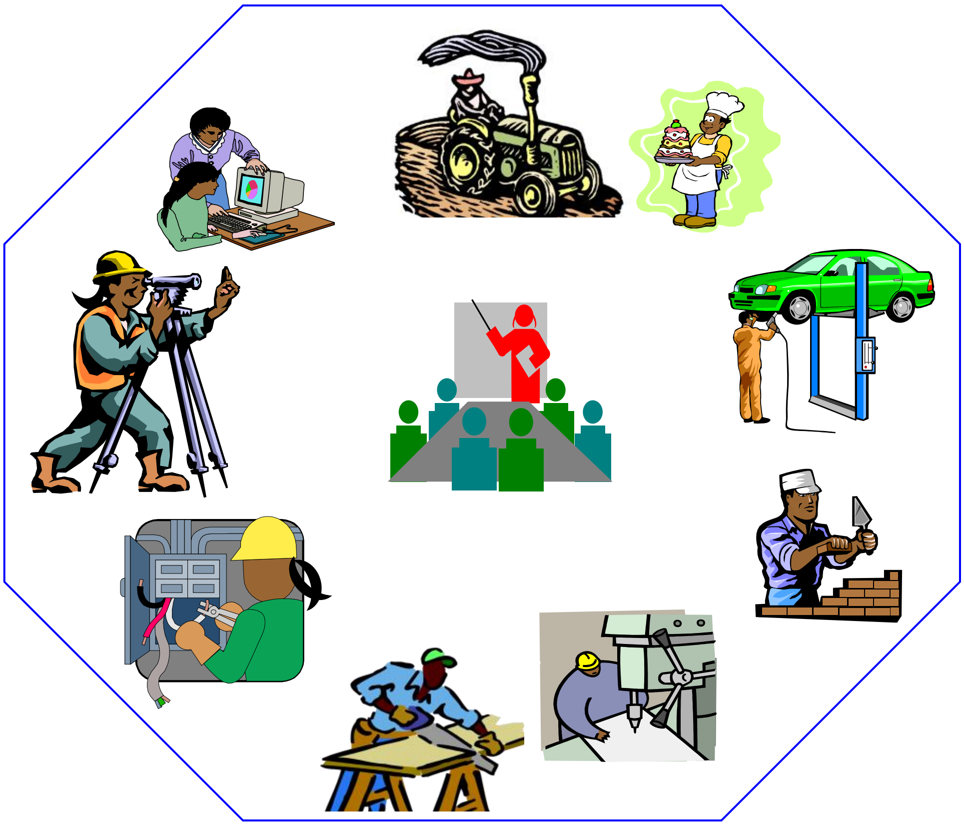
Dairy Products Processing
Level-III

Based on October 2019, Version 2 OS and March, 0321, V1 Curriculum



Module Title: - Performing Yoghurt Production Operation

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LG #33	LO #1- Apply sanitation procedures

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Keeping clean the storage area for starter cultures
- Cleaning and sanitizing all surfaces
- Applying stringent personal hygiene procedures
- Maintaining raw milk area
- Applying multi-phase cleaning systems
- Recording food safety related information

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Keep clean the storage area for starter cultures
- Clean and sanitizing all surfaces
- Apply stringent personal hygiene procedures
- Maintain raw milk area
- Apply multi-phase cleaning systems
- Record food safety related information

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished

answering the Self-checks).

6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, ask your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Keeping clean the storage area for starter cultures

1.1. Introduction

Yoghurt is a generic/classical name for a group of fermented/cultured milk-based food products. It is a value-added dairy product, which has high nutritional significance owing to its richness in pre-digested proteins, fat, minerals, and vitamins. Yoghurt making involves a series of processes that convert milk into different varieties of yoghurts known for their characteristic sensory attributes and nutritional value. The process of yoghurt making involves removal of water and lactose (and some minerals) from milk to produce a concentrate of milk fat and protein. Yoghurt is considered as a functional food owing to its health benefits beyond basic nutrition. The essential ingredients for yoghurt are milk, rennet, starter cultures and salt. Each step of the process has a relevant importance to obtain a good quality and characteristic yoghurt.

Despite starting from a limited range of raw materials (milk, starter cultures, coagulant and salt), a huge number (perhaps 1500 – 2000 varieties) of yoghurts are produced worldwide in a great diversity of flavors, textures, nutritive values and forms. Even a small alteration in the yoghurt making processes can result in a different variety of yoghurt altogether. Indeed, it has been said that “there is yoghurt for every taste preference and a taste preference for every yoghurt”. Despite the large number of varieties, however, yoghurts may be classified into different groups or families. Although there is no completely satisfactory and universally agreed classification criterion for yoghurt varieties, criteria for classification may include: its composition (consistency/texture/moisture content [very hard, hard, semi-hard/semi-soft, soft]; fat content [low or high fat yoghurt]); coagulating agent (rennet or acid coagulated); and ripening condition/extent/manner of ripening (matured/ripened or fresh/unripened).

The essential characteristic step in the manufacture of all yoghurt varieties involves coagulation of the casein component of the milk protein system (whole or skimmed milk, cream or whey sources) to form a gel which entraps the fat, if present. Coagulation may be achieved by:

- Limited proteolysis by selected proteinases (rennet's);
- Acidification to ~pH 4.6;
- Acidification to a pH value >4.6 (perhaps ~5.2) in combination with heating to ~80 – 90 C.

The majority of yoghurt varieties, and ~75 % of total production, are produced by rennet coagulation but some acid-coagulated varieties, e.g., quark (quarg), cottage and cream yoghurts, are of major importance globally. Acid-heat-coagulated yoghurts are of relatively minor importance and are usually produced from whey or a blend of whey and skim milk and probably evolved as a useful means for recovering the nutritionally-valuable whey proteins. Their properties are very different from those of rennet- or acid coagulated yoghurts and they are usually used as food ingredients. some explanations/answers.

1.1 Keeping clean the storage area for starter cultures

Starter Handling

Although there are still yoghurts made without the use of starters, the manufacture of the vast majority of yoghurts relies on the use of starter cultures. The way the starters are applied and handled, however, shows several variations from artisanal tradition to modern science-based technology.

The traditional approach involves using some milk of a successful product batch or some whey derived from it after further incubation, as a starter for the next batch. This approach results in selective enrichment of microorganisms that survive and multiply under yoghurt-making conditions and that have the desirable properties. Such good artisanal cultures are the archive stocks for the production of undefined starters used in industrial yoghurt manufacture.

Alternatively, these cultures are preserved and propagated under controlled laboratory conditions and supplied to the yoghurt factory in concentrated and frozen form, to be used as inoculum for the bulk starter. The culture suppliers often use whey-based media, enriched with yeast extract or another vitamin source, instead of milk for the propagation of their cultures. This renders cultures with a higher concentration of cells in a shorter time, which ultimately lowers their price. Defined-strain starters consisting of purified strains, free of contaminants, are also propagated under controlled laboratory conditions and supplied in frozen form.

Undefined and defined-strain starters are nowadays provided in highly concentrated freeze-dried form as well. In this form they are applicable as a direct inoculum for the yoghurt vat (DVI), thus avoiding the on-site cultivation of a bulk starter. The usage of DVI is limited due to the high price of the freeze-dried starter. In particular, any plant producing more than 10,000 tons of yoghurt per annum would consider the use of DVI a major cost item. On the other hand smaller plants would consider DVI more convenient and more economical than using a bulk starter. Secondary cultures and adjunct starters are ideally suited to be supplied to the yoghurt vat in DVI form.

Effective cleaning makes a substantial contribution to sound food preservation, and hence it is necessary to specify cleaning methods, procedures and materials, together with a cleaning schedule, and a system that records when cleaning was done and who did it. Separate lockable stores are necessary for cleaning materials.

Thoroughly clean the work and storage area and put away all other foodstuffs, particularly those containing yeasts and those with strong smells such as garlic and onion that may taint the starter cultures. Make sure all of the equipment is to hand and thoroughly cleaned. Wash your hands with non-perfumed soap or detergent and clean your fingernails (fingernails are best kept short as the action of acid and enzymes softens nails and they can break off in the curd).

The storage area must be clean, well ventilated and neither too hot nor too cold. A temperature of about 4° C is ideal.

Self-check 1	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Short Answer Questions

1. What are the factors affecting curd formation?(5pts)

Test II choose the best answer

1. Which one of the following groups of chemicals is not a food nutrient?(2pts)
   A. proteins
   B. enzymes
   C. Carbohydrates
   D. vitamins

Test III Write true if the statement is correct and false if statement is incorrect

1. The storage area must be clean, well ventilated and neither too hot nor too cold. (2pts)

2. The ideal temperature storage of starter culture is about 4° C. (2pts)

Satisfactory rating - 11 points **Unsatisfactory - below 11 points**

***Note:* Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers

Score = ___________
Rating: ____________

Information sheet -2. Cleaning and sanitizing all surfaces

2.1Cleaning and sanitizing all surfaces

In the dairy industry, cleaning and disinfection are essential operations. Fouling occurs because milk residues remain on the surfaces of the equipment. Residues of milk that have dried up are difficult to remove. Excessive fouling is costly because milk is lost, increased concentrations of detergents are required, and consequently more wastewater is produced.

Internal cleaning of food equipment can be manual or automatic. In hand cleaning, equipment should be designed to facilitate disassembling for cleaning and subsequent reassembling. Manual cleaning, however, requires a great deal of time and labor. On the other hand, automatic cleaning is carried out without disassembling the equipment, resulting in great savings in cleanup labor cost and time. This procedure is referred to as a clean-in-place (CIP) system. When applying a CIP system, following considerations should be taken into account:

- The food processing plant, in which the CIP system is installed, must exhibit hygienic design. The design solution for equipment, including construction materials, should permit the installation of this system. In other words, if the CIP system is installed in a running process plant, it must be assumed that similar or better hygienic levels will be achieved.
- Careful selection of cleaning products in conjunction with type of soil removed and materials used to construct food equipment.
- Impact of the CIP system installation on total cost must be estimated, since supplementary capital investment and other operation cost will be needed. Installation of the CIP system must be profitable and economically feasible.

CIP systems are designed according to the product (nature, composition, and quantity), the most suitable cleaning frequency, and the equipment being cleaned (process or storage tanks), pipes, pumps or food processing equipment, such as heat exchangers and evaporators. Thus, the cleaning program should use the most adequate cleaning and sanitizing agents, and the frequency of application should be determined. The selection of the best distribution system (spray-balls, rotating jets, etc.) depends on how the equipment will be cleaned. The main function of these devices is to distribute the cleaning agent uniformly over the entire surface being cleaned. Other designs for cleaning product distribution devices are spray rings and spray cane, used in evaporators, dryers, vacuum chambers, and other equipment of irregular design. All of these distribution devices, including spray-balls, allow the cleaning of more or less difficult points.

Kinds of Soils can be found in a food plant:

- Food product residue
- Water
- Airborne contamination
- Transient soil from workers
- Detergent ingredients
- Viable Microorganisms

Fundamentals for Success:

- Know your plant conditions and tailor sanitation to them.
  - ✓ Soils, water quality, equipment, facility and zoning
- Train your teams
- Plant hygienic zoning procedures apply here too
- Work safely – PPE
- Order is important:

Fig-1 factor of cleaning

The Seven Steps of wet sanitation process

A. Sanitation preparation

- Remove production supplies from the room ⁄ All ingredients, food products, packaging materials,
- Empty & remove garbage and scrap containers
- Purge process lines
- Empty drain baskets by dedicated personnel
- Remove all equipment that cannot get wet
- Lock-out tag-out equipment to be cleaned ⁄ Follow plant procedures for LOTO
- Disassemble equipment
- Dry clean & sanitize, then cover all electric eyes, electronic control equipment, adjacent production lines
- Remove loose soil & debris from equipment and floor (top to bottom)

B. Pre-rinse

- Rinse to remove visible soils
- Consider the water temperature & pressure
- Rinse from top to bottom
- Target removal of 95% of visible soil
- Rinse parts and place on dedicated sanitation carts or into COP tank or bucket for cleaning

C. Clean

Different approaches of cleaning:

- Foam cleaning
- Wetter foam generally better than dry foam
- Define a start point and an end point\
- No advantage to using hot water for foam
- Do not allow foam to dry
- Foam undersides of equipment
- Scrub as necessary to remove film, fats, and proteins
- Clean drains with dedicated tools & PPE
- Manual cleaning

- Manually scrubbing may be
- required to remove heavy soils
- Use color-coded, single-use
- pads and brushes as required
- Do not place parts on the floor
- Use a cart, table or mat for parts placement

- Clean Out of Place (COP) tanks
  - Automatic equipment parts washing
  - Thorough pre-rinse required
  - Be sure all parts are adequately covered
  - Test kit verification of concentration
  - Control cleaning solution temperature to melt fats
  - Separate rinse and sanitize steps
- Clean in Place (CIP)
  - Use dedicated personnel, equipment, & tools
  - Label and color coded appropriately
  - Clean & sanitize drains after equipment cleaning and before equipment sanitizing.
  - Take care of your tools
  - Clean and dry buckets & brushes after each use
    - Use sanitizer per label instructions

D. Rinse & inspect

Rinse to Remove Chemicals & Soil:

- Rinse in the order that soap was applied – walls, floor and then equipment
- Rinse equipment from top to bottom
- Avoid spraying floor once post rinse of equipment begin

E. Remove & assemble

- Put on clean outerwear
- Sanitize hands
- Verify all chemical is removed (sight, pH paper)

- Remove all standing water and overhead condensation
- Inspect parts that will not be accessible after assembling
- Sanitize inaccessible parts prior to assembling
- Assemble: follow lock-out/tag-out (LOTO) procedures
- Re-lubricate where needed

F. Pre-operation inspection & verification

- Inspect that equipment is free of chemicals, tools and cleaning supplies
- Inspect that guards are in place before starting equipment
- Run equipment prior to inspecting
- Complete formal pre-op inspection according to plant SSOP
- Correct any deficiencies and
- provide feedback to sanitation operator
- Use Adenosine Triphosphate (ATP) swab analysis to verify that surface has been effectively cleaned of soils

G. Sanitize

- Verify no standing water
- Measure concentration using test kits
- Flood sanitize entire processing area
- Walls, floors and equipment
- Ensure equipment is running
- Apply from top to bottom
- Follow label directions for EPA registered sanitizer applications

Self-check 2	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Short Answer Questions

1. List Kinds of Soils found in a Food Plant?(3pts)
2. What are the Seven Steps of wet sanitation process?(5pts)

Note: **Satisfactory rating - 8 points** **Unsatisfactory - below 8 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________
Rating: ____________

3.1 Applying stringent personal hygiene procedures

Personal hygiene- All persons handling milk should maintain high levels of personal hygiene. A milk transporter or handler should:

- wash hands and nails with clean water and soap before handling milk
- wear clean overalls/dust coat and gum boots while handling milk
- not be suffering from a communicable disease or have open sores or abscess on the arms, hands, head or neck
- not cough or sneeze over milk or milk containers
- bathe or shower regularly

To ensure that those who come directly or indirectly into contact with food are not likely to contaminate food by:

- Maintaining an appropriate degree of personal cleanliness;
- Behaving and operating in an appropriate manner.

People who do not maintain an appropriate degree of personal cleanliness, who have certain illnesses or conditions or who behave inappropriately, can contaminate food and transmit illness to consumers.

A. Health status

People known, or suspected, to be suffering from, or to be a carrier of a disease or illness likely to be transmitted through food, should not be allowed to enter any food handling area if there is a likelihood of their contaminating food. Any person so affected should immediately report illness or symptoms of illness to the management.

Medical examination of a food handler should be carried out if clinically or epidemiologically indicated.

Additional points to consider:

- The manufacturer should have and enforce a policy to prevent personnel known to be suffering from or known to be carriers of a disease transmissible through food from working in food handling areas.
- The manufacturer should require that employees advise management when they are suffering from a communicable disease likely to be transmitted through food.
- Employees having open cuts or wounds should not handle food or food contact surfaces unless the injury is completely protected by a secure waterproof covering, e.g. rubber gloves.

B. Illness and injuries

Conditions which should be reported to management so that the need for medical examination and/or possible exclusion from food handling can be considered, include:

- Jaundice
- Diarrhea
- Vomiting
- Fever
- Sore throat with fever
- Visibly infected skin lesions (boils, cuts, etc.)
- Discharges from the ear, eye or nose;

C. Personal cleanliness

Food handlers should maintain a high degree of personal cleanliness and, where appropriate, wear suitable protective clothing, head covering and footwear. Cuts and wounds, where personnel are permitted to continue working, should be covered by suitable waterproof dressings.

Personnel should always wash their hands when personal cleanliness may affect food safety, for example:

- At the start of food handling activities
- Immediately after using the toilet
- After handling raw food or any contaminated material, where this could result in contamination of other food items; they should avoid handling ready-to-eat food, where appropriate.

Additional points to consider:

- All persons should wash their hands upon entering food handling areas, before starting work, after handling contaminated materials, after break and after using toilet facilities. Where necessary to minimize microbiological contamination, employees should use disinfectant hand dips.
- Protective clothing, hair covering, footwear and/or gloves appropriate to the operation that the employee is engaged in, e.g. effective hair coverings for employees in production areas, should be worn and maintained in a sanitary manner.

D. Personal behavior

People engaged in food handling activities should refrain from behaviour which could result in contamination of food, for example:

- Smoking
- Spitting
- Chewing creating
- Sneezing or coughing over unprotected food.

Additional points to consider:

- Personal effects such as jewelry, watches, pins or other items should not be worn or brought into food handling areas if they pose a threat to the safety and suitability of food.
- Any behavior that could result in contamination of food, such as eating, use of tobacco or chewing gum or unhygienic practices such as spitting, should be prohibited in food handling areas.
- All persons entering food handling areas should remove jewelry and other objects that could fall into or otherwise contaminate food. Jewelry that cannot be removed, such as wedding bands and medical alerts, should be covered.
- Personal effects and street clothing should not be kept in food handling areas and should be stored in such a manner as to prevent contamination.

E. Visitors

Visitors to food manufacturing, processing or handling areas should, where appropriate, wear protective clothing and adhere to the other personal hygiene provisions in this section.

Access of personnel and visitors should be controlled to prevent contamination. The traffic pattern of employees should not result in cross-contamination of the product.

Self-check 3	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I choose the best answer

1. Due to Personal behavior of milk handling should refrain from which could result in contamination of food (2pts)

A. Smoking
B. Spitting
C. Sneezing or coughing over unprotected food
D. All

Test I Short Answer Questions

1. Define Personal hygiene(2pts)

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Information sheet - 4 maintaining raw milk area

4.1 Maintaining raw milk area

Raw or unpasteurized milk

Unprocessed milk transforms into yoghurt most easily, and is my favorite to work with because the live bacteria, enzymes, and intact proteins and calcium all assist with rennet activity and coagulation, but it's important to educate yourself about the risks of using raw milk, and to find a reputable source for your raw milk. A farm, for instance, will not necessarily provide better milk than a grocery store if the farm engages in unsanitary milking practices or the milk or animals are kept in unhealthy conditions. You may live in a state where raw milk sales are legal in grocery stores, but if you do If you have some curds sticking at the bottom of a stainless-steel pot, sprinkle in some regular flake salt and scrub at it with a sponge. This has worked better for me than any specialized scrubbers.

The pH of milk (around 6.6), its temperature in the udder (around 38^{0}C), and its high nutritional value are ideal for the growth of bacteria. However, bacteria growth does not usually occur because milk in the udder is sterile, unless the udder is infected. Bacteria can colonize the teat canal but are expelled in the first few squirts of milk. However, during milking, the milk becomes contaminated with microorganisms, mainly from the milking equipment, and it will, if maintained at a temperature above 15^{0}C for several hours, coagulate due to the production of acid by adventitious bacteria, such as lactic acid bacteria (LAB) and coliforms. Therefore, great care must be taken to ensure that milk is produced hygienically.

The major source of contamination of raw milk is improperly cleaned milking equipment. For this reason, considerable emphasis is placed on the satisfactory cleaning of the milking machine, its associated rubber hoses and pipework, and the bulk-storage tank. The machine should be cleaned after each milking, and the bulk-storage tank after it has been emptied. Hot and cold detergent washes are used and generally a hot acid rinse is given once a week to prevent the buildup of "milk stone," which can harbor bacteria and make the equipment difficult to clean.

Cooling significantly slows down the rate of multiplication of bacteria in raw milk. However, slow growth of bacteria, particularly psychrotrophs, still occurs at 4^0C, and significant numbers can often be reached in 3 or 4 days' storage on the farm. Raw milk

The number of spoilage bacteria in raw milk depends on the level of hygiene during milking and the cleanliness of the vessels used for storing and transporting the milk. During the first 2–3 hours after milking, raw milk is protected from spoilage by inherent natural antibacterial substances that inhibit the growth of spoilage bacteria. However, if the milk is not cooled, these antibacterial substances break down causing bacteria to multiply rapidly. Cooling milk to less than 10°C may prevent spoilage for up to three days. High storage temperatures result in faster microbial growth and hence faster milk spoilage.

Raw milk is also known to be associated with pathogenic bacteria which cause milk-borne diseases such as tuberculosis, brucellosis or typhoid fever, among others. Hygienic milk production, proper handling and storage of milk, and appropriate heat treatment can reduce or eliminate pathogens in milk. In many countries, milk processing factories are required by law to pasteurize milk before selling it to the public. Many consumers also routinely boil milk before drinking it to protect themselves from milk-borne diseases. Processed milk must be handled hygienically to avoid post-processing contamination.

Tankers are cleaned every day, as a rule at the end of a collection round. If the tanker makes several rounds a day, cleaning should take place after each round. Cleaning can be carried out by connecting the tanker to a cleaning system while in the reception area or by driving it to a special cleaning station. Many dairies also clean the outside of their tankers every day so that they always look clean when they are on the road.

Chilling the incoming milk

Normally a temperature increase to slightly above + 4 °C is unavoidable during transportation. The milk is therefore usually cooled to below + 4 °C in a plate heat exchanger before being stored in a silo tank to a wait processing.

