RQF LEVEL 5

FOPPM503

FOOD PROCESSING

Powdered Milk Making

TRAINEE'S MANUAL

October, 2024

POWDERED MILK MAKING

KOICA Korea International Cooperation Agency

TQUM TVET Quality Management Project

2024

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ACRONYMS

%: Percent

°C: Degree Celsius

°F: Degree Fahrenheit

N/9: Normality concentration of 0.11

CBT/A: Competency-Based Training/Assessment

CIP: 1. Clean in Place

CLR: Correct Lactometer Reading

CMT: California mastitis test

COP: Cleaning out of place

FDA: Food and Drugs Authorities

FIC: Food Information to Consumers

FIFO: First In first Out

g: gram

H2O2: peroxide

HPH: High pressure homogenization

hrs: hours

HTST: High-temperature, short-time

Kg: kilogram

KOICA: Korea International Cooperation Agency

ml: Milliliter

PPE: Personal Protective Equipment

RO: Reverse Osmosis

RQF: Rwanda Qualification Framework

RSB: Rwanda Standard Board

RTB: Rwanda TVET Board

SCC: Somatic Cell Count

TBC: Total bacteria count

TCC: Total Coliform Count

TQUM: TVET Quality Management Project

TS: Total Solid

TVET: Technical and Vocational Education and Training

UHT: Ultra-High Temperature

UV: Ultraviolet

WHO: World Health Organization

INTRODUCTION

This trainee's manual includes all the knowledge and skills required in food processing specifically for the module of "**Powdered Milk Making.''** Trainees enrolled in this module will engage in practical activities designed to develop and enhance their competencies.
The development of this training manual followed the Competency-Based Training and Assessment (CBT/A) approach, offering ample practical opportunities that mirror real-life situations.

The trainee's manual is organized into Learning Outcomes, which is broken down into indicative content that includes both theoretical and practical activities. It provides detailed information on the key competencies required for each learning outcome, along with the objectives to be achieved.

As a trainee, you will start by addressing questions related to the activities, which are designed to foster critical thinking and guide you towards practical applications in the labor market. The manual also provides essential information, including learning hours, required materials, and key tasks to complete throughout the learning process.

All activities included in this training manual are designed to facilitate both individual and group work. After completing the activities, you will conduct a formative assessment, referred to as the end learning outcome assessment. Ensure that you thoroughly review the key readings and the 'Points to Remember' section.

MODULE CODE AND TITLE: FOPPM503 POWDERED MILK MAKING

Learning Outcome 1: Pre-treat raw milk
Learning Outcome 2: Perform milk drying
Learning Outcome 3: Store powdered milk

Indicative contents
1.1 Preparing tools, equipment and materials used in powdered milk plant
1.2 Receiving Raw milk
1.3 Standardizing milk
1.4 Pasteurizing milk

Key Competencies for Learning Outcome 1: Treatment of Raw Milk

Knowledge	Skills	Attitudes
• Identification of tools and equipment used in powdered milk making • Identification of materials used in powdered milk making • Description of functionality of machines used in powdered milk plant • Description of the types of pasteurization • Description of milk standardization	• Cleaning tools and equipment used in powdered milk making • Receiving Raw milk • Adjusting milk fat content • Pasteurizing milk • Checking the effectiveness of pasteurization • Homogenizing pasteurized milk	• Being committed when selecting tools, equipment and materials • Being attentive when using cleaning products as some can be harmful to life • Being careful while using powdered milk making machine • Being honest while receiving milk • Being decision maker when receiving raw milk • Being accurate while standardizing milk

Duration: 15 hrs

Learning outcome 1 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Identify correctly materials, tools and equipment used in powdered milk making
2. Describe properly the functionality of machines used in powdered milk plant
3. Clean effectively tools and equipment according to cleaning methods
4. Receive properly raw milk according to acceptance criteria
5. Describe properly milk standardization according to the desired type of powdered milk
6. Adjust properly milk fat content according to the desired type of powdered milk
7. Pasteurize effectively milk according the pasteurization conditions
8. Describe correctly the types of pasteurization
9. Check properly the pasteurization effectiveness as applied in powdered milk making
10. Homogenize adequately the pasteurized milk according to homogenization methods

Resources

Equipment	Tools	Materials
• Lacto scan • Incubator • PPE • Weighing balance • Titration apparatus • Autoclave • Fire extinguisher • Tables • Pasteurizer • Homogenizer • Separator	• Lactometer • Thermometer • pH meter • Alcoholmeter • Brush • Mops • Bucket • Broom • Spoon • Measuring cylinder • Filters • Bunsen burner • Waste bin • Petri dish • Micropipette • Beaker	• Raw milk • Cleaning agent • Ethyl alcohol • Distilled water • Resazurin tablets • Sulphuric acid • Iso-amylic alcohol • CMT kits • Aflatoxin test kits • Sodium hydroxide N/9, • Phenolphthalein • Antibiotic kit • Detergent • Disinfectant • All-purpose cleaner • Alkaline phosphatase kit

• Vacuum evaporators • Dryers • Refrigerator • Freezer • Milk cooling tank • Centrifuge	• Colony counter • Milk sampler • Alcohol gun	• Glass cleaner

Indicative content 1.1: Preparing Tools, Equipment and Materials Used in Powdered Milk Plant

Duration: 3 hrs

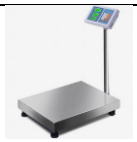
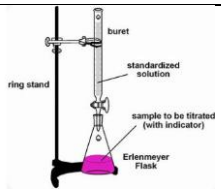
Theoretical Activity 1.1.1: Identification of tools and equipment used in powdered milk making

Tasks:

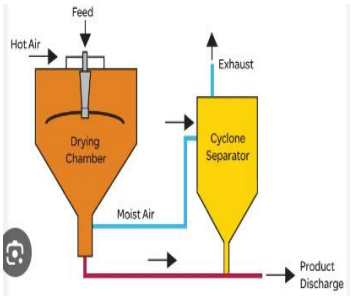
1. Answer the following questions related to the identification of tools, and equipment used in powdered milk making:
   i. Identify the tools and equipment used in powdered milk making.
2. Write the answers on papers or flip chart
3. Present the findings/answers to the whole class.
4. For more clarification, read the **key readings 1.1.1**

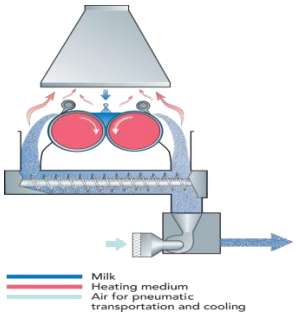
Key readings 1.1.1.: Identification of tools and equipment used in powdered milk making

Testing tools and Equipment		
Equipment/tool	**Image**	**Uses**
Lactometer		Used in determination milk density (Specific gravity)
Thermometer		Used for measuring the temperature of milk
pH meter		Used for determining the pH of milk
Alcohol gun		To measure the acidity in milk

Balance		For measuring the quantity of milk to be received
Sampler		allows to collect representative samples of every kind of milk
Titration apparatus		Are used in titration (for determining the concentration of any identified analyte (substance to be analyzed)
Centrifuge		Separate fat from milk and used in fat content analysis
Lactoscan		Instrument used for measuring the milk composition, temperature (°C), freezing point and pH
Incubator		Is an equipment used to maintain the sated artificial conditions (Temperatures and Humidity)
Cooler		This an equipment used to receive and cool milk
Hand dryer		Is an electrical machine which might make use of a heating and an air blower to dry the hands after hand washing

Autoclave		Autoclaves are used to perform sterilization
Milk pumps		It used for transferring raw milk, processed milk or any other fluids in plant
Cleaning tools		
Brush		Used for scrubbing surfaces to remove dirt and grime.
Mops		Ideal for cleaning floors by absorbing and wiping away liquid spills and fine particles
Bucket		Holds cleaning solutions or water, which can be used with mops or brushes
Broom		Sweeps larger debris and dirt from floors before mopping.
Equipment used in Milk Powder processing		
Milk cooling tank		This an equipment used to receive and cool milk

Pasteurizer		Heats the milk to kill harmful microorganisms.
Homogenizer		Breaks down fat globules into smaller particles, preventing separation.
Vacuum evaporator		Used to concentrate milk for various dairy products
Spray Dryer	 	It's a machine that rapidly dries liquids by atomizing them into fine droplets and exposing them to hot air.

Drum Dryer	 	drum dryers spread he milk onto heated drums and scraped off as powder.
Cooler		Cools the dried powder to prevent clumping.
Sifting Machine		Separates the powder into different particle sizes
Packaging Machine		Fills the powder into containers, such as cans or bags.
Sealing Machine		Seals the containers to preserve the product.

Theoretical Activity 1.1.2: Identification of materials used in powdered milk making

Tasks:

1. Answer the following questions related to identification of materials used in powdered milk making:
   i. According to your knowledge, identify materials used in powdered milk making.
2. Write the answers on papers or flip chart
3. Present the findings/answers to the whole class.
4. For more clarification, read the **key readings 1.1.2**

Key readings 1.1.2.: Identification of materials used in powdered milk making

- **Materials Used in a Powdered Milk Plant**

✓ **Raw Materials**

In a powdered milk plant, various materials are used throughout the production process. These materials are as follow:

- **Raw Milk:** The primary ingredient, obtained from dairy farms.
- **Skimmed Milk**: For producing skimmed milk powder, where the cream is removed before processing.
- **Cream**: For producing full-fat or enriched powdered milk.
- **Sugar:** Used to adjust sweetness and improve solubility.
- **Skim Milk Powder:** Added to adjust protein content and fat content.
- **Flavors:** Used to enhance taste and create different varieties.
- **Vitamins and Minerals:** Added to fortify the product with essential nutrients.

✓ **Cleaning Agents**

These are used to maintain the cleanliness and sanitation of the plant, tools and equipment, preventing contamination and ensuring food safety.

- **Alkaline Detergents:** Used for general cleaning of equipment and surfaces.
  Example: Sodium Hydroxide (NaOH) (Caustic Soda)
- **Acidic Detergents:** Used for removing mineral deposits and milk residues.
  Example: Nitric Acid (HNO_3)
- **Neutrals like** water
- **Disinfectants like** Chlorine-based Cleaners (Sodium Hypochlorite)
- **Sanitizers:** Used to kill microorganisms on food contact surfaces.
- **Degreasers:** Used to remove grease and oil from equipment.

✓ **Reagents**

Acids, antioxidants, and colorants are used during the processing of milk to modify its properties, improve its shelf life, and enhance its appearance.

- **Acids (e.g., citric acid):** Used for pH adjustment and to precipitate proteins.

- **Antioxidants:** Used to prevent oxidation and rancidity.
- **Colorants:** Used to improve the appearance of the product.

✓ **Packaging Materials**

Powdered milk is packaged in various materials depending on the intended use. Plastic bags are used for bulk storage, while paperboard cartons and tin cans are used to package small and medium size for direct consumption. Aluminum foil is often used as a barrier layer to protect the product from moisture and oxygen.

- **Plastic Bags:** Used for bulk packaging of powdered milk.
- **Paperboard Cartons:** Used to package small and medium size for direct consumption.
- **Tin Cans:** Used for storing powdered milk in larger quantities.
- **Aluminum Foil:** Used as a barrier layer in packaging to prevent moisture and oxygen penetration.
- **Multi-layer Paper Bags with Polyethylene Liners:** For bulk packaging (typically 25 kg bags) to ensure moisture protection and mechanical strength.
- **Cardboard Boxes:** For outer packaging and transportation protection.

Practical Activity 1.1.3: Cleaning tools and equipment used in powdered milk making

Task:

1: Referring to the previous theoretical activity 1.1.1 &1.1.2, go to the powdered milk making workshop to perform the following task:
Clean tools and equipment used in powdered milk making.
2: Apply safety precautions.
3: Present your work to the trainer/ workshop assistant. Ask for clarification where necessary
4: Read key **reading 1.1.3**
5: Perform the task provided in application of **learning 1.1.**

Key readings 1.1.3: Cleaning tools and equipment used in powdered milk making

- **Cleaning of tools and equipment used in powdered milk plant**

✓ **Criteria of selection of cleaning agent**

When choosing cleaning agents for a powdered milk plant, several factors should be considered:

- **Compatibility with Materials:** The cleaning agent should not damage or corrode the equipment materials (e.g., stainless steel, rubber, glass).

- **Effectiveness:** The cleaning agent should effectively remove milk residues, fats, proteins, and mineral deposits.
- **Safety:** The cleaning agent should be safe for employees to handle and use.
- **Regulatory Compliance:** The cleaning agent should comply with food safety regulations and standards.
- **Microbial Control:** The cleaning agent must be effective in reducing or eliminating microbial contamination to the acceptable level. Cleaning agents like chlorine-based cleaners or peracetic acid are commonly used to disinfect surfaces.
- **Temperature and Concentration Compatibility**: The cleaning agent should work effectively at temperatures suitable for the plant's operations, and its concentration should be manageable within the cleaning systems.

✓ **Cleaning methods**

The production of powdered milk involves a meticulous cleaning process to ensure product safety and quality. Both dry and wet cleaning methods are applied, each with its specific purpose and application.

1. **Dry Cleaning**

Dry cleaning is primarily method involves the removal of dust and loose particles from equipment and surfaces using tools like brushes, air blowers, or vacuum systems. It is particularly beneficial for maintaining hygiene without water, thus reducing the risk of contamination. It is typically the first step in the cleaning process and involves the following methods:

- **Vacuuming:** Powerful industrial vacuums are used to remove dust and powder from hard-to-reach areas, such as corners, crevices, and overhead surfaces.
- **Compressed Air:** Compressed air is used to dislodge stubborn particles from equipment and piping. It is important to ensure that the compressed air is clean and dry to prevent contamination.
- **Brushing:** Soft brushes are used to gently remove dust and powder from delicate surfaces.

2. **Wet Cleaning**

Wet cleaning is the most effective method that involves the use of water and cleaning agents to wash equipment and surfaces thoroughly. It includes processes like rinsing, scrubbing, and sanitizing to eliminate residues and bacteria. Wet cleaning is vital for ensuring that all traces of milk and contaminants are completely removed, thereby promoting hygiene and safety in the powdered milk production process.

It involves the following steps:

- **Pre-rinse:** The equipment and surfaces are rinsed with clean water to remove loose particles and prepare them for the cleaning solution.
- **Cleaning Solution Application:** A cleaning solution is applied to the surfaces. This solution typically contains a combination of detergents, enzymes, and sanitizers. The specific composition of the cleaning solution will depend on the type of equipment, the level of contamination and the type of contaminants.
- **Circulation and Soaking:** The cleaning solution is circulated through the equipment or allowed to soak on the surfaces for a specific period, depending on the level of contamination. This allows the cleaning agents to penetrate and break down milk residue.
- **Rinsing:** The equipment and surfaces are thoroughly rinsed with clean water to remove all traces of the cleaning solution.
- **Sanitization:** A sanitizing solution is applied to the surfaces to kill any remaining bacteria. This is typically done with a diluted bleach solution or other approved sanitizers.
- **Final Rinse:** The equipment and surfaces are rinsed again with clean water to remove any residual sanitizer.


Theoretical Activity 1.1.4: Description of functionality of machines used in powdered milk plant

Tasks:

1. Answer the following questions related to the functionality of machines used in powdered milk making:

I. Describe the functionality of machines used in powdered milk making.

2. Write the answers on papers or flip chart
3. Present the findings/answers to the whole class.
4. For more clarification, read the **key readings 1.1.4**

Key readings 1.1.4.: Description of functionality of machines used in powdered milk plant

- **Functionality of machines used in powdered milk plant**
  - ✓ **Evaporator**

Milk is fed into the evaporator, which reduces its water content by applying heat under reduced pressure (vacuum conditions). This allows the water to evaporate at

lower temperatures, preventing damage to the milk's nutrients. The evaporator can be a **falling film evaporator**, where milk flows down vertical tubes and is heated while water vapor is removed. This step increases the concentration of solids in the milk before it is dried.

- ✓ **Spray Dryer**

The concentrated milk from the evaporator is sprayed into a large chamber using an **atomizer** or a high-pressure nozzle. At the same time, hot air (160-200°C) is introduced into the drying chamber. As the milk droplets come into contact with the hot air, the water in the droplets evaporates almost instantly, leaving fine milk powder particles. The powder falls to the bottom of the chamber, while the air and moisture exit through the top.

- ✓ **Fluid Bed Dryer**

The partially dried milk powder from the spray dryer is further dried and cooled in a **fluid bed dryer**. In this machine, hot air is passed through a perforated surface, causing the powder to become suspended (fluidized) in the air. This removes any remaining moisture and ensures the powder is fully dry, with a moisture content of about 3-5%. The fluid bed dryer also helps cool the powder to prevent clumping and degradation.

- ✓ **Silos and Storage Tanks**

Silos are used to store large quantities of milk powder before it is packaged. These are airtight containers that protect the powder from moisture, contaminants, and oxidation. Liquid milk or cream is stored in stainless steel tanks that are temperature-controlled to maintain quality.

