3.1 Production requirement

3.1.1 Types of Ice Cream Freezers

A refrigeration system and air incorporation system are necessary for ice cream making. Efficient freezing is crucial for optimal product quality, as rapidly formed ice crystals tend to be smaller compared to those formed at a slower rate. The choice of freezer is crucial in the freezing process of ice cream mix and has a direct impact on the overall quality of the final product. There are two different types of ice cream freezers: the batch type and the continuous flow type. Batch freezers are commonly utilized in small-scale ice cream factories.

- **Batch freezers**

  In modern times, the utilization of batch freezers is limited to moderate production plants and as a complement to continuous freezers in the production of frozen desserts that are typically not made in large quantities, such as ices, sherbets and specialty flavoured ice creams.

  Batch freezers require individual measurements, coloring, and flavoring for each batch. They come in different types, such as brine, salt and ice, and direct-expansion (Fig 3.3). The salt or brine helps to lower the melting point of the ice. The direct-expansion type can use ammonia or Freon as a refrigerant and can be vertical, horizontal, or single, triple, or quadruple-type freezers. Modern batch freezers typically feature a horizontal cylinder design, with the freezing cylinder cooled using halo carbon refrigerants like R-22 or R-502.

  Fig. 3.3: Batch Freezer

  Batch freezers come in different sizes depending on the manufacturers' designs. The most common sizes are around 18-20 litres and 36-40 litres, which can produce 100% overrun ice cream. This particular type of batch freezer is no longer commonly used. In most cases, ice cream produced using batch freezers tends to have larger ice crystals and larger air cells compared to ice cream made using continuous freezers. Nevertheless, this device is freezing traditional Indian dairy products such as *Kulfi*.

Continuous Ice Cream Freezer

Fig.3.4: Continuous Ice-cream Freezer

The Continuous Ice Cream Freezer is a highly efficient machine designed for producing ice cream in a continuous process (Fig 3.4). It is engineered with precision and advanced technology to ensure consistent and high-quality results. The process involves continuously introducing a controlled quantity of ice cream mix and air into one end of the freezing chamber. When the mixture goes through the freezing chamber, it gets stirred and partially frozen before being released as a continuous stream with a consistency similar to what you would get from a batch freezer. The partially frozen stream is packaged and then placed in the hardening room to finish the freezing process. These days, the machines used for this purpose are referred to as "Continuous" or "Instant freezers". Freezing under pressure is a significant distinction in continuous processing.

3.1.2 Operating the continuous freezer

The operator's main task is to control the airflow and refrigerant temperature in order to achieve the desired overrun and freeze the mixture effectively. When the machine is on, the refrigerant is only cut off from the freezing chamber when the machine is being turned off. In most cases, the refrigerant is turned off a few minutes prior to the final mixture entering the machine. This allows the rinse water (37.8°C), which comes after the mixture, to flow through the freezing chamber without freezing. The refrigerant temperature in the freezing chamber is carefully regulated to ensure that the product has the desired consistency upon exiting the machine.

Proper operation and management of the continuous freezer is essential for optimal performance. Here are the main requirements for maintaining the proper operation of the freezer:

- It is important to maintain the cleanliness of the ammonia jacket by ensuring that it is free from oil, water, and nonvolatile ammonia fractions.
- It is important to maintain the sharpness and alignment of the scraper blades.
- Ensure that the mix pumps are maintained in optimal working condition.
- Ensure that there is always an ample amount of ammonia available at the freezer.
- Ensure a consistent suction pressure is maintained at all times to guarantee the freezer operates at the optimal temperature for producing high-quality ice cream.

3.2 Important precautions to consider

1. Ensure that all mix line connections are securely tightened to prevent any leakage of the mix and to prevent any air from entering.
2. Regularly monitor controls to ensure they are functioning correctly.
3. It is important to regularly drain the oil trap to ensure that all oil, water, and other substances have been completely removed from the system.
4. It is important to avoid bending scarper blades. Always handle the freezer dasher with care. Exercise caution when extracting it from the freezing cylinder.
5. It is recommended to let the freezing chamber reach room temperature before rinsing it with hot or warm water.
6. 6.Verify that the pump motor has adequate lubrication and that the pulley belts are securely tightened.
7. It is crucial to exercise caution when handling the dasher during assembly or disassembly of the freezer to avoid any potential harm.

Essential elements of ice cream production, including processing time, production order, and batch size, involve careful consideration of human resources, raw materials, and machinery/equipment:

i. Human Resources

1. **Skilled Workers:** Trained personnel are essential for operating machinery, monitoring production processes, and ensuring quality control.
2. **Production Staff:** Teams are needed for ingredient handling, mixing, freezing, and packaging stages.
3. **Supervisory Roles:** Managers oversee operations, ensuring efficiency, safety, and adherence to production schedules.

ii. Raw Materials

1. **Dairy Ingredients:** Milk, cream, and other dairy products form the base of ice cream, with fat content and freshness being crucial factors.
2. **Sweeteners:** Various sugars, syrups, or alternative sweeteners impact sweetness and freezing point depression.
3. **Stabilizers and Emulsifiers:** Ingredients like guar gum and lecithin maintain texture and prevent ingredient separation.
4. **Flavorings and Inclusions:** Natural or artificial flavorings, along with inclusions like chocolate chips or fruit chunks, add taste and texture variety.

iii. Machinery/Equipment

1. **Mixing and Blending Equipment:** Mixers and blenders combine ingredients uniformly, ensuring consistent flavor and texture.

2. **Pasteurization and Homogenization:** Machinery processes raw milk and cream to eliminate harmful bacteria and ensure product safety.
3. **Freezing Equipment:** Continuous freezers or batch freezers freeze the ice cream mixture, incorporating air to achieve desired texture.
4. **Packaging Machinery:** Filling and sealing machines package ice cream into containers, ensuring freshness and shelf stability.

By optimizing these elements, ice cream manufacturers can efficiently produce high-quality products that meet consumer demand while maintaining consistency and safety standards.

Practical Exercise

Activity

1. Develop a basic ice cream recipe following the guidelines provided.
2. Experiment with at least two different flavor combinations and document your process and results.

Check Your Progress

A. Multiple-Choice Questions (MCQs):

1. Which of the following is a primary ingredient in ice cream production?
   a) Eggs
   b) Cream
   c) Flour
   d) Rice

2. What is the minimum milk fat level required for ice cream according to FSSAI?
   a) 5%
   b) 8%
   c) 10%
   d) 15%

3. What do stabilizers do in ice cream production?
   a) Add flavor
   b) Prevent the formation of large ice crystals
   c) Increase fat content
   d) Enhance color

4. Which type of freezer is commonly used for large-scale ice cream production?
   a) Batch freezer
   b) Continuous freezer
   c) Blast freezer
   d) Chest freezer

B. Fill in the Blanks

1. The fat content of ice cream influences its_____.
2. The process of heating the ice cream mixture to a specific temperature to eliminate harmful bacteria is called_____.
3. _____and_____are examples of stabilizers used in ice cream production.
4. Ice cream mix is typically cooled and aged at temperatures ranging from _____.
5. Continuous and batch freezers are used in the_____process of ice cream production.

C. True or False

1. Ice cream requires a minimum milk fat level of 5%.
2. Emulsifiers are used in ice cream production to enhance flavor.
3. Sugar plays a crucial role in ice cream production by raising the freezing point of the mixture.
4. Pasteurization is a process used to eliminate harmful bacteria in the ice cream mixture. (True/False)
5. Continuous freezers are commonly used in small-scale ice cream factories. (True/False)

D. Subjective Questions

1. Describe the importance of quality control measures in ice cream production
2. Discuss the differences between batch freezers and continuous freezers in ice cream manufacturing, including their advantages and disadvantages.

What have you learned?

After completing this Session, you will be able to:

1. Identify the key raw materials used in ice cream production and their roles.
2. Understand the process flow involved in ice cream manufacturing.
3. Recognize the importance of production planning, equipment selection, and quality control in ensuring efficient and high-quality ice cream production.

Module 4 Basics of Ice Cream Production

SESSION 1: PRODUCTION OF ICE CREAM

This session on production of ice cream includes types of ice cream and their composition and the process of producing ice cream at a commercial scale. The objective of this session is to sensitize the students about different ice cream variants along with their composition and to give an overview of the process flow for manufacturing ice cream. This will enable the students to know the terminologies used for different ice cream and the steps involved in the process.

1.1 Ice Cream

Ice cream belongs to a broad category of frozen foods and consumed as a dessert. The generic term 'ice cream' is used for the products prepared by using dairy ingredients as a source of fat and solid-not-fat and other non-dairy ingredients such as stabilizers and emulsifiers added for various desirable functions in the product. These ingredients are mixed to prepare ice cream mix which is then frozen under dynamic conditions to prepare the product called as ice cream.

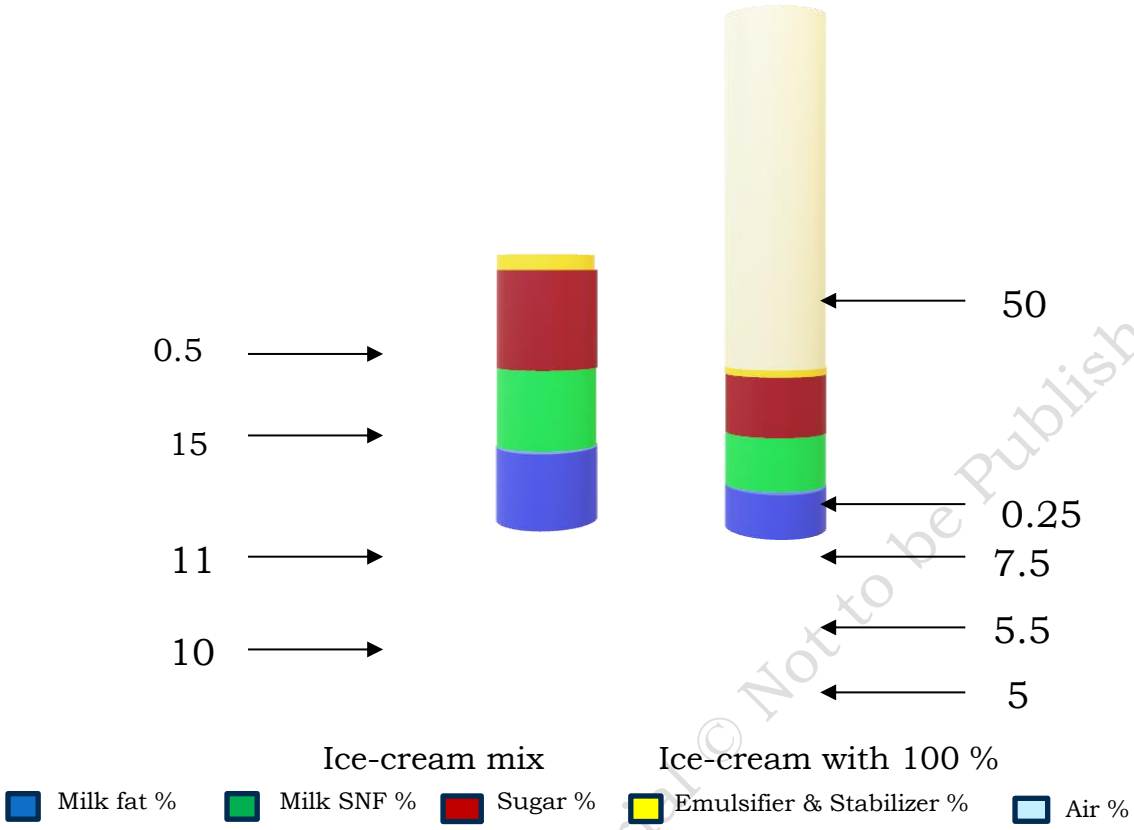
Frozen dessert is another term used in India for products similar to ice cream. Both ice cream and frozen desserts combinedly include products such as ice cream, frozen desserts, gelato, milk ices, frozen yoghurt, water ices, sorbet and many more. These legal terms and definitions vary from country to country. In India, there are two separate categories viz. 'ice cream' and 'frozen desserts' which are discussed in the subsequent sections in this session.

1.2 Types of ice cream

Based on the composition of ice cream, it may be categorized as premium, standard or economy. Premium ice cream is made from the best quality ingredients with relatively higher amount of milk fat and lesser air content. This makes the product relatively expensive. On the contrary, economy ice cream is made from cheaper ingredients and contains more air.

1.3 Composition of ice cream

Ice cream is a product which is rich in milk fat and solid not fat. Other than the milk constituents, it contains sweetener mostly in the form of sucrose. It also contains stabilizers and emulsifiers which are required for manufacturing good quality ice cream. In addition, ice cream may contain various flavours and other ingredients such as fruits, nuts, chocolate, cake etc.



*for ice cream mix, units are in terms of w/w and for ice cream, units are in terms of w/v

Fig.4.1: Illustration of Volume expansion of ice-cream from ice-cream mix

FSSAI standards for Ice cream are as follow:

Table 4.1: FSSAI standards for Ice cream

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

1.4 Process of producing ice cream

The process of producing ice cream can be divided into two major steps for ease of understanding (Fig.4.2). These are i) preparation of ice cream mix and ii) freezing of ice cream mix to ice cream. Preparation of ice cream mix involves selection of ingredients, formulation of the mix, blending of the ingredients, pasteurizing and homogenizing the blend followed by cooling and ageing.

Properly aged mix is then ready for the next step i.e. freezing the mix. Ice cream mixes are frozen in a specially designed ice cream freezer where the mixes are frozen under dynamic conditions. Dynamic conditions mean the mix is frozen with continuous agitation unlike that of a static freezing. Freezing of water to ice in a domestic refrigerator is a typical example of static freezing.

