PROGRAM STUDI S1 GIZI
FAKULTAS ILMU KEOLAHRAGAAN DAN KESEHATAN
UNIVERSITAS NEGERI SURABAYA



CHAPTER

MILK AND DAIRY PRODUCTS

FOOD SCIENCE MODULE

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INSTRUCTION FOR USE

In order to achieve the learning objectives, pay attention to the following instructions before using this module:

1. Read the introduction to the material. Students can ask the lecturer if there are any descriptions that are not clear.
2. Read the learning objectives that will be achieved after studying the material.
3. Do every exercise and activity provided in the module subsequently, so that you can conclude the topics. If there are any questions, ask the lecturer.
4. Evaluate your work with the key answers provided in the module.
5. Create a scientific report explaining the results of your activity.

A. INTRODUCTION

Milk and dairy products play a significant role in human nutrition, providing a rich source of essential macronutrients and micronutrients, including proteins, fats, carbohydrates, calcium, vitamins, and trace elements including essential amino acids and fatty acids. These nutrients are critical for the maintenance of bone health, muscle function, and overall metabolic processes. For nutritionists and healthcare professionals, a thorough understanding of milk's composition and the various factors that influence its quality is essential for formulating evidence-based dietary recommendations.

Milk is the only food of the young mammal during the first period of its life. The substances in milk provide both energy and the building materials necessary for growth. Milk also contains antibodies which protect the young mammal against infection. A calf needs about 1000 litres of milk for growth, and that is the quantity which the primitive cow produces for each calf.

This module will examine milk from a scientific perspective, beginning with a definition of milk and its inherent physical and chemical properties. The physical properties include density, colors, taste and smell, and pH, while the chemical properties, consisting of its protein, fat, and carbohydrate content. Additionally, we will review the various treatments milk undergoes, especially heat treatment in milk to prolong its shelf life. Milk quality parameters will also be mentioned in one's part of this module. The module will conclude with an exploration of some dairy products and their processing methods. By understanding these scientific principles, nutritionists will be better equipped to provide informed guidance on milk and dairy consumption, taking into account individual dietary needs and broader public health considerations.

B. LEARNING OBJECTIVES

The objectives of students learning this module includes:

a) The student will record milk secretion process
b) The student will recognize milk physical properties
c) The student will recognize milk chemical properties
d) The student will recognize milk treatment to prolong its shelf-life
e) The student will recognize dairy products

C. LESSONS

1. Milk Secretion

Lactation is the production of milk from mammary glands. Before a cow can start to produce milk, she must have calved first. Heifers reach sexual maturity at the age of seven or eight months but are not usually fertilized until they are 15 - 18 months old. The period of gestation is 265 to 300 days, varying according to the breed of cow, so a heifer produces her first calf at the age of about 2.5 years.

Milk is an emulsion of fat in an aqueous solution secreted by mammalian glands under the influence of the hormone prolactin. Comprising approximately 87% water and 13% dry matter, the dry components are either dissolved or dispersed within the water. Milk is produced in the cow's udder, a hemispherical organ that is divided into right and left halves by a central crease. Each half is further segmented into quarters by a shallower crease, with each quarter containing a single teat connected to its own independent mammary gland.

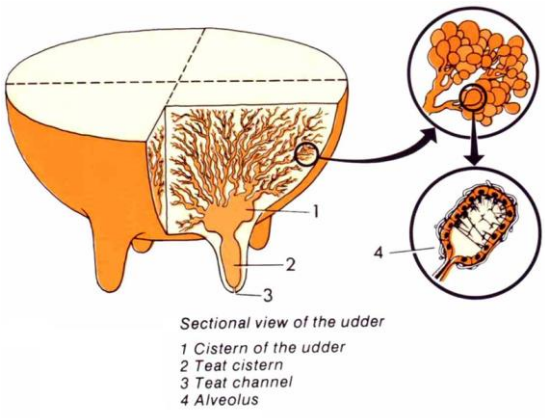


Figure 1. Udder of Cows

Prolactin, a peptide hormone produced during gestation, plays a crucial role in lactation. It stimulates the enlargement of mammary glands and the initiation of milk production. However, during pregnancy, high levels of progesterone inhibit milk secretion despite prolactin's presence. Milk production begins only after progesterone levels drop at the end of gestation, combined with the suckling stimulus provided by the offspring. Additionally, the release of the hormone oxytocin is essential to trigger the emptying of the udder. If the cow is not milked,

milk secretion ceases once the pressure reaches a critical threshold. The elevated pressure causes a small amount of milk to be expelled into the larger milk ducts and subsequently into the udder cistern.

The flow of blood through a cow's udder is remarkably high, amounting to around 90,000 liters per day. To produce just one liter of milk, between 400 and 800 liters of blood must circulate through the udder. A cow typically continues to produce milk for about 260 to 300 days, or roughly nine months, during what is known as the lactation period.