- ✓ **Bagging Machine (Powder Packaging Machine)**

The milk powder is fed into the packaging machine, where it is automatically weighed and filled into bags or pouches. The system ensures accurate quantities are filled based on preset specifications. After filling, the packaging machine seals the bags or pouches to protect the powder from moisture and contamination. Some machines also perform vacuum packing or nitrogen flushing to further preserve the product.

- ✓ **Conveyor System**

The conveyor system consists of belts or rollers that move milk products between various stages in the production process, from raw milk intake to finished product packaging. For example, powder can be transported from the dryer to the bagging station via conveyor belts or pneumatic conveying systems. This automation reduces labor costs and increases efficiency.

- ✓ **Vacuum Packaging Machine**

In vacuum packaging, the air inside the package is removed using a vacuum pump before sealing. This minimizes the exposure of the powder to oxygen, which could

lead to oxidation and spoilage. After the vacuuming process, the package is sealed tightly to prevent moisture ingress.

- ✓ **Vibrating Sieves/Screening Machines**

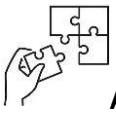
The milk powder passes through a vibrating sieve, which shakes the powder to break up clumps and remove oversized particles. The sieve has fine mesh screens that allow only uniform-sized particles to pass through. This ensures the powder's texture is smooth and consistent.

- ✓ **Blending Machines**

Blending machines are used when fortifying milk powder with additives like vitamins or minerals. The machine tumbles the powder in a rotating drum or uses a ribbon blender to ensure all the components are evenly mixed.

Points to Remember

- Tools and equipment used can vary depending on the scale of production, the desired product quality, and the regulations in place.
- Efficient operation of these tools ensures high product quality and hygiene throughout the process
- The specific ingredients and materials used can vary depending on the intended use of the powdered milk, regional regulations, and consumer preferences.
- By following proper cleaning protocols and using appropriate tools and cleaning agents, manufacturers can ensure the safety and quality of their powdered milk products.
- These machines work together in a coordinated manner to ensure efficient production, from the raw milk stage to the final powdered milk product.
- Each step requires precise control of temperature, moisture, and air to maintain product quality and safety.



Application of learning 1.1.

You are requested to go to the workshop of powdered milk making to clean tools and equipment.

Indicative content 1.2: Receiving Raw Milk

Duration: 6 hrs

Practical Activity 1.2.1: Testing raw milk

Task:

1: You are requested to go to the powdered milk making workshop and perform the following task:
Test raw milk used in powdered milk making.
2: Apply safety precautions.
3: Present your work to the trainer/ the workshop assistant. Ask for clarification where necessary.
4: Read key reading 1.2.1
5: Perform the task provided in application of learning 1.2.

Key readings 1.2.1.: Testing raw milk

- **Raw milk acceptance criteria**

These criteria often vary depending on local regulations and further processing. However, some common standards include:

✓ **Microbiological Quality**

- **Pathogen-free:** The milk should be free from harmful pathogens such as Salmonella, E. coli, Listeria monocytogeness, and Campylobacter.
- **Total Coliform Count (TCC):** A limited number of total coliform bacteria, which are indicators of potential fecal contamination.
- **Somatic Cell Count (SCC):** A low somatic cell count, indicating healthy cows and reduced risk of mastitis.

✓ **Physical and Chemical Properties**

- **Temperature:** The milk should be stored and transported at a temperature that prevents bacterial growth.
- **Acidity:** The acidity level should be within a specific range to ensure freshness and prevent spoilage.
- **Fat and Protein Content:** The milk should meet minimum standards for fat and protein content to ensure nutritional value.
- **Freezing Point:** The freezing point should be within a specific range to prevent adulteration.
- **Density:** Normal density ranging from 1.025-1.033g/cm^3

✓ **Sensory Attributes**

- **Odor:** The milk should have a normal, milk-like odor without any off-flavors.
- **Flavor:** The milk should taste fresh and free from any foreign or undesirable flavors.
- **Appearance:** The milk should be a uniform, opaque yellowish-white without any abnormal sediments or clots.

- **Preliminary Raw Milk Tests: Identification, Protocol, and Application**

✓ **Identification:**

Preliminary raw milk tests are designed to quickly assess the quality and safety of milk before further processing or consumption. These tests often focus on detecting common contaminants and abnormalities that can affect the milk's quality.

✓ **Protocol:**

The specific protocol for preliminary raw milk tests can vary depending on the intended use of the milk and local regulations. However, common tests include:

1. **Organoleptic Evaluation:**

Organoleptic test detects if the milk has a bad smell, or abnormal color, or any unpleasant taste, or any off-flavours, taints smells and visible contaminants or contains particles.

Procedure:

- Open a can of milk or milk container
- Immediately smell the milk
- Observe the appearance of the milk
- If still unable to make a clear judgment of the milk, taste the milk, but do not swallow it!
- Look at the can lid and the milk can to check for cleanliness

Notes: If the milk has a bad smell or abnormal colour, or contains particles, it should be rejected. If none of them accept.

2. **Acidity evaluation:**

- Use a pH meter to determine the acidity of the milk. An abnormal pH can indicate spoilage or contamination.
- The alcohol test: The alcohol test is mainly used to detect the degree of acidity of the supplier's milk.

Materials

- Alcohol gun or syringe
- Beaker or glass
- 68% alcohol *

Procedure

- Put equal volumes of milk and 68% alcohol in a test tube (e.g. 2 ml of milk in 2 ml of 68% alcohol).
- Invert the test tube several times; keep your thumb pressed tightly over the open end of the tube.
- Examine the tube to see whether the milk has coagulated. If it has, fine particles of curd will be visible.

Results

If the milk is of good quality, there will be no coagulation, clotting, flaking or precipitation.

If the milk has become acidic (pH below 6.4) it will flocculate.

3. Mastitis Test:

Conduct a mastitis test to check for inflammation of the mammary glands, which can affect milk quality.

Procedures:

- Take about 1 teaspoon (2 cc) milk from each quarter. This is the amount of milk that would be left in the cups if the CMT Paddle were held nearly vertical
- Add an equal amount of CMT solution to each cup in the paddle.
- Rotate the CMT Paddle in a circular motion to thoroughly mix the contents. Do not mix more than 10 seconds
- Read the test quickly. Visible reaction disintegrates after about 20 seconds. The reaction is scored visually. The more gel formation, the higher the score.

Interpretation:

- No thickening: Healthy milk.
- Slight thickening: Mild infection.
- Strong gel formation: Severe infection.

4. Lactometer test or density test:

The Lactometer test is a quick method used to detect adulteration of milk by adding water.

Materials

- Measuring cylinder 200-250 ml
- Lactometer

Procedure

- First, read the temperature of the milk
- Mix the milk sample gently and pour about 200 ml it into a measuring cylinder.
- Slowly dip the lactometer into the milk and leave it. It will sink slowly into the milk and then stop.

- Take the lactometer reading just above the surface of the milk
- Proceed to the reading of the lactometer

Results

- At 15°C the normal specific gravity of milk ranges from 1.026 to 1.032. Below the value indicate the possible addition of water to the milk.
- At 20°C the normal specific gravity of milk ranges from 1.028 to 1.032. Below the value indicate the possible addition of water to the milk.

The specific gravity of milk is calculated by the following formula.

Specific Gravity of milk is = 1 + CLR / 1000

Where CLR = Corrected lactometer reading.

✓ **Application:**

Preliminary raw milk tests are essential for:

- **Dairy Farms:** To monitor the quality of milk produced and identify any issues that need to be addressed.
- **Milk Processing Plants:** To ensure the safety and quality of the milk received and to prevent the processing of contaminated milk.
- **Regulatory Agencies:** To monitor compliance with food safety regulations and to detect any public health risks.
- **Quality Control**: Helps to identify spoiled milk, detect adulteration, and ensure that only milk of proper quality moves forward in the supply chain.
- **Consumer Safety**: Preliminary tests help ensure that milk entering the food system is safe for human consumption, reducing risks of foodborne illness.

Note: While preliminary tests can provide valuable information, they should be complemented by more comprehensive laboratory analysis to ensure the overall safety and quality of the milk.

Practical Activity 1.2.2: Grading raw milk

Task:

1: You are requested to go to the powdered milk-making workshop and perform the following task:

Grade raw milk used in powdered milk making.

2: Apply safety precautions.

3: Present your work to the trainer/ workshop assistant. Ask for clarification where necessary

4: Read key reading 1.2.2

5: Perform the task provided in application of learning 1.2.

Key readings 1.2.2.: Grading raw milk

- **Raw milk grading**

Raw milk grading is a system used to assess the quality and safety of milk produced on dairy farms. This grading system is typically implemented by government agencies or industry organizations to ensure that consumers receive milk that meets certain standards.

Common Grading Factors:

- ✓ **Physical and Chemical Properties:** This includes testing for factors such as fat content, density and protein content.
- ✓ **Microbiological Quality:** This includes testing for the presence of harmful bacteria like Salmonella, E. coli, and Listeria monocytogenes. The rapid test uses to determine the level of bacteria in milk is resazurin test.

Raw Milk Grading Categories

Grade A Milk

Raw milk Grade A is the highest quality standard for raw milk. It meets stringent criteria to ensure safety and suitability for consumption. Here are some key characteristics of raw milk Grade A:

- ✓ Low Bacterial Count: The number of bacteria present in the milk is significantly lower than in lower grades, reducing the risk of foodborne illness.
- ✓ Low Somatic Cell Count: The number of white blood cells (somatic cells) is minimal. A high somatic cell count can indicate mastitis, a disease that affects the cow's udder and can lead to reduced milk quality.
- ✓ No Antibiotic Residue: The milk is free from any detectable levels of antibiotics, which can be harmful to consumers and interfere with fermentation processes in dairy production.
- ✓ Proper Temperature Control: The milk has been stored and transported at appropriate temperatures (below 45°F or 7°C) to prevent bacterial growth.
- ✓ Acceptable Physical Appearance: The milk has a normal color, texture, and odor with no signs of abnormalities that could indicate quality issues.

Grade B Milk

Grade B milk is of slightly lower quality than Grade A and is primarily used in the production of dairy products such as cheese, butter, and powdered milk. It is not sold as fluid milk for direct consumption. Here are the key characteristics:

- ✓ Moderate Bacterial Count: The bacterial count is higher than in Grade A milk but still controlled to acceptable levels, typically under 100,000 bacteria per milliliter.

- ✓ Somatic Cell Count: The somatic cell count is generally higher than Grade A, but still within acceptable limits for processing.
- ✓ No Antibiotic Residue: Like Grade A, Grade B milk is free from antibiotics to ensure safe dairy product manufacturing.
- ✓ Proper Temperature Control: The milk is stored and transported under the same temperature standards to prevent spoilage.
- ✓ Physical Appearance: It should have a normal color and odor, though the quality may be less stringent than Grade A.
- ✓ Usage: Suitable for dairy product manufacturing but not typically sold as fluid milk.

Grade C or Non-Grade Milk (Rejected)

Milk in this category does not meet the standards for human consumption or dairy product manufacturing without further treatment. It is considered unsuitable due to poor quality or contamination.

- ✓ High Bacterial Count: The bacterial count exceeds acceptable limits, making the milk a health risk.
- ✓ High Somatic Cell Count: A very high somatic cell count can indicate severe udder infections, impacting milk quality.
- ✓ Possible Antibiotic Residue: This milk may contain traces of antibiotics, making it unsafe for both human and animal consumption.
- ✓ Improper Temperature Control: Milk may not have been stored at proper temperatures, leading to spoilage.
- ✓ Poor Physical Appearance: The milk may show signs of abnormalities in color, odor, or texture, indicating it is unfit for processing.
- ✓ Usage: Rejected milk cannot be used for human consumption or animal feed without further processing, such as pasteurization or other treatment methods to ensure safety.

Milk is graded according to their chemical composition:

✓ **Grading Milk by Fat Content**

Milk is often graded based on its fat content, which is a key factor in determining its nutritional value and flavor profile. Here are some common grading systems used to classify milk by fat content:

1. Whole Milk: This is the most common type of milk, containing a full range of fat content (typically around 3.25% to 3.5%). Whole milk has a rich, creamy flavor and is a good source of calcium, protein, and vitamins.

2. Reduced Milk: This type of milk has a lower fat content than whole milk, typically around 2%. It offers a balance of flavor and nutrition, making it a popular choice for those who want to reduce their fat intake.

3. Low fat Milk: This milk has a lower fat content than reduced milk, typically around 1%. It is a good option for those who are watching their fat intake but still want to enjoy the nutritional benefits of milk.

4. Fat-Free Milk (Skim Milk): This type of milk has less than 0.1% fat. It is a good choice for those who are trying to limit their fat intake or have certain dietary restrictions.

✓ **Grading Milk by Density**

Density is a measure of how much mass is contained in a given volume. In the case of milk, density can be an indicator of its quality and composition. While it's not as commonly used as grading by fat content, density can be a useful parameter for certain applications, especially in quality control and processing.

✓ **Grading Milk by Protein Content**

Protein content is a crucial nutritional component of milk and is often used as a grading factor. Higher protein content generally indicates a more nutritious milk

✓ **Grading Milk by Total Bacteria Count**

Total bacteria count (TBC) is a critical indicator of milk quality and safety. A high TBC can indicate potential contamination or poor hygienic practices during production and handling.

Practical Activity 1.2.3: Weighing, filtrating and storing of raw milk

Task:

1: You are requested to go to the powdered milk making workshop and perform the following task: Weigh, filtrate and store raw milk used in powdered milk making.

2: Apply safety precautions.

3: Present your work to the trainer/ workshop assistant. Ask for clarification where necessary.

4: Read key reading 1.2.3

5: Perform the task provided in application of learning 1.2.

Key readings 1.2.3.: Weighing, filtration and storing of raw milk

- **Weighing and filtration of raw milk**

Weighing and filtration of raw milk are essential steps in the handling and processing of milk to ensure quality control, prevent contamination, and prepare the milk for

further processing or sale. These procedures are important for both farmers and dairy processors.

1. Weighing of Raw Milk

Weighing raw milk is necessary to determine the volume and mass of milk collected for purposes such as:

- ✓ **Accurate Record Keeping**: Weighing helps farmers, milk collection centers, and processors keep track of milk yields.
- ✓ **Pricing and Payments**: Milk pricing is often based on volume or weight, and accurate weighing ensures farmers are compensated fairly.
- ✓ **Milk Distribution**: Knowing the exact weight or volume of milk ensures that transportation and storage systems are appropriately sized and handled efficiently.

Procedure for Weighing Raw Milk:

- ✓ **Milk Collection**: After milking, the raw milk is typically collected in clean, calibrated containers, such as stainless steel milk cans or bulk tanks.
- ✓ **Calibration and Accuracy**: Scales used for weighing milk must be calibrated regularly to ensure accuracy, as errors in weighing can affect payments to farmers and overall milk accounting.
- ✓ **Weighing**: A **weighing scale** or **weighing balance** designed for milk is used to measure the mass of the milk container, then subtract the tare weight of the container itself. In large-scale operations, **bulk milk tanks** are equipped with automated weighing systems that measure milk directly.
- ✓ **Record Keeping**: Weighing logs are maintained to document the amount of milk collected from each source (e.g., individual farms, herds) for transparency and traceability.

1. Filtration of Raw Milk

Filtration of raw milk is an essential step immediately after milking and before storage or transportation. This process helps remove visible impurities like dirt, hair, straw, and other debris that may have entered the milk during the milking process. Filtration does **not remove bacteria** or pathogens; it is only meant to eliminate physical particles.

Purpose of Filtration:

- ✓ **Improved Milk Quality**: Removing impurities ensures that the milk has a clean appearance and prevents the contamination of dairy products during processing.
- ✓ **Protection of Equipment**: Filtration helps protect dairy processing equipment by preventing clogging or damage caused by foreign matter in the milk.
- ✓ **Compliance with Regulations**: Many food safety standards require that milk be filtered to meet hygiene and quality criteria.

Procedure for Filtration of Raw Milk:

- ✓ **Filtration Equipment**:
- Milk is passed through **milk filters**, typically made of fine mesh or synthetic fibers, designed to capture solid particles.

- **Single-use filters** or **reusable filters** are used, depending on the dairy's capacity and milk volume. These filters are designed to handle the specific flow rates and volumes of the milk being processed.

- ✓ **Types of Filters**:

- **In-line filters**: Often used in larger dairy operations, these filters are placed in the pipeline as milk flows from the milking equipment to the bulk tank.
- **Manual filters**: In small farms or manual systems, filters are placed over the milk collection container, and the milk is poured through them.
- ✓ **Frequency of Filtration**:
- Filtration is done after each milking session, and the filters should be replaced or cleaned regularly to ensure efficiency.
- In large dairy operations, milk may be filtered multiple times, especially before processing to guarantee its cleanliness.
- ✓ **Handling and Cleaning**:
- The filters must be cleaned and sanitized after each use to prevent bacterial growth and contamination.
- Proper disposal of used filters is important in maintaining hygiene.

