TVET CERTIFICATE III IN FOOD PROCESSING

RAW MILK RECEPTION

FOPMR302

Receive raw milk

Competence

Credits: 5

Learning hours:50

Sector: Agriculture and Food Processing

Sub-sector: Food processing

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Purpose statement

This module covers the skills, knowledge and attitude required to perform raw milk reception in the food processing industry. Upon completion of this module, the trainee will be able to prepare work area, receive raw milk and Grade raw milk.

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Total Number of Pages: 60

0. Introduction

Milk may be defined as the whole, fresh, clean lacteal secretion obtained by the complete milking of one or more healthy milk of mammalian species animals, excluding that obtained within 15 days before calving or 3 to 5 days after calving. Such periods as may be necessary to render the milk practically colostrum free, and containing the minimum prescribed percentage of milk fat and milk-solids not fat.

The term market milk refers to fluid whole milk that is sold to individuals usually for direct consumption. It excludes milk consumed on the farm and that used for the manufacture of dairy products.

About 60 days before the next calving, the cow is **dried off**. There is no milking during this stage for two reasons:

1. Milk has tapered off because of maternal needs of the fetus
2. Udder needs time to prepare for the next milking cycle

Milk composition

- **Water**: Water constitutes the medium in which the other milk constituents are either dissolved or suspended. Most of it is free and only a very small portion is in the bound form, being firmly bounded by milk proteins, phospholipids etc.
- **Total Solids**: Total Solids constituent lipids (Fat) and solid not fat.
- **Milk Fat (Lipids)**: Milk fat is composed of a number glyceride-esters of fatty acids. Milk fat on hydrolysis gives a mixture of fatty acids and glycerol. (The milk fat is a mixture of true fats in established from the fact that it has no sharp melting point). The fatty acids are saturated or unsaturated fatty acids. Saturated fatty acids are relatively stable.

The fat associated substances are phospholipids, cholesterol, carotene and fat soluble vitamins (A, D, E, K).

- **Phospholipids:** Three types of phospholipids, ie. Lecithin, Cephalin and Sphingomylin. Lecithin, which forms an important constituent of the fat globule membrane, contributes to the richness of flavour of milk and other dairy products. It is highly

sensitive to oxidative changes, giving rise to oxidized / metallic flavours. Phospholipids are excellent emulsifying agents, and no doubt serve to stabilize the milk fat emulsion.

- **Cholesterol:** This appears to be present in true solution in the fat, as a part of fat globule membrane complex and in complex formation with protein in the non-fat portion of milk.
- **Fat Soluble Pigments:** Carotene in fat soluble and responsible for the yellow colour of milk, cream, butter, ghee and other fat rich products.
- **Fat Soluble Vitamins:** Milk is rich in Fat soluble vitamins ie. A, D, E and K.
- **Milk Sugar or Lactose:** Is the distinctive carbohydrate of milk. It is a disaccharide composed of glucose and galactose. Lactose is a reducing sugar.

This exists in milk only. It is in true solution in the milk serum. On crystallization from water, it forms hard gritty crystals. It is one-sixth as sweet as sucrose.

Lactose is responsible for the defect known as sandiness in ice-cream or condensed milk. It is fermented by bacteria to yield lactic acid and other organic acids and is important both in the production of cultured milk products and in the spoilage of milk and milk products by souring.

- **Milk Proteins:** The proteins in milk consists mainly of casein, lactaglobulin, lactalbumin, milk serum albumin, immuno globulins etc.

Casein forms more than 80% of the total proteins of the milk. Casein exists only in milk and is found in the form of calcium caseinate phosphate complex. It is present in colloidal state. It may be precipitated by acid, rennet, alcohol, heat and concentration

Lactalbumin and lactaglobulin are known as 'Whey or serum proteins'. They are also present in colloidal state and are easily coagulated by heat. Milk serum albumin is same as blood serum albumin of the blood. Immunoglobulins are present only in colostrum and gives immunity to the calves.

- **Non protein nitrogenous Compounds:** Eg: Ammonia, amino acids, proteose-peptones, urea, uric acid etc
- **Mineral Matter or Ash:** The mineral matter or salts of milk although present in small quantities, exert considerable influence on the physicochemical properties and nutritive value of milk. The major salt constituents i.e. those present in appreciable quantities,

includes potassium, sodium, magnesium, calcium, phosphate, citrate, chloride, sulphate and bicarbonate.

- **Other Constituents:**

Pigment: Water soluble pigments are Riboflavin and xanthophyll. Riboflavin besides being a vitamin, is a greenish yellow pigment which gives characteristic colour to whey. Earlier it is known as lactoflavin or lactochrome.

Dissolved Gases: Milk contains gases like O2, Co2, N2 etc.

Vitamins: Water soluble vitamins B complex and vitamin 'C'

Enzymes: These are biological catalysts. Milk contains Amylase, Lipase, Phosphatase, protease, peroxidase and catalase enzymes.

Factors affecting composition of milk

Milk differs widely in composition. All milk contains the same kind of constituents, but in varying amounts. Milk fat shows greatest daily variation, then comes proteins, followed by ash and lactose.

The various factors that affect the composition of milk are:

1. Species: Each species yields milk has a characteristic composition

Example: The composition of milk of Friesian is not the same as Jersey.

2. Breed: In general, breeds producing the largest amount of milk, yield milk of a lower fat percentage vice versa. Friesian gives less fat whereas Jersey gives high fat in cow breeds.

3. Individual Variation: Each cow tends to yield milk of a composition that is characteristic of the individual.

4. Season: Both fat and SNF show slight but well defined variation during the course of year. A variation in fat percent with maximum values in January and November and minimum in June. For non-fat-solids highest values in January and December. Lower values occur in April and August but during these two months' little increase.

5. Age: Fat percent increase up to 3rd lactation and after wards decreases. SNF will be high in the first lactation and slightly decreases as lactation increased.

6. Milking Interval: When milking is done a longer interval, the yield is more with a corresponding decrease in fat and vice versa. Not much effect on solid-not-fat content.

7. Completeness of Milking: Fore milk contains less fat and stripping (last milk) contains high fat. If the milking is not complete it tests less fat. Not much effect on SNF.

8. Irregularity in Milking: Frequent changes in the milking timings, and frequent changes in milking intervals results less fat and not much effect on SNF.

9. Yield: With increase in yield per milking the percentage of lactose increases, while fat and non-fatty solids decrease

10. Lactation Effect: The first secretion after parturition namely colostrum high in globules and chlorides and low lactose content. The yield increases and attains maximum within 2-4 weeks and then slowly decrease. When the yield is more, Fat and SNF decrease and vice versa.

11. Exercise: More exercise increase fat in milk as body fat is metabolized – no effect on SNF.

12. Excitement: Sexual or freight excitement causes decrease in fat, no effect in SNF.

13. Hormones: Prolactin and thyroid hormone which are essential for milk synthesis increase the fat percentage. Oestrogen has stimulating and depression effect, optimum levels causes increase in fat and higher dose decreases the fat percent.

14. Udder Diseases: Mastitis and other udder diseases causes low lactose and casein %, increase in chloride content. Subnormal SNF is the characteristic of mastitis.

15. Physiological Condition: The condition of cow at the time of parturition has effect on fat and SNF content. Healthy cows give high fat and SNF content.

16. Pasture Feeding: Pasture feeding increase both fat and SNF. Pasture feeding increases unsaturated fatty acids in milk.

17. Feeding: Feeding oils as palm oil, coconut oil increases fat percent where cod liver oil decreases the fat percentage. Starvation increases unsaturated fatty acids in milk.

Learning Unit 1-Prepare Work Area

LO 1.1 – Select Cleaning products

Content/Topic 1: Identify the types of contaminants

Contaminant: is a polluting or poisonous substance that makes something impure.

Contamination: is the action or state of making or being made impure by polluting or poisoning.

The dairy processing plant, including the milk reception area can be contaminated by a variety of contaminants such as biological, chemical and physical contaminants.

1. **Biological contaminants**

These include organisms like bacteria, parasites, viruses and protozoa. Most of these include microorganisms that are so small, they cannot be seen with the naked eye.

Groups of Human Microbial Pathogens Possibly Occurring in Milk and Milk Products

Organism	Disease
Enterobacteriaceae	
Escherichia coli[a]	Gastroenteritis
Salmonella	Gastroenteritis, typhoid fever
Shigella	Gastroenteritis
Yersinia enterocolitica[b]	Gastroenteritis
Other Gram-negative bacteria	
Aeromonas hydrophila[b]	Gastroenteritis
Brucella abortus	Brucellosis (abortion)
Campylobacter jejuni	Gastroenteritis
Gram-positive spore formers	
Bacillus cereus[a,b]	Intestinal intoxication
Bacillus anthracis	Anthrax
Clostridium perfringens	Gastroenteritis
Clostridium botulinum	Botulism
Gram-positive cocci	
Staphylococcus aureus[a]	Emetic intoxication
Streptococcus agalactiae[a]	Sore throat
Streptococcus pyogenes	Scarlet fever, sore throat

In addition to pathogenic bacteria, milk can also be contaminated by spoilage bacteria.

Spoilage is a term used to describe the deterioration of a foods' texture, colour, odour or flavour to the point where it is unappetizing or unsuitable for human consumption.

Microbial spoilage of food often involves the degradation of protein, carbohydrates, and fats by the microorganisms or their enzymes.

In milk, the microorganisms that are principally involved in spoilage are psychrotrophic organisms. Most psychrotrophs are destroyed by pasteurization temperatures, however, some like *Pseudomonas fluorescens, Pseudomonas fragi* can produce proteolytic and lipolytic extracellular enzymes which are heat stable and capable of causing spoilage.

Some species and strains of *Bacillus, Clostridium, Cornebacterium, Arthrobacter, Lactobacillus, Microbacterium, Micrococcus*, and *Streptococcus* can survive pasteurization and grow at refrigeration temperatures which can cause spoilage problems.

Viruses: Contamination of food by viruses, if it occurs, is most likely to be caused by contaminated water or an ill individual. Contamination of milk by viruses is not likely to occur in a processing facility that controls employee health and hygiene conditions that could result in the microbiological contamination of food, food packaging materials, and food contact surfaces under its Prerequisite Programs (PP's).