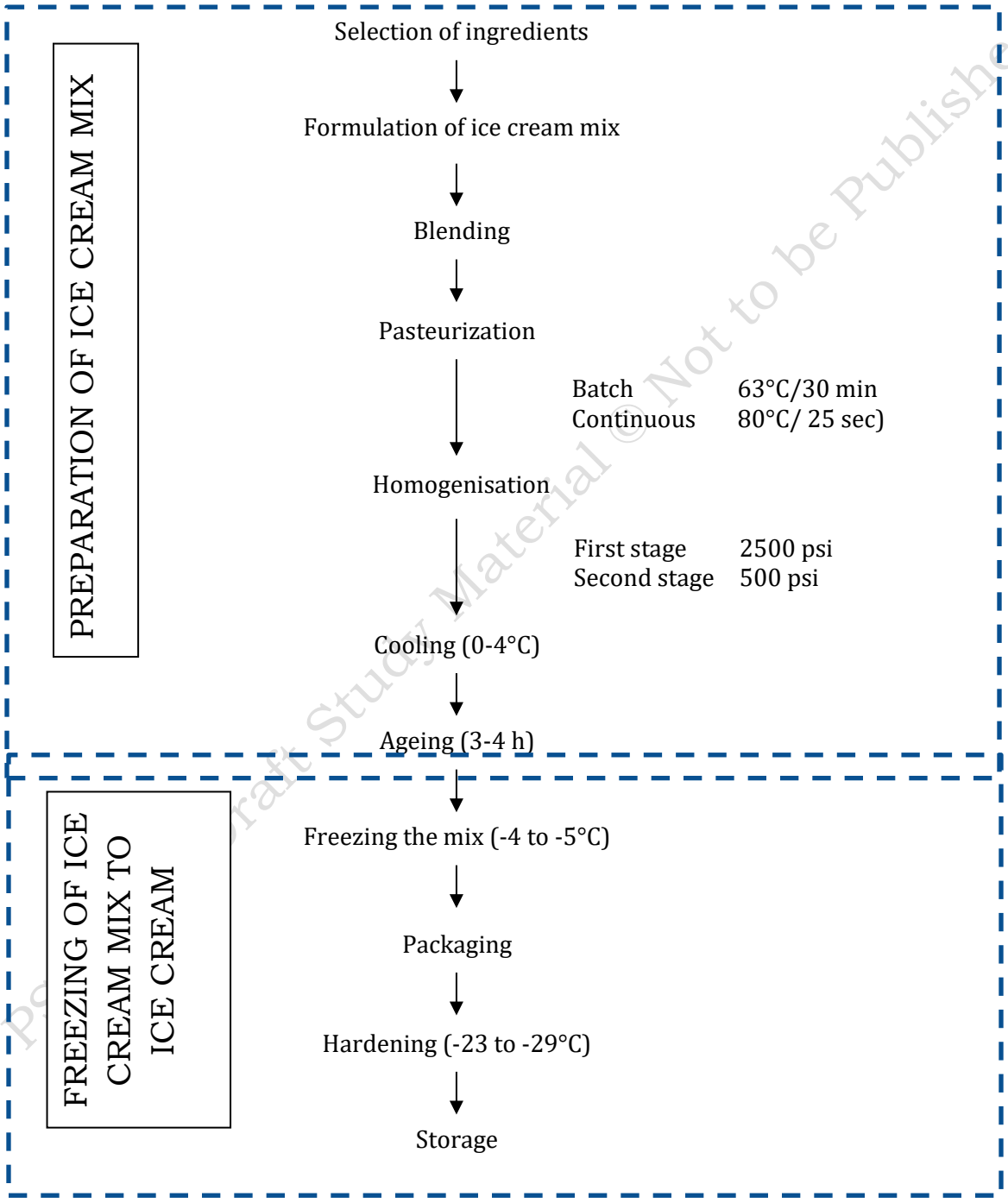


Fig: 4.2: Flow diagram for ice cream processing

Practical Exercise

Activity

1. Prepare ice cream recipes adhering to FSSAI standards and calculate ingredient quantities.

Check Your Progress

A. Multiple-Choice Questions (MCQs):

1. What is the primary source of fat in ice cream?
   a) Butter
   b) Vegetable oil
   c) Cream
   d) Skim milk

2. What is the purpose of stabilizers in ice cream production?
   a) To add flavor
   b) To prevent the formation of ice crystals
   c) To increase the fat content
   d) To improve color

3. According to FSSAI standards, what is the minimum milk fat content required for low-fat ice cream?
   a) Not less than 10.0 percent
   b) More than 2.5 percent but less than 10.0 percent
   c) Not more than 2.5 percent
   d) Not less than 30.0 percent

4. What is the main function of pasteurization in ice cream production?
   a) To add flavor
   b) To increase fat content
   c) To eliminate harmful bacteria
   d) To improve texture

5. What is the difference between premium and economy ice cream?
   a) Premium has more air content
   b) Economy is made with higher-quality ingredients
   c) Premium has lower milk fat content
   d) Economy is made with cheaper ingredients

B. Fill in the Blanks

1. The generic term_____ is used for products prepared using dairy ingredients as a source of fat and solid-not-fat, and other non-dairy ingredients such as stabilizers and emulsifiers.
2. Ice cream may be categorized as_____or_____based on composition.
3. Ice cream contains sweeteners, mostly_____.
4. According to FSSAI standards, low-fat ice cream contains_____milk fat.

C. True or False

1. Ice cream and frozen desserts include gelato, milk ices, and sorbet.
2. Premium ice cream contains less air and is made from cheaper ingredients.
3. Preparation of ice cream mix involves pasteurizing and homogenizing the blend.
4. Dynamic freezing involves continuous agitation, unlike static freezing.
5. Low-fat ice cream contains more than 10.0 percent milk fat according to FSSAI standards.

D. Subjective Questions

1. Explain the differences between premium, standard, and economy ice creams based on their composition and production methods.

What have you learned?

After completing this Session, you will be able to:

1. Understand the fundamentals of ice cream production, including its types, composition, and process flow.

SESSION 2: UNIT OPERATIONS INVOLVED IN ICE CREAM PRODUCTION

2.1 Unit operation of ice cream production

This session deals with the basic unit operations involved in manufacturing ice cream. Ice cream production begins with selection of the ingredients, followed by formulation of ice cream mix, blending all the ingredients in a proper manner, homogenizing the mix, pasteurizing followed by cooling and ageing the mix. Once the properly aged mix is prepared, it is subjected to freezing in specially made ice cream freezers (discussed in unit 02.). All these unit operations are discussed in detail in the following sections.

2.2 Selection of ingredients

The selection of high-quality ingredients is essential for producing ice cream of good quality. The ingredients required for the production of ice cream can be categorised into two distinct groups: dairy ingredients and non-dairy ingredients as you studied in detailed in Unit 3. Dairy ingredients serve as the primary sources of fat and milk solids not fat, which are essential for providing ice cream with its distinctive richness and flavour. In addition, these ingredients play a role in enhancing the smoothness of the texture and improving melting resistance. Several sources of milk fat and SNF are skim milk powder, sweetened condensed milk, milk, cream, and unsalted butter. Sweeteners, stabilisers, emulsifiers, eggs and egg products, flavours, and colours are examples of non-dairy ingredients. Each of these ingredients gives the ice cream mix a variety of functional attributes.

2.3 Formulation of ice cream mix

The composition of the ice cream mix is determined, and the amount of various dairy and non-dairy ingredients is calculated based on the desired composition, in order to produce high-quality ice cream and to comply with regulatory requirements. There are various methods followed for calculating amount of ingredients viz.

- Algebraic method
- Pearson square method
- Serum point method
- Computer developed formulations
- Formula tables/graphics method

Among these methods, algebraic method is the most common and therefore it is discussed in the following section in detail.

2.4 Formulation of simple Ice cream mix using algebraic method and verification with proof sheet

Various dairy and non-dairy ingredients are used for ice cream manufacturing. Most of the dairy products such as whole milk, cream, skim milk powder etc. are used as a source of both milk fat and milk SNF. Such ingredients can be calculated by making linear algebraic equation of two or three variables. Non-dairy ingredients are usually used as source of only one constituent like sugar, stabilizer and emulsifier etc. These ingredients can be calculated on direct percentage basis.

2.5 Algebraic method for ice cream mix formulation

1. First, desired composition i.e. fat, SNF, sugar, stabilizer, emulsifier etc. of ice cream mix is finalized.
2. Based on the availability, various dairy and non-dairy ingredients can be selected for making ice cream mix.
3. Dairy ingredients are analyzed for fat and SNF content.
4. Calculate the amount of ingredients supplying only one constituent of ice cream mix such as sugar and stabilizer.
5. Linear equations for made for fat, MSNF and total quantity.
6. These equations are solved to calculate the quantity of ingredients required.

Illustration 1: Prepare 100 kg ice cream mix containing 10% fat, 11% MSNF, 14.5% sugar, 0.3% Stabilizer. Given ingredients are whole milk with 6.8% fat and 9.6% SNF, cream with 40% fat and 5.4% SNF, Skim milk powder (SMP) with 0.5% fat and 97%SNF, sugar and stabilizer.

Solution:

Assume the quantity of whole milk is x, cream is y, and SMP is z

Quantity of mix to be prepared = 100 kg

Quantity of sugar = 14.5% of 100 Kg = 14.5 Kg

Quantity of stabilizer = 0.3% of 100 Kg = 0.3 Kg

Equations:

1. Fat equation:

Qty. of fat in whole milk + qty. of fat in cream + qty. of fat in SMP = qty. of fat in ice cream mix

$6.8x/100 + 40y/100 + 0.5z/100 = 10/100 \times 100$

Or $6.8x + 40y + 0.5z = 1000$ .....eq (1)

2. SNF equation

Qty. of SNF in whole milk + qty. of SNF in cream + qty. of SNF in SMP = qty. of SNF in ice cream mix

$9.6x/100 + 5.4y/100 + 97z/100 = 11/100 \times 100$

Or $9.6x + 5.4y + 97z = 1100$ .....eq. (2)

3. Total quantity equation

Qty. of (whole milk + cream + SMP + sugar + stabilizer) = qty. of ice cream mix

$x + y + z + 14.5 + 0.3 = 100$

or $x + y + z = 85.2$ .....eq. (3)

By solving eq 1,2 and 3, we get
x (whole milk) = 67.93 kg
y (cream) = 13. 40 kg and
z (SMP) = 3.87 kg

Proof Sheet:

Ingredient	Quantity (kg)	Fat %	SNF %	Fat (kg)	SNF (kg)
Whole milk	67.93	6.8	9.6	4.614	6.521
Cream	13. 40	40	5.4	5.360	0.724
SMP	3.87	0.5	97	0.019	3.754
Sugar	14.5	--	--	--	--
Stabilizer	0.3	--	--	--	--
TOTAL MIX	100.00	10	11	9.998	10.999

Illustration 2: Prepare 1000 kg ice cream mix testing 11% fat, 11.5% MSNF, 14.5% sugar, 1% stabilizer-emulsifier blend. Given ingredients are as follows:

	Fat (%)	MSNF (%)
Milk	3.8	8.5
Butter	80	1.8
SMP	1	95
Sugar	--	--
Stabilizer-emulsifier blend	--	--

Assume the quantity of milk is x, butter is y, and SMP is z
Quantity of mix to be prepared = 1000 kg
Quantity of sugar = 14.5% of 1000 Kg = 145 Kg
Quantity of stabilizer = 1.0% of 1000 Kg = 10 Kg

Equations:

1. **Fat equation:**
   Qty. of fat in milk + qty. of fat in butter + qty. of fat in SMP = qty. of fat in ice cream mix
   $3.8x/100 + 80/100 + 1z/100 = 11/100$ x1000
   Or $3.8x + 80y + z = 11000$ .....eq (1)

2. **SNF equation**
   Qty. of SNF in whole milk + qty. of SNF in cream + qty. of SNF in SMP = qty. of SNF in ice cream mix
   $8.5x/100 + 1.8y/100 + 95z/100 = 11.5/100$ x1000
   Or $9.6x + 5.4y + 97z = 11500$ .....eq (2)

3. Total quantity equation

Qty. of (whole milk + cream + SMP + sugar + stabilizer) = qty. of ice cream mix

x + y + z + 145 + 10 = 1000

or x + y + z = 845 .....eq (3)

By solving eq 1,2 and 3, we get

x (milk) = 682.655 kg

y (butter) = 104.349 kg and

z (SMP) = 57.996 kg

Proof Sheet:

Ingredient	Quantity (kg)	Fat %	SNF %	Fat (kg)	SNF (kg)
Milk	682.655	3.8	8.5	25.941	58.026
Butter	104.349	80.0	1.8	83.479	1.878
SMP	057.996	1.0	95	0.580	55.096
Sugar	145.000	--	--	--	--
Stabilizer	10.000	--	--	--	--
TOTAL MIX	100.00	11	11.5	110.000	115.000

2.6 Blending

The blending process involves combining all the ingredients in a vat that is equipped with agitators and has the capability for heating. The initial step involves placing all the liquid ingredients into the vat, followed by starting of agitation along with heating. The dry ingredients, such as skim milk powder, stabiliser, and sugar, should be introduced into the vat before 50°C is reached. The temperature at which dry ingredients are incorporated into a mixture is dependent upon the specific type of ingredients being used, with particular consideration given to any stabilisers present.

2.7 Pasteurization

The process of pasteurisation is employed to eliminate any pathogenic bacteria present in the mixture, thereby ensuring that the end product is safe for human consumption. In addition to this crucial role, pasteurisation serves the purpose of diminishing the presence of spoilage organisms, such as psychrotrophs, and facilitating hydration of certain components, like proteins and stabilisers. Mix pasteurisation is accomplished using both batch (69°C/30 min) and continuous (80°C/25 sec or 135-149°C for few sec) procedures.

Advantages of pasteurization of ice cream mix are:

- It effectively eliminates all pathogenic bacteria from the mix.
- It facilitates the mixing of various ingredients of the mix
- It enhances flavor.
- It enhances the preservation of quality.
- It results in a more consistent final product.

2.8 Homogenization

Homogenization is a critical process in cream production that facilitates the creation of a stable emulsion of fat. The preferred method for homogenising ice cream mix is typically two-stage homogenization. The reduction of fat clumping or clustering results in a thinner mix that can be whipped more rapidly. The melt-down properties of ice cream are also enhanced. In addition to its primary function of reducing fat globule size and forming an emulsion, homogenization offers several secondary benefits. These include enhancing the smoothness of ice cream, improving its air stability, and increasing its resistance to melting. Mix homogenization should be done at temperature same as used in pasteurization. The higher temperature enhances the effectiveness of fat globule dispersion under any given pressure, while also mitigating fat aggregation and tendency for dense, viscous mixes. Under most conditions, a pressure of 2000 - 2500 psi on the first stage and 500 - 1000 psi on the second stage should be adequate if a two-stage homogenizer is utilised.