2. Raw Milk Storage Conditions

Proper storage of raw milk is crucial to maintain its quality and safety. Here are the recommended conditions:

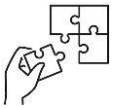
- ✓ **Temperature**
  Refrigerated: Immediately after milking, store raw milk in a refrigerator at 40°F (4°C). This significantly slows the growth of harmful bacteria.
  Bulk Tank: For larger quantities, a bulk tank should be kept at 38-40°F (3-4°C).
- ✓ **Cleanliness**
  Containers: Ensure that all containers used for storing raw milk are clean and sanitized to prevent contamination.
- ✓ **Storage Area:** The storage area should be free from dust, dirt, and other contaminants.
- ✓ **Duration**

Refrigerated: Raw milk can typically be stored in a refrigerator for 2-3 days before pasteurization.

Bulk Tank: In a bulk tank, raw milk can be stored for 48-72 hours under optimal conditions.

Points to Remember

- Regular testing ensure that only high-quality milk is used in the production of dairy products such as powdered milk, and it helps maintain the overall safety and consistency of the dairy supply chain.
- Grading raw milk ensures that it meets safety, quality, and compositional standards.
- By carefully weighing, filtering, and storing raw milk, dairy processors maintain the high quality and safety standards necessary for producing products such as powdered milk



Application of learning 1.2.

You are requested to go to the powdered milk making workshop to receive raw milk used in powdered milk making.

Indicative content 1.3: Standardizing Milk

Duration: 3 hrs

Theoretical Activity 1.3.1 Description of milk standardization

Tasks:

1. You are requested to answer the following questions related to milk standardization used in powdered milk making.
   I. What do you understand by milk standardization?
   II. What are the purposes of milk standardization?
   III. Suggest any standardization methods that may be used to standardize milk?
2. Write the answers on papers or flip chart
3. Present the findings/answers to the whole class.
4. For more clarification, read the **key readings 1.3.1**

Key readings 1.3.1.: Description of milk standardization

- **Standardizing milk**
  - ✓ **Definition**

    Milk standardization is the process of adjusting the fat content (raising or lowering) of milk to a specific level.
  - ✓ **Objective of standardization of milk**
    - It helps to achieve uniform milk composition, including fat content
    - It helps to meet consumer expectations for quality and consistency in milk products, leading to greater customer satisfaction and trust.
    - It ensures that milk products meet specific nutritional standards.
    - It ensures that milk meets national and international regulatory requirements.
    - It ensures that milk and dairy products are accurately labeled with their nutritional content, providing consumers with clear and reliable information.
    - It can lead to more efficient production processes by reducing variability and waste.
  - ✓ **Milk separation methods**

    Milk separation methods are used to divide milk into its various components, primarily fat and skim milk. The two main methods for milk separation are gravitational (traditional) separation and centrifugal separation. Here's a detailed overview of each method:

1. Gravitational or Traditional Separation

Gravitational separation, also known as traditional separation, is based on the principle of gravity. It relies on the natural tendency of milk's components to separate into different layers due to their varying densities.

Process:

In gravitational separation, milk is allowed to stand still in a container for a period. Over time, the fat, which is less dense than the liquid portion, rises to the top, forming a layer of cream. The remaining liquid, called skim milk, settles at the bottom. Once the milk has settled, the cream can be skimmed off the top, leaving behind the skim milk.

2. Centrifugal Separation

Centrifugal separation is a modern and efficient method of separating milk components using centrifugal force. It involves the use of a centrifuge to accelerate the separation process.

Process:

In a centrifuge, milk is spun at high speeds. The centrifugal force generated by the spinning causes the denser components (fat) to move outward towards the walls of the centrifuge, while the less dense components (skim milk) remain closer to the center. The separated components are then collected through different outlets. The cream is extracted from the outer part of the centrifuge, and the skim milk is collected from the center.

- **Mixing ratio calculation**

Fat standardization is the process of adjusting the fat content of milk to a desired level. Two common methods used for these calculations are the Pearson Square and the Algebraic method.

Pearson Square Method

The Pearson Square is a graphical representation that simplifies calculations.

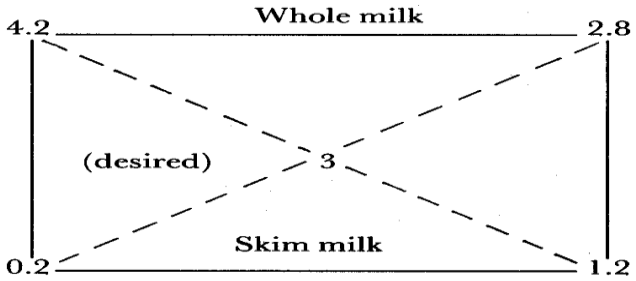
Steps:

- ✓ Draw a square.
- ✓ Place the desired fat percentage in the center.
- ✓ Place the fat percentages of the two milk sources in the opposite corners.
- ✓ Subtract the smaller fat percentage from the larger one.
- ✓ Place the difference in the remaining corner.
- ✓ The numbers in the opposite corners represent the proportions of each milk source needed to achieve the desired fat percentage.

Example:

The fat content of 300 kg of whole milk must be reduced from 4.2% to 3% using skim milk containing 0.2% fat

Answer:



- In order to reduce the fat content from 4.2% to 3%, 2.8 parts of whole milk have to be mixed with 1.2 parts of skim milk. Therefore:
- 2.8 kg of whole milk requires 1.2 kg skim milk,
- 300 kg of whole milk requires (1.2 × 300)/2.8 = 128.6 kg of skim milk
- Thus, 128.6 kg of skim milk (0.2% fat) must be added to 300 kg of whole milk (4.2% fat) to give 428.6 kg of milk containing 3% fat.

Algebraic Method

- **More flexible:** The algebraic method can handle more complex calculations, such as standardizing multiple components simultaneously.
- **Steps:**

1. Set up an equation using the desired fat percentage and the fat percentages of the milk sources.
2. Solve the equation to determine the proportions of each milk source needed.

Example:

You have a large quantity of cream with 18% fat. How much skim milk (0.1% fat) do you need to add to 100 liters of cream to reduce the fat content to 10%?

Let:

- x = liters of skim milk (0.1% fat) to be added.
- The total volume after adding the skim milk will be 100+x liters.

Step 1: Set up the equation for the fat content.

The fat in the cream is 18% of 100 liters, and the fat in the skim milk is 0.1% of xxx liters. The desired fat content in the final mixture is 10% of the total volume.

Fat from cream + Fat from skim milk=Fat in final mixture

$0.18(100) + 0.001(x)=0.10(100+x)$

Step 2: Solve the equation.

$18+0.001x=10+0.10x$

Subtract 10 from both sides:

8+0.001x=0.10x
Subtract 0.001x from both sides:
8=0.099x
Solve for x:

$$x = \frac{8}{0.099} \approx 80.81$$

Result:
You need to add approximately **80.81 liters** of skim milk to 100 liters of cream to reduce the fat content to 10%.

Practical Activity 1.3.2 Adjusting milk fat content

Task:

1: Referring to the previous theoretical **activity 1.3.1**, go to the powdered milk making workshop and perform the following task:
Adjust milk fat content used in powdered milk making.
2: Apply safety precautions.
3: Adjust milk fat content to be used in powdered milk making.
4: Read key **reading 1.3.2**
5: Perform the task provided in application of **learning 1.3.**

Key readings 1.3.2.: Description of milk standardization

- **Methods of milk standardization**

Milk standardization involves adjusting the composition of milk to achieve a consistent product with specific fat and solids content. This is essential for meeting product specifications and consumer expectations. Here are the primary methods of milk standardization:

1. Addition of Concentrated Non-Fat Milk Solids

This method involves adding concentrated non-fat milk solids to adjust the solids-not-fat (SNF) content of the milk. Common forms of concentrated non-fat milk solids include skimmed milk powder and condensed skim milk.

How It Works:

- **Skimmed Milk Powder**: Dry milk powder made from evaporated skim milk. It's added to liquid milk to increase the non-fat solids content without adding fat.

- **Condensed Skim Milk**: Skim milk that has been concentrated through evaporation and often sweetened. It is added to liquid milk to boost the non-fat solids content.

Advantages:

- ✓ Increases the total solids content of the milk, which can improve texture and mouthfeel.
- ✓ Extended Shelf Life

Disadvantages:

- ✓ Using these concentrated forms can be more expensive compared to other methods.
- ✓ Requires careful handling and mixing to ensure uniform distribution in the milk.

2. Addition of Skimmed Milk

This method involves adding liquid skimmed milk to whole milk to adjust the fat content and achieve the desired fat-to-solids ratio.

How It Works:

- ✓ **Skimmed Milk Addition**: Liquid skimmed milk, which is milk with the fat removed, is blended with whole milk to dilute the fat content to the desired level.
- ✓ **Ratio Adjustment**: The amount of skimmed milk added is carefully measured to achieve the target fat percentage in the final product.

Advantages:

- ✓ Easier to control and implement in dairy operations compared to using powdered or condensed products.
- ✓ Often less expensive than using powdered milk solids or other concentrated forms.

Disadvantages:

- ✓ Requires accurate measurement and mixing to achieve the correct fat content and consistency.
- ✓ Liquid skimmed milk has a shorter shelf life compared to powder forms, which may require more careful handling and storage.

3. Addition of Cream

This method involves adding cream to milk to increase the fat content and achieve the desired milk composition.

How It Works:

- ✓ **Cream Addition**: Cream, which is the high-fat layer separated from milk, is added to milk to increase its fat content.
- ✓ **Blending**: The cream is blended with whole milk to achieve the target fat percentage in the final product.

Advantages:

- ✓ Enhances the richness and flavor of the milk product due to the higher fat content.

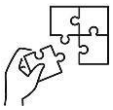
- ✓ Useful for creating various milk products with different fat levels, such as cream, half-and-half, and certain types of cheese.

Disadvantages:

- ✓ Requires careful management to achieve the desired fat content without over- or under-diluting the milk.
- ✓ Cream is generally more expensive than skimmed milk and can impact the overall cost of production.

Points to Remember

- Milk standardization is a critical process in dairy production that involves adjusting the fat and solids-not-fat content of milk to meet legal standards and produce uniform, high-quality dairy products.
- Adjusting milk fat content is an essential part of dairy processing that enables the production of a variety of milk products to meet consumer preferences and regulatory standards.



Application of learning 1.3.

You are requested to go to the workshop of powdered milk making to standardize raw milk used in powdered milk making.

Indicative content 1.4: Pasteurizing Milk

Duration: 3 hrs

Practical Activity 1.4.1: Pasteurizing milk

Task:

1: You are requested to go to the powdered milk making workshop and perform the following task:
Pasteurize milk used in powdered milk making.
2: Apply safety precautions.
3: Present your work to the trainer/ workshop assistant. Ask for clarification where necessary
4: Read key **reading 1.4.1**
5: Perform the task provided in application of **learning 1.4.**

Key readings 1.4.1.: Pasteurizing milk

- **Pasteurization in Powdered Milk Making**

Pasteurization is a crucial step in the production of powdered milk. It serves to ensure the safety and quality of the final product by destroying harmful microorganisms.

- **Objectives of Pasteurization in Powdered Milk Making**
  - ✓ **To eliminate pathogenic bacteria:** Pasteurization effectively removes harmful bacteria such as Salmonella, Listeria, and Escherichia coli, which can cause foodborne illnesses.
  - ✓ **To improve shelf life:** By reducing the microbial load, pasteurization extends the shelf life of powdered milk, preventing spoilage and ensuring product safety.
  - ✓ **To enhance product quality:** Pasteurization can improve the overall quality of powdered milk by removing undesirable flavors and odors caused by bacteria.
- **Types of Pasteurization Used in Powdered Milk Making**
  - ✓ **High-temperature, short time (HTST) pasteurization:** This is the most commonly used method in powdered milk production. It involves heating milk to 72°C (162°F) for 15 seconds. HTST pasteurization is effective in destroying harmful microorganisms while maintaining the nutritional value of the milk.

- ✓ **Ultra-high-temperature (UHT) pasteurization:** UHT pasteurization involves heating milk to 138°C (280°F) for 2 seconds. This method is less commonly used in powdered milk production but can provide a higher level of sterilization, resulting in a longer shelf life for the powdered milk.

- **Monitoring Pasteurization Factors in Powdered Milk Making**

Temperature and Time: These are two critical factors to monitor during the pasteurization process in powdered milk making. Ensuring accurate temperature and time control is essential to guarantee the safety and quality of the final product.

- ✓ **Temperature Monitoring**
  - **Accuracy:** Use calibrated thermometers or thermocouples to accurately measure the temperature of the milk during pasteurization.
  - **Consistency:** Maintain a consistent temperature throughout the pasteurization process. Deviations from the target temperature can compromise the effectiveness of pasteurization.
  - **Recording:** Keep detailed records of the temperature readings to ensure traceability and compliance with quality standards.
- ✓ **Time Monitoring**
  - **Precision:** Use timers or automated systems to accurately measure the duration of pasteurization.
  - **Consistency:** Maintain a consistent holding time at the target temperature. Insufficient holding time may not adequately kill harmful microorganisms.
  - **Recording:** Document the pasteurization time to provide evidence of compliance with regulatory requirements.

- **Monitoring Pasteurization Factors in Powdered Milk Making**

Temperature and Time: These are two critical factors to monitor during the pasteurization process in powdered milk making. Ensuring accurate temperature and time control is essential to guarantee the safety and quality of the final product.

Temperature Monitoring

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Time Monitoring

- **Precision:** Use timers or automated systems to accurately measure the

duration of pasteurization.

- **Consistency:** Maintain a consistent holding time at the target temperature. Insufficient holding time may not adequately kill harmful microorganisms.
- **Recording:** Document the pasteurization time to provide evidence of compliance with regulatory requirements.

Practical Activity 1.4.2: Checking the effectiveness of pasteurization

Task:

1: You are requested to go to the powdered milk making workshop and perform the following task:
Check the effectiveness of pasteurized milk used in powdered milk making.
2: Apply safety precautions.
3: Present your work to the trainer/ workshop assistant. Ask for clarification where necessary
4: Read key reading 1.4.2
5: Perform the task provided in application of learning 1.4.

Key readings 1.4.2.: Checking the effectiveness of pasteurization

- **Checking the effectiveness of pasteurization**
  - ✓ **Alkaline phosphatase test**

    Alkaline phosphatase is an enzyme which is naturally present in milk, but is destroyed at a temperature just near to the pasteurization temperature.

    Alkaline phosphatase test is used to indicate whether milk has been adequately pasteurized or whether it has been contaminated with raw milk after pasteurization.

    The test is not applicable to sour milk and milk preserved with chemical preservatives.

    <u>Apparatus required</u>

    - Water-Bath -maintained at 37±l^{o}C, thermostatically controlled.
    - Comparator - with special discs of standard colour glasses calibrated in µg p-nitro phenol per ml milk, and 2 x 25 mm cells.
    - Test Tubes - of size 16 x 1.50 mm and rubber stoppers to fit.
    - Pipettes - 1, 5, and 10 ml.

- Filter Paper - Whatman No. 2 or equivalent.
- Litmus Paper

Reagents

-**Buffer solution**: 3.5g of anhydrous sodium carbonate and 1.5g of sodium bicarbonate in one liter of distilled water. This is stored in a refrigerator and discard after 1 month.

-**Disodium p-nitrophenyl phosphate**: solid substrate that must be kept in the refrigerator.

-**Buffer-substrate solution**: 0.15g of substrate (disodium p-nitrophenyl phosphate) into a 100ml of distilled water and make it up to 100 ml with buffer solution. This solution should be stored in refrigerator and protected from light. It must be discarded after one week.

Procedure

-Pipette 5ml of buffer substrate into a clean, dry test tube followed by 1 ml of milk to be tested. Stopper the tube, mix (shake) by inversion and place in the water bath (incubate at 37^{o}c for 2 hours).
-At the same time place in the water bath a control tube containing 5 ml of the buffer substrate and 1ml of boiled milk of the same kind as that under test that is pasteurized, homogenized, low fat.
-After two hours, remove the tubes from the bath, invert each and read the colour developed using the comparator and special disc, the tube containing the boiled milk control being placed on the left of the stand and the tube containing the sample under test on the right.

Result Interpretation:

- **Positive Result:** A color change indicates the presence of alkaline phosphatase activity, suggesting that the pasteurization process may not have been completely effective.
- **Negative Result:** No color change indicates the absence of alkaline phosphatase activity, which is generally considered a good indicator of effective pasteurization.

✓ **Peroxidase test**

A sample of the pasteurized milk is tested for peroxidase activity using a specific reagent. If the enzyme is present, it will react with the reagent, producing a color change. The main function of the enzyme is **to catalyze the oxidation of molecules in the presence of hydrogen peroxide and to help production of products with a wide antimicrobial activity**.

Principle of the test

H_2O_2 + indicator ⟶ red coloured

In presence of an indicator and hydrogen peroxide, milk peroxidase catalyses forming a red compound with an intensity that is directly proportional to the concentration of peroxidase in the sample when measured at 505 nm.