Sources of biological contaminants

- ✓ **The cow's udder**

In most cows, no microorganisms are present in the milk in the alveoli, ducts, cistern, and teat cistern, but they are present in the teat canal and the sphincter of the teat, mainly *Micrococcus and Staphylococcus spp. and Corynebacterium bovis.*

Mastitis-causing microorganisms, including certain streptococci, *Staphylococcus aureus,* and certain strains of *Escherichia coli,* are also pathogenic to humans.

Figure: Cow udder

- ✓ **The cow's body**

During milking, microorganisms can enter the milk from the skin of the teats, which often are contaminated by dung, soil, or dust. Such microorganisms from the cows include coliforms, fecal streptococci, bacterial spores (mostly *Clostridium spp.),* yeasts, molds…

- ✓ **Soil, Dung, and Dust**

Contaminants can reach the milk from soil, dung, dust, air. Well known is *B. subtilis,* originating from hay dust. The spores can enter the milk through air sucked in during mechanical milking, or fall directly into it during milking in open pails. yeasts, and molds also occur in air.

- ✓ **The Feed**: Feed often contains large numbers of microorganisms. Feed can sometimes fall directly into the milk but, more significantly, certain microorganisms in the feed survive passage through the digestive tract and subsequently enter the milk through Dung. Spore-forming bacteria, including *Bacillus cereus, B. subtilis, and Clostridium tyrobutyricum, which can spoil milk and* milk products, are especially involved.
- ✓ **Milking unit**: Contact infection poses the largest threat of contamination to almost all foods, including milk. Poorly cleaned and disinfected milking equipment can contain large numbers of microorganisms.
- ✓ **Water Used**: Tap water may be of good quality, but dirty water may contain Gram-negative rods such as Pseudomonas, Achromobacter, Flavobacterium, and Alcaligenes spp., most of which are psychrotrophic.

- ✓ **The Milker**: Milker influences many of the preceding factors and thereby the microbiological quality of the milk. They can also contaminate the milk directly, e.g., with the hands. If they suffer from microbial infections, they might directly contaminate the milk with pathogens.

2. Chemical contaminants

Chemical contaminants can naturally occur or they can either be human made. Milk that is contaminated by chemicals can be extremely hazardous to your health. These include compounds or elements like toxins, pesticides, bleach, …

Cleaning and Sanitizing Chemical Residues

Cleaning chemical and sanitizers are used widely in dairy plants. The proper use of cleaning and sanitizing compounds renders the risk of contamination a hazard not likely to occur.

Animal drug Residues

Following the treatment of cows, especially the udder infections, the used antibiotics may end up in the raw milk and have adverse effects on the health of consumers. The used drugs to treat the animal will contaminate raw milk if the farmers have not followed the veterinary instructions on the use of those drugs.

3. Physical contaminants

These change the physical properties or appearance of milk. They can be visually identified without having to perform testing. The physical contaminants of raw milk may include: hair, feed, bedding, dung, blood, etc.

Practices used to reduce the risk of contamination present in milk

- ✓ Animal cleanliness
- ✓ All animals should be kept clean
- ✓ All lying areas should be of sufficient size and should be kept clean
- ✓ Passage ways and access routes should be free from accumulations of dung and slurry
- ✓ Fields, tracks and gateways should be well maintained and kept free from accumulations of dung, slurry and mud.
- ✓ Milk practices
- ✓ Milk from each animal must be examined for physical, chemical, organoleptic abnormalities and where abnormal milk is detected. This milk must be rejected.
- ✓ Teats, udders and adjacent parts must be clean before milking

- ✓ Hands, contact surfaces and milking equipment must be kept clean at all times

Milking equipment

- ✓ Milking contact surfaces must be appropriately cleaned and disinfected immediately after each milking
- ✓ All equipment must be kept clean and in good condition

Milk storage and cooling

- ✓ Milk must be protected from contamination during transfer and storage
- ✓ Milk must be cooled quickly to minimize bacteria multiplication
- ✓ Bulk tanks must be cleaned and disinfected after each milk collection and kept in good condition

Content/Topic 2: Cleaning products used to clean milk reception work area

1. Difference between cleaning and sanitizing

✓ **Cleaning**

A process which will remove soil and prevent accumulation of food residues which may decompose or support the growth of disease-causing organisms or the production of toxins.

✓ **Sanitizing**

A process which destroys disease causing organisms which may be present on equipment and utensils after cleaning.

2. Types of cleaning products

Different types of cleaning products can be used. Cleaning is primarily the removal of dirt and dust. **Cleaning agents** in general can be defined as natural or synthetic substances that are used to assist the cleaning process.

The various kinds of cleaning agents used are as follows:

a. Water

Water is referred as a universal solvent, and this is the prime agent in cleaning process. However, though an excellent solvent, water alone is not an effective cleaner.

b. Detergent

Desirable Characteristics of a good detergent:

- ✓ Good alkalinity
- ✓ Should be freely, easily, quickly and completely soluble.
- ✓ Should not have corrosive action on metal surface
- ✓ Good wetting power, or ability to make a contact with the surface to be cleaned.
- ✓ Should make emulsion with fat and remove the same from the surface (emulsifying power).
- ✓ Good dissolving power or ability to dissolve protein.
- ✓ Good deflocculating power or the ability to break up dirt particles.
- ✓ Germicidal power or effectiveness in killing microorganisms.
- ✓ Penetrating power, or the ability to penetrate the milk films on equipment surface
- ✓ Mild on hand, if used for hand washing
- ✓ Sequestering and chelating power
- ✓ Free rinsing
- ✓ Economical
- ✓ Stability during storage.

Detergents may be made from a base of either pure soap or organic chemicals. Detergents are of two types:

- ➢ **Soapy Detergent**: Soapy detergent is made from animal or vegetable fat and may be used as a solid block for washing materials and tools at milk reception.
- ➢ **Synthetic detergent**: synthetic detergent is made from organic chemicals derived from petroleum. These are used extensively in house keeping. They are used for cleaning task and for washing up the floors. They may be in the form of a powder, liquid, gel or crystals.

c. Acid cleaners

Acids used as cleaning agents may vary from mild acid e.g. acetic acid or strong concentrated hydrochloric acid. Acids should be used in solutions followed by thorough rinsing. All, except

citric and acetic acid should be used under supervision with extreme caution and with the protection of rubber gloves. Strong acids are poisonous and corrosive.

Examples:

- **Citric acid** and **acetic acid** used for metal cleaning
- **Dilute hydrochloric acid** used in removing lime scale from sanitary ware
- **Organic Acids:** They have a good buffering ability, so that they can be used to remove milk stone and hard water scales. They are only slightly irritating to human skin.
- **Oxalic acid** for removing stubborn water stains from hard floors and sanitary ware
- **Nitric Acid:** It is a strong inorganic acid that can easily dissolve milk stone and hard water scale, it attacks tinned metals very strongly but not aluminium or stainless steel. The strongly oxidizing acid has a stabilizing effect upon stainless steel and has also a good disinfecting effect. It burns the skin. It is widely used in cleaning in place (CIP) of plant employed for the heat treatment of milk.

d. Alkaline cleaners

Alkaline based cleaning agents are used in laundry and are particularly good for removing grease. Very strong alkali materials are known as caustic materials and are extremely corrosive and poisonous. They must be used under strict supervision.

Examples:

- **Sodium carbonate (washing soda) or soda ash:** it is used to soften water and remove light grease marks. It is an effective remover of film of fats and protein materials, is better for general cleaning purposes. It is an excellent water softener. When mixed with more active chemicals, it acts as a buffering agent and assists in cleaning. It corrodes both aluminium and tin, and is irritating to the human skin.
- **Sodium hydroxide (Caustic soda):** Removing grease from grills and blocked drains Caustic soda is the most alkaline cleaner. This is used when vigorous action is desired. It breaks up and dissolves protein particles, soponsifies fats and precipitates the hardness of the water as floccules. It has good bacterial action and good solvent properties but causes skin irritation and is harmful to painted surfaces should not be used on tinned surfaces as it destroys the tin coating and aluminium rapidly. This is more suitable for mechanical bottle washers and for vacuum pan and stainless steel heat exchangers in which heavy protein films are encountered.

- **Modified Sodas (Sesquicarbonate):** These products are a mixture of soda ash and sodium bicarbonates. They are useful for hand washing operations, as they do not cause skin irritation
- **Soap Powder:** Soap powders are understood to be alkaline salts of fatty acids. They have excellent emulsifying properties and therefore are used for removing fat films

e. Sanitizer

Sanitization implies the destruction of all pathogenic microorganism from equipment surface.

Desirable characteristics of a good Sanitizer:

1. Non toxic
2. Quick acting
3. Relatively non corrosive to hands and equipment
4. Easily and quickly applied
5. Relatively in expensive

There exist a variety of sanitizers including chemical and physical sanitizers

i. Chemical sanitizers

Chemical sanitizers or sterilants are very effective germicidal agents. There are a wide variety of known chemicals whose properties destroy or inhibit the growth of microorganisms. Many of these chemicals, however, are not suitable for use on food-contact surfaces because they may corrode, stain, or leave a film on the surface. Others may be highly toxic or too expensive for practical use. Therefore, the discussion on chemical sanitizing agents will be restricted to those agents in common use in the food industry.

Examples:

- ✓ **Chlorine**

Chlorine sanitizers generally corrosive to aluminium, copper, tinned surfaces and stainless steel. Corrosion by chlorine is increased by higher temperatures and concentrations.

Chlorine and its compounds combine indiscriminately with any and all protein and protoplasm. The mode of bactericidal action is thought to be the reaction of chlorine with certain oxidizable groups in vital enzyme systems.