The untreated raw milk/whole milk is stored in large vertical tanks/silo tanks which have capacities from about 25 000 liters up to 150 000 liters. Normally, capacities range from 50 000 to 100 000 liters. Smaller silo tanks are often located indoors while the larger tanks are placed outdoors to reduce building costs. Outdoor silo tanks are of double-wall construction, with insulation between the walls. The inner tank is of stainless steel, polished on the inside, and the outer wall is usually of welded sheet metal.

These large tanks must have some form of agitation arrangement to prevent cream separation by gravity. The agitation must be very smooth. Too violent agitation causes aeration of the milk and fat globule disintegration. This exposes the fat to attack from the lipase enzymes in the milk. Gentle agitation is therefore a basic rule in the treatment of milk. In very high tanks it may be necessary to fit two agitators at different levels to obtain the required effect. Outdoor silo tanks have a panel for ancillary equipment. The panels on the tanks all face inwards towards a covered central control station.

Cooling of milk causes several changes, the most important ones being:

- The growth of most microorganisms is much slower, if not stopped, and so are the changes induced in milk by their metabolism.
- Nearly all chemical and enzymic reactions are retarded.
- Autoxidation of lipids, whether induced by light, is enhanced, presumably because the activity of the enzyme superoxide dismutase is decreased.
- Changes in solubility and association of salts occur. The amount of micellar calcium phosphate decreases, and the pH increases.
- The casein micelles attain a higher voluminosity and part of the casein especially β-casein, goes into solution. This results in an increased viscosity and an enhanced susceptibility to attack by plasmin.

- The fat globule membrane loses some components, and its structure is altered. These changes are irreversible.
- Cold agglutination of fat globules occurs, e.g., enhancing creaming rate.
- The triglycerides in the fat globules will partly crystallize

Thermization

In many large dairies it is not possible to pasteurize and process all the milk immediately after reception. Some of the milk must be stored in silo tanks for hours or days. Under these conditions, even deep chilling is not enough to prevent serious quality deterioration. Long chilling of milk leads to insolubilization of calcium ions, but they are required in their soluble form in rennet cheese manufacture. To make them soluble again, moderate heating (thermization) of chilled milk is required. Many dairies therefore preheat the milk to a temperature below the pasteurization temperature to temporarily inhibit bacterial growth. This process is called thermization. The milk is heated to 63 – 65°C for about 15 seconds, a time/temperature combination that does not inactivate the phosphatase enzyme. Double pasteurization is forbidden by law in many countries, so to prevent aerobic spore-forming bacteria from multiplying after thermization, the milk must be rapidly chilled to 4°C or below and it must not be mixed with untreated milk. Thermization has a favorable effect on certain spore-forming bacteria. The heat treatment causes many spores to revert to the vegetative state, which means that they are destroyed when the milk is subsequently pasteurized. Thermization should be applied only in exceptional cases. The objective should be to pasteurize all the incoming milk within 24 hours of arrival at the dairy.

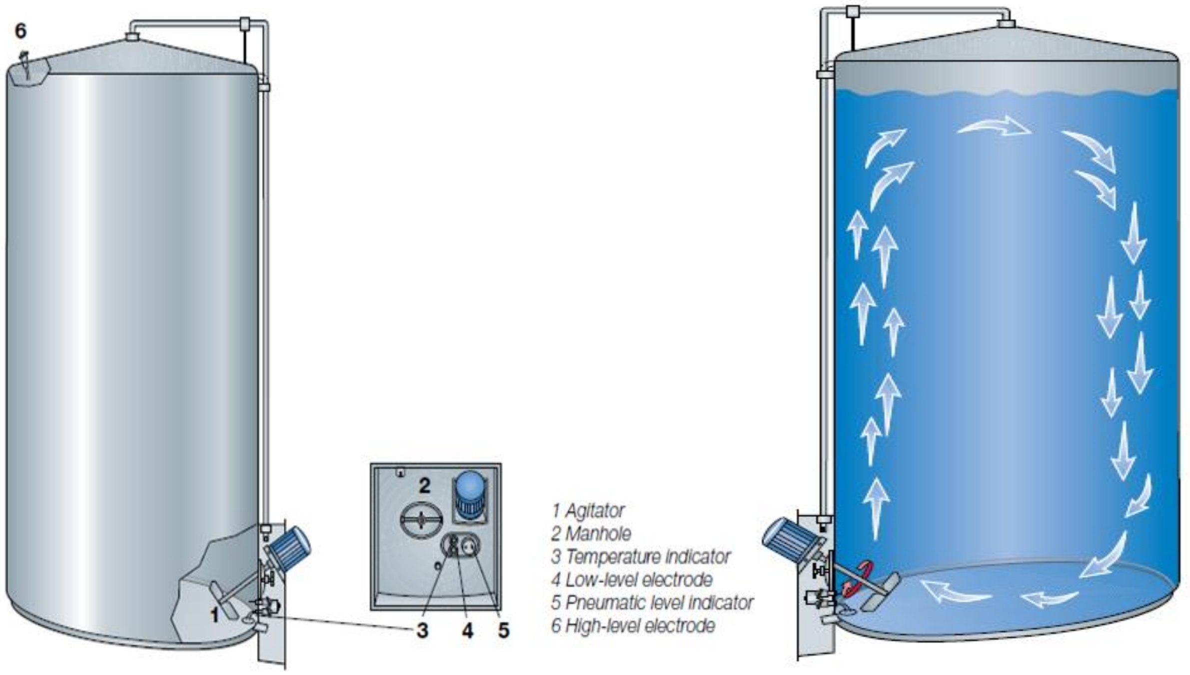


Fig. 2 Silo tank with propeller agitator

Self-check 4	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I. Short Answer Questions (10 points

1. What is raw milk (3 %?)

2. What is unpasteurized milk (3 %?)

3. Write the major source of contamination of raw milk (4%)

List the advantages of cooling of milk? (8pts)

What is thermization? (2)

Part II choose the best answer

1. Most micro-organisms grow best when the pH is: (2)
   A. pH 2-4
   B. pH 4-6
   C. pH 6-8
   D. pH 8-10

Note: **Satisfactory rating – 20 points** **Unsatisfactory - below 20 point**

You can ask you teacher for the copy of the correct answers

Score = ____________

Rating: _____________

Information sheet -5. Applying multi-phase cleaning systems

5.1 Applying multi-phase cleaning systems

Cleaning

Cleaning is primarily aimed at a thorough removal of material causing growth of microorganisms and removal of formed deposit that impairs the efficiency of the machinery. A satisfactory cleaning begins with the design of the equipment(smooth surfaces, no ‘‘dead ends’’) and of the manufacturing processes.

The following are essential operations in a cleaning process for dairy machinery:

a. Pre-rinsing

Vigorous pre-rinsing with water can remove some 80% to 90% of the material not absorbed onto the equipment. The consumed pre-rinse water should not contain much milk, partly to limit any loss of milk. Because of this, most milk residues should be removed before pre-rinsing.

b. Cleaning steps

A much applied method is first cleaning with alkali, followed by an acid rinse. Alkali (e.g., 1% NaOH) swells the outer layer of the type a deposit. The time needed for the alkali to reach the wall by diffusion is too long for a thick deposit layer. For a layer of 1 cm thickness, it would take a few hours. Presumably, cracks are formed in the layer and applying a sufficiently intense turbulence then causes break-up of the deposit, thereby detaching it from the wall. Strong alkali may cause the opposite, since it makes the outer layer rubbery and the deposit hard to remove. After rinsing with water, nitric or phosphoric acid are introduced to remove the scale. If the acid rinse is omitted, the alkali treatment may even increase the amount of calcium salts deposited. The latter deposit would also include protein, so contaminating organisms would have an increased growth potential.

c. Final rinsing with water

It is meant to remove cleaning agents. After acid cleaning, the acid should exhaustively be washed away if disinfection with sodium hypochlorite is subsequently applied.

Otherwise, the steel would become corroded and below pH 5 chlorine gas can be released.
Among the various cleaning systems, circulation cleaning (cleaning in place, CIP) is primarily applied. Automated CIP units are used, and several cleaning circuits are often connected to one such unit. Achieving a satisfactory separation of the consecutive liquids is essential to restrict consumption of water and loss of chemicals.

Efficient separation is facilitated by applying conductivity measurements, sometimes combined with determinations of pH, temperature, and/or turbidity.

Sanitizing

The common aim of disinfection is to kill the microorganisms present on surfaces and thereby prevent contamination of the product during manufacture and packing. A satisfactory disinfection does not necessarily kill all microorganisms present but reduces their number to a level where any quality and health risk can reasonably be assumed absent. Clearly, good cleaning should precede any disinfection. Combined cleaning and disinfection can only be used if just loosely connected deposit is present and if pre-rinsing removes most of it.

Most microorganisms are removed during cleaning. Moreover, some cleaning agents such as strong alkali and nitric acid solutions have a disinfecting action.

Heat or chemical agents can be used for disinfection. In the former method, hot water or steam is used. Maintaining the required minimum temperature in the machinery and at the surfaces for sufficient time is essential. High temperatures cause denaturation of remaining proteins, and these can then precipitate on the equipment. Prior to heat disinfection, good cleaning thus is necessary. Disinfection by heat, especially with steam, has the additional benefit of enhancing the subsequent drainage and drying of the machinery, hence of diminishing the risk of bacterial growth. Moreover, after heat disinfection no disinfectant residues are left.

Residues of cleaning agents and disinfectants should not be allowed to contaminate the finished products; thus, the final rinsing step is essential. Some agents, such as quaternary ammonium compounds, can absorb onto surfaces of equipment and such residues can eventually be taken up by the product.

Self-check 5	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part 1.write the define the question10%

1. What are the two universally principles of safe handling of raw milk?(4pts)
2. Define personal hygiene?(4pts)

Note: **Satisfactory rating - 20points** **Unsatisfactory - below 20 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________
Rating: ____________

Information sheet-6 Recording food safety related information

6.1 Recording food safety related information

In the dairy plant, processing of milk involves several unit operations: storage, clarification, preheating, separation, and standardization for fat content, homogenization, pasteurization, cooling and packing. The raw milk is stored in silos for a limited time (up to 72 hours) at below 7°C or preferably 4°C according to local regulatory requirements. Refrigeration is essential for limiting growth of organisms.

Pasteurization is designed to destroy the most heat-resistant pathogens: *C. burnetii*, *M. tuberculosis* and *L. monocytogenes*. The efficacy of pasteurization depends on the initial bacterial load. Other pathogens such as *Brucella*, *Campylobacter*, *E. coli*, *Salmonella*, *S. aureus* and *Yersinia* are all killed during the process. However, thermophilic and some mesophilic organisms as well as sporeforming bacteria (e.g. *Bacillus* and *Clostridium*) can survive the heat process and contribute to the spoilage of milk. To demonstrate that milk has been adequately pasteurized, the alkaline phosphatase test can be carried out. This is based on detecting the presence of a temperature-sensitive enzyme in milk (slightly more heat resistant than *C. burnetti*) that is inactivated during pasteurization.

Pasteurization does not eliminate spores of bacteria, and many spoilage bacteria are resistant to pasteurization temperatures. To destroy endospores, higher heat treatment such as UHT must be applied. Therefore, to prevent growth of microorganisms surviving or incidentally recontaminating milk, pasteurized milk products need to be refrigerated as soon as possible and maintained cold. As seen above, this is important to prevent growth of *S. aureus* and its production of heat stable enterotoxins.

In relation to yoghurt, a broad range of organisms are of concern. These include *S. aureus*, *Bacillus* spp., *Cl. botulinum*, *L. monocytogenes*, pathogenic *E. coli*, *Salmonella*, *Streptococcus* groups A and C, *B. abortus*, *M. bovis* and *C. burnetti*.

Production of yoghurt made from raw milk requires high-quality raw milk, minimal microbiological contamination and prevention of growth at all levels of the production chain. Some pathogens, e.g. most viruses, *Shigella*, enterohemorrhagic *E. coli*, *Campylobacter* and *Cryptosporidium*, have low infective doses and even a slight contamination of products can be the source of infection. In high fat products such as yoghurt, even pathogens usually requiring large numbers to cause infection can be infective in low doses. This implies that the presence of low numbers of pathogens in milk destined for the production of raw milk yoghurts can constitute a threat to the consumer.

To ensure safety, strict hygienic control based on the concept of hurdle technology must be applied. This consists of:

- Sourcing milk of high microbial quality from healthy animals;
- Rapid cooling and processing of the milk;
- Rapid acidification of the yoghurt and maturation to reduce the water activity; and
- Hygiene controls during its aging.

Outbreaks related to yoghurts made from unpasteurized milk are often related to one or a combination of the following factors:

- Animals shedding pathogenic bacteria
- Improper storage of milk prior to yoghurt production, e.g. no refrigeration for several days prior to manufacture
- Poor starter activity with consequent production of yoghurt with a too high pH;
- Poor starter activity due to inhibition of acid production by phage and/or antibiotic residues in the milk
- Poor plant hygiene, gross environmental contamination;
- Faulty pasteurization; and
- Shedding of the causative organisms by plant personnel

The following are the main reasons why contamination of raw milk by pathogens and growth of these organisms in milk during storage should be avoided as much as possible:

- During microbial growth in raw milk, toxins may be formed. Some toxins are fairly heat-resistant.

- Some pathogens survive heat treatments such as pasteurization. Fortunately, this is exceptional. The higher the count in the raw milk, the greater the number of organisms that may survive heat treatment. This is of importance if the heat treatment applied leaves only a narrow margin for error.
- The heavier the contamination of raw milks by pathogens, the greater the risk of recontamination of the heated milk.

To control of contamination in the processing area, the following measures need to be considered:

- Hygienic zoning, i.e. separation of the milk-receiving area and from the processing and packaging area and preventing any raw product from entering the processing area.
- Hygienic design of premises, drains and equipment to prevent build-up of organic matter, formation of biofilms and contamination through aerosols, and also to facilitate the effective cleaning and sanitization of the premises and equipment.
- Effective pasteurization
- Cleaning and sanitizing programs are vital in ensuring that post-pasteurization contamination does not occur.
- An environmental monitoring program should ensure that environmental hygiene is under control..
- In the case of a positive sample, there should be rapid and effective corrective action.

Self- Check _6	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I. Short Answer Questions (15 points)

1. What are the essential operations in a cleaning process for dairy machinery?(8pts)
2. What is the common aim of disinfection?(4pts)

Note: **Satisfactory rating - 12 points** **Unsatisfactory - below 12points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

LG #34	LO #2- Implement procedures to prepare milk for yoghurt making

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Carrying out clarification procedures for raw milk
- Implementing standardization procedures
- Carrying out pasteurization procedures
- Carrying out homogenization procedures

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Carry out clarification procedures for raw milk
- Implement standardization procedures
- Carry out pasteurization procedures
- Carry out homogenization procedures

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, ask your trainer for further instructions or go back to “Operation sheets”.

Information sheet 1 - Carrying out clarification procedures for raw milk

1.1. Carrying out clarification procedures for raw milk

One of the frequent problems associated with food processing and manufacturing is foreign objects, some of which are health hazards and pose risks of injury or choking. Examples are glass, stones, wood, plastic fragments and metal (or metal particles resulting from friction between metal parts).

Preventive measures should be put in place to protect products. These include:

- Hygienic design of equipment and preventive maintenance to prevent loose parts falling in the products and friction between metal parts;
- Using shatterproof light covers to prevent glass contamination from taking place
- Prohibiting jewelry, glass (glass-free policy) and wooden pallets in the processing area.

During the processing of milk, it is invariably subjected to procedures that will remove any physical contaminant. Centrifugal clarifiers are standard equipment in any commercial milk processing operation and filters are employed in many places. To further reduce risk, sieving milk powder or using magnets for incidental presence can be used. As a final verification measure, products can be passed through metal detectors or X-ray equipment (important if glass jars or bottles are used) to confirm that preventive measures are effective or as a corrective measure in case of failure.

Filtration (or, clarification using a filter-bag) refers to making the milk pass through a filter-cloth or filter-pad. The filtering medium has a pore size (25-100 mm) that permits most of the foreign matter to be retained on it.

The milk filter consists of a nylon filter-bag or a filter-pad supported on a perforated stainless steel (SS) support held in an SS enclosure with a tight-fitting lid, milk distributor, and inlet- and outlet- connections.

Filtration can be carried out either on cold milk (about 10^{o}C) or warm milk (40-45^{o}C). The filter-bag must periodically be cleaned. Accordingly, the operation run may vary from 2 to 10 hours depending on the level of foreign matter and the filter pore size..

Particles that have a density larger than that of milk plasma can also be removed by centrifugation. It concerns dirt particles, somatic cells, and even microorganisms.

Removal of dirt particles and somatic cells is a subsidiary result of centrifugal cream separation as usually applied, say at 40°C. Some centrifuges, sometimes called clarifiers, are specifically built for the removal of solid particles

Self-check 1	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Short Answer Questions

1. __________is the process of eliminating finer foreign matter by using a special filter or a centrifuged clarifier?(2pts)
   A. Clarification
   B. Sanitization
   C. Pasteurization
   D. Homogenization
2. Which of the following are Milk Processing Operations? (2pts)
   A. Clarification
   B. Pasteurization
   C. Homogenization
   D. All of the mentioned

Test I Short Answer Questions

1. Filtration can be carried out either on cold milk ________ or warm milk ________temperature. (4pts)

Note: Satisfactory rating - 8points Unsatisfactory - below 8 points

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Information sheet 2- Implementing standardization procedures for milk

2.1 Implementing standardization procedures for milk

Standardization

Milk is often mixed with skim milk and cream to standardize (or adjust) the fat content to the desired level. Milk powders, including nonfat dry milk, whey protein concentrates, or milk protein concentrate, can be blended with the milk using a powder dispersion unit. The milk solids content (including the fat content) for yogurt ranges from around 9% for skim milk yogurt to more than 20% for certain types of concentrated yogurt. Many commercial yogurt products have milk solids contents of 14-15%. The minimum milk solids non- fat content required in standards or regulations in many countries ranges from 8.2 to 8.6%. Codex regulations for yogurt indicate that the minimum milk protein content is 2.7% (except for concentrated yogurt where the minimum protein content is 5.6% after concentration) and the maximum fat content is 15%. The total solids content of milk can be increased by concentration processes, such as, evaporation under vacuum, and membrane processing (i.e., reverse osmosis and ultrafiltration).

Stabilizers, such as, pectin or gelatin, are often added to the milk base to enhance or maintain the appropriate yogurt properties including texture, mouthfeel, appearance, viscosity/consistency and to the prevention of whey separation (wheying-off). The use of stabilizers may help in providing a more uniform consistency and lessen batch to batch variation. However, there can be textural defects related to the use of stabilizers, including over-stabilization and under-stabilization. Over stabilization results in a “jelly like” springy body of yogurt while a weak “runny” body or whey separation can be produced due to under-stabilization.

Cream separating

Cream separator used to separate milk into cream and skim milk. All incoming raw milk is passed through separators, which are essentially high-speed centrifuges to produce standardized milk.

Once the milk has been separated the resulting products can be combined in a variety of process systems to make products with standardized milk fat contents. Use of a separator also permits fractionation of whole milk into standardized milk (or skim milk, low-fat milk) and cream. Skim milk should normally contain 0.1% fat or less.

Standardization means that the proportion between fat and fat-free milk solid and between fat and other components shall be adjusted to make milk products reach product standards. This process is generally called standardization.

Standardization of fat content involves adjustment of the fat content of milk, or a milk product, by addition of cream or skim milk as appropriate to obtain a given fat content.

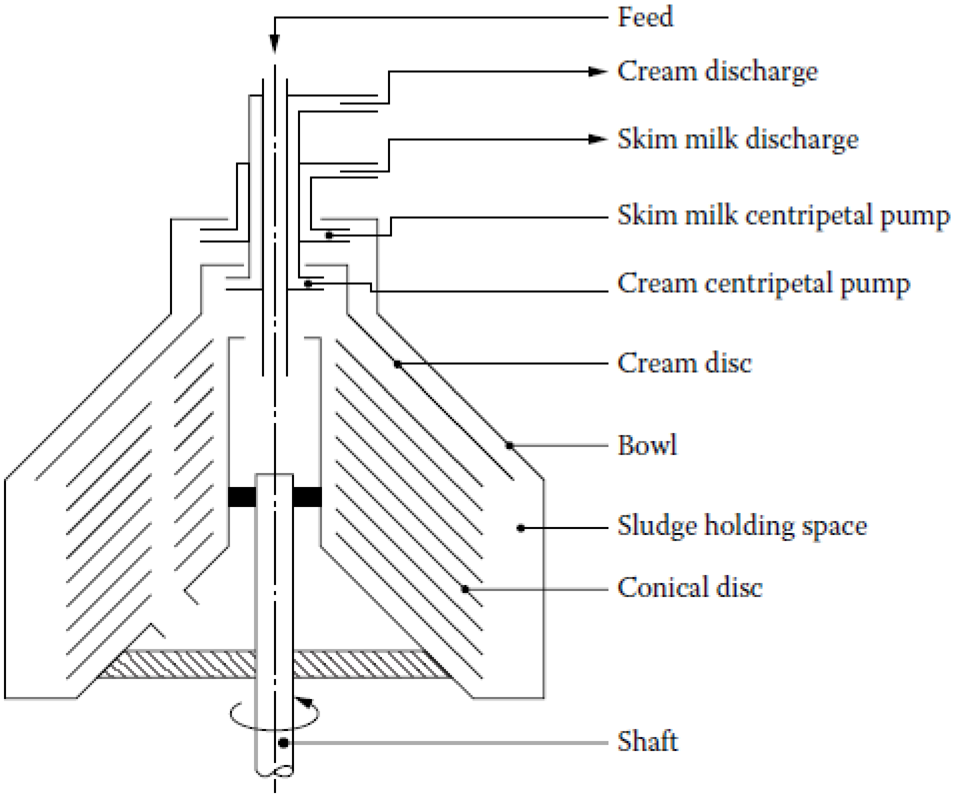


Fig 2 Semi-open centrifugal milk separator

Fig-3 standardization of milk and cream

Standardization of milk and cream

If fine adjustment of the fat content of cream is required or if the fat content of whole milk must be reduced to a given level, skim milk must be added. The usual method of making standardization calculations is the Pearson's Square technique.