Peroxidase Test Procedure

Materials:

- Pasteurized milk sample
- Peroxidase test kit (containing reagents and instructions)
- Test tubes
- Pipettes
- Water bath or heating block

Procedure:

- **Prepare the reagents:** Follow the instructions provided in the test kit to prepare the necessary reagents. This may involve diluting or mixing specific reagents.
- **Set up the test:**
  - Add a specified volume of the pasteurized milk sample to a test tube.
  - Add the appropriate amount of peroxidase reagent to the same test tube.
  - Mix the contents of the test tube gently.
- **Incubate:** Place the test tube in a water bath or heating block at the recommended temperature (usually around 37°C or 98.6°F) for the specified time (typically a few minutes).
- **Observe for color change:** After incubation, visually inspect the test tube for any color change. If peroxidase is present, it will react with the reagent, producing a color change.
- **Interpret results:**
  - **Positive result:** A color change indicates the presence of peroxidase activity, suggesting that the pasteurization process may not have been completely effective.
  - **Negative result:** No color change indicates the absence of peroxidase activity, which is generally considered a good indicator of effective pasteurization.

Practical Activity 1.4.3: Homogenizing pasteurized milk

Task:

1: You are requested to go to the powdered milk making workshop and perform the following task:
Homogenize pasteurized milk used in powdered milk making.
2: Apply safety precautions.
3: Present your work to the trainer/ workshop assistant. Ask for clarification where necessary
4: Read key reading 1.4.3
5: Perform the task provided in application of learning 1.4.

Key readings 1.4.3.: Homogenizing pasteurized milk

- **Homogenization of pasteurized milk**

Homogenization is a process used to reduce the size of fat globules in milk, creating a more uniform and stable product.

- **Purpose of Homogenization**
  - ✓ **Improved Texture:** Homogenization prevents the formation of cream lines, ensuring a consistent texture throughout the milk.
  - ✓ **Enhanced Stability:** Homogenized milk is less likely to separate into layers of cream and skim milk.
  - ✓ **Enhanced Appearance:** Homogenization creates a smoother, more uniform appearance for milk products.
  - ✓ **Extended Shelf Life:** By preventing the separation of fat globules, homogenization can help to extend the shelf life of milk.

Methods of homogenization

a) High pressure homogenization

- ✓ This is the most common method used in the dairy industry.
- ✓ Milk is forced through a narrow orifice at high pressure (typically 150-250 bar).
- ✓ The high pressure causes the fat globules to break down into smaller particles.

Advantages:

- ✓ Highly efficient and effective in creating a stable emulsion.
- ✓ Produces the finest fat globule size, leading to a smooth and creamy texture.
- ✓ Can handle milk with various fat contents.

Disadvantages:

- ✓ Requires high-pressure equipment, making it the most expensive method.
- ✓ Can slightly alter the taste and nutritional profile of milk due to high pressure impact.

b) Ultrasonic homogenization

- ✓ This method uses high-frequency sound waves causing the fat globules to break down.
- ✓ Ultrasonic homogenizers are often used for smaller-scale operations or for specific applications.

Advantages:

- ✓ Gentler process than HPH, potentially preserving milk's taste and nutritional value.
- ✓ Effective for smaller production volumes and less demanding homogenization needs.

Disadvantages:

- ✓ Less efficient than HPH, requiring longer processing times.
- ✓ Not as effective for producing extremely fine emulsions, leading to a potentially less creamy texture.
- ✓ Requires specialized equipment and can be more expensive than mechanical homogenization.

c) Mechanical homogenization

Milk is forced through a narrow gap between a rapidly spinning blade and a stationary stator, disrupting the fat globules through shear forces.

- ✓ This method involves the use of mechanical agitation to break down fat globules.
- ✓ It is less efficient than high-pressure or ultrasonic homogenization and is not as widely used.

Advantages:

- ✓ Simplest and most affordable method, suitable for small-scale operations.
- ✓ Easy to clean and maintain.

Disadvantages:

- ✓ Not as efficient as HPH or ultrasonic homogenization, requiring higher pressures for similar results.
- ✓ Can generate more heat due to friction, potentially impacting milk quality.
- ✓ May not achieve the same level of fineness and stability as other methods, leading to a slightly less creamy texture.

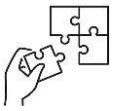
Comparison of Homogenization Methods:

Method	Pressure/Mechanism	Effectiveness	Application	Advantages
High-Pressure Homogenization	High pressure (100–250 bar)	Highly effective	Large-scale dairy production	Produces very fine, uniform fat globules

Ultrasonic Homogenization	Ultrasonic waves	Moderately effective	Specialty processing and some research labs	Can operate at lower temperatures
Mechanical Homogenization	Mechanical agitation/stirring	Less effective	Small-scale, batch production	Simple, cost-effective for smaller setups

Points to Remember

- By using heat to destroy harmful bacteria and extend shelf life, dairy producers can supply safe, nutritious milk that retains much of its original flavor and nutritional value.
- Ensuring the effectiveness of pasteurization involves a combination of real-time temperature monitoring, enzyme tests like the phosphatase test, microbiological testing, and chemical or sensory evaluation.
- Homogenization has become a standard practice in most commercial milk production, ensuring high-quality milk for a wide range of dairy products as fats are distributed throughout the milk.



Application of learning 1.4.

You are requested to go to the powdered milk making workshop to pasteurize and homogenize pasteurized milk.

Learning outcome 1 end assessment

Theoretical assessment

Q1. Read the following statement related to materials used in powdered milk making and answer **True** if statement is **correc**t, and **False** if the statement is **wrong**:

a) Skimmed milk is used in powdered milk to increase the fat content.
b) Cleaning product like Caustic Soda is effective to remove grease and oil from equipment.
c) Antioxidants are added to powdered milk to increase its protein content.
d) Cardboard boxes are used to protect powdered milk during transportation.
e) Powdered milk is only packaged in plastic bags for bulk storage.

Q2. The following are descriptions relating to cleaning of workplace of powdered milk processing workshop. Choose the appropriate description by encircling the correct letter:

a) Why is selection of cleaning agent being important in microbial control?

i) To change the color of the milk

ii) To reduce microbial contamination on surfaces

iii) To improve the smell of the cleaning agent

iv) To increase the acidity of the milk

b) Which of the following agents is commonly used for microbial control?

i) Sodium hydroxide

ii) Peracetic acid

iii) Nitric acid

iv) Water

c) Which cleaning technique is used for internal equipment like pipes and tanks without disassembling them?

i) Cleaning out of place (COP)

ii) Clean-in-place (CIP)

iii) Spray cleaning

iv) Soaking

d) Which cleaning technique involves disassembling equipment to clean external parts and areas that CIP cannot reach?

i) Clean-in-place (CIP)

ii) Spray cleaning

iii) Cleaning out of place (COP)

iv) Soaking

e) Which cleaning uses high-pressure spray nozzles to clean equipment surfaces?

i) Soaking

ii) Spray cleaning

iii) Scrubbing

iv) Rinsing

Q3. Read the following statement related to receiving raw milk and fill in the provided space by the appropriate term/number in brackets: (**alcohol, adulteration, somatic cell, 1.32, 1.26, bacteria, fat, water, mastitis**).

a. A low _____ count in raw milk indicates healthy cows and a reduced risk of mastitis.
b. The milk should be stored and transported at a temperature that prevents _____ growth.
c. The _____ test is mainly used to detect the degree of acidity in the milk by checking for coagulation.
d. The _____ test is used to check for inflammation of the mammary glands in cows, which can affect milk quality.
e. If the specific gravity of milk at 15°C is below _____, it may indicate the addition of water to the milk.
f. Preliminary raw milk tests help ensure the milk is safe for human consumption by identifying spoilage and detecting _____.

Q4 Match pre-treat raw milk terminologies in **Column A**, with their descriptions in **Column B**; and **write the letter corresponding to the correct description in provided space**.

Answer	Column A	Column B
…….	1. Purpose of Homogenization	a. Uses high-frequency sound waves to break down fat globules.
……..	2. High-Pressure Homogenization	b. Ensures a consistent texture throughout the milk.
……	3. Ultrasonic Homogenization	c. Simple, cost-effective for smaller setups.
……	4. Mechanical Homogenization	d. Most common method, forcing milk through a narrow orifice.
……..	5. Improved Texture	e. Creates a smoother, more uniform appearance for milk products.

…….	6. Alkaline Phosphatase Test	f. Used to check if milk has been pasteurized effectively.
…….	7. Peroxidase Test	g. Uses a reagent to detect enzyme activity indicating pasteurization effectiveness.
…….	8. Extended Shelf Life	h. Prevents the separation of fat globules, extending shelf life.
…….	9. Ultrasonic Homogenization Advantage	i. Gentler process that preserves milk's taste and nutritional value.

Q5. What is the function of alkaline phosphatase test?

Practical assessment

The production unit of XYZ School requested to supply pasteurized milk of reduced fat content with 2.5 % to their client A&B Hotel. You are requested to go to the powdered milk-making workshop to receive raw milk, standardize and pasteurize milk. The activity will be performed within four (4) hours. The activity will be performed within four (4) hours. All necessary tools and equipment are available in the workshop.

END

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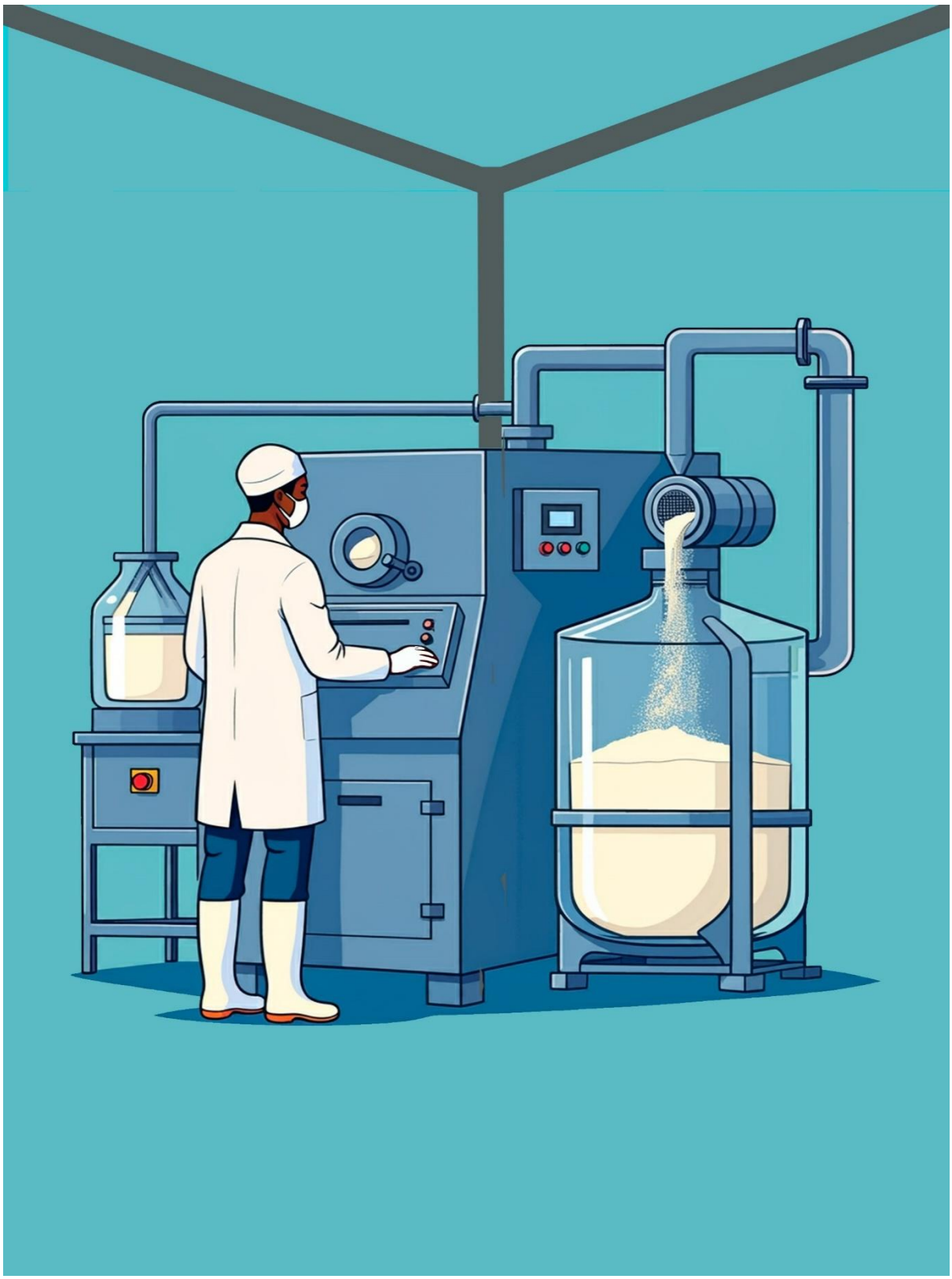


Indicative contents

2.1. Concentrating Milk

2.2. Drying Concentrated Milk

Key Competencies for Learning Outcome 2: Perform Milk Drying

Knowledge	Skills	Attitudes
• Description the types of concentrated milk and their specifications • Identification the factors that affect dryness of milk • Description of Powdered milk specifications • Description of the yield of the milk powder	• Concentrating the milk • Drying the concentrated milk • Analysing the quality of concentrated milk and powdered milk	• Being attentive when concentrating and drying the milk • Being honest while analysing the quality of concentrated milk and powdered milk • Being decision maker when analysing the quality of concentrated and powdered milk • Being accurate while calculating the yield of the milk powder

Duration: 25 hrs

Learning outcome 2 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Describe appropriately the types of concentrated milk and their specifications
2. Concentrate properly milk according to concentration methods
3. Dry properly the concentrated milk according to drying methods
4. Identify properly the factors affecting the dryness of the milk powder
5. Describe clearly powdered milk specifications according to their types
6. Determine properly the yield of the milk powder according to the products needed
7. Analyse effectively the quality of concentrated milk and milk powder according to their types

Resources

Equipment	Tools	Materials
• Milk atomizer, • Spray dryer, • Roller/drum dryer, • Freezer, • Falling film • Evaporators, • Storage tank, • Fluidized bed cooler, • Boiler, • Oven	• Thermometer, • Timer, • Moisture meter,	Concentrated milk

Indicative content 2.1: Concentrating Milk

Duration: 8 hrs

Theoretical Activity 2.1.1: Description the types of concentrated milk and their specifications

Tasks:

1. Answer the following questions related to the description of the types of concentrating milk:

I. According to your understanding, what should be the purpose of concentrating milk?

II. What should be the types of concentrating milk.

2. Ask trainees to write their findings on paper or flip chart.
3. Present the findings/answers to the whole class.
4. For more clarification, read the key readings 2.1.1

Key readings 2.1.1.: The types of concentrating milk and their specifications

Definition: Concentrated milk is a dairy product that has had a portion of its water removed. This process increases the milk's solids content, making it thicker and more flavorful.

- **The Purpose of Concentrating Milk**

  Concentrating milk is primarily done to:

  - ✓ **Increase shelf life:** By removing a portion of the water, the product becomes less susceptible to spoilage.
  - ✓ **Reduce transportation costs:** Concentrated milk is heavier and takes up less space, making it more efficient to transport.
  - ✓ **Improve product versatility:** Concentrated milk can be used in various applications, from baking to beverages.
  - ✓ **Create new products:** Concentrated milk can be further processed into products like sweetened condensed milk, powdered milk, and infant formula.
  - ✓ **Reduce storage requirements**

- **The types of Concentrating Milk**

  - ✓ **Sweetened Condensed Milk**: Sweetened condensed milk is made by evaporating about 60% of the water from milk and then adding sugar. This process creates a thick, syrupy milk product. This product contains not less than 8% milk fat and not less than 28% total milk solids.

- ✓ **Evaporated milk**: Evaporated milk is made by removing about 60% of the water from fresh milk, but without adding any sugar. This results in a creamier, more concentrated form of milk.
- ✓ **Powdered milk**: Powdered milk is created by dehydrating milk until it turns into a fine powder. It can be made from whole milk, skimmed milk, or other milk forms.
- ✓ **Buttermilk powder**: Buttermilk powder is made by dehydrating cultured buttermilk, leaving behind the dry buttermilk solids.
- ✓ **Whey powder**: Whey powder is derived from the liquid whey left over after the curdling process in cheese production. It is dehydrated to form a fine powder.
- ✓ **Nonfat Dry milk**: is made by removing water from pasteurized skim (nonfat or fat free) milk, the product contains not more than 5% by weight of moisture, and not more than 1.5% by weight of milk fat.

- **Key characteristics and specifications of the types of concentrated milk:**

1. **Sweetened Condensed Milk**

- ✓ **Water Content**: About 60% of the water is removed.
- ✓ **Ingredients**: Milk and sugar.
- ✓ **Texture**: Thick and syrupy.
- ✓ **Taste**: Very sweet due to the added sugar.
- ✓ **Common Uses**: Popular in desserts (pies, cakes, fudge), drinks (Vietnamese coffee, milkshakes), and confectionery.
- ✓ **Shelf Life**: Long shelf life due to the sugar content acting as a preservative.
- ✓ **Packaging**: Typically found in cans or tubes.