- ✓ **Iodophors**

Iodophors are soluble complexes of iodine combined usually with non ionic surface-active agents, loosely bound. They will if used regularly, help to prevent accumulation of milk stone, but they should not be expected to remove existing milk stone. They cannot be used at higher temperatures, say higher than 50^{o}c, as Iodine vapours will be released which are highly corrosive for all metals

- ✓ **Quaternary Ammonium Compounds**

Quaternary ammonium compounds (QACs) compounds are synthetic surface-action agents. The most common ones are the cationic detergents, which are poor detergents but excellent germicides. In these compounds, the organic radical is the cation, and the anion is usually chlorine.

ii. Physical sanitizer

- ✓ **Hot Water:** It is one of the most effective germicidal agents as it can contact all clean surfaces of the equipment. It is used in sufficient quantities and it kills a large percentage of the bacteria
- ✓ **Steam:** It is very effective for sterilizing vats, pipe lines and equipment's, which can be at least partially closed during the process. The equipment should attain a temperature of 78oc for at least 15 minutes or 93^{o}c for 5 minutes
- ✓ **Sunlight:** The microbicidal activity of sunlight is mainly due to the presence of ultra violet rays in it. It is responsible for spontaneous sterilization in natural conditions. In tropical countries, the sunlight is more effective in killing germs.
- ✓ **Heat:** Heat is considered to be most reliable method of sterilization of articles that can withstand heat. Heat acts by **oxidative effects** as well as **denaturation** and **coagulation of proteins.**
- ✓ **Incineration:** This is a method of destroying contaminated material by burning them in incinerator.
- ✓ **Hot air oven:** This method was introduced by Louis Pasteur. Articles to be sterilized are exposed to high temperature (160^{o} C) for duration of one hour in an electrically heated oven. ion. The oven should be fitted with a thermostat control, temperature indicator, meshed shelves and must have adequate insulation.

- ✓ **Flaming:** This is a method of passing the article over a Bunsen flame, but not heating it to redness. Articles such as moist heat acts by coagulation and denaturation of proteins. Moist heat is superior to dry heat in action.
- ✓ **Red heat:** Articles such as bacteriological loops, straight wires, tips of forceps and searing spatulas are sterilized by holding them in Bunsen flame till they become red hot. This is a simple method for effective sterilization of such articles, but is limited to those articles that can be heated to redness in flame.
- ✓ **Infrared rays:** Infrared rays bring about sterilization by generation of heat. Articles to be sterilized are placed in a moving conveyer belt and passed through a tunnel that is heated by infrared radiators to a temperature of 180°C.

LO 1.2 – Cleaning the work area, tools, equipment for raw milk reception

Content/Topic 1: Tools and products used to work area

Tools and products used to work area are:

- ✓ Microfiber cloths for dusting, cleaning and polishing: Microfiber is great for removing debris from mirrors and windows without scratching your surface.
- ✓ Glass cleaning cloth for mirrors and windows
- ✓ Vacuum (mop if you have hardwood floors): Hardwood is fragile material; hence, the method of mopping it should be keenly chosen if at all, we aim at keeping its new look. Among the things we do to maintain the fine finishing of our hardwood floors is to mop them.
- ✓ All-purpose cleaner: An all-purpose cleaner is a cleaning agent, usually a liquid, used to remove dirt, grime, and stains from surfaces. Some all-purpose cleaners require dilution, scrubbing, and rinsing, while others employ a simpler “spray and wipe” process. Oftentimes what you lose in cleaning power.
- ✓ Glass cleaner: Glass cleaners usually contain surfactants and solvents that adhere to the glass surface and lift away dirt and grime, providing shiny surfaces extra sparkle. Sometimes they even have fragrances for a pleasant aroma. This highly efficient combination helps to easily clean surfaces without leaving the residue that appears in our mirrors and windows as streaks.

- ✓ Disinfectant (points of contact) – if you wish
- ✓ Garbage bag, bag for recyclables, replacement garbage bag
- ✓ Mop pole, hair elastic

Content/Topic 2: Cleaning techniques

Cleaning is A process which will remove soil and prevent accumulation of food residues which may decompose or support the growth of disease-causing organisms or the production of toxins.

A cleaning program can be composed of the following steps, the steps included in each particular case depend on the nature of the soils and films to be removed:

- ➢ Pre-rinsing
- ➢ Caustic treatment
- ➢ Intermediate rinsing
- ➢ Acid treatment.
- ➢ Intermediate rinsing.
- ➢ Disinfection
- ➢ Final Rinsing

The types of cleaning techniques

There are three main types of cleaning techniques in dairy industry:

- CIP (cleaning in place)
- COP (cleaning out of place)
- Manual cleaning

CLEAN-IN-PLACE (CIP) Cleaning in Place (CIP) is a method of cleaning designed to clean interior surfaces of tanks and pipelines of liquid process equipment without disassembling. CIP allows process plant and pipe work to be cleaned between process runs without the requirement to dismantle or enter the equipment. It can be carried out with automated or manual systems and is a reliable and repeatable process that meets the stringent hygiene regulations especially prevalent in the food, drink and pharmaceutical industries.

The recommended steps in a clean in place (CIP) operation may involve the following:

- ✓ Remove those items that require manual cleaning such as fill tubes, manhole gaskets, plug valves, etc.
- ✓ Provide physical breaks between any circuits or tanks containing product.
- ✓ Pre-rinse or flush thoroughly with cool water not to exceed 80^{o}F.
- ✓ Discard pre-rinse water, flushing until relatively clear.
- ✓ Circulate an effective detergent solution throughout the circuit for the period of time necessary to remove the residues in the circuit.
- ✓ Circulate a rinsing water.
- ✓ Circulate an acid detergent when needed followed by another rinse.
- ✓ Sanitize immediately before use.

Cleaning in Place system has many benefits to the end user, some of the main reasons for implementing cleaning in Place are:

- ✓ Safety operators are not required to enter plant to clean it
- ✓ Difficult to access areas can be cleaned
- ✓ Production down time between product runs is minimised
- ✓ Cleaning costs can be reduced substantially by recycling cleaning solutions
- ✓ Water consumption is reduced as cleaning cycles are designed to use the optimum quantity of water
- ✓ The cleaning system can be fully automated therefore reducing labour requirements
- ✓ Automated CIP systems can give guaranteed and repeatable quality assurance
- ✓ Automated CIP systems can provide full data logging for quality assurance requirements
- ✓ Hazardous cleaning materials do not need to be handled by operators
- ✓ Use of cleaning materials is more effectively controlled using a CIP system

CLEAN OUT OF PLACE (COP): This is the term used for those cleaning operations involving the removal of small sections of piping, valve parts, filler parts, and other small appurtenances that are not normally cleaned in place and placing them into a cleaning vat. This cleaning

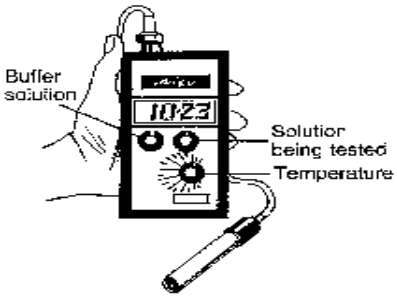
occurs outside of the equipment. The vat is equipped with a heat source, adequate dairy cleaner or caustic, normally steam injection, and a recirculating pump. Recording devices are not required on these units, although many plants have installed them to provide cleaning records as a part of their overall quality program.

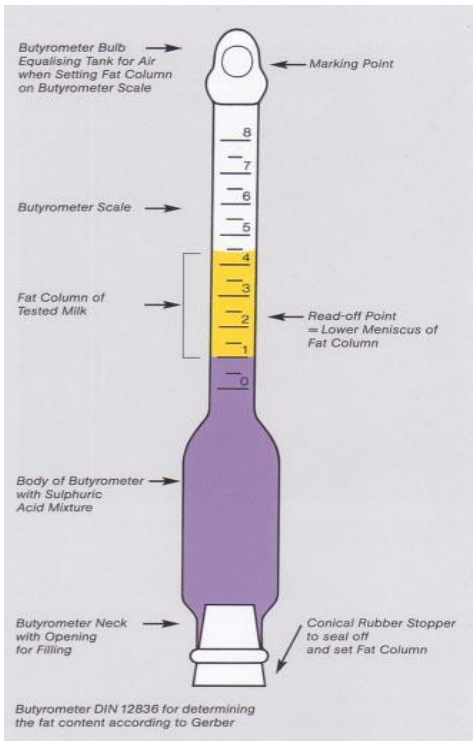
MANUAL CLEANING: is a cleaning techniques done by using hand. Regardless of the automation and engineering built into a plants operation, there is usually a need to manually clean the contact surfaces of the many small parts used in a normal day's operation. This may include filler parts, valves, small vats, cultured product packaging equipment appurtenances, equipment (curd cutting knives, etc)

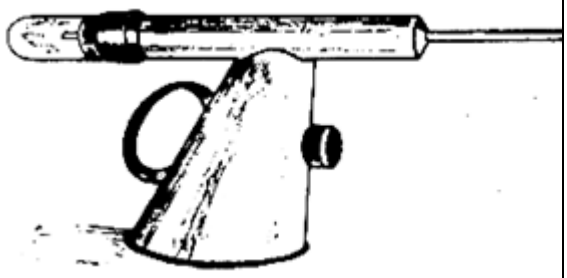
LO 1.3 – Monitor the functionality of raw milk reception tool

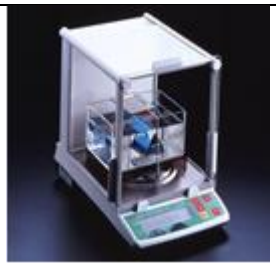
Content/Topic 1: Types of instruments used to receive raw milk, Working principles of instruments and equipment, and Adjustment of instruments and equipment

No	Types of Equipment, tools and utensils	Figure	Working principles and uses
1	sieves		Filtration of milk from foreign particles like hair ...

2	pH meter	 	Measure the pH of milk in order to show the acidic and alkaline milk
3	Centrifuge		-Separate fat in milk - Remove visible foreign matter in milk through clarification process
4	**Cryoscope**		Instrument used for measuring the milk freezing point
5	**Lactoscan**		Instrument used for measuring the milk freezing point of fat (FAT), solids non-fat (SNF), density, proteins, lactose, salts, water content percentages, temperature (°C), freezing point, pH, as well as total solids of one and the same sample directly after milking, at collecting and during processing.