2.9 Cooling the mix

The mixture should be rapidly cooled to a temperature range of 0-5°C immediately after the homogenization process and maintained at this temperature until used. Slow cooling rate results in increase in viscosity and results in ice cream that exhibits a less smooth melting behaviour. In addition, lowering the temperature to that extent inhibits bacterial growth.

2.10 Ageing

The mix is then subjected to an ageing process, which typically lasts for four hours and often extends overnight. Initially, the emulsifiers undergo adsorption onto the surface of the fat droplets, thereby displacing a portion of the milk protein as depicted in Fig.4.3. Next, the fat held within the droplets initiates the process of crystallisation. The absence of these two processes poses challenges in effectively integrating and stabilizing air bubbles during the freezing process in the freezer. The nature of the mix determines the ageing duration and, consequently, the degree of fat crystallisation and emulsifier adsorption. For most types of mixtures, overnight ageing is sufficient.

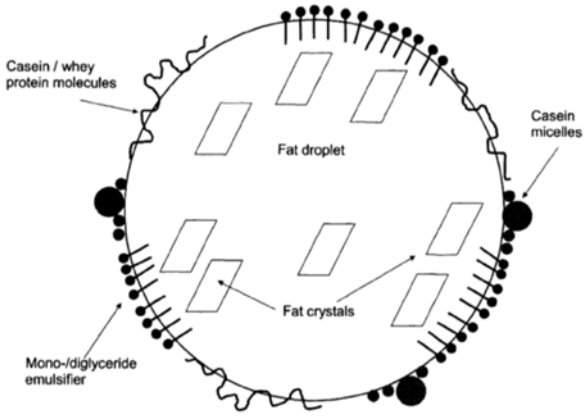


Fig. 4.3 Adsorption of milk proteins and emulsifiers at the surface of the fat droplet and crystallization of the fat

2.11 Freezing and Hardening

The ice cream mixture is frozen in ice cream freezers after it has been cooled and aged.

These freezers can be of batch type or continuous. The ice cream freezer employs a process that involves the simultaneous aeration, freezing, and beating of the mix to produce ice crystals, air bubbles, and a matrix as can be seen in Fig 4.4. The freezer is a scraped-surface, tubular heat exchanger that is equipped with a jacket, which is utilised for the circulation of boiling refrigerants like ammonia or Freon. Mix is circulated through the freezer, and ice cream is taken out within a time frame of 30 seconds (or 10 to 15 minutes when utilising batch freezers), resulting in approximately 50% of its water being frozen. The freezer is equipped with rotating blades within the barrel, which effectively scrape ice from its surface. Also, it is equipped with dashers that aid in whipping the mix and incorporating air. Air is additionally introduced to achieve the desired overrun in the partially frozen mixture during the freezing procedure. This achieved by introducing compressed air into the freezer.

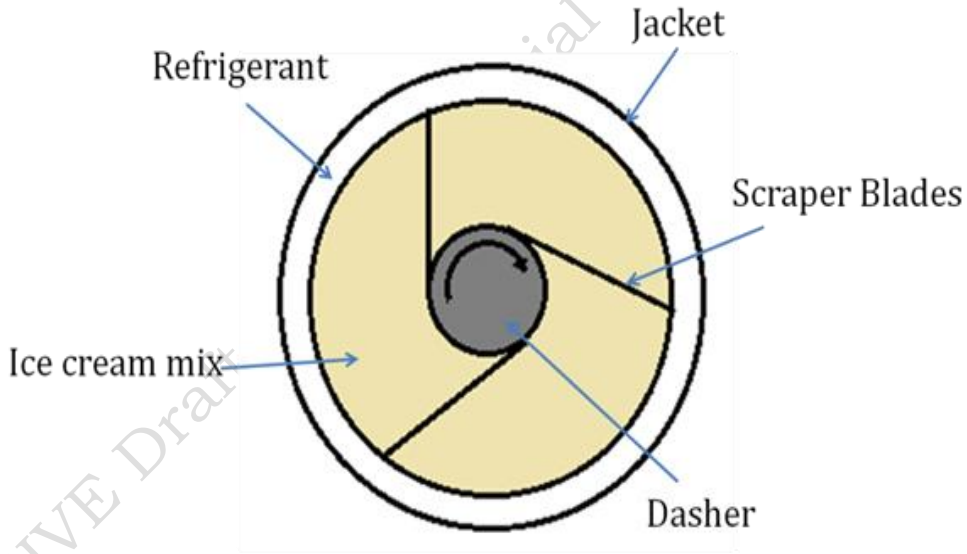


Fig. 4.4: Cross section of an ice cream freezer

(Source: Vivek, 2001)

During the extraction of ice cream from the freezers, various particulate matter such as fruits, nuts, candy, cookies, and other ingredients are introduced into the partially frozen slurry. This slurry possesses a consistency that closely resembles that of soft-serve ice cream. The primary distinction between hard frozen ice cream and soft-serve lies in the method of serving. Soft-serve ice cream is dispensed directly into cones during this stage, while hard frozen ice cream is packaged for further hardening.

2.12 Hardening

When ice cream is removed from the freezer, it possesses a consistency that allows it to be easily placed into containers such as cups or bulk packages. Following the process of filling ice cream into containers, it is important to rapidly decrease the temperature of the product. This phenomenon is hardening. The process of hardening ice cream is crucial in order to achieve the necessary stabilization of its microstructure subsequent to freezing and the inclusion of air.

The process of hardening ice cream involves the use of a hardening tunnel, which serves as an enclosed chamber where the ice cream is transported via a conveyor belt from the freezer. Within this system, a stream of cold air (typically - 30 °C to - 45 °C) is directed onto the ice cream. Heat is removed from the ice cream at a faster rate with lower air temperature and high air flow. Cold stores, commonly maintained at temperatures around -25 °C, do not provide optimal conditions for the hardening process because of their insufficient low temperatures and the presence of stagnant air. Consequently, these factors hinder the rapid cooling required to minimize recrystallization in ice cream. The hardened ice cream is subsequently stored within a temperature range of -23°C to -18°C in order to maintain its structural stability.

2.13 Overrun

"Overrun" in ice cream refers to the amount of air that is incorporated into the ice cream during the freezing process. In other words, overrun is the percent increase in volume of ice cream than the amount (volume) of ice cream mix used for preparing that ice cream. It is to be noted here that the difference is expressed in terms of volume. If the difference is expressed in terms of weight, it should be of the same volume of ice cream mix and resultant ice cream. Formula for calculating overrun in ice cream (both on the basis of weight and volume) are given as below:

1) In terms of volume:

$$\%Overrun = \frac{(\text{Volume of ice cream after freezing (V2)} - \text{Volume of same weight of ice cream mix before freezing (V1)})}{\text{Volume of same weight of ice cream mix before freezing (V1)}} * 100$$

2) In terms of weight:

$$\%Overrun = \frac{(\text{Weight of ice cream mix before freezing of volume V (W2)} - \text{Weight of ice cream after freezing of volume V (W1)})}{\text{Weight of ice cream after freezing of volume V (W1)}} * 100$$

The higher the overrun, the lighter and fluffier the ice cream will be. However, too much overrun can result in an airy, less creamy texture. It's important for ice cream manufacturers to control the overrun to produce a high-quality product.

As mentioned in table 4.1, as per FSSAI, the minimum weight of 1 litre ice cream should be 525 g. This actually prevents manufacturers to incorporate too much air in the product for financial gains.

2.14 Packaging and Storage

The ice cream needs to be kept between -18 and -23°C in a deep freezer. Melting of ice cream should be prohibited due to two primary reasons. Firstly, allowing ice cream to melt facilitates the growth of bacteria, which can lead to spoilage of the product. Secondly, when ice cream melts, the air within it escapes, resulting in a loss of its desired texture and transforming it into a solid block of ice upon refreezing. When the molten ice cream undergoes the process of re-freezing, it results in the formation of ice crystals that are significantly larger compared to the crystals formed during the freezing process in, resulting in gritty taste.

Practical Exercise

Activity

1. Demonstrate ingredient selection based on functional properties for ice cream formulation.
2. Conduct sensory evaluation to assess the quality of different ice cream products.
3. Calculate overrun in ice cream samples and discuss its implications.

Check Your Progress

A. Multiple-Choice Questions (MCQs):

1. What is the primary purpose of pasteurization in ice cream production?
   a) Enhancing flavour
   b) Ensuring food safety
   c) Increasing overrun
   d) Improving texture

2. What is the function of stabilizers and emulsifiers in ice cream?
   a) Enhancing flavour
   b) Increasing shelf life
   c) Improving texture
   d) Providing color

3. Which method is commonly used for calculating ingredient quantities in ice cream formulation?
   a) Pearson square method
   b) Fermi estimation
   c) Trial and error method
   d) Random selection

4. What is the role of homogenization in ice cream production?
   a) Creating a stable emulsion of fat
   b) Increasing overrun
   c) Adding flavor
   d) Reducing freezing time

5. What is the purpose of hardening ice cream after freezing?
   a) Increasing overrun
   b) Enhancing flavor
   c) Stabilizing microstructure
   d) Improving texture

B. Fill in the Blanks

1. _____ is employed to eliminate any pathogenic bacteria present in the ice cream mixture, ensuring that the end product is safe for human consumption.
2. In ice cream formulation, the composition of the ice cream mix is determined, and the amount of various dairy and non-dairy ingredients is calculated based on the desired _____.
3. Ice cream mix is frozen in ice cream freezers after it has been cooled and aged. These freezers can be of batch type or _____.
4. The process of hardening ice cream involves directing cold air onto the ice cream to rapidly _____ the temperature of the product.
5. " Overrun in ice cream refers to the percent increase in volume of ice cream compared to the amount of ice cream mix used, expressed in terms of _____.

C. True or False

1. Premium ice cream typically contains a higher amount of milk fat and lower air content compared to economy ice cream.
2. The process of pasteurization in ice cream production is primarily aimed at enhancing the flavor of the final product.
3. The primary function of homogenization in ice cream production is to increase the resistance of ice cream to melting.

4. Hardening of ice cream involves rapidly decreasing the temperature of the product to maintain its structural stability.
5. Overrun in ice cream refers to the increase in volume of ice cream compared to the volume of the same weight of ice cream mix before freezing.

D. Subjective Questions

1. Describe the process of formulating an ice cream mix using the algebraic method. What are the key considerations and steps involved in this formulation process?
2. Explain the importance of homogenization in ice cream production. How does homogenization impact the texture, stability, and overall quality of the ice cream?
3. Describe the freezing and hardening process in ice cream production. What are the key steps involved, and how do these processes ensure the desired texture, consistency, and shelf-life of the ice cream?
4. Prepare 500 kg of ice cream mix with 12% fat, 10.5% MSNF, 14% sugar, and 0.4% stabilizer-emulsifier blend.

Given:

Whole milk: 3.5% fat, 8.7% MSNF, Cream: 40% fat, 3.5% MSNF, SMP: 0.5% fat, 97% MSNF, Sugar: 100%, Stabilizer-emulsifier: 100%

Using algebraic method, determine quantities of whole milk, cream, SMP, sugar, and stabilizer-emulsifier blend needed.

What have you learned?

After completing this Session, you will be able to:

1. Recognize the different categories of ice cream based on their composition and quality.
2. Comprehend the importance of ingredient selection and formulation in producing high-quality ice cream.
3. Describe the key unit operations involved in ice cream production, such as blending, pasteurization, homogenization, and freezing.
4. Apply mathematical methods, such as the algebraic method, for formulating ice cream mixtures with specific fat, solid-not-fat, sugar, and stabilizer contents.

Module 5 FOOD SAFETY AND HYGIENE

In previous Units, you have learnt about the different elements of ice cream production including raw material preparation, getting ready the equipment and the work area before starting the production of the ice cream. Have you wondered that what will happen if you do not use the clean utensils and tools, do not check the quality raw materials or if you do not store the food materials at appropriate temperatures? Well the consequences of such practices can be unsafe to the shelf-life of the product as well as to the human health. Then what you should do to avoid these? Here food safety and hygiene comes and plays a crucial role in eliminating such instances or risk. In this Unit we will learn about food safety, food hazards, food safety regulations and standards in relation to the ice cream processing industry and preparing the equipment and work area for production. We will also learn about the significance of the maintaining personal hygiene and sanitation in Ice cream processing plant.

SESSION 1: FOOD SAFETY

Food safety refers to the practice of handling, manufacturing and storing food in a way that prevents contamination and reduces the risk of food borne illnesses. Safe food handling practices and procedures are thus implemented at every stage of the food production cycle in order to control these risks and prevent harm to consumers.

In the ice cream processing industry ensuring food safety is of critical aspect denoting the skilled handling, manufacturing, and storage of consumables to prevent contamination and mitigate the risks of foodborne illnesses. This is vital due to the range of health issues that can arise from consuming compromised or unsafe ice cream, from mild gastrointestinal discomfort to severe, life-threatening conditions. The assurance of food safety within the ice cream processing industry necessitates the implementation of careful food handling, manufacturing, and storage protocols. An Ice Cream Processing Technician is expected to adhere the regulations and standards prescribed by food safety authorities.

1.1 Shelf Life Considerations in Ice Cream Processing

The shelf life of food refers to the period during which a food product remains safe to consume and maintains its desired quality when stored under appropriate conditions. It is the timeframe within which the food product is expected to retain its nutritional value, taste, texture, and appearance without becoming hazardous to health or losing its appeal to consumers.

Several factors influence the shelf life of ice cream, including its composition, packaging, storage conditions and the incorporation of preservatives or additives. Understanding and managing the shelf life of food products is crucial for preventing food wastage and ensuring that consumers receive products of high quality and safety.