During the lactation period, milk production initially peaks before gradually declining. Approximately six to nine months after calving, milk production ceases. A new lactation cycle commences following the birth of a subsequent calf, usually one to two months after calving. On average, a cow remains productive for about five years; however, in intensive breeding systems, cows are often culled after completing only two or three lactation cycles.

2. Physical Properties of Milk

When assessing milk quality, evaluating its physical properties is essential to ensure it meets the required standards for safety, consistency, and consumer satisfaction. These properties provide crucial insights into the milk's composition, freshness, and suitability for various applications. Understanding what to check in terms of physical properties helps to identify potential issues and maintain high-quality production processes.

Table 1. Physical Properties of Milk

What to check?	Important notes
Colour	- Varies from white to yellow - Influenced by its content of suspended particles of the fat - Skim milk appears more transparent and has a faint bluish hue.
Density	- Varies between 1.028 - 1.034 g/ml at 27°C

What to check?	Important notes
Freezing point	- Varies between (-0.54°C) and (-0.59°C)
pH	- pH 6.6 to 6.7
Colostrum (raw milk)	- high content of beta-lactoglobulin, globulin and albumin. - contains antibodies - Yellowish to brownish-yellowish colour
Taste	- Chloride leads to savoury taste in milk - Lactose makes sweety taste in milk
Smell	Normal (fresh)

Physical properties in milk are essential to evaluate milk quality. For example, freezing point varies between -0.54 and -0.59 °C, depending on the content of lactose, proteins and minerals The presence of these substances in water lowers the freezing point. A higher concentration would result in an even lower freezing point. If water accidentally (or deliberately) is added to the bulk tank, the freezing point of the milk will move closer to 0˚C.

3. Chemistry of Milk

The principal constituents of milk are water, fat, proteins, lactose (a type of sugar) and minerals (salts). Milk also contains trace amounts of other substances such as pigments, enzymes, vitamins, phospholipids (substances with fatlike properties), and gases. Milk consists of about 87% water and 13% dry substance. The dry substance is dispersed or dissolved in the water. Milk contains several natural emulsifying agents. The fat droplets in milk, for example, are surrounded by a membrane of lipoprotein only 5 nm (0.000005 mm) thick acting as an emulsifying agent. Consequently, milk is a stable system from this point of view.

Composition of milk can vary considerably between cows of different breeds and between individual cows of the same breed. Therefore, only limit values could be stated for the variations.

Table 2. Composition of Fresh Cow Milk (Main Constituents)

Main constituents	Limit of variations (%)	Mean value (%)
Water	85.5 - 89.5	87.5
Total dry substances	10.4 - 14.5	13.0
Fat	2.5 - 6.0	3.9
Proteins	2.9 - 5.0	3.4
Lactose	3.6 - 5.5	4.8
Minerals	0.6 - 0.9	0.8

a) Milk Fat

Fat in milk is present as small globules surrounded by a special membrane (mucous membrane and phospholipids). This membrane skin protects the fat from being broken down by enzymes present in the milk. The fat globules are the largest particles in milk. Their diameters range from 0.1 to 20 m (1 m = 0.001 mm). The average size is 3 - 4 m, and there are 3 000 - 4 000 million fat globules in a millilitre of whole milk. The size of the fat globules has a significant effect on the yield of dairy processes. The larger the globules, the easier they are to separate from the skim milk.

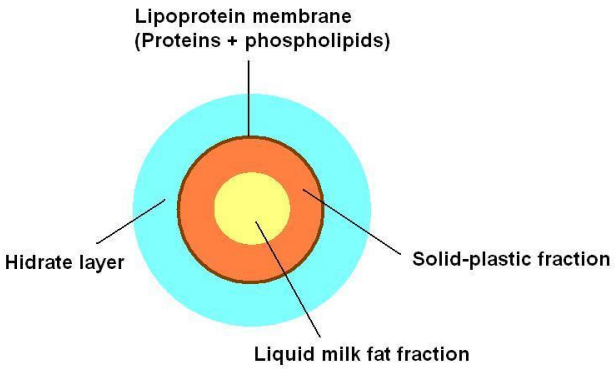


Figure 2. Fat Globules

Fat in milk is present as small globules surrounded by a special membrane (mucous membrane and phospholipids). This membrane skin protects the fat from being broken down by enzymes present in the milk. The fat globules are the largest particles in milk. Their diameters range from 0.1 to 20 m (1 m = 0.001 mm). The average size is 3 - 4 m, and there are 3 000 - 4 000 million fat globules in a millilitre of whole milk. The size of the fat globules has a significant effect on the yield of dairy processes. The larger the globules, the easier they are to separate from the skim milk.

Milk fat is a mixture of different fatty-acid esters called triglycerides, which are compounds of an alcohol called glycerol and various fatty acids. Fatty acids make up about 90% of milk fat. The number of different glycerides in milk is very large.