7	Alcoholmeter		To measure the acidity in milk
8	Butyrometer	 	-To determine the fat content in milk - To make accurate adjustments of the butterfat percentage in standardised milk and milk products
9	**Mastitis kit**		This a kit used to determine whether the raw milk is from an infected cow (suffering from mastitis)

10	Alcohol gun	 	Detects the acidity of milk or the colostrum and mastitic milk
11	Lactometer	 	To determine adulteration of milk by adding water This an instrument used to measure the density of milk
12	Lovibond comparator		For hygiene and the potential keeping quality of raw milk
13	Thermometer		Used to measure milk temperature at the reception

14	Densimeter		Used to measure density of milk
15	Milk cooling tank		This an equipment used to receive and cool milk
16	**Pasteurizer**		Equipment used to pasteurize milk

Learning Unit 2-Receive Milk

LO 2.1 – Control the quality of raw milk

Raw milk is milk that has not been pasteurized or milk that has not yet undergone any kind of treatment (heat, separation, purification, …)

Content/Topic 1: Purpose of raw milk quality control

- ✓ To identify if the milk is fit for production
- ✓ To ensure that milk and milk products are safe and healthy
- ✓ To meet the standards for chemical composition and purity of milk
- ✓ To meet the standard levels of bacteria and other microorganisms in milk
- ✓ To ensure that milk collectors, processors and marketing agencies follow the correct methods
- ✓ To monitor the quality of the milk during processing
- ✓ The consumer expects to pay a fair price for milk and milk products of acceptable to excellent quality
- ✓ Helps the government and public agencies to protect against nutritional problem

Content/Topic 2: Types of raw milk tests

In order to ensure that the milk received at a collection center is of normal or good quality, it is important to carry out some tests before accepting the milk delivered to the collection center. The various tests that can be carried out, some on the **platform** and some in the **laboratory**.

Platform tests are rapid tests on which acceptance or rejection of milk can be based. Platform tests or milk reception tests are the commonly used names for the tests carried out on the raw milk at collection and/or reception. These can be carried out both at the Milk Collection Centre and at the Dairy Plant.

Examples: Organoleptic tests, alcohol test, clot -on-boiling test, …

Laboratory tests are the tests on the basis of which milk can be graded according to microbial population or composition.

Examples: Gerber test for fat, bacterial test, …

The most important aspects of maintaining high quality of fresh raw milk are:

- ✓ Good animal health,
- ✓ Hygienic milking,
- ✓ Cooling of milk immediately after milking,
- ✓ Transport of milk to milk processing plant as soon as possible after milking, within 2 hours at maximum
- ✓ Protect the milk containers/cans from dust and direct exposure of sun.

1. **The organoleptic tests** (**Taste, smell, visual observation) and temperature**

In these tests the milk quality is judged by the use of a person's senses: sight/ view, smell, and taste. The organoleptic tests are always used for the first screening of the incoming raw milk. If the milk has a bad smell, or abnormal color, or any off-flavours, taints smells and visible contaminants or contains particles, can be detected by a trained assessor. It is cheap, quick and does not require any equipment. The person carrying out the tests should be experienced for reliable results.

The result of the test is obtained instantly. If not discarded after the organoleptic tests, milk is subjected to other more sensitive and objective tests.

Procedure:

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

Judgment/Observations:

- Conditions of container/can: ……
- Appearance of milk: ……
- Colour of milk: ……
- Extraneous matter: ……
- Accept/reject milk: ……
- Comments: ……

Notes:

- ✓ If the milk has a bad smell or abnormal colour, or contains particles, it should be rejected.
- ✓ During organoleptic inspection, if the milk appears to too thin and watery and its colour is “blue thin” it is suspected that the milk contains added water.

Abnormal smell and taste or appearance of milk may be caused by:

- Types of feed. Example: Milk from animals fed with malting residues will have a particular flavor
- Physiological taints (hormonal imbalance, cows in late lactation, rancidity)
- Bacterial taints
- Chemical taints or drug taints or discoloration. Example: contamination with sanitizing agents, disinfectants, …
- Advanced acidification (pH<6.4)
- Boiling of poor quality milk
- Presence of smoke or other atmospheric taints
- Spontaneous rancidity of milk from animals in late lactation
- Oxidation due to presence of heavy metals (e.g: copper) and exposure to light

2. Clot-on-boiling test (COB test)

The clot-on-boiling test measures the degree of acidity of milk and involves boiling a small amount (2–5 cc) of milk in any suitable container. If clotting (coagulation or precipitation) occurs, this indicates that the milk is bad because it has a large number of acid-producing bacteria.

The clot-on-boiling test is simple, quick and cheap.

Materials

- Test tube or spoon
- Paraffin burner or Bunsen burner

Procedure

- Boil about 5 ml of milk in a test tube or spoon or any other suitable container over a Bunsen burner.

Results

If there is clotting, coagulation or precipitation the milk is sour (acidic), the milk has failed the test and should be rejected because milk is not fit for any process which involves heating, like pasteurization. This means the milk must contain many acid or rennet producing microorganisms or the milk has an abnormal high percentage of proteins like colostrum. Such milk cannot stand the heat treatment in milk processing and must therefore be rejected. An alternative is the Alcohol test.

Notes:

- ✓ If the milk is sour or if the milk is abnormal (colostrum or mastitis milk) the milk will not pass this test.
- ✓ Precipitation of milk is caused by a very high percentage of whey proteins in the milk that make it sour.
- ✓ If no coagulation occurs the milk can stand heating operations at the time of testing.

4. The alcohol test

The alcohol test is mainly used to detect the degree of acidity of the supplier's milk. This test is more sensitive than the COB test. COB only detects milk which is highly acidic (pH<5.3). The alcohol test detects even medium-acidity milk (pH <6.4). Therefore, milk which passes the COB test, may fail the alcohol test. Colostrum and mastitis milk may also fail the alcohol test.

- **Materials**
  - ✓ Alcohol gunner or syringe
  - ✓ Beaker or glass
  - ✓ 68% alcohol *
- **Procedure**
  - ✓ Put equal volumes of milk and 68% alcohol in a test tube (e.g. 2 ml of milk in 2 ml of 68% alcohol).
  - ✓ Invert the test tube several times; keep your thumb pressed tightly over the open end of the tube.
  - ✓ Examine the tube to see whether the milk has coagulated. If it has, fine particles of curd will be visible.
- **Results**
  - ✓ If the milk is of good quality, there will be no coagulation, clotting, flaking or precipitation.
  - ✓ If the milk has become acidic (pH below 6.4) it will flocculate. To quickly see whether milk is acidic, you can use a litmus paper. For more accuracy, a titration test can be done in a laboratory.

Notes:

- ✓ To prepare 68% alcohol solution, mix 68 ml of absolute alcohol (96% alcohol) with 28 ml of distilled water.
- ✓ The alcohol test, together with the acidity test, is used on fresh milk to indicate whether it will coagulate on processing. Milk that contains more than 0.21 % acid, or calcium and magnesium compounds in greater than normal amounts, will coagulate when alcohol is added.
- ✓ If the result of the alcohol test indicates a too high acidity, a milk sample can be taken to the laboratory for a more detailed testing by the titratable acidity test.

5. The Lactometer Test or Density test

The Lactometer test is a quick method used to detect adulteration of milk by adding water. The test is based on the fact that the specific gravity (density) of whole milk, skim milk and water differ from each other. The density or specific gravity of milk is determined by lactometer reading. At 15°C the normal specific gravity of milk ranges from 1.026 to 1.032. Below the value indicate the possible addition of water to the milk.

It is also possible that the lactometer reading can be combined with the fat test to have the total solid levels in milk. Density of fat is lower than that of milk.

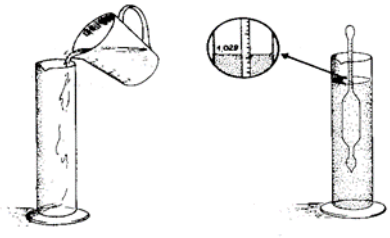
- ✓ Results of the low fat test and higher specific gravity indicate the possible skimming of milk.
- ✓ Results of low fat test and low specific gravity indicate the possible addition of water in milk

Note: Always read the temperature of the milk first; the lactometer reading varies according to the temperature.

Materials

- Measuring cylinder 200-250 ml
- Lactometer

Procedure



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

Results

- ✓ At 15°C the normal specific gravity of milk ranges from 1.026 to 1.032. Below the value indicate the possible addition of water to the milk.
- ✓ At 20°C the normal specific gravity of milk ranges from 1.027 to 1.033. Below the value indicate the possible addition of water to the milk.

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

Specific Gravity of milk is = 1 + CLR / 1000

Where CLR = Corrected lactometer reading.

Specific gravity: is the ratio of density of the substance to the density of standard substance(water).

The specific gravity of milk is decreased by:

-Addition of water

-addition of cream(fat)

-increase of temperature

The specific gravity of milk is increased by:

-Addition of separated milk

-Removal of fat

-Reduction of temperature

6. California Mastitis Test

The California Mastitis Test (CMT) is a quick, easy and economical test for the detection of subclinical infection of a quarter. It provides an indication of the number of somatic cells found in the milk. The CMT will only trigger a visible reaction with a concentration of 400,000 cells/ml or more.

- ✓ Take about 1 teaspoon (2 cc) milk from each quarter. This is the amount of milk that would be left in the cups if the CMT Paddle were held nearly vertical

Fig. California Mastitis test 1

✓ Add an equal amount of CMT solution to each cup in the paddle.

Fig. California Mastitis test 2

✓ Rotate the CMT Paddle in a circular motion to thoroughly mix the contents. Do not mix more than 10 seconds

Fig. California Mastitis test 3

✓ Read the test quickly. Visible reaction disintegrates after about 20 seconds. The reaction is scored visually. The more gel formation, the higher the score.