Example1: How much skim milk containing 0.1% fat is needed to reduce the percentage fat in? 400 kg of cream from 35% to 30%?

Cream (35%) 29.9

30%

Skim milk (0.1%) 5

If 29.9 parts of cream require 5 parts of skim milk, 400 parts of cream require x parts of skim milk.

$$\text{Weight of skim milk needed} = X = 400 * 5/_{29.9} = 66.89 \text{ kg}$$

Example 2: The fat content of 300 kg of whole milk must be reduced from 4.2% to 3% using skim milk containing 0.2% fat.

Whole milk (4.2%) 2.8

Desired 3%

Skim milk (0.2%) $^{1.2}/_{4}$

Every 4.0 kg of the mixture will contain 2.8 kg of whole milk and 1.2 kg of skim milk.
If 2.8 kg of whole milk requires 1.2 kg skim milk, 300 kg of whole milk requires

$$\frac{1.2}{2.8} * 300 = 128.6 \text{ kg of skim milk}$$

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.

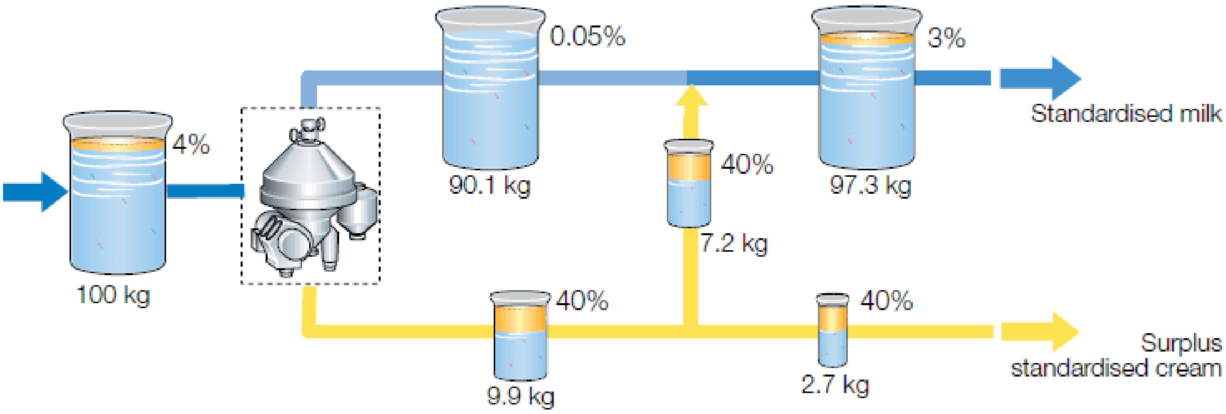


Fig. 4 Principle of fat standardization

After the standardization, performed tentatively or by means of continuous determination, the desirable content will have to be checked. This implies that it may be necessary to make an adjustment by the addition of cream, skim milk, water, etc. Any bacterial or other contamination should be rigorously avoided. The added compound should have been treated (especially with respect to heating) in a way similar to that of the product itself.

Self-check 2	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Short Answer Questions

1. Assuming negligible loss of fat in the separator, the amount of fat entering the separator with the whole milk will be collected at the other side of the separator in either the cream or the skim milk. Therefore, if we separate 1000 kg of milk containing 3% butterfat, what weight of cream containing 38% butterfat can we expect?(8pts)
2. The fat content of 300 kg of whole milk must be reduced from 4.2% to 3% using skim milk containing 0.2% fat?(4pts)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 12points** **Unsatisfactory - below 12 points**

Score = ___________

Rating: ____________

Information sheet 3 - Carrying out pasteurization procedures for milk

3.1 Carrying out pasteurization procedures for milk.

Before heat treatment was introduced, milk was a source of infection, as it is a perfect growth medium for micro-organisms. Diseases such as tuberculosis and typhus were sometimes spread by milk.

Fortunately, all common pathogenic organisms likely to occur in milk are killed by relatively mild heat treatment which has only a very slight effect on the physical and chemical properties of milk. The most resistant organism is the tubercle bacillus (T.B.), which is considered to be killed by heating milk to 63°C for 10 minutes. Complete safety can be assured by heating milk to 63°C for 30 minutes. T.B. is therefore regarded as the index organism for pasteurization: any heat treatment which destroys T.B. can be relied upon to destroy all other pathogens in milk.

Apart from pathogenic micro-organisms, milk also contains other substances and micro-organisms which may spoil the taste and shorten the shelf life of various dairy products. Hence a secondary purpose of heat treatment is to destroy as many as possible of these other organisms and enzymatic systems. This requires more intense heat treatment than is needed to kill the pathogens.

This secondary purpose of heat treatment has become more and more important as dairies have become larger and less numerous. Longer inter-vats between deliveries mean that, despite modern cooling techniques, micro-organisms have more time to multiply and to develop enzymatic systems. In addition, the constituents of the milk are degraded, the pH drops, etc. To overcome these problems, heat treatment must be applied as quickly as possible after the milk has arrived at the dairy.

3.2 Time/temperature combination

The combination of temperature and holding time is very important, as it determines the intensity of the heat treatment. According to these curves, coliform bacteria are killed if the milk is heated to 70°C and held at that temperature for about one second.

At a temperature of 65°C it takes a holding time of 10 seconds to kill coliform bacteria. These two combinations, 70°C/1 s and 65°C/10 s, consequently have the same lethal effect. Tubercle bacilli are more resistant to heat treatment than coliform bacteria. A holding time of 20 seconds at 70°C or about 2 minutes at 65°C is required to ensure that they are all destroyed. There might also be heat resistant micrococci in milk. As a rule they are completely harmless.

3.3 Limiting factors for heat treatment

Intense heat treatment of milk is desirable from the microbiological point of view. But such treatment also involves a risk of adverse effects on the appearance, taste and nutritional value of the milk. Proteins in milk are denatured at high temperatures. This means that the yoghurt making properties of milk are drastically impaired by intense heat treatment. Intense heating produces changes in taste; first cooked flavor and then burnt flavor. The choice of time/temperature combination is therefore a matter of optimization in which both microbiological effects and quality aspects must be taken into account. Since heat treatment has become the most important part of milk processing, and knowledge of its influence on milk better understood, various categories of heat treatment have been initiated.

Table 1. The main categories of heat treatment in the dairy industry

Process	Temperature	Time
Thermisation	63 – 65°C	15 s
LTLT pasteurization of milk	63°C	30 min
HTST pasteurization of milk	72 – 75°C	15 – 20 s
HTST pasteurization of cream etc.	>80°C	1 – 5 s
Ultra pasteurization	125 – 138°C	2 – 4 s
UHT (flow sterilization) normally	135 – 140°C	a few seconds
Sterilization in container	115 – 120°C	20 – 30 min

I. Low temperature long time (LTLT) pasteurization

The original type of heat treatment was a batch process in which milk was heated to 63°C in open vats and held at that temperature for 30 minutes. This method is called the holder method or low temperature, long time (LTLT) method. Nowadays milk is almost always heat treated in continuous processes like thermisation must stop short of pasteurization conditions.

II. High temperature short time (HTST) pasteurization

HTST is the abbreviation of High Temperature Short Time. The actual time/temperature combination varies according to the quality of the raw milk, the type of product treated, and the required keeping properties.

III. Ultra pasteurization

Ultra pasteurization can be utilized when a particular shelf life is required. For some manufacturers two extra days are enough, whereas other aim for a further 30 – 40 days on top of the 2 – 16 days which is traditionally associated with pasteurized products. The fundamental principle is to reduce the main causes of reinfection of the product during processing and packaging so as to extend the shelf life of the product. This requires extremely high levels of production hygiene and a distribution temperature of no more than 7°C – the lower the temperature the longer the shelf life. Heating milk to 125 – 138°C for 2 – 4 seconds and cooling it to <7°C is the basis of extended shelf life (ESL). Extended Shelf Life is a general term for heat treated products which have been given improved keeping qualities by one means or another. Nevertheless, ESL products must still be kept refrigerated during distribution and in the retail stores.

IV. Ultra high temperature (UHT) treatment

UHT treatment is a technique for preserving liquid food products by exposing them to brief, intense heating, normally to temperatures in the range of 135 – 140°C. This kills micro-organisms which would otherwise destroy the products. UHT treatment is a continuous process which takes place in a closed system that prevents the product from being contaminated by airborne micro-organisms. The product passes through heating and cooling stages in quick succession. Aseptic filling, to avoid reinfection of the product, is an integral part of the process.

Two alternative methods of UHT treatment are used:

- Indirect heating and cooling in heat exchangers,
- Direct heating by steam injection or infusion of milk into steam and cooling by expansion under vacuum.

V. Sterilization

The original form of sterilization, still used, is in-container sterilization, usually at 115 – 120°C for some 20 – 30 minutes. After fat standardization, homogenization and heating to about 80°C, the milk is packed in clean containers – usually glass or plastic bottles for milk, and cans for evaporated milk. The product, still hot, is transferred to autoclaves in batch production or to a hydrostatic tower in continuous production.

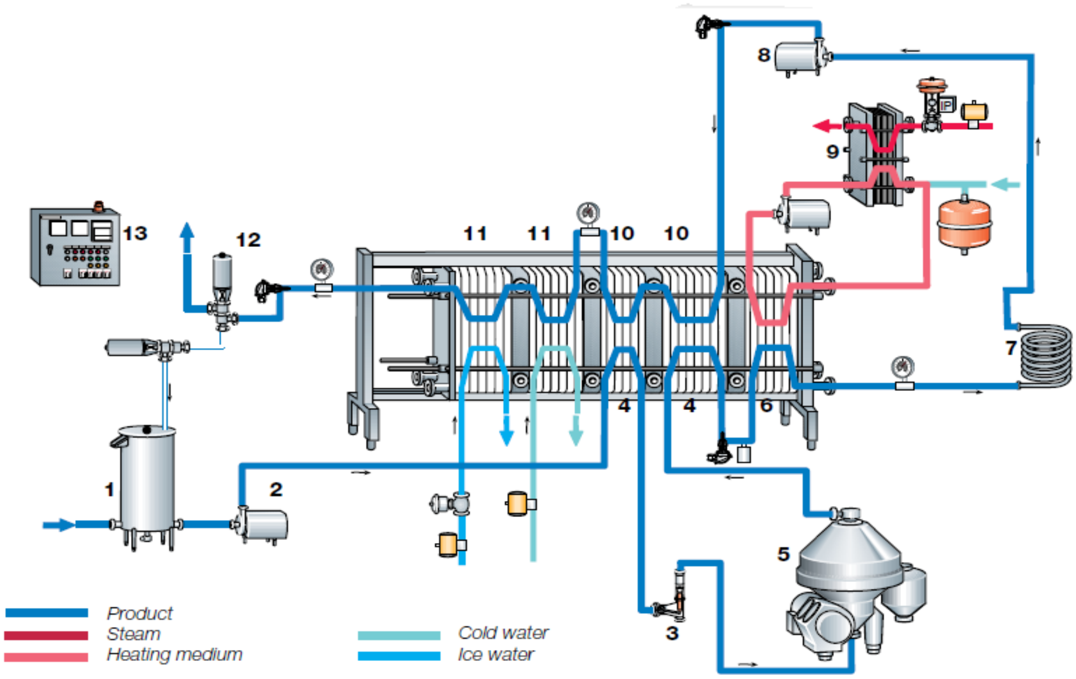


Fig 7 The complete pasteuriser plant consists of:1 Balance tank, 2 Feed pumps, 3 Flow controllers, 4 Regenerative preheating sections, 5 Centrifugal clarifiers, 6 Heating section, 7 Holding tube, 8 Booster pump, 9 Hot water heating system, 10 Regenerative cooling sections, 11 Cooling sections, 12 Flow diversion valve and 13 Control panel

Self-check 3	Written test

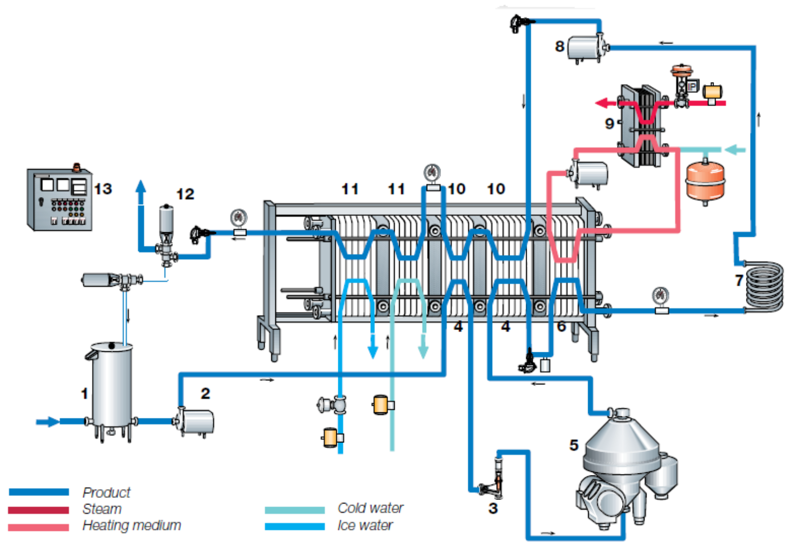
Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Short Answer Questions

1. The HTST method of canning involves heat treatment at a temperature of approximately(2pts)
   A. 60°C
   B. 80°C
   C. 100°C
   D. l20°C
2. the process of heat treatment to destroy the pathogenic microorganisms is?(2pts)
   A. Clarification
   B. Sanitization
   C. Pasteurization
   D. Homogenization

Test I Short Answer Questions

1. Write each parts of pasteurizer?(13pts)



Note: **Satisfactory rating - 17 points** **Unsatisfactory - below 17 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Information sheet 4 – Carrying out homogenization procedures

4.1 Carrying out homogenization procedures

Homogenization of milk causes disruption of milk fat globules into smaller ones. The milk fat–plasma interface is thereby considerably enlarged, usually by a factor of 5 to 10. The new interface is covered with milk protein, predominantly micellar casein.

Effect of homogenization

The effect of homogenization on the physical structure of milk has many advantages:

- Smaller fat globules leading to no cream-line formation
- Whiter and more appetizing color
- Reduced sensitivity to fat oxidation
- More full-bodied flavor, better mouth feel
- Better stability of cultured milk products

However, homogenization also has certain disadvantages:

- Homogenized milk cannot be efficiently separated.
- Somewhat increased sensitivity to light, sunlight and fluorescent tubes - can result in "Sunlight flavor
- Reduced heat stability, especially in case of single-stage homogenization, high fat content and other factors contributing to fat clumping.

Homogenization of the milk base is an important processing step for yogurts containing fat. Milk is typically homogenized using pressures of 10-20 and 5 MPa first and second stage pressures, respectively, and at a temperature range between 55 and 65°C. Homogenization results in milk fat globules being disrupted into smaller fat globules and the surface area of homogenized fat globules greatly increases. The use of homogenization prevents fat separation (creaming) during fermentation or storage, reduces whey separation, increases whiteness, and enhances consistency of yogurts. When milk is homogenized, caseins and whey proteins form the new surface layer of fat globules, which increases the number of possible structure-building components in yogurt made from homogenized milk. Homogenized milk fat globules act like protein particles due to the presence of protein on the fat surface. Recently, ultra-high pressure homogenization at 200 or 300 MPa was investigated for the production of yogurt. Compared with a conventional homogenization at 15 MPa, the use of ultrahigh pressure homogenization resulted in an increase in yogurt firmness and water-holding capacity. Ultra-high pressure causes whey protein denaturation as well as partial disruption of the casein micelles.

The main factors affecting fat globule size are:

I. Type of homogenizer, especially construction of the homogenizer valve.
II. Homogenizing pressure
III. Two-stage homogenization
    The milk first passes the usual homogenizer valve, due to which the pressure is reduced and through the second homogenizer valve the pressure is more reduced.
IV. Fat content and ratio of amount of surfactant (usually protein) to that of fat
    If sufficient protein is not available to cover the newly formed fat surface, the average diameter of the fat globules and the relative distribution width will be larger. In cream, the time needed for formation of adsorption layers is longer than in milk, whereas the average time between encounters of one droplet with another is much shorter. As a result, in cream, far more re-coalescence of newly formed droplets can occur.
V. Type of surfactant
    When a small-molecule surfactant is added, such as Tween 20 or sodium dodecyl sulfate, the effective interfacial tension becomes lower and smaller globules result.
VI. Temperature
    Homogenization is usually done at temperatures between 40 and 75°C. Homogenization is poor if the temperature is so low that part of the fat is

crystalline. Further increase of the temperature still has a small effect, presumably because the viscosity of the oil decreases somewhat.

VII. Proper operation of the homogenizer

Pressure fluctuations (caused by leaking valves, etc.), a worn homogenizer valve, and air inclusion may have adverse effects. Air inclusion and wear of the homogenizer valve should be rigorously avoided. If the liquid contains solid particles such as dust or cocoa, the valve may quickly wear out, resulting in unsatisfactory homogenization.

The effect of the homogenization should be checked regularly. The average fat globule size may be derived from specific turbidity measurements at a long wavelength after the milk has been diluted and the casein micelles dissolved. In this way, the homogenizing effect can be evaluated rapidly and simply. In principle, continuous determination is possible. In actual practice, however, an accelerated creaming test is usually done. A certain quantity of milk is centrifuged, and the fat content of the resulting skim milk determined.

The homogenization of cream usually causes its viscosity to be very much increased. Microscopic examination shows large agglomerates of fat globules rather than single globules in the homogenized cream. These so-called homogenization clusters contain very many fat globules, up to about 105. Because the clusters contain interstitial liquid, the effective volume fraction of particles in the cream is increased, and hence also its (apparent) viscosity. Adding casein micelle–dissolving agents can disperse the clusters. In other words, the fat globules in the cluster are interconnected by casein micelles.

During homogenization, when a partly denuded fat globule collides with another globule that has been covered with casein micelles, such a micelle can also reach the surface of the former globule. As a result, both fat globules are connected by a bridge and form a homogenization cluster. The cluster will immediately be broken up again by turbulent eddies. If, however, too little protein is available to fully cover the newly formed fat surface, clusters are formed from the partly denuded fat globules just outside the valve slit of the homogenizer, where the power density is too low to disrupt the clusters again.

Clearly, the following conditions promote formation of homogenization clusters:

- High fat content
- Low protein content
- High homogenizing pressure
- A relatively high surface load of protein, promoted by a low homogenization temperature (less rapid spreading of casein micelles), intense preheating (little serum protein available for adsorption) and, subsequently, a high homogenizing pressure

Under practical conditions, clustering due to homogenization does not occur in a cream with less than 9% fat, whereas it always does in a cream with more than Clusters can be disrupted again to a large extent (but not fully) in a two-stage homogenizer. In the second stage, the turbulent intensity is too low to disrupt fat globules and hence to form new clusters, whereas existing clusters are disrupted; this is accompanied by some coalescence. Two-stage homogenization of high-fat cream (e.g., 30% fat) insufficiently breaks up homogenization clusters.

Homogenizing milk that contains lipase strongly enhances lipolysis. Raw milk turns rancid within a few minutes after homogenization. This can be explained by the capability of lipoprotein lipase to penetrate the membrane formed by homogenization but not the natural membrane. Accordingly, raw milk homogenization should be avoided, or the milk should be pasteurized immediately after homogenization in such a way that the lipase is inactivated. Homogenization is often done before pasteurization because in the homogenizer, the milk may readily be contaminated by bacteria. Furthermore, mixing of homogenized milk with raw milk should be prevented, again to avoid lipolysis.