Table 3. Composition of Fresh Cow Milk Fatty Acids

Fatty Acid	% of total fatty acid content	Melting point (°C)
Saturated	**avg. 63.7**	
Butyric acid	3.0 - 6.2	(-7.9)
Caproic acid	1.3 - 3.8	(-1.5)
Caprylic acid	0.8 - 2.0	+16.5
Capric acid	1.8 - 3.8	+31.4
Lauric acid	2.0 - 5.0	+43.6
Myristic acid	7.8 - 14.0	+53.8
Palmitic acid	22.0 - 41.90	+62.6
Stearic acid	7.0 - 13.6	+69.3
Unsaturated	**avg. 36.3**	
Oleic acid	20.0 - 36.0	+14.0
Linoleic acid	0.8 - 5.2	(-5.0)
Linolenic acid	0.3 - 2.9	(-11.0)

Looking at table 2, it is readily apparent that myristic, palmitic, stearic and oleic acid are the most common fatty acids found in milk fat. Based on the melting

point, myristic, palmitic, and stearic are solid at room temperature, while oleic acid is liquid. Therefore, fat with high content of high melting-fatty acids like palmitic acid, will be hard in texture, while fat high in low-melting oleic acid will make soft butter.

b) Proteins

Protein makes up approximately 3.5% of raw milk, serving as one of its most vital and versatile components, essential for both nutrition and the creation of a wide range of dairy products. Proteins are giant molecules built up of smaller units, the amino acids. A protein molecule consists of one or more interlinked chains of amino acids, where the amino acids are arranged in a specific order. Milk proteins are composed of 18 amino acids, though some may undergo chemical modifications, slightly increasing the number. The specific sequence and arrangement of amino acids in protein molecules dictate their unique properties. With almost limitless combinations of 18 amino acids in chains of 100-200 units, an immense variety of proteins with distinct characteristics exists. Amino acids are either hydrophilic or hydrophobic, depending on the length and substituents of their hydrocarbon chains, influencing a protein's solubility and compatibility with water. Essential amino acids, eight of which humans cannot synthesize, must be consumed through diet.

Proteins also exhibit distinct behaviors depending on pH. The electric charge of amino acids in milk proteins is influenced by the milk's pH level. At a neutral pH of 7, certain amino acids like aspartic and glutamic acids carry a negative charge, while others, such as lysine and arginine, are positively charged. A protein's overall charge at neutral pH depends on the balance of acidic and basic amino acids; it will be negatively charged if acidic amino acids dominate and positively charged if basic amino acids are more prevalent. When acid is added to milk, altering its pH, the charge distribution of the proteins changes as well. The isoelectric point of a protein occurs at the pH where its positive and negative charges are balanced, resulting in a net charge of zero. For casein, this point is at a pH of 4.6.

Milk contains hundreds of proteins, classified into caseins, serum proteins, and fat-globule membrane proteins, each with unique properties and functions. Caseins precipitate easily, serum proteins remain in solution, and fat-globule proteins adhere to fat surfaces, with whey proteins emerging as a subset during cheese-making.

The most dominant protein in milk is **casein**. The 'special' molecular polymers formed by the caseins are called ‘casein micelles’. These micelles possess a remarkable balance of ionizable groups and hydrophobic and hydrophilic sites, forming a colloidal solution. Casein is further categorized into subgroups: αs-casein, β-casein, and κ-casein. Each subgroup has distinct structural properties that influence its role in dairy processing. For instance, αs-casein has a molecule with one hydrophobic and one hydrophilic end, while β-casein has two hydrophobic ends and a hydrophilic middle. κ-casein, on the other hand, contains a region rich in long-chain amino acids (hydrophobic) and another rich in carbohydrates (hydrophilic). One unique characteristic of casein is its ability to precipitate into solid form by acids or enzymes, a property crucial for forming casein curd, which is the basis for many dairy products such as cheese and yogurt.

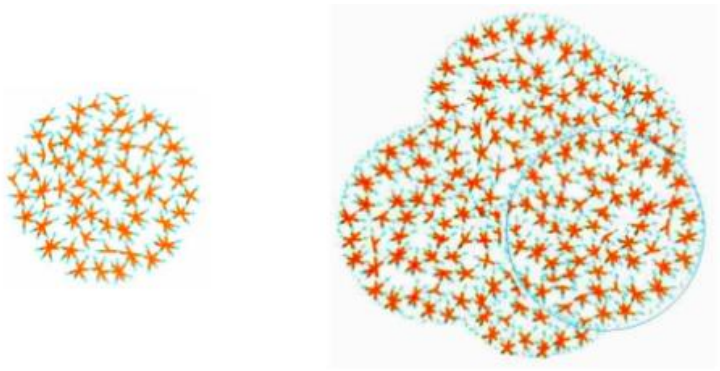


Figure 3. Casein Submicelles Attach to Large Casein Micelles

Milk-serum proteins consist of α-lactalbumin found in the milk of all mammals, where it plays a crucial role in lactose synthesis within the udder and β-lactalbumin that is unique for cloven hoofed animals and serves as the primary serum protein in cow’s milk. Milk-serum proteins in general, and α-lactalbumin in particular, have very high nutritional values. Their amino-acid composition is

very close to that which is regarded as a biological optimum. Whey protein preparations derived from these proteins are extensively utilized in the food industry.

