Dairy product processing level III

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Module Title: - Carrying out Cheese Making Operations

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Table of content

LG #39	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

Cheese 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. Cheese making involves a series of processes that convert milk into different varieties of cheeses known for their characteristic sensory attributes and nutritional value. The process of cheese making involves removal of water and lactose (and some minerals) from milk to produce a concentrate of milk fat and protein. Cheese is considered as a functional food owing to its health benefits beyond basic nutrition. The essential ingredients for cheese are milk, rennet, starter cultures and salt. Each step of the process has a relevant importance to obtain a good quality and characteristic cheese.

Despite starting from a limited range of raw materials (milk, starter cultures, coagulant and salt), a huge number (perhaps 1500 – 2000 varieties) of cheeses are produced worldwide in a great diversity of flavors, textures, nutritive values and forms. Even a small alteration in the cheese making processes can result in a different variety of cheese altogether. Indeed, it has been said that "there is a cheese for every taste preference and a taste preference for every cheese". Despite the large number of varieties, however, cheeses may be classified into different groups or families. Although there is no completely satisfactory and universally agreed classification criterion for cheese 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 cheese]); 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 cheese 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);
- 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 cheese varieties, and ~75 % of total production, are produced by rennet coagulation but some acid-coagulated varieties, e.g., quark (quarg), cottage and cream cheeses, are of major importance globally. Acid-heat-coagulated cheeses 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 cheeses and they are usually used as food ingredients.

1.2. Keeping clean the storage area for starter cultures

Starter cultures

The bacteria used in cheese starter cultures perform one or more of the following functions in cheese:

- Lactose metabolism, producing lactic acid, which is central to conventional cheese manufacture and also minimizes the growth of spoilage and pathogenic organisms in the cheese;
- Production of a wide range of enzymes and metabolic products that play an active role in generating a flavor profile and enhance organoleptic properties during maturation of the cheese;
- Production of other antimicrobial substances that reduce the risk of survival and proliferation of pathogens; and
- Enhancement of the health-promoting properties of the cheese

These properties have a significant impact on cheese making and flavor development. For instance, the rate and amount of lactic acid produced during cheese making will determine the amount of moisture lost the final pH, and residual lactose in the curd, which in turn will have a strong influence on the maturation rate and the final flavor profile of the cheese.

Lactic acid bacteria are found on plants in nature, but some species occur in particularly large numbers in places where there is milk. Others are found in the intestines of animals. The group includes both bacilli and cocci, which can form chains of varying length but which never form spores.

Lactic acid bacteria are facultatively anaerobic. Most of them are killed by heating to 70 ºC, though the lethal temperature for some is as high as 80 ºC. Lactic acid bacteria prefer lactose as a source of carbon. They ferment lactose to lactic acid. The fermentation may be pure or impure, i.e. the end product may be almost exclusively lactic acid (homofermentative fermentation), or other substances may also be produced, such as acetic acid, carbon dioxide and ethanol (heterofermentative fermentation).

Fermentation capacity varies according to species. Most lactic acid bacteria form between 0.5 and 1.5% lactic acid, but there are species that form up to 3%. Lactic acid bacteria need organic nitrogen compounds for growth. They get them from casein in milk by breaking it down with the help of protein-splitting enzymes. However, the ability to split casein varies greatly from one species to another. Some common species of mesophilic lactic acid bacteria have recently been renamed by substitution of Lactococcus (Lc.) for Streptococcus (Sc.) as the generic name. Thus, Sc. lactis, cremoris and diacetylactis have now become Lc. Lactis, cremoris and diacetylactis respectively.

Fermented dairy products and cheeses have different characteristics, and different starter cultures are therefore used in their manufacture. Starter cultures can be classified according to their preferred growth temperatures:

- Mesophilic bacteria – optimal growth temperatures of 20 to 30 °C
- Thermophilic bacteria – optimal growth temperatures of 40 to 45 °C

The cultures may be of:

- Single-strain type; containing only one strain of bacteria
- Multiple-strain type; a mixture of several strains, each with its own specific effect

Mesophilic bacteria cultures can be further divided into O and LD cultures. Some *Streptococcus diacetylactis* bacteria are such powerful acidifiers that they can be used alone as acidifying cultures, but they are used primarily together with *Str. cremoris/lactis*. However, it is not possible to use a pure *Leuc. citrovorum* culture, because growth of *Leuc. citrovorum* in milk is conditional upon the availability of nutrients produced by *Str. lactis or Str. cremoris. Leuc. citrovorum* grows very slowly in milk in the absence of acid-producing bacteria, and cannot produce aromatic substances in such conditions.

Bacterial characteristics such as optimum growth temperature and salt tolerance are very important in the composition of a culture. The purpose of the component strains is to produce the desired result in symbiosis, not to compete with each other. Their characteristics must therefore be complementary in this respect. Table 10.1 lists essential data for some important culture bacteria.

Dairies normally buy ready-mixed starters – commercial cultures – from special laboratories. These laboratories put a lot of effort into research and development to compose special cultures for a given product, e.g. butter, cheese and a large number of fermented milk products. Thus, the dairies can obtain cultures with selected properties for specific product characteristics such as texture, flavor and viscosity.

The dairies can buy the commercial cultures in various forms:

- **Deep-frozen**, highly concentrated cultures in readily soluble form, for direct inoculation of the product
- **Freeze dried**, highly concentrated cultures in powder form, for direct inoculation of the product
- **Deep-frozen**, concentrated cultures for propagation of bulk starter

- **Freeze dried**, concentrated cultures in powder form, for propagation of bulk starter
- **Liquid**, for propagation of mother culture (nowadays fairly rare)

Starter Handling

There are still cheeses made without the use of starters, the manufacture of the vast majority of cheeses 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 cheese-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 cheese manufacture. These cultures are sequentially propagated in milk at the cheese factory before adding them to the cheese vat.

Alternatively, these cultures are preserved and propagated under controlled laboratory conditions and supplied to the cheese 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 cheese 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 cheese 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 cheese 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 starter culture must be clean, well ventilated and neither too hot nor too cold. A temperature of under 10° 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)

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

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

Score = ___________
Rating: ____________

1.3. Cleaning 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.

Fouling especially occurs during heating of milk which results in the formation of a deposit on metal surfaces that is difficult to remove. Deposit formation reduces the rate of heat transfer and the flow rate of milk in the equipment. Eventually, the equipment will stop operating. In a multiple-effect evaporator with, say, six effects, the costs due to fouling (milk losses and cleaning) can account for more than half of the total running costs (including machinery, energy, etc.). Cleaning of equipment is necessary to reduce all of these problems and to prevent the growth of microorganisms in milk residues, which is highly undesirable. Several microbes can readily grow on surfaces containing a thin film of milk deposit.

Cleaning objectives

Talking about cleaning results, the following terms are used to define the degree of cleanliness:

- Physical cleanliness – removal of all visible dirt from the surface
- Chemical cleanliness – removal not only of all visible dirt but also of microscopic residues that can be detected by taste or smell but are not visible to the naked eye
- Bacteriological cleanliness – attained by disinfection
- Sterile cleanliness – destruction of all microorganisms.

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 is defined as the ‘cleaning of complete items of plant or pipeline circuits without dismantling or opening of the equipment and with little or no manual involvement on the part of the operator.

The process involves the jetting or spraying of surfaces or circulation of cleaning solutions through the plant under conditions of increased turbulence and flow velocity.

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

Fig 1Factors 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 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)
  - ✓ This system of cleaning is engineered to clean processing equipment without dismantling and reassembling the different units and, in addition to minimizing manual operations, the CIP system has proved beneficial in respect of:
    - Improved hygiene, possibly through a combination of the chemical action of the detergent and the physical action of the circulating solution(s);
    - Better plant utilization;
    - Increased savings (of detergent, steam and sterilizing agents);
    - Greater safety.

In order to make use of a CIP system, it is essential to have a closed circuit through which the cleaning solution(s) can be circulated. The design of any CIP system is tailor made for a specific cleaning objective, but the principal methods of CIP cleaning are classified into three basic systems: the single-use system, the re-use system and a combination of the two systems known as the multi-use system.

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-operation inspection
- 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

2. List Kinds of Soils found in a Food Plant?(3pts)

3. What are the Seven Steps of wet sanitation process?

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 Applying stringent personal hygiene procedures

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 behavior 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 separately from pasteurized milk

4.1. Maintaining raw milk area

Raw or unpasteurized Milk

This unprocessed milk transforms into cheese 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 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 not, you can purchase straight from a small farm legally.

To keep things simple, follow these tips for maintaining supplies and keeping equipment in good, working order.

A. For any equipment that will come in contact with milk (a pot, spoon, and so on), place it in a large bowl of cold water as finish using it. Then wash it in very hot, soapy water.
B. The cheesecloth can be reused again and again if drop it in cold water immediately after use, and then rinse the curds off. After you're done cleaning up, either washes it completely by hand with hot water and soap *or* rinses it very well, then hang it to dry, and fully wash it with your kitchen laundry in the next load.
C. If 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 38^0C), 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 15^0C 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 may also be stored in silos for 1 or 2 days at the factory before use, during which further growth of psychrotrophs will occur. It is more important to use properly cleaned milking equipment than to cool the milk rapidly. In other words, rapid cooling of milk will not compensate for improperly cleaned milking machines and storage tanks, either on the farm or at the factory.

Anyone dealing with raw milk on a day-to-day basis knows very well how quickly it becomes sour when it is stored for long periods at high ambient temperatures prevalent in tropical and subtropical countries. This is because the inherent lactic acid bacteria and contaminating microorganisms from storage vessels or the environment break down the lactose in milk into lactic acid. When sufficient lactic acid has accumulated, the milk becomes sour and coagulates, much like when you add sufficient lemon juice or vinegar to fresh milk. Raw milk that contains too much lactic acid, even if it does not appear to be curdled, will coagulate when heated. This acidity is known as "developed acidity" and such milk is not acceptable for sale to consumers or milk processors.

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 wait processing.

Large milk 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.

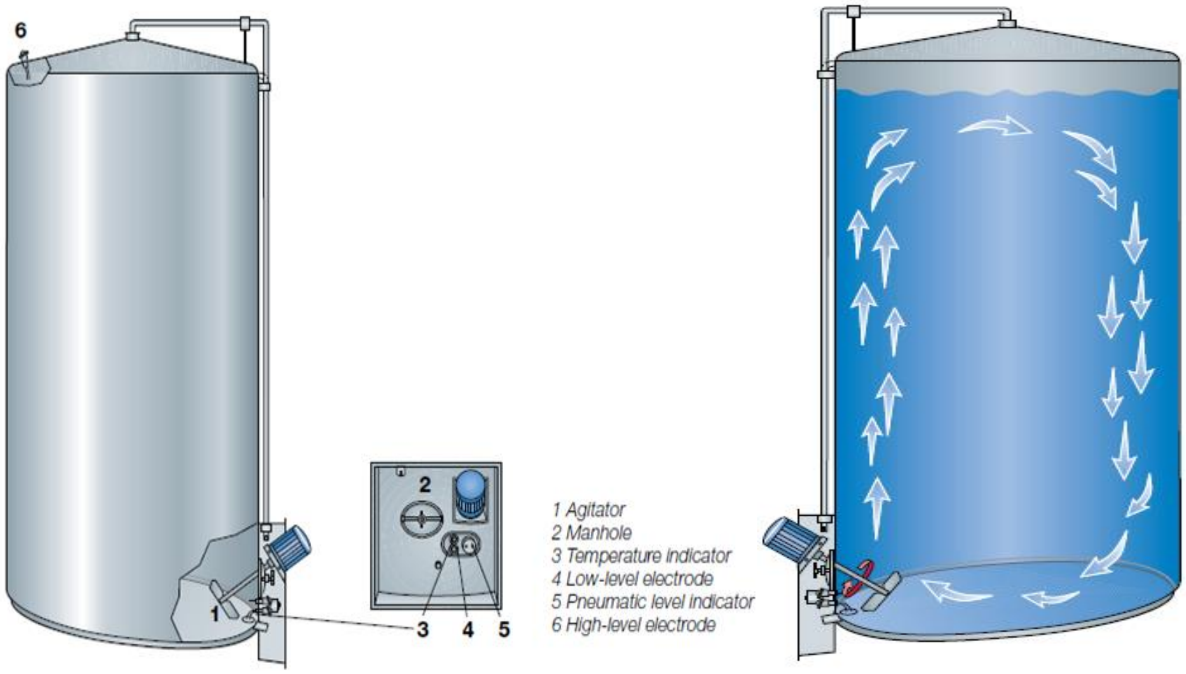


Fig. 2 Silo tank with propeller agitator

Self-check 4	Written test

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

Test I Short Answer Questions

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

What is thermization? (2)

Test I Short Answer Questions

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 - 12 points** **Unsatisfactory - below 12 points**

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

Score = ___________
Rating: ____________

5.1. Applying multi-phase cleaning systems

In the dairy industry, cleaning and disinfection are essential operations. Fouling occurs because milk residues remain on the surfaces of 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. Fouling of membranes by the formation of a gel layer considerably reduces the flux. Heating of milk is results in the formation of a deposit on metal surfaces that is difficult to remove. Deposit formation reduces the rate of heat transfer and the flow rate of milk in the equipment. Eventually, the equipment will stop operating. In a multiple-effect evaporator with, e.g., six effects, the costs due to fouling (milk losses cleaning) can account for more than half of the total running costs (including machinery, energy, and so forth). Cleaning of equipment is necessary to reduce all of these problems and to prevent the growth of microorganisms in milk residues, which is highly undesirable. Several microbes can readily grow at surfaces containing a thin film of milk deposit.

It is important to note that equipment can be bacteriologically clean without necessarily being physically or chemically clean. However, it is easier to achieve bacteriological cleanliness as a matter of routine if the surfaces in question are first rendered at least physically clean.

In dairy cleaning operations, the objective is nearly always to achieve both chemical and bacteriological cleanliness. The equipment surfaces are therefore first thoroughly cleaned with chemical detergents and then disinfected.

There are three primary reasons for using a CIP system.

Firstly, a CIP system is far superior to any other cleaning method due to:

- Its fully automated nature,
- Low variability and

- Good reliability.

Secondly, CIP lowers costs associated with labor and plant downtime as the time required for cleaning is reduced, thus increasing plant capacity. Also the volume of water and solvents for cleaning are significantly reduced.

Thirdly, there are significant safety improvements with CIP because plant personnel no longer have to dismantle equipment, enter dangerous vessels, nor partake in such inherently hazardous activities as manual scraping, vacuuming and high-pressure water blasting. CIP also greatly reduces any possible exposure of personnel to cleaning chemicals.

A number of variables must be carefully controlled to ensure satisfactory results with a given detergent solution. These are:

- Concentration and types of the detergent solution
- Temperature of the detergent solution
- Mechanical effect on the cleaned surfaces (velocity)
- Duration of cleaning (time)

A typical CIP regime consists of five steps with the rinse and circulation times depending on pipe length and the equipment being cleaned. Typical steps in a CIP regime are:

- **Pre-rinse**: The purpose of this step is to remove as much 'loose' soil as possible prior to the formulated alkaline wash. Removal of most of the organic fat, carbohydrate or proteinaceous soil is generally accomplished with ambient or warm temperature water.
- **Alkaline wash** with heated, (70–80°C) re-circulated, formulated solutions. Since relatively long contact times are required for this primary cleaning step, recirculation of cleaning solution is essential for economical operation.
- **Post-rinse with water**, normally at ambient temperature. This step is to rinse away most of the alkaline cleaner. This solution is sometimes recovered for the pre-rinse in the next CIP cleaning program.

- **Acid rinse** at ambient, or heated (55–80°C) temperatures with recirculate acid solutions. The purpose of this step is two-fold. The acid rinse will neutralize and remove residual alkaline cleaner. Alkaline cleaners form films on equipment that are not readily removed by a simple post-rinse with water. The acid rinse will also remove mineral deposits.
- **Post-rinse** with water or re-circulated sanitizing rinse, used to apply a bactericidal agent to all cleaned surfaces. The post-rinse is sometimes heated to permit faster drying of equipment.

The cleaning chemicals play an important role in the CIP regime.

Caustic detergents

The effectiveness of a CIP regime is greatly dependent on the chemical action. Of all steps in a CIP system the most effective component has been reported to be the caustic step, because, as a general 'rule of thumb' most residues are easily removed with a dilute (1% or less), formulated caustic cleaner. Three steps required for effective cleaning:

- Separation of the soil from the substrate.
- Dispersion of the soil in the detergent medium.
- Prevention of soil re-depositing on the substrate.

The most common and aggressive caustic cleaner is sodium hydroxide (NaOH). It is typically used in 1–5% concentrations for plate-type and tubular heat exchangers, and other heavily soiled surfaces

Acid detergents

An acid detergent is used to remove the mineral scale left on the plant surfaces after exposure to the caustic detergent. Acid detergents also: aid in the removal of any traces of alkaline product from equipment surfaces; enhance draining and drying; and provide bacteriostatic conditions that delay the growth of organisms that can be found in the water supply. The acid step requires critical temperature-concentration combinations to be completely effective). The most common acid detergent used in the dairy industry is nitric acid. A major initial concern regarding the use of acid was its corrosive effect on the stainless steel; however, it is now well established that low concentrations of nitric acid are not corrosive to stainless steel type 304 and can be used routinely for prolonged periods. As with caustic chemicals, acid detergents can be formulated to contain compounds such as surfactants which improve their, surface wetting, soil penetration and cleaning properties.

Sanitizers

Sanitizers are used primarily to kill vegetative cells that remain on the surface after 'cleaning'. In some cases sanitizers have been found to be ineffective at reducing the biofilm. This could be due to either increased resistance of the bacteria within the biofilm, the chemical nature of the sanitizer or the presence of milk residues. It is not possible to clean frequently enough to totally prevent biofilm formation within a DMP as cell attachment can occur very rapidly. In addition, once biofilms have formed, some cells may persist after a standard CIP regime.

Biofilms are glycocalyx-containing materials secreted by individual microorganisms in which are encased communities of these microorganisms**.** Biofilms allow these microorganisms to adhere to a solid surface and be enveloped within a protective extracellular glycocalyx-containing matrix.

Cleaning procedure of HTST pasteurizer line cleaning:

- Rinse with warm water about 10 min
- Circulate alkaline solution caustic soda with 3kg at 72-75^{o}C for 20min
- Calculate out caustic soda with warm water pill removing any flake in the and measure PH =7
- Circulate nitric acid solution of 2 lit at 55/20min
- Rest rinse with cold water of remove any acid than measure PH =7
- Gradually cooling with cold water for about 8min

Self-check 5	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 essential operations in a cleaning process for dairy machinery?(8pts)
2. What is the common aim of disinfection?(4pts)

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

Bacteria in milk

The major group of bacteria in milk is the group of lactic acid bacteria. These are able to use the lactose in the milk and to convert it into lactic acid. The most important family in this group is the Streptococcus lactis. These multiply and grow very fast when the milk is kept at ambient temperatures after milking. The produced lactic acid causes the natural souring of milk.

The primary source of these bacteria is the environment: air, dust, dirty equipment and operators, etc. How soon the milk turns sour depends on the degree of contamination and on the temperature of the milk. Therefore, proper cleaning and sanitizing procedures are essential to control the quality of milk. Cooling to a temperature of 4 ºC makes the bacteria inactive and prevents them to grow and produce the lactic acid.

Once again the milk should be produced as clean as possible in the first place, but after that it should be cooled soonest. There are also types of micro-organisms which make use of other milk components, like the proteins and the milk fat. All this microbial activity deteriorates the milk quality. Therefore only fresh milk of tested quality should be used as raw material to enable processing into high quality milk products. For this reason the dairy industry strictly controls the quality of the incoming milk from the dairy farmers. If the milk quality does not fulfill the set minimum quality standards, it is rejected. This means an economical loss to the farmer. Most countries have implemented special laws and regulations concerning the composition and hygienic quality of milk and milk products to protect both the consumers and the public health.

When high counts become a problem it is generally due to one or more of the following reasons:

- Improper cleaning of milking equipment (the most common cause of high bacteria counts in milk);
- Improper cooling of milk;

- Occasionally, a herd experiencing a high prevalence of bacterial infection.

Heating is another method to prevent the Streptococcus lactis to produce too much lactic acid and make the milk sour. In the dairy plant this is usually done in the form of pasteurization. During this process the milk is heated to 72 ºC for a period of 15 seconds. After pasteurization we are sure that all pathogenic bacteria, in particular the one causing tuberculosis, and at the same time most lactic acid bacteria are destroyed.

When the milk is cooled after pasteurization it can be kept for approximately 5 days by the consumer without spoilage. However, certain organisms are capable of surviving pasteurization and continue to multiply during refrigeration. These bacteria are an important source of concern because they reduce the product shelf-life. To eliminate these bacteria milk can be boiled at 100 ºC or sterilized at temperatures of 120 – 140 ºC. Sterilized milk will keep its quality for a long time without cooling. However, at these high temperatures the taste of the milk is affected.

Somatic cells in milk

Somatic cell counts represent another important milk quality parameter. The word somatic means body and thus a somatic cell is a body cell. Most important in milk are the leukocytes (white blood cells). Milk Originating from an infected udder contains a high concentration of leukocytes. Consequently, somatic cell counts are an important indicator of udder health, in particular of mastitis, Fresh milk from healthy cows has a somatic cell count of less than 200,000 cells per ml of milk. Cell counts from herd bulk milk, which are consistently in excess of 500,000 per ml, are an indication of a high prevalence of mastitis in the herd.

Milk with a high somatic cell concentration can be harmful to human health and contains less casein. This results in lower cheese yields. In addition milk with a high cell count generally contains an increased amount of enzymes, which have effect on the quality of the protein and the fat in milk. The presence of these enzymes in milk increases the potential for off flavors and odors. Because the somatic cell content of raw milk is important for the shelf-life, flavor and the yields (particularly of cheese), milk processors strive to obtain raw milk of the highest hygienic quality from their producers.

Hygienic quality of milk

Milk when it emerges from a healthy udder contains only a very few bacteria. However, milk is a perishable product. It is an ideal medium for micro-organisms and as it is a liquid, it is very easily contaminated and invaded by bacteria. Almost all bacteria in milk originate from the air, dirt, dung, hairs and other extraneous substances. In other words, milk is mainly contaminated with bacteria during milking. It is possible to milk animals in such a clean way that the raw milk contains only 500 to 1,000 bacteria per ml. usually the total bacteria count after milking is up to 50,000 per ml. However, counts may reach several millions bacteria per ml. That indicates a very poor hygienic standard during milking and the handling of the milk or milk of a diseased animal with i.e., Mastitis.

If milk is cooled within this period to 4 ˚C, it maintains nearly its original quality. Timely cooling ensures that the quality of the milk remains good for processing and consumption. The bacterial load in fresh raw milk should be less than 50,000 per ml when it reaches the collection point or processing plant. To prevent a too high multiplication of bacteria, the milk has to be produced as hygienic as possible and should be cooled or heated at the earliest. Hygienic milk only originates from mastitis free and healthy animals. Cows suffering from a disease may secrete the pathogenic bacteria, which cause their disease, in the milk they produce. Consumption of raw milk therefore might be dangerous to the consumer. Some of these diseases, like tuberculosis, brucellosis and anthrax, can be transmitted to the consumer. Whatever the milk is used for during processing, the hygienic standard of the produced milk at farm level forms the basis of the quality of the ultimate milk products.

Clean milk production results in milk that:

- Is safe for human consumption and free from disease producing microorganisms;
- Has a high keeping quality; has a high commercial value;
- Can be transported over long distances

The safe handling of raw milk is based universally on the following two principles:

- Avoid or minimize contamination at the various stages of handling raw milk;
- Reduce the growth and activity of the micro-organisms in raw milk.

The bacteriological quality

Table 1 Bacteriological standard for cheese at 14 days

Coliforms	≤ 5 x 103 c.f.u./gram cheese
Escherichia coli	≤1 x 102 c.f.u./gram cheese
Lactobacilli	≤2 x 106 c.f.u./gram cheese (≤3 x 107 c.f.u./gram cheese after 6-8 weeks)
Coagulase positive Staphylococcus	≤1 x 102 c.f.u./gram cheese
Somatic cell	≤ 500,000 cells per ml of milk
Listeria monocytogenes	Absent in 25 gram cheese

Self-check 6	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 two universally principles of safe handling of raw milk?(4pts)
3. Define personal hygiene?(4pts)

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

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

Score = ___________

Rating: ____________

LG #40	LO #2- Implement procedures to prepare milk for cheese 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".

2.1. 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.