2. **Evaporated Milk**

- ✓ **Water Content**: Approximately 60% of water is evaporated.
- ✓ **Ingredients**: Whole or skimmed milk.
- ✓ **Texture**: Creamy, smooth, slightly thicker than regular milk.
- ✓ **Taste**: Mildly sweet with a slightly caramelized flavor due to the heating process.
- ✓ **Common Uses**: Baking, soups, sauces, custards, and as a substitute for cream or milk in recipes.
- ✓ **Shelf Life**: Long shelf life due to its sterilization process; can be stored at room temperature.
- ✓ **Packaging**: Typically sold in cans.

3. **Powdered Milk (Dry Milk)**

- ✓ **Water Content**: Nearly 100% of the water is removed through drying.
- ✓ **Ingredients**: Whole or skimmed milk, with some varieties fortified with vitamins.
- ✓ **Texture**: Powdery.

- ✓ **Taste**: Neutral when reconstituted; less flavorful than fresh milk.
- ✓ **Common Uses**: Reconstituted for drinking, baking, making sauces, and emergency food storage.
- ✓ **Shelf Life**: Very long, typically several years when kept dry and stored properly.
- ✓ **Packaging**: Available in bags, pouches, or cans.

4. Buttermilk Powder

- ✓ **Water Content**: Dehydrated form of cultured buttermilk; almost all water is removed.
- ✓ **Ingredients**: Cultured buttermilk solids.
- ✓ **Texture**: Fine powder.
- ✓ **Taste**: Tangy, with a slightly sour flavor.
- ✓ **Common Uses**: Baking (biscuits, pancakes, cakes), salad dressings, and sauces where buttermilk's acidity and creaminess are desired.
- ✓ **Shelf Life**: Long shelf life when stored in a cool, dry place.
- ✓ **Packaging**: Sold in bags or pouches.

5. Whey Powder

- ✓ **Water Content**: Almost all the water content is removed, leaving dried whey.
- ✓ **Ingredients**: Derived from the liquid whey left over after milk has been curdled and strained in cheese production.
- ✓ **Texture**: Fine powder.
- ✓ **Taste**: Mildly sweet, depending on the whey's lactose content.
- ✓ **Common Uses**: Used in protein supplements, baked goods, confectionery, and processed foods.
- ✓ **Nutritional Content**: High in protein and essential amino acids; may contain some lactose.
- ✓ **Shelf Life**: Can last for several months when stored properly.
- ✓ **Packaging**: Available in pouches or tubs, especially in the supplement industry.

6. Nonfat Dry milk (Skimmed dry milk):

Nonfat Dry Milk (NDM), also known as **Skimmed Milk Powder (SMP)**, is a dairy product created by removing water from pasteurized skim milk. This process significantly extends its shelf life and makes it a convenient and versatile ingredient.

Key Specifications:

- ✓ **Fat Content:** Typically contains less than 1.5% milkfat.
- ✓ **Moisture Content:** Usually contains less than 5% moisture.
- ✓ **Protein Content:** High in protein, typically around 35%.
- ✓ **Lactose Content:** Contains lactose, a type of sugar found in milk.

- ✓ **Vitamins and Minerals:** Retains many of the vitamins and minerals found in fresh milk, such as calcium, vitamin D, and vitamin B12.

Practical Activity 2.1.2: Performing milk concentration

Task:

1: Referring to the previous theoretical activity 2.1.1, go to the powdered milk making workshop and perform the following task:

Concentrate the milk.

2: Apply safety precautions.

3: Present your work to the trainer and the whole class. Ask for clarification where necessary

4: Read key reading **2.1.2.**

5: Perform the task provided in the application of **Learning 2.1**

Key readings 2.1.2: Performing milk concentration

- **Milk Concentration Methods**

Concentrating pasteurized milk involves removing a portion of the water content, resulting in a thicker, more flavourful product. It's a great way to extend the shelf life of milk and intensify its taste.

Milk concentration refers to the process of partially removing water from milk, resulting in a product with a higher concentration of milk solids like proteins, fats, and lactose. This is for saving energy during drying.

The three main methods for concentrating milk are **thermal evaporation**, **freeze concentration**, and **membrane concentration using reverse osmosis**. Each has its own process, advantages, and applications.

1. Thermal Evaporation (Traditional Method of Concentration)

In thermal evaporation, milk is heated to evaporate water, resulting in a concentrated product. This method is commonly used to produce **evaporated milk** and **sweetened condensed milk**.

Process:

- ✓ Milk is placed in large evaporation chambers.

- ✓ It is heated under vacuum to around 40–60°C (104–140°F), which reduces water content while minimizing nutrient loss.
- ✓ As the water evaporates, the milk becomes thicker and more concentrated.

Advantages:

- ✓ Well-established, widely used in commercial milk concentration.
- ✓ Effective for producing long-shelf-life milk products like evaporated milk.
- ✓ Easy to scale for large industrial production.

Disadvantages:

- ✓ Heat-sensitive nutrients such as some vitamins and proteins may degrade.
- ✓ The process can slightly alter the flavor due to caramelization (especially in sweetened condensed milk).

Applications:

- ✓ Used in the production of evaporated milk, condensed milk, and other concentrated milk products.
- ✓ Suitable for both small-scale and industrial operations.

2. Freeze Concentration

Freeze concentration involves freezing the water content of milk and then removing the ice crystals, leaving behind a more concentrated liquid.

Process:

- ✓ Milk is chilled to temperatures where the water forms ice crystals.
- ✓ The ice is then removed through filtration or mechanical separation, leaving the remaining milk with a higher concentration of solids.
- ✓ This process is typically done in multiple stages to reach the desired concentration.

Advantages:

- ✓ No exposure to high temperatures, so nutrients and flavors are preserved better than in thermal evaporation.
- ✓ Minimal impact on the quality of sensitive components such as proteins and vitamins.
- ✓ The taste and texture of the final product remain closer to fresh milk.

Disadvantages:

- ✓ Energy-intensive due to the need for freezing and the separation process.
- ✓ Higher operational costs compared to thermal evaporation.
- ✓ Slower process than traditional evaporation methods.

Applications:

- ✓ Often used for producing high-quality concentrated milk or dairy products where nutrient and flavor preservation is critical.

- ✓ Ideal for premium dairy products or when nutrient integrity must be maintained, such as in some types of cheese-making.

3. Membrane Concentration by Reverse Osmosis

Reverse osmosis (RO) is a membrane-based concentration method where milk is passed through a semipermeable membrane that allows water to pass through while retaining larger molecules like proteins, fats, and lactose.

Process:

- ✓ Milk is forced under pressure through a reverse osmosis membrane.
- ✓ The membrane allows water molecules to pass, but retains solids such as proteins, fats, and lactose, concentrating the milk.
- ✓ This process can concentrate milk by up to 2–4 times its original solids content, depending on the setup.

Advantages:

- ✓ Energy-efficient compared to thermal evaporation and freeze concentration.
- ✓ No heat is involved, preserving the nutritional content and flavor of milk.
- ✓ Can be used continuously, making it suitable for large-scale operations.

Disadvantages:

- ✓ Limited by the concentration factor, as reverse osmosis cannot concentrate milk as much as thermal evaporation or freeze concentration without fouling the membrane.
- ✓ The membranes used need regular cleaning and replacement, leading to higher maintenance costs.
- ✓ May not remove all dissolved solids (like salts and some small molecules) as effectively as evaporation.

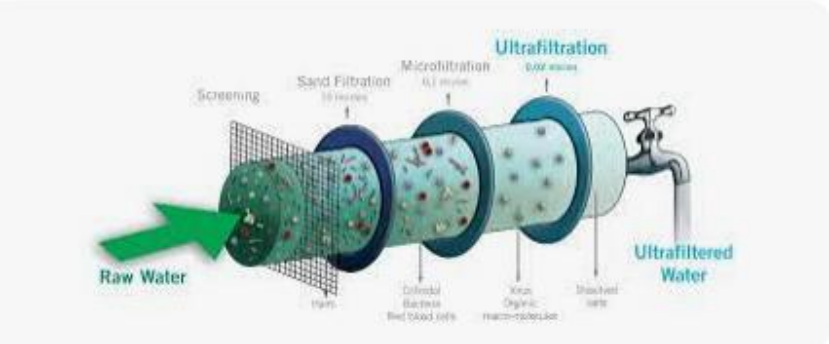
Applications:

- ✓ Commonly used in the dairy industry to concentrate milk before further processing, such as in cheese production.
- ✓ Ideal for applications requiring low-temperature processing to preserve milk's quality.
- ✓ Used in conjunction with other methods for more intensive concentration.

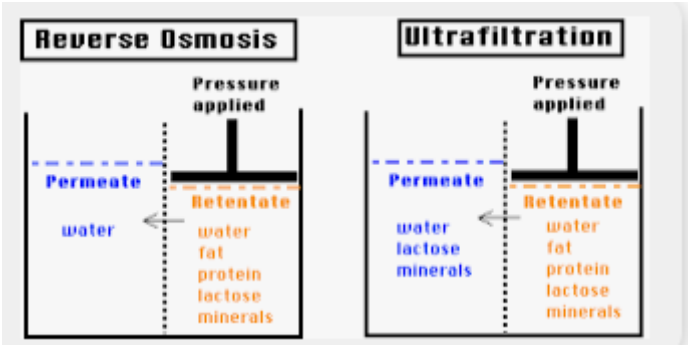
Membrane concentration includes:

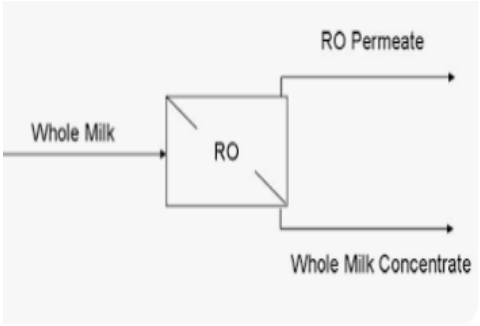
- **Ultrafiltration:** Ultrafiltration is a selective fractionation process using pressures up to 145 psi (10 bars). The whey proteins are separated to form a product with 35, 60 or 80% Whey Protein Concentrate. If ultra-

filtration is applied to skim milk, then Milk Protein Concentrate is obtained.



- **Reverse osmosis:** RO refers to a high pressure between 20-30 bars driven membrane separation technique in which a membrane is employed to separate different components in a fluid mixture by removal of water from the cooled milk using very small pores of RO- membranes. Only water can pass through the membrane but milk components do not pass through the membrane. In this case the water is the permeate and the concentrated milk is the retentate





Practical Activity 2.1.3. Analysing the quality of concentrated milk

Task:

1: You are requested to go to the powdered milk making workshop and perform the following task:
Analyse the quality parameters of concentrated
2: Apply safety precautions.
3: Present your work to the trainer/the workshop assistant. Ask for clarification where necessary
4: Read key reading **2.1.3.**
5: Perform the task provided in the application of **Learning 2.1**

Key readings 2.1.3: Analyse the quality of concentrated milk

- **Physical parameters:**
  - **Color:** Concentrated milk usually has a creamy white color, similar to whole milk.
  - **Viscosity:** Concentrated milk has a thicker consistency than whole milk due to the removal of water. It is often described as viscous or syrupy.
  - **Flavor:** Concentrated milk generally, has a similar flavor to whole milk, although it may be slightly sweeter due to the concentration process.
  - **Film formation:** (protein break), and serum separation
- **Chemical parameters:**
  - **Total Solid (TS):** Concentrated milk has a higher solid content than whole milk due to the removal of water. This typically ranges from 25-30%.

$$\textbf{Total solids \%} = \frac{\textbf{Weight of residue}}{\textbf{Weight of milk sample}} \textbf{ x 100}$$

Example:

1. If 5 liters of raw milk has been concentrated by thermal evaporation, what percentage of total solid can be expected if 2 liters of milk have been left after evaporation?

Answer:

Given datas;

- Weight of milk = 5l
- Weight of residue milk = 2l

Formula

$$\text{Total solids \%} = \frac{\text{Weight of residue}}{\text{Weight of milk sample}} \text{ x 100}$$

Calculation:

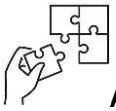
$$\text{Total solid } \% = \frac{2l}{5l} * 100 = \mathbf{40}\%$$

The expected total solid shall be 40%

- **Fat content:** The fat content of concentrated milk can vary depending on the type of milk used and the concentration process. However, it generally falls within a similar range as whole milk (around 3.2-3.5%).
- **Moisture content:** Concentrated milk typically contains higher moisture content (around 25-30%) compared to powdered milk. This is due to the process of concentrating the milk without removing significant amounts of water.

Points to Remember

- The specific specifications, such as nutritional content and caloric values, may vary depending on the brand and type of milk products used. Always refer to the product label for the most accurate information.
- Thermal evaporation is traditional and cost-effective, freeze concentration preserves quality, and reverse osmosis is energy-efficient and nutrient-friendly.
- By conducting quality analysis, manufacturers can ensure that their concentrated milk and powdered milk products meet the highest standards of safety, nutritional value, and consumer satisfaction.



Application of learning 2.1.

You are requested to go to the powdered milk making workshop, to concentrate pasteurized milk and analyse its quality parameters used in powdered milk making.

Indicative content 2.2: Drying Concentrated Milk

Duration: 17hrs

Practical Activity 2.2.1: Drying of concentrated milk

Task:

1: You are requested to go to the powdered milk making workshop and perform the following task:
Dry concentrated milk used in making powdered milk.
2: Apply safety precautions.
3: Present your work to the trainer/ workshop assistant. Ask for clarification where necessary
4: Read key reading **2.2.1.**
5: Perform the task provided in the application of **Learning 2.2**

Key readings 2.2.1: Drying of concentrated milk

- **Purpose of drying concentrated milk**

✓ **Increase shelf life and preservation:** Dried milk products, such as powdered milk, have a significantly longer shelf life compared to liquid milk. This is because the removal of water reduces the risk of microbial growth and spoilage.

✓ **Improve transportability:** Dried milk is much lighter and takes up less space than liquid milk, making it more efficient to transport, especially over long distances.

✓ **Create versatile ingredients:** Dried milk can be easily reconstituted with water, making it a versatile ingredient for various food and beverage applications. It's commonly used in baking, cooking, and the production of other dairy products.

✓ **Reduction of Bulk and Weight:** Dried milk powder occupies much less space and weighs considerably less than its liquid counterpart. This makes it more economical to transport and store, reducing costs associated with logistics.

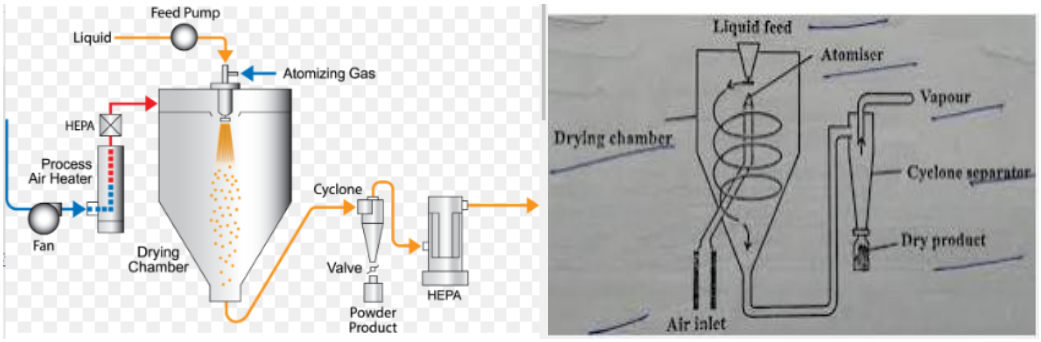
✓ **Drying method**

✓ **Spray driers:**

The most common way of making milk powder is by spray drying. It's a process in which milk is quickly dried into a powder form. To spray dry milk, the milk is first flash-pasteurized to kill any bacteria. Next, the milk is reduced to around 50% of its original mass by steaming it, separating the vapour from the concentrated powder and then condensing the vapour into a liquid to be

removed. The milk is then sprayed into a drying chamber, where it's exposed to hot air. The liquid milk droplets quickly evaporate, leaving behind a dry powder with around 6% moisture content with a mean particle size typically of fluidized powder removing water to the point of a moisture content between 2-4%.

This removes water from milk in order to make powdered milk products. Milk's nutritional value remains the same.



The main components of a spray drier include:

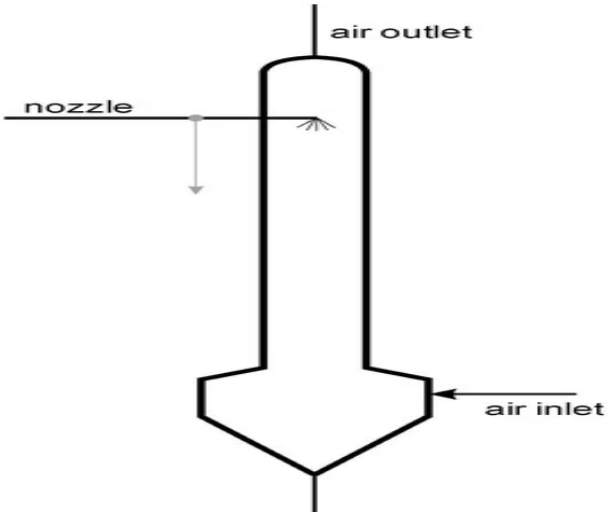
- ✓ Air heating and circulating system
- ✓ A spray forming system comprising of pressure nozzle, centrifugal atomizer and bowl nozzle
- ✓ A drying chamber
- ✓ Cyclone separator for product recovery (2 cyclones, scrubber with cloth filter)
- ✓ For successful drying, complete and uniform atomization is necessary. Different types of atomizers are centrifugal atomizer, pressure nozzle atomizer, two fluid nozzle atomizer and ultrasonic atomizer.