Milk has also been studied widely about its bioactive peptides (BPs). Bioactive peptide is specific protein fragments that have positive influence on physiological and metabolic functions or condition of the body and may have ultimate beneficial effects on human, for example:

- Minor whey proteins such as lactoferrin, lysozyme, lactoperoxidase and immunoglobulins are believed to be antimicrobial proteins. Lactoferrin is a dominant whey protein in human milk and plays an important role in iron uptake in the intestine.
- Lactoferricin is a peptide that exhibits both antimicrobial and anticancer properties. It is an amphipathic, cationic peptide with the ability to combat infections and may also contribute to cancer prevention.
- ACE-inhibitory peptides were discovered through in vitro digestion of milk proteins or the chemical synthesis of peptide analogs. These ACE inhibitors, derived from milk proteins, are found in fragments of casein (referred to as casokinins) or whey proteins (known as lactokinins).
- Peptides derived from αs-casein have demonstrated antioxidant activity, scavenging free radicals and inhibiting both enzymatic and non-enzymatic lipid peroxidation, contributing to the protection of lipids from oxidative damage.
- Caseinomacropeptide (CMP) is a peptide produced from k-casein during the coagulation of milk by the rennin enzyme. This CMP has been shown to prevent platelet aggregation and to block the binding of the human fibrinogen γ-chain to platelet surface fibrinogen receptors, potentially reducing clot formation.

c) Carbohydrate

Milk typically contains carbohydrates in the form of a disaccharide called lactose, which ranges from 3.6% to 5.5%. Lactose is composed of two simple sugars:

glucose and galactose. Compared to other sugars, lactose is much less sweet—about 30 times less sweet than cane sugar. When lactic acid bacteria are introduced to milk, their lactase enzyme breaks down lactose into glucose and galactose. Other enzymes then convert these sugars into various acids, giving the milk a sour taste—a process known as fermentation.

People with lactose intolerance means they do not have enough lactase enzyme needed to digest lactose. Lactose intolerant people are unable to break down and provide food for gas-producing gut flora, which can cause bloating, flatulence, and other gastrointestinal symptoms. Lactose in the colon promotes the growth of putrefactive bacteria.

Next, when milk is heated to a high temperature and maintained at that level, it turns brown and develops a caramel-like flavor. This is due to **caramelization** and the **Maillard reaction**, a chemical interaction between lactose and proteins. Lactose, a water-soluble sugar, exists as a molecular solution in milk. During cheese production, most of the lactose remains dissolved in the whey. When whey is evaporated to produce whey cheese, the concentration of lactose increases further.

d) Vitamins and Minerals in Milk

Milk is a rich source of essential vitamins, including A, B1, B2, B6, B12, C, and D. Vitamins A and D are fat-soluble, dissolving in fats or fat solvents, while the others are water-soluble, dissolving in the aqueous phase of milk.

In addition to vitamins, milk contains a variety of minerals, though their total concentration is less than 1%. Mineral salts are found either dissolved in the milk serum or bound to casein compounds. The most significant minerals include calcium, sodium, potassium, and magnesium, which exist as phosphates, chlorides, citrates, or caseinates. Of these, potassium and calcium salts are the most prevalent in normal milk. However, the mineral content can fluctuate. For example, towards the end of lactation or during udder infections, the sodium chloride level increases, giving the milk a salty taste, while the concentrations of

other minerals decrease. This variability reflects the physiological and health status of the milk-producing animal.

e) Comparison in Milk composition

While milk generally comprises similar fundamental components, significant variations in composition are evident across different species. These differences are outlined in Table 3, which compares the specific constituents of milk based on its source, highlighting the unique biochemical profiles of each type.

Tabel 4. Average Variations of Milk Components per 100 g

Proximate	Human	Cow	Buffalo	Goat	Sheep
Energy (kcal)	70	62	99	66	100
Water (g)	87.5	87.8	83.2	87.7	82.1
Total protein (g)	1.0	3.3	4.0	3.4	5.6
Total fat (g)	4.4	3.3	7.5	3.9	6.4
Lactose (g)	6.9	4.7	4.4	4.4	5.1
Ash	0.2	0.7	0.8	0.8	0.9
Minerals					
Calcium (mg)	32	112	191	118	190
Iron (mg)	Tr	0.1	0.2	0.3	0.1
Magnesium (mg)	3	11	12	14	18
Phosphorus (mg)	14	91	185	100.4	144
Potassium (mg)	51	145	112	202	148
Sodium (mg)	17	42	47	44	39
Zinc (mg)	0.2	0.4	0.5	0.3	0.6
Copper (mg)	0.1	Tr		Tr	0.1
Selenium (mg)	1.8	1.8		1.1	1.7
Vitamins					
Vitamin A (mcg RE)	61	37	69	48	64
Vitamin E (mg)	0.08	0.08	0.19	0.05	0.11