Homogenization of milk has several other effects:

- The color becomes whiter
- The tendency to foam increases somewhat

- The proneness to fat autoxidation, and hence to the formation of ensuing off-flavors, is reduced.
- The fat globules lose their ability to be agglutinated upon cooling

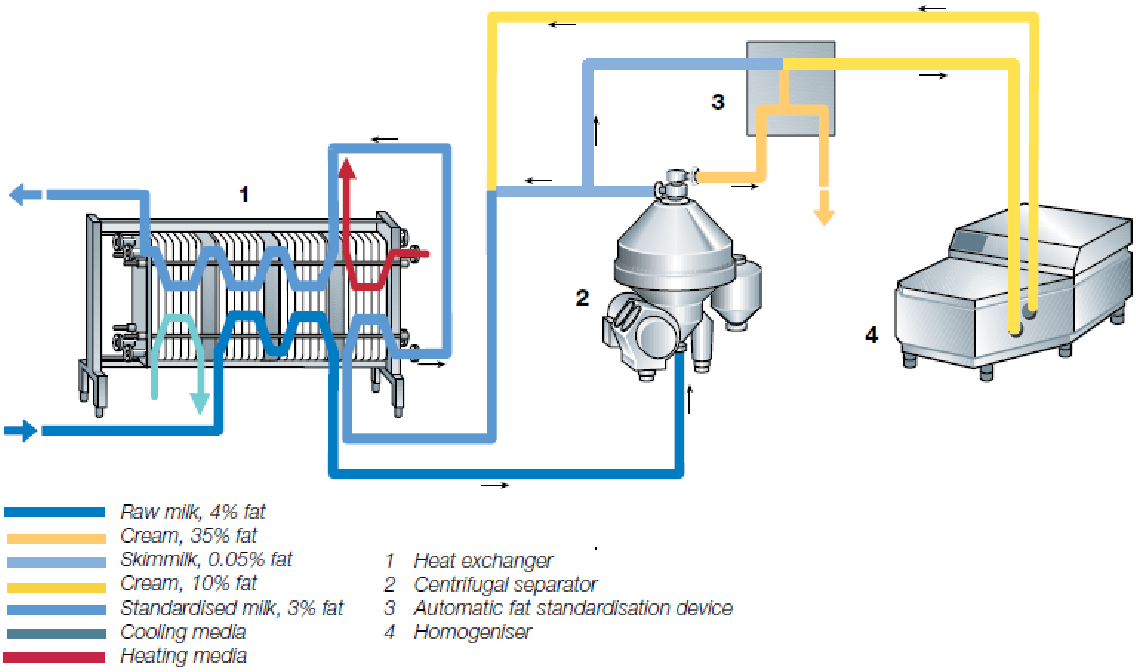


Fig. 5 Product flow at partial stream homogenization

Self-check 4	Written test

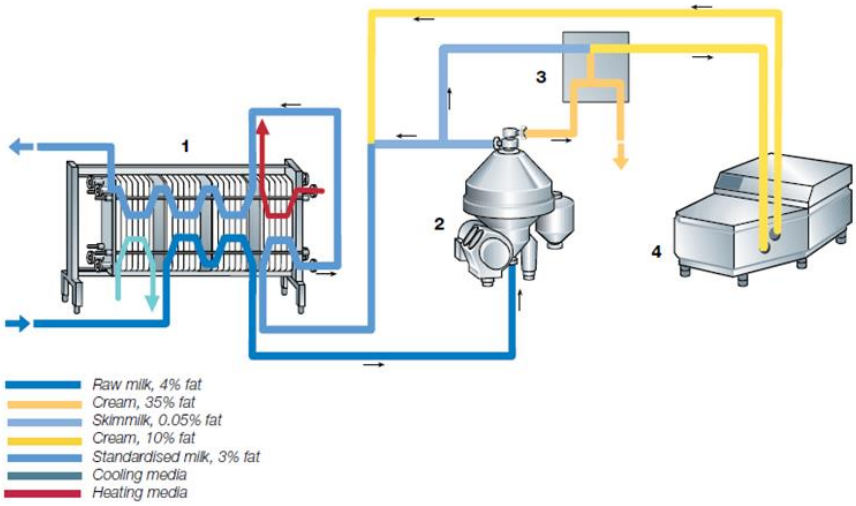
Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Short Answer Questions

1. Homogenized milk has ______? (2pts)
   A. Creamier structure
   B. Whiter appearance
   C. Bland flavor
2. The aim of pasteurization is?(2pts)
   A. Improve color
   B. Kill disease causing microorganism
   C. Improve flavor
   D. Improve texture

Test I Short Answer Questions

2. Write each parts of partial stream homogenizer?(8pts)



Note: **Satisfactory rating - 12 points** **Unsatisfactory - below 12 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________
Rating: ____________

LG #35	LO #3- Carry out procedures to inoculate milk

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Adding inoculants and adjuncts
- Maintaining incubation temperature at specified level evenly throughout the vat/tank.
- Taking samples at appropriate stages and tests carried out for acidity

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Add inoculants and adjuncts
- Maintain incubation temperature at specified level evenly throughout the vat/tank.
- Take samples at appropriate stages and tests carried out for acidity

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to "Operation sheets
7. Perform "the Learning activity performance test" which is placed following "Operation sheets" ,
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9. If your performance is unsatisfactory, ask your trainer for further instructions or go back to "Operation sheets".

Information sheet-1 Adding inoculants and adjuncts

1.1. **Introduction**

A great number of fermented milk types have developed. Variables include species of dairy animal, heat treatment of the milk, percentage fat in the milk, concentration of the milk, fermentation temperature, and inoculation percentage. According to these conditions, various species of lactic acid bacteria become predominant, producing various flavor components. Most types of fermented milk contain two to four species of bacteria. In some products, yeasts or molds participate in the fermentation.

Nearly all types of fermented milks are the result of a very long evolution. Modern manufacture makes use of carefully selected and grown starters, and strictly hygienic processing is applied. Fermented milks are very popular products, and new varieties regularly enter the consumer market. In this chapter, several types of fermented milks will be discussed. They are classified according to the type of fermentation. The nutritive value of fermented milks is a special aspect and will also be addressed. Finally, the manufacture of two fermented milks, cultured buttermilk and yogurt, is treated in some detail.

I. Mesosphelic fermentation

A. Cultured Buttermilk

Cultured buttermilk is a pasteurized skim milk fermented by a mixture of mesophilic lactic acid bacteria. It has a mild acidic taste with an aromatic diacetyl flavor and a smooth viscous texture. *Lactococcus lactis* sspp. *cremoris* and *lactis* are responsible for the acid production, whereas *Lc*. *lactis* ssp. *lactis* biovar. *diacetylactis* and *Leuconostoc mesenteroides* ssp. *cremoris* are the primary sources of the characteristic aromatic flavor of the product because of their ability to produce diacetyl.

After pasteurization, the milk is fermented at 20°C to 22°C to ensure a balanced growth of acid- and flavor-producing species. Incubation at higher temperature would favor the growth of *Lc*. *lactis* ssp. *lactis*, resulting in excess acid production and diminishing the flavor production by the aroma bacteria.

B. Sour Cream

Cultured cream or sour cream is produced by the fermentation of high-pasteurized cream with a fat percentage of 18% to 20%, which is homogenized at a low temperature, to promote formation of homogenization clusters.

The cream is inoculated with an aromatic starter and incubated at 20°C to 22°C until the pH has reached a value of 4.5. The functions of the starter culture are the same as in cultured buttermilk. During the acid production, the homogenization clusters aggregate, resulting in a highly viscous cream. To increase the firmness, a little rennet and/or a thickening agent are sometimes added before fermentation.

C. Fermented Milks

Several types of fermented milks produced by mesophilic lactic acid bacteria have been developed in countries that have cool climates. They constitute a group of products distinctly different from fermented milks made elsewhere, primarily owing to their unique physical properties, which are characterized by high viscosity and ropiness.

II. Thermophilic fermentation

A. Yogurt

Yogurt is probably the most popular fermented milk. It is made in a variety of compositions (fat and dry-matter content), either plain or with added substances such as fruits, sugar, and gelling agents. The essential flora of yogurt consists of the thermophiles *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus*. For a satisfactory flavor to develop, approximately equal numbers of both species should be present. They have a stimulating effect on each other's growth. Volatile compounds produced by the yogurt bacteria include small amounts of acetic acid, diacetyl, and most importantly, acetaldehyde.

B. Bulgarian Buttermilk

Bulgarian buttermilk is a high-acid fermented milk, made from pasterurized whole milk, inoculated with *Lb*. *delbrueckii* ssp. *bulgaricus* alone (at 2% inoculum), and incubated at 38°C to 42°C for 10 to 12 h, until a curd forms with about 150°N titratable acidity. The product has a sharp flavor and is popular only in Bulgaria.

C. Acidophilus Milk

Acidophilus milk is cultured with *Lb*. *acidophilus*, whose primary function is to produce lactic acid. Moreover, *Lb*. *acidophilus* is considered to be a probiotic bacterium, and has been claimed to confer various health benefits. It is not a natural representative of the milk flora and grows slowly in milk. Hence, contamination during the manufacture of acidophilus milk should be avoided. Sterilized milk is inoculated with a large amount of starter (2% to 5%) and incubated at about 38°C for 18 to 24h. Because *Lb. acidophilus* is fairly acid-tolerant, the lactic acid content of the milk can become high, i.e., 1% to 2%, if the product is stored at an insufficiently low temperature. The flavor of the milk then becomes sharp, and the number of living bacterial cells decreases quickly. This problem can be overcome by blending plain milk with a deep-frozen concentrated culture of *Lb. acidophilus* and by keeping the mixture at low temperature (say, 4°C), which prevents the milk from souring.

Manufacture

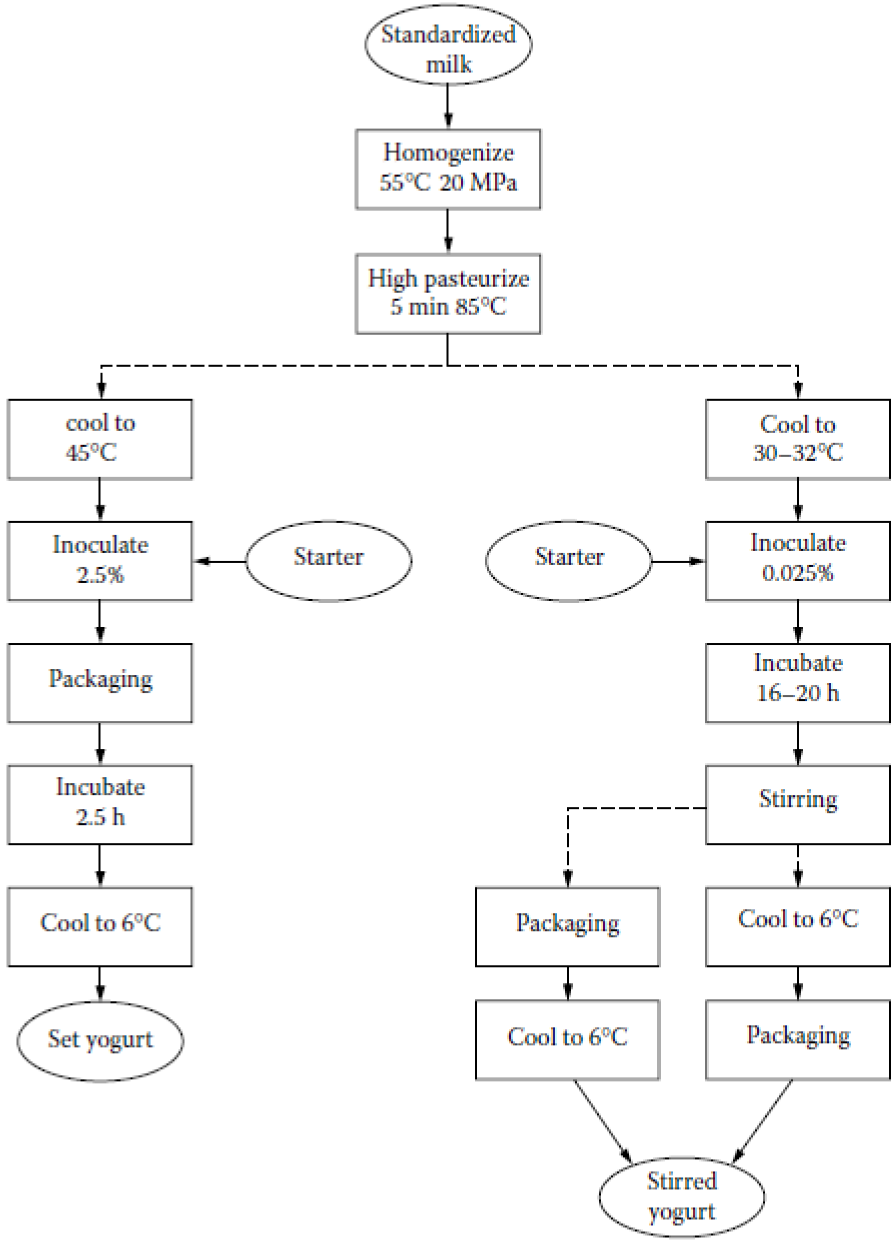

Fig 6 Manufacture of set yogurt and of stirred yogurt from whole milk

Yoghurt

Yogurt is a fermented milk product. The main ingredient in yogurt is milk. The type of milk used depends on the type of yogurt. Whole milk is for full fat yogurt, low fat milk for low fat yogurt, and skim milk for non-fat yogurt. Other dairy ingredients are allowed in yogurt to adjust the composition, such as cream to adjust the fat content, and non-fat dry milk to adjust the solids content. All yogurts contain at least 8.25% solids not fat. The solids content of yogurt is often adjusted above the 8.25% minimum to provide a better body and texture to the finished yogurt.

Stabilizers may also be used in yogurt to improve the body and texture by increasing firmness, preventing separation of the whey (syneresis), and helping to keep the fruit uniformly mixed in the yogurt. Stabilizers used in yogurt are alginates, gelatins, gums, pectin's, and starch. Sweeteners, flavors and fruit preparations are used in yogurt to provide variety to the consumer.

The main (starter) cultures in yogurt are Lactobacillus bulgaricus and Streptococcus thermophilus. The function of the starter cultures is to ferment lactose (milk sugar) to produce lactic acid. The increase in lactic acid decreases pH and causes the milk to clot, or form the soft gel that is characteristic of yogurt. The fermentation of lactose also produces the flavor compounds that are characteristic of yogurt.

Type of yogurt

- Set yoghurt incubated and cooled in the package
- Stirred yoghurt incubated in tanks and cooled before packing,
- Concentrated yoghurt incubated in tanks, concentrated and cooled before being packed. This type is sometimes called strained yoghurt
- Drinking yoghurt similar to stirred type, but the coagulum is broken down to a liquid before being packed
- Probiotic yoghurts
- Frozen yoghurt incubated in tanks and frozen like ice cream,

Table 2 set vs. stirred yoghurt preparation

Procedures	Description	Set yoghurt	Stirred yoghurt
Quality test of raw milk	For adulteration and freshness	✓	✓
Standardization	Standardize milk from 0 - full cream fat% (according to world health org. code and principle)	✓	✓
Pasteurization	Heat to 85°C for holding time 20 min, and 9o °C holding time 10 minute and 95 for 5 min	cool down to 45-46 ˚C	cool down to 31 ˚C
Inoculation	Use mother culture 2.5 - 3 l/100l or 1-3% powder of starter culture of thermophilic	✓	Mother culture 0.025-1 L/100L or 1-3% of starter culture powder
Optional Additive	• Sugar • Stabilizer • Different flavors • skimmed milk powder /for dry matter increment/ viscosity/	According to standard required	According to standard required. Depend upon additives, in this type products added after incubation.
Packaging	• Package yoghurt in cups	Before incubation	After incubation
Incubation	• Temperature 45 °C, • Time 2:30-3:00 Hours • check PH <4.6 is good	✓	Temp. 31^{o}c for 18-20 hrs
Cooling	• Cool to 4-7 ˚C	✓	✓
Shelf life	Under good handling 10-14 days	✓	✓

Set Yogurts

The traditional product is set yogurt, made of concentrated milk. The milk was heated on an open fire until, say, one third of the water had evaporated. Then the milk was allowed to cool, and when a temperature of about 50°C was reached, the milk was inoculated with a little yogurt. After fermentation, a fairly firm gel was obtained. A similar process is still being used, but either the milk is evaporated under vacuum or milk powder is added. One may use the same process for making set yogurt from non-concentrated milk. The yogurt so obtained is less rich in flavor, far less firm, and prone to syneresis (wheying off). Generally, some gelling agent is added to prevent syneresis and to enhance firmness, especially if pieces of fruit are added. Another difference between both these products is their titratable acidity. Because a satisfactory flavor and texture are only obtained at a pH below, say, 4.5 and concentrated milk has a greater buffering capacity, the latter is fermented to an acidity of about 130 mM, as against 90 to 100 mM for non-concentrated milk.

Table 3 - Set Yoghurt

Standardized	Standardized of 2.7 fat
Pasteurization	- Heat to 90 - Holding time 5 minute - cool down to 45 °C
Inoculation	Use fresh yoghurt 2.5 -3l/100l or starter
Optional Additive	- 6% sugar - 6% sugar + 0.5% vanilla - 4.5% skimmed milk powder
Packaging	- Package yoghurt in cups
Incubation /Ripening	- Temperature 45 °C, use Incubator - Time 3Hours - check PH <4.6 is good
Cooling	- Cool to 4 °C
Next day	- Check PH < 4,5 is good - taste the yoghurt

Stirred yogurt

Another type is stirred yogurt, almost always made from non-concentrated milk. After a gel is formed, it is gently stirred to obtain a smooth and fairly thick, but still pourable, product. There are other differences in the manufacturing process. Set yogurt is fermented after being packaged, implying that final cooling has to be achieved in the package. Stirred yogurt is almost fully fermented before it is packaged. Another difference is that only certain strains of yogurt bacteria produce the correct consistency or thickness after stirring, and only so when incubating at a fairly low temperature. However, the bacteria make less of the desired flavor compounds at lower temperatures. In order to ensure that stirred yogurt has a distinct yogurt flavor, it is necessary that the starter be propagated under the same conditions as for set yogurt, i.e., at about 45°C and with such an inoculum size and incubation time as to reach about equal numbers of cocci and lactobacilli.

The rate of acidification greatly differs in set and stirred yogurt due to the differences in inoculum size and incubation temperature.

Table 4 **of Stir Yoghurt**

Standardized	Standardized of 2.5 fat
Pasteurization	- heat to 90 °C - holding time 5 minute - cool down to 31 °C
Inoculation	- Use fresh yoghurt 0.025 -1 L/100L
Additives	- 6% sugar - 6% sugar + 0.5%Vanilla - 4.5% Skimmed milk powder
Incubation	- Temp. 31 °C - Time 18 – 20 hrs. - check PH < 4.6 is good
Stirring	- In case of non- homogenized milk mix in cream layer gently - stir the yoghurt, until homogeneous - Packing

Cooling	- Cool to 4 °C
Next day	- Check PH < 4.5 is good - Taste the yoghurt

Yogurt Drinks

From milk fermented with yogurt bacteria, several products can be derived, such as yogurt drinks, yogurt ice cream, and fruit yogurt. After fermentation, specific additives may be included, together with the appropriate processing, to obtain a product with the desired flavor, color, or consistency. The manufacture of yogurt drinks will be discussed here in some more detail.

The starting milk for the manufacture of most yogurt drinks is standardized skimmed milk, which is pasteurized for 15 min at 85°C to 95°C. The milk is fermented with the yogurt bacteria at 43°C till a pH of around 4.0 is reached. After cooling to approximately 20°C, fruit juice, sugar, and a dispersion of pectin in water are added. Also, flavoring and coloring agents may be added if required. The mixture is slowly agitated and adjusted to pH 3.8 to 4.2 with lactic acid. Subsequently, the mixture is homogenized at 15 to 20 MPa to disperse the pectin. The addition of high methoxyl pectin is essential for the stabilization of the yogurt drink; it is primarily needed to allow heat treatment of the sour product, as it prevents separation of serum. Other stabilizing agents may be applied, such as carboxy-methyl cellulose or guar gum. Finally, the yogurt drink undergoes a heat treatment in order to extend its shelf life. This heat treatment may be pasteurization at 75°C for 20 s, after which the product is cooled and filled aseptically. Alternatively, the product may be UHT-treated (110°C, 5 s) and then cooled and filled aseptically. The latter product is essentially sterile and has a long shelf life. The packaging material should be impermeable to oxygen to avoid the development of oxidized flavor. Because many variations in the additions to yogurt and in the subsequent processing are possible, numerous varieties of yogurt drinks are on the market.

3.1 **Adding inoculants and adjuncts**

Qualities of an ideal yoghurt starter

- Purity, i.e. free from contaminants
- Vigorous growth
- Production of the right consistency
- Production of good flavor without off flavor
- Stability i.e. its balance should be easily maintained
- No tendency to induce syneresis.
- Should not develop excessive acidity on cold storage.
- Should have a reasonable tolerance to sugar.
- Should be resistant to penicillin and other antibiotics.
- Its maintenance should be easy.
- It should be phage resistant**.**

The milk is inoculated with active yoghurt cultures, S. thermophilus and L. delbrueckiis ubsp. bulgaricus at the rate of 2% (v/v) of milk. Usually both the cultures are added in equal proportion (1% each).

Continuing incubation or inadequate cooling is causes the rods to become preponderant.

Varying the aforementioned conditions during incubation changes the ratio between the rods and the cocci as follows:

Incubation time: A shorter incubation time, which means a lower acidity, will cause too high a proportion of cocci. Transferring a yogurt starter repeatedly after short incubation times during the production of the starter may cause also the rods to disappear from the culture. Conversely, long incubation times will cause an increasing preponderance of the rods.

Inoculum percentage: Increasing the inoculum percentage will enhance the rate of acid production. The acidity at which the cocci are slowed down will thereby be reached earlier, resulting in an increased number of rods (incubation time being the same). At a smaller inoculum percentage, the ratio between the bacteria will shift in favor of the cocci.

Incubation temperature: The rods have a higher optimum temperature than the cocci. Incubation at a slightly higher temperature than 45°C will shift the ratio in favor of the rods; incubation at a lower temperature will enhance the cocci.

Obviously, a correct ratio between the species in the starter can be maintained, or be recovered if need be, by proper selection of the propagation conditions. Currently, concentrated starters are increasingly used, ensuring a correct bacterial composition of the starter.

Metabolites

S. *thermophilus* and *L*. *delbrueckii* ssp. *bulgaricus* form products that contribute to the flavor of yogurt as well as to its structure and consistency. The following are the main compounds involved:

- Lactic acid
- Acetaldehyde (ethanal):
- Diacetyl (CH3–CO–CO–CH3)
- Polysaccharides

Incubation

After adding culture in the milk, it is uniformly mixed without aeration. It is then incubated in bulk or in the same tank, if stirred product is to be made. If set-product is required, the milk is filled in retail containers before incubation. Incubation is purely a biological process during which the culture grows and brings necessary transformations in milk to get a desirable fermented product. Incubation temperature should be kept 42 C. The period of incubation varies between 3-6 h, depending upon the rate of acid production by the culture in the milk. However, the best end point to stop fermentation is just after the milk sets. Setting takes place at about 0.6% acidity and the remaining acidity required in the product can develop while cooling. During incubation, the milk is very sensitive to mechanical disturbances and other changes. Hence, it should not be disturbed.

Cooling

As soon as the curd sets or desired acidity in the product is achieved, it must be cooled. Cooling is done to reduce the rate of multiplication of starter cultures and stop their growth at the end of cooling. This is essential to avoid over acidification in the product. The final acidity desired in the product and total count of starter cells excepted in the product will depend on the rate of cooling and how much times it takes to reduce the temperature below $5^{O}C$.