Raw milk as produced on the farm and transported to the collection center or a dairy plant generally contains varying amounts of visible, invisible impurities. This foreign matter includes straw and hair pieces, dust particles, leukocytes (somatic cells or white blood cells), insects, etc. If not effectively removed, such extraneous insoluble matter can result in deposits in milk handling equipment such as cooler, etc., and, more importantly, cause unsightly appearance.

Relatively large pieces of such material e.g. straw, hair and insects, are usually removed by „straining‟ (passing the milk through a fine metal–gauge strainer or metallic sieve on the farm, at the collection center or at the processing plant. Tubular sieves located in the milk inlet pipe to the processing unit (e.g. Pasteurizer) are also used.

However, finer foreign matter to be eliminated requires clarification using a special filter or a centrifuged clarifier. These steps of aesthetic improvement of product are particularly useful for overcoming the problem of sediments in fluid milk and liquid milk products in general and homogenized milk in particular.

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. Milk usually passes from top to bottom. In case of twin filters, three way valves in the inlet and outlet lines enable switching from one filter to the other when the first is to be cleaned. Sometimes, filters may be provided in the form of cylindrical bags or „stockings" fitted over perforated SS tubes as in the modern continuous pasteurizing plants.

Filtration can be carried out either on cold milk (about 10^{o}C) or warm milk (40-45^{o}C). Since warm milk filtration is more rapid due to lower viscosity of warm milk, it is universally used. For cold filtration, the filter is located in the line connecting the milk receiving tank or holding tank and the pasteurizer. Since warm filtration requires preheating, the filter of this type is placed between the regenerator and the final heating section of the HTST pasteurizer.

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. Generally, twin filters located in parallel are employed to permit cleaning of one filter while the other is in use. This enables continuous process run. We should be able to realize that filtration removes only the gross impurities, and does not remove bacteria from milk. Accordingly, it does not improve the keeping quality of the milk. In fact, bacteria may grow in the filters if they are used for unusually long times before cleaning.

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. In a traditional separator, sludge is collected in a holding space, and it is removed after stopping the operation. In the current machines, the deposit can be removed through small valves in the outer wall of the bowl; the valves can be opened and flushed with water at intervals without interrupting the separation process.

Some centrifuges, sometimes called clarifiers, are specifically built for the removal of solid particles. The liquid enters the bowl at the periphery to move between the disks to the center; from where it is discharged (there are thus no inlet holes in the disks). This improves separation efficiency by giving the particles a longer time to sediment. Often, the dirt is continuously removed from the bowl through a number of small holes. Clarifiers are rarely used in the dairy except for one specific purpose, which is described in the following text.

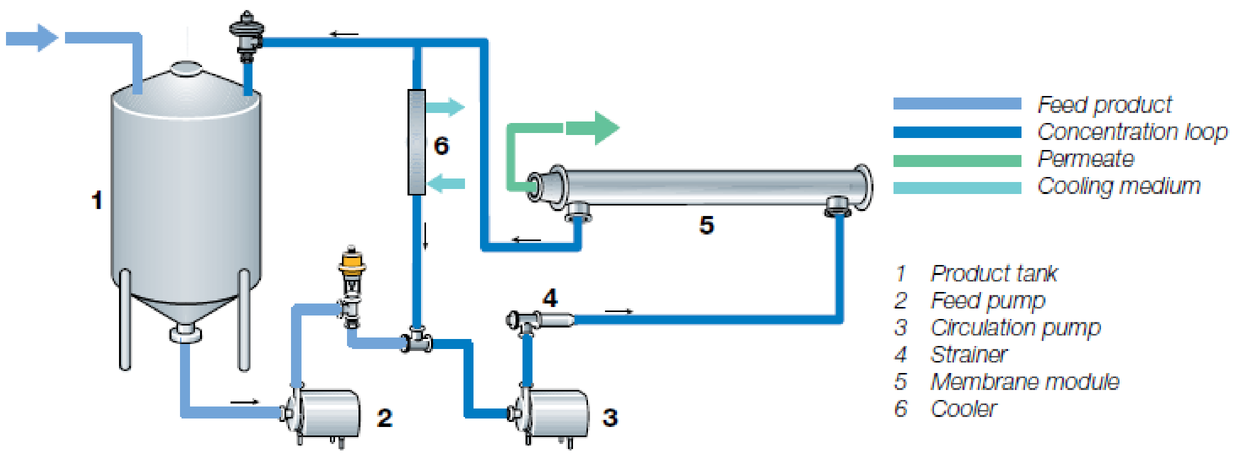


Fig. 3 Batch membrane filtration plant

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

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.

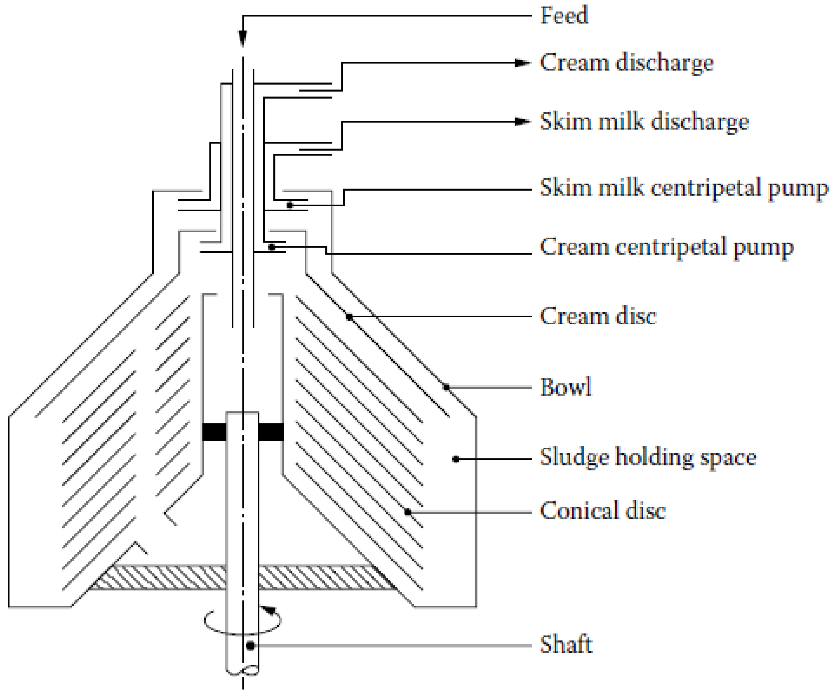


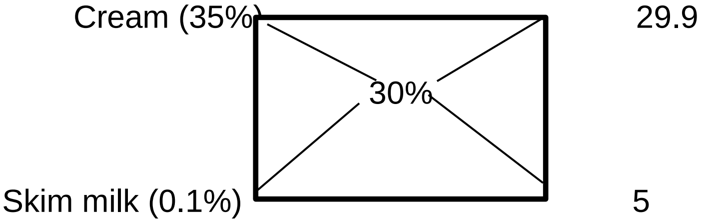
Fig 4 Semi-open centrifugal cream separator

Fig 5 centrifugal cream separator

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.

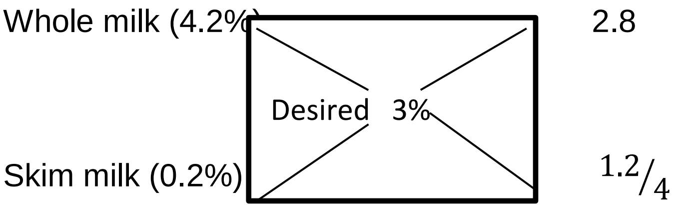
Example1: How much skim milk containing 0.1% fat is needed to reduce the percentage fat in? $400 \text{ kg of cream from } 35\% \text{ to } 30\%$?



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

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

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.



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.

Using formula for desired quantity skim milk or cream required to standardize milk

$$\text{Y} = \frac{\text{F} - \text{F}_1}{\text{F}_1 - \text{q}} * \text{X}$$

F=fat percentage of raw milk (%);
F_1= fat percentage of standardized milk (%);
q=fat percentage of skimmed milk or cream (%);

X= available raw milk
Y= the desired quantity need of skim milk or cream

Based on Example 2
F=4.2%, F1=3%, q=0.2%, X=300

Then $Y = \frac{4.2-3}{3-0.2} * 300 = \frac{1.2}{2.8} * 300 = 128.6 \text{ kg ofskim milk}$

Example 3: There is 3500 kilograms of raw milk with a fat percentage of 3.5%, which should be adjusted with skimmed milk with a fat percentage of 0.2% because of its too high fat percentage. Then how much skimmed milk should be added to the raw milk, to make the standardized milk mixture have a fat percentage of 3.2%?

$$Y = \frac{F - F_1}{F_1 - q} * X$$

$$Y = \frac{3.5 - 3.2}{3.2 - 0.2} * 3500$$

$$Y = \frac{0.1}{1} * 3500$$
$$Y = 350 \text{ kg of skimmilk}$$

Example 4: There is 3200 kilograms of raw milk with a fat percentage of 2.9%. How much cream with a fat percentage of 35% should be added to the raw milk to make its fat percentage rise to 3.2%?

$$Y = \frac{F - F_1}{F_1 - q} * X$$

$$Y = \frac{2.9 - 3.2}{3.2 - 35} * 3200 = \frac{-0.3}{-31.8} * 3200 = 0.009 * 3200 = 30.2 \text{ kg of cream}$$

Calculation of cream yield

$$\text{kg of cream} = \frac{\text{kg milk} * (\% \text{ fat in milk} - \% \text{ fat in skimmilk}}{\%\text{fat in cream} - \% \text{ fat in skimmilk}}$$

Example 5: How many kg of cream can be produced from 1000 kg of milk containing 4% fat is separated to be made into cream. Assume that fat composition of the cream and skim milk will be 40% and 0.1% respectively.

$$\text{kg of cream} = \frac{1000\text{kg milk} * (4\% \text{ fat in milk} - 0.1\% \text{ fat in skimmilk})}{40\%\text{fat in cream} - 0.1\% \text{ fat in skimmilk}}$$

$$\text{kg of cream} = \frac{1000 * (4\% \ - 0.1\%)}{40\% - 0.1\%} = \frac{1000 * 3.9\%}{39.9\%} = \frac{3900}{39.9} = 97.74 \text{ kg}$$

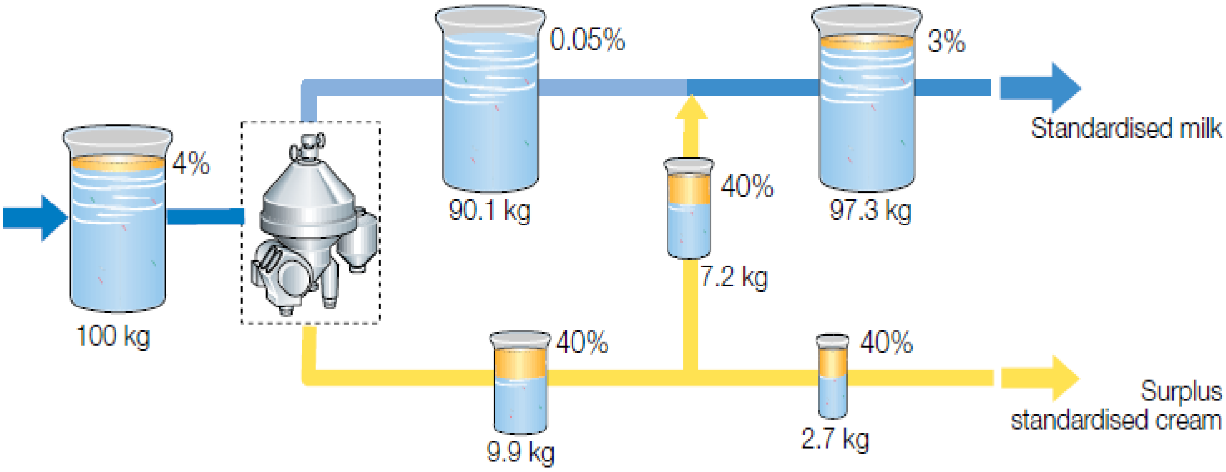


Fig. 6 Principle of fat standardization

Milk for cheese is subjected to a number of pretreatments, with various objectives. Different cheese varieties have a certain fat in- dry-matter content, in effect, a certain fat-protein ratio, and this content has legal status in the "Standards of Identity" for many cheese varieties. While the moisture content of cheese, and hence the level of fat plus protein, is determined mainly by the manufacturing protocol, the fat-protein ratio is determined mainly by the fat casein ratio in the cheese milk. Depending on the ratio required, it can be modified by:

- Removing some fat by natural creaming, as in the manufacture of Parmigiano-Reggiano, or centrifugation
- Adding skim milk
- Adding cream
- Adding milk powder, evaporated milk, or ultrafiltration retentate (such additions also increase the total solids content of the milk and hence cheese yield

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)

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

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

Score = ___________
Rating: ____________

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.

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.

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 cheese 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 2.The main categories of heat treatment in the dairy industry

Process	Temperature	Time
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

The categories of heat treatment in the dairy industry:

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.

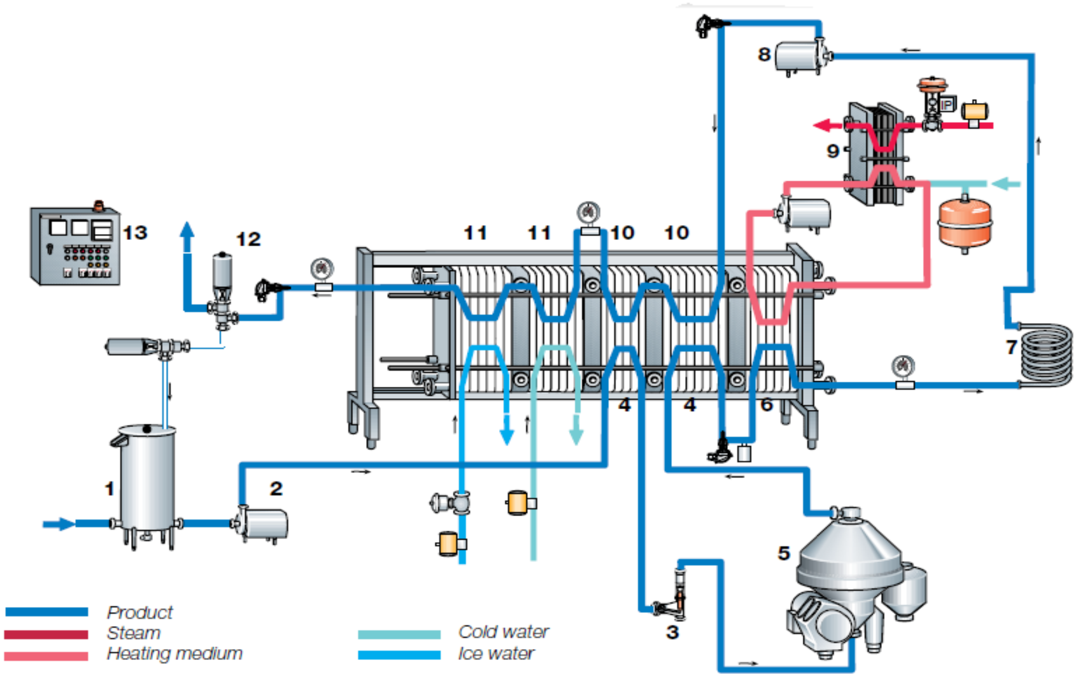


Fig 7 The complete pasteuriser plant consists of:1 Balance tank, 2 Feed pumps, 3 Flow controllers, 4 Regenerative preheating sections, 5 Centrifugal clarifiers, 6 Heating section, 7 Holding tube, 8 Booster pump, 9 Hot water heating system, 10 Regenerative cooling sections, 11 Cooling sections, 12 Flow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

Self-check 3	Written test

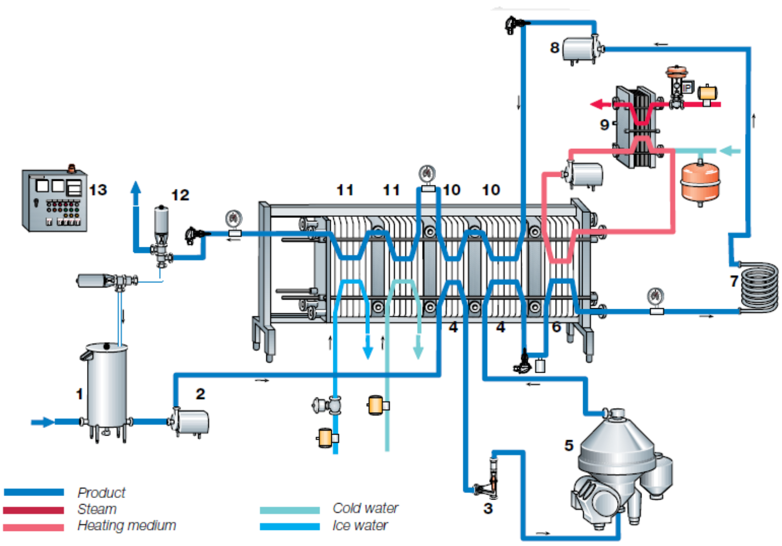
Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

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: _____________

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.
- The milk will not be suitable for production of semi-hard or hard cheeses because the coagulum will be too soft and difficult to dewater.

Homogenizers of the common type consist of a high-pressure pump that forces the liquid through a narrow opening, the so-called homogenizer valve.

During homogenization, the liquid upstream of the valve has a high potential energy. On entering the valve, this energy is converted to kinetic energy. The high liquid velocity in the very narrow opening in the valve leads to very intense turbulence; the kinetic energy of the liquid is now dissipated, that is, converted to heat (thermal energy). Only a very small part of the kinetic energy, generally less than 0.1%, is used for globule disruption, that is, for conversion into interfacial energy.

The passage time of the liquid through the valve is very short, generally less than 1 minute. The pressure is adjusted by letting the control spring press down the valve with an appropriate force. In large machines hydraulic pressure rather than mechanical pressure is generally applied.

Most homogenizer valves are more complicated. Usually, they are more or less conically shaped. More sophisticated surface reliefs occur as well. To prevent uneven wear, the valve in some homogenizers is rotated relative to the valve seat.

During homogenization, several processes occur simultaneously. Droplets are deformed (line 1) and possibly disrupted (line 1). Consequently, the total surface area is increased and additional surfactant (i.e., protein in milk) has to adsorb onto the drops (line 2). Newly formed drops will frequently collide with each other, which may result in re-coalescence if the protein surface load is still small (line 3). If sufficient protein has already adsorbed, the collision may have no effect (line 4). Disruption and collision occur several, e.g., 50, times during passage of the valve. Disruption occurs in steps because a deformed drop will rarely break up into more than a few smaller ones. The surface load will thus several times decrease and increase again.

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. 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.

VI. 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. 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

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

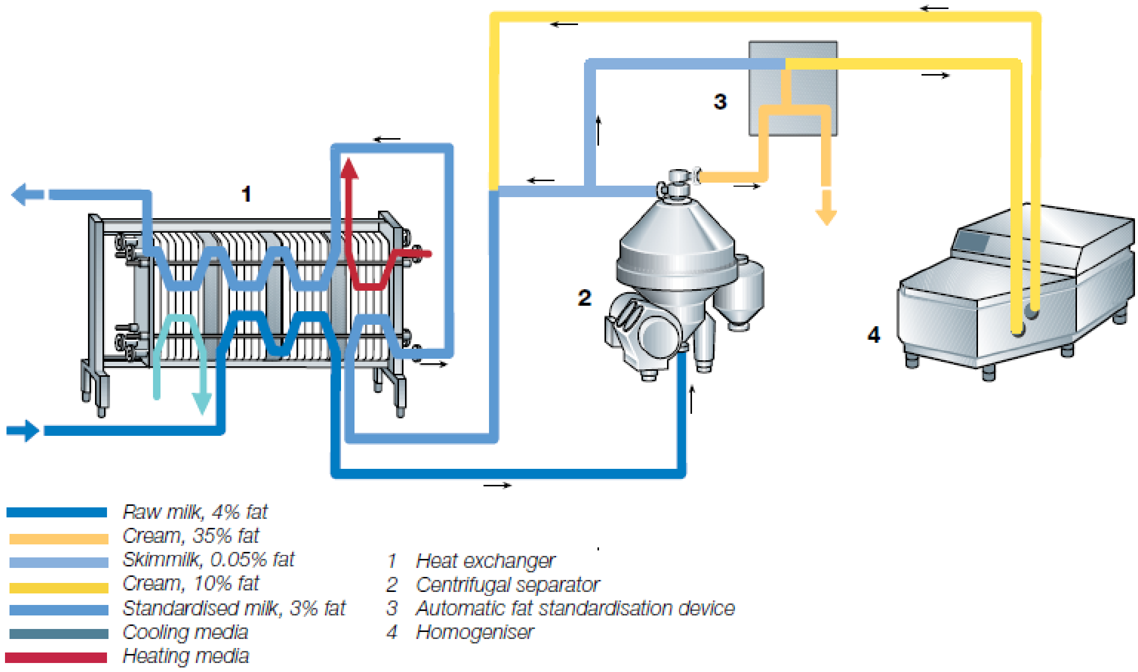


Fig. 8 Product flow at partial stream homogenization

Self-check 4	Written test

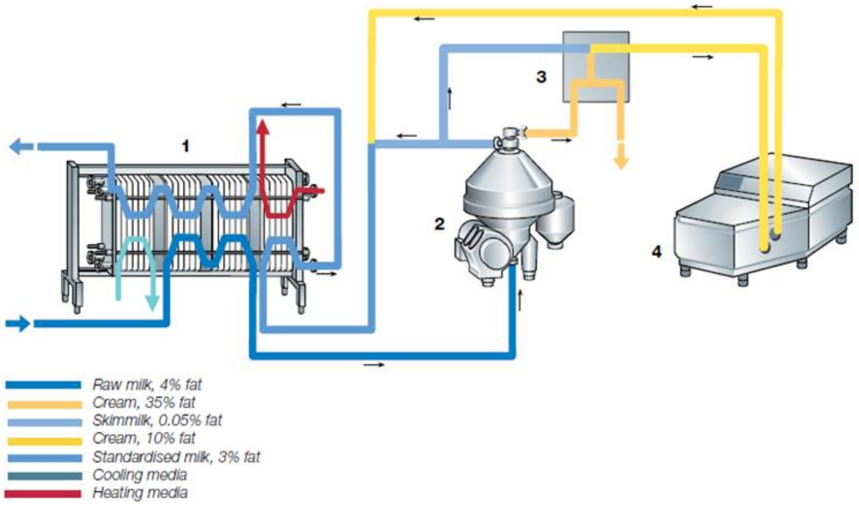
Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

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 #41	LO #3- Carry out procedures to inoculate milk, fermentation, produce and cut curd, separate the whey, wash the curd, and drain

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 temperature
- Measuring rennet and diluting before adding to milk
- Carrying out curd cutting
- Taking curd samples and carrying out tests for acidity and temperature
- Assessing whey fat levels
- Carrying out curd separation and washing activities
- Continuing acidification of curd
- Transferring the cut curd to molds and holding at a constant temperature
- Following the cooking schedule and stirring curd
- Carrying out draining and optional washing 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:

- Add inoculants and adjuncts
- Maintain temperature
- Measure rennet and diluting before adding to milk
- Carry out curd cutting
- Take curd samples and carrying out tests for acidity and temperature
- Assess whey fat levels
- Carry out curd separation and washing activities
- Continue acidification of curd
- Transfer the cut curd to molds and holding at a constant temperature
- Follow the cooking schedule and stirring curd
- Carry out draining and optional washing 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 Adding inoculants and adjuncts

1.1. Introduction

Importance of milk process

There are many reasons to process milk into dairy products, such as the following:

- Many dairy products can be kept longer than fresh milk; therefore the milk does not have to be consumed immediately.
- The demand for fresh milk may be limited, and there may be more interest in dairy products.
- If the daily amount of fresh milk for sale is limited, it may be more economical to process the milk into less perishable products, store them, and sell them later in greater quantities.
- There may be no market for fresh milk close by, and only preserved products can be sold at markets at a greater distance.
- Greater financial gain may be obtained.
- Lactose intolerance. Dairy products in which a proportion of the milk sugar is converted during production, such as cheese, curd, yoghurt and sour milk or buttermilk, do not cause many problems in this respect.

When fresh milk is left to become sour, the casein aggregates. If souring occurs at not too low a temperature and without any stirring or shaking of the milk, a gel is formed. Some whey separation generally occurs when the gelled or clotted milk is kept for some time. This can be enhanced by heating and stirring; the mass then separates into curd grains and whey.