1.2 Factors Affecting Food Safety and Shelf Life in of Ice Cream

Ensuring food safety and extending the shelf life of dairy and ice cream products requires careful consideration of various factors unique to these industries. Various factors which affect food safety and shelf-life of the products include temperature control, moisture levels, oxygen exposure, pH levels, packaging, preservatives, and storage conditions as illustrated in Fig. 5.1. Let us now understand how these factors affect shelf-life of dairy and ice cream products:

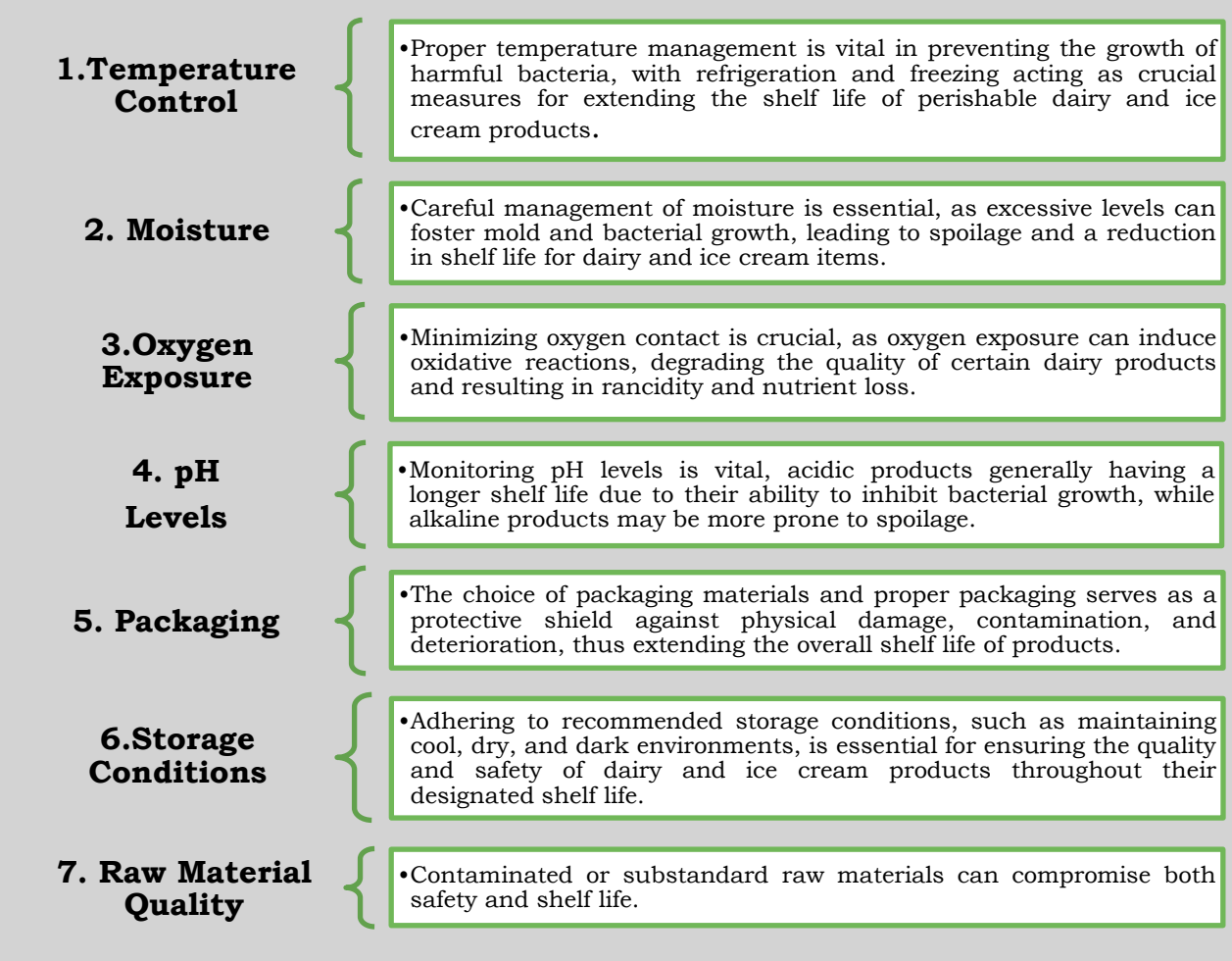


Fig. 5.1: Factors affecting shelf-life of dairy products

Regular cleaning, maintenance, and microbial testing ensure product safety and longevity. Rigorous quality control measures, including frequent testing, are vital during production. Adherence to food safety regulations is a legal requirement for product safety and quality.

1.3 Food Safety Hazards in Ice Cream Production

The dairy and ice cream processing industry is recognized as one of the most perishable category of food, therefore recognizing and mitigating food safety hazards is of utmost importance. These hazards, classified as biological, chemical, or physical agents, pose potential threats to the safety and integrity of the final products. The categories of food safety hazards include:

1.3.1 Biological hazards

These include living organisms such as Weevils, fly, worms, cockroaches etc. and microbiological organisms such as viruses, bacteria, moulds and parasites (Fig.5.2-5.3). For example: *E.Coli, B. Cereus*, *Salmonella*. Food borne bacteria grow and reproduce rapidly in "temperature danger zone" which ranges between 5ºC – 60ºC. To keep food safe, it should either be stored below 5ºC or should be held at a temperature above 60ºC.

Contamination with pathogenic microorganisms can result in foodborne infections or intoxications, emphasizing the need for stringent hygiene practices in dairy and ice cream processing.

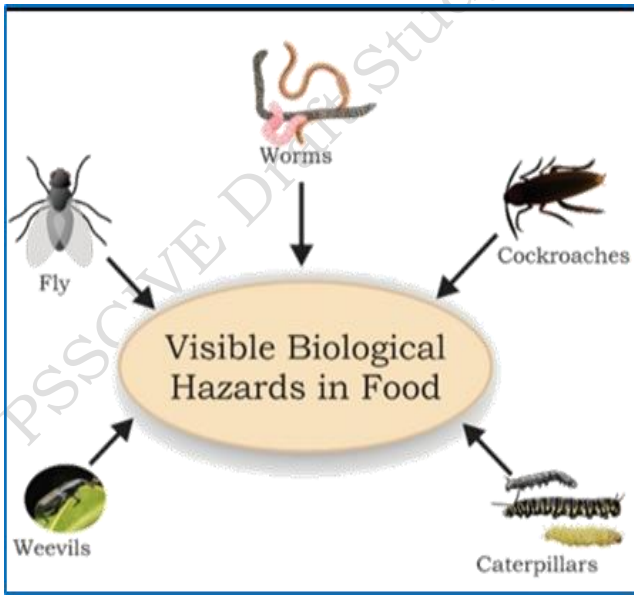


Fig. 5.2: Visible biological hazards

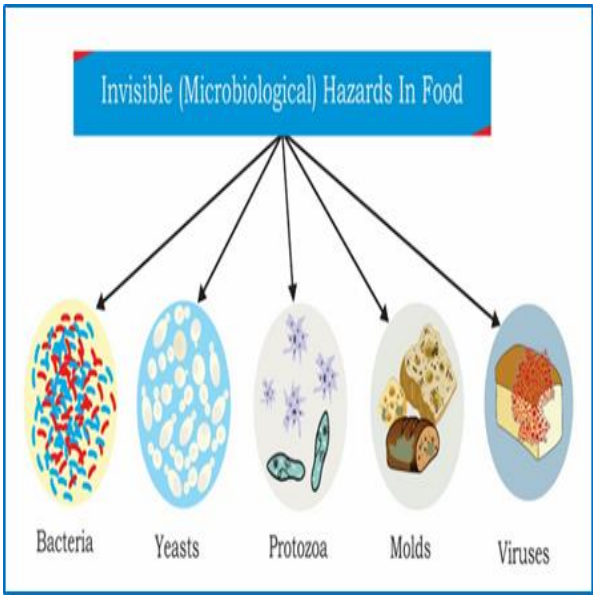


Fig. 5.3: Invisible biological hazards

1.3.2 Chemical Hazards

Chemical c ontamination can happen at any stage in ice cream production facility. Commonly used chemicals such as cleaning agents or pesticides, when comes in contact with food can cause serious health disorders. When a food contains chemicals such as food additives, food colors or preservatives more than the permitted levels then the food becomes hazardous to human consumption. Vigilance in ingredient selection and processing is crucial to mitigate chemical risks.

DETECTION OF WATER IN MILK

1. Put a drop of milk on a polished slanting surface.
2. Pure milk either stays or flows slowly leaving a white trail behind.
3. Milk adulterated with water will flow immediately without leaving a mark.

1.3.3 Physical Hazards

These hazards involve foreign objects or materials accidentally introduced into food, such as glass, metal fragments, plastic, or stones. Stringent quality control measures and equipment maintenance are essential to prevent physical contamination in the production process.

DETECT STARCH IN MILK AND MILK PRODUCTS

1. Boil 2-3 ml of milk with 5 ml of water
2. Let the sample cool
3. Add 2-3 drops of iodine solution or tincture of iodine
4. If the milk turns blue, it contains starch.

1.4 Quality Testing of Ice Cream

Quality testing of ice cream is a vital aspect of ensuring product safety and quality. This process involves the careful evaluation of physical, microbial, nutritional and sensory evaluation. The assessment of physical properties includes Total Soluble Solids (TSS), acidity, pH level, viscosity, overrun, freezing point, and melting rate. Microbiological testing is conducted to detect potential threats like Salmonella and Listeria, along with assessing the Total Plate Count. Nutritional properties, including fat, sugar, protein, and other nutrients, are scrutinized to meet specified standards.

Sensory evaluation focusses on analysis of color, flavor, texture, uniformity, mouthfeel, creaminess, and the absence of defects like ice crystals using sensory organs. The examination extends to packaging integrity and proper labeling to ensure safety and provide clear information to consumers. Lastly, shelf life testing is employed to determine the duration for which the ice cream remains both safe and enjoyable for consumption. This comprehensive approach considers both chemical and physical properties of the product, ensuring a thorough assessment of its quality and safety.

1.5 Total Solids (TSS)

Total Solids (TSS) Analysis Using a Refractometer

Materials Needed:

- Milk samples
- Refractometer
- Graduated cylinder or pipette
- Clean tissue or lint-free cloth
- Distilled water (for calibration)

TSS is a measure of the concentration of all soluble an d suspended solids in a liquid. It is expressed as a percentage of the total weight of the liquid. TSS in milk represents the total amount of solids, including proteins, fats, lactose, minerals, and other dissolved substances. Higher TSS in milk generally indicates a higher concentration of these solids, making the milk more viscous and richer in nutrients. However, TSS in ice cream refers to the total solids present in the mixture before freezing. The composition of these solids includes milk proteins, milk fat, sugars, stabilizers, emulsifiers, and flavorings. Proper control of TSS in ice cream formulation is crucial for achieving the desired texture, creaminess, and sweetness in the final product. A refractometer is a valuable tool for quickly and conveniently determining the Total Solids (TSS) content of a liquid sample, including milk. A typical refractometer is shown in Fig.5.4. Calibration is crucial for accurate readings, specially if the refractometer has not been used for a while. Step wise determination of TSS is depicted in Fig. 5.5.

Fig. 5.4: Refractometer

1.6 Procedure for TSS analysis using a refractometer

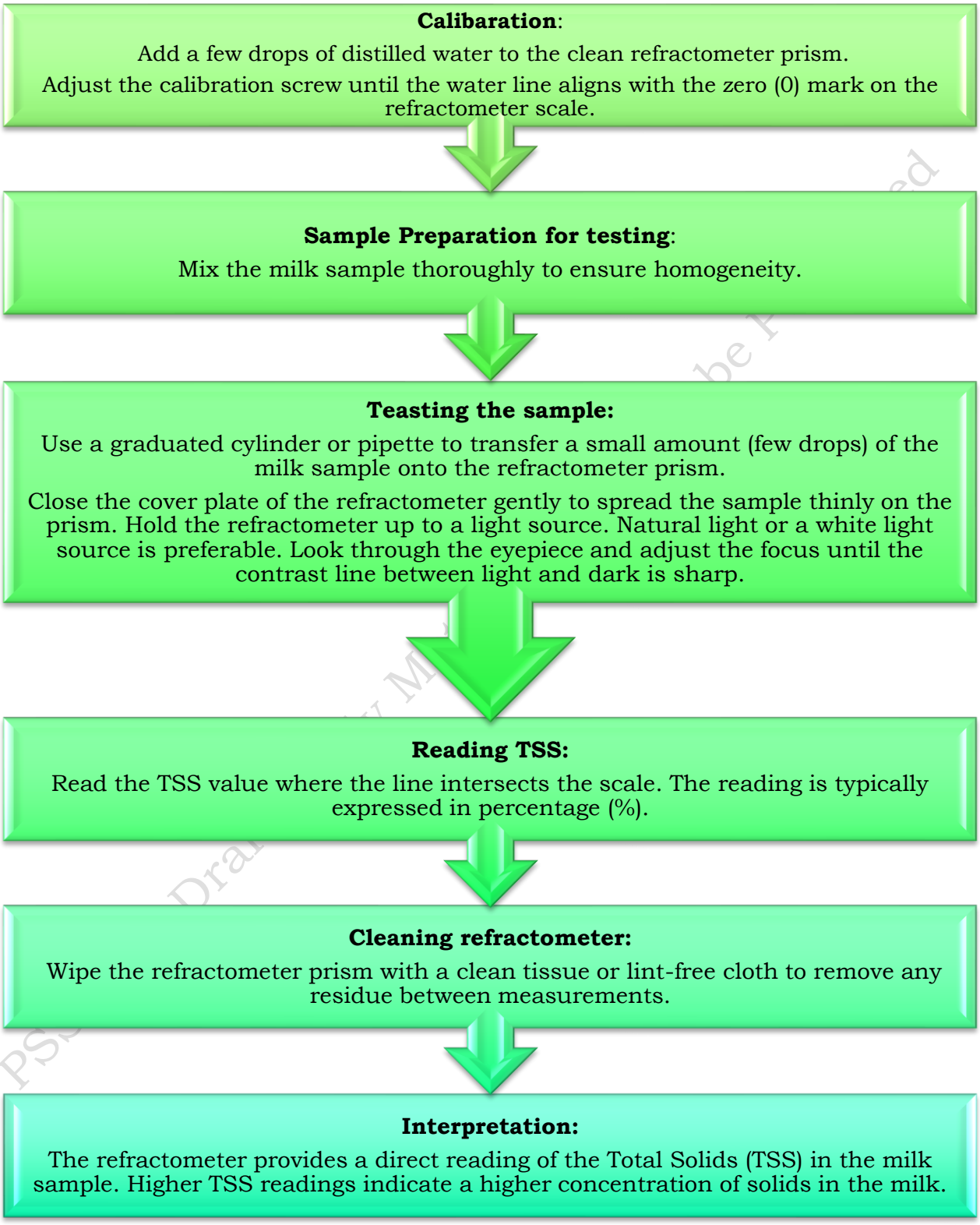


Fig. 5.5: Total Solids (TSS) Analysis Using a Refractometer

Do it Yourself: Microscopic Inspection of a Milk Sample for the Presence of Microbes