Milk atomization methods

Atomization can be defined as the breakup of a liquid stream into fine particles such as a spray or conversion of the bulk fluid stream (milk) into discrete droplets.

- ✓ **Single nozzle**

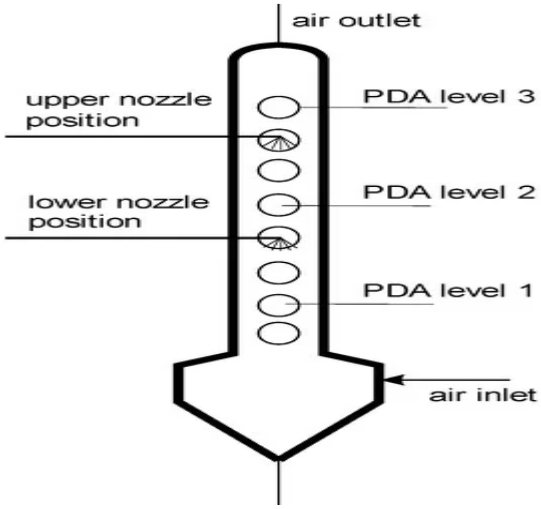
Single nozzle spraying means using one spray nozzle in the drying chamber for the purpose of creating small droplets for drying.



Product out

- ✓ **Multiple nozzle**

The concept of multiple-nozzle spraying means using single nozzles on different levels or several nozzles on each level in the drying chamber. Multiple-nozzle spraying means using single nozzles on different levels or several nozzles on each level in the drying chamber. Several nozzles arranged in a specific pattern (e.g., circular, linear) generate a wider or more evenly distributed spray.



- ✓ **Steam-swept wheel**

In steam-swept wheel, steam is introduced into the atomizer and consequently the air-liquid interface is replaced with a steam liquid interface. Milk is spread onto a rapidly rotating disk, while hot air or steam sweeps the droplets away, creating a fine mist.

- ✓ **Rotary wheel**

Milk or similar liquids are spray dried using a rotary atomizer wheel where by such temperature is imparted to the liquid that violent release of gas and vapour from the liquid takes place in the atomizer wheel which gas and vapour are removed before the atomization of the liquid.

Advantages of Atomization

(1) Rapid evaporation

(2) Less effect on the quality of the product

Advantages of Spray Drying:

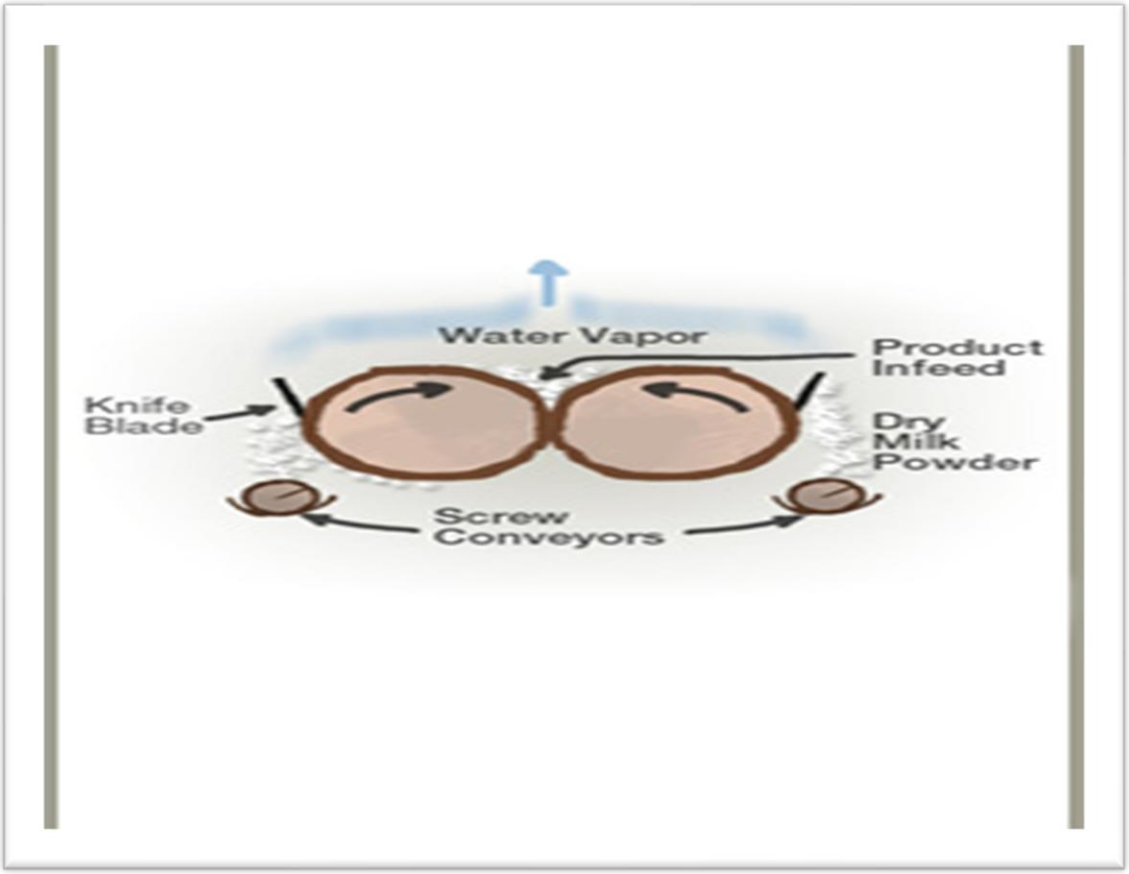
- ✓ **Rapid Drying:** The process is very fast, often taking only a few seconds to dry the liquid. This is particularly beneficial for heat-sensitive materials.
- ✓ **Uniform Particle Size:** The spray drying process can produce particles with a consistent size distribution, which is important for many applications.
- ✓ **High Production Capacity:** Spray dryers can handle large volumes of material, making them suitable for industrial-scale production.
- ✓ **Versatile Applications:** The technique can be used to dry a wide range of materials, including solutions, suspensions, and emulsions.
- ✓ **Improved Product Quality:** Spray drying can enhance the flow ability, solubility, and stability of the final product.
- ✓ There is minimum heat damage to the food.
- ✓ Suitable for heat-sensitive materials.

Disadvantages of Spray Drying:

- ✓ **High Initial Investment:** The equipment required for spray drying can be expensive, making it a significant upfront cost.
- ✓ **Energy Consumption:** The process can be energy-intensive, as it requires heating large volumes of air.
- ✓ **Potential for Heat Damage:** Although rapid, the process can still cause some heat damage to sensitive materials.
- ✓ **Waste Generation:** Spray drying can generate significant amounts of waste, including exhaust air and dust.
- ✓ **Complexity of Operation:** The process can be complex to operate and requires skilled personnel to maintain and optimize.

- **Roller Drying.**

Roller or drum drying can have a number of advantages over other drying methods. It's faster and is believed to produce a higher-quality product. This method involves passing the milk over a thin film on a heated drum which steams the milk or heated rotating cylinder (roller) in a thin layer, As the cylinder rotates, the milk dries, leaving behind the solids to be extracted and ground into a fine powder. Of the three methods listed here, drum drying is the least used as it has a tendency to caramelize the milk, which can leave the solids with a slightly burnt, bitter taste.



Advantages of Roller Drying:

- ✓ **Gentle Drying:** Compared to spray drying, roller drying can be gentler on heat-sensitive materials, as the contact time with the hot surface is relatively short.
- ✓ **High Production Capacity:** Roller dryers can handle large volumes of material, making them suitable for industrial-scale production.
- ✓ **Simple Design:** The equipment is relatively simple and easy to maintain.
- ✓ **Low Dust Generation:** Roller drying typically produces less dust than spray drying, which can be beneficial in some applications.
- ✓ Simple and inexpensive.
- ✓ Suitable for high-viscosity liquids.

Disadvantages of Roller Drying:

- ✓ **Potential for Heat Damage:** Although gentler than spray drying, heat damage can still occur if the drum temperature is too high or the material is in contact with the drum for too long.
- ✓ **Limited Control over Particle Size:** The particle size distribution can be less uniform compared to spray drying.
- ✓ **Difficulty with Viscous Materials:** Roller drying can be challenging for highly viscous materials, as they may not spread evenly on the drum.
- ✓ **Cleaning Challenges:** Cleaning the drum can be time-consuming and labor-intensive.

- **Freeze Drying:**

Of the three methods describing the process of how powdered milk is made, freeze drying is the most complex, time-consuming and expensive. The slower it's dried, the bigger the ice crystals which makes for a better product. The milk is then subjected to a low heat and low pressures in a partial vacuum, which helps a process called sublimation turning the ice from a solid state to a gas. The gas is then condensed and collected, leaving behind a dry powder that remains rich in the proteins and nutrients found in liquid milk.

Advantage of freeze drying:

- ✓ With a freeze drying, foods and liquids can be dried at low temperatures without damaging their physical structure.
- ✓ Freeze drying do not need to be refrigerated or preserved with chemicals and can be reconstituted quickly and easily by adding water.
- ✓ Preserves product quality and flavor.
- ✓ Suitable for heat-sensitive and biological materials.
- ✓ Produces a high-quality, porous product.

Key differences of milk drying methods:

Features	Spray Drying	Freeze Drying	Roller Drying
Drying Method	Atomization and evaporation	Sublimation	Evaporation on a heated surface
Suitability	Heat-sensitive materials, fine powders	Heat-sensitive and biological materials, porous products	High-viscosity liquids, sheet-like products
Quality	High quality, preserves flavor	Highest quality, preserves flavor	Good quality, may affect flavor
Cost	Moderate	High	Low

Theoretical Activity 2.2.2: Identification of the factors that affect dryness of milk and description of powdered milk specifications

Tasks:

1. Answer the following questions related to the optimisation of drying processes for concentrated milk:

i. What should be the factors affecting dryness of milk?
ii. Suggest the specifications of powdered milk.

2. Ask trainees to write their findings on paper or flip chart.

3. Present the findings/answers to the whole class.

4. For more clarification, read the key readings 2.2.2:

Key readings 2.2.2.: Identification the factors that affect dryness of milk and description of powdered milk specifications

- **Factors affecting the dryness of milk**

✓ **The drying temperature** is the parameter with the biggest influence on drying speed. It is important that the temperature use must be high enough to evaporate moisture but not too high to cook the food. If the temperature remains high at the end of the drying process, then food will become burned.

✓ **Drying time** will depend on the material used based on the diffusion rate of the water from the granules, the initial moisture content and the target residual moisture content. Damage to material can occur if the drying process is too long or is carried out at an overly elevated temperature.

✓ **The flow of dry air transfers heat energy to the material:** it is essential to ensure the volume of air is sufficient to raise the temperature of the granules to the required level within the given period. The dew point and/or relative humidity is determined by the dryness of the air.

✓ **Drying method and speed of drying:** The speed of drying plays a major role in achieving a good quality dried products. It is important that the drying process to be conducted rapidly, but not so fast to avoid poor quality of products.

✓ **Ventilation:** Ventilation in the food dryer must be adequate to avoid moisture saturation in the dryer.

✓ **Proper ventilation** will also have helped to speed up the drying process and shorten the drying time.

✓ **Size of droplets of the raw material**

✓ **Rate of heat transfer on the surface of the food,**

As a general rule, all first four parameters must be adjusted in line with one another and with respect to the material being dried. Because each parameter influences the drying process and the outcome in a different way, changing one will always mean altering the others if the same drying results are to be achieved.

- **Description of powdered milk specifications**

Powdered milk comes in various forms, such as whole milk powder, skim milk powder, and reduced-fat milk powder, each with specific characteristics and applications. Here are the general specifications:

1. Whole Milk Powder (WMP)

Whole milk powder is made by evaporating water from fresh whole milk. It retains the natural fat content and is typically used in products requiring a rich and creamy flavor.

Specifications:

- ✓ **Milkfat content:** 26%–40% (typical is around 28%–30%)
- ✓ **Moisture content:** Max 5%
- ✓ **Protein content:** Min 24% (on a dry basis)
- ✓ **Carbohydrate (lactose) content:** 36%–38%
- ✓ **Minerals (ash):** 5.5%–7%
- ✓ **Color:** Creamy white to light cream
- ✓ **Flavor:** Clean and creamy, free from off-flavors
- ✓ **Solubility:** High solubility index (minimal sediment)
- ✓ **Shelf life:** Typically, 12–18 months when stored in a cool, dry place

Applications:

- ✓ Infant formula, confectionery, bakery products, beverages, and ice cream

2. Skim Milk Powder (SMP)

Skim milk powder is made by removing the milkfat from fresh milk and then evaporating the water. It is used in products that require the nutritional benefits of milk without the fat.

Specifications:

- ✓ **Milkfat content:** Max 1.5%
- ✓ **Moisture content:** Max 4%
- ✓ **Protein content:** Min 34% (on a dry basis)
- ✓ **Carbohydrate (lactose) content:** 50%–52%
- ✓ **Minerals (ash):** 8%–9%

- ✓ **Color:** White to light cream
- ✓ **Flavor:** Clean, slightly sweet, free from off-flavors
- ✓ **Solubility:** High solubility index
- ✓ **Shelf life:** Typically, 18–24 months when stored in appropriate conditions

Applications:

- ✓ Low-fat or non-fat dairy products, sports nutrition, bakery products, and reconstitution into liquid skim milk.

3. Reduced-Fat Milk Powder (RFMP)

Reduced-fat milk powder has a fat content between that of whole milk powder and skim milk powder, offering a balance of creaminess and reduced calories.

Specifications:

- ✓ **Milkfat content:** 1.5%–26% (typically 10%–15%)
- ✓ **Moisture content:** Max 4%
- ✓ **Protein content:** Min 34% (on a dry basis)
- ✓ **Carbohydrate (lactose) content:** 40%–50%
- ✓ **Minerals (ash):** 6%–8%
- ✓ **Color:** Light cream
- ✓ **Flavor:** Clean, slightly creamy, free from off-flavors
- ✓ **Solubility:** High solubility index
- ✓ **Shelf life:** Typically, 12–18 months under proper storage

Applications:

- ✓ Used in products where moderate fat content is desired, such as specific beverages, bakery goods, and processed foods.

Theoretical Activity 2.2.3: Determination of the yield of the milk powder

Tasks:

1. Answer the following questions related to the description of determination of the yield of the milk powder:
    i. What should be the factors affecting the yield of the milk powder?
    ii. How can you calculate the yield of the milk powder?
2. Ask trainees to write their findings on paper or flip chart.
3. Present the findings/answers to the whole class.
4. For more clarification, read the key readings 2.2.3

Key readings 2.2.3: Yield of the powdered milk

- **Factors affecting the yield of the milk powder**
    - ✓ **Milk Concentration:** Higher milk solids concentration in the feedstock leads to higher milk powder yield.
    - ✓ **Drying Method:** Spray drying generally offers higher yields compared to roller drying or freeze drying.
    - ✓ **Drying Conditions:** Optimal drying conditions, including temperature, air flow, and atomization pressure, are crucial for efficient water removal and high yield.
    - ✓ **Equipment Maintenance:** Proper maintenance of drying equipment ensures optimal performance and minimizes losses.
    - ✓ **Milk Quality:** The quality of the raw milk significantly impacts the yield and quality of the final milk powder.
- **The yield of the milk powder**

The yield of powdered milk refers to the amount of milk powder produced from a given quantity of liquid milk.

Calculation

Formula:

Powdered Milk Produced (kg) = Raw Milk (kg) * Solids Content (%) * (1 - Powdered Milk Moisture Content) / 100

$$Powdered\ Milk\ Produced\ (Kg) = RawMilk\ (Kg) * Solids\ contents\ (\%) * \frac{(1 - Powdered\ Milk\ \ Moisture\ content/100)}{100}$$

Example:

If you have 100 kg of raw milk with a solids content of 12% and want to produce powdered milk with a moisture content of 3%, then:

Powdered Milk Produced = 100 kg * 12 * (1 – 3%) / 100 = 11.64 kg

Yield (kg) = Volume of Milk (liters) x Total Solids Content (%) x Expected Recovery Rate (%) / 1000

For more precise calculations, consider incorporating factors like:

- **Evaporation Efficiency:**

  Evaporation Efficiency = (Mass of Water Evaporated / Mass of Water in Feed) * 100

- **Spray Drying Efficiency:**

  Spray Drying Efficiency = (Mass of Powdered Milk Produced / Mass of Solids in Feed) * 100

- **Overall Yield:**

  Overall Yield =Yield* Evaporation Efficiency * Spray Drying Efficiency

Practical Activity 2.2.4: Analysing the quality of powdered

Task:

1: Referring to the previous theoretical activity 2.2.3, go to the powdered milk making workshop to and perform the following task:
Analyse the quality parameters of powdered milk.
2: Apply safety precautions.
3: Present your work to the trainer/ Workshop assistant. Ask for clarification where necessary
4: Read key reading **2.2.4.**
5: Perform the task provided in the application of **Learning 2.2**

Key readings 2.2.4: Analyse the quality of powdered milk

- **Physical parameters:**
  - **Color:** Can vary in color depending on the type of milk used and the processing method. It can range from white to slightly yellow.
  - **Viscosity:** When reconstituted, it has a similar viscosity to whole milk. However, when dry, it is a fine powder
  - **Flavor:** Can have a slightly different flavor than whole milk, especially if it has been stored for a long time or if it is reconstituted improperly
  - **Film formation:** (protein break), and serum separation
- **Chemical parameters:**
  - **Total Solid (TS):** Powdered milk has a very high solid content, typically around 95-98%. This is because most of the water has been removed during the drying process.