This may have been the origin of cheese making. However, for centuries, milk has also been clotted by the addition of specific agents, especially rennet, an extract of calf stomach. It was possibly discovered when the stomach of a slaughtered animal was used to store milk. Various vegetable clotting agents were also used, for instance, from cardoon flowers, or fig tree latex. Altogether, the art of transforming milk into curd and whey is very old. It has always been accompanied by acidification, caused by the omnipresent lactic acid bacteria.

To make a real cheese, other process steps are needed: shaping (often by pressing), salting, and curing. These steps could readily evolve, and further evolution has led to a great variety of cheese types. However, all cheeses have a few things in common:

- The greater part of the casein and the fat of the milk are concentrated in the cheese, which is thus a very nutritious product.
- Cheese keeps much longer than milk, and also longer than fermented milks. During keeping there are changes in its properties: this is called ripening or maturation.
- Cheese generally has a distinct and characteristic flavor due to a great number of flavor compounds formed during ripening. The process of ripening, in particular, shows great variation.

When milk is made into cheese, casein and fat are concentrated, whereas the other milk components, especially water, are mainly removed along with the whey. None of the milk components is fully retained and new substances may be added, notably salt.

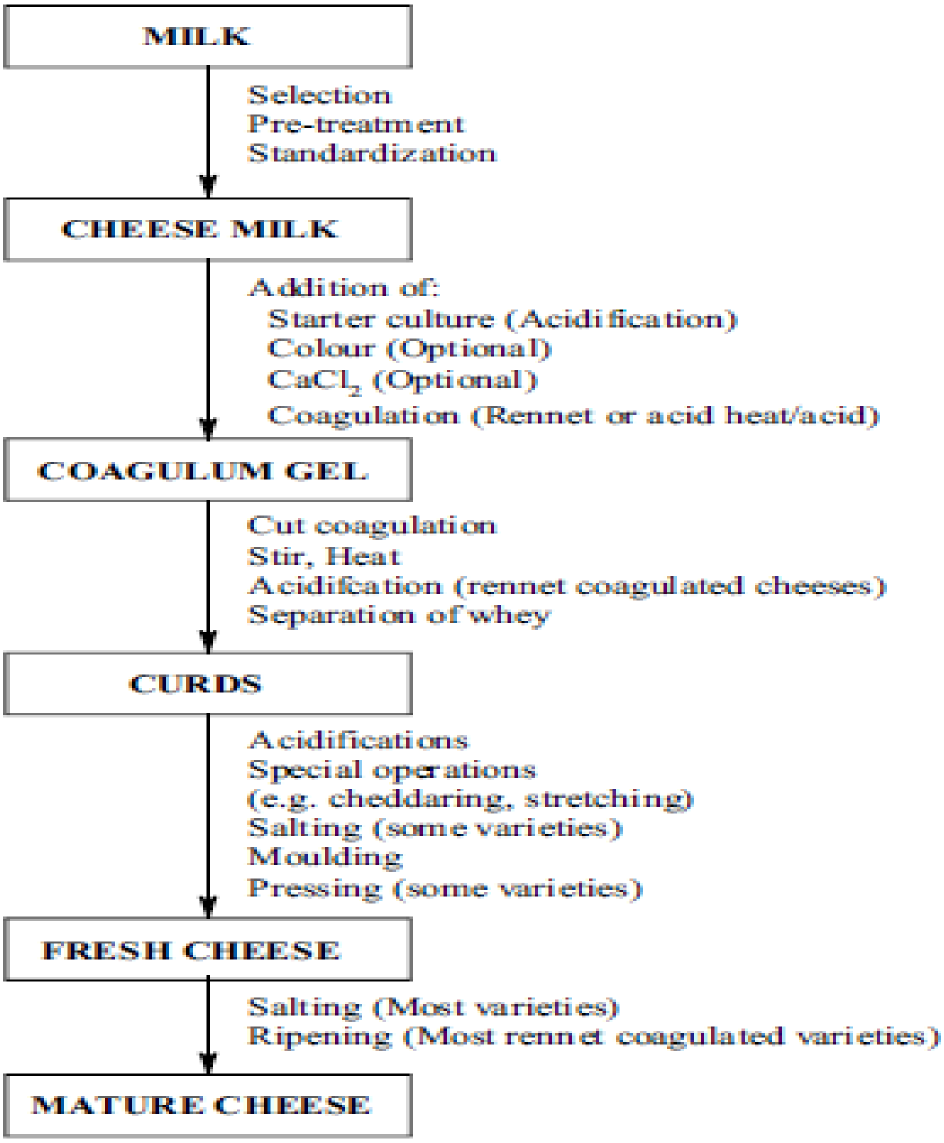


Fig 8 General Protocol for cheese manufacture

1.2. Adding inoculants and adjuncts

All modern cheeses need laboratory-produced starter cultures, the selected bacteria for cheese making, to ripen the milk. Even the small occasional producer will have to purchase this, but with careful management it need not be expensive. There are two main types of starter culture available from suppliers; simple cheese culture and DVI (direct to vat inoculation). DVI needs no pre-preparation and, as the name suggests, goes straight from the sachet to the vat of warm milk. The drawback with DVI for the small producer is that the smallest sachet available contains sufficient for 50 liters (88 pints) of milk and it is not advisable to portion the dry powder as this can affect the balance of types of bacteria in the culture. So the small producer will have to use simple cheese culture and pre-prepare it.

The role of starters in the dairy industry is as follows:

- The production of lactic acid as a result of lactose fermentation, the lactic acid imparts a distinctive and fresh, acidic flavor during manufacture of fermented milks and in cheese making, lactic acid is important during the coagulation and texturization of the curd.
- The production of volatile compounds (e.g. diacetyl and acetaldehyde) which contribute towards the flavor of the dairy products.
- The starter cultures may possess a proteolytic and lipolytic activity, which may be desirable, especially during the maturation of some types of cheeses.
- The acidic condition of the products due to the activity of the starters prevents the growth of pathogens as well as spoilage organisms.

Primary starter cultures are mesophilic lactic acid cultures and thermophilic lactic acid cultures. The mesophilic lactic acid starter cultures (optimum temperature 20 – 30 °C) are homofermentative producing lactic acid only and are widely used in the cheese industry. Mesophilic starters include but are not limited to *Lactococcus lactis* subsp. *lactis* and *Lactococcus lactis* subsp. *cremoris*. Thermophilic lactic acid starter cultures (optimum temperature 37 - 45 °C) are heterofermentative producing lactic acid; carbon dioxide; aroma compounds (e.g. ethanol and acetic acid) from glucose rapidly at high temperatures and are used in the manufacture of yoghurt, acidophilus milk and high scalded cheese (e.g. Swiss varieties). Thermophilic starters include *Streptococcus thermophilus*, *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Lactobacillus helveticus*. The combined activity of mesophilic and thermophilic lactic acid cultures and yeasts yields a lactic acid/ alcohol fermentation in milk. Ethyl 5 alcohol is mainly produced, and the level can reach as high as 1.5 %; the flavor components are due to acetaldehyde, diacetyl and lactic acid.

Starter

Direct-set powdered cheese starter cultures have a frozen lifetime of a year or more, but once used to make cheese, that starter culture is finished, and a new packet of powdered starter culture is needed for the next batch of cheese. However, by making and preserving mother culture, for effectively inoculate many gallons of cheese/yoghurt without using a new packet of starter. Both mesophilic and thermophilic mother cultures can be made using the steps below. Follow the general rules that apply to any cheese/yogurt making process

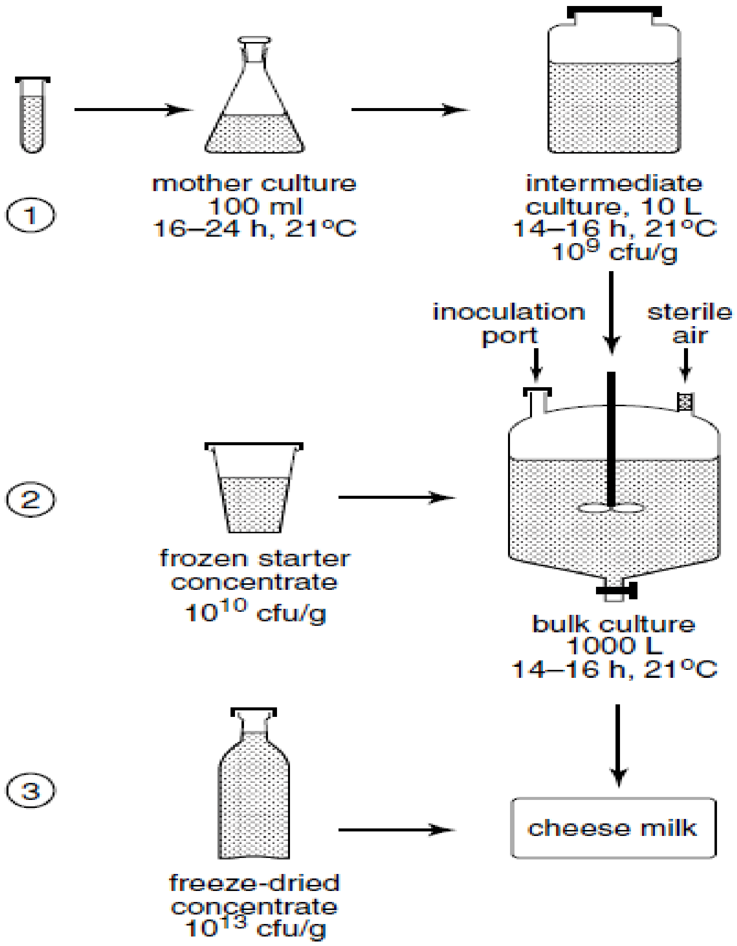


FIG. 7 Schematic presentation of starter manufacture in a dairy for cheese production

Freezing the mother culture

Clean and sanitize two or more plastic ice trays. Fill all the cubes with freshly made mother culture. Freeze in the coldest part of the freezer until solid. After they are solid, remove the cubes from the trays (avoid touching cubes with your hands or anything else that is not scrupulously clean) and put them into airtight freezer bags. Label the bags with the name of the starter and the date it was made. These cubes will keep in the freezer for up to one month, after which they may still be viable, but their strength will begin to degrade.

Adjuncts

Calcium chloride ($CaCl_2$):

It is added at the rate of 10 - 20 grams per 100 liters of milk (or 0.02% maximum) to restore the calcium level changed during handling and heating processes. Correct calcium level is required for proper coagulation using rennet.

Sodium or Potassium nitrate/nitrite

It is added at the rate of 10 - 20 grams, per 100 liters milk (or 0.02% maximum) to prevent growth of gas producing spoilage microbes e.g. coliforms (which cause blowing of young cheese) and spore forming bacteria (which cause blowing of aged cheese and bitter taste

Calcium plays a major role in the coagulation of milk by rennet and the subsequent processing gan to grow and produce acid, a process referred to as *ripening.* Ripening served a number of functions:

- It allowed the starter bacteria to enter their exponential growth phase and hence to be highly active during cheese making; this is not necessary with modern high-quality starters.
- The lower pH was more favorable for rennet action and gel formation.

Sodium or Potassium nitrate/nitrite

It is added at the rate of 10 - 20 grams, per 100 liters milk (or 0.02% maximum) to prevent growth of gas producing spoilage microbes e.g. coliforms (which cause blowing of young cheese) and spore forming bacteria (which cause blowing of aged cheese and bitter taste.

Fat or oil

Hard cheeses that are not brined or surface salted are rubbed with fat or oil after pressing. This keeps the surface supple and prevents cracking. Use butter, solid vegetable fat or olive oil. Coat the cheese all over and be prepared to re-grease it as cracks appear, especially if the cheese has needed a lot of cleaning.

Color additives

Carotene or Annatto are the main color additives added in cheese milk at the rate of 0.06% maximum to impart the desirable yellowish color of cheese hence even out color variations especially during the dry season when the green fodder (a source of yellow pigments) is not available.

Flavorings

If you are adding herbs, fruit, wine etc. to cheese, ensure that these are mold free. Herbs and fruit should be thoroughly washed and drained before chopping and adding. It is better to use fresh herbs where possible as dried herbs can contain mold spores. Beer, wine or cider should also be pasteurized before use.

Add the starter culture

A starter culture in cheese making is a medium of harmless, active microorganisms which by growing in cheese milk and curd assists the development of mature cheese with desirable characteristics of flavor, aroma, pH, texture and body.

Fig 10 Bulk Starters / DVI Cultures

The choice of starter will depend on:

- Type of cheese
- Activity required of it e.g. propionic acid development, gas production, lactic acid production, lipolysis etc.
- Cooking temperature to be used. (Influenced by type of cheese) e.g. where cooking temperature to be used is 37 – 45^{o}C, a thermophilic starter is preferred; while for 20 - 30°C, a mesophilic starter is preferred.

Mixed starters are preferred due to:

- Resistance to bacteriophage attack
- Good adaptation to environmental characteristics of temperature, pH, salt concentration etc.

Note: The amount of the culture added to the cheese milk is depending on the direction of the culture producer company e.g. Chr. Haisens. If the direction is not indicated on the packet it is optional to use 3g culture per 100 liters of milk.

Top stir

Top stirring is carried out to stop the butterfat in the milk rising to the top and being lost to the whey after cutting or ladling the curd. This could lead to a tough, dry cheese. To top stir, dip the fingers of one hand into the milk to about the first joint, about 2.5 cm (1 in), say. Now make slow, gentle movements to keep the top of the milk moving. Do not make circles or move fast or you will end up making butter instead of sinking the cream. When your fingers leave a wake or trail in the milk, stop stirring immediately and leave to set. It is not important to top stir homogenized milk as the process itself breaks down the size of the fat globules so that the cream does not rise to the surface. When the setting time is up, test the curd for coagulation. Stick your little finger into the curd and curl it up out of the milk. Keep the hole you make as small as possible. If the curd breaks leaving milk on your finger and in the hole you have made, leave the curd a further ten minutes and try again in a different part of the vessel. The curd is ready to cut when you get a 'clean split' – your finger is free of milk on removal from the curd and the hole does not fill with milk.

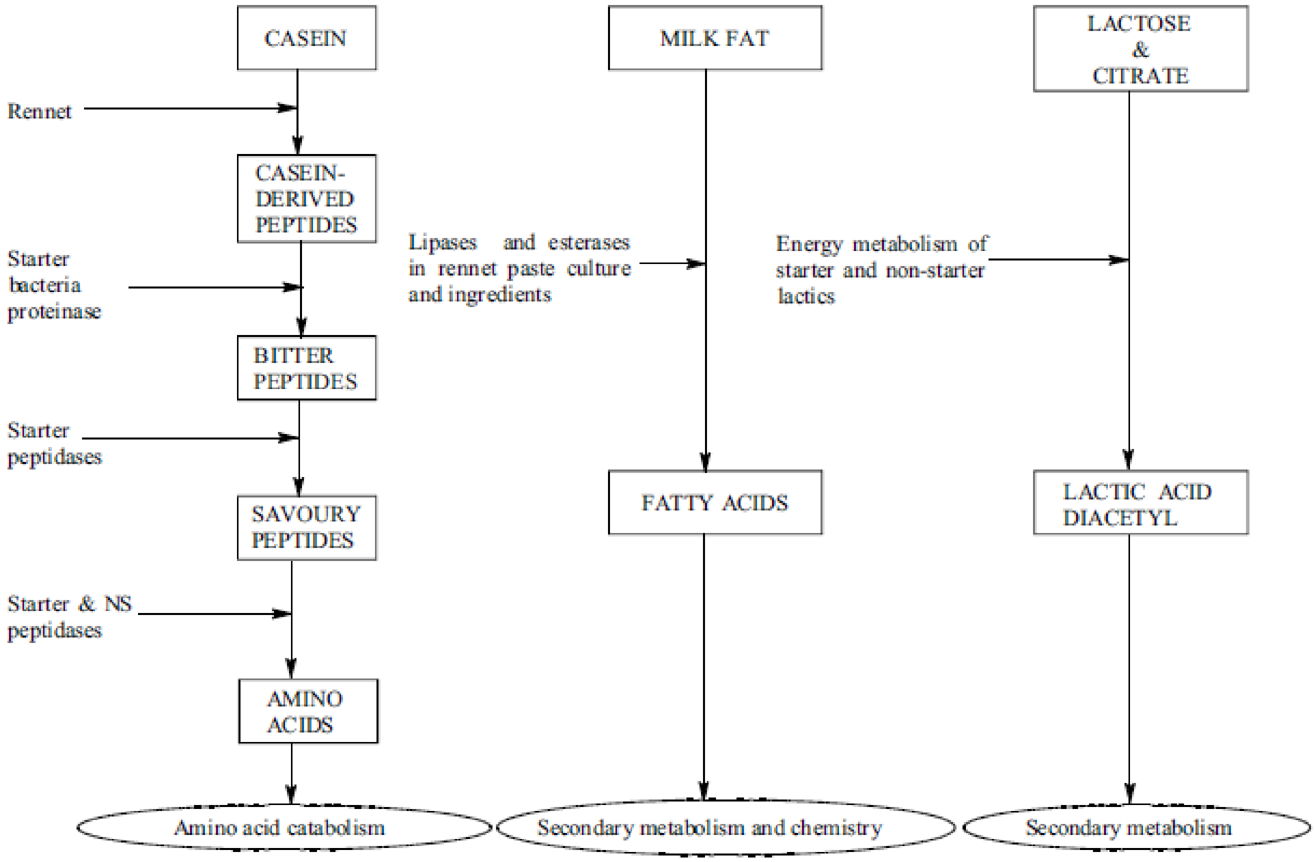


Figure 11 Basic cheese ripening biochemistry

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 - 18 points** **Unsatisfactory - below 18 points**

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

Score = ___________

Rating: ____________

Information sheet 2 - Maintaining temperature

2.1. Maintaining temperature

Cheese making for the most part is by the addition of bacterial starter cultures. These bacteria are living entities and do a specific job of consuming lactose and creating, as a waste product, lactic acid. This requires us to consider temperature for two reasons, the first being keeping the bacteria alive – a wide temperature range – the second being a focus on their productivity, which is a narrow range of temperatures at which bacteria are most efficient at lactic acid production. Our most vital piece of equipment to help us regulate temperature is, of course, the thermometer. There are many of them on the market and it is not a tool that needs to get from a specialist cheese kit supplier. It's best to use a thermometer that can clip onto the side of the pan if using a dial type. Digital thermometers tend to give a quicker read out so a clip is less essential, but having one means you can use it 'hands free' which is a benefit. The temperature range used for cheese making is quite narrow, so a thermometer that ranges from 0C to 100C will be suitable the more important feature your thermometer needs to have is 1C / 2F marker points because to make good cheese we do need to control the temperature of our milk or curds to an accuracy of 1C.

Cheese with a Flora of Coryneforms

As in the above-mentioned flora, surface organisms succeed one another. This applies to yeasts, micrococci, and especially coryneforms (added and contaminating organisms). Again, the cheese is deacidified. The growth of coryneform bacteria is greatly enhanced, whereas that of contaminating molds is suppressed. Domi-nance of mold growth can only occur if the mycelium can develop; any rubbing or washing destroys the hyphae. The cheese surface is therefore regularly washed with a NaCl solution or with water, especially at the beginning of curing. Furthermore, the cheese is matured at high relative air humidity. A contiguous slimy layer forms around the cheese due to the production of microbial polysaccharides and because of the swelling of the protein matrix. Under these conditions, the slower-growing molds lose the competition.

The floras of corynebacteria and micrococci are influenced by the salt content. A relatively high NaCl content enhances the growth of the cream- or orange-colored *Staphylococcus equorum* and the orange-red strains of *Brevibacterium linens*, a lower content, the yellow-pigmented *Arthrobacter* strains. Several strains are scarcely or not at all pigmented in pure culture, but appear colored when growing on cheese. A high salt content also enhances the proteolytic activity of the bacteria. This is because they need a high concentration of proline to keep their internal osmotic pressure at a sufficiently high level compared to the environment. The proline can only be obtained by proteolysis of casein.

These principles are also valid when a flora settles on other types of cheese, including some hard varieties. The number of yeasts involved closely depends on the initial pH of the cheese. The higher the pH, the less important the yeasts are, and the earlier a dominating growth of molds or corynebacteria appears.

The flora of coryneforms is responsible for the development of volatile aromatic sulfur compounds originating from methionine and cysteine. These compounds are clearly key flavor compounds of cheeses with this type of surface flora.

Curd Formation and Acid Development

The caseins in milk are packaged into a stable suspension of casein–calcium phosphate supra molecules (commonly called casein micelles). Casein micelles lose colloidal stability upon cleavage of k-casein into Para-k-casein (which remains part of the casein supramolecule) and a macropeptide portion (also known as caseinomacropeptide or glycomacropeptide), which is lost into the surrounding aqueous environment. At cheese making temperatures (30–35°C), casein is supra-molecules aggregate converting milk from a dispersed colloidal suspension of casein supra-molecules into a semisolid gel or curd. This coarse-stranded gel network entraps fat globules and bacterial cells, and fills the entire volume of the cheese vat. This initial gel network is comprised of clusters and chains of individual micelles that have surface contact with each other.

Subsequent changes to the curd during cheese making can be attributed to a shifting balance between entropy induced hydrophobic protein–protein interactions and electrostatic/ hydrophilic interactions between the caseins and water brought about by release of the macro peptide portion of k-casein upon renneting. In essence, the Para-caseins become “sticky” and start to rearrange as the hydrophobic groups cluster together to shield them from water, and salt bridges form through interactions with calcium and phosphate. As the pH drops, charges on the proteins change. For example, imidazole side chains of histidine change from being 60% uncharged at milk pH 6.7, to 60% carrying a positive charge at cheese pH 5.3. The phosphate groups on phosphoserine side chains also become more protonated reducing the negative charge and ability to bind calcium.

Consequently, the lowest free energy state of the curd protein matrix continually changes, so protein rearrangements occur during cooking and stirring of the curd. The process of casein supra molecule destabilization continues (since the impact of entropic forces increases with temperature) to the extent that the supra molecules fuse together with a loss of the serum originally occluded. It is important to realize that while the casein supra molecules lose their colloidal identity, the individual protein molecules retain their identity, even as they aggregate.

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. What is the effect of temperature on curd formation?(4pts)
2. What is the effect of temperature on curd formation?(3pts)

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 - Measuring rennet and diluting before adding to milk

3.1. Measuring rennet and diluting before adding to milk

Rennet should be measured into a small cup, jug or bowl in accordance with the recipe. It should then always be diluted with 4 to 6 times its volume of cold water. This is to enable the rennet to mix evenly throughout the ripened milk. Spread the diluted rennet all over the surface of the milk and immediately stir it in. Keep stirring until you are sure it is thoroughly mixed but not for too long as there is no way of guessing when coagulation will begin and not want to break the gel.

Types of rennet

Organic acids:

1. Direct addition of an external edible acid like lemon juice, vinegar, citric acid etc. into hot fresh milk to cause curd separation from whey e.g. Ricotta cheese
2. Acidification of cheese milk by inoculation of a lactic starter culture into pasteurized milk. Fermentation of the milk sugar (lactose) will result in production of lactic acid and coagulation of milk proteins leading to formation of curd and separation of whey.

Commercial rennet is supplied in two forms:

- Powder
- Tablets

Most of the time the required amount of rennet added in to the cheese milk is suggested by the rennet producer company. Therefore, it needs to follow the direction written on the packet. If the direction is not clear (well known), for good coagulation adding rennet at the rate of 3 grams per 100 liters of cheese milk is enough. The rennet should be diluted at least 10 times in distill cold water.

When rennet is added to milk it takes a while before the micelles start to aggregate, but from that time on the aggregation rate increases rapidly. At a certain moment, small aggregates can be detected by eye. The time required for this may be defined as the renneting time. It is an important parameter in cheese making. Its dependence on some process variables is comparable to that of the clotting time.

The temperature especially affects the aggregation rate. Consequently, when milk of low temperature (say, 10°C) is provided with rennet, κ-casein is split, but the micelles fail to aggregate. When the milk is subsequently heated it clots very fast. The increase of the renneting time at temperatures above 35°C is due to heat inactivation of the chymosin.

Milk shows considerable variation in renneting time, especially milk of individual cows. The variation is partly caused by variation in casein content: if it is high, clotting is faster. The main parameter, however, is the Ca_2+ activity. If it is low, the aggregation is slow. The reaction can be accelerated by adding $CaCl_2$. Increasing the amount of $CaCl_2$ to more than a given level does not result in much change because the enzyme reaction will now determine the reaction velocity.