Proximate	Human	Cow	Buffalo	Goat	Sheep
Thiamin (mg)	0.01	0.04	0.05	0.06	0.07
Riboflavin (mg)	0.04	0.20	0.11	0.13	0.34
Niacin (mg)	0.18	0.13	0.17	0.24	0.41
Pantothenic acid (mg)	0.22	0.43	0.17	0.24	0.41
Vitamin B6 (mg)		0.04	0.33	0.05	0.07
Folate (mcg)	5.0	8.5	0.6	1.0	6.0
Biotin (mcg)		2.0	13.0	2.5	2.5
Vitamin B12 (mcg)	0.05	0.51	0.40	0.07	0.66
Vitamin C (mg)	5.0	1.0	2.5	1.1	4.6
Vitamin D (mg)	0.1	0.2		0.1	0.2

Source: Milk and dairy products in human nutrition, FAO, 2013

4. Milk Quality

Milk composition is influenced by several factors, which include:

a. Genetics and Species: Different breeds and species exhibit significant variations in milk composition. For example, Jersey cows produce milk with higher fat and protein content compared to Friesians. Zebu cows can yield milk with fat levels as high as 7%.

b. Age and Lactation Period: Younger cows and those early in lactation tend to produce milk with higher protein and fat content. As cows age, the fat content decreases slightly per lactation.

c. Environmental Factors: Weather and temperature significantly impact milk yield and composition. Hot conditions, for instance, can reduce milk yield and alter its composition due to heat stress.

d. Milking Frequency and Schedule: The fat content in milk can vary depending on the time between milkings. More consistent milking intervals reduce fluctuations in fat content, though this may not always be practical on farms.

e. Feeding Regime: The cow's diet heavily influences milk composition. Adequate forage-to-concentrate ratios and appropriate nutrient levels are

essential for maintaining the desired levels of milk fat and protein. Underfeeding or imbalances in diet can lead to lower fat and protein levels.

Milk from sick animals or milk containing antibiotics or sediment must not be accepted at dairies. Even trace amounts of antibiotics can disrupt bacterial fermentation processes essential for producing acidified dairy products like yogurt and cheese. Antibiotics inhibit the growth of starter cultures, rendering the milk unsuitable for such applications.

Typically, an initial, general quality assessment is conducted at the farm, focusing on visual and odor-based indicators. However, comprehensive analyses of milk composition and hygienic quality are performed upon its arrival at the dairy. These tests include screening for contaminants, evaluating somatic cell counts, and determining bacterial levels to ensure compliance with food safety standards. The results of these tests have significant implications, as they directly influence the price paid to farmers.

Milk that meets higher quality standards often commands better compensation, while poor-quality milk may result in penalties or rejection. This system incentivizes producers to maintain high standards of animal health and hygiene throughout the production process. In addition to physical properties, there are other several aspects to check related to food safety in raw milk:

a. Colony Forming Unit (CFU): threshold level 100,000 cells/ml.

   A simplified method for determining bacterial content in milk is the Leesment technique. In this process, bacteria are cultivated at a temperature of 30°C for 72 hours using a 0.001 mL sample of milk and a nutritive substrate to support growth. In some countries, the average bacterial count in high-quality milk is approximately 25,000 CFU/mL, reflecting stringent dairy hygiene practices and quality standards.

b. Somatic Cell Count (SCC): threshold level 400,000 cells/ml

   An elevated somatic cell count (SCC) exceeding 500,000 cells per milliliter of milk is a clear indicator of udder infections, such as mastitis.

These cell levels are accurately measured using advanced particle counters like the Somacount, Coulter Counter, or Fossomatic devices, which are employed for official classifications. For on-farm or rapid assessments, simpler methods, such as the California Mastitis Test (CMT) or portable instruments that measure milk conductivity, are commonly used. In many regions, the average SCC in high-quality milk is around 189,000 cells/mL, showcasing effective herd management and disease control.

c. Resazurin test could also be used to measure the hygiene quality. Resazurin is a blue dye which becomes colourless when it is chemically reduced by the removal of oxygen. When it is added to the milk sample, the metabolic activity of the bacteria present has the effect of changing the colour of the dye at a rate which bears a direct relationship to the number of bacteria in the sample.

   This test can be applied in two ways:

   - Quick-Screening Test: Used for rapid assessment, this method may lead to the rejection of milk if the dye's color changes immediately, indicating poor hygiene and unsuitable milk for consumption.
   - Routine Test: This involves refrigerating a 10 mL milk sample overnight before adding 1 mL of Resazurin solution. The sample is then incubated at 37.5°C for two hours.