The rate of cooling affects the quality characteristics of the product and should be decided according to the per cent lactic acid expected in the final product. Rapid cooling may lead to more contraction of gel and separate more whey, while too slow cooling may sour the product. In yoghurt, two stages cooling is preferred, i.e. in first stage cooling from $42^{O}C$ to $20^{O}C$ and in the second stage from $20^{O}C$ to $5^{O}C$ in cold store.

In the stirred products, cooling and stirring are simultaneously done. It is advisable to stir the product at lower temperature to reduce the problems of wheying-off. In most cases, the product is stirred at about $20^{O}C$ and also blended with color, flavor, fruits, nuts and other additives and then packed in retail containers. The product is to be stored at less than $5^{O}C$, until its consumption.

Self-check 1	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Short Answer Questions

1. The choice of starter culture is depends on different factors. What are these factors? (6pts)
2. What is the role of calcium chloride in milk processing? (3pts)
3. What are the two starter culture bacteria group and their optimum temperature to grow? (3pts)
4. What is the role of starter culture in milk processing? (3pts)
5. What is the role of rennet in milk processing? (3pts)

***Note:* Satisfactory rating – 19 points** **Unsatisfactory - below 18 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Information sheet 2 – Maintaining incubation temperature at specified level evenly throughout the vat/tank

2.1 Maintaining incubation temperature at specified level evenly throughout the vat/tank.

After heat treatment, the milk base is cooled to the incubation temperature used for growth of the starter culture.

An optimum temperature of the thermophilic lactic acid bacteria, i.e., *Streptococcus* subsp. *thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus*, is around 40-45°C. Bacterial fermentation converts lactose into lactic acid, which reduces the pH of milk. During acidification of milk, the pH decreases from 6.7 to ≤4.6. Gelation occurs at pH 5.2 to 5.4 for milk that was given a high heat treatment.

Physical properties and microstructure of yogurt are influenced by incubation temperature. The use of high incubation temperature resulted in a decrease in gelation time at pH 4.6 and whey separation compared with yogurt gels incubated at low temperature. This result indicates that gels formed at high temperature are weak and have a coarse gel network due to extensive rearrangement resulting in the formation of large pores and greater whey separation. During the formation of yogurt gels at a low incubation temperature, slow protein aggregation occurs resulting in the formation of a large number of protein-protein bonds and less rearrangement of the particles/clusters. A highly cross-linked and branched protein network that had small pores was observed in micrographs of yogurt gels incubated at low temperature. At lower incubation temperature, there is an increase in the voluminosity of casein particles, which results in an increase in the area of the junctions between aggregated casein particles. Increased contact area between casein particles could contribute to the increased stiffness of gels observed at low temperature.

Higher viscosity was observed in stirred yogurts that had been incubated at lower temperatures (e.g. <40°C) compared to gels incubated at high temperature (e.g.

>40°C). As incubation temperature increased, there was a decrease in the sensory attributes, such as, mouth coating and smoothness of stirred yogurts.

If incubation temperature was changed after gelation, the textural properties of yogurt became similar to those of yogurts made at that new temperature for the entire fermentation process. It may be possible to use high incubation temperature for the initial stage of fermentation to facilitate rapid growth of the starter cultures and then slowly reduce the incubation temperature at some stage to achieve better textural properties.

Cooling

When yogurts have reached the desired pH (e.g., ~4.6), yogurts are partially cooled (~20°C) before fruit or flavoring ingredients are added. Yogurt products are often blast chilled to <10°C (e.g., 5°C) in the refrigerated cold store to reduce further acid development. In the production of set yogurt, yogurts are directly transferred to a cold store or blast chilled in cooling tunnels. For stirred yogurts, cooling is first performed by agitation in the jacketed fermentation vat and the product is sheared and smoothened by devices like back-pressure values, high shear devices or sieves.

Self-check 2	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I. True or false

1. Yogurts are directly transferred to a cold store or blast chilled in cooling tunnels. (2pts)

2. Physical properties and microstructure of yogurt are influenced by incubation temperature. (2pts)

3. An optimum temperature of the thermophilic lactic acid bacteria (2pts)

4. Gelation occurs at pH 5.2 to 5.4 for milk that was given a high heat treatment. **(2pts)**

Note: **Satisfactory rating – 8 points   Unsatisfactory - below 8 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________
Rating: ____________

Information sheet -3 Taking samples at appropriate stages and tests carried out for acidity

3.1 Taking samples at appropriate stages and tests carried out for acidity

Acidification of milk leads to the disruption of the internal structural properties of casein micelles due to the solubilization of CCP. As caseins approach their isoelectric point (pH 4.6), the net negative charge on casein is reduced, which decreases electrostatic repulsion between charged groups, including the phosphoserine residues that are exposed when the CCP is solubilized. Electrostatic attraction increases and protein-protein attraction also increases through enhanced hydrophobic interactions.

Ph 6.o-6.7

When the pH of milk decreases from 6.6 to 6.0, the net negative charge on the casein micelles decreases which results in a decrease in electrostatic repulsion. Since only a small amount of CCP is solubilized at pH >6.0, the size of the casein micelles is largely unchanged.

pH 5.0-6.0

As the pH of milk decreases further from pH 6.0 to 5.0, the net negative charge on casein micelles greatly decreases and the charged "hairs" of κ-casein may shrink (or curl up). This results in a decrease in electrostatic repulsion and steric stabilization, which are both responsible from the stability of casein micelles in the original milk. At pH ≤6.0 the rate of solubilization of CCP increases, which weakens the internal structure of casein micelles and increases electrostatic repulsion between the exposed phosphoserine residues. In milk, CCP is completely solubilized in casein micelles by pH ~5.0. However, in rennet-coagulated cheese, a significant amount of CCP is not solubilized at this pH, probably because of a protective role on CCP solubility from the higher solids content of curd compared with milk.

The amounts and proportions of caseins dissociated from the micelles were both temperature- and pH-dependent. More casein is dissociated from micelles into the serum as temperature decreases from 30 to 4°C. The pH at which maximum dissociation occurs is between pH 5.6 and ~5.1, which may be attributed to a partial loosening of bonds within and between caseins due to loss of CCP. At low temperatures, hydrophobic interactions involved in casein association are very weak.

pH ≤5.0

When the pH of milk becomes close to the isoelectric point of casein (pH 4.6), there is a decrease in the net negative charge on casein, which leads to a decrease in electrostatic repulsion between casein molecules. On the other hand, casein-casein attractions increase due to increased hydrophobic and plus-minus (electrostatic) charge interactions. The acidification process results in the formation of three-dimensional network consisting of clusters and chains of caseins

.

Self-Check – 3	Written Test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I. Short Answer Questions (10 points)

Part 1.True or False

1. Yoghurts products are often blast chilled to <10%
2. Whey the separation is difference as the expulsion of whey form the network which becomes as surface whey.
3. As the PH of milk decreases further from Ph 6.o-5.0

***Note:* Satisfactory rating – 10 points   Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Operation Sheet 1– preparing mother culture

Objectives

- To identify: Equipment and ingredients used preparing mother culture
- To prepare mother culture

Equipment and Ingredients

- milk
- rennet powder
- Cheese vat
- Strainer
- Thermometer
- Stirrer
- pH meter

Procedure

Step 1: Sterilize the milk

Boil (100°C) a bottle with band and cover in a covered pot for 5 minutes. The holding capacity of the bottle is depending on the amount of cheese we plan to process.

After the sterile bottle has cooled a bit, fill it with skim milk/homogenized milk to an inch below the rim of the bottle. (Skim milk or low-fat milk must be used, as the cultures tend to rise with cream if it is present in the milk).

Turn the cover firmly and Place the bottle in a large, deep pot. Fill the pot with water until it covers the bottle and Heat at 90˚C for 10 or 95 for 5 minutes.

Step 2: Cool the sterilized or pasteurized milk

Remove the bottle from the pot of water.

Cool the milk: For mesophilic starter, cool to 32°C. For thermophilic starter, cool to 45ºC. You may remove the cover to monitor the temperature with a thermometer, but ensure that the environment stays clean, to avoid contaminating the milk.

Step 3: Inoculate the milk

Once the milk cools, inoculate it with 0.5g/means the starter culture activity is 5% of the milk /according to activity of starter culture or producers instruction to one litter milk ratio

Quickly put the cover on the bottle and mix/turn it up and down up to 15 times to incorporate /mix /the cultures.

Step 4: Ripen the milk with culture

For mesophilic cultures, ripen at around 32-35°C for 15-20 hours. Check the bottle at 16 hours for coagulation; if not fully ripened, leave up to 8 hours more. For thermophilic cultures, ripen at 43 - 45°C for 6-8 hours, or until it becomes a yogurt-like consistency.

Proper coagulation has been achieved when the milk is between the consistency of butter and yogurt. It may separate from the sides of the bottle and be shiny. When the milk has fully coagulated, taste it. It should be acidic and a little sweet.

Step 5: Chill the mother culture

Once the milk has properly ripened and passed the taste test, chill the bottle immediately. Keep the starter in the refrigerator for up to three days for cheese/yoghurt making or freeze immediately.

Step 6: Using the mother culture

It can be achievable to use 1-2 liter of mother culture for 100 liters of milk depending on the culture strength.

Operation Sheet 2– Making Set Yoghurt

Objectives:

- To identify Equipment and ingredients used for Set Yoghurt making
- To make Set Yoghurt

Ingredients

- Raw milk
- starter culture (Mesophilic)

Materials required

- Stainless steel double jacket cheese vat
-

Procedures

1. Standardized -Standardized of 2.7 fat
2. Pasteurization - Heat to 90
   -Holding time 5 minute
   - Cool down to 45 °C
3. Inoculation - Use fresh yoghurt 2.5 -3l/100l or starter
   - Optional Additive6% sugar
   - 6% sugar + 0.5% vanilla
   - 4.5% skimmed milk powder
4. Packaging - Package yoghurt in cups
5. Incubation /Ripening - Temperature 45 °C, use Incubator
   - Time 3Hours
6. Cooling - Check PH < 4,5 is good

Operation Sheet 3– Making stirred Yoghurt

Objectives:

- To identify Equipment and ingredients used for stirred Yoghurt making
- To make stirred Yoghurt

Ingredients

- Raw milk
- starter culture (Mesophilic)

Materials required

- Stainless steel double jacket cheese vat

Procedures

1. Standardized Standardized of 2.7 fat
2. Pasteurization - Heat to 90
   - Holding time 5 minute
   - Cool down to 45 °C
3. Additives - 6% sugar
   - 6% sugar + 0.5%Vanilla
   - 4.5% Skimmed milk powder
4. Inoculation - Use fresh yoghurt 2.5 -3l/100l or starter
5. Incubation - Temp. 31 °C
   - Time 18 – 20 hrs.
   - check PH < 4.6 is good
6. Incubation /Ripening - Temperature 45 °C, use Incubator
   - Time 3Hours
7. Stirring In case of non- homogenized milk mix in cream layer gently
   - stir the yoghurt, until homogeneous
8. Cooling - to $4^{o}C$
9. Next day - Check PH < 4,5 is good

LAP TEST	Performance Test

Name………………………………. ID…………… Date………………………………

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **4** hour. The project is expected from each student to do it.

Task 1

Identify ingredients and equipment for mother culture preparation

Preform successfully mother culture preparation

Task 2

Identify ingredients and equipment for Set Yoghurt making

Preform successfully Set Yoghurt making

Task

Identify ingredients and equipment for stirred Yoghurt making

Preform successfully stirred Yoghurt making

LG #36	LO4. Implement packaging procedures

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Applying requirements for a range of product
- ✓ Duration
- ✓ Temperature
- ✓ Acidity
- Monitoring packing environment
- Adding necessary additives and agents
- Doing pre packing preparations
- Carrying out packaging and labeling procedures

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Apply requirements for a range of product
  - ✓ Duration
  - ✓ Temperature
  - ✓ Acidity
- Monitor packing environment
- Add necessary additives and agents
- Do pre packing preparations
- Carry out packaging and labeling procedures

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.

5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, ask your trainer for further instructions or go back to “Operation sheets”.

Information sheet 1 Applying requirement for a range of products

1.1Applying requirement for a range of products

A. Composition

The milk solids content (including the fat content) for yogurt ranges from around 9% for skim milk yogurt to more than 20% for certain types of concentrated yogurt. Many commercial yogurt products have milk solids contents of 14-15%. The minimum milk solids not-fat content required in standards or regulations in many countries ranges from 8.2 to 8.6%

B .Duration

Duration of milk exposed to heat treatment is a critical requirement in yogurt manufacturing. The holding time of pasteurized milk for yogurt processing varies from 5 minute up to 20 minute, according to pasteurization heat applied. Similarly holding time is critical requirement in quality product processing incubator, the milk should be incubated for 2-3 hours for proper multiplication of yogurt bacterial. Storage duration also required for proper temperature to below 4^{o}C for 6-12 hours in refrigerator.

C.Temperature

Pasteurization temperature is a critical requirement in yogurt products manufacturing. Yogurt milk is pasteurized within the range of 85^{o}C – 95^{o}C for determined time. The milk cooled down to the required temperature within the range of 45^{o}C – 46^{o}C for set yogurt.

Cooling temperature- the required temperature for stirred yogurt is 31^{o}C before incubation and after inoculation of appropriate culture (*Streptococcus* subsp. *thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus*.).

Incubation temperature Physical properties and microstructure of yogurt are influenced by incubation temperature. The use of high incubation temperature resulted in a decrease in gelation time incubate at 45^{o}C and 31^{o}C for set yogurt and stirred yogurt; respectively. After incubation both type of yogurt will be cooled down within the range 4 - 7^{o}C.

a. **Acidity**

Freshly drawn milk shows certain acidity as determined by titration with an alkali (sodium hydroxide) in the presence of an indicator phenolphthalein (equivalent to pH 8.3). This acidity, also called titratable acidity, as determined by titration, is known as “natural” or “apparent” acidity. It is caused by the presence of casein, acid-phosphates, citrates, etc., in milk. The natural acidity of individual milk varies considerably depending on species, breed, individuality, stage of lactation, physiological condition of the udder, etc., but the natural acidity of fresh, herd/pooled milk is much more uniform. The higher the SNF content in milk, the higher the natural acidity and vice versa. The titratable acidity of individual cow milk varies from 0.12% to 0.18%, but in commercial pooled milk the range is only 0.14–0.16%.

b. **pH**

The pH plays a critical role in determining the heat stability of milk. The pH effects both the molecular disassociation of casein components and the formation of aggregated protein complexes through protein–protein interactions. Further, pH strongly affects the salt equilibrium between the colloidal and ionic states of the minerals of milk. Maximum heat stability is observed between pH 6.6–6.8.

c. **Cooling**

When yogurts have reached the desired pH (e.g., ~4.6), yogurts are partially cooled (~20°C) before fruit or flavoring ingredients are added. Yogurt products are often blast chilled to <10°C (e.g., 5°C) in the refrigerated cold store to reduce further acid development. In the production of set yogurt, yogurts are directly transferred to a cold store or blast chilled in cooling tunnels. For stirred yogurts, cooling is first performed by agitation in the jacketed fermentation vat and the product is sheared and smoothened by devices like back-pressure values, high shear devices or sieves.

Self-Check – 4	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part 1 explain the question 5%point

1. Write the different b/t cooling Temperature and Pasteurization yogurt manufacturing

Part 2.write black space

1. _______________is critical equipment in yoghurt manufacturing (5%)

2 .___________is physical properties and micro structure of yoghurt are influenced by incubation temperature. (5%)

Note: **Satisfactory rating – 10 points Unsatisfactory - below 15 points**

You can ask you teacher for the copy of the correct answers

Score = ___________
Rating: ____________

Information sheet-2 Monitoring packaging environment

2.2. Monitoring packaging environment

Monitoring

Packaging is the most effective means to protect contained dairy products from their point of manufacture through to their consumption. It is also arguably the most effective means of communication between the dairy products' marketer and the end user of the dairy products since the package's form, dress, and surface graphics are visible prior to at the instant of purchase decision and as the package is used. Packaging is a tool that is used to contain the product, protect the product from environmental hazards and help in marketing the product. Environmental monitoring (EM) is a planned sequence of samplings, observations, and measurements used to evaluate the effectiveness of microbiological agents in food processing facilities. Environmental monitoring is a key prerequisite program (PRP) that determines whether or not cleaning and sanitation procedures and frequencies are effective packaging. The scope of EM covers all areas of a facility. As a PRP, EM supports the implementation of food safety management systems such as HACCP, HARPC, and others.

Self-Check – 2	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part 1. **Test I Short Answer Questions**

1. What is monitoring packaging environment (1O %)

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers

Score = ___________
Rating: ____________

Information sheet-3 Adding necessary additives and agents

3.1. Adding **necessary additives and agents**

3.2. Additives

In yoghurt production, mainly because of sensory characteristics, different types of additives are used. Each group and also each substance from the same group have different characteristics and properties. For that reason, for improvement of yoghurt sensory characteristics apart from addition selection, the quantity of the additive is very important. The same substance added in optimal amount improves yoghurt sensory attributes, but too small or too big addition can reduce yoghurt sensory attributes.

Characteristics and properties of mostly used additives in yoghurt production are described; skimmed milk powder, whey powder, concentrated whey powder, sugars and artificial sweeteners, fruits, stabilizers, casein powder, inulin and vitamins. Also the impact of each additive on sensory and physical properties of yoghurt, syneresis and viscosity, are described, depending on used amount added in yoghurt production

Self-Check – 3	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers

Part 1.difene the question

1. What is Additives (10)point

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Information sheet 4 - Doing all other pre packing preparations

4.1 Doing all other pre packing preparations

The objective of this project is to design a modified version of the existing yoghurt packaging which is commonly available in the market. Our aim is to design a package which can minimize the loss or wastage of the product. As we feel that there is significant loss of product in case of yoghurt packages which are currently being used. This package can only be used for yoghurt and other similar viscous products like cream, but it will not be a good idea to use this packaging for some kind of drink e.g. milk.

Fig -7 .Packaging

There are various types of yoghurt packaging available in the market and we have focused our attention towards maximum utilization of the product by minimizing the loss of the product as we feel that this area needs some improvement as it is neglected in the packaging currently available in the market.

2 Protection of product

2.1 Packaging material

The most common types of material used for packaging are paper, fiberboard, plastic, glass, steel and aluminum. Great packaging begins with the right material - one that can deliver performance, quality and reliability for the product it houses. So in order to design efficient packaging selection of proper materials is the first and most important step. Materials which we have used are mentioned below.

A. Paper board
B. Polymers
C. Aluminum

2.1.1 Paper board

Paperboard packaging comes in several different grades that possess unique characteristics making each grade suitable for different packaging requirements and needs. Strength and durability of primary packaging largely depends upon the proper selection of paperboard. Paperboard is eco-friendly as it is based on wood, the only naturally renewable packaging raw material.

Polymers In order to preserve the product and to enhance the storage life we have used various layers of different polymers. Our paperboard is laminated from externally and internally with suitable type of polymers. Lamination of paperboard with polymers serves following purpose.

Provide protection to the food and to the paperboard against hazardous environmental effects like sunshine, moisture, air, dust, oxygen. These layers give extra strength and stiffness to the packaging. Lamination is also done for aesthetic reason. Factors which become the basis of polymer selection are Percentage of water present in the product Moisture in the atmosphere.

- Percentage of water present in the product
- Moisture in the atmosphere
- Oxygen
- Effective sealing, preservation and safety of the product
- Surface finish, gloss and printing of the packaging

- Barrier properties
- Cost

Inner layer

There are a lot of barrier materials available in the market for inner layer of food packaging. We have selected two layers of HDPE (15+25 g/m2) because of its properties and price.

Polypropylene is a common and least expensive plastic to produce, it is still being used in food cans like yoghurt, margarine but its recycling is less efficient so high density polyethylene was selected; it is being widely used in packaging industry now a days although it is little more expensive but it can be recycled mores easily as compared to polypropylene. With the increase in the use of HDPE recycling industry is also focussing and trying to refine the recycling process to make it less expensive and to increase its use in packaging industry. Salient features of HDPE are mentioned below.

- Chemical resistance is superior as well as resistance to oil and grease.
- HDPE has 90% crystallinty which increases its stiffness.
- The opaque HDPE film offer excellent moisture protection and significantly decreasesgas permeability.
- It has also good heat sealing properties so no adhesives is required

Aluminium

Aluminum foil acts as a complete barrier to light and oxygen (which cause fats to oxidise or become rancid), odours and flavours, moisture, and bacteria. Aluminium foils are good choice for dairy products; it also helps in preservation of dairy products for some time without refrigeration.

Primary packaging

Handling

Primary packaging is tray made up of paperboard with laminate layers of various polymers.

Product inside the package is divided into two parts, both parts contains yoghurt of different flavors, two parts of the packaging can also be filled with yoghurt of different fat composition.

While designing the yoghurt packaging we kept certain things in our mind i.e.

- Protection of the product.
- Easy handling.
- Aesthetic appeal.
- Minimizing the loss of the product
- Compact and sleek design, effective utilization of the space in the store shelf and warehouses.

Salient features of primary packaging are mentioned below.