    Procedure:

    ✓ Accurately weigh an empty, clean, and dry aluminum dish.

    ✓ Weigh a known amount of powdered milk sample into the dish.

    ✓ Place the dish in a preheated oven at the specified temperature.

    ✓ Dry the sample for a specific time (usually several hours) until constant weight is achieved (i.e., no significant weight loss occurs in subsequent drying periods).

    ✓ Remove the dish from the oven, cool it in a desiccator, and weigh it accurately.

Here, $M_{INITIAL}$ and M_{DRIED} are the mass of the sample before and after drying, respectively.

$$\%\text{Total Solids} = \frac{M_{DRIED}}{M_{INITIAL}} \times 100$$

Thus, %Total solids = (100 - %Moisture).

- **Fat content:** Powdered milk can have a higher fat content than concentrated milk, especially if it is made from whole milk. It can range from 3.5% to 8% or more.

- **Moisture content:** Powdered milk has much lower moisture content (around 2-5%). The water is removed during the drying process, resulting in a dry, powdery product.

Procedure:

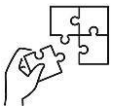
1. Prepare the Sample:
   - ✓ Accurately weigh an empty, clean, and dry weighing dish with a lid.
   - ✓ Weigh a suitable amount of powdered milk sample (typically 2-3 grams) into the dish.
2. Drying:
   - ✓ Place the uncovered dish and lid in the preheated oven at 102 ± 2°C for 1 hour.
   - ✓ Remove the dish from the oven, cover it with the lid, and transfer it to a desiccator to cool to room temperature.
   - ✓ Weigh the covered dish and sample.
   - ✓ Repeat the drying step (1 hour in the oven) and cooling in the desiccator.
   - ✓ Continue drying and weighing until two consecutive weighing differ by no more than 0.005 grams. This indicates constant weight has been achieved.
3. Calculation:

$$\%\text{Moisture} = \frac{M_{\text{INITIAL}} - M_{\text{DRIED}}}{M_{\text{INITIAL}}} \times 100$$

Points to Remember

- Each drying method has specific applications depending on the desired product characteristics, with spray drying being the most common for producing high-quality milk powder for general consumption.
- The specific specifications for powdered milk can vary depending on the intended use, such as infant formula, baking, or beverage applications. It's essential to consult the product label or relevant standards for detailed information.
- By carefully considering these factors and employing appropriate methods, manufacturers can effectively determine and optimize the yield of milk powder.

- By conducting thorough quality analysis, manufacturers can ensure that their powdered milk products meet the highest standards of safety, nutritional value, and consumer satisfaction.



Application of learning 2.2.

You are requested to go to the powdered milk making workshop, to dry concentrated milk and analyse the quality of powdered milk.

Learning outcome 2 end assessment

Written assessment

I. Read the statement below related to the types of concentrating milk and their specifications and answer **True** if it is **correct** and **False** if it is **wrong**:
   1. Concentrating milk helps reduce transportation costs by increasing the water content.
   2. Evaporated milk contains added sugar, making it sweeter than regular milk.
   3. Whey powder is derived from the liquid left over after curdling milk in cheese production.
   4. Sweetened condensed milk typically has a thicker texture than evaporated milk.
   5. Powdered milk has nearly all the water removed, making it ideal for long-term storage.

II. The following are descriptions relating to drying of milk. **Choose the appropriate description by encircling the letter corresponding to the correct answer:**

1. Which drying method involves removing the water by sublimation?
   a. Spray drying
   b. Freeze drying
   c. Roller drying
   d. Thermal evaporation
2. Which one of the following factors does **NOT** affect dryness of milk powder?
   a. Temperature
   b. Time
   c. Drying method
   d. Milk's original fat content

III. Match the type of concentrated milk in **Column A**, with their descriptions in **Column B**; and **write the letter corresponding to the correct description in provided space**.

Answer	Column A	Column B
……	1. Sweetened condensed milk	a. Contains added sugar and has a thick consistency
…….	2. Evaporated milk	b. Concentrated milk with a high water content
…….	3. Powdered milk	c. Milk that has been dried to a powder form
……	4. Buttermilk powder	d. Powdered form of whey
…..	5. Whey powder	e. Powdered from buttermilk

IV. What is the amount of moisture content in:

a) Concentrated
b) powdered milk

V. Differentiate drying from roller drying.

VI. Use the following data and Calculate the yield of powdered milk:

Raw milk: 1000 kg
Solids content: 12%
Powdered milk moisture: 3%
Evaporation efficiency: 90%
Spray drying efficiency: 88%

Practical assessment

SSISO nursery school signed a supply contract with AYACU dairy milk processing Ltd. to supply powdered milk to feed their pupils. The AYACU dairy milk processing Ltd. must supply 5kg of powdered milk as sample. You are requested to go to the powdered milk-making workshop to produce 5kg of powdered milk. This activity will be performed within four (4) hours and all required tools and equipment are available in the workshop.

END

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POWDER
MILMK

Indicative contents
3.1 Packaging of powdered milk **3.2 Labelling of packaged milk powder** **3.3 Storing powdered milk**

Key Competencies for Learning Outcome 3: Store powdered milk

Knowledge	Skills	Attitudes
• Description of pre-packaging standard of the powdered milk products • Identification of the factors that affect packaging of powdered milk • Description of the requirements of a good packaging material for powdered milk • Description of the standards for labelling package powdered milk • Description of the information appearing on the powdered milk label • Description of the storage requirements of powdered milk	• Packaging of powdered milk • Labelling of the package powdered milk • Store powdered milk	• Being attentive while packaging powdered milk • Being an effective communicator when labelling the package of powdered milk • Being protective while storing powdered milk

Duration: 10 hrs

Learning outcome 3 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Describe properly the pre-packaging standard of the powdered milk products
2. Identify properly the factors that affect packaging of powdered milk
3. Describe correctly the requirements of a good packaging material for powdered milk
4. Package properly powdered milk according to the standards
5. Describe correctly the standards for labelling package powdered milk
6. Describe properly the information appearing on the powdered milk label
7. Label properly the package of powdered milk according to the standards
8. Describe correctly the storage requirements of powdered milk
9. Store properly the powdered milk according to the storage requirements

Resources

Equipment	Tools	Materials
• PPE, • filling machines, • sealing machine, • labelling machine	• Balance, • moisture meter, • sampler,	• Powdered milk, • Metal cans, • plastic container, • Multilayer pouches, • paper bags

Indicative content 3.1: Packaging of Powdered Milk

Duration: 5 hrs

Theoretical Activity 3.1.1: Description of pre-packaging standard of the powdered milk products

Tasks:

1. Answer the following questions related to the identification materials used in powdered milk making:
   i. According to your knowledge, what are the purposes of packaging powdered milk
   ii. Describe the pre-packaging standard of the powdered milk products.
2. Write the answers on papers or flip chart.
3. Present the findings/answers to the whole class.
4. For more clarification, read the **key readings 3.1.1**

Key readings 3.1.1.: Description of pre-packaging standard of the powdered milk products

- **Packaging of powdered milk**
  - ✓ **Purpose of Packaging Powdered Milk:**

The main objectives of packaging powdered milk include:

- **Protection from moisture:** Powdered milk is highly hygroscopic, meaning it absorbs moisture from the environment, which can lead to spoilage, clumping, and reduced shelf life.
- **Prevention of oxidation:** Exposure to air can cause oxidation of fats in the powdered milk, leading to rancidity and a decline in product quality.
- **Barrier to light:** Light can degrade vitamins like vitamin A and D and cause the product to lose its nutritional value.
- **Microbial protection:** Proper packaging ensures that powdered milk is kept in a sterile environment, free from microbial contamination.
- **Ease of transportation and storage:** Packaging helps in safely transporting and storing the product without spillage or contamination.
- **Extended shelf life:** Through effective packaging, powdered milk can maintain its quality for a longer period.
- **Convenience:** It provides a convenient and hygienic way to store, transport, and use the product.

- **Branding:** Packaging can be used to create a strong brand identity and differentiate the product from competitors.

✓ **Pre-Packaging Standards of Powdered Milk Products:**

Before packaging, powdered milk must meet certain standards to ensure quality:

- **Moisture content:** The moisture content of the milk powder should be reduced to about 2-5% to prevent microbial growth and clumping.
- **Particle size and uniformity:** The powder should be uniform in texture, facilitating proper packaging and reducing the chances of agglomeration.
- **Hygiene:** The product must be free from foreign materials, bacteria, or other contaminants.
- **Nutrient preservation:** The milk powder should retain its essential nutrients (proteins, vitamins, etc.) during the packaging process.
- **Proper sealing and sterilization:** The equipment used for packaging must be sterilized to avoid contamination during the process.
- **Net weight:** The package must contain the specified net weight of the powdered milk.
- **Labeling:** The label should clearly indicate the product name, ingredients, nutritional information, best-before date, and storage instructions.
- **Safety:** The packaging should be designed to prevent accidental spills or leaks.

Theoretical Activity 3.1.2: Identification of the factors that affect packaging of powdered milk

Tasks:

1. Answer the following questions related to the identification of factors that affect packaging of powdered milk:
   I. According to your knowledge, identify of the factors that affect packaging of powdered milk
2. Write the answers on papers or flip chart
3. Present the findings/answers to the whole class.
4. For more clarification, read the **key readings 3.1.2**

Key readings 3.1.2.: Identification of the factors that affect packaging of powdered milk

- **Factors Affecting the Packaging of Powdered Milk:**

Several environmental factors can affect the quality of powdered milk and must be considered in the packaging:

- ✓ **Moisture Transfer:** Powdered milk is hygroscopic, and exposure to moisture will cause clumping, spoilage, and microbial growth. Packaging must offer a strong barrier to prevent moisture ingress.
- ✓ **Oxidation:** Oxygen exposure leads to the oxidation of fats, resulting in rancidity and the degradation of flavor. Packaging should be airtight to limit oxygen exposure.
- ✓ **Light:** Light exposure can cause the degradation of vitamins and other nutrients in powdered milk. Packaging should provide a light barrier to prevent nutrient loss and maintain the product's color and flavor

Theoretical Activity 3.1.3: Description of the requirements of a good packaging material for powdered milk

Tasks:

1. Answer the following question related to the description of the requirements of a good packaging material for powdered milk:
   I. According to your knowledge, what are the requirements of a good packaging material for powdered milk.
2. Write the answers on papers or flip chart.
3. Present the findings/answers to the whole class.
4. For more clarification, read the **key readings 3.1.3**

Key readings 3.1.3.: Description of the requirements of a good packaging material for powdered milk

✓ **Requirements of Good Packaging Material for Powdered Milk:**

To ensure the protection and longevity of powdered milk, packaging materials must have the following characteristics:

- **Moisture barrier:** The material should prevent the ingress of moisture to avoid spoilage and clumping of the product.
- **Oxygen barrier:** The packaging should be able to block oxygen to prevent oxidation of fats, which causes rancidity.
- **Light barrier:** It should be opaque or have a protective coating to block light, preventing the degradation of sensitive nutrients like vitamins.
- **Mechanical strength:** The packaging should have the physical strength to withstand transportation and handling without tearing or breaking.

- **Heat-sealable:** The packaging should allow for easy sealing to create airtight containers, preventing contamination and oxygen exposure.
- **Chemical inertness:** The packaging material must be food-safe, non-reactive with the powdered milk, and not contribute any undesirable flavors or odors.
- **Cost-effective:** While ensuring all protective qualities, the packaging should also be economical to keep the overall cost of the product manageable.

Common packaging materials for powdered milk include:

- **Laminated films:** These are made by combining different layers of materials, such as polyethylene, aluminum foil, and polyester, to provide a barrier against moisture, oxygen, and light.
- **Rigid containers:** These can be made of materials such as plastic, metal, or cardboard. They offer good protection but may be heavier and more expensive than flexible packaging.
- **Pouches:** These are typically made of flexible materials such as polyethylene or polypropylene. They are lightweight, convenient, and cost-effective.

Practical Activity 3.1.4: Packaging of powdered milk

Task:

1: Referring to the previous theoretical activity 3.1.1, 3.1.2 & 3.1.3, go to the powdered milk making workshop to perform the following tasks:
Package powdered milk.
2: Apply safety precautions.
3: Present your work to the trainer/ Workshop assistant. Ask for clarification where necessary.
4: Read key reading 3.1.4
5: Perform the task provided in application of learning 3.1.

Key readings 3.1.4.: Packaging of powdered milk

- **Packaging Procedures for Powdered Milk**

Packaging powdered milk involves a series of steps to ensure its safety, quality, and preservation. Here's a general outline of the procedures:

✓ **Preparation and Cleaning:**

- **Equipment Cleaning:** Thoroughly clean and sanitize all packaging equipment, including filling machines, sealing machines, and conveyors.
- **Material Preparation:** Ensure that the powdered milk is of high quality and free from contaminants.

✓ **Filling:**

- **Weighing:** Accurately weigh the desired amount of powdered milk for each package.
- **Filling Machines:** Use filling machines to transfer the powdered milk into the packaging containers.
- **Density Control:** Monitor the density of the filled product to ensure consistency.

✓ **Sealing:**

- **Sealing Machines:** Use sealing machines to close the packages securely, preventing moisture, oxygen, and contamination.
- **Seal Integrity:** Verify the integrity of the seals to ensure proper closure.

✓ **Coding and Labeling:**

- **Coding:** Apply codes (e.g., batch number, production date) to the packages for traceability.
- **Labeling:** Attach labels with necessary information, such as product name, ingredients, nutritional facts, and best-before date.

✓ **Inspection and Quality Control:**

- **Visual Inspection:** Check for any defects, such as package damage, incorrect labeling, or foreign objects.
- **Weight Verification:** Verify that the net weight of each package corresponds to the declared weight.
- **Seal Integrity Check:** Ensure that the seals are intact and properly closed.

✓ **Packaging Material Handling:**

- **Storage:** Store packaging materials (e.g., bags, cartons) in a clean and dry environment.
- **Rotation:** Implement a rotation system to ensure that older materials are used first.

✓ **Product Storage:**

- **Storage Conditions:** Store the packaged powdered milk in appropriate conditions, considering factors like temperature, humidity, and light exposure.
- **FIFO (First-In, First-Out):** Follow the FIFO principle to ensure that older products are used first.

✓ **Shipping and Distribution:**

- **Packaging for Shipment:** Pack the packaged powdered milk securely for transportation, considering factors like distance, climate, and handling.
- **Transportation:** Arrange for transportation to the desired destination, ensuring proper handling and storage during transit.

Points to Remember

- The factors need to be considered to ensure that powdered milk packaging not only protects the product but also meets market demands, safety regulations, and environmental considerations.
- By meeting these requirements, packaging materials for powdered milk can effectively preserve product quality and safety while ensuring consumer satisfaction.
- Effective packaging of powdered milk requires materials and designs that protect the product from moisture, oxygen, light, and contamination while offering durability and convenience for consumers.
- The packaging must also comply with food safety regulations and be designed to meet environmental concerns, increasingly focusing on recyclability and sustainability.

Application of learning 3.1.

You are requested to go to the powdered milk making workshop to pack five (5) cans of processed powdered milk; each contains 1000g.

Indicative content 3.2: Labelling of Packaged Milk Powder

Duration: 3 hrs

Theoretical Activity 3.2.1: Description of the standards for labelling package powdered milk

Tasks:

1. Answer the following questions related to the description of the standards for labelling package powdered milk.
   i. According to your knowledge, describe the purpose of labelling
   ii. Based to your knowledge, describe the standards for labelling package powdered milk.
2. Write the answers on papers or flip chart
3. Present the findings/answers to the whole class.
4. For more clarification, read the **key readings 3.2.1**

Key readings 3.2.1.: Description of the standards for labelling package powdered milk.

- **Labelling of packaged milk powder**
  - ✓ **Purpose of Labelling Milk Powder:**

The labeling of powdered milk serves several important purposes:

- **Product identification:** Labels help consumers and retailers identify the product, including the type of milk (whole, skimmed, fortified, etc.).
- **Regulatory compliance:** Labels ensure compliance with national and international food safety and packaging regulations, making it easier to monitor product quality and safety.
- **Consumer information:** Labels provide essential information about the product, including nutritional content, usage instructions, and allergen warnings, allowing consumers to make informed choices.
- **Marketing and branding:** Labels serve as a branding tool, differentiating the product from competitors and appealing to target markets.
- **Traceability:** Lot numbers, batch codes, and manufacturing information on labels allow for tracking in case of recalls or quality issues.
- **Storage and handling instructions:** Important guidance on how to store the product to maintain its quality (e.g., "Store in a cool, dry place") is provided to the consumer.