   While this test provides a practical estimate of microbiological quality, it is not commonly used in countries with excellent raw milk quality standards or strict classification systems. Instead, it is more relevant where rapid or preliminary microbial assessments are necessary.

d. Methylene Blue Reduction Test (MBRT) is a simple and traditional method for assessing milk quality by measuring its bacterial load. It relies on the principle that certain microorganisms in milk can reduce methylene blue dye under anaerobic conditions, causing the dye to lose its blue color. In the test, a standardized amount of methylene blue is added to a milk sample, which is then incubated at 37°C in sealed tubes to create anaerobic conditions. The time taken for the blue color to disappear is recorded: longer times indicate lower bacterial loads, while faster decolorization

suggests higher microbial activity. For example, milk that takes over 8 hours to decolorize is considered excellent quality, while decolorization in less than 2 hours indicates poor quality.

Despite its simplicity and cost-effectiveness, MBRT has limitations. It provides a general indication of bacterial load but does not identify specific bacterial species. This makes it less precise compared to modern microbiological techniques like plate counts or DNA-based methods. However, MBRT remains widely used in regions with limited resources due to its affordability and ease of use, offering a practical solution for quick quality checks in dairy production and supply chains.

Additionally, fresh milk quality in Indonesia is concluded by Standard Nasional Indonesia (SNI) 3141-01:2011.

Table 5. Fresh Milk (Cow) from Standard Nasional Indonesia

Parameters	Unit	Values
Min. Density (at 27.5 °C)	g/ml	1,0270
Min. Fat content	%	3,0
Min. Dry substances without fat content	%	7,8
Min. Protein	%	2,8
Colour, smell, taste, viscosity	-	No change
pH	-	6,3 – 6,8
Max. *Total plate count*	CFU/ml	1×10^5
Max. *Staphylococcus aureus*	CFU/ml	1×10^2
Max *Enterobacteriaceae*	CFU/ml	1×10^3
Max. Somatic cell count	Cells/ml	4×10^5
Antibiotic trace	-	Negative
Freezing point	°C	(-0.520) to (-0,560)
Peroxidase test		Positive
Lead (Pb)	mcg/ml	0,02
Mercury (Hg)	mcg/ml	0,03
Arsen (As)	mcg/ml	0,1

5. General Milk Treatment

Milk should be rapidly chilled to a temperature below +4°C immediately after milking and maintained at this temperature throughout its journey to the dairy. If the cold chain is disrupted, such as during transportation, bacterial growth in the milk will be triggered. This leads to the production of various metabolic byproducts and enzymes. While subsequent chilling may halt this process, the damage is already done, resulting in an increased bacterial count and the presence of substances that can negatively impact the quality of the final dairy product.

Generally, milk should be pasteurized to eliminate all the pathogenic micro-organisms, especially when it will be processed further to produce dairy products. However, there are many heat treatments that could be applied to milk to prolong its shelf-life. These heat treatments are meant to:

a. kill all microorganisms capable of causing disease in human beings.
b. destroy as many organisms and enzymatic systems as possible in order to safeguard product quality

These heat treatments include:

a. Thermization is a mild heat treatment process applied to milk, where the milk is heated to temperatures between 63-65°C for 15 seconds. This step helps reduce the microbial load without compromising the milk's flavor or nutritional quality.
b. Pasteurization, which follows a more rigorous approach, comes in two forms.
   (1) The High-Temperature Short Time (HTST) method heats the milk to 72-75°C for just 15 seconds, effectively eliminating harmful bacteria while preserving milk's taste and nutrients.
   (2) Alternatively, the Low-Temperature Long Time (LTLT) method involves heating the milk to 63°C for 30 minutes.

   Both methods extend the milk's shelf life to 12-21 days when stored at 4°C.

c. For a longer shelf life, the Extended Shelf Life (ESL) process heats the milk to higher temperatures between 115-130°C for 4-6 seconds. This process can keep milk fresh for 30 to 90 days at 4°C

d. UHT (Ultra High Temperature) processing involves heating milk to temperatures ranging from 135-150°C for just 2-10 seconds. This rapid heat treatment effectively sterilizes the milk, destroying harmful microorganisms while preserving its flavor and nutritional content. When combined with aseptic packaging, UHT milk becomes commercially sterile, meaning it remains safe for consumption without the need for refrigeration until opened. This process significantly extends the shelf life of the milk, making it a convenient option for long-term storage.

e. Commercial sterilization involves applying heat to milk or milk products at temperatures between 110–140°C for 20–30 minutes. This process ensures that the products become microbiologically stable and safe for consumption at room temperature. The high temperatures and sufficient processing time are effective at destroying harmful microorganisms, ensuring the product is commercially sterile. As a result, such sterilized products do not require refrigeration until opened, offering convenience and a longer shelf life.

These heat treatments have their consequence on milk, the following table conclude the effect of heat treatment on milk (Table 5).