Fig. California Mastitis test 4

Reading of the CMT

N = Negative

No infections. No thickening of the mixture. 100,000 SCC

T = Trace

Possible infections. Slight thickening of the mixture, trace reaction seems to disappear with continued rotation of the paddle. 300,000 SCC. Example: If all four quarters read trace there is no infection. If one or two quarters read trace, infections are possible

1 = Weak Positive

Infected. Distinct thickening of the mixture, but no tendency to form a gel, if CMT paddle is rotated more than 20 seconds, thickening may disappear. 900,000 SCC

2 = Distinct Positive

Infected. Immediate thickening of the mixture, with a slight gel formation, as mixture is swirled, it moves toward the center of the cup, exposing the bottom of the outer edge. When motion stops, mixture levels out and covers bottom of the cup. 2.7 million SCC

3 = Strong Positive

Infected. Gel is formed and surface of the mixture becomes elevated (like a fried egg). Central peak remains projected even after the CMT paddle rotation is stopped. 8.1 million SCC

7. **Inhibitor test**

Milk collected from producers may contain drugs and/or pesticides residues. These when present in significant amounts in milk may inhibit the growth of lactic acid bacteria used in the manufacture of fermented milk such as cheese and Yoghurt, besides being a health hazard.

Principle of the method: The suspected milk sample is subjected to a fermentation test with starter culture and the acidity checked after three (3) hours. The values of the titratable

acidity obtained are compared with titratable acidity values of similarly treated sample which are free from any inhibitory substances.

Procedure:

Three test tubes are filled with l0 ml of sample to be tested and three test tubes filled with normal milk. All tubes are heated to 90 ºC by putting them in boiling water for 3 - 5 minutes. After cooling to optimum temperature of the starter culture (30,37, or 42ºC), 1 ml of starter culture is added to each test tube, mixed and incubated for 3 hours.

Fig. Inhibitor test

Assessment of results:

If acid production in suspected sample is the same as the normal sample, then the suspect sample does not contain any inhibitory substances;

If acid production in the suspect sample is less than in the normal milk sample, then, the suspect sample contains antibiotics or other inhibitory substances.

8. Gerber test for fat

This test is used to determine the fat content of the milk.

Procedure:

- ✓ Add 10 ml sulphuric acid to the butyrometer followed by 11 ml of well mixed milk. Avoid wetting of the neck of the butyrometer.

- ✓ Next add 1 ml of Amyl alcohol, insert stopper and shake the butyrometer carefully until the curd dissolves and no white particles can be seen.
- ✓ Place the butyrometer in the water bath at 65ºC and keep it there until a set is ready for centrifuging.
- ✓ The butyrometer must be placed in the centrifuge with the stem (scale) pointing towards the center of the centrifuge. Spin for 5 min. at 1100 rpm.
- ✓ Remove the butyrometers from the centrifuge.
- ✓ Put the butyrometers in a water bath maintained at 65ºC for 3 min. before taking the reading.

(**Note:** When transferring the butyrometers from the centrifuge into the water bath make sure that the butyrometers are all the time held with the neck pointing up).

The fat column should be read from the lowest point of the meniscus of the interface of the acid-fat to the 0-mark of the scale and read the butterfat percentage. The butyrometers should then be emptied into a special container for the very corrosive liquid of acid-milk, and the butyrometers should be washed in warm water and dried before the next use.

Appearance of the test:

a. The colour of the fat column should be straw yellow.
b. The ends of the fat column should be clearly and sharply defined.
c. The fat column should be free from specks and sediment.
d. The water just below the fat column should be perfectly clear.
e. The fat should be within the graduation.

9. Alcohol-Alizarin test

The procedure for carrying out the test is the same as for alcohol test but this test is more helpful. Alizarin is a colour indicator changing colour according to the acidity of milk. the Alcohol-Alizarin solution can be bought readymade or be prepared (0.4 g alizarin powder) in 1 lit of alcohol (61%).

Procedure

- ✓ Mix equal amounts of milk and 68% of ethanol solution in a small test tube. For routine testing 2 ml milk is mixed with 2 ml 68% alcohol.
- ✓ Observe the coagulation, clotting or precipitation in milk and change in colour of milk.

Observations/Results for alcohol-alizarin test

Parameter	normal milk	slightly acid Milk	acid milk	alkaline Milk
pH	6.6 – 6.7	6.4 – 6.6	6.3 or lower	6.8 or higher
Colour	red brown	Yellowish-brown	Yellowish	Lilac
Appearance of milk	No coagulation no lump	no coagulation	coagulation	no coagulation

10. Resazurin Test

The resazurin test measure the general bacteriological condition of raw milk. Resazurin test is the most widely used test for hygiene and the potential keeping quality of raw milk. Resazurin is a dye indicator. Under specified conditions Resazurin is dissolved in distilled boiled water. the resazurin solution can later be used to test the microbial activity in a given milk sample. the 10 min resazurin test is useful and rapid, screening test used at the milk platform. the 1-hour test and 3 hour tests provide more accurate information about the milk quality, but after a fairy long time. they are usually carried out in the laboratory.

Materials and reagents

- ✓ Resazurin tablets
- ✓ Test tubes with 10 ml mark
- ✓ 1 ml pipette or dispenser for resazurin solution.
- ✓ Water bath thermostatically controlled
- ✓ Lovibond comparator with resazurin disc 4/9

Procedure

- ✓ The solution of resazurin as prepared by adding one tablet to 50 ml of distilled sterile water. resazurin solution must not be exposed to sunlight, and it should not be used for more than eight hours because it losses strength.
- ✓ Mix the milk and with a sanitized dipper put 10 ml milk into a sterile test tube.
- ✓ Add one ml of resazurin solution, stopper with a sterile stopper,
- ✓ Mix gently the dye into the milk and mark the tube before the incubation in a water bath,
- ✓ Place the test tube in a Lovibond comparator with resazurin disk and compare it colourimetrically with a test tube containing 10 ml milk of the same sample, but without the dye (Blank).

Observations

resazurin disc no.	Colour	grade of milk	Action
6	Blue	excellent	Accept
5	Light blue	v. good	Accept
4	Purple	Good	Accept
3	Purple pink	Fair	Separate
2	Light pink	Poor	Separate
1	Pink	Bad	Reject
0	White	Very bad	Reject

The Resazurin test is essentially a rapid bacteria estimation. Resazurin is a blue dye which gives normal milk a characteristic blue colour. The test is based on the ability of bacteria in the milk to reduce the blue dye. The quality of the milk is judged by noting the degree of colour change - from blue through mauve and purple and pink and finally colourless - after a stated period of incubation, or the time required to reduce the dye to a predetermined colour

11. Titratable acidity test

Milk acidity

The evaluation of milk acidity at reception is to determine the freshness of milk. Two values are determined: the pH and the acidity.

- ✓ **pH**

The determination of pH is usually carried out with an electronic pH-meter. It depends on the potential difference set up between two electrodes when they are in contact with a test sample. A reference electrode whose potential is independent of the pH of the solution and an electrode whose potential is proportional to the hydronium ion concentration [H^+] of the test sample are used. Saturated calomel electrodes are usually used as reference electrodes, and glass electrodes are used to measure the pH.

Instruments which measure the current produced by the difference in potential between the glass and calomel electrodes are called pH meters.

- ✓ **Milk acidity test**

Involves determination of the acid content in milk due to presence of acid-producing bacteria. The normal fresh milk has a pH between 6.6 and 6.8.

- If the pH < 6.60, the milk is acidic. Further acidity test is needed to make a clear evaluation
- If the pH > 6.80, the milk contains added water or it is from a mastitic cow. Further tests (freezing point, CMT) have to be carried out to have a clear evaluation.

The production of acid in milk is normally termed "souring" and the sour taste of such milk is due to **lactic acid**. The percentage of acid present in milk at any time is a rough indication of the age of the milk and the manner in which it has been handled. Fresh milk has an initial

(titratable) acidity due to its buffering capacity and for normal milk, this "natural" acidity varies between 0.13% and 0.17% lactic acid.

The acidity test measures the lactic acid in the milk. If the acidity is higher than 0.19%, then the milk quality is poor and cannot be processed. If the acidity is lower than normal (e.g. 0.10% lactic acid) then the milk is of poor bacterial quality or sodium hydroxide/bicarbonate might have been added.

The acidity in milk is measured usually by titration with a 0.1N NaOH solution with phenolphthalein as an indicator. Lactic acid is an organic acid with one carboxylic acid, CH3-CHOH-COOH, having a molecular weight of 90.

Using N/10 Sodium Hydroxide to determine milk acidity:

- ✓ Fill the burette with N/10 NaOH and make sure there are no air bubbles trapped in the lower part.
- ✓ Adjust the level of NaOH in the burette to the top mark – the lowest reading being at the upper end.
- ✓ Place 10ml (for example) of milk in the cup
- ✓ Add 3 to 5 drops of phenolphthalein to the sample in the cup.
- ✓ Note the reading of the NaOH in the burette at the lowest point of the meniscus.
- ✓ Allow the NaOH to flow slowly into the cup containing the sample and stir continuously. When a faint but definite pink colour persists, the end-point has been reached.
- ✓ Take the reading of the burette at the lowest point of the meniscus. Subtract the first reading from the second to determine the number of milliliters of alkali (NaOH) required to neutralize the acid in the sample.

Calculations: $N_{NaOH}\ V_{NaOH} = N_{Sample} V_{Sample}$

% Lactic Acid : $\frac{Volume\ required\ for\ neutralization(used\ ml\ of\ 0.1N\ NaOH)\ x\ 0.009}{Weight\ of\ sample}$ x100

Weight of sample = Volume of milk x specific gravity

12. The sediment test

The sediment test involves filtering a definite amount of milk through a white cotton pad and observing the character and amount of residue. Amount of residue found in milk may serve

to help people learn how to improve on milk quality and the test does not lead to milk rejection.

LO 2.2 – Filter the raw milk

After the milk reception quality tests, raw milk is filtered to remove hair, stones and other physical contaminants. Filtration of milk ensure that sediment or other extraneous matter is removed from the milk.

Objective: To improve the aesthetic quality of milk by removing visible foreign matter which is unsightly and may therefore cause consumer complaints.