The influence of the pH is rather complicated. It appreciably affects the enzyme reaction, but little affects the aggregation rate of the paracasein micelles, provided that the Ca_2+ activity is not too low. The hairs are not removed at random at low pH, which causes the aggregation of the micelles to start at an earlier stage of the enzyme reaction. This effect explains much of the dependence of the clotting time on the pH to be different at low pH.

Factors that cause an increase in renneting time, generally also decrease the rate of firming of the gel, i.e., the rate of increase of the gel modulus. However, the changes are not proportional to each other; it also depends on what is taken as the characteristic time. The cheese maker is more interested in the ‘clotting time,’ i.e., the time when the curd is (presumed to be) firm enough to start cutting the gel.

An important point is determination of the rennet strength of a clotting agent. It is generally expressed in Soxhlet units, i.e., the number of grams of normal fresh milk that can be renneted by 1 g of rennet in 40 min at 35°C. The renneting time is defined as the time needed for the emergence of small aggregates in a tube with milk. The tube is held in a slanted position in a water bath while rotating; the aggregates are then readily spotted in the thin film of milk on part of the glass wall. A problem is that fresh milk varies in rennetability. Consequently, a synthetic peptide is used as a standard to set the renneting time of the milk used for testing at a specified value. Most rennet preparations are standardized at strength of 10,000 Soxhlet units.

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. Write types of rennet ?(4pts)
2. Write the effect of pH on rennet coagulation?(5pts)

Note: **Satisfactory rating - 9 points** **Unsatisfactory - below 9 points**

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

Score = ___________
Rating: ____________

Information sheet 4 - Carrying out curd cutting

4.1. Carrying out curd cutting

After the milk has been allowed to ripen for a time with the coagulant (again, times will vary depending on the type of cheese you are making), the milk has become a thick, custard-like consistency. The curds are ready to be cut when there is a clean break in the surface of the curd when you stick a (clean) finger into them. A clean break means that a soft crack appears in the curd's surface and finger comes out clean. If the milk is still yogurt-like, the curds are not yet ready to be cut. Knowing when the curds are ready to be cut takes some practice. If the curds have not developed enough because they will not cut cleanly, and a clean break is not apparent when you stick your finger or a curd knife in. On the other hand, also wait too long before the cut them, and the result will be that the curds become too hard and mash when you try to cut them. If you test your curds and they are not ready, wait another five minutes and try again. Keep a close eye on them.

Cutting the curd is done to allow the whey to separate from the curd. Different cheeses call for different size curds to be cut. To cut the curds, follow this procedure, supposing that you are required to cut 3/4-inch curds:

1. Place the curd knife into the pot at the pot's center and cut down to the bottom of the pot.
2. Draw the curd knife across the entire width of the pot, making a cut from the top of the curd to the bottom of the curd and all the way across the center of the pot. At this point, you will have cut the mass of curd in half.
3. Withdraw the curd knife and make another cut from top to bottom, ¾ inch and parallel to your first cut.
4. Go to the other side of first cut and make a parallel cut, 3/4 inch from top to bottom.
5. Continue cutting in this manner until you have a series of parallel cuts that are 3/4 inch apart, covering the top of the curd.

6. Turn the pot 900 and repeat this operation. When done, the top of the curds will look like a checkerboard pattern of 3/4-inch squares.
7. Using the previously cut squares as a guide, insert the curd knife at a 450 angle and cut along each of the top cut lines in this manner. You will be cutting the curds at a 45° angle from top to bottom. If you were to look at a bisection of your cut curds, they would appear diamond-shaped.
8. After cut the curds, allow them to sit for a short period of time before stir them, allowing the curds to firm up a bit.
9. Gently use a spatula to stir the curds, bringing the bottom curds to the top.
10. Any curds that seem much larger than others should be cut.
11. It is not vital that the curds are all the same size, but they should be all be relatively similar in size so as to allow for an even drainage.
12. Allow the curds to rest for five minutes.

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. What is the importance of curd cutting?(3pts)
2. Write the procedures of curd cutting? (12pts)

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

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

Score = ___________
Rating: ____________

Information sheet 5 - Taking curd samples and carrying out tests for acidity and temperature

5.1. Taking curd samples and carrying out tests for acidity and temperature

The cheese making process begins with the addition of microorganisms, referred to as “starter cultures,” to a dairy product such as milk. The bacteria in the starter cultures consume the sugar (lactose) in the milk and produce a byproduct (lactic acid) during a process called fermentation.

Lactic acid production begins the process of coagulation, by which the starting liquid begins to solidify. Cheese makers often aid and expedite this process through the addition of the enzyme rennet to the fermenting mixture. When coagulation has produced the ideal mixture consistency, the process continues with cutting. Cutting is a mechanical process that encourages the solid element (curds)—which ultimately become the cheese—to separate from the liquid (whey). After cutting, the mixture is cooked and stirred, causing additional expulsion of whey from the curds.

At this point, salt is often added to promote whey expulsion, improve taste, and preserve the final product. Finally, the cheese is pressed to remove remaining whey. The product may then be consumed fresh or placed in a controlled environment for aging or “ripening.”

The role of pH in cheese making

To properly execute the cheese making process and achieve the desired flavor and texture of the product, it can be useful to monitor temperature and pH. These measurements provide insight into the cheese making process, informing the cheese maker on how to adjust for optimal results. For example, cheese makers adjust the temperature of the milk and the type and amount of starter culture added to control the amount of lactic acid produced by fermentation. This helps guarantee that the desired taste and texture of cheese is produced. Measuring pH allows cheese makers to monitor lactic acid levels, because lactic acid decreases the pH of the mixture.

Many cheese recipes advice proceeding to a subsequent process step, such as cutting, only when a certain pH level is reached. Most cheese making processes at a pH between 5.1 and 5.9 which is slightly acidic. Monitoring pH provides the information necessary to properly follow more advanced recipes, or to ensure that your own favorite cheeses come out perfect every time.

Measure pH for Cheese Making

The simplest way to measure pH throughout the cheese making process is by using an electronic pH meter. With the PH meter, cheese makers can now turn any smart device into an electronic pH and temperature meter by simply plugging the PH meter into the sampled milk.

Milk used for cheese manufacturing must be of excellent quality and its pH value contributes to whether the cheese will be soft or hard. pH is also checked during cheese preparation, souring of milk and cream maturation. Pathogen multiplication of the fresh and soft variety is slowed down considerably by ensuring that the pH stays in the 4.1 to 5.3 region.

With yogurt production, the cooling of cultured milk can start only once acidification has reached a pH value of 4.4 to 4.6. As for fruity yogurts, the pH value of the added fruit must be the same as the yogurt itself to avoid undesirable reaction at the end of the cycle. The finished product should ideally have a pH of 4.0 to 4.4 for longer conservation.

Even small changes in the pH value of spring or well waters can indicate a possible fouling of the natural strata. Where municipal water is used, it is often pretreated and its pH monitored. In making fruit juices, the pH of sugar extracts as well as those of juices during purification and refining are checked.

Fig 12 PH meter

Self-check 5	Written test

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

Test I Short Answer Questions

1. How pH and temperature affecting curd formation and coagulation?(6pts)
2. Most cheese making processes at a pH between ____ to ____ which is slightly acidic.(4pts)

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 6 - Assessing whey fat levels

6.1. Assessing whey fat levels

Whey contains appreciable amount of lactose which can be fermented by lactic acid bacteria. This lactose component makes the whey fit for the preparation of fermented beverages. Sweet whey is generally utilized for fermentation purpose. The fermentation process via specific strains of bacteria makes the whey beverage more functional because of production of bioactive peptides during fermentation. Whey can also be utilized in drinkable yogurt which is fermented products of dairy milk. Whey can replace the milk portion in these beverages. Fermentation of whey and whey components has also been studied using kefir grains and reported to be an attainable process for commercial preparation.

Whey composition

Whey contains 95% of the original water, most of the lactose, 20% of the milk protein and traces of fat. The remaining milk solids, about 50%, are incorporated into cheese. The composition of whey depends upon the type of cheese produced. Factors such as the season, location, and type and health of dairy cattle also affect whey composition. There are two main types of whey: sweet whey and acid whey. Sweet whey (pH > 5.6) is produced from the manufacture of rennet cheese such as cheddar or mozzarella. Acid whey (pH < 5.1) is produced by lactic acid fermentation to produce fresh cheese such as cottage or cream cheese or by hydrochloric acid casein production. Acid whey contains higher levels of calcium phosphate compared with sweet whey.

The mineral composition of sweet and acid whey is determined by the method of curd formation, either acid precipitation or rennet coagulation. Acid whey is formed as the pH is lowered and the colloidal calcium phosphate is solubilized, the casein micelle structure of milk is disrupted and the casein proteins aggregate releasing calcium phosphate into the whey. Sweet whey is produced when rennin cleaves κ-casein on the surface of the casein micelle, destabilizing the casein complex, releasing casein-macro peptide into the whey, the remaining hydrophobic α, β Para casein flocculates together in the presence of calcium to form the cheese curd.

Most important for the cheese composition is that not only protein is accumulated but so is fat. Treatment of the curd, i.e., cutting and stirring causes loss of particles, especially at the cut surfaces. For instance, about 6% of the fat is lost with the whey. Most of this fat is recovered by centrifugation of the whey. A part of the curd, defined as curd fines, is also lost. Losses of fat and fines greatly depend on the firmness of the renneted milk at the moment of cutting and on the intensity of cutting and stirring. If the curd is too weak, the losses are great; if it is too firm; cutting needs excessive force, which can also enhance losses.

If the particles are not only entrapped in the network, but attach to it, or even form part of it, their loss during the mechanical curd treatment is lower. Fat globules become part of the casein network if they have casein in their surface layer. This can occur because of damage during processing of the milk (beating in of air, evaporation, or atomization) and especially by homogenization. In addition to a smaller loss of fat into the whey, a somewhat different consistency of the cheese results often designated as 'sticky.'

Fat is recovered in centrifugal separators

The collected fines are often pressed in the same way as cheese, after which they can be used in processed cheese manufacture and, after a period of ripening, also in cooking.

The whey cream, often with a fat content of 25 – 30 %, can partly be reused in cheese-making to standardize the cheese milk; this enables the corresponding quantity of fresh cream to be utilized for special cream products. Normally, this works well for short maturation cheeses such as mozzarella, but note that the risk of rancid off flavors is heightened as the maturation time is increased. It is important to break the recycle loop to avoid the build-up of free fatty acids and other undesirables that are not trapped in the curd matrix. For cheddar production, whey cream is generally not reused due to the sensitivity of the starter to bacteriophages. In some of these cases, whey cream is converted to whey butter.

Table 3 Composition of sweet and acid whey and ultrafiltration (UF) permeate.

Composition	**Sweet whey cheddar**	**Acid whey**		**UF permeate cheddar**
		HCl	**Lactic**	
Solids (%)	6.6	5.1	6.0	5.5
pH	6.1	4.7	4.0	6.1
Lactose (%)	4.8	3.7	3.9	4.7
Protein (%)	0.9	0.73	0.72	0.01
Ash (%)	0.59	0.60	0.72	0.53
Lactic acid (%)	0.13	0	0.60	0
Fat (%)	0.06	0.05	0.003	0
Calcium (ppm)	430	1200	1140	375
Phosphorus (ppm)	440	680	900	275
Potassium (ppm)	1460	1200	1530	1450
Sodium (ppm)	430	270	400	430
Chloride ppm	970	2600	910	940

Self-check 6	Written test

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

Test I Short Answer Questions

1. During treatment of the curd, especially at the cut surfaces, about ____% of the fat is lost with the whey. (3pts)
2. How Fat is recovered in centrifugal separators? (5pts)

Note: **Satisfactory rating - 9 points** **Unsatisfactory - below 9 points**

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

Score = ___________
Rating: ____________

Information sheet 7 - Carrying out curd separation and washing activities

7.1. Carrying out curd separation and washing activities

The water content of the curd sharply decreases when the curd is taken out of the whey. This effect should largely be ascribed to a greater gravitational pressure on the curd. It is seen that extended stirring causes smaller final water content. If the temperature of the curd mass could be kept constant after drainage of the whey, then the time of separation would affect the final water content only slightly.

This illustrates that in practical cheese making the lowering of the temperature after the whey drainage rapidly restrains syneresis. The larger the block of curd, i.e., the larger the loaf of cheese, the slower it cools and the lower the final water content will be, although the transport distance of the moisture is longer in a larger loaf.

The curd grains can be allowed to settle and form a layer. Alternatively, the mixture of curd and whey is transferred to a vertical drainage cylinder in which the curd settles. As long as the curd is under the whey, any mechanical pressure has an effect on the water content and so has the height of the column. The drainage of whey may be crucial in a column of curd in a drainage cylinder. Whey flows primarily between the curd grains, but these deform because of the pressure involved and also fuse, lowering the curd surface area, narrowing the pores between the grains and eventually almost closing them. A great spread in the size of the curd grains (e.g., presence of many curd fines) enhances blockage of the pores, which decreases drainage. According to conditions, one or the other process will prevail, i.e., enhancement of syneresis by pressure or slowing it down by fusion, respectively.

In the traditional cheddaring process, the drained curd is left for a long time, preferably without cooling it too much. Meanwhile, considerable acid production occurs. The long waiting time and the low pH cause the water content to become low. However, during cheddaring, the curd is allowed to spread, and this enhances closing of the pores between curd grains and fusing of grains. The latter two factors lead to higher water content than would occur if the curd cannot spread. The difference amounts to some 1 to 2% water in the cheese.

If the curd has been made very dry before drainage of the whey, e.g., by means of prolonged stirring or a high scalding temperature, a higher temperature during drainage leads to higher water content. Probably, this is caused by a more rapid closing of pores between curd grains which, in turn, is due to a more rapid deformation at the higher temperature.

To make curd very dry, the drained curd can be stirred again. This causes a considerable loss of fat and curd fines in the whey and marked mechanical openness in the cheese.

After it has been made batch wise in a tank, is subsequently drained, molded, and pressed in a continuous process, as syneresis goes on in the tank. It will lead to significant variation in water content of the cheeses. To overcome this problem the curd and whey mixture can be stirred gently in a buffer tank while being gradually decreased in temperature. In the meantime it can be transferred from the buffer tank to the filling/molding device.

The mechanization and scaling up of the curd making that now have become normal practice has led to the use of a fixed time schedule for the various process steps. Adaptations during the manufacturing process, necessitated for instance by changing development of acidity or syneresis rate, are hard to achieve. One should therefore start from large quantities of milk (because this implies little variation in composition from one batch to the next) and precisely standardize the process conditions. Problems can still arise from varying rates of acid production, generally caused by contamination by bacteriophages.

Each cheese is known for its distinctive shape, aroma, and flavor. It should be using the detailed process of warm washing the curds and the technique of salt brining. The process steps required to make these cheeses are more complex than the previous cheese recipes, but the reward is worth the extra effort.

Two approaches to washing, or soaking, are used by Colby cheese manufacturers: batch washing (BW) and continuous washing (**CW**). During CW, the curd is stirred as water is added and allowed to drain immediately. In BW, water is added to the vat and the curd remains in contact with the water. We predicted that the different washing methods could alter the amount of lactose, lactic acid, and soluble Ca remaining in the curd after washing. In Gouda cheese making, about 98% of the lactose is washed out or lost in the whey, but that is dependent on the duration of washing (contact time), the size of curd grains, and the intensity of stirring). The objectives of this study were to investigate the effects of different curd washing methods on the Ca equilibrium and the functional properties of Colby cheese.

Fig13 draining 1/3 of whey

Self-check 7	Written test

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

Test I Short Answer Questions

1. How much whey is drained during first whey separation?(3pts)

2. What is the importance of curd washing? (6pts)

Note: **Satisfactory rating - 9 points** **Unsatisfactory - below 9 points**

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

Score = ___________
Rating: ____________

8.1. Continuing acidification of curd after draining and adding dry salt to milled curd before pressing

The pH in the curd decreases because of the action of the starter bacteria. This decrease greatly enhances the syneresis (Many gels tend to shrink spontaneously, thereby expelling liquid. A rennet milk gel can do so, expelling whey). The rate of decrease in pH is determined by factors including starter (amount added, type, and strain), composition and pretreatment of the milk, and temperature during curd treatment.

Almost all starter bacteria are entrapped in the curd, implying that the acid is mainly produced in the curd grains. As long as the grains are in the whey, lactic acid can diffuse from them into the whey and lactose in the opposite direction. In this way, acid is produced in the whole mixture. After drainage of the whey the accumulation of acid in the curd proceeds more quickly, and the lactose content in the curd decreases more rapidly.

In most cases, the rate of acid production and so the pH at molding, has little effect on the final pH of the cheese. In most cheese types all lactose is converted, mainly to lactic acid. It implies that the ratio between lactic acid and buffering compounds determines the pH. The moisture content of the curd is of paramount importance. The higher it is, the more lactose, or its product lactic acid, is retained in the curd, and the more acidic the resulting cheese will be. The main buffering substances are paracasein and calcium phosphate.

Consequently, the rate of acid production can have a secondary effect on the pH of the cheese. It can affect syneresis and thereby the water content of the cheese. If the latter is held constant by means of additional measures, a small effect persists, e.g., minus 0.1 unit in pH. If the curd is more acidic at the moment of molding, more calcium phosphate has dissolved, and so less buffering substance is left in the cheese. Pre-acidification and inoculation with a large amount of starter have similar effects. Furthermore, a lower pH at molding causes a slightly lower yield of cheese dry matter. If cheese is salted at the curd stage, the bulk of the lactose must have been converted before molding because the lactic acid fermentation is markedly slowed down by the added salt.

To adjust the pH of the cheese independently of its water content, other steps should be taken. A smaller drop in pH is achieved by washing, i.e., adding water to the mixture of whey and curd. The lactose diffuses away from the curd grains until identical concentrations are attained in the water inside and outside the curd. The effect of the washing closely depends on the size of the grains and on the contact time. Equilibrium is rarely attained. In practice, the efficiency of reducing the lactose concentration in the curd approximates 90%.

The wash water is commonly also employed to raise the temperature of the curd and whey mixture, i.e., scalding or cooking. The higher temperature causes the syneresis to be stronger. There are also other methods for scalding the curd, such as direct heating.

If the temperature of acid production is not too low (e.g., 30°C) and the milk is at rest, a gel forms, as during rennet coagulation. However, the gel is rather different. For instance, it is shorter and may be firmer than a rennet-induced gel. Its composition also differs. Rennet coagulation yields a coagulum of Para casein micelles including colloidal calcium phosphate, whereas an acid milk gel consists of casein particles of a similar size as in rennet coagulation, but without calcium phosphate. The acid gel can be cut and stirred like a rennet gel, but it shows little syneresis, especially in the pH range of 4.2 to 5. For removal of a sufficient amount of whey the temperature should be fairly high, but low-moisture cheese cannot be made via acid coagulation.

Alternatively, the milk may be acidified at some lower temperature while stirring, so that a voluminous precipitate forms, not a gel. Centrifugation separates the soured milk into whey and pumpable curd slurry. The dry-matter content of such curd cannot be made higher than about 23% or about 17% if skim milk is used.

Acid coagulation by bacterial growth requires a long time, even at optimum temperature. Of course, acid can also be added directly, for instance, lactic acid or hydrochloric acid. This causes clotting of the milk to start already during addition of the acid, which results in curd particles of widely varying shape and size. Rather than an acid, a lactone can be added, which is slowly hydrolyzed (e.g., over an hour) to form an acid. In this way, a homogeneous gel can be obtained.

Alternatively, acid can be added to cold milk, i.e., at about 5°C. As in rennet clotting, acid coagulation does not occur at low temperature. After acidification, the milk is uniformly heated to ensure undisturbed gel formation. This process can be used in the manufacture of cottage cheese. Often, a combined acid and rennet coagulation is applied, especially in the manufacture of fresh and ripened soft cheeses. In fact, rennet coagulation is more or less enhanced by acid coagulation when a high percentage of starters are added. Further, the manufacture of some cheeses includes pre-culturing of the milk before rennet addition.

Salting

Most cheese recipes include salt, added either during processing or by brining or dry salting the cheese after pressing or molding. Whilst special dairy salt is ideal, it is perfectly alright to use good cooking salt. But do not use table salt; there is a 'free running additive' in all domestic salt to stop it forming lumps and table salt contains more of this chemical and will give a bitter flavor to the cheese.

Salting is an essential step in the manufacturing of cheese. Salt is a substantial component of cheese with respect to preservation, flavor, consistency, usually the rate of ripening, often the rind, and sometimes shape retention.

The methods as applied in the salting of cheese can be classified as follows:

- The salt is mixed with the ''dry'' milled curd pieces, e.g., Cheddar.

- Dry salt can be rubbed onto the surface of the molded and pressed cheese, as was originally done in the manufacture of soft-type cheeses and of Edam. The rubbing is repeated several times.
- The cheese is kept immersed in a concentrated solution of NaCl (brine) until the desired amount of salt has been absorbed.

Self-check 7	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 is by syneresis means?(5pts)
2. What is the importance of salting the curd? (4pts)

Note: **Satisfactory rating - 9 points** **Unsatisfactory - below 9 points**

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

Score = ___________

Rating: ____________

Information sheet 9 - Transferring the cut curd to molds and holding at a constant temperature

9.1. Transferring the cut curd to molds and holding at a constant temperature

In most cases, it is desirable to make the curd into a coherent mass that is easy to handle, is of a suitable size, and has certain firmness and a fairly smooth closed surface. To achieve this, the curd is shaped by putting it in molds or hoops; in hard and most semi hard cheeses, the operation includes pressing of the curd.

Shaping of the curd can only be done if the grains deform and fuse. Deformation is needed because the whole mass of curd must adopt the shape of the mold and because the grains should ideally touch one another over their total surface area. Viscous deformation is needed, i.e., the mass of curd must approximately retain its obtained shape when the external force is released. The greater the force, the faster the deformation; pressing thus can help. The deformation is considerably affected by the composition of the curd. With decreasing pH, the deformability increases until pH 5.2 to 5.3 is attained; at still lower pH, the curd becomes far less deformable. Furthermore, the deformability increases with the water content and especially with the temperature. At very high temperatures (e.g., 60°C) the curd can be kneaded into almost any shape and at a suitable pH it can even be stretched. This property is used in the manufacture of cheeses with Pasta Filata. The high temperature and the kneading also affect the consistency, i.e., the cheese becomes tough and smooth. For a poorly deformable curd (low pH, low water content, and low temperature) holes can remain in the cheese, even if it is heavily pressed.

Cheddar cheese, but here it concerns fairly large pieces of curd, formed by cutting an already fused curd mass, and these pieces must undergo considerable deformation; moreover, the outside of these pieces of curd is firm due to the added salt. The applied pressure should therefore be high and the temperature not too low.

The fusion of the curd grains into a continuous mass is enhanced by increasing the area over which they touch one another. Obviously, conditions allowing easy deformation thereby enhance fusion. If, however, the curd still shows significant syneresis during molding, fusion is counteracted by the layer of whey forming between the grains. The fusion proceeds most easily if the pH is fairly low, e.g., 5.5.

This may be caused by new bonds forming readily between the Para casein micelles. Soured curd fuses poorly. If curd is stirred until its pH has dropped to 5.0 and is also cooled, it cannot be pressed into a coherent mass: the loaf immediately disintegrates upon de-molding.

Within a day after curd making, the fusion usually is complete, which means that no visible pores between curd grains are left in the mass of curd. A few days may be needed to complete the fusion to the point where the mechanical properties of the cheese have become more or less homogeneous. Thus, if a piece of one-day-old cheese is strongly deformed; it fractures between the original curd grains, whereas a cheese that is 4 days old generally fractures through the grains. These observations do not apply to cheese that is salted at the curd stage.

Before and during pressing, a rapid temperature decrease must be avoided because it hinders the deformation of the curd grains and the rind formation. Larger loaves cool more slowly. (They may even rise in temperature due to the heat produced by the starter bacteria.) If the curd is not yet very dry, it can still show syneresis, and this proceeds more vigorously at a higher temperature; therefore, the water content of the pressed cheese will be lower for a larger loaf size. Within an unsalted cheese mass, the water content is lower in the center than in the rind, with the difference amounting to, say, and 6% water. The above does not apply, however, to cheese that is made of curd stirred very dry. Applying a higher pressure to such curd results in lower water content as does a lower temperature. Presumably, the rind of these cheeses only forms after a considerable proportion of the moisture has been squeezed out. In turn, the unevenness in the distribution of the water is much less.

The treatment of the curd grains during the molding process is of paramount importance for the texture and appearance of the cheese in the later phases, and it should be especially emphasized that the extent to which atmospheric air is allowed to penetrate between the grains or not is a fundamental criterion.