Materials Needed:

1. *Microscope*
2. *Clean microscope slides and coverslips*
3. *Pipette or dropper*
4. *Stain (optional, for better visualization)*

Procedure:

1. ***Preparation of Slide:***

   - *Clean the microscope slides and coverslips thoroughly to avoid contamination.*
   - *Using a pipette or dropper, place a small drop of the milk sample onto the center of a clean microscope slide.*

2. ***Covering the Slide:***

   - *Gently place a coverslip over the milk drop, ensuring there are no air bubbles trapped underneath.*

3. ***Microscopic Observation:***

   - *Place the prepared slide on the microscope stage and start with the lowest magnification.*
   - *Focus the microscope to get a clear view of the milk sample.*

4. ***Identification of Microbes:***

   - *Scan the field of view for any moving or stationary particles. Microbes may appear as small, often translucent or slightly colored specks.*
   - *Pay attention to the shape, size, and movement of any observed particles.*

5. ***Recording Observations:***

   - *Document your observations. Note the presence of any microbes, their characteristics, and their approximate quantity.*
   - *If possible, draw what you observe, highlighting any significant features.*

Proper food safety practices, adherence to regulations, and knowledge of potential hazards and contaminants throughout the processing and supply chain are essential. These practices safeguard public health and ensure the quality and safety of ice creams from production to consumption.

Practical Exercise

Activity

1. Identify and categorize food safety hazards in your food laboratory considering the hazards mentioned in this session. Suggest the measures for removal of these hazards.
2. Take a sample of milk and check it for adulteration and Total Soluble solids (TSS).
3. Store milk and paneer sample at room and refrigeration temperature. Study their shelf life for 3 days and tabulate your observations.
4. Using a microscope inspect milk sample for presence of microbes and note your observations.

Check Your Progress

A. Multiple-Choice Questions (MCQs)

1. Food safety refers to the practice of handling, manufacturing, and storing food to prevent contamination and reduce the risk of _____.
   a) Food wastage
   b) Flavor deterioration
   c) Foodborne illnesses
   d) Overcooking

2. Oxygen exposure can induce_____, degrading the quality of certain dairy products and resulting in rancidity and nutrient loss.
   a) food flavor
   b) spoilage
   c) oxidative reactions
   d) food texture

3. Which factor does not influence the shelf life of food products?
   a) Temperature
   b) Oxygen
   c) Taste
   d) Packaging

4. Biological hazards in food safety involve:
   a) Physical contaminants
   b) Harmful chemicals
   c) Microorganisms
   d) Food additives

5. Temperature danger zone" which ranges between:
   a) 5ºC – 60º C
   b) 2ºC – 85º C
   c) 65ºC – 80º C
   d) 5ºC – 60º C

B. Fill in the Blanks

1. _____ is a measure of the concentration of all soluble and suspended solids in a liquid.
2. _____ tool for determining the Total Solids (TSS) content of a liquid sample.
3. Foreign objects or materials accidentally introduced into food known as _____.
4. _____ can cause oxidative reactions that degrade food quality and flavor.
5. Food safety hazards are categorized as biological, _____ and physical hazards.

C. True or False:

1. Food safety refers to the practice of handling, manufacturing, and storing food to prevent contamination and reduce the risk of foodborne illnesses.
2. The shelf life of food products is not affected by factors such as temperature, packaging, and moisture.
3. Chemical hazards in food can arise from the presence of harmful substances like allergens, pesticides, and heavy metals.
4. Physical hazards include microorganisms like bacteria and viruses that can contaminate food.
5. Contamination with pathogenic microorganisms never result in foodborne infections or intoxications.

D. Subjective Questions

1. Explain the concept of "shelf life" of food products. What are the key factors that influence the shelf life of dairy based products?
2. Discuss the different types of food safety hazards with suitable examples. How can Ice Cream Processors mitigate these hazards to ensure the safety of consumers?

What have you learned?

After completing this Session, you will be able to:

- Explain the importance of food safety in preventing contamination and reducing the risk of foodborne illnesses.
- Describe the concept of shelf life, considering factors like composition, packaging, and storage conditions that influence a food product's quality and safety over time.
- Discuss various hazards that can compromise food safety, including biological, chemical, and physical agents.
- Discuss the significance of adhering to regulations and proper handling practices to ensure public health and maintain the quality of food products from production to consumption.

SESSION 2: FOOD SAFETY REGULATIONS AND STANDARDS

As aspiring ice cream makers, understanding food safety regulations is crucial to creating delicious and healthy treats. This session will explore the legal framework governing food safety in India, with a specific focus on its relevance to ice cream production. These regulations ensure the quality, safety, and hygiene of the ice cream you enjoy, protecting consumers from potential health hazards. This session will explore key food safety laws in India, focusing on their relevance to ice cream production.

2.1 Food Safety Laws in India

India's journey in food safety regulations has seen significant developments over time. Before the introduction of the Food Safety and Standards Act of 2006, several laws played crucial roles. These included the Vegetable Oil Products (control) Order (1947), Prevention of Food Adulteration Act (1954), Fruit Products Order (1955), Solvent Extracted Oil, De-Oiled Meal, and Edible Flour (Control) Order (1967), Edible Oils Packaging Order (1988), and Milk and Milk Products Order (1992). The consolidation of these diverse regulations into a unified framework resulted in the creation of the Food Safety and Standards Act in 2006 (Fig.5.6). This comprehensive legislation streamlined and modernized food safety regulations in India, providing a more cohesive and efficient approach to ensuring the safety and quality of food products.

Food safety regulation relating to dairy foods in India are crucial for protecting public health and ensuring that the food consumed by citizens is safe and free from contamination or adulteration. Over the years, India has witnessed a

significant evolution in its food safety regulations, from early unstructured practices to a well-defined modern framework.

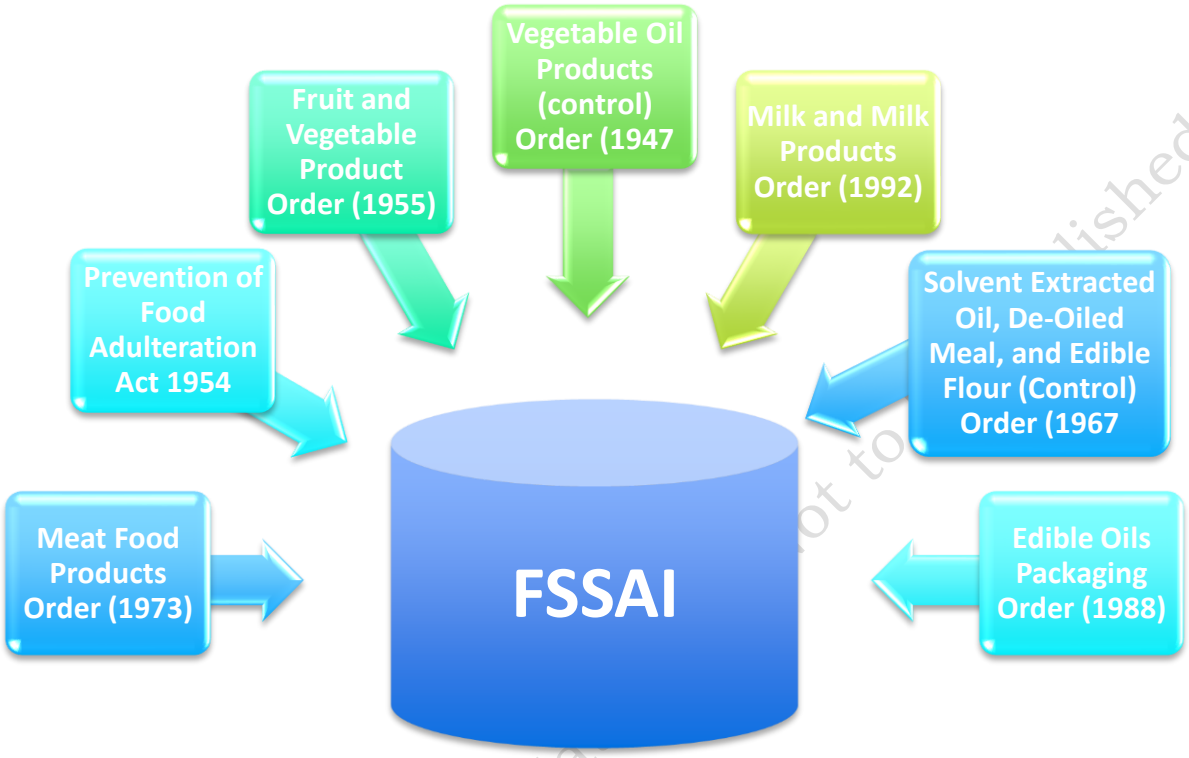


Fig. 5.6: Acts integrated into FSSAI

2.2 Food Safety and Standards Act, 2006 (FSS Act)

The Food Safety and Standards Act was passed by the Indian Parliament on August 4, 2006 to oversee the standards of food safety. This comprehensive act is the cornerstone of food safety regulation in India today. It established the Food Safety and Standards Authority of India (FSSAI) as the central body responsible for regulating food safety and standards across India under Ministry of Health & Family Welfare, Government of India.

2.3 Food Safety and Standards Authority of India (FSSAI)

The FSSAI is the regulatory body responsible for ensuring food safety and standards in India. It sets standards for food products and regulates their manufacturing, storage, distribution, sales, export and import.

The Food Safety and Standards Authority of India (FSSAI) have emerged as a pivotal organization in India's quest for safer and healthier food. Its proactive approach towards setting standards, enforcing regulations, and educating consumers has contributed to improving the overall food safety scenario in the country.

2.4 Role and function Food Safety and Standards Authority of India (FSSAI)

The main role of FSSAI is to bring together the scientific community and the various regulatory agencies in the country to initiate an integrated food safety regulatory framework (Fig.5.7). The FSSAI plays a critical role in ensuring the safety and quality of ice cream. Its regulations encompass various aspects of ice cream processing, including:

1. **Setting Food Product Standards:** One of the primary responsibilities of the FSSAI is to lay down science-based standards for various food products including ice creams to ensure their safety, quality, and nutritional value. These standards define the composition, quality, and safety parameters for ice cream, ensuring consistency and consumer protection.
2. **Licensing and Registration:** The FSSAI mandates the licensing and registration of all food businesses to ensure their compliance with food safety regulations based on their size and risk category. All ice cream manufacturers, distributors, and retailers require FSSAI licenses appropriate to their operations.
3. **Packaging and Labeling:** FSSAI regulations specify mandatory information on ice cream packaging, such as ingredients, nutritional values, expiry dates, and FSSAI license numbers.
4. **Food Additives:** Regulations govern the permitted types and levels of additives used in ice cream production, safeguarding consumers from harmful substances.
5. **Scientific Panels and Research:** The FSSAI has established various scientific panels comprising experts to advise on specific food-related matters, risk assessment, and formulation of food standards based on the latest scientific evidence.
6. **Consumer Awareness:** The FSSAI conducts campaigns and educational programs to raise awareness among consumers about food safety, nutrition, and their rights as consumers.
7. **Food Recall and Traceability:** The FSSAI has laid down procedures for food recall in case of food safety emergencies. It also promotes the use of technology for ensuring traceability in the food supply chain.
8. **Capacity Building:** The FSSAI provides training and capacity building programs to stakeholders in the food industry to enhance their understanding of food safety requirements and compliance.

9. **Schedule 4 of FSSAI:** Outlines food safety and hygiene standards for work areas, including sanitation, cleanliness and hygiene of ice cream processing facilities, equipment, personnel training and pest control.

Fig. 5.7: Functions of FSSAI

2.5 Schedule 4 of FSSAI

Schedule 4 is the recommendation of the General Hygienic and Sanitary practices to be followed by Food Business operators (Fig.5.8). It states that in the field of human nutrition, safe, clean, wholesome food - is indispensable to the health and welfare of the consumer of the country; that - food is a perishable commodity susceptible to contamination and adulteration; - and that - basic sanitary and hygienic conditions are deemed to be necessary for the production and distribution of milk - Meat products, service establishments etc.

Food businesses, whether registered or licensed, must follow strict rules to ensure the safety of the food they handle. These rules include maintaining cleanliness and hygiene, implementing food safety measures, and meeting standards outlined in Schedule 4. It is crucial for food businesses to continuously improve hygiene conditions and aim for India HACCP standards.

To guarantee food safety, businesses should adopt a Food Safety Management System (FSMS) based on Hazard Analysis and Critical Control Point (HACCP) principles. They must actively control hazards throughout the entire food chain, from production to consumption. Schedule 4 provides details about sanitary

practices according to FSSAI for aspiring food entrepreneurs, ensuring the implementation of rules for safe food production and consumption.

Under the FSS Regulations 2011, every food business seeking a license must have a documented FSMS plan and adhere to Schedule 4. This schedule introduces the concept of FSMS, based on Good Hygiene Practices (GHP) and Good Manufacturing Practices (GMP), divided into five major parts for effective implementation.