✓ **Standards for Labelling:**

Powdered milk labels must meet certain national and international standards to ensure consistency, transparency, and consumer safety. Some common regulatory standards for labeling include:

- **Codex Alimentarius Standards:** These are internationally recognized food standards, guidelines, and codes of practice that ensure fair trade and consumer protection. Codex includes guidelines for labeling prepackaged food items, including powdered milk.
- **Local regulatory requirements:** Different countries may have specific labeling regulations. For example, in the U.S., the FDA regulates food labeling, while the European Union follows its Food Information to Consumers (FIC) Regulation.
- **Nutritional labeling standards:** Many countries require a standardized format for nutritional information, including guidelines on how to display calorie content, fat, protein, carbohydrates, vitamins, and minerals.
- **Language and legibility:** Labels must be in the official language(s) of the country where the product is sold, and all information should be clear and easy to read.
- **Allergen declarations:** Countries require the mandatory disclosure of any common allergens (such as dairy, soy, etc.) on the label.

In Rwanda, food and product labeling is governed by the **Rwanda Standards Board (RSB)**, which enforces regulations to ensure consumer protection, fair trade practices, and safety. The primary standard for labeling is **RS 186:2017** (Rwanda Standard for Labeling of Prepackaged Foods), which is aligned with international standards, such as the **Codex Alimentarius** and other regional guidelines. These standards apply to all prepackaged food products sold in Rwanda.

Here is a summary of the key requirements and standards for labeling in Rwanda:

✓ **General Labelling Requirements:**

- **Language:** Labels must be written in **Kinyarwanda**, **English**, or **French**, which are the official languages of Rwanda. Information must be clear and easily understandable by the local consumer base.
- **Accuracy:** All information on the label must be truthful and not misleading. Misrepresentation of the product's nature, quality, origin, or nutritional value is prohibited.
- **Legibility:** The text on the label must be easy to read, with clear fonts and appropriate font sizes that do not require magnification aids for readability.

✓ **Mandatory Information on Labels**

✓ **Prohibited Practices:**

- **Misleading Information:** The label must not contain any false, misleading, or deceptive statements regarding the product's characteristics, ingredients, origin, or safety.
- **Unauthorized Health Claims:** The product must not claim to prevent, treat, or cure diseases unless approved by relevant authorities (e.g., the **Ministry of Health**).
- **Incomplete or Omitted Information:** Labels must not omit key details like expiry dates, allergens, or batch numbers that could affect consumer safety and trust.

✓ **Specific Labeling for Infant and Child Nutrition:**

Rwanda has strict guidelines regarding products meant for infants and young children, such as infant formula or powdered milk for babies. Labels on such products must:

- Provide specific feeding instructions.
- Warn about the health risks of improper feeding or overuse.
- Clearly state that breastfeeding is the best for babies, following WHO and local health policies.

✓ **Penalties for Non-Compliance:**

Manufacturers or distributors who fail to comply with labeling standards may face:

- **Fines:** Non-compliance with labeling regulations can result in monetary penalties.
- **Product recalls:** Unsafe or improperly labeled products can be removed from the market.
- **Legal action:** Severe cases of mislabeling or consumer deception can result in legal action and further sanctions from regulatory authorities.

✓ **Enforcement and Regulation:**

The **Rwanda Standards Board (RSB)** is responsible for enforcing food labeling regulations. Products found on the market without compliant labeling are subject to seizure, and the responsible parties may face penalties. RSB also carries out regular market inspections to ensure compliance.

Theoretical Activity 3.2.2: Description of the information appearing on the powdered milk label

Tasks:

1. Answer the following questions related to the description of the information appearing on the powdered milk label.

i. According to your knowledge, describe the information appearing on the powdered milk label

2. Write the answers on papers or flip chart
3. Present the findings/answers to the whole class.
4. For more clarification, read the **key readings 3.2.2**

Key readings 3.2.2.: Description of the information appearing on the powdered milk label

- **Information appearing on the powdered milk label**

According to Rwanda's labeling standards, the following information must appear on the label of prepackaged powdered milk:

- ✓ **Product name:** The common or usual name of the product, such as "Powdered Milk," must be clearly stated. If it's a specific type (e.g., "Whole Milk Powder" or "Skimmed Milk Powder"), that should be specified.
- ✓ **Ingredients list:** All ingredients must be listed in descending order by weight. This helps consumers understand the composition of the product and avoid allergens.
- ✓ **Net content:** The label must clearly state the net quantity of the product, either in weight (grams, kilograms) or volume (liters, milliliters).
- ✓ **Country of origin:** The country where the product was manufactured or processed must be listed on the label.
- ✓ **Nutritional information:** Labels must provide a detailed nutritional breakdown, typically including energy (in kilocalories or kilojoules), protein, fat (including saturated fat), carbohydrates (including sugars), sodium, and sometimes specific vitamins and minerals if applicable.
- ✓ **Expiry date and manufacturing date:** The label must show both the **manufacturing date** (or packing date) and the **expiry date** (or best-before date), indicating how long the product is safe and fit for consumption.
- ✓ **Manufacturer's details:** The name and address of the manufacturer, packer, or distributor must be included for consumer contact and product traceability.
- ✓ **Instructions for use:** For powdered milk, clear instructions on how to reconstitute the powder into liquid milk should be provided (e.g., how much water to mix with the powder).
- ✓ **Storage conditions:** Labels should include information on how to store the product, such as "Store in a cool, dry place" or "Refrigerate after opening."
- ✓ **Batch/lot identification:** Each package must have a batch or lot number for traceability in case of any quality or safety issues.
- ✓ **Allergen declaration:** If the product contains any known allergens (e.g., dairy, soy), this must be clearly indicated on the label. This helps consumers avoid allergic reactions.

- ✓ **Certifications and Logos:** If the product meets specific certification requirements (e.g., **RSB certification**, **Halal**, **Kosher**, or **Organic**), the appropriate logo or certification mark may be displayed on the label. Unauthorized use of such marks is prohibited.

Practical Activity 3.2.3: Labelling of the package of powdered milk

Task:

1: Referring the previous theoretical activity 3.2.1& 3.2.2, go to the workshop of powdered milk making to perform the following task:
Label the package of powdered milk
2: Apply safety precautions.
3: Present your work to the trainer/ Workshop assistant. Ask for clarification where necessary.
4: Read key reading 3.2.3
5: Perform the task provided in application of learning 3.2.

Key readings 3.2.3.: Labelling of the package of powdered milk

- **Labeling Procedures for Powdered Milk Packages**

Labeling is a critical step in ensuring consumer safety and product information. Here are the general procedures involved in labeling powdered milk packages:

- ✓ **Design and Creation:**

- **Label Design:** Create a visually appealing and informative label design that complies with relevant regulations.
- **Information Gathering:** Collect all necessary information for the label, including product name, ingredients, nutrition facts, allergen declarations, and storage instructions.

- ✓ **Printing:**

- **Material Selection:** Choose appropriate label materials that are durable, resistant to moisture and fading, and compatible with the packaging.
- **Label Printing:** Print the labels using high-quality printing techniques, ensuring clarity and readability.

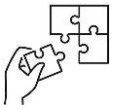
- ✓ **Label Application:**

- **Label Placement:** Determine the optimal placement of the label on the packaging, ensuring visibility and compliance with regulations.

- **Application Methods:** Use suitable application methods, such as manual application, label applicators, or automated labeling systems.
    - ✓ **Verification and Inspection:**
- **Label Accuracy:** Verify that all information on the label is accurate and complete.
- **Label Placement:** Check that the labels are properly positioned and adhere securely to the packaging.
- **Legibility:** Ensure that the text and graphics on the label are legible and easy to read.
    - ✓ **Quality Control:**
- **Random Sampling:** Conduct random inspections of labeled packages to verify label accuracy and quality.
- **Correction of Errors:** Address any errors or inconsistencies found during inspections.
    - ✓ **Regulatory Compliance:**
- **Compliance Check:** Ensure that the labeling complies with all relevant food safety and labeling regulations, such as those set by the Rwanda Standards Board (RSB).
- **Documentation:** Maintain records of labeling activities, including label designs, production records, and quality control checks.

Points to Remember

- By adhering to these labelling standards, manufacturers ensure that powdered milk products are marketed transparently, safely, and in compliance with local and international regulations.
- This comprehensive labelling ensures that consumers have all the necessary information to use powdered milk safely and appropriately while complying with food safety regulations.
- By ensuring that all these elements are present and clearly displayed, manufacturers comply with food safety regulations, while consumers receive the necessary information to use the product safely and appropriately.



Application of learning 3.2.

You are requested to go to the powdered milk making workshop to label packaged can contains 1000g of processed powdered milk.

Indicative content 3.3: Storing Powdered Milk

Duration: 2 hrs

Theoretical Activity 3.3.1: Description of the storage requirements of powdered milk

Tasks:

1. Answer the following questions related to the description of the storage requirements of powdered milk

   i. Based to your knowledge, what are the purposes of storing powdered milk?
   ii. According to your knowledge, describe the storage requirements of powdered milk.

2. Write the answers on papers or flip chart.
3. Present the findings/answers to the whole class.
4. For more clarification, read the **key readings 3.3.1**

Key readings 3.3.1.: Description of the storage requirements of powdered milk

- **Storing powdered milk**
  - ✓ **Purpose of storing powdered milk**

The main goals of storing powdered milk are to:

- **Preserve product quality:** Proper storage ensures that powdered milk maintains its flavor, texture, and nutritional value over time.
- **Extend shelf life:** Powdered milk has a longer shelf life than liquid milk, but optimal storage conditions can further prolong this by preventing spoilage and deterioration.
- **Prevent contamination:** Correct storage helps protect the powdered milk from contamination by bacteria, mold, or pests.
- **Reduce waste:** By properly storing powdered milk, both consumers and manufacturers can avoid premature spoilage, reducing food waste and financial losses.
- **Ensure Safety:** Minimize the risk of contamination and foodborne illnesses.
  - ✓ **Storage conditions**

To ensure powdered milk retains its quality and safety, certain storage conditions must be met. These conditions revolve around controlling moisture, temperature, and light exposure.

a. Moisture Content:

- **Critical Moisture Control:** Powdered milk is highly hygroscopic, meaning it absorbs moisture from the surrounding environment. If exposed to moisture, the

powder clumps and its quality deteriorates, leading to potential microbial growth or spoilage.

- **Recommended Storage:** To prevent moisture absorption, powdered milk should be stored in airtight containers or packaging with strong moisture barriers. Once opened, reseal the container or transfer the powder to an airtight container with a desiccant packet, if available.
- **Ideal Humidity:** Store powdered milk in environments with relative humidity below **65%** to minimize moisture exposure.

b. Temperature:

- **Optimal Temperature:** The ideal storage temperature for powdered milk is **below 25°C (77°F)**. Storing it in a cool place helps maintain its quality by reducing the risk of chemical reactions such as fat oxidation.
- **Avoid Heat Exposure:** Elevated temperatures can accelerate the degradation of fats, proteins, and vitamins in the milk, causing rancidity and reducing shelf life.
- **Refrigeration (optional):** While not required, storing powdered milk in a refrigerator may help preserve freshness once the package is opened, especially in hot climates.

c. Light Exposure:

- **Light Sensitivity:** Exposure to light, especially ultraviolet (UV) light, can degrade certain vitamins in powdered milk (such as vitamins A and D) and lead to off-flavors.
- **Opaque or Light-Resistant Packaging:** To prevent light degradation, store powdered milk in packaging that blocks or limits light exposure (e.g., metal tins, opaque plastic, or aluminum foil-lined bags).
- **Dark Storage Areas:** If possible, store powdered milk in a cupboard or pantry away from direct sunlight.

d. Air Exposure:

- **Oxygen Sensitivity:** Exposure to oxygen can lead to the oxidation of fats, causing rancidity and off-flavors. Powdered milk should be kept in airtight containers to minimize oxygen contact.

- **Stock Management for Powdered Milk**

Effective stock management is crucial for maintaining the quality of powdered milk, especially in retail or food service environments where larger quantities are handled.

a. First-In, First-Out (FIFO) Method:

- **FIFO Principle:** Always use the oldest stock first to ensure that no powdered milk remains unused past its expiry date. This prevents waste and ensures freshness.
- **Rotation:** Regularly rotate stock so that new arrivals are placed behind older stock. This ensures that the older stock is used up before it can spoil or lose quality.

Practical Activity 3.3.2 Store powdered milk

Task:

1: Referring to the previous theoretical activities 3.3.1, go to powdered milk making workshop to perform the following task:
Store packaged powdered milk
2: Apply safety precautions.
3: Present your work to the trainer/ Workshop assistant. Ask for clarification where necessary.
4: Read key reading 3.3.2
5: Perform the task provided in application of learning 3.3.

Key readings 3.3.2.: Store powdered milk

- **Storage Procedures for Powdered Milk**

Proper storage of powdered milk is essential to maintain its quality, prevent spoilage, and extend its shelf life. Here are the recommended procedures:

- ✓ **Preparation:** Clean and organize the storage area to ensure a clean and safe environment for your powdered milk.
- ✓ **Storage:** Store items according to their specific needs and use storage instructions
- ✓ **Maintenance and Inventory:** Periodically inspect stored items for signs of damage or deterioration. If applicable, rotate stock to ensure that older items are used first.

- **Storage Conditions:**
  - **Temperature**: Store in a cool, dry place away from direct sunlight and heat sources. Avoid storing near stoves, ovens, or radiators.
  - **Humidity**: Maintain a low humidity level to prevent moisture absorption, which can lead to clumping and spoilage.
  - **Light:** Protect from direct sunlight, as exposure can accelerate oxidation and nutrient degradation.

Points to Remember

- By following these storage guidelines, you can maximize the shelf life and quality of powdered milk, ensuring it remains safe and nutritious for use.
- By following these storage procedures, you can help ensure the quality, safety, and longevity of your powdered milk.

Application of learning 3.3.

You are requested to go to the powdered milk making workshop to store packaged powdered milk.

Learning outcome 3 end assessment

Written assessment

1. Read the following statement related to packaging of powdered milk making and answer **True** if statement is **correct** and **False** if the statement is **wrong**:

a) Packaging powdered milk has no effect on preventing oxidation or protecting the product from air exposure.
b) Proper packaging of powdered milk does not help prevent microbial contamination.
c) Packaging powdered milk makes it easier to transport and store without contamination or spillage.
d) Proper sealing and sterilization of packaging equipment is unnecessary for powdered milk products.
e) Packaging for powdered milk should be designed to ensure safety and prevent accidental spills or leaks.

2. Read the following statement related to packaging of powdered milk and fill in the provided space the appropriate terminologies in brackets: **(Light, mechanical, chemical, moisture, cost, oxygen, laminated, heat, pouches, rigid).**

a. The packaging material for powdered milk should provide a _____ barrier to prevent the ingress of moisture and avoid spoilage and clumping of the product.
b. To prevent rancidity, the packaging must also serve as an _____ barrier to block oxygen from reaching the powdered milk.
c. A _____ barrier is necessary to block light and prevent the degradation of sensitive nutrients like vitamins in the powdered milk.
d. The packaging should possess _____ strength to withstand transportation and handling without tearing or breaking.
e. The packaging material must exhibit _____ inertness to ensure it is food-safe and does not react with the powdered milk.
f. Common packaging materials for powdered milk include _____ films, which are made by combining different layers of materials like polyethylene and aluminum foil.
g. _____ containers can be made of plastic, metal, or cardboard and offer good protection but may be heavier and more expensive than flexible packaging.
h. _____ are typically made of flexible materials such as polyethylene or polypropylene, making them lightweight, convenient, and cost-effective for powdered milk.

3. Match the packaging procedure step in **Column A**, with their descriptions in **Column B**; and **write the letter corresponding to the correct description in provided space**.

Answer	**Column A**	**Column B**
……..	1. Preparation and Cleaning	A. Accurately weigh the desired amount of powdered milk for each package.
……	2. Filling	B. Store packaging materials in a clean and dry environment.
……..	3. Sealing	C. Clean and sanitize packaging equipment, ensuring no contaminants are present.
…….	4. Coding and Labelling	D. Apply codes and labels with product information and traceability.
……	5. Inspection and Quality Control	E. Ensure seals are intact and verify package weights.
……	6. Packaging Material Handling	F. Use filling machines to transfer the powdered milk into containers.
……	7. Product Storage	G. Store the packaged powdered milk under appropriate temperature and humidity.
……	8. Shipping and Distribution	H. Pack and arrange for transportation, ensuring proper handling during transit.

Practical assessment

Your school plan to go to the exhibition of agriculture and animal products. They want five cans of powdered milk. You are requested to go to the powdered milk making workshop to pack five (5) cans of powdered milk, each contain 5kg, label and store packaged powdered milk within 3 hours. All necessary tools and equipment are available in the workshop

END

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