Pressing

The purpose of pressing is to give the curd a specific shape, to make the grains fuse, and to make a smooth, close rind. An additional effect is that some more whey is squeezed from the curd.

During pressing the pH of the cheese is still decreasing and the temperature of the curd usually decreases.

One can distinguish two phases in the pressing process:

- In phase 1, whey is still squeezed from the curd.
- In phase 2 the cheese gets its definite shape, the curd grains fuse completely and the surface of the cheese is closed.

During phase 1 the pressure applied is low, while in phase 2 the pressure is increased gradually. At first the whey in between curd grains is forced to the surface, and to the net, cloth or perforations. More whey from the curd (syneresis) replaces the whey.

By means of the pressing schedule the quantity of squeezed out whey and thus the moisture content of the cheese, can still be affected: a long first phase results in more squeezed out whey than a shorter first phase.

When the pressure is increased a rind is formed. The rind has low moisture content and will become more and more impermeable for whey.

The quantity of squeezed out whey depends on:

- Pressure and pressing program;
- Pressing time, especially the time phase 1 lasts;
- Temperature of the curd: a higher temperature improves syneresis and thus more whey is squeezed from the curd;
- Degree of acidity: the lower the pH the better the syneresis and thus the more whey is drained from the curd;

- Size of the curd grains: whey drains more easily from smaller grains than from larger ones.

The temperature is very important. A higher temperature results in:

- More squeezed out whey;
- A better rind;
- A faster acidification process;
- A higher risk that the cheese will stick to the net, cloth or perforations

Brine Treatment

Brining is a wet method of introducing salt into a cheese. During the brining treatment, water (whey) is expelled and salt (sodium chloride) replaces it. This method results in a gradient level of salt being present in the cheese, with the salt concentration higher at the surface than in the center of the cheese.

Successful brining is dependent on the condition of the brine in relationship to the cheese. Ideally both the cheese and the brine will be the same temperature, have the same pH, and contain equal amounts of calcium. Calcium chloride is added to the brine to balance the calcium contained in the cheese. Vinegar is added to lower the pH of the brine to more closely match that of the cheese. Without these additions, the rind of the cheese will become soft and gummy and eventually the cheese will lose its shape.

The amount of salt the cheese will contain and the depth it reaches inside the cheese are dependent on the original moisture content of the cheese after pressing and the length of time it spent in the brine. Drier curd cheeses will take up less salt than moist curd cheeses. The rind of brine-treated cheese will tend to be firmer and thicker than that of dry salted cheese.

Self-check 9	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 make cheese a poor deformable curd and holes can remain in the cheese, even if it is heavily pressed? (3pts)
2. The quantity of squeezed out whey depends on? (5pts)
3. Write the two phases in the pressing process? (2pts)

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 10 - Following the cooking schedule and stirring curd

10.1. Following the cooking schedule and stirring curd

Most cheese starts out with cooking the curds. This involves slowly bringing the curds up to a higher temperature, while stirring every 5 minutes to prevent the curds from clumping together.

Stirred curds are cooked after the whey has been drained. The dry curds are put back into the pot and gently cooked and stirred for several hours. It's important to maintain the temperature by using a double basin or fermentation chamber.

Pulled curd cheeses, like stirred curd cheeses, are heated after the whey has been drained. The goal is to continue cooking the curd until the curds are acidic. When they reach the right acidity the curds will become elastic. At those points the curds are submerged into very hot water and kneaded and massaged until they become stretchy.

Very slowly, bring the curds up to 100°F, stirring gently but continuously. The temperature should rise no faster than 2°F every 5 minutes or so. This process will take about 30 minutes.

Once the curds reach 100°F, maintain this temperature and continue stirring gently for another 30 minutes.

Stir the curd and cook it with a slow rise in temperature. This step isn't necessary for some types of cheese but for other types of cheese such as harder types, it need to stir and heat the curd to make it release more whey even after cutting the curd.
After cutting, it is normally time to stir and cook – when I use the word 'cook' it means to heat up the curd inside the pot. The reason for stirring is to help the curd cubes keep on expelling whey. While you stir, keep in mind that all want to do is to let the curds float in the whey and bump into each other.

Just like the cutting stage, try to avoid squeezing or forcing the whey out of the curd. So it’s finding a balance of expelling and keeping small amounts of moisture in the curd that will make a successful cheese.

Cooking the curds is necessary to help them become more resistant to pressure and actually help keep some whey inside the curd. During this process, the bacteria cultures stay active as they continue to acidify their environment. The acidity level in the cheese before proceed to the next step is really important. This whole step is usually done by continually stirring and raising the temperature of the curds and whey at a very slow rate. This step covers it all and mastering it is probably the toughest challenge in the early stages of cheese making.

Again hand stirring has become automated with bigger batches of cheese. The paddles stir consistently and gently making sure the curd doesn't break as it cooks down into curds and whey. This process can take 30 minutes to several hours. As the curd is stirred, the vat is gently heated and the bacteria in the culture are given the right environment in the milk to thrive. When the target pH is reached, showing that the culture has done its job, then whey off (remove the whey) and proceed to the next step.

Fig 14 Automatic stirring machine

Self-check 10	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 is the importance of stirring?(3pts)
2. Write the necessity cooking the curds? (3pts)

Note: **Satisfactory rating - 6 points** **Unsatisfactory - below 6 points**

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

Score = ___________

Rating: ____________

Information sheet 11 - Carrying out draining and optional washing procedures

11.1. Carrying out draining and optional washing procedures

Drain the whey

It's easiest to drain the cheese curds by pouring the whole pot through a butter muslin lined strainer. I like to save the whey for cooking, so drain the whey into a large bowl. Pour the whey down the drain, but don't condone that because whey is full of flavor and protein.

Once the whey has been drained through a strainer, either hang the curds for further draining or pack the curds into a cloth lined mold and press the cheese.

Washing curds is a variation of cooking curds. It curbs the action of the bacterial culture by removing some of the lactose. The result is a less acidic cheese.

To wash cheese curds, let the cut curds rest for 5 minutes, then drain off 1/3 of the whey. Stirring gently, add back the equivalent amount of whey with warm water. Then the curds are slowly cooked by slowly raising the temperature and stirring every five minutes.

Depending on the specific recipe, curds are often salted after draining and before packing into a cheese mold. Just be sure to use non-iodized salt.

At this point, you can also add other seasonings, like spices, herbs or hot peppers. Seasonings (other than salt) should be pre-boiled for 15 minutes prior to use to ensure that they are sterile and softened. Then mix the seasonings in with the salt.

Cheese types:

A. Acid-coagulated (e.g. Cottage and cream cheese)

B. Acid/heat-coagulated (e.g. Ricotta)

C. Rennet-coagulated (e.g. Cheddar, Parmesan, Gouda, Swiss and Camembert).Provolone, Mozzarella, Feta

Acid-coagulated

Cream cheese

Cream cheese is a simple cheese to make and its flavor is incomparably better than store-bought versions. The entire cheese making process will take two days, but not much of that is actual work, and the finished product is well worth the effort. Fresh cream cheese will not look like store-bought cheese. It will be soft and appear slightly curdled, but it smooth's once it is warmed to room temperature and stirred. Once upon a time, cream cheese made no demands.

Rennet-coagulated (e.g. Cheddar, Parmesan, Gouda, Swiss and Camembert), Provolone, Mozzarella, Feta

Mozzarella cheese

- Mild-flavored, white cheese originally made from buffalo's milk but now made from cow's milk.
- Comes in two styles: fresh or regular

Mozzarella is a small cheese, weighing 50 to 400 g. The loaf shape is a somewhat flattened sphere. The flavor should not be pronounced. Originally, it was mainly made from buffaloes' milk. Nowadays it is usually made from cows' milk or from a mixture. The cheese contains 35 to 45% fat in the dry matter, 52 to 56% water, and about 1% salt. Being only a few days old, it is little matured and has a rather soft and long consistency.

The starter is mainly composed of S. thermophilus, L. delbrueckii ssp. bulgaricus, and L. helveticus, although some mesophilic lactococci may be present. The Lactobacilli can produce acid in the cheese even after the stretching process. A decrease of the pH of the curd to 5.2 to 5.3 before kneading starts is of prime importance because otherwise stretching is not possible. If the pH is above 5.4, the cheese mass is too firm; if the pH is below 5.1, it is too crumbly.

Then the curd is kneaded. Traditionally, the proper moment was fixed by testing if a string could be drawn from a heated curd piece, i.e., 'pasta filata'. The soured curd mass can be cut into strips, or it can be coarsely milled as in Cheddar cheese manufacture. The slabs or strips are put in hot water and kneaded, which may be done by hand. The kneading implies stretching and shearing of the curd mass; its main function is to rapidly increase the temperature of the whole mass to the desired level of about 55°C. The kneading also appears to slightly slow down syneresis (which may proceed rapidly at high temperature) and to affect the texture of the cheese: the cheese mass appears somewhat layered. Moreover, the milk fat globules may be disrupted into smaller ones, which can cause enhanced lipolysis. Finally, lumps of curd are kneaded into the desired shape and placed in cold water. Usually, the cheese is not pressed.

The product just described is meant for direct consumption. Currently, large quantities of Mozzarella are made for cooking purposes, especially for use on pizzas. The cheese should have adequate melting properties, i.e., soften on heating, become smooth, and flow. However, the melted cheese should remain rather viscous and become solid again when the temperature decreases somewhat. This is only possible if the water content is lower, generally between 45 and 50%. The manufacturing procedure often is significantly modified; even coagulation with acid is applied. The product may differ greatly from the traditional Mozzarella; it is sometimes called pizza cheese'.

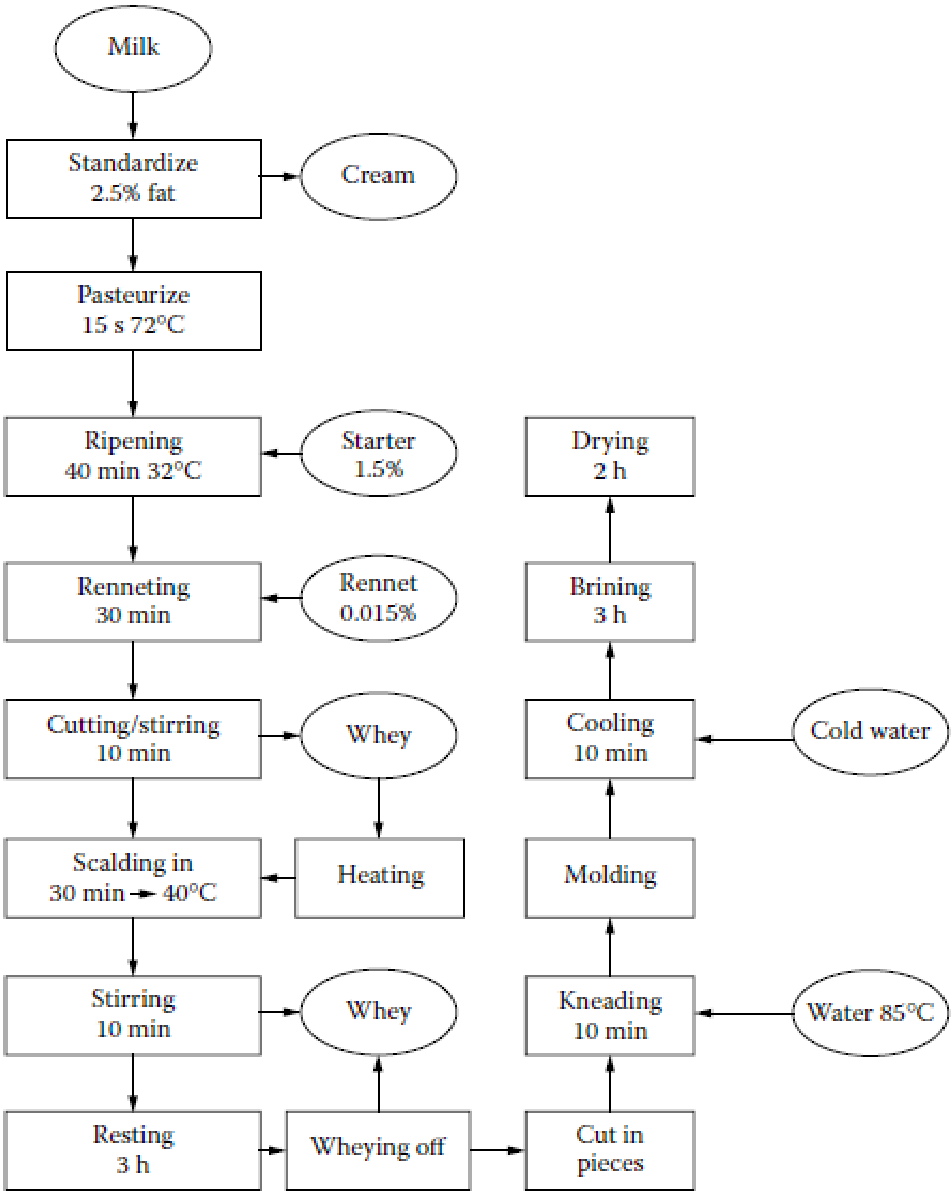


Fig 15 flow diagram of Mozzarella

Gouda cheese

Type, color, texture and flavor use

- Creamy-textured cow's milk cheese with a nutty flavor;
- Red wax outer surface and yellow interior.

Gouda-type cheeses are ripened, fairly firm, sliceable cheeses made from fresh cows' milk. Mesophilic starters are used that generally produce CO_2, mainly from citric acid, thus causing formation of holes in the cheese. The cheese is pressed, salted in brine, and has no essential surface flora.

.It is semi hard cheese type. During the preparation of Gouda cheese, the fat content of the cheese milk should have to take in to consideration. If the fat content of the cheese milk is higher it needs to reduce to 3%.

Age classification of Gouda Cheese

Young	4 weeks
Young matured	8 weeks
Matured	4 months
Extra matured	7 months
Old	10 months
Over a year	1 year and more

Before cheeses can be sold, they must be cleaned and packaged. Well treated cheeses, coated with plastic, can be packaged in outer packaging material to protect the cheese from mechanical damage during its journey from the place of production to the retailer. The outer packaging material may be wooden crates or vats, corrugated paper or fiber boxes. The outer packaging material must be both practical and easy to handle and it must be packed tightly around the cheeses to avoid loose cheeses.

Cleaning, washing and drying

The cheeses may be cleaned by scraping or washing. Before washing, the cheeses are softened in water for 15-30 minutes. The cheeses should not be soaked for too long because this may weaken the rind.

Washing can be performed by washing machines with rotating brushes or spray nozzles. During washing, clean water must be added continuously and, immediately after washing, the cheese must be rinsed in clean water. The temperature of the water should not be more than 20-25^{o}C.

After washing, the cheeses must be dried because paraffin will not adhere to a damp rind. Drying may take place by passing the cheeses through a drying tunnel on a conveyor belt. The temperature of the drying air must not exceed approx. 60°C as higher temperatures may cause fat to run off the cheese surface, which makes it difficult for the paraffin coat to adhere to the cheese rind. Drying may also take place in a dry room with vigorous air circulation. The cheeses are placed in this room for 24-48 hours after washing.

Waxing

Purpose:

- To give the cheese a clean and attractive appearance;
- To reduce the water evaporation (weight loss) during further storage and shipment;
- To prevent further development of micro-organisms on the cheese surface; labor requirements in the store room are reduced.

For the most commonly used paraffin qualities, the dipping time is 4-5 seconds, and the temperature is about 150°C. Lower temperatures will give a thicker coat and higher temperatures a thinner coat because more paraffin can run off the cheese before hardening when the temperature is much higher than the hardening point of the paraffin. Longer dipping times will give a thinner coat and shorter dipping times a thicker coat.

The reason for this is that when cheese is immersed for a longer time, the temperature of the rind increases and more paraffin can run off the cheese before hardening.

The cheese should preferably be cooled to approx. 12°C before waxing because it will then be so rigid that it will not be deformed and the paraffin coat will not break during removal after immersion. Brushing with paraffin must repair any marks in the paraffin coat made by dipping utensils. If this is not done, mold growth may very quickly develop in the spots where the paraffin is thin or missing.

After waxing, most cheeses should be stored at 12°C. At higher temperatures, the cheese may change shape and break the paraffin coat, and there is also a risk that the CO_2-production will be too rapid and, thus, cause blisters and rind cracking.

Waxing must not be performed too early because a sufficiently hard rind must have formed before waxing, and because the diffusion of CO_2 must be more or less complete before the cheese is enclosed in a tight paraffin coat. On the other hand, the waxing must not be performed too late because then the evaporation of water from the cheese will have been too high, causing too thick a rind to form (less edible cheese) and too large a weight loss.

Re-waxing

When cheeses have been stored for some weeks in the ripening room or in cold store, it will often be necessary to re-wax them before shipment. Cheeses which have been stored at a temperature of 12^oC (ripening store) can be re-waxed immediately, but cheeses that have been cold stored must be warmed at 12^oC for 24-48 hours to prevent condensation of vapor on the cheese surface prior to re-waxing. In most cases the second waxing should be performed at a slightly higher temperature and/or with a slightly longer dipping time than the first waxing.

Provolone cheese

Type, color, texture and flavor use

- Pale yellow color cow's milk cheese with a smooth and elastic texture.
- Sharp, salty and has sometimes smoky flavor.

Provolone cheese is made using the principle of working or kneading the curd to produce the desired melting and stretching properties. Provolone requires thermophilic starters to promote curing. Provolone is suspended with ropes at 85% humidity for curing. The following procedure is for Provolone.

Standards: 45% moisture; 24% fat.

Feta cheese

Type, color, texture and flavor use

- Crumbly white sheep or cow's milk cheese with a strong salty flavor.

Fig 16 final product of feta cheese

Cheddar cheese

Type, color, texture and flavor use

- Hard cow's milk cheese ranging from nearly white to bright orange in color.
- Mild to sharp in flavor depending upon aging.

Cheddar cheese has its origins in Britain. Traditionally the cheese was made in different sizes from about 0.5 to 25kg. The procedure for making Cheddar may be considered difficult and tedious by the inexperienced but the resultant mature cheese with its characteristic nutty flavor and close texture makes the task worthwhile. The Cheddar cheese recipe can be manipulated to give a cheese which may be consumed in four weeks or stored for up to two years.

In order to obtain a cheese of good body and texture it is necessary to use milk with about 3.3% fat. If milk with excess fat content is used there will be high losses of fat in the whey and the cheese will have a weak, pasty body.

Parmesan Cheese

Hard cow's milk cheese with a granular texture and a straw-colored interior

Sharp and piquant flavor

This Parmesan style cheese making recipe uses raw milk to produce the classic grain texture of this traditional cheese. This guide is based on the true Parmigiano-Reggiano that is produced, in copper vats, in Emilia-Romagna, northern Italy.

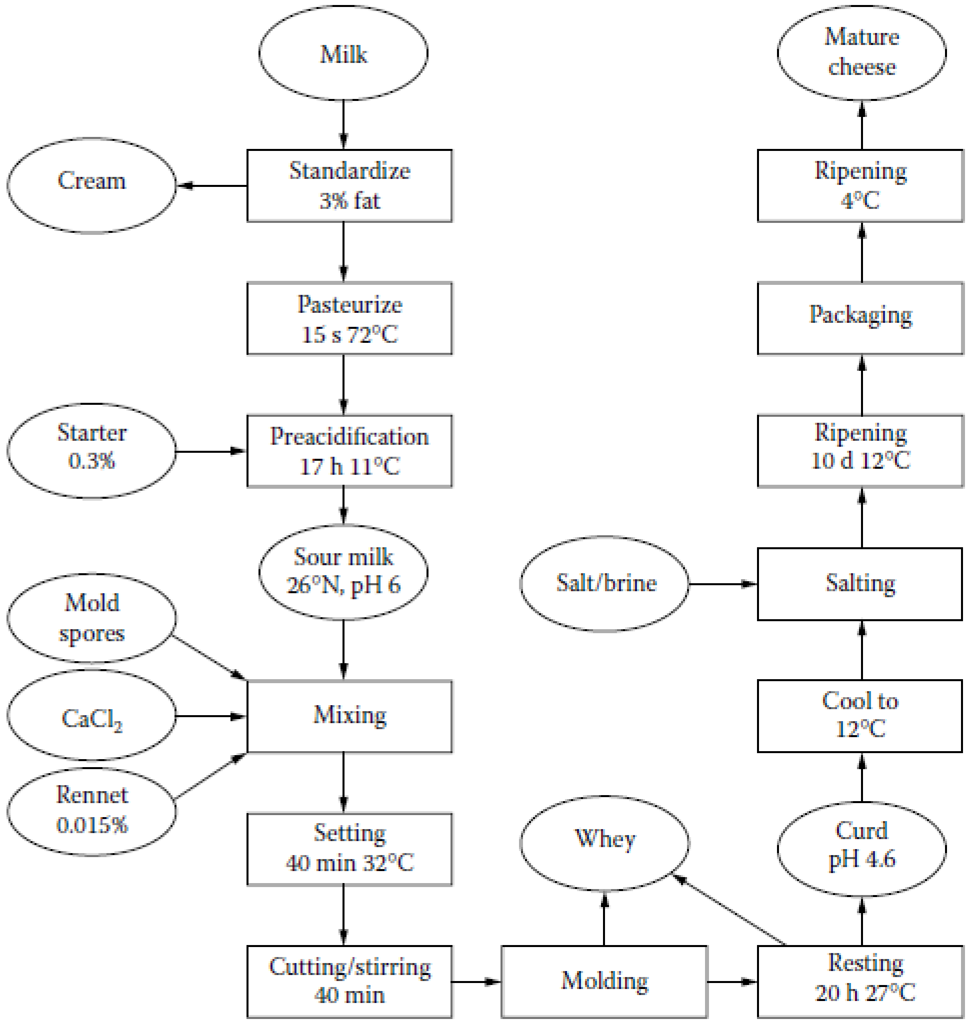


Fig 15 Soft cheese having surface flora (e.g. Cheddar, Parmesan, Gouda, Swiss and Camembert)

Ricotta cheese

Type, color, texture and flavor use

Fresh, white cow's milk cheese, soft and smooth texture

Mild and delicate flavor

Simple Ricotta Cheese can be made from the Saved Mozzarella and/or Provolone whey

Self-check 10	Written test

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

Test I Short Answer Questions

1. Write the types of cheese based on their coagulant?(3pts)
2. What are the purpose of waxing?(3pts)

Test II choose the best answer

1. Whey is the byproducts in manufacture of (2pts)
   A. Skimmed milk
   B. Butter
   C. Cheese
   D. Yoghurt
2. Soft fresh cheese (2pts)
   A. Cottage
   B. Cream
   C. Gouda
   D. Ricotta

***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 mozzarella cheese

Objectives

- To identify: Equipment and ingredients used for mozzarella cheese making
- To make mozzarella cheese

Equipment and Ingredients

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

Procedure

1. Measure10 liters of raw milk fat standardized to 3% at a pH of 6.5
2. Strain and warm the milk to 34°C in vat
3. Add 200 ml of whey cultures
4. Add 0.3g powder rennet and stir gentle rennet into the milk for 15 seconds
5. Leave undisturbed for 20 minutes to 30 minutes.

6. Cut the curd into peanut size pieces (7.5 mm) with steel knife (9.5mm blades). Stir to float curd and then leave to settle.

7. Removing Whey off 1/3rd
8. Collect the curd in large pieces on a rack in the vat. Cut and pile for 2:30 – 3:00 hours until the curd reaches pH 5.1.

9. Soak strips of the curd in hot water, 80-90^{o}C, to test the curd for stretching (strip should pull out to about 1 meter long). Allow the curds to stretch out in single layers on the bottom of the vat. Then cut into strips through mechanical mill.




10. Put a quantity of milled strips into hemispherical vat with hot water 80^{o}C. Leave to heat up and then stretch the curds (manually or with paddles) repeatedly until smooth plastic body of the curd is developed.

11. Cooling

- ✓ Form the hot curd in shapes and cool the cheese during 30 minutes in very cold water (ice water) or cold brine water (100g NaCl/L, 2 gram $CaCl_2$/L, pH to 5.1)


12. Packing & storage

- ✓ Drip dry for 10 minutes at room temperature and vacuum wrap in bags/foil with low O_2 permeability
- ✓ Add citric acid solution or lactic acid solution, seal and Store at 4 °C

Operation Sheet 3– Making Gouda cheese

Objectives:

- To identify Equipment and ingredients used for Gouda cheese making
- To make Gouda cheese

Ingredients

- Raw milk
- Rennet
- starter culture (Mesophilic)

Materials required

- Stainless steel double jacket cheese vat
- Cheese curd cutting knife
- Round cheese molds
- Cheese press
- Brine tank
- Curing room with wooden shelves
- Wax

Procedures

Use fresh milk for manufacture of ripened cheese. Gouda cheese can be made from full-fat milk or standardized milk of 3-3.5% butterfat depending on the desired fat content in the final cheese (full-fat of half-fat cheese).