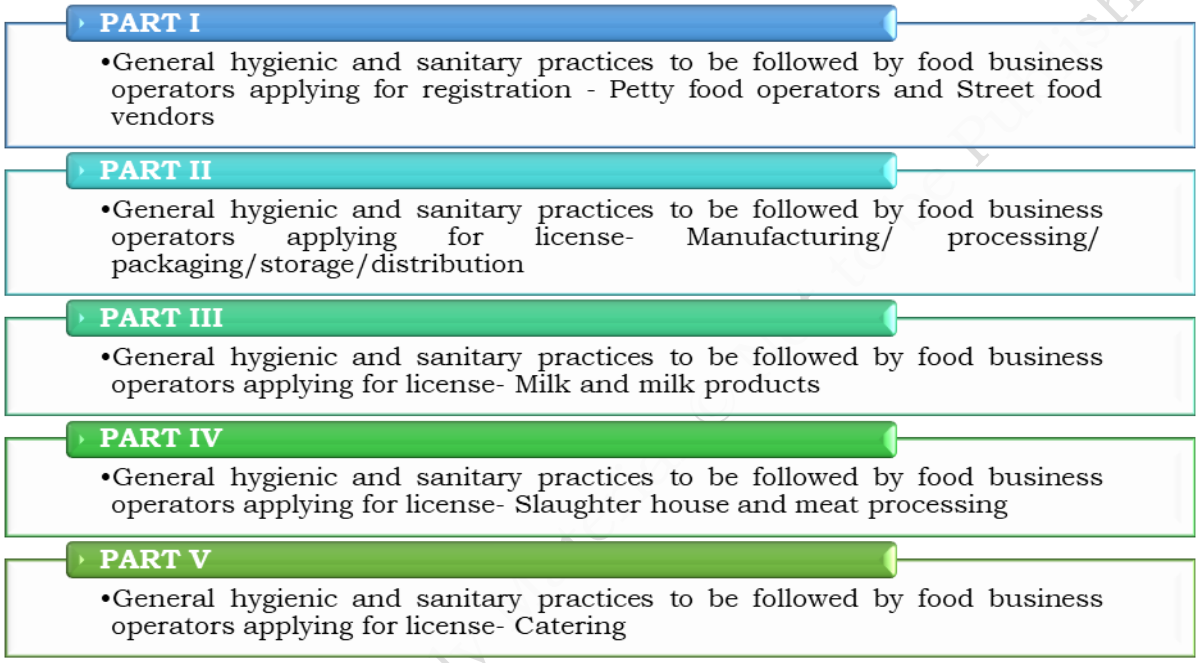


Fig.5.8: Parts of Schedule 4 of FSSAI

2.6 Part III of the Schedule 4

Part III of Schedule 4 focuses on the dairy section (PART-III Regulation 2.1.2. (1)(5)). Food Business Operators (FBOs) involved in the production, processing, storage, and sale of Milk and Milk Products must adhere to specific hygienic and sanitary practices. This includes complying with the sanitary and hygienic requirements, food safety measures, and other standards outlined in Part II of the schedule, as discussed earlier in this unit. The regulations ensure that establishments dealing with dairy-based foods follow strict hygiene standards throughout the entire process, from handling and processing to distribution and sale:

Activity:

Access the following link to know details about other specifications provided in the document for different food categories.

https://www.fssai.gov.in/upload/uploadfiles/files/Licensing_Regulations.pdf

(i) Sanitary Requirements

1. Dairy Establishments shall have the following:
   a) Proper facilities must be in place to handle and protect raw materials and unpacked or unwrapped dairy products during loading, unloading, transportation, and storage. This includes the provision of Bulk Milk cooling facilities.
   b) Use watertight, non-corrodible containers for raw materials or dairy products intended for human consumption. If removal is through conduits, they must be constructed and installed to prevent any contamination of other raw materials or dairy products.
   c) Implement a hygienic and approved wastewater disposal system.
   d) Ensure facilities are available for the cleaning and disinfection of tanks used to transport dairy products and raw milk. These containers must be cleaned after each use to maintain hygiene standards.
2. The occupier of a dairy establishment shall take appropriate measures to avoid cross-contamination of dairy products in accordance with the cleaning program. When a dairy establishment produces food containing dairy products and untreated ingredients, they must store these separately to prevent cross-contamination.
3. Heat-treated milk or milk-based products that could contaminate other dairy products should be produced in a distinct working area.
4. Equipment, containers, and installations in contact with dairy products or raw materials must be cleaned and, if necessary, disinfected based on a verified and documented cleaning program.
5. For equipment and areas with microbiologically stable dairy products, cleaning and disinfection should follow a verified and documented Food Safety management program. Disinfectants used should not harm machinery, equipment, or products. They must be in identifiable containers with clear labels and used as per instructions, followed by thorough rinsing with potable water, unless otherwise specified by the supplier.

(ii) Personal Hygiene Requirements

The Food Business Operator must ensure that individuals directly handling raw materials or dairy products provide a medical certificate during recruitment, confirming their fitness for the job.

Individuals handling raw materials or dairy products must maintain high personal cleanliness standards:

(a) Wear clean and suitable working clothes along with headgear covering all hair.

(b) Wash hands regularly, especially after activities like coughing, sneezing, using the toilet, or smoking.

(c) Cover skin wounds with a waterproof dressing, and individuals with hand injuries, even with dressing, should not work in product-making sections.

(d) Avoid certain hand habits that could lead to food contamination, such as scratching nose, running fingers through hair, rubbing eyes, ears, mouth, or other body parts. If unavoidable, hands must be thoroughly washed before resuming work after such actions.

(iii) Sanitary Requirements for Storage

1. Raw milk, upon procurement, should be placed in a clean and appropriately equipped space to prevent any contamination.
2. Storage and transportation containers made of mild steel metal and plastic materials are not allowed for milk and milk products.
3. If a producer or farmer brings raw milk to the dairy plant, it must be done within four hours of milking. The milk should be cooled to 4°C or lower as soon as possible and maintained at that temperature until processing.
4. Raw milk collected daily from a producer should be promptly cooled to 4°C to 6°C or lower and maintained at that temperature until processing.
5. After pasteurization, pasteurized milk must be immediately cooled to 4°C or lower.
6. Any dairy product not intended for ambient storage should be rapidly cooled to the manufacturer-specified temperature for durability and stored accordingly.
7. For dairy products other than raw milk stored under cooled conditions, their storage temperatures must be recorded, and the cooling process should be swift to reach the required temperature.
8. The maximum temperature for storing pasteurized milk until it leaves the treatment establishment should not exceed 5°C.

(iv) Wrapping and Packaging

Dairy products must be wrapped and packaged in rooms dedicated to satisfactory hygienic conditions. Manufacturing and packaging can occur in the same room if certain conditions are met:

(a) The room must be adequately large and equipped for hygienic operations.

(b) Packaging should be transported in protective covers from manufacture to the dairy establishment and stored under hygienic conditions.

(c) Rooms for storing packaging materials must be vermin-free, dust-free, and separate from rooms containing substances that could contaminate the products. Packaging should not be placed directly on the floor.

(d) Packaging must be assembled under hygienic conditions before entering the room, except for automatic assembly or packaging with no contamination risk.

(e) Packaging should be done promptly by a separate group of experienced staff.

(f) After packaging, dairy products must be stored in designated rooms at the required temperature.

Minimum requirement for labeling and marking on the packaging of milk products: The ink used for marking shall be of such quality which may not contaminate the product. Each package shall be suitably marked legibly and indelibly to give the following information:

- Name and type of the product;
- Nutritional information
- List of ingredients
- Method of use
- Name and address of the manufacturer;
- Date of manufacture or packaging;
- Lot/batch number;
- Net quantity;
- Expiry/use by date;
- Storage instructions;
- Vegetarian green dot logo and
- FSSAI logo
- MRP
- Customer helpline number/email address
- Any other requirements under the Food Safety and Standards (Labelling and Display) Regulations, 2020 and the Legal Metrology Act, 2009 and

2.7 Good Manufacturing Practices (GMP)

Good Manufacturing Practices (GMP) are a set of guidelines and standards that ensure the safe and consistent manufacturing, processing, and packaging of food products. GMP focuses on maintaining hygiene, sanitation, and quality throughout the production process. The key elements of GMP includes:

- Facility and equipment monitoring and care,
- Maintenance of personnel hygiene,
- Raw material and process controls
- Documentation and record keeping.

2.8 Good Handling Practices (GHP)

Good Handling Practices (GHP) focus on maintaining food safety and quality during the transportation, storage, and handling of food products. These practices aim to minimize the risk of contamination and ensure that food products are safe for consumption. Key elements of GHP include:

- Storage Conditions
- Cross-Contamination Prevention
- Cleaning and Sanitization
- Pest Control

2.9 Hazard Analysis Critical Control Points (HACCP)

Hazard Analysis Critical Control Points (HACCP) is a systematic approach to food safety that identifies, evaluates, and controls potential hazards throughout the food production process. HACCP is based on seven principles:

1. Conducting a Hazard: Evaluating the production process and Identifying the points where potential hazards (physical, chemical, and biological) associated with each step in the production process may be introduced.
2. Identifying Critical Control Points (CCPs): Determining the points in the process where preventive measures can be applied to prevent, eliminate, or reduce hazards.
3. Establishing Critical Limits: Stating the boundary line between safe and unsafe processes and stating the limit until which a critical point maybe controlled.
4. Monitoring CCPs: Regularly monitoring CCPs to ensure they are within critical limits.
5. Implementing Corrective Actions: Developing procedures to take corrective actions and specifying the corrective actions that should be followed when control points exceed critical limits.
6. Verifying the System: Stating the verification process to check whether HACCP principles are applied and followed. Testing the HACCP plan and ensuring compliance on a regular basis. Lastly validating and verifying the effectiveness of the HACCP plan in preventing hazards effectively Documenting and Record Keeping: Maintaining detailed documentation of the HACCP plan and related activities including the critical points, situations when critical limits were exceeded, corrective measures applied and records of the development and maintenance of the system.

HACCP is widely used in the milk food industry to ensure the production of safe and high-quality dairy food products.

Practical Exercise

Activity

Visit the FSSAI website and make a report covering food safety regulations, certifications, and practices in the context of dairy foods in India.
Highlight or note down the following key points:

- The role of Food Safety and Standards Authority of India (FSSAI) in regulating food safety and standards.
- Various food quality certifications such as ISO 22000, FSSC 22000, BRC, and HACCP.
- The FSSAI standards for various dairy products.
- Minimum requirements for labeling and packaging of dairy products.

Check Your Progress

A. Multiple Choice Questions

1. Food safety regulations aim to protect public health by ensuring that food is safe and free from _____.
   (a) Flavors
   (b) Contamination
   (c) Additives
   (d) Labels

2. Which regulatory body is responsible for ensuring food safety and standards in India?
   (a) ISO
   (b) BIS
   (c) FDA
   (d) FSSAI

3. The main role of the Food Safety and Standards Authority of India (FSSAI) is to:
   (a) Promote food additives
   (b) Monitor agricultural practices
   (c) Enforce labeling laws
   (d) Ensure food safety and standards

4. Food Safety and Standards Act was passed by the Indian Parliament on August 4, _____.
   (a) 2011
   (b) 2006
   (c) 2015
   (d) 2020

5. Good Manufacturing Practices (GMP) focus on maintaining hygiene, sanitation, and quality throughout the _____ process.
   (a) Distribution
   (b) Packaging
   (c) Advertising
   (d) Production

B. Fill in the Blanks

1. _____is the recommendation of the General Hygienic and Sanitary practices to be followed by Food Business operators.
2. FSMS refers to _____.
3. BIS stands for_____.
4. GMP means _____
5. Hazard Analysis Critical Control Points (HACCP) is a systematic approach to food safety that identifies, evaluates, and controls potential _____ throughout the food production process.

C. State True or False

1. FSSAI is responsible for regulating food safety standards and practices in India.
2. Organic certification ensures that food products are produced using pesticides and chemicals.
3. Good Manufacturing Practices (GMP) focus on maintaining hygiene, sanitation, and quality throughout the production process.
4. Hazard Analysis Critical Control Points (HACCP) is a set of guidelines for food packaging.
5. Food safety regulations and certifications play a significant role in ensuring the quality and safety of dairy products in India.

D. Subjective Questions

1. Explain the role and functions of the Food Safety and Standards Authority of India (FSSAI). How does FSSAI contribute to ensuring food safety and quality in India's food industry?
2. Describe the key principles of Hazard Analysis Critical Control Points (HACCP) and its importance in ensuring the safety of dairy food products.
3. Discuss the significance of Good Manufacturing Practices (GMP) and Good Handling Practices (GHP) in the context of food safety for dairy products.

SESSION 3: ICE CREAM PROCESSING TECHNICIAN

An **Ice Cream Processing Technician** is a professional responsible for the production and processing of ice cream. This role involves various tasks, including preparing ingredients, operating ice cream-making equipment,

monitoring production processes, ensuring quality control, and maintaining hygiene standards. Ice Cream Processing Technicians play a crucial role in the ice cream manufacturing industry, ensuring that the production process is efficient, the product meets quality standards, and safety regulations are adhered to throughout the processing stages. Some of the key job responsibilities of an Ice Cream Processing Technician include:

- **Receiving and Inspecting Raw Materials**: Checking the raw material for quality and ensuring that the raw material meet the required standards for further processing while minimizing the loss of raw material.
- **Record-keeping and documentation:** Document and maintain records of raw materials, production schedule, production processes, finished products, quality checks, and other relevant information for traceability and audits
- **Operate dairy equipment and machineries**: Optimise the use of machinery and ensure smooth operation of machinery to complete production line.
- **Inspect machines and troubleshoot issues:** Attend to minor repairs of tools and machinery when required and ensure that safety rules and regulations are observed to prevent accidents.
- **Plan and execute the production process:** Examining products at different stages of production, adhering to Good Manufacturing Practices (GMP), GHP and HACCP. Inspect intermediate as well as finished products. Achieve good quality products of the correct quantity. Ensure the products meet the quality standards set by the organisation.
- **Quality Control:** Conducting regular quality checks during processing to ensure that the products meet the desired standards for taste, texture, and nutritional value.
- **Follow Packaging Labeling and Storage:** Ensuring that the finished products are properly packaged and labeled and stored according to regulations and company standards.
- **Compliance with Regulations**: Complying with all relevant food safety and regulatory requirements set by the Food Safety and Standards Authority of India (FSSAI) or other relevant authorities.