Table 6. General Effect of Heat Treatment on Milk

Compartment	Consequence
Fat globule membrane	Denaturation of protein membrane
Casein	Partly denaturation
Serum protein	Denaturation and aggregation; inactivation of immune globulins
Amino acids	Maillard reaction (browning)
Vitamins	Decomposition in different rate
Minerals	Unsoluble Ca-phosphate formation, new mineral balance in milk
Enzymes	Different degrees of inactivation

6. Dairy Products

Dairy products are very famous among people worldwide, these are derived from milk through various biochemical processes, each resulting in distinct characteristics and applications.

a) Cheese

Cheese production involves the coagulation of milk proteins, primarily casein, using rennet and bacterial cultures. The milk undergoes acidification, leading to the separation of curds and whey. The curds are then pressed and aged under controlled conditions, allowing for the development of specific textures, flavors, and nutritional properties. The diversity of cheese types arises from variations in the microorganisms used, the aging process, and the type of milk (cow, goat, sheep).

The production of cheese begins with ensuring the raw milk meets specific quality standards. The milk must be fresh and unadulterated, with low Colony Forming Units (CFU) and Somatic Cell Counts (SCC). It should exhibit a good mineral balance, particularly in calcium ions, to facilitate curd formation. Additionally, the milk must support fermentation, containing essential nutrients for microbial growth while being free from inhibitory substances. The milk's ability to coagulate efficiently is also a crucial factor for successful cheese production.

Following milk selection, several pre-treatment steps are performed, including clarification, separation, fat standardization, pasteurization, pre-ripening, and enhancement of the milk’s properties. Next, the curd-making phase involves inoculating the milk with starter cultures, adding rennet to promote clotting, and subsequent processes such as post-heating, stirring, and settling. The resulting curd undergoes molding, pressing, and salting to develop its structure and flavor. Finally, the cheese is ripened under controlled conditions, allowing enzymatic and microbial actions to enhance its texture and taste over time.

Table 7. Classification of cheese

Classified by	Criteria	Cheese Type
Moisture content	Hard and extra hard (>56,0% moisture in nonfat cheese)	Cheese for grating (rasping), Round-eye cheese, cheddar
	Semi-hard (54,0-69,0% moisture in nonfat cheese)	Round-eye cheese, granular cheese, heated cheese (Mozarella, etc), Cheese made with rind cultures (red cheeses) or special moulds (camembert, etc)
	Soft (>67% moisture in nonfat cheese)	Camembert, Brie, Feta cheese
Time of ripening	Short ripening period (few days)	Cottage cheese
	Medium ripening period (2-6 weeks)	Trappist, Edamer, Gouda, Camembert
	Long ripening period (2-18 months)	Emmenthal, Stilton, Cheddar, Parmesan
Texture	Round-eyed (3-6 mm or bigger round holes in homogeneous distribution in the texture)	Trappist, Edam, Emmenthal, Gouda
	Granular texture (Zygomorphic holes in the texture)	Tilsit
	Close texture (fully or almost closed texture without holes)	Hard or semi-hard cheeses
By coagulation	Rennet cheeses	Fresh Cheese (e.g., Cottage Cheese): Produced using pre-ripened milk, this type involves inoculating the milk with starter cultures, adding clotting enzymes to induce protein coagulation, and releasing whey or permeate. The

		resulting product has a solid or semi-solid texture, with the whey protein (WP) to casein protein (CP) ratio being comparable to that of milk. It requires a moderate ripening period to achieve the desired qualities.
	Acid and mixed clotting	Derived from milk, buttermilk, or whey (or combinations thereof), this type primarily utilizes acid coagulation, though rennet may also be included. The process involves extended clotting times followed by partial whey drainage. These cheeses typically have a short ripening period and are distinguished by their tangy flavor and soft texture.

b) Fermented Milk Products

Fermented milk products, a diverse category of dairy-based foods, are cherished for their nutritional benefits, unique textures, and flavors. They are produced after homogenization and heating of milk or cream, using acidification with starters, clotting of milk and cold ripening as well. These products can be classified based on texture, microbial content, and starters. Texturally, they are categorized into set-type (firm and unshaken, such as traditional yogurt), stirred-type (smooth and blended consistency), and drinkable forms (liquid with a thinner consistency, like kefir). From a microbial perspective, they are divided into products with living flora, which retain active beneficial bacteria, and post-heated products, where microbes are eliminated through heat treatment after fermentation, ensuring a longer shelf life but without probiotic benefits. Table 7 highlights the classification of fermented milk products based on starters used.