Content/Topic 1: Types of filters used for raw milk reception

Two types of filter used for raw milk are:

- ✓ **Cloth**

A filter cloth or pad of desired pore size, which can retain the smallest particle.

- ✓ **Metallic (stainless steel)**

This type consists of a nylon filter bag/pad supported of perforated stainless steel filter element. This filter also called in line filter should be installed before the chiller

NOTE: During filtration of milk clarification and straining are also the process that can be used

- ➢ **Clarification of milk**

Milk clarification is the process of removing undesirable foreign matter such as dirt, curd particles, blood corpuscles, epithelial cells, bacteria sediment, sludge etc from the milk. To some extent bacteria also get removed as slime during the clarification process.

However, clarification cannot be considered an effective means of bacteria removal.

- ➢ **Straining of milk**

Straining removes only the coarse particles of dirt and removes neither the bacteria nor the fine dirt.

Filtration and straining removes suspended foreign particles like dirt, fly, straw, hair etc. by the straining process while clarification removes the same by centrifugal sedimentation.

Filtration is for removal of material lighter than milk such as wood, cellulose, packaging material residue etc., whereas clarification is done to remove components heavier than milk.

Content/Topic 2: Raw milk filtration methods

Two techniques or methods are used during raw milk filtration:

1. **Vacuum filtration**

Vacuum filtration is used primarily to collect a desired solid, for instance, the collection of crystals in a recrystallization procedure this method separates a solid product from a liquid. Vacuum filtration uses a Buchner funnel and a side-arm flask and they are usually used when the substances to be filtered is small in volume. Vacuum filtration is faster because the solvent or solution and air is forced through the filter paper by the application of reduced pressure. Do not use vacuum filtration to filter a solid from a liquid if it is the liquid that you want, and if the liquid is low boiling.

2. **Membrane filtration**

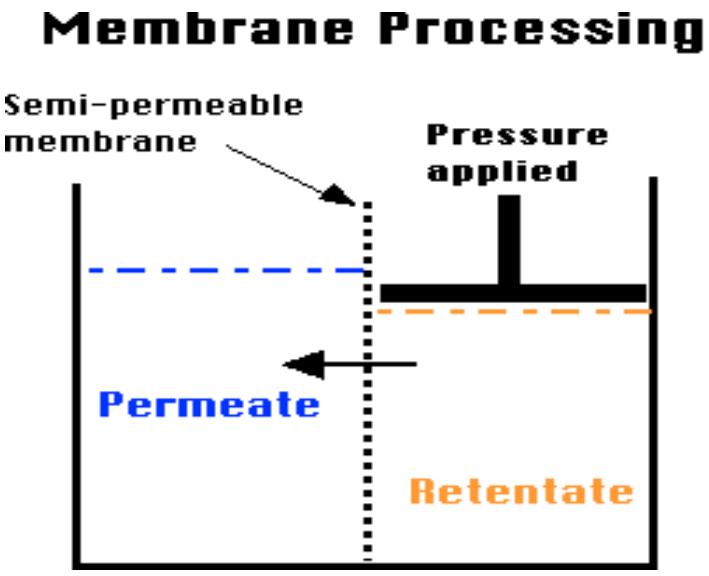
Membrane processing is a technique that permits concentration and separation without the use of heat. Particles are separated on the basis of their molecular size and shape with the use of pressure and specially designed semi-permeable membranes.

Membrane filter technique is an effective, accepted technique for testing fluid samples for microbiological contamination. It involves less preparation than many traditional methods and is one of a few methods that will allow the isolation and enumeration of microorganisms. Membrane filters are used extensively in the laboratory and in the industry to sterilize fluid materials.

Principle of Operation

When a solution and water are separated by a semi-permeable membrane, the water will move into the solution to equilibrate the system. This is known as "*osmotic pressure"* If a mechanical force is applied to exceed the osmotic pressure (up to 700 psi), the water is forced to move down the concentration gradient i.e. from low to high concentration.

Permeate designates the liquid passing through the membrane, and retentate (concentrate) designates the fraction not passing through the membrane.



There are four different membrane filtration processes that are typically used to filter milk.

The processes are:

- ✓ **Reverse osmosis:** This process provides the tightest membrane possible in liquid separation. That
- ✓ means that only water can pass through the membrane while all other material (dissolved and suspended) is removed.
- ✓ **Nanofiltration:** This process removes a range of different minerals from liquid, letting only the liquid and specific monovalent ions to pass through the membrane.
- ✓ **Ultrafiltration:** This process separates skim milk (also called the feed) into two different streams, which allows water, salts, lactose, and acids to pass through the membrane in either direction while keeping (and concentrating) protein and fat.
- ✓ **Microfiltration:** this process uses the most open kind of membrane. It's used to remove spores, bacteria, and fat globules from the liquid and also for fractionation of skim milk.

LO 2.3 – Cool the raw milk

Cooling/chilling restricts the growth of microorganisms and hence prevents or delays the acidity development in the milk.

Content/Topic 1: Cooling equipment for raw milk

Equipment used for cooling raw milk are:

- ✓ Milk cooling tank
- ✓ Refrigerator

Content/Topic 2: Cooling techniques

Different cooling techniques are used and they include the following:

1.Cooling milk by Tank

Milk is stored at the farms in either closed or open milk tanks. To maintain the quality of the milk it is quickly cooled from 38^0c leaving the cow to 4^0c in the milk tank. The milk tank is typically equipped with a mixer to accelerate the cooling process and homogenize the milk. Milk farm really on highly efficient cooling of milk at consistent temperature of about 4^0c in the milk tanks until the milk is collected for further processing.

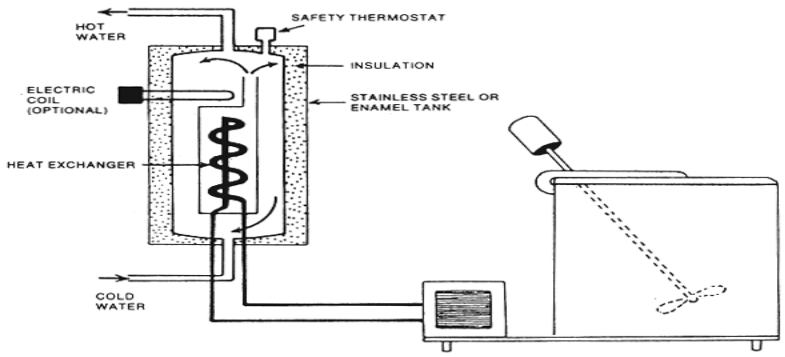


Fig. Cooling of milk

2. Cooling milk by cold room

Industries require the use of cold rooms to preserve goods or as a part of the manufacturing process.

The choice of a cold room should be fully aligned with your industry's operational requirements. Measure how much space you have and compare it with your choice of cold room facility. Decide how much storage space you will need; this will ensure that the cold room is used to its full potential and maximizing space could save money in the long run.

Milk in containers such as milk cans is place inside a cold room for which the temperature is controlled with a refrigeration unit.

3. Cooling milk in cold water bath

Milk cans are immersed in water bath containing cold water.

Is ideal for general laboratory use and are economical reliable and very cost effective.

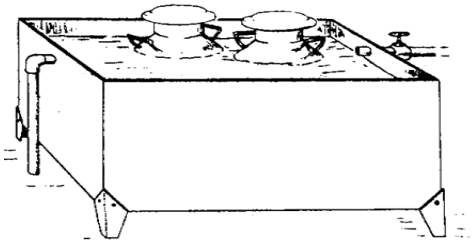


Fig. Water cooling

4. Cooling milk by refrigerator

This cooling is carried using a tank equipped with a refrigeration system. The milk should be cooled to 4-5ºC

LO 2.4 – Keep records of received raw milk

Content/Topic 1: Purpose of keeping records

Purpose of keeping records in milk reception centers:

- ✓ To inform the farmers/producers about his production quality
- ✓ Act as resource for new strategies as processor
- ✓ Helps to find new solutions for business

Content/Topic 2: Information to include in the records

After the reception quality tests of milk, the quantity and quality must be recorded.

Information to include in the records:

- ✓ Milk quality control results
- ✓ Quantity received
- ✓ Decision taken
- ✓ Supplier identification
- ✓ code number

- ✓ records of dates,
- ✓ places

The following techniques are used during recording:

1. Quantitative record of milk

Once the milk has passed the reception quality tests, its quantity is determined. This can be done by measuring the weight or by measuring the volume

The weight of received milk is determined using balance.

Procedure:

- The milk in a container is weighed, x kg is obtained
- The milk is emptied from the container into a reception tank
- The empty container is weighed after emptying the milk, y kg is obtained
- To get the weight of milk alone: (x-y) kg

The quantity of received milk can also be determined by measuring its volume. However, the disadvantage of this method is that the volume of milk can vary by temperature change

Procedure:

- The received milk is poured into a graduated container
- Its volume is read

2. Qualitative record of milk

For all the milk quality tests carried out, records must be kept. For this purpose, a simple table like the following could be used:

Name of farmer: …….

Location and contact of farmer: ……

Date: …….

Quantity of milk: …….

Milk quality test results

Quality parameters	Results	Observation
Color		
Odors		

Temperature		
pH		
Alcohol test		
CMT		
Inhibitor test		
Density		
Fat content		

Conclusion: …….

Name and signature of analyst: …….

Content /Topic 3: Tips for milk reception

Good records must be kept **neat** and in a **dry** place. It is desirable that milk producers should see their milk being tested, and the records should be made available to them if they so require.

Learning Unit 3-Grade the Milk

The importance of milk grading lies in the fact that dairy products are only as good as the raw materials from which they were made.

LO 3.1 – Grade milk by fat

Content/Topic 1: Purpose of milk fat grades

At reception the milk is graded by fat for five main reasons:

- ✓ To allocate the received milk to process a specific product (cheese, cream, butter)
- ✓ To determine the price of received milk
- ✓ To separate milk into similar classes so that the consumer may select milk for particular purposes according to his desires and pocketbook
- ✓ Select milk products that may be consumed and rejects unfit food products
- ✓ To separate the available supply of potable milk into classes differing in superiority

Content/Topic 2: Categories of milk based on fat content

1. Definition of milk fat content

The fat content of milk is the proportion of milk by weight made up by butterfat and varies depending on the product.