3.1 Aspects of Maintaining Personal Hygiene and Sanitation

Personal hygiene and sanitation in the ice cream processing unit conceptually refer to its adoption by the personnel and its implementation in the work area. Hygiene means clean and contamination-free environment for the staff and the working area. Ice cream processing technician can eliminate the possibilities of

infection which they may carry on their body, hair or clothes by following hygiene and sanitation standards.

Aspect of maintaining personal hygiene and sanitation include hands, hair, cloths and personal habits as discussed below:

3.1.1 Hands Hygiene

Hands are the most likely source and carrier of contamination in food industry. Therefore, they must be washed with soap solution and water at least for 20 seconds followed by rinsing in running water.

1. Wash hands before and after handling of food material.
2. Use protective hand gloves while working. Gloves must be cleaned and sanitized after every work cycle.
3. Personnel working in dairy processing unit should not wear hand jewelry, wristwatch or bangles.
4. Person suffering from any kind of skin diseases or open wound are not allowed to work in dairy processing unit.
5. Wash basins are provided near the working area.

3.1.2 Hair hygiene

1. Hair to be kept short and clean.
2. Combing of hair is avoided in working area.
3. Hair is covered using hairnet.

3.1.3 Cloth hygiene

1. Apron should be used by every personnel working in processing area.
2. The apron needs to be regularly washed.
3. Adequate changing rooms, rest rooms and cabinets for clothes and personal belongings are provided while developing the layout of the dairy processing unit.

3.1.4 Prohibited activities

1. Touching nose, eye, ear, mouth and hair while working is strictly prohibited as it carries a lot of bacteria which immediately contaminates the dairy products.
2. Coughing or sneezing without covering the mouth and nose with cloth.
3. Eating, drinking, consumption of tobacco products or chewing gum is strictly prohibited in plant premises.

3.2 Aspects of Maintaining a Hygienic Workplace - Waste Disposal and Pest Control

- **Good Storage Practices:** Properly storing raw materials, intermediate products, and finished goods in designated areas helps maintain a clean

and organized workplace, reducing the risk of cross-contamination and pest infestation.

- **Pest Control:** Implementing effective pest control measures is crucial to prevent pest infestations in the food processing facility. Regular inspections, sealing entry points, and using approved pest control methods help minimize the risk of contamination.
- **Cleaning and Sanitization:** Regular and thorough cleaning of all surfaces, equipment, and utensils used in food processing is vital to maintain a hygienic workplace. Sanitization procedures should be followed to kill harmful bacteria and prevent their growth.
- **Drains and Floor Cleaning:** Cleaning and maintaining drains and floors prevent the buildup of food debris and standing water, which can attract pests and create a breeding ground for bacteria.
- **Waste Disposal**: Proper waste disposal is essential to prevent the accumulation of waste materials that could attract pests or become a breeding ground for harmful bacteria. Waste should be segregated, stored in appropriate containers, and disposed of regularly following local regulations.
- By strictly following personal hygiene guidelines and maintaining a hygienic workplace with proper waste disposal and pest control measures, ice cream processors can ensure the production of safe, high-quality dairy-based food products. These practices are essential for complying with food safety regulations and protecting the health of consumers.

Practical Exercise

Activity

1. Prepare a HACCP for ice cream production.
2. Demonstrate effects of not wearing an apron, gloves, hairnet on personal and product level.
3. Demonstrate how will you maintain hygiene and safety in Ice Cream Processing unit using the following guidelines:

A. Multiple-Choice Questions (MCQs)

1. What is a key responsibility of an Ice Cream Processing Technician?
   (a) Managing finances
   (b) Quality control
   (c) Marketing strategies
   (d) Human resources

2. What does personal hygiene in the ice cream processing unit refer to?
   (a) Hygiene of the equipment
   (b) Hygiene of the raw materials
   (c) Adoption by personnel and implementation in the work area
   (d) Hygiene of finished products

3. Which is a prohibited activity in the dairy processing unit?
   (a) Regular hand washing
   (b) Wearing PPE
   (c) Combing hair in the working area
   (d) Using protective hand gloves

4. What is crucial for preventing pest infestations in the food processing facility?
   (a) Regular inspections
   (b) Blocking entry points for pests
   (c) Using pest control method
   (d) All of the above

B. Fill in the Blanks

1. The Ice Cream Processing Technician is responsible for checking the _____ of raw materials before further processing.
2. Proper storage of raw materials, intermediate products, and finished goods helps maintain a clean and organized workplace, reducing the risk of _____.
3. Hygiene and sanitation standards include washing hands with soap and water for at least _____ seconds.
4. Adequate changing rooms, rest rooms, and cabinets for clothes are provided to maintain _____ in the dairy processing unit.
5. Implementing effective _____ measures is crucial to prevent pest infestations in the food processing facility.

C. True or False:

1. An Ice Cream Processing Technician is responsible for the production and processing of ice cream.
2. Record-keeping and documentation are crucial for traceability and audits in the ice cream processing industry.
3. Hair hygiene in a dairy processing unit includes covering hair with a hairnet.
4. Eating, drinking, consumption of tobacco products, or chewing gum is allowed in the plant premises.
5. Regular and thorough cleaning of all surfaces, equipment, and utensils is not essential for maintaining a hygienic workplace.

D. Subjective Questions

1. Explain the key responsibilities of a Ice Cream Processing Technician in the production of dairy-based products. How do these responsibilities contribute to ensuring the quality, safety, and efficiency of the production process?
2. Discuss the significance of personal hygiene and sanitation in a soy processing unit. How can proper personal hygiene practices, including hand, hair, and clothing hygiene, contribute to preventing contamination and ensuring the safety of ice cream and dairy products?

What have you learned?

After completing this Session, you will be able to:

1. Discuss significance of food safety regulations and certifications in the soy food industry, including the role of regulatory bodies like FSSAI and BIS.
2. Demonstrate essential hygiene and safety practices required in soy processing, encompassing personal hygiene, waste disposal, pest control, and maintaining a clean workplace.
3. Apply concepts like GMP, GHP, and HACCP in a practical context, ensuring the production of safe and high-quality soy-based food products while complying with relevant regulations.

GLOSSARY

1. **Acid Cleaners:** Cleaning solutions used to remove mineral deposits, scale, and *rust from surfaces and equipment, particularly useful in regions with hard* water.
2. **Additives:** Chemical substances added to food to improve its taste, texture, appearance, or shelf life, such as flavorings, colorings, and preservatives.
3. **Ageing**: Allowing the ice cream mix to undergo a period of rest, typically overnight, to facilitate the adsorption of emulsifiers onto fat droplets and the crystallization of fat, improving stability and texture.
4. **Algebraic Method:** A method used for calculating the quantities of ingredients in ice cream mix formulation by creating linear algebraic equations based on the desired composition and the fat and MSNF content of the ingredients.
5. **Alkaline Cleaners:** Cleaning agents effective in removing protein and organic residues from surfaces and equipment in dairy processing facilities.
6. **Alkaline foods:** Foods with a pH level above 7, which are considered basic or alkaline in nature.
7. **Allergens**: Substances that can cause allergic reactions in sensitive individuals when consumed or exposed to, such as peanuts, shellfish, dairy, and gluten.
8. **Ambient condition:** The normal environment or surroundings in which something exists or operates, like room temperature or natural atmospheric conditions.
9. **Appeal to consumers:** Factors or characteristics of a product that make it attractive or desirable to consumers, such as taste, packaging, price, or nutritional content.
10. **Atomization:** The process of transforming liquid milk into tiny droplets for drying in spray dryers.
11. **Bakery and Confectionery**: The production of bakery and confectionery products such as bread, cakes, cookies, chocolates, and candies.
12. **Beverages Industry:** The production of various drinks and ready-to-drink (RTD) products, including bottled water, energy drinks, soft drinks, coffee, milk and dairy products, different types of alcohol, and nutritional beverages.

13. **Biological Hazards**: Living organisms such as viruses, bacteria, molds, and parasites that pose potential threats to the safety and integrity of food products.
14. **Blending:** The process of combining all the ingredients in a vat equipped with agitators, ensuring proper mixing and heating, with dry ingredients added before reaching a certain temperature.
15. **Chemical Hazards:** Contamination by chemicals such as cleaning agents, pesticides, food additives, or food colors that can cause serious health disorders if present in food products beyond permitted levels.
16. **Colloid Dispersion:** A mixture where small particles of one substance are evenly distributed throughout another substance.
17. **Condensed Milk:** A concentrated dairy product with added sugar produced by evaporating water from milk and adding sugar for preservation.
18. **Contamination:** When harmful substances, such as bacteria, chemicals, or other pollutants, get into food or the environment, making it unsafe or impure.
19. **Continuous Freezer:** Equipment used for continuous freezing of ice cream mixtures while incorporating air to achieve the desired texture.
20. **Convenience Foods:** Ready-to-eat or easy-to-prepare food products that provide convenience and save time for consumers.
21. **Cooling:** Rapidly cooling the ice cream mix to 0-5°C after homogenization to prevent bacterial growth and maintain desired viscosity.
22. **Cross-Contamination:** The transfer of harmful microorganisms from one surface or substance to another, potentially leading to foodborne illnesses.
23. **Dairy Cooperatives:** Organizations like Amul and the National Dairy Development Board (NDDB) that have played a crucial role in empowering dairy farmers and improving milk productivity.
24. **Dairy Industry:** The sector involved in milk production, processing, distribution, and marketing of dairy products. It contributes significantly to the Indian economy, rural livelihoods, and nutrition.
25. **Dairy Ingredients:** Ingredients derived from milk, such as whole milk, cream, skim milk powder, sweetened condensed milk, and unsalted butter, which provide fat and milk solids not fat (MSNF) to ice cream.
26. **Dairy Processing:** The conversion of raw milk into various dairy products such as milk powder, cheese, butter, yogurt, and flavored milk.

27. **Dairy Products:** Various products derived from milk, including liquid milk, butter, ghee, yogurt, cheese, ice cream, and dairy sweets.
28. **Degreasers:** Specialized cleaners designed to remove oil and grease from machinery and surfaces, essential in areas where oils and fats are handled.
29. **Detergents:** Chemical substances used to remove grease, grime, and residues from surfaces, typically approved for use in food processing areas.
30. **Dynamic Freezing:** Freezing ice cream mix under continuous agitation to incorporate air and create a smooth texture, as opposed to static freezing.
31. **Emulsifiers:** Ingredients that help blend fat and water components in ice cream mix, ensuring a smooth and creamy texture.
32. **Enzyme Cleaners:** Cleaning agents containing enzymes that break down protein and organic pollutants, useful for removing stubborn organic residues.
33. **Evaporated Milk:** A concentrated sterilized dairy product produced by evaporating water from milk under reduced pressure.
34. **Evaporation and Concentration Unit:** Processes designed to remove water from milk, concentrating its solids content for the production of condensed or powdered milk products.
35. **FAO (Food and Agriculture Organization):** A specialized agency of the United Nations that leads international efforts to defeat hunger and improve food security and nutrition.
36. **Fat-in-Oil Emulsion:** A type of emulsion found in milk where fat globules are dispersed in a continuous phase of liquid.
37. **Fermented Dairy Products:** Dairy products produced through controlled fermentation processes, such as yogurt and cultured buttermilk.
38. **Filtration and Clarification Unit:** The unit responsible for purifying raw milk by removing impurities and solid particles through mechanical filtration and centrifugal clarification techniques.
39. **Food additives**: Substances added to food for various purposes, such as enhancing flavor, color, texture, or shelf life, or to improve nutritional value.
40. **Food Processing Industry:** The sector involved in processing raw agricultural items into consumable food products. It includes various sub-sectors such as fruits, vegetables, dairy, meat, cereals, and packaged foods.
41. **Food Processing:** The set of methods and techniques used to convert raw agricultural items or livestock into consumable food products, including cleaning, sorting, milling, and preservation techniques.

42. **Food Safety and Standards Act, 2006 (FSS Act):** A comprehensive legislation passed by the Indian Parliament to regulate food safety and standards in India. It established the Food Safety and Standards Authority of India (FSSAI) as the central body responsible for ensuring food safety.
43. **Food Safety and Standards Authority of India (FSSAI):** The regulatory body responsible for setting standards for food products, regulating their manufacturing, storage, distribution, sales, export, and import in India.
44. **Food Safety Hazards:** Identifying biological, chemical, and physical hazards in ice cream production and mitigating risks.
45. **Food Safety:** Ensuring safe handling, manufacturing, and storage of food to prevent contamination and reduce the risk of foodborne illnesses.
46. **Foodborne illnesses:** Sicknesses or diseases caused by consuming contaminated food, which can lead to symptoms like nausea, vomiting, diarrhea, and fever.
47. **Foodborne infections:** Infections caused by consuming food contaminated with pathogenic microorganisms, leading to symptoms like fever, nausea, diarrhea, and abdominal pain.
48. **Formulation:** The process of determining the composition of the ice cream mix and calculating the amounts of various ingredients needed to achieve the desired quality and comply with regulatory standards.
49. **Fortification:** The process of adding vitamins, minerals, or other essential nutrients to food products to improve their nutritional value.
50. **Freezer:** Equipment used for freezing various dairy products such as ice cream, ensuring consistent quality and texture.
51. Freezing: The process of freezing the ice cream mix in ice cream freezers, incorporating air and forming ice crystals to create the desired texture.
52. **Freezing**: The process of lowering the temperature of food to below its freezing point to preserve it by preventing the growth of microorganisms and enzymatic activity, thus extending its shelf life.
53. **Fruit and Vegetable Processing:** The processing of fresh fruits and vegetables into various products including juices, canned fruits, frozen vegetables, pickles, jams, dried fruits, and juice concentrates.
54. **Good Handling Practices (GHP)**: Practices aimed at maintaining food safety and quality during the transportation, storage, and handling of food products, minimizing the risk of contamination.