1. Pasteurize the cheese milk at 63°C for 30 minutes/
2. Cool the pasteurized milk to 32°C.
3. 1 - 2 ml of annatto per 1000 kg of milk may be added during the winter months.
4. Add mesophilic starter culture according to the instruction of the manufacturer of starter. 0.5 - 1% starter (Hansen DVS 1ml/L cheese milk)
5. Leave the milk to ripen for about 30 minutes; the acidity should drop to 6.45-6.5.
6. Add rennet at a rate that will cause coagulation within 30-40 minutes./ according to the instruction of the manufacturer of rennet/25 ml/100 L
7. Add $CaCl_2$ at rate 60 ml/100 L
8. Coagulation/resting - 25 – 30 minutes

9. Test the firmness of the curd to see. If it is strong enough to be cut without shattering cut the curd into 5 mm cubes.

10. Stir the curd gently while cutting (stabbing) larger pieces.
11. Settle for about 10 minutes and remove some whey

12. Raise the temperature slowly from 32°C by adding hot whey directly to the cheese curd or adding hot water in the jacket so that temperature of the curd reaches 38-40°C in 30-40 minutes. This called cooking the curd. Check the firmness of the curd. It should feel firm but not rubbery

13. Settling curd

- Stop stirring
- Collect the curd, and leave for 5 minutes

14. Molding

- Fill the molds equally with the curd
- Apply a cheese-number on each cheese

15. Scoop the curd and press it in the round mold designed. pressing for 2 -3 hour; 1st hour 4 -5 weight of the curd, 2nd hour 5-7 weight of the curd , 3rd hour 7 – 10 weight of the curd

16. Resting/acidification

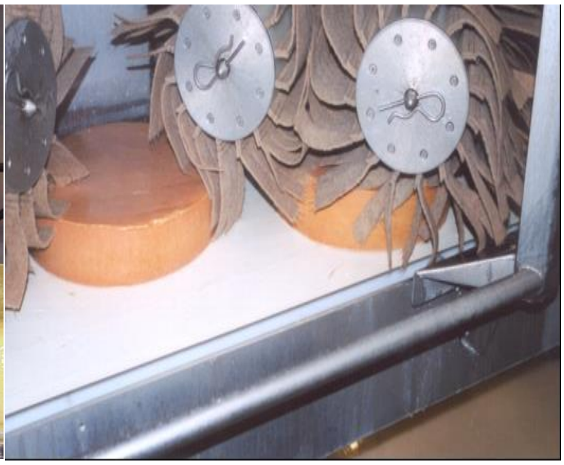
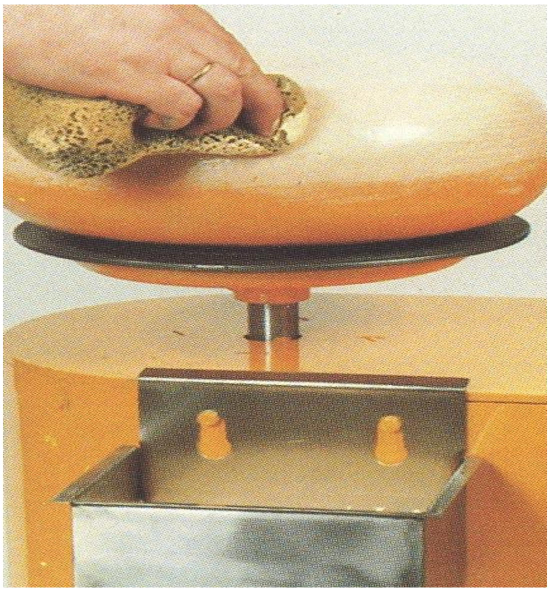
- Leave the cheese in the mold, without net, to acidify to pH 5.2 – 5.4
- Required time is normally 6 hours after addition of the starter
- be sure curves are well rounded

17. Brining

- 1.5 days or 36 hours (4 kg cheese)
- Turn the cheese every 12 hours (or use the rack to keep under the brine surface)

18. Coating

- Let the cheese dry during 12 - 24 hours
- Coat one side of the cheese using a wet sponge and plastic coating
- Wait 24 hours before coating the other (second) side
- Cover every side 2 times with plastic coating
- Before selling coat again


19. Ripening/aging and storage

- Wait at least 28 days until selling
- Turn the cheese every 24 hours
- If necessary wash or coat the cheese
- Let the cheese ripen till the required taste (normally 2 to 6 months)

Operation Sheet 4– Making Provolone cheese

Objectives

- To identify: Equipment and ingredients used for Provolone cheese making
- To make Provolone cheese

Ingredient

- Raw milk, Culture, Rennet, Salt

Equipment's

- Pasteurizer
- pH meter
- Thermometer
- Cheese knife and wax

Procedure

1. Standardize milk to Protein/Fat = 1.17, pasteurize and cool to 38^{o}c
2. Add thermophilic starter (S. thermophilus and L. bulgaricus) Ripen at 38^{0}C for 20min until acidity increases 0.01%.
3. Add lipase enzymes as directed by manufacturer's instructions.
4. Measure 190 ml rennet per 1,000 kg milk. Dilute the rennet with 10 volumes of water and add the mixture to the milk. Milk should set in 30 min.
5. Cut when curd is firm with 1/4" (6.4 mm) knives.
6. Agitate gently for 10 min. and then cook according to the Cheddar heating schedule to a final temperature of 39C in 30 min.
7. Stir the curd and whey for about 10 min., and then allow the curd to settle for 5 min. Drain 1/3 of the whey and store it in a cylindrical vat for use in Ricotta cheese manufacture. Resume agitation until the pH of the whey is 6.1 - 6.2. Then allow the curd to settle for 5 min. before removing the remaining whey.
8. Form the curd into a continuous slab 12 - 20 cm (5 - 8") deep and 45 cm (18") wide along the sides of the vat. Trim the edges and put loose curd under the slab.
9. After 10 min. cut the slab into blocks 20 - 30 cm (8 - 12") wide and turn every 15 min. until the pH is 5.4. Pile the blocks two high on the third turn.
10. When cheese pH is 5.4 and curd strings in 77C water, mill or cut the curd into strips as in Cheddar cheese manufacture. If stretching is to done by hand, wait

until the pH is 5.2 - 5.0. Test the curd by dipping a small piece in hot water for 30-45 s or until the whole piece is heated to 55-60C. Remove the curd from the water and stretch. When the curd is ready to work, it should stretch easily to 25 - 50 cm without breaking. Do not hurry to start working.

11. Work the curd in a mechanical stretch machine. Or, if working and stretching is to be done by hand, cover the curd with its weight of hot (>70C) water. Fuse, stretch and work curd until it looks and stretches like taffy. The internal temperature (greater than 50C) and pH (5.3 - 5.0) must be right for this appearance. Work and roll the stretched curd into desired shapes. Beginners will not want to make the large styles at the first attempt. Learn to seal the ends of the curd first. Keep curd hot while working by dipping it in the hot water. When the curd is formed and sealed, drop it in cold water until chilled and hardened in shape. If the curd gets to hot (>60C) or remains in the hot water too long, it will lose stretchability and moldability.
12. Float the curd in 22% salt brine. Salting time depends on the size of the cheese. Most of the cheeses made in our teaching labs at Guelph are less than 1 kg. Three to four hours of brining is sufficient for these small cheeses.
13. Hang the cheese in the conventional smooth rope or plastic netting. The cheese may be lightly smoked in a cool room for 2 - 4 hrs. Alternatively, vacuum pack the cheese.

Operation Sheet 5– Making Feta cheese

Objectives:

- To identify: Equipment and ingredients used for Provolone cheese making
- To make Provolone cheese
- Ingredients
- Rennet, mesophilic starter culture and salt

Equipment

- A pasteurizer either vat or cont.
- Cheese curd cutting knife
- Cheese molds
- Brine tank

Procedure

1. Standardize the milk to 3.3% fat
2. Pasteurize At 63°C for 30minutes or 72°C for 15 seconds
3. Cool down to 34°C
4. Culture addition pre-ripening 20-30 minute
5. Add commercial rennet at the rate of producer's instruction. Leave the milk until a firm clot has formed. This usually takes 30 to 40 minutes.
6. Cut the curd into 1 to 2 cm to facilitate whey drainage. Stir intermittently during this time.
7. Allow the curds to settle and decant the supernatant whey.
8. Transfer the curds and some whey to cheese molds lined with muslin. Place the lid on the mold and invert at half-hourly intervals in the first few hours (usually 3x within interval of 30 min) to facilitate whey drainage.
9. Allow the curd to settle overnight.
10. Cut the curd mass into blocks of suitable size and sprinkle them with salt.
11. Place the salted blocks in a 15% brine solution to give 6-8% salt in the cheese at equilibrium.

Operation Sheet 6– Making cheddar cheese

Objectives:

- To identify: Equipment and ingredients used for Cheddar cheese making
- To make cheddar cheese

Ingredients

- Rennet
- Mesophilic culture
- Coloring agent/optional/

Equipment

- Cheese making equipment and accessories
- Thermometer
- Curd Knife
- Cheese cloth
- Cheese wax and Cheese press

Procedures

1. Standardize milk about 3.3% fats.
2. Pasteurize at 63^{o}C for 30 min. or 72^{o}C for 15 sec. and cool to 30^{o}C.
3. Add starter according to manufacturer of the culture to the milk.
4. After about half an hour adds rennet at a rate of (according to manufacturer guideline).
5. When the curd is firm enough, i.e. in 30–40 min, cut it into 1.25cm cubes.
6. Stir the curds and whey and heat gradually to 38–40^{o}C in about 30 min.
7. Continue stirring until the curd pieces have firmed and an acidity of 0.20% lactic acid has been reached.
8. Drain off the whey the curds mat together.
9. Keep the cheese block or blocks warm (30^{o}C) and turn frequently until the correct texture and acidity is reached. This process (Cheddaring) may take 1.5–2 hours after the whey is removed.
10. Break up the cheese blocks into small pieces (milling) about 3-4 cm long.
11. Add salt to the curd pieces at a rate of 2-2.5%. Distribute the salt evenly and mix well with the cheese curd.

12. Pack the salted curd into molds lined with cheese (muslin) cloth and press. Apply pressure gently at first and then increase to ensure that the curd pieces mat. If too much pressure is applied the expressed whey from the curd is milky white indicating high fat losses while too little pressure results in poor matting of the curd pieces and a cheese which will not retain its shape during storage.
13. After removing from the mold cover the surface of the cheese with wax
14. Store the cheese at ambient temperature; lower temperatures (15^{o}C) will slow down the rate of ripening. Storage temperatures can therefore be varied to give a rapid or slow maturing cheese.
15. The ripening or storage period of the cheese can vary from four weeks to two years depending on the manipulation, e.g. rate of acid production of the recipe and temperature of storage.

Operation Sheet 7– Making parmesan Cheese

Objectives

- To identify: Equipment and ingredients used for parmesan Cheese making
- To make parmesan Cheese

Ingredients

- Raw Milk
- Culture
- Rennet
- Salt
- Bottom of Form

Equipment

- Curd Knife
- Thermometer
- Slotted Ladle
- Cheesecloth
- Large Colander
- Cheese Mold
- Cheese Press or Weights

Procedure

1. Standardize the milk and pasteurize the milk
2. Cool it at 34°C and add culture, stir for 1min. then wait for 30 min. or use mother culture
3. Add rennet then stir for 30 sec. and wait for 20-30min for coagulation.
4. Cut the curds to about 3/8 to 1/4 inch. And stir for 10 min.
5. Then the water bath should be heated to achieve the final curd temp of 55-56^{o}c slightly in 20 min. by adding enough of the boiling water to the sink or outer hot water jacket with cont. stirring. The obvious 'science' here is that the small curd

size, rapid speed of stirring in the vat and high heat do a great job at drying the curds out evenly.

6. Consolidate the curd in the whey with the help of cheese cloth.
7. We are missing the weight of that large curd mass, so will not quite accomplish the tight consolidation of the larger cheese-but this will work just fine. We will simply need to add a bit more weight in the final molding step.
8. Immediately after achieving the proper curd, it is time to transfer the curds to a cloth lined colander. Collect the whey to pour back into the pot and reheat to 135^{o}F.
9. Form the cloth and curds into a ball and submerge the cloth with curds in warm whey at 57^{o}c for 60 minutes. It is best to allow this cloth of curds to "free-hang" by tying the cloth around a bar or long spoon across the vat. Make sure the entire curd mass remains submersed in the whey. This will help in forming a natural round curd mass.
10. At 10-15 minute intervals, untie and roll the curd mass back and forth in the cloth to consolidate it into a smooth surfaced mass.
11. At this point the culture will not be active due to the high temp, but this step is needed for the "Grana" structure of the cheese. It is "soft" consolidation of the small curds that gives the cheese its characteristic grain or 'Grana' structure.
12. Finally, retrieve the consolidated curd from the warm whey and transfer the consolidated curd mass in the cloth to the prepared mold. At this point the curd should have formed a nice smooth surfaced mass. Press firmly with hand pressure into the mold, but do not break the curd mass.
13. The mold should already be sanitized and placed into its draining area. Now transfer the consolidated curd mass in the cloth to the prepared mold. At this point the curd should have formed a nice smooth surfaced mass. Press firmly with hand pressure into the mold but do not break the curd mass. Begin pressing with the follower in place. Initial pressure will be just enough to keep a thin trickle of whey running from the curd mass (10-15 lbs) for 15-30 minutes. The curd should be removed from the press, turned, and re-dressed (smooth out wrinkles) in the cloth at 10-15 minute intervals for the first hour. As whey runoff slows,

increase weight to 25 lbs for another 30-60 minutes and then to 50 lbs for another 8-12 hours. At this point the culture will not be active due to the high temp, so keep the cheese warm (80-85^{o}F) since the culture is still working and acid is being produced.

14. You will need saturated brine prepared for salting this cheese. A simple brine formula is:
    - 1 gallon of water
    - 2.25 lbs of salt
    - 1 lbs calcium chloride
    - 1 tsp white vinegar
15. Bring the brine and cheese to 10-12°c before using. The cheese should place in the brine solution for about 6.5 hours per pound of cheese
16. For aging, the cheese is now ready to dry off for a day or two and then can be aged at 80-85% moisture and 11-14^{o}c. Mold should be brushed or rubbed down with a medium stiff brush or coarse cloth as it develops. After about 1-2 weeks the rind should harden somewhat and the mold will not grow as readily. A light coat of oil will also discourage mold growth and make the mold easier to remove. This cheese will be somewhat earlier in ripening and should show good character at about 12-14 months.

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Operation Sheet 8– Making ricotta cheese

Objectives

- To identify: Equipment and ingredients used for ricotta cheese making
- To make Ricotta cheese

Ingredients and Equipment

- Whey left over from making Mozzarella and/or Provolone
- Raw milk
- Thermometer
- Stainless steel pot
- Bowl
- Cheese cloth
- Refrigerator

Procedures

1. Place the whey left over from making Mozzarella and/or Provolone in a stainless steel pot
2. Cover and let sit overnight (12 to 24 hours) at room temperature to develop sufficient acidity.
3. The next day, heat the acidified whey over a moderate fire stirring continuously (do not let it stick or burn) until its temperature is near boiling (200°F or 95 °C). Do not let it boil over.
4. Remove whey from the heat. Cover and allow the "cooked" whey to cool undisturbed until it is comfortable to the touch – this will take several hours. Do not stir up the curds.
5. Gently scoop out most of the fine, delicate curds with the fine strainer and place in them a bowl.
6. Place a large strainer over a large bowl, lined with a boiled fine white cotton handkerchief or very fine clean cheese cloth. Pour the remaining whey through

the cloth (it will filter through very slowly). After most of the whey has drained through, add the curds and continue to drain.

7. Allow the whey to drain out for 1-2 hours. Then pick up the corners of the cloth, give its light twist and suspend the bag over the sink to allow the last of the whey to drain out of the ricotta. This will take several hours. It can be done in the refrigerator overnight.
8. Remove the drained ricotta from the cloth, pack into a container, cover and store in the refrigerator. Freeze or use it soon after making

Operation Sheet 9– Making cream cheese

Objectives

- To identify: Equipment and ingredients used for cream cheese making
- To make cream cheese

Ingredients

- Raw milk
- starter culture

Materials required

- Stainless steel double jacket cheese vat
- Thermometer
- Cheese cloth

Procedure

1. Past. At 63°C for 30minutes or 72°C for 15 seconds
2. Cool down to 40°C
3. Add Culture and stirring for 10-20 seconds
4. warm the milk to 40°C in vat for 3 – 10 hours(as a time increase the sourness and curd formation also increase)
5. Allow the curds to settle and decant the supernatant whey
6. Gently scoop out most of the fine, delicate curds with the fine strainer and place in them a bowl.
7. Place a large strainer over a large bowl, lined with a boiled fine white cotton handkerchief or very fine clean cheese cloth. Pour the remaining whey through the cloth (it will filter through very slowly). After most of the whey has drained through, add the curds and continue to drain.
8. Allow the whey to drain out for 1 hour. Then pick up the corners of the cloth, give its light twist and suspend the bag over the sink to allow the last of the whey to drain out of the cream cheese. This will take several hours. It can be done in the refrigerator overnight.
9. Properly mix after adding salt and important flavors

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 mozzarella cheese making

Preform successfully mozzarella cheese making

Task 3

Identify ingredients and equipment for Gouda cheese making

Preform successfully Gouda cheese making

Task 4

Identify ingredients and equipment for provolone cheese making

Preform successfully provolone cheese making

Task 5

Identify ingredients and equipment for feta cheese making

Preform successfully feta cheese making

Task 6

Identify ingredients and equipment for cheddar cheese making

Preform successfully cheddar cheese making

Task 7

Identify ingredients and equipment for parmesan Cheese

Preform successfully parmesan cheese making

Task 8

Identify ingredients and equipment for ricotta cheese

Preform successful ricotta cheese making

Task 9

Identify ingredients and equipment for cream cheese

Preform successful cream cheese making

LG #42	LO #4- Implement cheese curing and packaging procedures

Instruction sheet

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

- Applying curing requirements for a range of cheeses
- Monitoring the curing environment
- Adding ripening agents
- 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 curing requirements for a range of cheeses
- monitor the curing environment
- Add ripening agents
- 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 curing requirements for a range of cheeses

1.1 Applying curing requirements for a range of cheeses

Treatment of cheese during storage (ripening)

After brining the cheese must be carefully dried. The first days the cheese could be dried in the brining room, where the temperature is relatively low and the humidity high. After 24-48 hours the cheese can be transferred to the storeroom. Here the cheese is turned regularly:

- Every day for two weeks;
- Every second day for the next 3-12 weeks.

The purpose of turning is:

- To prevent deformation of the cheese;
- To facilitate evaporation from both sides of the cheese;
- To prevent the cheese to get stuck to the shelf.

It is very important to prevent and restrict the growth of fungi on the cheese surface. Fungi***:***

- Affect the rind, and even the cheese under the rind;
- Other organisms may follow the fungi, as the rind has become a weak barrier;
- Fungi may produce products that enter the cheese and affect the taste adversely (sometimes toxic substances may be produced by fungi);
- A cheese overgrown with fungi does not look nice.

The growth of fungi can be restricted by:

- Maintaining the proper storage conditions everywhere in the store room;
- The store room must be kept clean as must the shelves;
- Clean the cheese regularly with a cloth soaked in water and vinegar;

- Coat the cheese with a plastic coating;
- Before selling: clean the cheese and coat it with paraffin.

Coating

The cheese surface is coated with a plastic emulsion that forms a protective layer against mold attacks. Some plastic coatings contain fungicides (natamycin):

- Apply the first coating as soon as the cheese is dry; the coating must be sufficiently thick and brushed into the rind;
- Do not leave any part untreated;
- Repeat after 4-7 days;
- Repeat after 3-4 weeks (if cheese is meant for longer storage);
- Remove fungi before applying the coating.

Note

It is very well possible to produce a good quality cheese without applying a plastic coat. A prerequisite is then, that the cheese is treated every day, if necessary, without exceptions for Sundays, bank holidays, etc.

Rind formation

The purpose of the rind is to protect the soft cheese against attacks by micro-organisms, against drying out and mechanical damage.

The rind consists of cheese with lower moisture content than the rest. The rind should preferably not ripen to the same degree as the rest of the cheese because a splitting of the casein molecules in the rind will make it less tough and cohesive. A cheese in which the casein has been decomposed cannot form a tough rind, even if dried very strongly.

The conversions that take place in the cheese are prevented in the rind by the lower moisture content and by the high salt concentration at the beginning of the storage period.

Rind formation already starts during pressing, continues during brining, but is strongest in the storeroom due to water evaporation from the cheese.

The temperature, humidity and air circulation in the cheese store mostly determine the rate at which and the extent to which the rind is formed. If the air does not circulate, the temperature and humidity may be very different in different parts of the storeroom.

Temperature, humidity, and air circulation must be monitored constantly.

The protective functions of the rind can be performed instead by a synthetic film (protection against drying out and micro-organisms) and by a stiff carton or the like (protection against mechanical damage).

When assessing the quality of cheese one has to look at the composition, the bacteriological quality, and the organoleptic quality.

The storage of cheese starts after its manufacture. Often, this is after the salting. In Cheddar cheese making salt is mixed with the curd before pressing. Feta-type cheeses are first salted, after which they are packaged and cured in brine or in acid whey with salt added. This holds also for the Domiati type of cheese; in its manufacture, the milk is provided with a high salt content (8% to 15% NaCl), and acid is produced in the cheese by salt-tolerant lactic acid bacteria.

The storage of ripening cheese is aimed at making and keeping it suitable for consumption. The product should develop its characteristic properties: flavor, consistency, body (cross-sectional appearance), and rind. Any loss, especially that caused by excessive evaporation of water, as well as deterioration of the rind and/or of the texture due to undesirable microbes and cheese mites, should be prevented. For some cheeses, the handling during curing may require more labor than the manufacture proper.

The actual treatment significantly depends on the type of cheese involved and varies with the progress of maturation. Various types have a short ripening time and shelf life, whereas other cheeses are adapted for extended storage.

The following factors are the main variables:

A. pH

- The pH profile is the single most important trouble-shooting tool. Critical points are: cutting, draining, milling, forming, 1 day and 7 days.
- Most predominantly rennet coagulated cheese with some exceptions, should reach a minimum pH of 5.0 – 5.3 during the first week after manufacture. Obtaining a final pH in this range is greatly helped by increased buffer capacity of milk proteins in the pH range 5.2 – 4.6.
- Factors determining the pH at 1 day are amount of culture, draining pH, washing, curd treatment such as curd ripening, and salting.
- Draining pH is most important to cheese texture and also determines residual amounts of chymosin and plasmin in the cheese.
- pH increases with age due to release of alkaline protein fragments. This is especially true of mold ripened cheeses. The pH of Camembert increases from a pH of 4.6 to a pH of 7.0, especially on the surface.
- Increasing pH during curing encourages activity of both proteases and lipases.

B. **Temperature of Curing**

- Cheddar types: it is desirable to initiate ripening for several weeks at 4 – 6ºC and then increase the temperature to 8 – 10ºC. Low temperature initially, minimizes early growth of starter and non-starter bacteria and reduces the risk of off flavor development. It also minimizes the risk of the minimum pH reaching levels below 5.0.
- Most firms to hard varieties are ripened at 10 – 15ºC and then stored at about 4ºC until consumed.
- Most surface ripened varieties are ripened at 12 – 15ºC and then stored at about 4ºC until consumed.

C. Humidity of Curing

Surface ripened cheeses also require adequate air circulation to provide sufficient oxygen for molds and yeasts. Humidity requirements in general are:

- Washed bacterial surface ripened: 90 – 95%
- Fungal flora: 85 – 90%
- Dry rinds: 80 – 85%

D. Air conditions

Humidity, temperature, and velocity of the air affect the vaporization of water. The air humidity has a considerable effect on growth of microorganisms on the cheese rind. To allow the cheese to retain a satisfactory shape, the ripening cheese loaves should be turned, initially frequently. Such turning should also enhance the growth of any aerobic flora on the whole cheese surface and prevent, in cheese without a specific surface flora, the growth of microaerophilic microorganisms between loaf and shelf. The air humidity in the vicinity of the cheese surface (the 'microclimate') can appreciably differ from that elsewhere in the storage room.