Product weight = 1500g

Shelf Life = 30 days

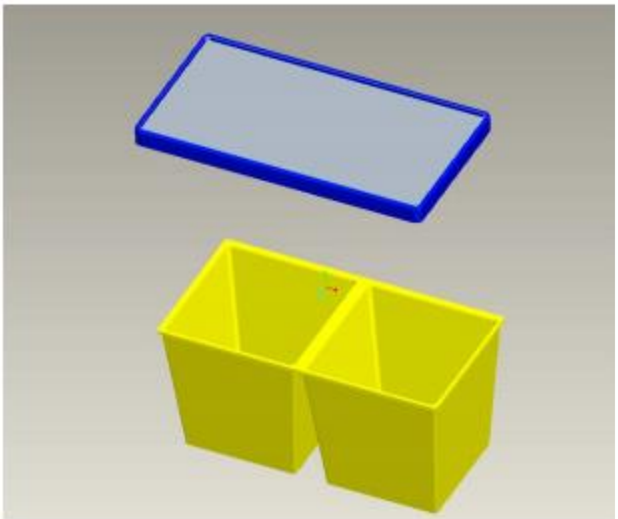

Fig -8 Primary packaging

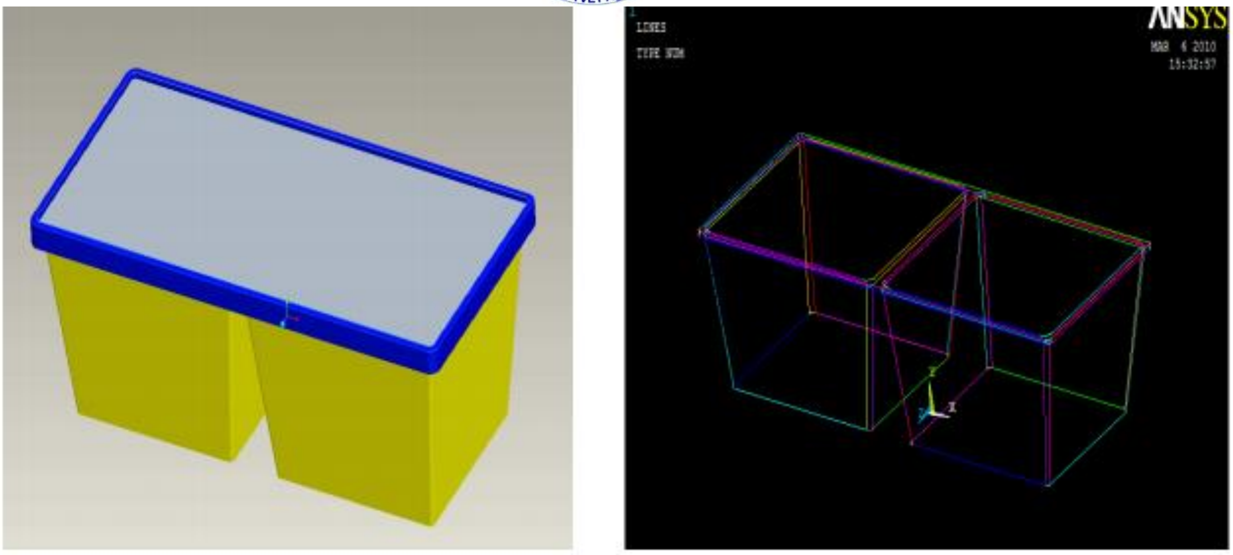

Fig -9 primary packaging

Storage

Storage of primary packaging is important for the end user; end users are people who will purchase this product from the retailers so storage for end user is usually not a big problem as majority of the end users do not purchase such perishable items in bulk quantities. While designing this package for the end user we have focused more towards effective and maximum utilization of product inside the packaging, appearance of the packaging and how it can communicate with its purchaser in a better way.

Secondary packaging

Handling

The secondary packaging consists of a tray which contains six packs of yoghurt. six pack packaging is intended towards retailers, it has been designed in a way to provide ease of handling to those working in stores. tray of six yoghurt packaging can easily be handled by the personnel working in the shop, it is easy to carry and it can easily be stack at a dedicated place inside the store. weight of the tray is around 9.5 kg and an average adult person can easily carry this load

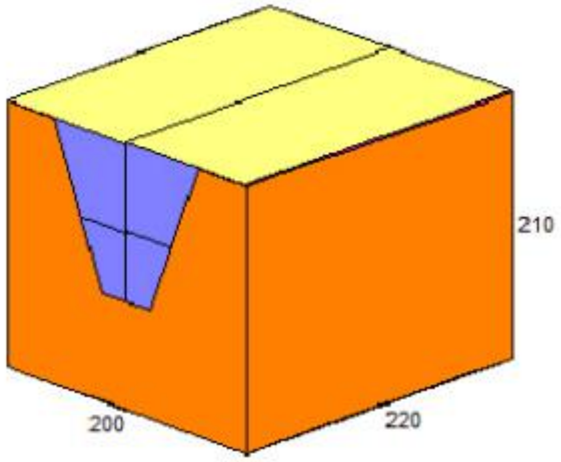

Fig 10 Secondary packaging

Transportation

While designing secondary packaging we have ensured safe and easy transportation from the warehouses to the shelf.

Storage

Storage of secondary packaging is particularly aimed at retailers; it has been designed in a way to provide ease of storage to the retailers. A secondary packaging of six items can easily be stored at a dedicated area in a refrigerator, wide base of primary packaging will nullify the chances of falling and its less thickness will ensure that it will occupy less space in the shelf.

Load carrier

Standardized pallet has been selected, cube efficiency is 81 % and area utilization is 82

%. Dimension of load on the pallet is 800x606x984.

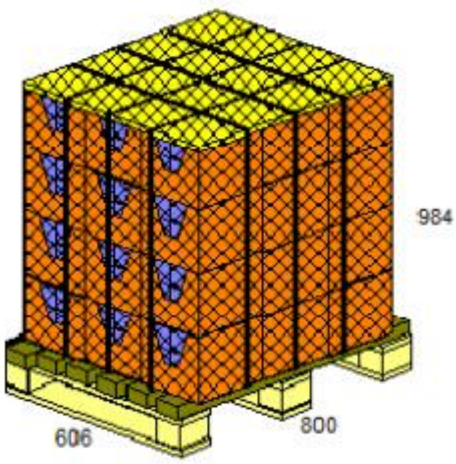

Figure.11. Load carrier

Self-Check – 4	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Short Answer Questions

1. Writes the different b/n primary packaging and secondary packaging (5%)

Part 2 say true or false

1. The secondary packaging contains six packaging of yoghurt. (4%)

2. Poly propylene is a common and least expensive plastic to produce. (4%)

Note: **Satisfactory rating – 15 points** **Unsatisfactory - below 15 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________
Rating: ____________

5.1 Carrying out packaging and labeling procedures

Fundamentals of packaging

Definitions

Packaging is the most effective means to protect contained dairy products from their point of manufacture through to their consumption. It is also arguably the most effective means of communication between the dairy products' marketer and the end user of the dairy products since the package's form, dress, and surface graphics are visible prior to at the instant of purchase decision and as the package is used. Packaging is a tool that is used to contain the product, protect the product from environmental hazards and help in marketing the product.

Main objectives packaging

The following are the main objectives:

A. **Containment, i.e., separating the food from the environment:** It involves partitioning of the product into units that can be handled during distribution, storage, transport, and final use. It prevents contamination of the environment with the food material, which would cause hygienic problems. It generally guarantees the integrity and the quantity of the contents.

B. **Protection of the product from outside influences:** This implies prevention of contamination with microorganisms and chemical compounds or dirt particles, and exclusion of radiation, especially light. Packaging often is an essential part of food preservation. Protection also implies preventing loss of components, such as water and flavor substances, to the environment.

C. **Convenience for the consumer:** An obvious point is that it should be easy to open the package and close it again. Minimizing contamination after a portion has been taken out of the package is also of importance, as is easy stacking of the containers. Packaging in a range of portion sizes is convenient for those who need either a little or a lot of food per day. Modern packaging systems often enable the distribution of foods that are ready to eat, or that need only little preparation.

D. **Providing information:** This may be factual information regarding the quality of the product, its composition, nutritive value, keeping quality, manner of storage, how to handle the product, and so forth. Moreover, several marketing messages may be printed on the label, from the brand name, to possible applications of the product (recipes) and potential benefits of its consumption.

Functions of packaging

The principal and fundamental functions of packaging are

- To enable efficient food distribution
- To maintain product hygiene
- To protect nutrients and flavor
- To reduce food spoilage and waste
- To increase food availability
- **To convey product information**

Primary packaging: - is that which is in intimate and direct contact with the contents. As such it represents the major barrier between the product and the environment. Most, and sometimes all, of the protection against oxygen, microorganisms, light, moisture gain or loss, and so forth, is built into the primary packaging. Among the more common primary packages are metal cans, plastic and glass jars and bottles, plastic tubs and cups, flexible pouches, and paperboard folding cartons.

Secondary packaging: is usually an outer carton or multipack that enables the consumer to carry more than one primary package of a product at a time. Sometimes the secondary package is an outer carton or wraps to hold just one primary packaging.

Packaging material criteria

The followings are packaging material criteria:

I. Process ability:

- Material brittle, pliable, or moldable

- Available in the desired thickness (e.g., cellophane can only be made thin-walled)
- Suitable for being sealed (especially by heat sealing) or suitable for lamination (adhesiveness).
- Readily be cleaned and sterilized
- Resistant to high temperatures, for example, during in-bottle sterilization

II. **Resistance:**

- Strong enough (this depends very much on its thickness) and wear resistant
- Withstand fluctuations in pressure and temperature, for example, during sterilization, freezing, or gas formation
- Resistant to a moist atmosphere, that is, does it not softens
- Show rapid aging, some plastics rapidly become weak or brittle when exposed to light.

III. Permeability

Bacteria are generally not let through, provided that the closure of the package is perfect. Passage of a substance through the packaging material may be by diffusion and, consequently, greatly depends on the solubility of the substance in the material. The amount of substance permeating generally is proportional to contact area, time, and concentration difference and inversely proportional to the thickness of the material.

IV. **Heat Insulation:**

Often a well-insulating package is not desirable, because after packaging heating and/or cooling are to be applied. Although most plastics have poor heat conductivity, the layer often is too thin for satisfactory insulation. If insulation is needed, expanded polystyrene (polystyrene foam) can be applied.

V. **Light Transmission:**

For many foods a transparent package is desirable so that the user can see the contents. The drawback for milk products is that light induced flavors (cardboard or sunlight flavor, and oxidized or tallow flavor) may develop. Cardboard is not transparent but is certainly not impermeable to light. Glass can be browned (it is the short-wavelength light that is most harmful), but brown glass is often considered unattractive. Most plastics are quite transparent. Fillers can be applied to give color, and TiO_2 is often used for a white color. Printability of the material often is important for the trade.

VI. **Laminates:**

It will be clear that in many instances no single packaging material meets all requirements. Because of this, laminates are applied. In a milk carton for durable, aseptically packaged products, we may find (going from outside to inside):

- **Polyethylene:** for water repellence, for making cardboard adhere to aluminum, for good seal-ability; sealing here means closing the filled package by pressing while heating.
- **Paper:** for printing.
- **Cardboard:** for firmness.
- **Aluminum:** against passage of light and all substances.

Types of package materials

In an ideal world, a single package material would suffice to protect all dairy products. In this ideal world, a steel can could function in this role, but the size, weight, and economics of a steel can dictate that it not be employed when a less expensive and lighter weight material is available. Even metal requires coating, usually plastic, in order to be useful in most dairy packaging applications.

Plastic

All plastic package materials are characterized by their light weight, relative ease of fabrication, low-cost, and ability to be tailored for specific end applications. Together, by weight, all plastics comprise about 20% of package materials, but because of their low densities, protect far larger volumes of contents than any other package materials.

The advantages offered by the plastic packages are:

- Good barrier properties

- Visibility of the contents
- Light weight (thus reducing the cost of transportation)
- Single-service, thus eliminating the need for return, washing and sanitation
- Easy to carry
- Economical and Can be made more attractive.

Fig 12 Yoghurt packed in plastic containers with flexible peelable lids

Paper and paperboard

Paper and paperboard represent the packaging material used by far in largest volume around the world. Because of its origins, it must be combined with other materials to render it effective in packaging applications. Most of this category is consisted of paperboard rather than paper, with the boundary being 0.010 inch, paper being below this gauge dimension and paperboard above

Metal

Metal is most often used for cylindrical cans which are either thermally processed for microbiological stability or internally pressurized with carbon dioxide as for beer and carbonated beverages. Aluminum is by far the most important metal used for can fabrication, being the primary metal for beer and carbonated beverage cans, increasingly used for still beverage cans, but only sparsely for food cans except for shallow pet food and fish cans. Almost all aluminum cans are two pieces, that is, a body and an end seamed to the body.

- Steel represents the major metal used for food and dairy product cans, usually coated with chrome/chrome oxide and subsequently over coated with plastic to protect the metal from corrosion and the product from metallic flavors.
- Aluminum is also used in very thin or foil gauges as a flexible or semi rigid packaging laminate to impart oxygen and/or water vapor barrier to the lamination. In this form, the aluminum must be protected from damage by plastic or paper.

Glass

Glass is historically the oldest packaging material still in use. Glass is the best barrier and by far the most inert to product contents. Further, in appropriate structures, glass has the greatest vertical compressive strength. On the other hand, glass is very heavy per unit of contents contained, is energy intensive to manufacture, and, as is well known, is prone to breakage with impact especially impact after abrasion. Glass may be fabricated into bottles and jars, almost all of which require plastic or metal devices to close.

Filling operation

Bottles are usually filled to a certain level, but for highly viscous products a measuring pump should be used; one or a few turns of a plunger determines the amount of product delivered, nearly independently of the product viscosity. Sometimes the filling step itself can cause problems because the high strain rates applied may change the consistency of the product, which then becomes too thin.

Sterilization of the packaging material should not impair that material. Consequently, steam or hot water heating often is not possible. In most cases, sterilization with a hot (60 to 80°C) and concentrated (20 to 35%) solution of H_2O_2 is applied. Hot air (>100°C) can readily remove residues of H_2O_2, and it provides an additional sterilizing effect. H2O2 has an advantage over other liquid disinfectants in that it causes no serious problems with respect to residues left in the milk. Gaseous disinfectants such as ethylene oxide have a slow spore-killing action and can only be applied if a long reaction time (several hours) is feasible.

Because suitable light sources have been developed, sterilization by UV irradiation is becoming increasingly prevalent, especially for packaging materials and machines that are less readily sterilized by H_2O_2. UV light of 200 to 280 nm accounts for the sterilizing effect. If dust particles have become attached to the packaging material, H_2O_2 will produce better effects due to its rinsing effect, whereas UV irradiation will be less effective due to particle shade. Clean-room techniques combined with irradiation are sometimes applied.

Aseptic packaging has to be meticulously checked. Not only must the packaged product be examined, but so must all preceding steps, as well as the operators, which are potential carriers of pathogens. If just one bacterium reaches the product, and that bacterium is pathogenic and can proliferate (for example, *Staphylococcus aureus*), the result could be disastrous. In addition to regular sampling during production, further samples should be taken at the times or in situations known to be associated with an increased risk of contamination. It is advisable to incubate these samples long enough, in most cases from 5 to 7 days at 30°C to allow sub-lethally damaged bacteria also to grow to detectable counts.

The products should only be delivered if the result of the shelf-life test is satisfactory.

Active packaging techniques can be divided into two categories for preservation and improving quality and safety of foods:

- Absorbing systems (scavengers)
- Releasing systems (releasers)

Absorbing systems remove undesired compounds such as oxygen, carbon dioxide, ethylene, excessive water, taints, some unwanted aromatic compounds and other specific compounds from the package, whereas releasing systems actively add or emit compounds to the packaged food or into the head-space of the package, such as carbon dioxide, ethanol, antioxidants, and preservatives.

In active packaging, active compounds can be incorporated into the packaging material or integrated to the closure of the bottle, or can be directly added to the package in the form of sachets or labels.

Since the main objective of the active packaging is to extend shelf life and to enhance safety of food, it is especially useful for fresh foods and extended shelf life foods. Dairy products are one of the main food products that have found application area for active packaging technology since dairy products are very susceptible to microbiological spoilage, enzymatic and non-enzymatic spoilage because of the characteristics and processing conditions of the dairy products.

The packaging for set product is done in retail containers before incubation. However, for stirred product, the packing is done during cooling. The packaging materials may be polythene pouches, polystyrene cups, bottles or cartons. All such packaging materials serve as additional source of contamination and their sterility should be ensured before packaging. Packaging materials should also prevent the contamination during storage and distribution.

Yoghurt packaging machines are based on one of the following principles.

- Volumetric level filling- When fluid yoghurt is poured in to glass bottles.
- Volumetric piston filling- As applied to the packaging of stirred yoghurt in the plastic container.

This is more widely used, but the piston pump can cause some shearing of the coagulum. To minimize this reduction in viscosity, it is recommended to use low speed of filling and the use of a filling nozzle with a large orifice. It is also important that the design of the filling head should allow for a high standard of hygiene.

Antimicrobial Packaging

Antimicrobial packaging is one of the most promising versions of an active packaging technology, and antimicrobial food packaging materials interact with the food or headspace of the package to reduce, inhibit, or retard the microorganisms present in food or in packaging material by extending the lag phase and reducing the growth rate of microorganisms in order to extend shelf life and maintain the product quality and safety.

Antimicrobial (AM) packaging technology can be applied by several methods:

- Addition of sachets/pads containing volatile antimicrobial agents in to the packages. No direct surface contact occurs and volatile antimicrobials are released in to the headspace of the package to retard the growth of pathogenic or spoilage bacteria.
- Incorporation of volatile or nonvolatile antimicrobial agents directly into the polymer by extrusion, heat press, or casting. Coating or adsorbing antimicrobials onto the polymer surfaces. Coatings and dips serve as carrier of antimicrobial compound and are in contact with food surface.
- Immobilization of antimicrobials to polymers by ion or covalent linkages.
- Use of polymers like chitosan that are inherently antimicrobial

A. Chemical Antimicrobials

The chemical agents in antimicrobial packaging can be incorporated into the packaging material or inserted into the headspace atmosphere by sachets or labels or closures. The most common chemical antimicrobials used by researchers are the various organic acids. The organic acids, including fatty acids, are naturally existing chemicals and widely used as chemical antimicrobial agents because their efficacy is generally well understood and cost effective. Sorbic acid, p-aminobenzoic acid, lactic acid, and acetic acid have a long history and are generally recognized as safe (GRAS) food preservatives. LDPE (low-density polyethylene) is a polyolefin group of synthetic plastic packaging material that has been commonly used in antimicrobial packaging studies. Because of the yeast and mold spoilage in cheese and most dairy products, most of the studies in this area are related to the use of organic acids having antifungal property.

B. Natural Antimicrobials

Especially in recent years, consumers have begun to show a strong preference for natural over synthetic, and for this reason, naturally derived antimicrobial agents are becoming increasingly important in antimicrobial packaging, as they present a perceived lower risk to the consumers and the use of natural antimicrobial agents may become popular areas of packaging research.

These natural compounds are perceived to be safer and claimed to alleviate safety concerns. Main natural compounds are essential oils derived from plants (e.g., basil, thyme, oregano, cinnamon, clove, and rosemary), enzymes obtained from animal sources (e.g., lysozyme, lacto-ferrin), bacteriocins from microbial sources (nisin, natamycin), organic acids (e.g., sorbic, propionic, citric acid), and naturally occurring polymers (e.g., chitosan).

Storage

All packaged retail units are packed in larger cartoon and stored in cold stores. The yoghurt must be stored at less than 5 C to ensure inhibition of growth starters and non-starter microorganism. If there are temperature fluctuations or temperature increases during storage, the growth of culture as well other microorganisms may take place and it will make the product sour or produce other defects. Hence, maintenance of temperature during storage is very important.

The distribution of the finished product should always be through cold-chain. Good quality yoghurt has shelf-life of 2-3 weeks days at 5 C.

Disposing of packages

All packages end up as waste. The growing volume of household waste could become an environmental problem in our society. Ways of tackling this problem can be summarized in principle under five headings:

- **Reduction:** Reducing the input of raw materials and choosing materials that are not environmentally harmful helps to conserve natural resources.
- **Recycling:** Packages can be collected after use and used again. However, it should be remembered that even a refilled package ultimately ends up as waste.
- **Recovery of materials:** Packages can be collected and the materials used to manufacture new products, but it is important that the new products meet a real need.

- **Recovery of energy:** All packages incorporate energy, which can be extracted when the waste is incinerated. The potential yield depends on the type of packaging material.
- **Landfill:** Waste can be deposited as landfill and the area can ultimately be landscaped for recreational or other purposes

Self-Check – 5	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I. Short Answer Questions (10 points)

1. Define Packaging (2pts)
2. What are main objectives packaging? (4pts)
3. What are functions of packaging? (4pts)
4. What is packaging material criteria? (5pts)
5. Write types of package materials(5pts)
6. Write the advantages of plastic packaging material (5pts)
7. List of the principle of disposing packages (5pts)

Note: **Satisfactory rating – 30 points Unsatisfactory - below 30 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________
Rating: ____________

LG #37	LO5. Assess the organoleptic properties of yoghurt and relate to specifications

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying desirable and undesirable flavors in products
- Recognizing different chemical and physical properties
- Assessing yoghurt
    - ✓ Evenness of appearance
    - ✓ Smoothness
    - ✓ Mouth fill
    - ✓ Texture
    - ✓ Taste
- Identifying possible causal factors and making changes to address product quality issues

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify desirable and undesirable flavors in products
- Recogniz different chemical and physical properties
- Assessyoghurt
    - ✓ Evenness of appearance
    - ✓ Smoothness
    - ✓ Mouth fill
    - ✓ Texture
    - ✓ Taste
    - Identify possible causal factors and making changes to address product quality issues

Learning Instructions:

6 Read the specific objectives of this Learning Guide.

7 Follow the instructions described below.

8 Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.

9 Accomplish the “Self-checks” which are placed following all information sheets.

10 Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
11 If you earned a satisfactory evaluation proceed to “Operation sheets
12 Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
13 If your performance is satisfactory proceed to the next learning guide,
14 If your performance is unsatisfactory, ask your trainer for further instructions or go back to “Operation sheets”.

5.1 Identifying desirable and undesirable flavors in products

Sensory evaluation may be defined as a scientific method used to evoke, measure, analyze and interpret results of those characteristics of foods perceived through five senses of sight, smell, taste, touch and hearing.

The sensory evaluation is very important in product evaluation on account of following advantages:

- It is relatively simple analytical process.
- Employing sensory evaluation techniques quality attributes like colour, appearance, flavour etc are measured in objective (quantifiable) manner. The use of chemical and microbiological methods for examining quality of milk and milk products are time consuming, complicated and expensive.
- It directly determines the eating quality of milk products that cannot be done by other analytical techniques.
- Sensory evaluation helps to ensure that consumers get a defect free product that provides them great enjoyment while eating.