55. **Good Manufacturing Practices (GMP):** Guidelines and procedures designed to ensure that food products are consistently produced and controlled according to quality standards.
56. **Hardening:** Rapidly cooling the ice cream after freezing to stabilize its structure and prevent the growth of large ice crystals, typically done in a hardening tunnel.
57. **Hazard Analysis and Critical Control Points (HACCP):** A systematic approach to identify, evaluate, and control food safety hazards at critical points in the production process.
58. **Heavy metals**: Metallic elements that can be harmful to human health when consumed in high amounts through contaminated food or water, such as lead, mercury, and cadmium.
59. **Homogenization:** A process that breaks down fat globules in the ice cream mix to create a uniform texture and prevent separation.
60. **Homogenizer:** Equipment used to achieve uniform dispersion of fat globules in milk, ensuring product consistency and preventing cream separation.
61. **Hygiene Standards:** Guidelines and protocols established to maintain cleanliness and prevent contamination in food processing environments.
62. **Hypochlorites:** Cleaning chemicals formed by combining chlorine with inorganic compounds like calcium or sodium, often used as disinfectants in food processing facilities.
63. **Ice Cream Mix:** A blend of ingredients including dairy components, sweeteners, stabilizers, and flavorings, prepared before freezing to make ice cream.
64. **Ice Cream Processing Technician:** A professional responsible for the production and processing of ice cream, involving tasks such as ingredient preparation, equipment operation, quality control, and hygiene maintenance.
65. **Milk Chiller:** Refrigeration units used to rapidly cool milk to desired temperatures post-pasteurization, preserving freshness and quality.
66. **Milk Reception Area:** The initial section of a dairy processing plant where raw milk is received, tested, and stored before further processing.
67. **Naturally occurring toxins**: Harmful substances that occur naturally in certain foods, such as toxins produced by molds, fungi, or plants, which can cause illness or poisoning when consumed in large quantities.

68. **Non-Dairy Ingredients:** Ingredients other than dairy products, including sweeteners (e.g., sugar), stabilizers, emulsifiers, eggs, flavorings, and colors, which contribute various functional attributes to ice cream.

69. **Nutritional Value:** The amount of nutrients, such as vitamins, minerals, proteins, and carbohydrates, present in a food product.

70. **Organized and Unorganized Sectors:** The division of the food processing industry into organized and unorganized sectors, where the unorganized sector contributes about 42% of the output, the organized sector contributes 25%, and the rest comes from small-scale players.

71. **Overrun:** The amount of air incorporated into ice cream during freezing, expressed as a percentage increase in volume from the original ice cream mix.

72. **Oxidative reactions:** Chemical reactions that occur when oxygen reacts with certain compounds in food, leading to changes in flavor, color, texture, and nutritional value.

73. **Palatability:** The taste, texture, and appearance of a food product that make it appealing to consumers.

74. **Pasteurization Unit:** The section where milk undergoes heat treatment to destroy harmful bacteria while preserving its nutritional integrity. Pasteurization methods include HTST, low temperature long time treatment, and ultra-pasteurization (UHT).

75. **Pasteurization:** The heat treatment process used to eliminate pathogenic bacteria from the ice cream mix, ensuring safety for consumption, and also aiding in the hydration of components like proteins and stabilizers.

76. **Pasteurizers:** Machines used to heat milk or other liquid ingredients to a specific temperature for a predetermined time to kill harmful bacteria and pathogens.

77. **Pathogenic microorganisms:** Microscopic organisms, such as bacteria, viruses, and parasites, that can cause illness or disease when consumed in contaminated food.

78. **Perishable foods**: Foods that are likely to spoil or decay quickly, such as fresh fruits, vegetables, dairy products, and meats.

79. **Peroxyacetic Acid (PAA):** A chemical used for disinfection, particularly effective in cold conditions and for removing biofilms in food processing environments.

80. **Personal Hygiene:** Practices that ensure cleanliness and prevent contamination by maintaining the cleanliness of the body, hair, and clothing of food handlers.
81. **Pest Control:** Strategies and methods implemented to prevent and control pest infestations in food processing facilities, ensuring the safety and quality of food products.
82. **pH levels:** A measure of acidity or alkalinity in a substance, with values ranging from 0 to 1 A pH of 7 is neutral, below 7 is acidic, and above 7 is alkaline.
83. **Physical Hazards:** Foreign objects or materials accidentally introduced into food products, including glass, metal fragments, plastic, or stones, which can cause physical harm if consumed.
84. **Platform Test:** A series of tests conducted to assess the quality and safety of raw milk, including organoleptic tests, alcohol tests, total solid and SNF tests, lactometer tests, freezing tests, sediment tests, clot on boiling tests (COB), and dye reduction tests or Resazurin tests.
85. **Post-harvest Losses:** The loss of food items, usually due to spoilage or damage, that occurs between harvest and consumption.
86. **Preservatives:** Substances added to food to prevent spoilage, decay, or growth of harmful bacteria, thus extending its shelf life.
87. **Primary Processing:** The initial processing of raw agricultural items, such as cleaning, sorting, and milling, to produce basic food commodities.
88. **Processed Foods:** Food products that have undergone various levels of processing, including primary, secondary, and tertiary processing, to enhance their appeal, shelf life, and nutritional value.
89. **Quality Control:** The process of ensuring that products meet specified quality standards throughout all stages of production.
90. **Quality Testing:** Evaluation of physical, microbial, nutritional, and sensory aspects to ensure product safety and quality.
91. **Quaternary Ammonium Compound**): Chemical compounds containing nitrogen and alkyl chains, effective as disinfectants over a wide range of temperatures, suitable for light soil.
92. **Rancidity:** The development of unpleasant odors and flavors in fats and oils due to oxidation, making them unfit for consumption.
93. **Receiving and Storage Unit:** The area where raw milk is accepted from dairy farms, tested for quality and safety, and temporarily stored in tanks or silos equipped with temperature control mechanisms.

94. **Refrigeration**: The process of cooling or chilling food to low temperatures to slow down the growth of bacteria and other microorganisms, thus extending its shelf life and maintaining its freshness.
95. **Regulatory Requirements:** Laws, regulations, and standards set by governmental agencies to ensure the safety, quality, and integrity of food products.
96. **Sanitation:** Measures to maintain a clean and hygienic environment in the workplace, including cleaning, disinfection, and waste disposal.
97. **Sanitizers/Disinfectants:** Agents used to eliminate or inhibit the growth of microorganisms such as bacteria, viruses, and molds, ensuring sanitation in food processing environments.
98. **Schedule 4 of FSSAI:** A set of recommendations outlining general hygienic and sanitary practices to be followed by food business operators in India to ensure the safety of the food they handle.
99. **Secondary Processing:** Further processing of primary food products to create a variety of food items, such as sauces, jams, and baked goods, to meet consumer preferences.
100. **Separation Unit:** The unit that separates milk into its constituent components, such as cream and skim milk, for tailored processing and product formulation.
101. **Shelf Life:** The length of time that a food product can be stored and remain safe to eat while maintaining its quality, taste, and nutritional value.
102. **SNF (Solids-Not-Fat):** The portion of milk solids that is not fat, including protein, lactose, and minerals.
103. **Spray Dryer:** Equipment used for producing powdered dairy products like milk powder or whey powder through atomization and drying processes.
104. **Stabilizers:** Substances added to ice cream mix to maintain texture, prevent crystallization, and improve stability during storage.
105. **Sterilized Milk:** Milk that undergoes intense heat treatment to eliminate almost all bacteria, extending its shelf life.
106. **Tertiary Processing:** Industrial-level processing of food products for marketing purposes, resulting in products like instant noodles, bottled juices, and ready-to-eat meals.
107. **Total Solids (TSS):** A measure of the concentration of all soluble and suspended solids in a liquid, used to assess the texture, creaminess, and sweetness of food products like ice cream.

108. **Traceability:** The ability to track the movement of ingredients, products, and processes throughout the supply chain, from raw materials to the end consumer.

109. **Ultra-Pasteurization (UHT):** A pasteurization method where milk is heated to 140°C for 4 seconds, significantly extending its shelf life.

110. **Unit Operations:** The fundamental steps involved in the production of ice cream, including ingredient selection, formulation, blending, pasteurization, homogenization, cooling, ageing, freezing, and hardening.

ABBREVIATIONS

°C: Degrees Celsius

B. Cereus: Bacillus cereus

CAGR: Compound Annual Growth Rate

CCPs: Critical Control Points

CIP: Cleaning in Place

COP: Cleaning out of Place

E. Coli: *Escherichia coli*

FAO: Food and Agriculture Organization

FBOs: Food Business Operators

FDI: Foreign Direct Investment

FSMS: Food Safety Management System

FSS Act: Food Safety and Standards Act

FSSAI Food Safety and Standards Authority of India

FSSAI: Food Safety Authority

g/L: grams per liter

g: Gram

GDP: Gross Domestic Product

GHP: Good Handling Practices

GMP: Good Manufacturing Practices

HACCP: Hazard Analysis Critical Control Points

HTST High Temperature Short Time

kg: Kilogram

LBG: Locust Bean Gum

LTLT: Low Temperature Long Time Treatment

MoFPI: Ministry of Food Processing Industries

MSNF: Milk Solids Not Fat

MT: Metric Ton

MT: Million Tons

Na – CMC: Sodium Carboxy Methyl Cellulose

NDDB: National Dairy Development Board

Nx6.38: Nitrogen x 6.38 (a measure of protein content)

PPE: Personal Protective Equipment

psi: Pounds per Square Inch

R22: A type of refrigerant

R502: Another type of refrigerant

RTD: Ready-to-Drink

SDS: Safety Data Sheets

SIP: Sterilizing-in- Place

SMP: Skim Milk Powder

SNF: Solid Not Fat

TS: Total Solids

TSS: Total Soluble Solids

UHT: Ultra High Temperature

USD: United States Dollar

WWTP: Wastewater Treatment Plant

ANSWER KEY

Unit 1: Overview of Food Processing

Session 1: Food Processing

A. Multiple Choice Questions

1. (d)
2. (b)
3. (c)
4. (b)
5. (d)

B. Fill in the Blanks

1. cleaning, grading, sorting
2. taste preferences
3. Industrial Level
4. shelf life
5. processing techniques

C. State True or False

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

Session 2: Sub Sectors of Food Processing

A. Multiple Choice Questions

1. (b)
2. (c)
3. (b)
4. (c)

B. Fill in the Blanks

1. Dairy
2. Largest
3. 40%
4. Processing
5. consumption

C. State True or False

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

Session 3: Significance of The Indian Food Processing and Dairy Industry

A. Multiple Choice Questions

1. (b)
2. (b)
3. (c)
4. (b)
5. (a)

B. Fill in the Blanks

1. 2025
2. e-Commerce
3. dairy
4. 1st
5. 5%

C. State True or False

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

Unit 2: Overview of Dairy Processing Industry in India

Session 1: Origin of Icecream

A. Multiple Choice Questions

1. (a)
2. (d)
3. (b)
4. (c)
5. (c)

B. Fill in the Blanks

1. Milk
2. Vadilal
3. Freezing
4. 65%
5. St. Louis

C. State True or False

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

Session 2: Milk & Milk Products

A. Multiple Choice Questions

1. (d)
2. (d)
3. (b)
4. (b)
5. (c)

B. Fill in the Blanks

1. Fat
2. 65°C
3. dairy
4. Lactic
5. Heat

C. State True or False

1. True
2. True
3. False

Session 3: Units of a Dairy Processing Plant

A. Multiple Choice Questions

1. (c)
2. (c)
3. (c)
4. (a)
5. (b)

B. Fill in the Blanks

1. receiving and storage
2. Homogenization
3. 72 degree/15 sec

C. State True or False

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

Session 4: Perform Cleaning and Maintenance of Work Area

A. Multiple Choice Questions

1. (b)
2. (c)
3. (d)
4. (a)

B. Fill in the Blanks

1. Degreasers
2. Bristle brushes
3. Sponges & scrub pads
4. Respiratory protection
5. Disassembling them

C. State True or False

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

Unit 3: Elements of Ice Cream Processing

Session 1: Ice Cream Processing Technician Processing

A. Multiple Choice Questions

1. (a)
2. (b)
3. (c)

B. Fill in the Blanks

1. cleaning and sanitizing
2. measurement and handling
3. safety protocols

C. State True or False

1. True
2. True

Session 2: Raw Materials used For Ice Cream Production

A. Multiple Choice Questions

1. (c)
2. (d)
3. (b)
4. (a)
5. (c)

B. Fill in the Blanks

1. 10%
2. freezing point
3. Locust bean gum, Guar gum, Sodium alginate, Carrageenan, and Sodium carboxy methyl cellulose
4. flavour profile

C. State True or False

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

Session 3: Identification of Production Requirement

A. Multiple Choice Questions

1. (b)
2. (c)
3. (b)
4. (b)

B. Fill in the Blanks

1. flavor & texture
2. Pasteurization
3. Guar gum and carrageenan
4. 0-4 degree Celsius

C. State True or False

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

Unit 4: Basics of Ice Cream Production

Session 1: Production of Ice cream

A. Multiple Choice Questions

1. (c)
2. (b)
3. (b)
4. (c)
5. (d)

B. Fill in the Blanks

1. icecream
2. premium, standard or economy
3. sucrose
4. More than 2.5% but less than 10%

C. State True or False

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

Session 2: Unit Operations involved in Ice Cream Production

A. Multiple Choice Questions

1. (b)
2. (c)
3. (a)
4. (a)
5. (c)

B. Fill in the Blanks

1. Pasteurization
2. Composition
3. Continuous
4. Decrease
5. Volume

C. State True or False

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

Unit 5: Food Safety and Hygiene

Session 1: Food Safety

A. Multiple Choice Questions

1. (c)
2. (b)
3. (c)
4. (c)
5. (a)

B. Fill in the Blanks

1. TSS
2. Refractometer
3. Physical hazards
4. Oxygen
5. physical

C. State True or False

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

Session 2: Food Safety Regulations and Standards

A. Multiple Choice Questions

1. (b)
2. (d)
3. (d)
4. (b)
5. (d)

B. Fill in the Blanks

1. Schedule 4
2. Food Safety Management System
3. Bureau of Indian Standards
4. Good Manufacturing Practices
5. Hazards

C. State True or False

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

Session 3: Ice Cream Processing Technician

A. Multiple Choice Questions

1. (b)
2. (c)
3. (c)
4. (b)
5. (d)

B. Fill in the Blanks

1. quality
2. cross-contamination
3. 20
4. personal hygiene
5. pest control

C. State True or False

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