Rate and extent of vaporization can be partly responsible for developing microbial defects in that the cheese does not become dry enough. On the other hand, the cheese should not dry too quickly, especially not just after brining, as this may cause cracks in the rind. (Sometimes the cheese loaf is rinsed with water after brining, causing the rind to become more supple.) Initially, the relative humidity may be taken somewhat lower and the air velocity higher, if the cheese has not been pressed or was pressed in such a way as to form a weak rind.

Vaporization causes the rind to become firmer. If much water vaporizes the cheese rind turns into a closed horny layer that slightly retards the transport of water and gases. Surface-ripened soft cheese often develops a thin crust containing much calcium phosphate, especially when the pH of the rind becomes high. Of course, vaporization implies loss of weight. This loss approximates 0.2% per day for the first 2 weeks in Gouda cheese (10-kg loaf).

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 purpose of turning?(3pts)
2. What is effect of fungi growth on the cheese surface?(4pts)
3. The growth of fungi can be restricted by?(4pts)
4. What are factors which cause main variables on ripening time and shelf life? (3pts)

Note: **Satisfactory rating - 14 points Unsatisfactory - below 14 points**

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

Score = ___________

Rating: ____________

Information sheet 2– Monitoring the curing environment

2.1. Monitoring the curing environment

Types of cheese that are cured are considered, i.e., the types produced most. Can distinguish:

- Types of cheese with a specific surface flora or internal molds, in addition to the normal flora of lactic acid bacteria
- Types without a specific flora

Cheese ripening

As stated before, in the store room the characters of most cheese changes completely. The changes are performed by enzymes and micro-organisms in the cheese and on its surface. The effect of these enzymes and micro-organisms depends on a number of factors like pH, moisture and salt content of the cheese, the storage temperature and humidity, and the surface treatment during ripening. The organic matter in the cheese that is converted during ripening is lactose, citric acid, protein and fat.

Fermentation of lactose and citric acid

Lactic acid bacteria ferment within 24 hours the lactose present in cheese. The decreasing pH encourages syneresis and inhibits the development of pathogenic and otherwise harmful bacteria. A further development of lactic acid bacteria and a required secondary flora is, however, still possible. Enzymatic processes in cheese do take place, but usually at a low rate. The ripening of cheese takes, therefore, a long time.
If the starter culture contains aroma bacteria, which is normal for Gouda and Edam, the citric acid is fermented into acetic acid, acete-aldehyde, diacetyl, carbon dioxide, etc.

Carbon dioxide is dissolved in the moisture of the cheese until the point of saturation, after which further development of CO_2 will lead to the release of gaseous CO_2, which will collect in the small spaces between the curd grains and expand these. In Gouda and Edam this will create round eyeholes, provided that the cheese curd has fused sufficiently and has developed a sufficient degree of elasticity.

Lactate fermentation

The lactic acid can also be fermented by lactate fermenting micro-organisms. In Gouda and Edam this kind of fermentation usually leads to defects in the cheese: late blowing.

Propionic acid bacteria can convert lactate into propionic acid, acetic acid and carbon dioxide.

In Swiss-type cheeses, the production of large quantities of CO_2 is a necessity to make the large holes, characteristic for these cheeses.

Propionic acid and acetic acid also influence the flavor of the cheese.

The growth and metabolism of propionic acid bacteria are promoted by weak acidification and salting and by high storage temperatures.

Butyric acid bacteria can convert lactate to butyric acid, CO_2, hydrogen, etc. The strong gas production (CO_2 and H_2) will cause late blowing in Gouda and Edam. Furthermore, butyric acid and the other constituents formed by butyric acid fermentation will create an unclean and bittersweet flavor. The growth of butyric acid bacteria is inhibited by strong acidification and salting and by low storage temperatures.

Some hetero fermentative lactobacilli are capable of producing gas in cheese in which unfermented citric acid (e.g. Cheddar) or lactose (e.g. Feta) remains. Such bacteria may also create slits and large holes as well as an unclean flavour during the final stages of ripening.

Lipolysis

When triglycerides of milk fat are hydrolyzed, glycerol and fatty acids are released. The fatty acids, especially butyric acid, caproic acid, caprilyc acid, and capric acid, have sharp, pungent flavours which in milk and butter are called rancid, but which are desirable to some degree in many cheese varieties, including Gouda and Edam.

Fat is broken down by fat-splitting enzymes: lipases. Mesophilic lactic acid bacteria do not produce lipases and there are no lipases in the rennet.

Different lipases may contribute to the lipolysis in cheese:

- Milk lipase

Milk lipase is inactivated by HTST-pasteurization (≥ 95%). In cheese made from raw milk, it plays an important role. It is not sensitive to NaCl. In cheese it is more active at a lower pH, although its optimum pH is high.

In cheese made from pasteurized milk its activity should be minimal.

- microbial lipase

  In general, lipase-producing bacteria do not survive an HTST-treatment, nor can they compete with the lactic acid bacteria in the cheese. But lipase-producing bacteria, especially Gram-negative, psychrotrophic, rod shaped types, may grow in raw milk before pasteurization even if the milk is cold stored. Such bacteria can produce lipases and proteases that will survive pasteurization even if the bacteria themselves are already killed by thermization.

- Enzyme preparations

  In the manufacture of Feta cheese from cow-milk enzyme preparations with lipase activity are used.

Proteolysis

The protein molecules in cheese consist of chains of many interlinked amino acids. Most protein in cheese is para-casein. During ripening, the casein molecules are split into poly-peptides. Polypeptides can be split further into free amino acids, and free amino acids can be broken down completely too inorganic constituents: ammonia, carbon dioxide, water. To a greater or lesser degree, all these processes happen simultaneously during ripening.

The proteolytic products are very important for the flavor as well as for the consistency of the cheese. Some peptides are bitter tasting, whereas the taste of amino acids is more sweet and agreeable and, furthermore, characteristic of each amino acid. Too much peptide in relation to the amount of amino acids may give the cheese a bitter flavor.

At the beginning, the consistency of a normally acidified, semi-hard cheese is rubbery and elastic. Because of the protein splitting during ripening, the cheese will gradually become less cohesive, i.e. its consistency changes from being rubbery to becoming more pliable and sliceable. With prolonged storage and extensive proteolysis, the consistency will gradually become more brittle and crumbly.

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. The effect of t enzymes and micro-organisms depends in cheese making depends on different factors. Write at list 6 factors? (6pts)

Test II discussion

1. Discussed on the following enzymatic and microbial reaction? (10pts for each)

Note: **Satisfactory rating - 36 points** **Unsatisfactory - below 36 points**

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

Score = ___________

Rating: ____________

10.2. Adding ripening agents

Ripening of cheese includes all the chemical changes occurring in the cheese, some of which begin before the curd making is finished. The structure and composition of the cheese changed and hence its organoleptic properties. Biochemical and microbiological, as well as purely chemical and physical aspects are involved. Development of cheese properties, including consistency and flavor, is especially attributable to the conversion of lactose, protein, fat, and, in some cheeses, citrate.

Cheese ripening involves three main processes namely:

- The decomposition of protein (proteolysis),
- The decomposition of lactose (glycolysis)
- The decomposition of fat (lipolysis).

Changes during cheese ripening may be divided into two general stages. The first stage (primary fermentation) which includes changes that occur in carbohydrate, fat and protein content of the cheese curd, resulting in the accumulation of lactic acid, fatty acids and free amino acids, which are responsible for the basic textural changes and flavor that occur during ripening/ maturation. The second stage (secondary fermentation) comprises changes involving the formation of flavor, aroma and/ or volatile compounds brought about by the action of enzymes primarily from microorganisms on the primary fermentation products which include – deamination, decarboxylation and desulfurylation of amino acids, β - oxidation of fatty acids, further fermentation of the organic acids and even some synthetic changes i.e. esterification. These secondary changes are responsible for the finer aspects of cheese flavor and modify cheese texture.

The gradual breakdown of carbohydrates, lipids and protein during ripening is mediated by several agents, including:

- Residual coagulant.
- Starter bacteria and their enzymes.

- Non- starter bacteria and their enzymes.
- Indigenous milk enzymes, especially proteinases
- Secondary inoculant with their enzymes

The activity of an enzyme in cheese naturally depends on the enzyme concentration. Obviously, for microbial enzymes the final number of organisms in the cheese is an essential parameter, as is lysis of cells. Moreover, the activity of all enzymes depends on the conditions in the cheese, which may alter significantly during ripening. The following are important variables:

- **Acidity:** Every enzyme has its optimum pH at which its activity is highest.
- **NaCl content of the moisture in the cheese**: NaCl at fairly low concentration activates certain enzymes but inhibits others.
- **Ripening temperature**: Under normal conditions, activity increases with temperature. The effect of temperature is stronger for lipolysis than for proteolysis.
- **Water content of the cheese**: This affects the composition of the cheese moisture (for example, the calcium ion activity) and the conformation of proteins. This means that the enzyme activity may depend on the conformation of the enzyme and, for proteolytic enzymes, on that of the substrate.

Clotting enzymes

These enzymes, which have a specific function in milk clotting, also have a considerable effect on proteolysis in cheese and the ensuing properties of the product. The action of calf rennet (consisting of chymosin and 15 to 20% pepsin, as calculated on clotting activity) greatly depends on the amount of rennet retained in the cheese. It should be realized that the chymosin included in the cheese originates almost completely from adsorption onto the paracaseinate. It is not well known to what extent this is also true for other milk clotting enzymes.

The following factors determine the amount retained:

- **The amount of rennet added to the milk**.

- **The pH during curd making**: The lower it is, the higher the quantity of calf rennet that is adsorbed onto the paracasein. Hence, factors having an effect are the initial pH of the milk, rate of acid production by the starter; percentage of starter added, addition of $CaCl_2$, and preacidification of the milk as, for example, in the manufacture of Camembert.
- **The scalding temperature of the curd**: At a high scalding temperature such as 55°C as applied for Emmentaler cheese, rennet (chymosin) is for the greater part inactivated. At low pH, however, chymosin is more heat-resistant.

Accelerated ripening

Various approaches used to accelerate cheese ripening include:

- Addition of exogenous enzymes
- Increasing the level of LAB enzymes through the use of attenuated starters or an increased rate of lysis
- Use of adjunct cultures
- Genetic modification of starter bacteria
- The use of high hydrostatic pressures
- Elevated ripening temperature.

Obviously, most semi-hard and hard cheeses need a long ripening time. Storage and maintenance of cheese are expensive because of investments in buildings and machinery, and costs of energy and labor. Reducing the ripening time is therefore attractive from an economical point of view, especially for slowly maturing cheese without a secondary flora. Conditions for an accelerated ripening process are as follows:

- The properties of the cheese should not differ greatly from those of the reference product.
- Over ripening of the cheese should be prevented.
- The additional processing costs should not exceed the economic gain of the shortened ripening time.
- Legal and public health aspects should be upheld, for example, with respect to the permissibility of enzyme preparations and their possible toxicity.

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. Cheese ripening involves three main processes. What are there?(3pts)
2. The gradual breakdown of carbohydrates, lipids and protein during ripening is mediated by several agents. What are there?(6pts)
3. The activity of all enzymes depends on the conditions in the cheese, which may alter significantly during ripening. What are those variables?(5pts)

Note: **Satisfactory rating - 9 points** **Unsatisfactory - below 9 points**

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

Score = ___________
Rating: ____________

4.1. 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

Packaging is an important aspect of the curing of cheese. Several factors are involved in selecting a package:

- Type of cheese and its consequent resistance to mechanical damage,
- Presence of a specific flora,
- Wholesale or retail packaging,
- Permeability to water vapor, oxygen, co2, nh3, and light,
- Labeling facilities,
- Migration of flavors from package to product, and
- The system for storage, distribution, and sale (supermarket, specialist shop, and rate of turnover in the market).

These aspects cannot be discussed in detail here but a few remarks will be made:

A. Formerly, semi hard or hard cheese was often treated with paraffin wax, whereas currently many are coated with latex which, of course, is also a kind of packaging.

When the cheese is going to be waxed its surface should be very clean and dry; otherwise growth of bacteria between cheese rind and paraffin wax or latex coating will cause problems, especially because of gas production and off-flavors. Waxing thus can be applied for low-moisture cheese shortly after manufacture, whereas cheese with higher water content may be waxed only after a suitable rind has developed.

B. Some cheese is cured while being packaged in an air- and water vaportight shrinking film, e.g., Saran foil. The cheese may be made in rectangular blocks of up to 300 kg, which are usually intended for sale in prepackaged portions or slices, or for the processed cheese industry.

Compared to normally ripened cheese, important differences are as follows:

- The cheese has no firm rind.
- Its composition is more homogeneous due to moisture losses being quite small.
- The cheese has lower water content immediately after manufacture because this content must meet the requirements for a ‘normal’ cheese after ripening (which loses more water during storage).
- The starter may not produce too much CO2, as otherwise loosening of the wrapping would readily occur (‘ballooning’).
- The larger the blocks, the longer it takes to cool them to curing temperature, increasing the chance of microbial defects to occur.

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.

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/chromeoxide 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.

Packaging

- Vacuum and/or gas flush (N_2 and CO_2) in gas and moisture proof film are common.
- Vacuum alone is not recommended because complete evacuation of oxygen is difficult and small unsightly mold spots often appear.
- Gas flush with CO_2 or blends of CO_2 and N_2 effectively prevent mold growth.
- CO_2 is water soluble so it is absorbed into the water of the cheese and the package becomes tight.
- N_2, which is not water soluble, is useful for applications such as shredded cheese and cheese curd where a loose package is desired.
- High density plastic (rigid) containers are used for fresh cheese such as cottage.
- Oxygen permeable wrap such as grease proof paper and foil-laminated but unsealed wraps are preferred for surface ripened soft cheese.
- Firm to hard cheese with dry rinds or coated rinds may be transported and offered for sale with no further packaging

Vacuum packing

There is a vacuum sealing machine that will provide packaging that is superior to any other type available. For a cheese manufacturer, having a machine that can meet the needs of so many cheese types is a bonus. Vacuum sealing works with bulk cheese, shredded cheese, blocks of cheese, individual snack cheese and more. It doesn't matter if it is natural, organic, or processed; the vacuum sealing benefits are the same and will be the easiest and best way to keep your cheese fresh for optimum shelf life.

Advantages of vacuum sealing cheese

Keeping cheese fresh is a priority along with preserving product integrity. Vacuum packaging easily handles both of those. Let's look at what other benefits vacuum packaging provides for cheese manufacturers. Below are a few reasons manufacturers should choose vacuum packaging for their cheese products:

Product Protection – Protects cheese from spoiling and helps to preserve the flavor, look, and freshness for maximum appeal.

Extends Shelf Life – Vacuum sealing extends shelf life of cheese to 4 to 6 months.

See Through Packaging – Some vacuum packaging allows the consumer to see most of the product they are buying. Foil, containers, and other types of packaging often hide the actual product. A clear sealed package allows the consumer to buy with confidence.

Product Integrity – Along with enhancing look of the cheese, a vacuum seal will keep it free from dust, pests, moisture and any other environmental contaminants that could harm or damage the cheese.

Quick Processing – With the proper machine, vacuum sealing is a very quick and efficient method of packaging and preserving cheese.

Space Saving Equipment – Vacuum sealers are small enough to be convenient to use in smaller processing places such as a farm or small processing facility.

When it comes to cheese, vacuum sealing is the best option for packaging. Simply put, it is designed to maintain freshness while providing the best display and handling options. We've helped many processors find the best cheese vacuum sealing machine to meet their production needs.

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. 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)

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

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

Score = ___________

Rating: ____________

LG #43	LO #5- Assess the organoleptic properties of cheese 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 cheese
- Recognizing different textures of cheeses
- Assessing cheese for evenness of color and finish
- Identifying possible causal factors and making changes

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 cheese
- Recognize different textures of cheeses
- Assess cheese for evenness of color and finish
- Identify possible causal factors and making changes

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 Identifying desirable and undesirable flavors in cheese

1.1. Identifying desirable and undesirable flavors in cheese

The organoleptic quality

In organoleptic evaluation, the different characteristics are, as far as possible, assessed individually. The following scheme could be followed:

I. Shape, size; this should be in accordance with the standard for the cheese under investigation;

II. Rind; the rind must be smooth, well closed and neither too thick nor too thin; the coating should be well applied; cracks because of mechanical damage, poor nets, clothes, etc., should be absent.; the rind should be clean and free from molds and other micro-organisms

III. The body: consistency, texture, color, eyeholes (size, distribution, shape), salt rim, acid rim, saltpeter rim, etc.;

IV. Aroma and taste; this should be in accordance with the standard for the cheese under investigation.

The organoleptic quality is assessed by sense of vision, touching, smelling and tasting. The strength of the rind is testes by touching it. The consistency is assessed by feeling the cheese, by cutting it, by breaking off a piece, and by biting into and chewing the cheese.

The aroma is best assessed through a fresh cut, and when the taste is assessed, the grader should allow him time to distribute the chewed cheese over the surface of his tongue and should not swallow or spit out the cheese until the volatile flavours have been released.

1.2. Identifying desirable and undesirable flavors in cheese

A cheese of satisfactory flavor always contains many different flavor compounds, well balanced. In curd, weak flavor compounds prevail, originating from fat and some other milk components. The initial sweetness in the taste of curd, due to lactose, disappears quickly. Lactic fermentation is responsible for the acid taste characteristic of almost all cheese varieties. In fresh-type cheeses, aroma compounds formed by the starter bacteria (for example, diacetyl) can play an important role. In ripened cheeses, salt are also an essential flavor component; the concentration varies widely among cheese types. The organoleptic saltiness of the cheese is about proportional to its salt content rather than to its salt-in-water content.

In the broadest terms, there are three sources of cheese flavor:

- Flavors present in the original cheese milk, such as natural butter fat flavor and feed flavor
- Breakdown products of milk proteins, fats and sugars that are released by microbial enzymes, enzymes endogenous to milk, and added enzymes.
- Metabolites (various chemicals) produced by starter bacteria and other microorganisms

Flavor and texture development are strongly dependent on:

- pH profile
- Composition
- Salting
- Temperature
- Humidity
- Experience

Large changes in flavor develop during ripening. Protein has no flavor, but many degradation products have. Free amino acids and short-chain peptides contribute to the basic flavor that is perceived in most cheese varieties. These compounds have specific tastes: sweet, bitter, and broth-like, in particular. The stage of ripening largely determines the intensity of the basic cheese flavor. The cheese may develop a bitter flavor if the protein is degraded in such a way that many shortchain hydrophobic peptides are formed.

The protein degradation also greatly affects the cheese consistency and thereby the mouth feels. Presumably, the consistency also affects the flavor perception. Carbon dioxide, although without flavor *per se*, appears to affect the cheese flavor. Loss of CO_2 may contribute to the rapid loss of the typical flavor of grated cheese.

Fat plays an essential part in the flavor of cheese, although largely an indirect part. Reducing the fat content of several well-known ripened cheese varieties results in a much less satisfactory flavor perception, even if flavor compounds associated with the fat as such contribute little to the flavor. Probably, the distribution of aroma compounds over the fat and aqueous phases enhances a balanced flavor. The most important flavor compounds originating from the fat are the free fatty acids formed by lipolysis. The acids impart a somewhat pungent flavor. A pronounced and distinct flavor may be obtained when free fatty acids develop together with flavor compounds from protein degradation. In cheese lacking sufficient basic flavor from proteolysis, free fatty acids are considered undesirable because they impart a soapy-rancid flavor.

The methods currently used to evaluate the quality of cheese flavor are based on sensory evaluation by a panel of experts. These panels are able to monitor the flavor by descriptive tests, to compare samples to a standard, and to detect defects (off-flavors). This evaluation, using the sensory flavor descriptors, allows the establishment of the flavor profile of a cheese sample, a technique widely applied in the dairy industry and research. Instrumental analysis of cheese flavor compounds has concentrated on the volatile compounds, by a combined gas chromatography– olfactometry technique.

Mature cheese contains small amounts of several essential volatile flavor compounds. The compounds are predominantly degradation products of amino acids, including NH_3, various amines (in cheeses with a surface flora), methional (for example, in Cheddar cheese), H_2S, phenylacetic acid, and other compounds. Furthermore, the following components have been indicated: aldehydes, primary and secondary alcohols and their esters, short-chain fatty acids, and δ-lactones.

The characteristic flavor, aroma, texture and appearance of individual cheese varieties developed during ripening are predetermined by the manufacturing process:

- composition, especially moisture, pH, salt

- Micro-flora - starter, non-starter micro-flora and adjunct cultures.

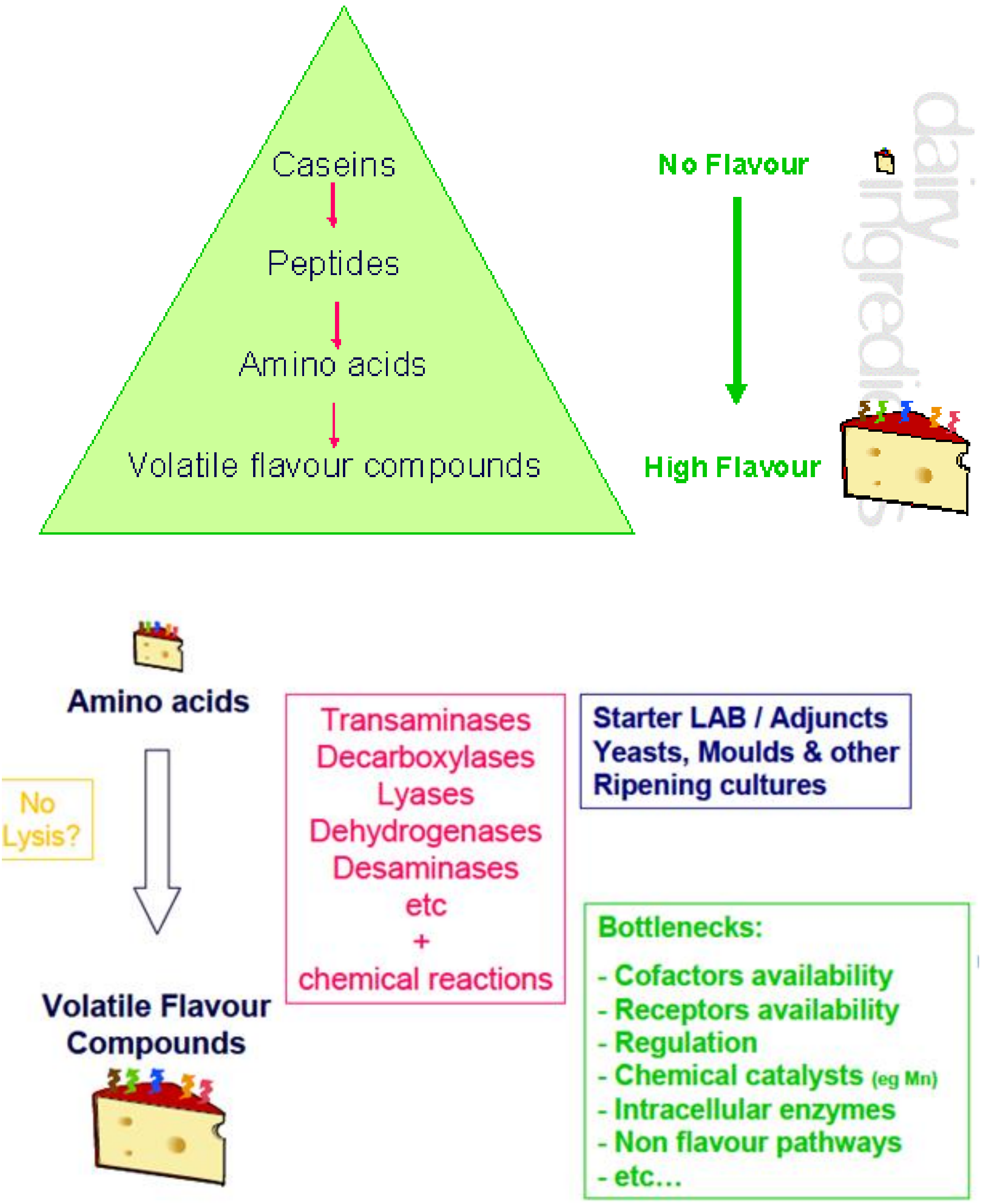

Fig 16 Cheese Flavor–Protein breakdown

Defective flavors

Acid flavor

This results from the development of too much acid at any stage of cheesemaking or curing. It may occur from high acid milk as received, ripening too long before setting, too much starter, improper cutting, cooking too fast or other factors which may interfere with proper expulsion of whey from the curd, or otherwise developing acid faster and higher than normal. Low salt content of cheese may also be a contributing factor.