The normal bovine milk has a fat content of 2.5 to 5.5%. The higher the fat content the better the grade.

2. Categories of milk based on fat content

Milk is processed on the basis of the maximum content of fat and solid nonfat it would ultimately possess:

- ✓ **Regular or whole milk**

This is natural milk with nothing added or removed. It called whole milk because all the milk fat found them. It is also called full cream milk and full of flavour. This type of milk is usually consumed by children, teenagers and body builders because all the milk fat found them.

Whole milk must contain at least 3.25% milk fat and 8.25% milk solid by weight which means it derives about 50% of its calories from fat.

- ✓ **Reduced fat milk**

This type of milk contains 2% milk fat. It is called reduced because there is some amount of fat that is removed; such milk actually derives 35% of its calories from fat.

- ✓ **Low fat milk**

This milk contains 1% of milk fat. It has lower energy content and slightly lower levels of vitamins A and E, but higher calcium content.

- ✓ **Skimmed milk**

It is also called nonfat milk because it has much of fat removed as possible. It may not contain more than 0.5% milk fat by weight. Skimmed milk has about half the calories of whole milk. It is the best choice for adults and is the only type of milk that should be consumed by people on strict low fat diets.

- ✓ **Toned milk**

Toned milk also called the single toned milk is obtained by adding skimmed milk powder and water to whole milk. It contains about 3.0% fat. It restricts the body from absorbing cholesterol from the milk to the minimum. Toned milk contains the same nutrition as whole milk minus the fat soluble vitamins.

- ✓ **Double toned milk**

This milk is obtained by adding skimmed milk powder to whole milk and has about 1.5% fat content. Double toned milk is ideal for those trying to maintain weight as it keeps the calorie intake under check and aids weight loss.

Content /Topic 3: Factors affecting fat content

- ✓ The different factors that affect the fat content are:
- ✓ Dietary
- ✓ Feeding strategy/patterns or Nutritional
- ✓ Genetics
- ✓ Age of lactation
- ✓ Season
- ✓ Ambient temperature
- ✓ Heat stress
- ✓ Breed

- ✓ Unsaturated fat
- ✓ Sampling strategy/Analytical methods
- ✓ Milk protein concentration
- ✓ Animal physiology

LO 3.2 – Grade milk by total bacteria count

Received milk is graded according to its microbial total count. This helps in determining the product to be processed from that milk. Normally acceptable raw milk contains up to 500,000/ml bacteria count.

Content/Topic 1: Acceptable range of bacteria in raw milk content

Acceptable range of bacteria in raw milk content:

- ✓ Total bacteria are 30,000cfu/mL
- ✓ Somatic cell count should not exceed750,000cfu/mL
- ✓ No positive test on drug residue detection

Bacteria are relatively simple single-celled organisms. One method of classification is by shape or morphology:

Cocci: spherical shape

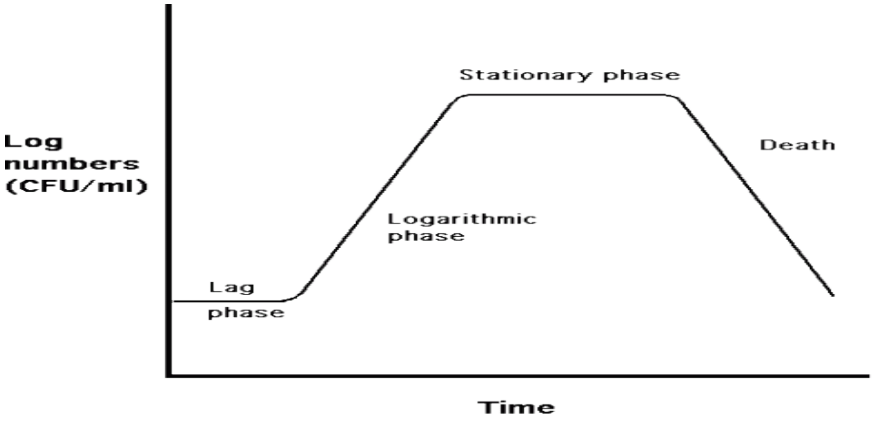
0.4 - 1.5 µ m

Examples: **staphylococci** - form grape-like clusters; **streptococci** - form bead-like chains

Rods: 0.25 - 1.0 µ m width by 0.5 - 6.0 µ m long

Examples: **bacilli** - straight rod; **spirilla** - spiral rod

Note: Bacterial populations are expressed as **colony forming units (CFU)** per gram or millilitre.



Hypothetical bacterial growth curve.

Bacterial growth generally proceeds through a series of phases:

- **Lag phase**: time for microorganisms to become accustomed to their new environment. There is little or no growth during this phase.
- **Log phase**: bacteria logarithmic, or exponential, growth begins; the rate of multiplication is the most rapid and constant.
- **Stationary phase**: the rate of multiplication slows down due to lack of nutrients and build-up of toxins. At the same time, bacteria are constantly dying so the numbers actually remain constant.
- **Death phase**: cell numbers decrease as growth stops and existing cells die off.

The shape of the curve (shown on the right) varies with temperature, nutrient supply, and other growth factors.

Content/Topic 2: Parameters of raw milk deterioration

Parameters of raw milk deterioration are:

- ✓ Atmospheric taint (e.g. barny/cowy odour).
- ✓ Physiological taints (hormonal imbalance, cows in late lactation- spontaneous rancidity).
- ✓ Bacterial taints.
- ✓ Chemical taints or discoloring.
- ✓ Advanced acidification (pH < 6.4)

The factors that affect the survival and growth of bacteria in milk:

The parameters that are inherent to the milk, or intrinsic factors, include the following:

- ✓ nutrient content
- ✓ moisture content
- ✓ pH
- ✓ available oxygen
- ✓ biological structures
- ✓ antimicrobial constituents

LO 3.3 – Grade milk by density

At reception milk can also be graded according to density. For normal bovine milk the density varies from 1.028 to 1.033 at 15°C.

Content/Topic 1: Effect of density on milk product quality

Effects of density on milk products quality:

- ✓ Low density means low SNF content in milk which results in end products with low nutrients
- ✓ High density means high SNF given that milk has not been adulterated with solids such as starch.
- ✓ Loss of milk quality
- ✓ No further processing

Content/Topic 2: Factors affecting density of milk

Factors that affect the milk density (Specific gravity) include:

- ✓ Breed
- ✓ Feed
- ✓ Fat content
- ✓ Solids-not-fat
- ✓ Milk adulteration (addition of water, removal of fat)
- ✓ Water
- ✓ Temperature
- ✓ Mixture of different milk

Content /Topic 3: Causes of Milk adulteration

Adulteration of milk may be defined as addition of any material to the milk, or removal of any constituent of milk. This is done in order to get the milk of the high quality compared to the natural quality milk.

The causes of milk adulteration are:

- ✓ Addition of adulterants in milk (water, flour, …)
- ✓ Addition of preservatives in milk (formalin, benzoic acid, …)

A. ADULTERANTS IN MILK AND THEIR DETECTION

The common adulterants in milk are:

- ✓ Addition of water
- ✓ Removal of fat
- ✓ Addition of cane sugar
- ✓ Addition of starch / cereal flour
- ✓ Addition of skim milk powder
- ✓ Addition of gelatin
- ✓ Addition of urea
- ✓ Addition of Ammonium sulphate
- ✓ Addition of glucose

Detection of Adulterants in milk

1. Added Water

Many methods are used for detection of milk adulteration with water.

a) By estimation of SNF

Estimate the solid not fat content of the sample of milk and calculate the percent of added water using the following formulae

$$\% \text{ added water} = \frac{S-s}{S} x100$$

Where S = Standard SNF (9.0 for buffalo milk, 8.5 for cow milk)

s = SNF of sample milk.

This method is not appropriate, as the people will make up SNF with addition of other adulteration listed from 3 to 9 as given above.

b) Detection of Nitrate

Natural water supplied usually contain nitrates, where as milk contains no appreciable traces, therefore the presence of nitrates in milk may be taken as evidence of watering the milk. The disadvantage of this method is some public water supplies are free of nitrates.

c) Freezing point Test

Freezing point of milk is its most constant property. By using hortvet cryoscope freezing point of milk is estimated. Addition of water will dilute the dissolved constituents so that the freezing point of milk on adulteration with water causes less depression. The normal freezing point depression of cow milk is 0.547oC and buffalo milk is 0.549oC. This method cannot detect addition of fat separated milk, as skim milk has the same freezing point that of whole milk. When acid is formed in water adulterated milk, the freezing point will be normal, as acid will give soluble ions to depress the freezing point.

d) Spectrometric method

Recently spectrometer has been suggested as a means of detecting addition of water to milk. This method will detect 10% of adulteration of milk with water. This method cannot detect pure water as rain water or many upland surface water.

2. Removal of Fat (Detection of skimming)

Fat being the costly ingredient of milk, some portion of fat is removed. Removal of fat also comes under adulteration of milk.

Detect the fat percentage of the sample of milk and calculate the percent of fat removed using the following formulae.

% of fat removed = $\frac{F-f}{F} x100$

Where F = Standard fat or fat in pure milk.

f = Fat percent in the sample of milk.