Flavor defects and shelf life

A main quality problem with yogurt is that souring tends to go on after delivery to the retailer, and the product may be too acidic when consumed; the acid flavor tends to be more pronounced in low-fat yogurt. Moreover, the yogurt may become bitter due to excessive proteolysis; this would also depend on the starter strains used. The development of these defects generally determines the shelf life. Of course, the product is cooled to slow down acidification, but it is difficult to cool it fast enough. Set yogurt is acidified in a package and cannot be stirred; stirred yogurt should not be stirred too vigorously because it would then become too thin. And even at refrigerator temperatures, acidification and other changes caused by the enzyme systems go on, albeit slowly.

Other defects may be caused by contaminating organisms, mainly yeasts and molds. The off-flavors may be characterized as yeasty, fruity, musty, cheesy, or bitter, and occasionally, soapy-rancid. A flavor threshold is generally reached at a count of about 104 yeasts and molds per ml. The growth of these microbes is largely determined by the amount of oxygen available, and hence by the headspace volume and the air permeability of the container.

Another defect is insufficient characteristic flavor due to reduced acetaldehyde formation (which is of less importance in yogurts with added fruits). It may be due to a low incubation temperature, an excessive growth of the streptococci, or the lactobacilli being weak aroma producers. Insufficient acidification, e.g., because the milk is contaminated with penicillin, also leads to a bland product.

Finally, off-flavors in the milk used for manufacture may naturally cause flavor defects in the product

Self-Check – 1	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers

Part 1 Write the question

1. Identifying desirable products (5%)

1. **Undesirable flavors in products (5%)**

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Score = ____________
Rating: _____________

5-1 Recognizing different chemical and physical properties

Firmness of Set Yogurt

Firmness of set yogurt is often estimated by lowering a probe of a given weight and dimensions into the product for a certain time. The reciprocal of the penetration depth then is a measure of firmness. Firmness is not closely related to an elastic modulus but rather to a yield stress. Its value depends on the method of measurement, especially the timescale, and on several product and process variables:

- Casein content of the milk:
  Firmness is approximately proportional to the cube of the casein content. Natural variation in casein content can thus have a marked effect. Evaporating the milk, adding skim-milk powder, or partial ultrafiltration increase firmness.
- Fat content: The higher the fat content, the weaker the gel because the fat globules interrupt the network.
- Homogenizing: Homogenization of the milk leads to a much enhanced firmness because the fat globules then contain fragments of casein micelles in their surface coat by which they can participate in the network upon. The volume fraction of casein is thus effectively increased. (Homogenization of skim milk makes no difference.)
- Heat treatment: Heat treatment of the milk considerably enhances firmness. The deposition of denatured serum proteins increases the volume fraction of aggregating protein; it also may alter the number and the nature of the bonds between protein particles. Milk is generally heated for 5 to 10 min at 85°C to 90°C.
- Yogurt cultures: These vary in the firmness they produce (at a given acidity), but as a rule, the differences are small.
- Acidity: Generally, the yogurt is firmer at a lower pH. The preferred pH is between 4.1 and 4.6.

- Incubation temperature: The lower it is, the longer it takes before a certain pH, and thereby certain firmness is reached, but the finished product is much firmer.
- Temperature of the yogurt: For the same incubation temperature, a lower measuring temperature gives a greater firmness. The effect is quite strong. The explanation is, presumably, that the casein micelles swell when the temperature is lowered (and vice versa); because the particles are essentially fixed in the network and the network cannot swell, this would imply that the contact or junction area between any two micelles is enlarged, by which a greater number of bonds are formed per junction.

Syneresis

Syneresis is for the most part due to a rearrangement of the network, leading to an increase in the number of particle–particle junctions. The network then tends to shrink, thereby expelling interstitial liquid. Acid casein gels are not very prone to syneresis. In yogurt, syneresis is, of course, undesirable.

The tendency to exhibit syneresis greatly depends on the incubation temperature. If milk is incubated at 20°C (with a mesophilic starter because yogurt bacteria hardly grow at that temperature) so that the gel is formed at that temperature, absolutely no syneresis occurs, whereas when incubating at 32°C, syneresis is possible. When incubating at 45°C, syneresis can only be prevented if the milk has been intensively heated, if its casein content has been increased, and the storage temperature is low. However, if the package containing the product is even slightly shaken at a time when gel formation has just started and the gel is still weak, it may fracture locally with copious syneresis occurring subsequently. If the top surface of the set yogurt is wetted, possibly because water is condensed on the inside of the lid of the package and a few drops fall off, whey separation may be induced. If the pH of the yogurt has fallen below 4, some syneresis may also occur, especially if the temperature is fairly high and the package is shaken. Containers made of a material to which the formed gel does not stick will readily induce whey separation between the wall and the product.

In the manufacture of stirred yogurt, significant syneresis will lead to a poor product. The stirring breaks the gel into lumps, which then would immediately exhibit syneresis.

An inhomogeneous mixture of lumps in whey is formed; further stirring would break down the lumps and make a smoother product, but it would then become insufficiently viscous. To prevent this, it is necessary to incubate the milk at a low temperature, e.g., 32°C or even lower, if the casein content of the milk is small.

Viscosity of Stirred Yogurt

Stirred yogurt should be smooth and fairly viscous. A good product also gives the impression of being 'long' or 'stringy': when slowly pouring it, a fairly thin thread readily forms that behaves somewhat elastically when it breaks. Viscosity is most easily determined by means of a Ford cup; a given amount of yogurt is allowed to flow from an opening at the conical lower end of a cup, and the time needed for that is a measure for the viscosity.

After a high shear rate is applied, the apparent viscosity at lower shear rates is permanently decreased, and the viscous behavior becomes closer to Newtonian. This implies a lasting breakdown of structure. (Incidentally, the viscosity increases slightly on prolonged standing.) This is all in agreement with the behavior of a liquid containing gel fragments. The viscosity increases with the viscosity of the continuous liquid ('solvent' or 'whey') and with the volume fraction *j* of gel fragments. The latter is larger than the volume fraction of casein particles because the fragments contain a lot of interstitial solvent. More intensive stirring (a higher shear rate) further breaks down the gel fragments and also gives them a more rounded shape.

The apparent viscosity at a given shear rate of stirred yogurt depends on:

- Firmness of the gel before stirring
- Intensity of stirring
- Syneresis
- Bacterial strains applied

Vigorous agitation of stirred yogurt during further processing must be avoided to prevent the product from becoming too thin. Packaging machines can be especially damaging.

Nutritional aspects

Milk is a food of almost complete nutrition. Many changes occur to the components of milk during fermentation, although there is no significant difference between the gross composition of unfermented and fermented milk. Considerable progress has been made in demonstrating certain beneficial effects of fermented milk in animals, probably due to the changes occurring in milk during fermentation.

However, unequivocal experimental or epidemiological evidence still needs to be gathered to substantiate claims of similar effects in humans. Some important health aspects comparing fermented milk with plain milk are discussed in the following text.

Several other health-improving and health-threatening effects of yogurt consumption have been suggested, but these have been shown to be insignificant or, at best, questionable. These will therefore not be included in the discussion.

Composition

A. Lactose content

Fermentation decreases the lactose content, but should not be allowed to continue to such a low pH that further sugar breakdown is impossible because the resulting product would become too acidic. At a lactic acid content of, say, 0.9% the fermentation is often slowed down by cooling. About 20% of the lactose in the milk has then been split if both glucose and galactose are fermented. In yogurt, twice as much as lactose is split because most of the yogurt bacteria do not decompose galactose.

B. Vitamin content

Lactic acid bacteria often require certain B vitamins for growth and can produce other vitamins. Accordingly, the properties of the cultures involved largely determine the extent to which the concentrations of vitamins in the fermented milk differ from those in the original milk. In yogurt, the level of most of the vitamins is somewhat reduced; the folic acid content may be increased. Also, some lactic acid bacteria can produce vitamin K_2. The vitamin content in fermented products is also affected by the storage conditions and especially by the pretreatment of the milk. For instance, heat treatment of milk results in a decrease of vitamins B1, B12, C, and folic acid.

C. Other changes due to bacterial action are nutritionally insignificant.

D. Composition can be changed by such process steps as standardization and ultrafiltration and by addition of skim milk powder, caseinates, stabilizers, flavorings, or fruit pulp.

Nutritional value

A. Edible energy

The fermentation process per se does not cause a substantial change of the energy content of milk. The conversion of lactose to lactic acid reduces the energy value by only a small percentage.

B. **Lactose intolerance**

Lactose-intolerant users can digest a sour milk product like yogurt much better than plain milk. The lowered lactose content of sour milk plays a part. In addition, other factors must exist that cause easier digestion of lactose. The lactase activity of the yogurt bacteria as well as the stimulation of the lactase activity of the intestinal mucosa has been held responsible. Alternatively, the depletion of the stomach contents into the duodenum may be retarded when fermented milks are consumed; thereby, the contact time of lactose hydrolyzing enzymes with the substrate would be extended, resulting in a better digestion of lactose.

C. **pH adjustment**

The consumption of fermented milks causes a smaller increase of the pH of the stomach contents and thereby diminishes the risk of passage of pathogens. This is of particular importance for people suffering from a weakened secretion of gastric juice, e.g., many elderly people and babies.

Antimicrobial action: Lactic acid bacteria can form antibiotic compounds that injure pathogens in vitro. The in vivo significance of these compounds in suppressing gastroenteritis is not clear.

D. Lactic acid type

The type of lactic acid formed has some physiological significance. Two stereoisomers of lactic acid exist: dextrorotatory L(+) lactic acid and levorotatory D(−) lactic acid. L(+) lactic acid can readily be metabolized in the body but D(−) at a slower rate. The latter acid is partly removed from the body through the urine. In traditional yogurt around 40% to 60% of the lactic acid is levorotatory, formed by Lactobacillus delbrueckii ssp. bulgaricus. Ingesting excessive quantities of D(−) lactic acid may cause acidosis, resulting in some tissue injury.

E. Properties of yeasts

Heating the mixture to around 80 to 85°C for 15 to 30 min and cooling the mixture and then fermenting it with pure cultures of L. bulgaricus and S. thermophilus. After fermentation, flavor, fruit, and color are added, and then the product is dispensed, packaged, cooled, and retailed. Yeast contaminants in the first set of ingredients are destroyed by the heating temperatures and times given above, and it is generally accepted that yeast contamination of the final product arises from added fruit material or poor hygienic practices during the packaging operation. The association of yeasts with fruits in general is well documented. On some occasions, we found yeasts in coloring agents, and this has prompted some manufacturers to heat pasteurize solutions of these agents before adding them to the product. To overcome the risk of yeast contamination from fruit ingredients, most yogurt producers either heat pasteurize the fruit material immediately before use or purchase the heat-processed fruit in cans from a supplier. Since the added fruit material may constitute about 10% of the final volume of yogurt, it is essential that the fruit be free of viable yeasts.

On a number of occasions we found levels of yeasts as high as 105 cells per g in heat-processed fruit pulps, suggesting inadequate heat processing.

High yeast counts were particularly encountered in those fruit pulps that had been stored for some time after they were processed.

With good manufacturing practice, it is possible to obtain yogurts with a yeast count of less than 1 cell per g at the time of packaging. With proper refrigerated storage of the product, the yeast count should not exceed 10 cells per g after 3 to 7 days. The yogurts examined in this study were all studied within 5 days of the date of manufacture, yet only 20% showed yeast counts of less than 10 cells per g. Yeast counts in excess of 103 cells per g were noted in 45% of the samples, which suggested an unsatisfactory degree of contamination during production.

Moreover, inadequate refrigeration after packaging aging and during marketing probably encouraged yeast growth and accounted for those samples with yeast counts in the range of 104 cells per g.

Self-Check – 2	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part 1 Write short answer

1. Write the apparent viscosity at a given shear rate of stirred yogurt depends on :(4pts)

2.______________is often estimated by lowering a probe of a given weight and dimensions into the product for a certain time (2pts)

3. _________is thermophilus. After fermentation, flavor, fruit, and color are added, and then the product is dispensed, packaged, cooled, and retailed (2pts)

Note: **Satisfactory rating – 8 points** **Unsatisfactory - below 8 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Information sheet-3 Assessing yoghurt for evenness of appearance

3.1 Assessing yoghurt for evenness of appearance

Yoghurt strength

Viscosity, ropiness and strength of the yoghurt are influenced by:

- Slime or mucus production
  - ✓ Exo Poly Saccharides (EPS)
- Fat-casein network
  - Fat distribution
  - Denaturated serum / whey proteins
  - Dry matter content

Relation of yoghurt viscosity with the protein content of the milk

Lumps and flavor: > 4 mg O2

- > 4 mg O2: less formation of formic acid: less growth of *Str. thermophilus*
- Slower ripening / fermentation
- Risk of growth of *Bacillus cereus*(“hay bacterium”)
- Aberrant yoghurt:
- Lumps and no characteristic yoghurt flavor
- characteristic yoghurt flavor= acetaldehyde

Action:

De-aeration of the milk is important

Slow agitation during cooling of the milk after pasteurization

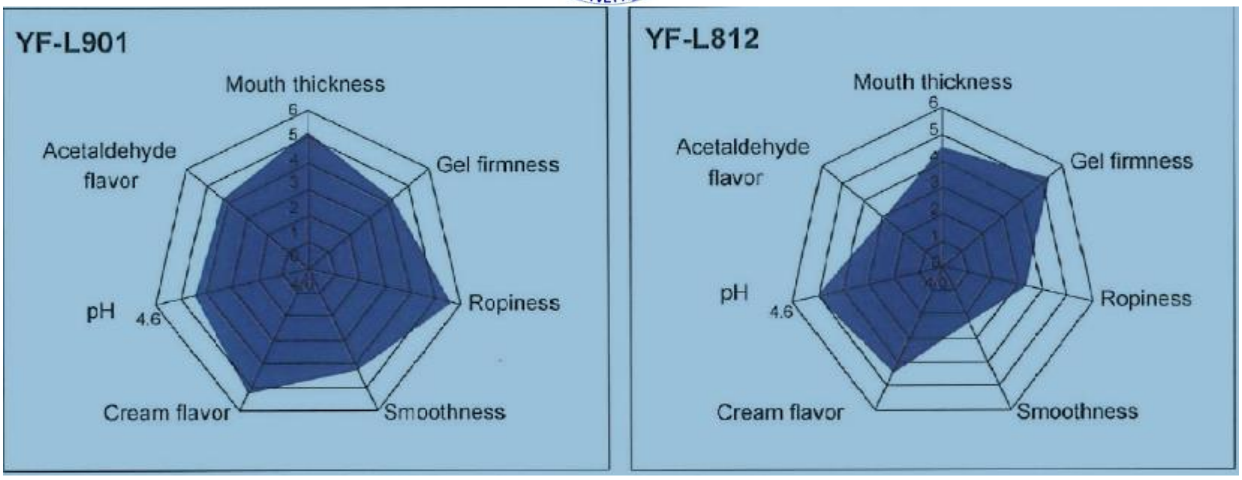

Fig 13 Sensory profile of stirred yoghurt – 0.5% fat

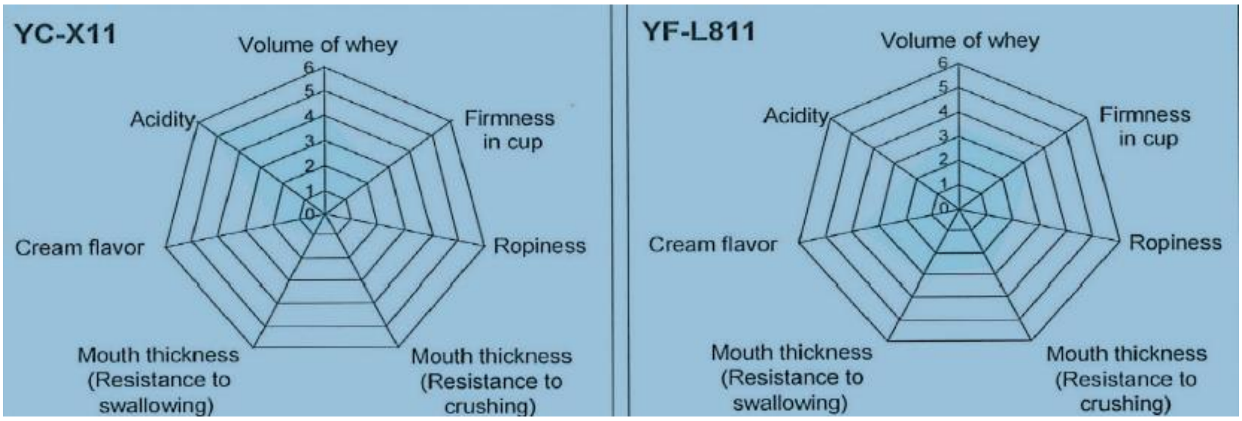

Fig 14 Sensory profile of set yoghurt – 1.5% fat

Self-Check – 3	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part 1.choose the best answer question

1. Viscosity, ropiness and strength of the yoghurt are influenced by(4%)

A. Slime or mucus production   C. Fat distribution

B. Fat-casein network   D. none

2. Write the b/t Sensory profile of stirred yoghurt and Sensory profile of set yoghurt(6%)

***Note:* Satisfactory rating – 10 points   Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________
Rating: ____________

Information- 2 Identifying possible causal factors and making changes to address product quality issues

2.1. Identifying possible causal factors and making changes to address product quality issues

Problem 1: A grainy texture during fermentation

Often, plant managers get in a hurry. They know the higher temperature they set their yogurt, the faster the fermentation time will be, and the faster they can break, cool and package it. Although this is true to some degree, it can be detrimental to the consistency or texture of the finished yogurt. Yogurt set at higher incubation temperatures can incubate to a grainy texture.

Faster acid production from the culture as it metabolizes lactose and ferments it into lactic acid can shock the inherent dairy proteins in the yogurt. Incubating yogurt at a set temperature of 110 F may reach the break pH in a shorter amount of time—let's say, 7.5 hours instead of 8 hours. But the faster acid production from the lactic acid bacteria can shock the dairy proteins and make the finished texture grainy in the incubation vat or in the cup, if it is set in the cup.

Solution: If the problem is created from setting too high of a fermentation temperature, then obviously the solution is to set it at a lower incubation temperature. Why? Setting the yogurt at a lower set temperature of 104 F will produce acid at a slower rate, with less probability of shocking the dairy proteins.

So if you are having trouble with a grainy texture, try setting your yogurt at a lower set temperature with the same culture. You may be surprised at the results.

Problem 2: Yogurt is too tart, or has too low of a finished pH, or too high titratable acidity

Consumers don't usually like yogurt that is too tart. How does this happen? You need to take care in anticipating at what pH the yogurt should be broken and cooled. If you want to have yogurt that has a pH of 4.30 in the finished cup, then you might need to break the yogurt at a pH of 4.70 in order for it not to go below 4.30 by the time the yogurt is packaged in the retail cup, cased, stacked and cooled in the cooler.

Solution: Obviously the solution to this problem is to simply raise the break pH to allow less of a pH drift downward by the time the yogurt has cooled, been mixed with any added fruit and sugar, and it is finally cooled down in the finished retail package.

If you are having trouble controlling acidity development or having the pH drift lower at a break pH of 4.6, raise the yogurt break pH to 4.65 or 4.70, and cool it as quickly as you can. You can also use a milder culture that doesn't continue to produce acid as quickly once the yogurt is broken. Culture suppliers offer a wide range of mild yogurt cultures, so perhaps a change of culture is in order.

Problem 3: A grainy appearance from starch selection or stabilizer selection

Many starches can have a grainy texture if they are not fully cooked out and swollen. Starch exists as tiny "granules" that swell and enlarge in size, which develop viscosity as they tie up or bind the available moisture in the dairy product. After all, milk contains 87% water, and plain sweetened yogurt in fact would have about 76% available water, depending upon the fat level and the total solids level.

Not fully swelling the starch granule or "undercooking" the starch can result in a grainy texture in the finished yogurt. The yogurt will not appear "grainy or gritty" in the mouth, but will have a coarse or "unsmooth" look to it. It may appear dull and not have a shiny look to it as well.

Solution: Choose another starch or increase the cook-out temperature of the starch by pasteurizing the yogurt at a higher temperature. If the starch is part of a stabilization system, it may be necessary to work with your supplier to change the starch portion in the yogurt stabilizer if you feel a smoother starch is necessary. Perhaps the starch may be too highly cross-linked or modified and cannot fully swell or cook out at your current pasteurization temperature.

Problem 4: Too weak of a body and texture

Often yogurt is over-sheared. In other words, after incubation and breaking in the vat, it is over-agitated; resulting in a weak or loose body and texture before it even gets into the final retail package. In this case, it may be sheared down in the setting vat itself as it is being cooled, sheared too much during transfer through a cooling plate, or sheared too much when the fruit and additional sugar is added.

Be careful that you don't over-stir the product along every step of the process once the yogurt has reached the break pH. Over-stirring results in yogurt with weak body and texture. This can mean a lower filling viscosity at the filler, and a weaker finished product in the retail package.

Solution: Keep agitation of the white mass to a minimum in the vat, during cooling and before filling. This may mean intermittent agitation with timers being placed on the yogurt vat agitators to minimize shear in the vat during cooling. If you hold it in a flavor vat while it is waiting to be packaged by the cup fillers, watch that you don't over-agitate it here.

Problem 5: Syneresis in the finished package

All dairy products can suffer from free moisture or syneresis after the product is incubated and broken. When the "protein gel matrix" is disturbed, the interspatial areas between the casein micelles have a tendency to give up the free moisture or whey that has been trapped in that matrix. This result in free whey or a term we refer to as "wheying off."

Whey can be stirred back into the white mass before packaging, and stabilizers can help tie up the free whey so that it has fewer tendencies to be “expressed” once the protein gel or yogurt coagulum is broken in a vat set product.