Bitter flavor

This is a common defect. It is associated with inferior milk and poor starter, with excessive moisture and high acidity in cheese and using too much rennet and unclean utensils. Relatively higher temperature and use of Leuconostoc sp. as starter has been noted to cause the defect. Unclean conditions e.g. rust spots, open seams; milk stones in cans and utensils may cause this defect. Conditions associated directly with the manufacturing operations may also be responsible e.g. excess acid, excess moisture, lack of salt, and high curing temperature.

Fermented flavor

These flavors are characteristics of the odor of fermented whey and possess some of the qualities of the combined odors of alcohol, acetic acid and propionic acid. They may appear in cheese soon after it is made, but they usually develop after the cheese is two weeks old. They are believed to be caused by yeasts or bacteria. These organisms may get into the milk on the farms by contact with unclean and non-sterile surfaces of utensils, milking machines, and milk cans.

This can be prevented by:

- Utmost precaution in plant sanitation,
- Clean and active starter and
- Ripening at 7°C or below.

Fruity flavor

The fruity flavor defect has been described as pineapple, raspberry or pear-like flavor in cheese. The compounds responsible for the defect are esters, certain acetaldehydes and ketones and some alcohols. This flavor defect is closely related to the fermented flavor defect. Hence the origin, prevention and remedies are identical to that of fermented flavor defect.

Rancid flavor

Rancidity is the flavor characteristic of the odor of butyric acid. It is believed to be present in all normal Cheddar. This flavor may come from the milk itself.

Unclean flavor

Flavors that are foreign to milk and cheese but which cannot be identified or otherwise described are usually called unclean. Unclean flavors are often attributed to the development of undesirable microorganisms in the milk, curd or cheese.

Below a number of defects that might occur in Dutch cheeses are mentioned. In a few words possible remedies for the defects are given.

Moldy flavor

It is associated with curing conditions. It is caused by the growth of mold in or on the cheese. Mold will grow in Cheddar cheese only when O_2 gains entry through openings in the rind or through openings or cracks inside the cheese which connect with trier holes or other defects in the rind.

Mold grows slowly on cheese held at low temperature and under dry conditions; it grows rapidly at high temperature and high humidity. It grows most luxuriantly on non-paraffined cheese.

Prevention – Proper paraffining, close texture, sound rind, curing at 7°C and relative humidity below 75% minimize the defect.

Bitter

- Work the curd more intensive and longer to make a dryer curd
- Higher scalding temperature in order to include less rennet
- Use a good starter

Moldy (smell of beer)

- Use a fresh starter
- Prevent contamination of milk with whey.
- Check pasteurization.
- Check the hygienic condition of all equipment.

Foul (caused by coliforms, often accompanied by early blowing)

- Check pasteurization
- Prevent any recontamination.
- Check the hygienic condition of all equipment.

Bitter-sweet (often in connection with butyric acid fermentation)

- Check pasteurization
- Prevent any recontamination
  Use good quality milk

Feed flavors (milk with off flavor form feed).

- Use good quality milk.

Off-flavors (undesirable flavors that cannot be described more precisely)

- Use good quality milk
- Use a good, fresh starter
- Prevent recontamination
- Check pasteurization

Unclean (undesirable flavors that cannot be described more precisely)

- See off-flavors

In cheese made of pasteurized milk the main defects include:

- Butyric acid fermentation
- Off-flavors, usually caused by excessive growth of lactobacilli
- A bitter flavor, which can develop when the cheese retains much rennet while the starter bacteria form too many bitter peptides and decompose them insufficiently

- Cracks in the cheese mass
- Mold growth on or in the rind
- Shape and rind defects (e.g., due to rough handling)

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. Write at list 8 defective of flavors their reason and prevention? (24pts)

Note: **Satisfactory rating - 24 points** **Unsatisfactory - below 24 points**

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

Score = ___________
Rating: ____________

Information sheet – 2 Recognizing different textures of cheeses

2.1 Recognizing different textures of cheeses

The development of a recognizably fibrous texture is part of the manufacturing procedure for a small number of cheese varieties, and this texture was traditionally regarded as an essential organoleptic characteristic of these cheeses.

Texturized cheeses belong to two classes: Cheddar and some closely related varieties, in which a fibrous texture is developed prior to pressing, and pasta filata types, such as Mozzarella and Provolone, in which texturization is accomplished by heating, stretching, and kneading the curd.

During cheddaring, the curd flows under its own weight, leading to fusion and deformation of curd particles, which was believed to be responsible for the "chicken breast meat" structure of fresh Cheddar curd and for the characteristic texture of mature Cheddar cheese. Cheddaring promotes a number of physicochemical conditions that are conducive to curd flow and texturization:

- Solubilization of micellar calcium, which is bound to the casein and acts as a cementing agent between the casein micelles/submicelles
- A decrease in the concentration of micellar
- Ca, resulting in an increase in the ratio of soluble to casein-bound Ca (soluble Ca as a percentage of total Ca in the curd increases from ~ 5% to 40% as the pH decreases from 6.15 to 5.2)
- An increase in paracasein hydration, which increases with decreasing pH in the range
- An increase in the viscous character of the curd

Defects Related to Texture

Open texture is the most common defect in cheese. It may be due to the formation of gas or mechanical faults. The causes of this defect are as follows:

- Contamination of cheese with gas producing bacteria and yeasts.
- Lack of acidity
- Moisture content
- free whey trapped in curd
- Lack of sufficient pressure during pressing of cheese.

Prevention: The defect can be controlled by eliminating source of contamination, using pure culture, and pasteurizing the milk efficiently. Acidity of 0.16% LA at draining, piling high, milling at acidity 0.60% LA, delayed salting; washing the curd with water at 30°C and curing below 10°C also help in controlling the defect.

Blind (no holes)

- Mix some air with the curd just before molding
- Use a starter with more active aroma bacteria
- Make a cheese with a higher pH
- Put the cheese at a higher storage temperature

Brittle (low pH)

- Make a dryer curd
- Add sufficient water to extract more lactose
- Decrease the size of the curd grains
- Prolong post-stirring

Dry (low moisture content/high pH)

- Shorten the curd treatment time and stir at a lower speed to get a curd with higher moisture content
- Use less water (the same cooking temperature) to include more lactose
- Increase the size of the curd grains

Bland (usually high pH and very dry)

- Use less water

- Shorten the curd treatment time and stir at a lower speed to get a curd with higher moisture content
- Use less water (the same cooking temperature) to include more lactose
- Increase the size of the curd grains

Many small holes (air inclusion and/or gas production by bacteria)

- Prevent air inclusion by collecting the curd under the whey.
- Check cheese milk for coliforms

Short (sour and very pale)

- Make a dryer curd
- Add sufficient water to extract more lactose
- Decrease the size of the curd grains

Prolong post-stirring Long (high pH, often dry and tough)

- Use less water
- Shorten the curd treatment time and stir at a lower speed to get a curd with higher moisture content
- Use less water (the same cooking temperature) to include more lactose
- Increase the size of the curd grains

Nests

- Let the cheese rest (15-30 minutes) before applying pressure
- Prevent knitting of particles while working the curd

Open rind

- Press effectively

White rim (the cheese is brittle, sour and salty too).

- Let the curd ripen sufficiently.
- Use an active starter so that sufficient whey will be removed when working the curd.

Fungus (in foil wrapped cheese between plastic foil and rind):

- Evacuate properly
- Package the cheese when it is dry

Whey separation (in foil wrapped cheese between plastic foil and rind):

- Put only cheese with a dry rind in a plastic bag

Slits and cracks in the body (caused by gas formation in short, brittle cheese)

- Make a dryer curd
- Add sufficient water to extract more lactose
- Decrease the size of the curd grains
- Prolong post-stirring

Soft (high moisture content and/or high fat content, usually too acidic)

- Take a longer stirring time
- Take a higher scalding temperature
- Reduce the diameter of the curd grains
- Make a dryer curd

Salty

- Reduce the brining time
- Make all cheese of the same size

Acid (low pH; too much lactose in the cheese)

- Make the curd dryer
- Add more wash water
- See "brittle"

  Note: do not use less starter

Malty (like roasted peanuts; caused by a contaminated or an old inactive starter)

- Use a new starter.
- Check the milk quality

Gassy curd

Irregular closely spaced eyeholes with thin broken membranes between them. It may be caused by lump formation during stirring or coli-fermentation in connection with too slow acidification. Starter cultures with too many Lactococcus lactis subsp. lactis var. diacetylactis can also cause too early and irregular formation of eyeholes.

- Use a new, fresh starter.
- Check the hygienic condition of all equipment.
- Check pasteurization.

Blown

Far too strong gas production, this may be caused by coli fermentation (early blowing, usually a large number of relatively small holes), butyric acid fermentation (late blowing, usually relatively few, but very large holes) or, in some cases, too strong propionic acid fermentation.

- Check pasteurization
- Prevent any recontamination
- Use good quality milk

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. Write at list 8 defective of texture their reason and prevention? (24pts)

Note: **Satisfactory rating - 24 points** **Unsatisfactory - below 24 points**

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

Score = ___________
Rating: ____________

Information sheet – 3 Assessing cheese for evenness of color and finish

3.1. Assessing cheese for evenness of color and finish

Color can give a clue as to what animal made the milk, the animal's diet, and other ingredients that were added to the cheese.

Orange

If a cheese is a deep-orange color it has annatto extract added to it. Annatto is a seed from the South American achiote tree. Studies have concluded it doesn't alter flavor by any measureable degree, meaning that, all other things being equal, orange cheddar and white cheddar have the same flavor. The main pigment in annatto generating the orange color is norbixin.

Yellow

Many cow and sheep cheeses range in color from very pale yellow to very deep yellow. This indicates the extent to which these animals were pasture fed. Grass contains high levels of ß-carotene (yellow color), which is deposited in the milk fat during metabolism. Very pale yellow cheeses probably come from animals that don't feed on grass, or contain less fat.

White

If a cheese is very white (snow white, no hint of pale yellow) then good chances are that it is a goat cheese. Goats' digestive processes break down ß-carotene (yellow) into colorless vitamin A. This leaves very little ß-carotene in the milk, but high levels o vitamin A makes it into the cheese.

Effect on the Color of the Cheese Surface

The orange–red color of cheese varieties originates from carotenoid-type pigments produced by ripening bacteria, such as Brevibacterium sp., Corynebacterium sp., Micrococcus sp., and Arthrobacter sp.

The precise contribution of strains belonging to these genera to the final color of the rind is difficult to determine due to the complexity of the surface microbiota. Nevertheless, *B. linens* (or *B. aurantiacum/B. antiquum*) were long considered to be the main contributor; it produces three distinctive red-orange aromatic carotenoid pigments: isorenieratene, 3-hydroxy-isorenieratene, and 3, 3′-di-hydroxy-isorenieratene depending on the growth conditions (dissolved oxygen concentration and substrates). Moreover, it has been shown that the color of *B. linens* depends on the yeast used for cheese deacidificatio, that is, the color intensity was higher when *D. hansenii*, and not *K. marxianus*, was used with *B. linens*.

Other bacteria have been also reported to be as important as Brevibacterium for cheese color development.

It is believed that complex interactions between the yellow-pigmented bacteria (*Brachybacterium*, *Arthrobacter*, and *Microbacterium*) and other proteolytic and lipolytic microorganisms enable the final coloration of cheeses. *A. arilaitensis* is assumed to be responsible for the yellow pigmentation of the cheese's rind because of its characteristic overall color and its involvement at the different stages of cheese ripening. The yellow pigmentation of *A. arilaitensis* is probably due to the C50 carotenoid, decaprenoxanthin, and recent studies on color contribution of this species revealed a great variation in color development, together with a sensitivity to light exposure.

The color exhibited by surface bacteria is a major criterion used in the screening and selection of strains as adjuncts. Several tests are used, the most relevant being the development of color on model cheeses, which takes into account the interactions between surface microorganisms.

Lipolysis, Proteolysis, Peptidolysis, and Amino Acid Catabolism

Production of extracellular proteases has been shown in cheese surface bacteria, such as *B. linens*, *Microbacterium gubbeenense*, and *A. nicotianae*. These proteases from smear-ripened cheese microorganisms generally show alkaline pH optima, but most of these enzymes have significant activity at cheese pH values of 6.0–7.0.

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. Color difference in final product is due to different factors. What are there?(9pts)

Note: **Satisfactory rating - 9 points** **Unsatisfactory - below 9 points**

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

Score = ___________
Rating: ____________

Information sheet - 4 Identifying possible causal factors and making changes

4.1. Identifying possible causal factors and making changes

The scheme is greatly simplified and applies fully only for some types of cheese. For instance, for Cheddar types, shaping and salting would occur in reverse order, and the timescale would be somewhat different. Nevertheless, the essential changes are given. Much of the figure speaks for itself.

Lactic acid bacteria (predominantly *Lactococcus* species), generally added in the form of a starter, play a key role in the development of flavor and texture.

Their prime action is the conversion of lactose into lactic acid, which considerably lowers pH to, say, 5.1. An important consequence is the dissolution of the colloidal calcium phosphate. The pH decrease greatly affects cheese composition, the rate of syneresis, and the fusion of curd grains into a continuous mass. Moreover, specific flavor components and CO_2 can be formed, and the redox potential (*E*h) of the cheese will be greatly reduced. In most types of cheese, no sugar remains. Some starter organisms also produce antibiotics.

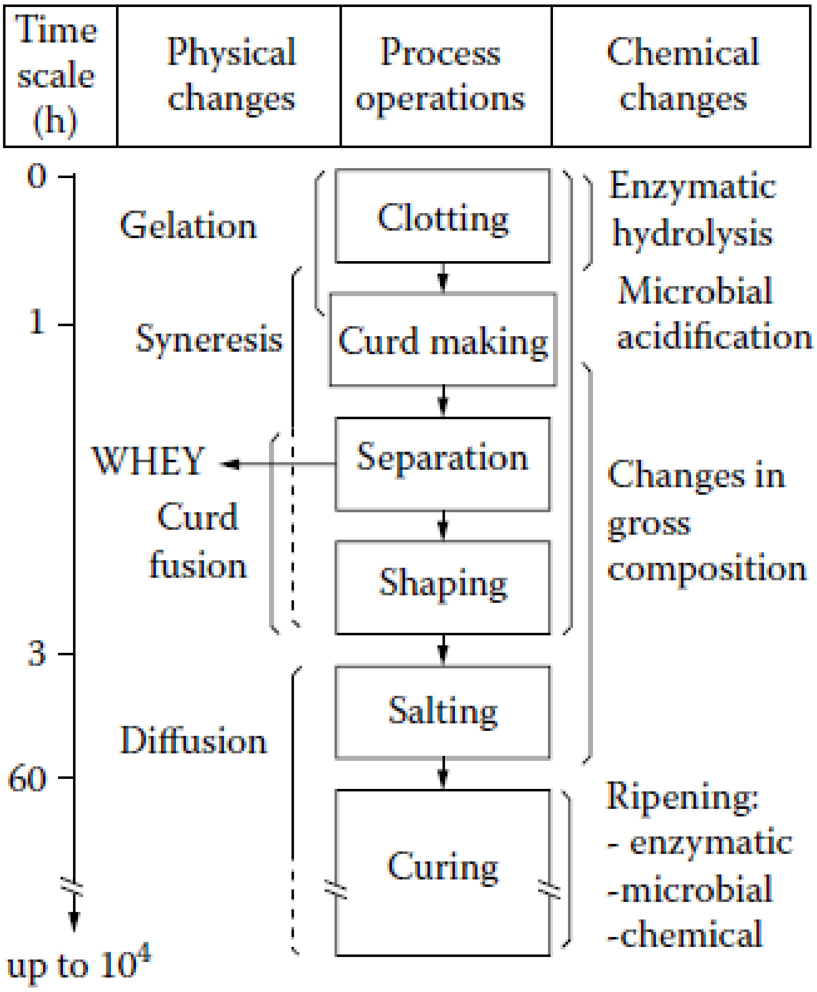

Fig 17 Schematic of the most essential physical and (bio) chemical changes occurring during the transformation of milk into cheese

A number of these factors are of great importance for limiting the growth of undesirable microorganisms and, therefore, for the preservation of the cheese. These concerns:

- The high concentration of lactic acid combined with a low pH;
- The low *E*h, i.e., strictly anaerobic conditions;
- The absence of a suitable carbon source (sugar) for most bacteria; and
- The presence of other inhibiting substances.

The formation of a closed rind around the cheese loaf, caused by fusion of curd particles and enhanced by local moisture loss, prevents further contamination of the interior of the cheese with microbes. Moreover, most cheese is solid-like, implying that bacteria are immobilized and that molecules (enzymes, reactants, etc.) diffuse sluggishly. Oxygen can diffuse into the loaf, but it is rapidly consumed by the enzyme system of the starter bacteria. Salting causes another important change in composition, which further limits microbial growth. The salt also affects flavor, texture, and the ripening processes.

What happens during ripening may be the most complicated and thereby the least understood part of cheese manufacture, although considerable progress has been made in recent years. Several enzymes, originating from milk (e.g., plasmin and lipase) or added to milk (especially chymosin), or from microorganisms (be it starter bacteria or a more specific flora), cause a wide range of biochemical reactions, generally followed or accompanied by purely chemical transformations. The main changes are that a considerable part of the protein is broken down; resulting in peptides of various size, free amino acids, and smaller breakdown products. A small part of the fatty acids is split off the triglycerides. Moreover, diffusion of salt, water, and of the products resulting from the mentioned reactions occurs, especially from the rind into the interior and vice versa. In several types of cheese, a flora of yeasts and bacteria, and often molds as well, grow on the cheese rind, considerably altering cheese composition, e.g., by consuming lactic acid and by producing flavor compounds.

The various process steps are mutually dependent, and any variation in process conditions (temperature, amount of starter added, time allowed for process steps, and so on), influences several changes, not just one. The reactions themselves affect other reactions. Also, composition and pretreatment of the milk influence the results of the process steps and ripening. Altogether, cheese manufacture and curing is highly intricate, and changing one factor always has several consequences. On the other hand, this allows the production of cheese in a great number of varieties.

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. What are the most essential physical and (bio) chemical changes occurring during the transformation of milk into cheese and their changes?(9pts)

Note: **Satisfactory rating - 9 points** **Unsatisfactory - below 9 points**

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

Score = ___________
Rating: ____________

LG #44	LO #6- 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 cheese manufacture
- Implementing health and safety and environmental protection procedures
- Disposing waste and reviewing environmental impact

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 records of cheese manufacture
- Implement health and safety and environmental protection procedures
- Dispose waste and reviewing environmental impact

Learning Instructions:

10. Read the specific objectives of this Learning Guide.
11. Follow the instructions described below.
12. 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.
13. Accomplish the “Self-checks” which are placed following all information sheets.
14. 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).
15. If you earned a satisfactory evaluation proceed to “Operation sheets
16. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
17. If your performance is satisfactory proceed to the next learning guide,
18. If your performance is unsatisfactory, ask your trainer for further instructions or go back to “Operation sheets”.

Information sheet 1 – Keeping records of cheese manufacture

1.1 Keeping records of cheese manufacture

Keeping records of cheese manufacture, including required measurements for timing of operations, temperature, milk and curd acidity, curd weight, hooped yield and curing data.

Record of mozzarella cheese

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

Rennet: ………… ml 20 ml / 100 L

	Time	Temperature	Vat content	pH
Start pasteurisation				
End pasteurisation				
Pre-ripening starter				
Renneting				
Start cutting				
Cooking				
Stirring				
Draining whey				
Cheddaring				
Cutting & Salting				
Stretching				
Moulding				
Cooling				
Packing /storage				

Cheesemaker: ……………………………………… Total time working the curd: ………………

Record of Gouda cheese

Date: .... batch no: .... cheese vat number: 1 / 2 / 3

Pasteurization method: flow / batch

	Kg milk	Fat%	Protein%	Lactose%	TS%	Batch past. 68°C - 30min	Time
Whale milk							
Skimmed milk							
Stand. milk							
1st whey							
2nd whey							

Additives:	Normal addition:
Starter .... ml	(0.5 - 1.0 %) Acidity ………. °N or DVS Type……….
Saltpetre / Lysozyme .... ml	(10 - 20 ml/ 100 L milk) / (10 ml/ 100 L milk)
Dye .... ml	(0 -2 ml/ 100 L milk), annatto
Calcium chloride .... ml	(20 - 60 ml/ 100 L milk)
Rennet .... ml	(18 - 25 ml/ 100 L milk) (Kalase-Chymosin-Maxiren)

	time	Content vat	Curd T°	Wash-water T°	Wash-water liter	Wash-water %
renneting						
cutting						
draining whey						
stirring						
cooking curd						
end stirring						

start pressing						
end pressing						
pH (after 6 hours/ next day						

Calculated yield:..................kg

Renneting time: .... Minutes
Cutting time: .... Minutes
Cooking time: .... Minutes
Total time working the curd: .... minutes

Weight before brining: ....kg
Weight after brining: ....kg
Weight after packaging: ....kg

Number of cheeses: **PTC+number**

___x 1 kg ________________
___x 2 kg ________________
___x 4 kg ________________
___x 8 kg ________________
___x 10 kg ________________

Date: ....……
Days after preparation:........(±12)
Moisture content..............%
Fat content in DM ....%
Description taste, flavor, texture, eyes

Cheesemaker(s): ……………………..........................……. ....…

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

4. What are the most important information Keeping records of cheese manufacture and consumer that must be recorded?(9pts)

Note: **Satisfactory rating - 9 points** **Unsatisfactory - below 9 points**

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

Score = ___________
Rating: ____________

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). When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. These industry sector EHS guidelines are designed to be used together with the General EHS Guidelines document, which provides guidance to users on common EHS issues potentially applicable to all industry sectors. For complex projects, use of multiple industry-sector guidelines may be necessary.

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.

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.

C. 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 multi staged 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)

D. 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.

E. Heat and Cold

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

F. 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.

Test I Short Answer Questions

1. What are the recommended management techniques to prevent and control odor emissions?(4pts)
2. What are the recommended management techniques to prevent and control odor emissions?(4pts)
3. What are the recommendations for the prevention and control of exposures to biological hazards specific to dairy processing?(4pts)

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

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

Score = ___________
Rating: ____________

Information sheet 3 – Disposing waste and reviewing of environmental impacts

3.1. Disposing waste and reviewing of environmental impacts

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.

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 - 12 points** **Unsatisfactory - below 12 points**

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

Score = ___________

Rating: ____________

References

1. Bylund, G. (1995) In Tetru Pak Dairy Processing Handbook, Tetra Pak Processing Systyms AB, Lund, Sweden, pp. 175-1 77.
2. Frank, J. F., Christen, G. L., and Bullerman, L. B. (1993) In Standard Methods for the Examination of Dairy Products, 16th ed., R. J. Marshall, ed., American Public Health Association, Washington, DC, pp. 271-286.
3. Griffiths, M. W., Phillips, **J.** D., and Muir, D. D. (1980) J. Soc. Dairy Techno/., **33, 8-10.**
4. Dairy microbiology handbookthird edition
5. Walstra .P. (1999).Dairy technology: principles of milk properties and processes. Department of Food Science Wageningen Agricultural University Wageningen, The Netherlands.
6. H. D. Kay, J. R. Cuttell, H. S. Han,, A. T. R. Mattick And A. Rowlands. Milk Pasteurization Planning, Plant, Operation And Control. Published Jointly By F Ao And Who And Issued Also As.World Health Organizatiqh: Monograph Series. No. 14
7. Bertucco, A. and Spilimbergo, S. (2006) Food pasteurization and sterilization with highpressure. In: Functional Food Ingredients and Nutraceuticals (ed. J. Shi). CRC Press, pp. 269–295.
8. Boor, K.J. and Murphy, S.C. (2002) Microbiology of market milks. In: DairyMicrobiology Handbook: The Microbiology of Milk and Milk Products, 3rd edn (ed R.K. Robinson). John Wiley & Sons, Inc., New York, pp. 91–122.
9. Bartoszewicz, M., Hansen, B.M. and Swiecicka, I. (2008) The members of the Bacillus cereus group are commonly present contaminants of fresh and heat-treated milk. Food Microbiol, 25(4): 588–596.
10. Bertucco, A. and Spilimbergo, S. (2006) Food pasteurization and sterilization with high pressure. In: Functional Food Ingredients and Nutraceuticals (ed. J. Shi). CRC Press, pp. 269–295.

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