3. **Addition of Cane Sugar**
    - ✓ Take 10 ml of milk in a test tube
    - ✓ Add 1 ml of concentrated hydrochloric acid and mix
    - ✓ Add 0.1 g of resorcinol powder and mix thoroughly.
    - ✓ Place the test tube in a boiling water bath for 5 minutes and observe for colour
    - ✓ Red colour obtained with resorcinol indicates adulteration of milk with cane sugar
4. **Detection of neutralizers**
    - ✓ Take 1 ml milk in test tube.
    - ✓ Add 5 ml alcohol.
    - ✓ Add a few drops of rosalic acid solution (1%) and mix well.
    - ✓ Appearance of rose red colour indicates the presence of carbonate

5. **Addition of starch / Cereal flour**
    - ✓ Take 3 ml of well mixed sample of milk in a test tube
    - ✓ Boil the milk over a Bunsen burner
    - ✓ Cool and add a few drops of 1 percent Iodine solution and observe for colour change.
    - ✓ Appearance of blue colour indicates the presence of starch.
    - ✓ So development of blue colour indicates adulteration of milk with starch / cereal flour.
    - ✓ Blue colour disappears when the sample is boiled

6. **Addition of skim milk powder.**
    - ✓ Take 50 ml of milk in each of two centrifuge tubes and balance properly in the centrifuge.
    - ✓ Centrifuge at 3000 RPM for 30 minutes.
    - ✓ Decant the supernatant liquid carefully.
    - ✓ Dissolve the residue in 2.5 ml of concentrated nitric acid.
    - ✓ Dilute the solution with 5 ml of water
    - ✓ Add 2.5 ml of liquid ammonia and observe for colour development.

Skim milk powder being highly proteinacious in nature gives orange colour with nitric acid, while unadulterated milk being low in protein content gives only a yellow colour.

7. Addition of Gelatin

- ✓ Take 10 ml of milk in a test tube
- ✓ Add an equal amount of acid mercuric nitrate solution (mercury is dissolved in twice its weight of nitric acid of sp. G. 1.422. Before use this solution is diluted with distilled water to 25 times its volumes.
- ✓ Shake and add 20 ml of distilled water, shake again and allow to stand. - Filter after 5 minutes.
- ✓ Add to a part of the filtrate an equal volume of picric acid reagent (saturated solution of picric acid solution) and observe.

White cloudiness shows the presence of gelatin in the milk. Yellow Precipitate indicates a large amount of gelatin added. Transparent yellow solution indicates absence of gelatin.

8. Addition of Urea

- ✓ Take 5 ml of milk sample in 50 ml of conical flask.
- ✓ Add 5 ml of sodium acetate buffer or 24% Trichloroacetic acid solution and heat for 3 mts in boiling water bath (no heating if Trichloroacetic acid is used).
- ✓ Filter the precipitates through a what man no 42. Filter paper and collect 1 ml of filtrate in a test tube.
- ✓ Add one ml of sodium hydroxide solution (2% solution) to the filtrate, followed by 0.5 ml of sodium hypochloride solution (2% solution), mix thoroughly and finally add 0.5 ml of 5% (W / V) phenol solution and observe.

A characteristic blue or bluish green colour in the filtrate from the milk with extraneous urea indicate the presence of urea. Colourless indicates no urea added. This will detect even 0.1 percent of urea addition.

9. **Addition of Ammonium Sulphate**

- ✓ Take 1 ml of milk in a test tube.
- ✓ Add 0.5 ml of sodium hydroxide (2%) solution and 0.5 ml of sodium hypochlorite solution (2%) and mix thoroughly.
- ✓ To the solution add 0.5 ml of phenol solution (5%) and heat for 20 seconds in a boiling water bath, and observe.

A bluish colour immediately forms, which turns deep blue after wards, in the sample of milk having added ammonium sulphate. In case of pure milk only a salmon pink colour forms which gradually changes to bluish in course of about 2 hours, even 0.1 % addition of ammonium sulphate can be detected by this method.

10. **Addition of Glucose**

- ✓ Take 1 ml of milk sample in a test tube. - Add 1 ml of Bar foed's reagent.
- ✓ Heat the mixture for 3 minutes in boiling water bath and cool for 3 mts under tap water.
- ✓ Add one ml of phosphomolybdic acid reagent to the turbid solution and observe.

Immediate formation of deep blue colour indicates the presence of extraneous glucose, which is stable for 24 hours. In case of pure milk only faint bluish colour due to diluted barfoeds reagent appears. By this method as low as 0.05 % extraneous glucose in milk can be detected.

Note: Barfoeds Reagent: Dissolve 24 gs of cupric acetate in 450 ml of boiled distilled water. (If precipitate forms do not filter) add immediately 25 ml of 8.5% lactic acid to the hot solution. Shake to dissolved precipitate, cool and dilute 500 ml and after sedimentation filter of impurities.

Phosphomolybdic acid reagent: To 35 g of ammonium molybdate add 5 g of sodium tungstate. Add 200 ml of 10% (W / V) sodium hydroxide solution and 200 ml of distilled water. Boil vigorously for 20 – 60 minutes so as to remove nearly the whole of ammonia. Cool, dilute to about 350 ml and add 125 ml concentrated (85%) phosphoric acid. Dilute to 500 ml

B. PRESERVATIVES IN MILK AND THEIR DETECTION

If milk containing preservatives is accepted, processed milk or dairy products when offered for sale may be a hazard to health. It may also be impossible to process the milk into fermented products such as yoghurt and cheese. The most common preservatives found in milk are listed below, together with a short description of a detection test.

The preservatives used in milk are:

- ✓ Boric acid or Borax
- ✓ Formalin
- ✓ Benzoic acid
- ✓ Hydrogen peroxide
- ✓ β – Naphthol
- ✓ Hypochlorite
- ✓ Carbohydrates
- ✓ Maltodextrins

1. Detection of Boric Acid or Borax

- ✓ Take 5 ml of milk in a test tube.
- ✓ Add 1 ml of concentrated hydrochloric acid and mix well.
- ✓ Dip a strip of turmeric paper in the acidified milk.
- ✓ Dry the filter paper immediately and note the change in colour.

Turmeric paper turns red if boric acid or its salts are present. If boric acid or borax is present, the paper will colour red.

2. Detection of Formalin

There are two tests

a) Hehnes Test

- ✓ Take 10 ml of milk in a test tube
- ✓ Add 0.5 ml of 1% ferric chloride solution.

- ✓ Add carefully about 5 ml of concentrated sulphuric acid down the side of the test tube in such a way that it forms a separate layer at the bottom without mixing with milk.
- ✓ Observe the colour of the ring formed at the junction of the two liquids.

b) Leech Test

- ✓ Take 5 ml of milk in a test tube
- ✓ Add to it equal volume of concentrate hydrochloric acid containing 1 ml of 10% ferric chloride solution to each 500 ml of the acid.
- ✓ Heat over a flame for 5 minutes.
- ✓ Rotate the tube to break up the curd and observe the colour.
- ✓ Violet colour indicate presence of formaldehyde.

3. Detection of Benzoic Acid

- ✓ Acidify milk with hydrochloric acid (5 ml hydrochloric acid to 100 ml milk), then shake until curdled.
- ✓ Filter and extract the filtrate with 50 to 100 ml of ethyl ether. Wash the ether extract layer with two 5-ml portions of water. Evaporate the greater portion of ether in a porcelain dish on a water-bath and allow the remainder to evaporate spontaneously.
- ✓ If benzoic acid is present in large quantity, it will crystallize from the ether in shining leaflets and give a characteristic odour on heating.
- ✓ Dissolve the residue in hot water and add a few drops of ammonium hydroxide, expel the excess of ammonia by evaporation, dissolve the residue in a few ml. hot water and filter if necessary.
- ✓ Then add a few drops of the neutral ferric chloride solution (0.5 % w/v), neutral).
- ✓ A salmon coloured precipitate of ferric benzoate indicates the presence of benzoic acid.

4. Detection of Salicylic Acid

- ✓ Acidify 100 ml of milk with 5 ml of dilute hydrochloric acid (1:3 by volume).
- ✓ Shake until curdled and filter.
- ✓ Extract with 50-100 ml of ethyl ether. Wash the ether layer with two 5-ml portions of water.

- ✓ Evaporate the greater portion of ether in a porcelain dish on a steam bath; allow the remainder to evaporate.
- ✓ Add one drop of the ferric chloride solution (0.5%, neutral).
- ✓ A violet colour indicates the presence of salicylic acid.

5. Detection of Hydrogen Peroxide

- ✓ Take 10 ml of a sample of milk in a test tube.
- ✓ Add 2 drops of paraphenylene diamine hydrochloride solution mix thoroughly and observe.
- ✓ Development of an intense blue colour indicates presence of hydrogen peroxide.

6. Detection of β - Naphthol

Milk is extracted with chloroform and heated with potassium hydroxide for few mts. If a deep blue colour appears it indicates the presence of β - naphthol.

7. Detection of Hypochlorite

- ✓ Prepare a stannous chloride solution (0.025 % w/v) in 73.5% sulphuric acid: mix 3 volumes of concentrated sulphuric acid and 1 volume of water. Cool 3 ml of milk in a test-tube to 2 - 5 °C.
- ✓ In another tube, take an equal volume of the stannous chloride solution, similarly cool, and add to milk.
- ✓ Gently shake the tube while in the freezing mixture for 3 minutes.
- ✓ Pour in to a 12.5 ml centrifuge tube and centrifuge for 3 minutes at 2500 rpm.
- ✓ A yellow-green colour indicates the presence of hypochlorite

8. Detection of Carbohydrates

- ✓ To an aqueous solution of milk, add a little alcoholic solution of Molisch's reagent.
- ✓ Pour concentrated sulphuric acid down the side of the test tube until a separate layer of the acid is formed at the bottom.
- ✓ A red-violet ring at the junction of the two layers will be observed if Carbohydrates are present.

9. Detection of Maltodextrins

Maltodextrins are produced from starch and usually found as a creamy white hygroscopic powder. They can be cheaply and widely available.

- ✓ Put 20 ml of milk in a beaker, boil and cool.
- ✓ Coagulate the milk using 10% Trichloroacetic acid.
- ✓ Filter through Whatman filter paper no. 42 and collect the filtrate.
- ✓ Add 2 ml of 2% Barium chloride to the filtrate and mix well.
- ✓ Appearance of blue colour indicates the presence of maltodextrins.

10. Detection of Carbonates / Bicarbonates

- ✓ Take 10 ml of milk in a test tube.
- ✓ Add 10 ml of alcohol and shake well.
- ✓ Add 3 drips of aqueous solution of rosalic acid (1%)
- ✓ Mix well and observe the change of colour.

Rose red colour indicates presence of carbonate / bicarbonate in the milk. Only brownish colour indicates absence of carbonate / bicarbonate.

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