Solution: If excessive wheying off is an issue you may need to increase the stabilizer level, use a different stabilizer, or add more solids (nonfat dry milk) to the yogurt formula to increase the total solids. Adding more total solids (and more specifically increasing the milk solids not fat) means less available moisture or whey that can be expressed out of the yogurt considering the basic yogurt formulation itself.

Cultured dairy products are complex and require strict attention to detail in order to have the best-quality product your dairy can produce and put in front of the consumer.

Self-Check – 2	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part 1 say true or false (10%)

1. Firmness of set yoghurt is often estimated by lowering probe of a given weight and dimensions into the production for a certain time (4%)
2. Heat treatment of the milk considerable enhances firmness (3%)
3. Stirred yoghurt should be smooth and fairly viscous. (3%)

Note: **Satisfactory rating – 10 points Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Score = ____________
Rating: _____________

LG #38	LO6. Meet workplace requirements for food safety, quality and environmental management

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- keeping records of yoghurt manufacture
- Implementing health and safety and environmental protection procedures
- Disposing waste

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- keeping records of yoghurt manufacture
- Implementing health and safety and environmental protection procedures
- Disposing waste

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to "Operation sheets
7. Perform "the Learning activity performance test" which is placed following "Operation sheets" ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, ask your trainer for further instructions or go back to "Operation sheets".

Information sheet-6. keeping records of yoghurt manufacture

6.1 keeping records of yoghurt manufacture

Keeping Records of yoghurt manufacture is including required measurements for timing of operations, temperature, milk and acidity, quantity.

Quality guarantees of yoghurt

Shelf life / Expiry date: at least 3 weeks at 4 °C

Microbiology:

- Coliforms: < 10 c.f.u. / ml
- Yeastsandmoulds: < 100 c.f.u. / ml
- Titratableacidity: 80 –100 °N
- pH = 4.6 –4.4

Record of set yoghurt

Date: …………………………………………………

Kg milk	Fat%	Protein%	Lactose%	TS%	pH

Heat treatment: Flow / Batch Pasteurisation

Standardization: Yes / No (required fat……………….. %)

ADDITIVES: **NORMAL ADDITION:**

Starter: …… g Type: ……… See instructions

……… g Type: ……….

………… g Type: ……….

Calcium chloride: ………… ml 20 ml / 100 L

Table **5** Record of set yoghurt

	Time	Temperature	Vat content	pH
Start pasteurisation				
End pasteurisation				
Add starter culture				
Start cutting				
Cooking				
Stirring				
Cooling				
Packing				
Storage				

Yoghurt maker: ……………………………………… Total time working the curd: ………………

Information sheet-2 Implementing health and safety and environmental protection procedures

2.1 Implementing health and safety and environmental protection procedures

Introduction

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry specific examples of Good International Industry Practice (GIIP).

The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them. The applicability of the EHS

Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables, such as host country context, assimilative capacity of the environment, and other project factors, are taken into account.

The applicability of specific technical recommendations should be based on the professional opinion of qualified and experienced persons. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these

EHS Guidelines are appropriate, in view of specific project circumstances; a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment.

Applicability

The EHS Guidelines for Dairy Processing facilities applies to the reception, storage, and industrial processing of raw milk and the handling and storage of processed milk and dairy products.

A. Air Emissions

I. Exhaust Gases

Exhaust gas emissions (carbon dioxide [CO_2], nitrogen oxides [NOX] and carbon monoxide [CO]) in the dairy processing sector result from the combustion of gas and fuel oil or diesel in turbines, boilers, compressors and other engines for power and heat generation. Guidance for the management of small combustion source emissions with a capacity of up to 50 megawatt thermal (MWth), including air emission standards for exhaust emissions, is provided in the General EHS Guidelines.

For combustion source emissions with a capacity of greater than 50 MWth refer to the EHS Guidelines for Thermal Power.

II. Dust

Emissions of dust during dairy processing activities include fine milk powder residues in the exhaust air from the spray drying systems and bagging of product. Recommended measures to prevent and control dust emissions mainly consist of the installation of exhaust ventilation equipped with dry powder retention systems (e.g. cyclones or bag filters). Bag filters are generally favored over wet scrubbing methods, as they use significantly less energy, generate less or no wastewater, and produce less noise. The presence of hot air and fine dust creates fire and explosion impacts. All modern spray dryers should be equipped with explosion release mechanisms and fire prevention systems.

III. Odor

The major sources of odor emissions in dairy processing facilities are related to on-site wastewater treatment facilities, in addition to fugitive odor emissions from filling / emptying milk tankers and storage silos. Recommended management techniques to prevent and control odor emissions include the following:

- Ensure wastewater treatment facilities are properly designed and maintained for the anticipated wastewater load;
- Keep all working and storage areas clean;
- Empty and clean the fat trap frequently (e.g. daily emptying and weekly cleaning);
- Minimize stock of waste and by-products and store for short periods in cold, closed, and well-ventilated rooms;
- Enclose production activities that cause odor and operate under vacuum.

B. Energy Consumption

Dairy processing facilities consume considerable amounts of energy. Typically, approximately eighty percent of the energy requirements are for thermal uses to generate hot water and produce steam for process applications (e.g. pasteurization, evaporation, and milk drying) and cleaning purposes. The remaining 20 percent is used as electricity to drive processing machinery, refrigeration, ventilation, and lighting. In addition to recommendations to increase energy efficiency discussed in the General EHS Guidelines, the following industry-specific measures are recommended:

- Reduce heat loss by:
    - Using continuous, instead of batch, pasteurizers
    - Partially homogenizing milk to reduce the size of heat
    - exchangers
    - Using multistaged evaporators
    - Insulating steam, water, and air pipes / tubes
    - Eliminating steam leakage and using thermostatically controlled steam and water blending valves
- Improve cooling efficiency by:
    - Insulating refrigerated room / areas
    - Installing automatic door closing (e.g. with microswitches) and applying airlocks and alarms;
- Employ heat recovery for both heating and cooling operations in milk pasteurizers and heat exchangers (e.g. regenerative countercurrent flow);
- Investigate the means to recover waste heat, including:

- Recovering waste heat from refrigeration plant, exhaust, and compressors (e.g. to preheat hot water)
- Recovering evaporative energy
- Employing heat recovery from air compressors and boilers (e.g. waste gas exchanger)

C. Occupational Health and Safety

Occupational health and safety hazards for dairy processing facilities are similar to those of other industrial facilities and recommendations for the management of these issues can be found in the General EHS Guidelines. In addition, occupational health and safety issues that may be specifically associated with dairy processing operations include the following:

- Physical hazards
- Biological hazards
- Chemical hazards
- Exposure to heat, cold, and radiation

IV. Physical Hazards

Physical hazards include exposure to same-level fall hazards due to slippery conditions, the use of machines and tools, and collisions with internal transport equipment (e.g. forklift trucks and containers). Guidance on general workplace conditions, including design and maintenance of working and walking surfaces to prevent slips and falls, is presented in the General EHS Guidelines. Additional, industry-specific recommendations are presented below.

- Maintain walking and working surfaces clean and dry and provide workers with antislip footwear;
- Provide workers with training in the proper use of equipment (including the proper use of machine safety devices) and personal protective equipment (PPE), such as hearing protection;
- Ensure that the process layout reduces opportunities for process activities to cross paths, thus avoiding collisions and falls;

- Demarcate transport corridors and working areas and ensure the proper placement of handrails on platforms, ladders, and stairs;
- Ground all electrical equipment and installations in wet rooms.

Lifting, Repetitive Work, and Work Posture Injuries

Dairy processing activities may include a variety of situations in which workers can be exposed to lifting, carrying, repetitive work, and work-posture injuries. Such injuries may result from heavy manual lifting and repetitive work, including the operation of slicing and vacuum-packing machines and poor working postures caused by inadequate workstation and process activity design. Recommended management approaches, including the use of mechanical equipment where necessary (e.g. to move pallets of milk carton) to reduce these injuries are discussed in the General EHS Guidelines.

V. Biological Hazards

Exposure to biological and microbiological agents may be associated with inhalation and ingestion of dust and aerosols, particularly in milk powder operations. Dust from the ingredients used in dairy processing and high levels of humidity may cause skin irritation or other allergic reactions.

In addition to the guidance included in the General EHS Guidelines, recommendations for the prevention and control of exposures to biological hazards specific to dairy processing include the following:

- Avoid dust- and aerosol-generating activities (e.g. use of compressed air or high-pressure water for cleaning) and, where they cannot be avoided, provide proper ventilation of enclosed or semi-enclosed areas to reduce or eliminate exposure to dust and aerosols;
- Install exhaust ventilation equipped with filters and / or cyclones, at sources of dust;
- Provide workers with PPE that is appropriate for the process activity;
- Ensure physical segregation of work and welfare facilities to maintain worker personal hygiene;

- Avoid direct contact with non-conforming dairy products.

VI. Chemical Hazards

Exposure to chemicals (including gases and vapors) typically involves chemical-handling activities related to cleaning operations and disinfection of process areas, in addition to the maintenance of heating (thermal oils) and cooling systems (ammonia). Recommended measures to prevent and control exposure to chemicals are discussed in the General EHS Guidelines.

D. Heat and Cold

Workers at dairy processing facilities may be exposed to heat from process activities and to cold in refrigeration areas and rooms. Recommendations for the management of exposure to heat and cold are presented in the General EHS Guidelines.

E. Noise and Vibrations

The main sources of noise in a dairy processing facility are centrifuges, homogenizers, spray towers, and filling and packing machinery which are all typically located in enclosed buildings.

Recommendations for the management of exposure to noise and vibration are presented in the General EHS Guidelines.

Community Health and Safety

Community health and safety impacts during the construction of dairy processing plants are common to those from the construction of other industrial facilities and are discussed in the General EHS Guidelines. During the facility's planning phase, the location of the processing facility should be designated at an appropriate distance from neighbors, and access roads should be assessed for suitable use in food transport. Community health and safety impacts during the operation phase that are common to most industry sectors, including those related to traffic safety during transport of raw materials and finished product, are discussed in the General EHS Guidelines.

Industry-specific issues with the potential to impact the community or the public at large are those associated with pathogens or microbial contaminants, as well as other chemical or physical impacts, associated with processed dairy products.

Food Safety Impacts and Management

A food product recall caused by contaminated or adulterated food products can damage a viable business. If a company can trace its products to specific lot numbers, then recall is a matter of removing all foods associated with those numbers. With a robust food safety program in place, a company can protect itself from product adulteration, contamination, and the impacts of food recalls.

Dairy processing should be undertaken according to internationally recognized food safety standards consistent with the principles and practice of HACCP3 and Codex Alimentarius.4

Recommended food safety principles include the following:

- Respect "clean" and "dirty" zoning, designed in accordance with HACCP prerequisites (e.g. sanitary standard operating procedures), as discussed below;
- Ensure the cooling chain is unbroken for sensitive products requiring refrigeration;
- As far as possible, ensure full traceability of all materials and products throughout the supply chain;
- Ensure adequate veterinary inspection, including examination of vaccination certificates for the animals in the supply chain;
- Comply with veterinary regulations and precautions for management of waste, sludge, and by-products;
- Institutionalize all HACCP prerequisites, including
  - Sanitation
  - Good-management practices
  - Implementation of integrated pest and vector management programs and maximization of pest and vector control through mechanical means (e.g. traps and use mesh on doors and windows to reduce the need for chemical pest and vector control)
  - Chemical control

- Allergen control
- Customer complaints mechanism
- Traceability and recall

Self-Check – 2	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers

Part 1.write the short answer

1. Write the difference between **Food** Safety Impacts and Management (5pts)

2. Write the recommended food safety principles (5pts)

3. What is chemical hazard (5pts?)

Note: **Satisfactory rating – 15 points** **Unsatisfactory - below 15 points**

You can ask you teacher for the copy of the correct answers.

Score = ____________
Rating:

Information sheet3 - Disposing waste and reviewing environmental impact

3.1 Industry-Specific Impacts and Management

The following section provides a summary of EHS issues associated with dairy processing facilities that occur during the operational phase, along with recommendations for their management. Recommendations for the management of EHS issues common to most large industrial facilities during the construction and decommissioning phases are provided in the General EHS Guidelines.

Environment

Environmental issues specifically associated with dairy processing facilities include the following:

- Wastewater
- Solid waste
- Emissions to air
- Energy consumption

Wastewater

Industrial Process Wastewater

Due to the presence of milk solids (e.g. protein, fat, carbohydrates, and lactose), untreated wastewater from dairy processing facilities may have a significant organic content, biochemical oxygen demand (BOD), and chemical oxygen demand (COD). Whey may also contribute to high organic loads in wastewater. Salting activities during cheese production may result in high salinity levels in wastewater. Wastewater may also contain acids, alkali, and detergents with a number of active ingredients, and disinfectants, including chlorine compounds, hydrogen peroxide, and quaternary ammonia compounds.

Wastewater may have a significant microbiological load and may also contain pathogenic viruses and bacteria.

The following recommended techniques can be used to prevent the contamination of the wastewater stream:

- Avoid milk, product, and by-product losses (e.g. from spills, leaks, excessive changeovers, and shut downs) through the adoption of good manufacturing procedures and facility maintenance;
- Separate and collect product waste, including rinse waters and by-products, to facilitate recycling or further processing for subsequent use, sale, or disposal (e.g. whey and casein);
- Install grids to reduce or avoid the introduction of solid materials into the wastewater drainage system;
- Process and foul drains should be separate in process areas and should discharge directly to a treatment plant and / or municipal sewerage system;
- Pipes and tanks should be self–draining, with appropriate procedures for product discharge prior to, or integral with, cleaning procedures;
- Subject to sanitary requirements, recycle process water, including condensate from evaporation processes, for preheating and heat-recovery systems for heating and cooling processes, to minimize water and energy consumption;
- Adopt best-practice methods for facility cleaning, which may involve manual or automated Clean In Place (CIP) systems, using approved chemicals and / or detergents with minimal environmental impact and compatibility with subsequent wastewater treatment processes.

Solid Waste

Solid organic waste in dairy processing facilities mainly originates from production processes and includes nonconforming products and product losses (e.g. milk spillages liquid whey and buttermilk), grid and filter residues, sludge from centrifugal separators and wastewater treatment, and packaging waste (e.g. discarded cuts, spent ripening bags, wax residues from cheese production) arising from incoming raw materials and production line damage.

Recommended measures to reduce and manage solid waste include the following:

- Where possible and subject to sanitary requirements, segregate solid process waste and non-conforming products for reprocessing into commercial products and byproducts (e.g. butter oil, processed cheese, animal feed, soap stock, or other technical-grade materials);

- Optimize product filling and packaging equipment to avoid product- and packaging-material waste;
- Optimize the design of packaging material to reduce the volume of waste (e.g. by using recycled materials and by reducing the thickness without compromising food safety criteria). If PET bottles are blown on site, plastic waste cuttings can be reused, or should be sorted as plastic waste for off-site recycling or disposal;
- Use uncontaminated sludge from on-site wastewater treatment for agricultural fertilizer or production of biogas.
- Remaining waste should be managed and disposed of according to the recommendations for industrial waste in the General EHS Guidelines.

Performance Indicators and Monitoring

Environment

Effluent Guidelines

- Guideline values for process emissions and effluents in this sector are indicative of good international industry practice as reflected in relevant standards of countries with recognized regulatory frameworks.
- Guideline values for process emissions and effluents in this sector are indicative of good international industry practice as reflected in relevant standards of countries with recognized regulatory frameworks.
- These guidelines are achievable under normal operating conditions in appropriately designed and operated facilities through the application of pollution prevention and control techniques discussed in the preceding sections of this document.
- These levels should be achieved, without dilution, at least 95 percent of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours. Deviation from these levels in consideration of specific, local project conditions should be justified in the environmental assessment.

- Effluent guidelines are applicable for direct discharges of treated effluents to surface waters for general use.
- Site-specific discharge levels may be established based on the availability and conditions in use of publicly operated sewage collection and treatment systems or, if discharged directly to surface waters, on the receiving water use classification as described in the General EHS Guidelines.
  - Emissions guidelines are applicable to process emissions Combustion source emissions guidelines associated with steam- and power-generation activities from sources with a capacity equal to or lower than 50 MWth are addressed in the General EHS Guidelines with larger power source emissions addressed in the EHS Guidelines for Thermal Power.
  - Guidance on ambient considerations based on the total load of emissions is provided in the General EHS Guidelines.

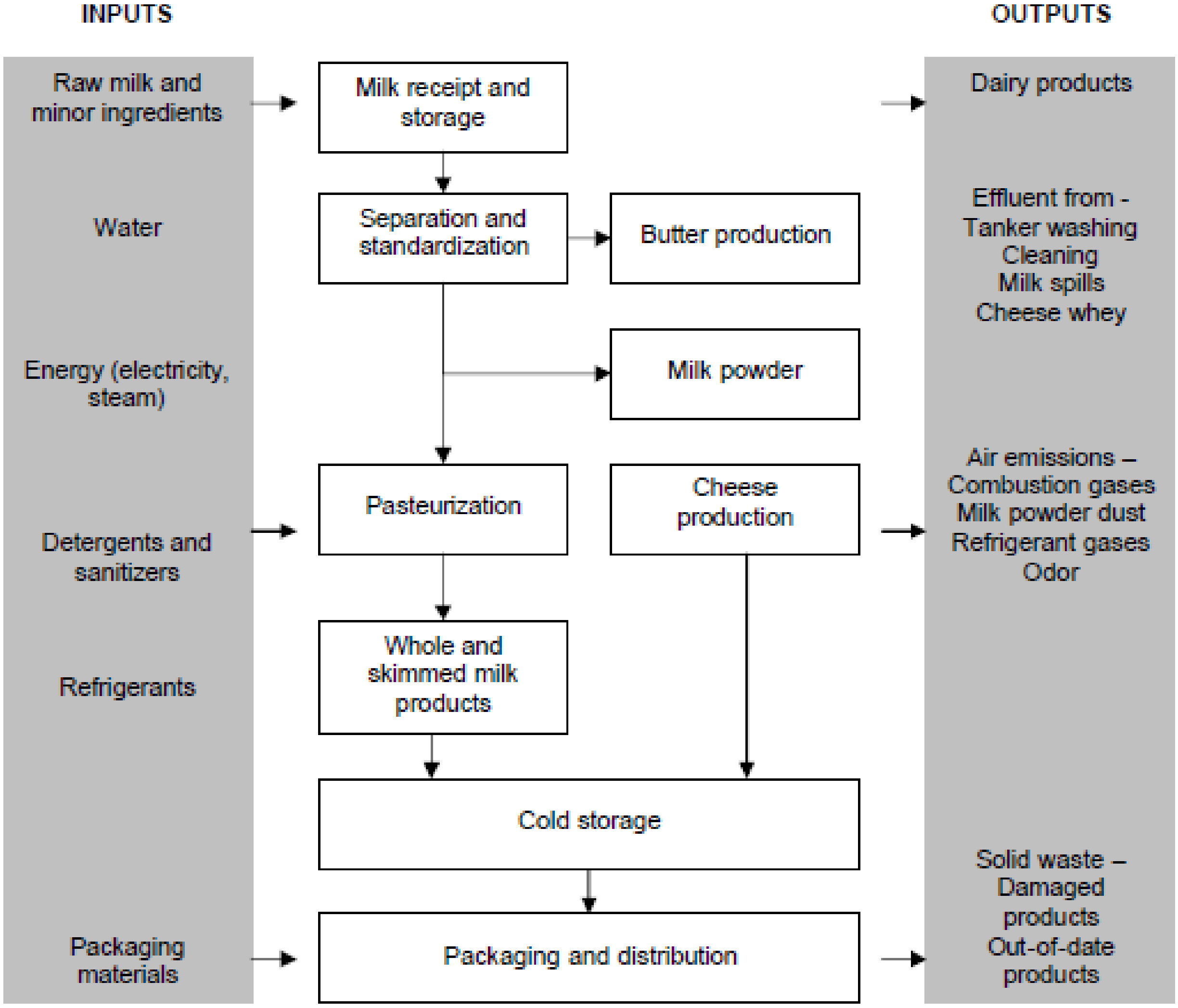

Figure A-15. Dairy Processing Activities

Self- Check _3	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Short Answer Questions

1. What are the environmental issues specifically associated with dairy processing facilities?(4pts)
2. What are the recommended measures to reduce and manage solid waste?(4pts)
3. What are the recommended techniques can be used to prevent the contamination of the wastewater stream?(4pts)

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers

Score = ___________

Rating: ____________

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The trainers who developed this learning guide

S.N	Name	Level	Educational Background	Institution	Region	Telephone	E-mail
1	Abera Shiferaw	B	Animal Production & Health	Holeta PTC	Oromia	0911556155	aberashiferaw2014@gmail.com
2	Geresu Germamo	B	Food Science & Post harvest Technology	Wolayita Sodo PTC	SNNP	0916610590	geresug57@gmail.com
3	Hirpha Ketema	A	Animal Production	Holeta PTC	Oromia	0969432985	hirphaketema2@gmail.com
4	Mulugeta Tesfaye	A	Dairy Science	EMDIDI	Oromia	0911984834	tmulugeta47@yahoo.com
5	Sefi Shiferaw	B	Food Science & Post harvest Technology	Holeta PTC	Oromia	0938872353	sefishifera@gmail.com
6	Tadesu Fikrie	A	Animal Production	Burie PTC	Amhara	0946238747	tadesufikrie2016@gmail.com
7	Tarekegn Cheo	B	Agricultural & Process Engineering	Hawasa PTC	Sidama	0931239119	tarekegecheo155@gmail.com
8	Tesfaye Asrat	B	Animal Science	Motta PTC	Amhara	0923233339	tesfaye99love@gmail.com
9	Wondye Hatew	B	Animal Production	Holeta PTC	Oromia	0925255341	hare2013@gmail.com

Federal TVET Coordinator

S.N	Full Name	Organization	Position	Telephone	E-mail
1	Workneh Asmamaw	Federal TVET Agency	TVET Curriculum TTLM Expert	0955205855	workasmamaw@gmail.Com