Table 8. Classification of Fermented Milk Products by starters

Starters	Products
With thermophilic starters	Yoghurt; Cream yoghurt; "Filant" yoghurt; Bifidus yoghurt; Bifidus milk; Acidofilus milk
With thermophilic and mesophilic starter mixes	Yakult Prostokvasa
With mesophilic starters	Sour cream (16-20% fat) Light sour cream (8-12% fat) Sour cream spreads (25-40% fat) Viscous sour cream (12% fat) Cultured milk Enriched cultured milk Viscous cultured milk L. Bacteria + Yeasts: Kefyr Koumiss Laplander viscous cultured milk

One of the most renowned fermented milk products is yoghurt, created through the fermentation of milk by specific bacterial cultures, such as *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. These bacteria metabolize lactose, converting it into lactic acid, which lowers the pH and causes milk proteins (casein) to coagulate, giving yogurt its characteristic creamy texture and tangy flavor. Yogurt is also celebrated as a rich source of probiotics, beneficial microorganisms that support gut health by promoting a balanced intestinal microbiome. Fermented milk products not only enhance dietary variety but also provide functional health benefits.

c) Butter

Butter us created by churning cream, separating the butterfat from the buttermilk. The process of churning causes the fat molecules in cream to coalesce into a solid form, while the liquid phase, buttermilk, is drained off. Butter is primarily composed of milk fat, water, and a small percentage of milk solids. It is also considered as water in oil emulsion which high in fat content. Butter is commonly used in cooking, baking, and as a spread.

There are several groups when it comes to butter:

1. Butter (80-95% fat) salted or not salted, for example: Sweet cream butter, Soured cream butter, Dairy spreads (62-80% fat), Reduced fat dairy spreads (39-62% fat), Low fat dairy spreads (<39% fat)
2. Butter cream, which is oil in water emulsions with different fat content. Could be flavored or unflavored
3. Anhydrous milk fat (butter oil or ghee ~ 100% fat). Could be made by evaporation (results in traditional ghee); by vacuum evaporation of water from butter using low temperature; and by separation.

d) Ghee

Ghee is considered as anhydrous butter oil which really high in fat content. It is made by evaporation of water from butter by simmering butter to remove its water content and milk solids. This process results in a product with a higher smoke point and a nutty flavor due to the caramelization of the milk solids during the heating process. Ghee is widely used in South Asian cuisines and is known for its stability at high cooking temperatures, as well as its rich flavor profile.

e) Ice cream

Ice cream is airy dessert composed primarily of milk, cream, sugar, and flavorings. Ice-cream can be divided into four main categories according to the ingredients used:

- ice-cream made exclusively from milk products
- ice-cream containing vegetable fat

- sherbet ice-cream, made of fruit juice with added milk fat and milk solids-non-fat
- water ice (sorbet) is made of water, sugar and fruit concentrate

Table 9. Average composition of ice cream types

Type of ice cream	Fat (w/w%)	MNFS (w/w%)	Sugar (w/w%)	E/S (w/w%)	Water (w/w%)	Overrun (w/w%)
Ice cream	10	11	14	0.4	64.6	100
Milk Ice	4	12	13	0.6		85
Sherbet	2	4	22	0.4	71.6	50
Water ice (Sorbet)	0	0	22	0.2	77.8	0

Notes:

- Fat : Milk, cream, butter or vegetable fat
- Water : May include flavouring or colouring agents
- MNFS : Milk non-fat-solids (protein, minerals, lactose)
- Sugar : Liquid or solid sucrose
  (10% of sugar may be glucose or non-sugar sweetener)
- E/S : Emulsifier and stabiliser, e.g. mono glycerides, gelatine, alginate
- Overrun : Amount of air in product

The mixture is churned during freezing, which incorporates air and prevents large ice crystals from forming, giving it a smooth and creamy texture. Ice cream can also contain stabilizers and emulsifiers to improve its consistency. Variants like gelato (which contains less air and more milk fat) or sorbet (dairy-free and fruit-based) highlight the versatility of frozen dairy products.

Ingredients

The various ingredients are received, weighed and analyzed in the raw-material reception department, which is usually divided into one section for dry ingredients and one for liquid ingredients. The ingredients used in ice cream production are:

- Fat constitutes approximately 10–15% of the weight of a dairy ice cream mix and can be derived from either milk or vegetable sources. When milk fat is used, it may come from whole milk, cream, butter, or anhydrous milk fat (AMF). Alternatively, some or all of the milk fat may be substituted with hardened vegetable fats, such as sunflower oil, coconut oil, soybean oil, or rapeseed oil. Ice cream made with vegetable fat exhibits slight variations in color and flavor compared to those made with milk fat. However, these differences can be minimized with the addition of coloring and flavoring agents. It should be noted that the use of vegetable fat in ice cream production is prohibited in certain countries.
- Milk solids-non-fat (MSNF). Milk solids-non-fat (MSNF) in ice cream primarily consist of proteins, lactose, and mineral salts. These components are typically introduced through the addition of milk powder or condensed skim milk. To achieve optimal results, the ratio of solids-non-fat to fat must be carefully maintained. For example, in the production of ice cream with a fat content of 12%, the solids-non-fat content should ideally range between 11% and 11.5%. The inclusion of solids-non-fat provides several key benefits. They enhance the nutritional value of the ice cream and contribute to its texture by binding and replacing water. Additionally, SNF improves the structural integrity of the ice cream by aiding in the even distribution of air during the freezing process, which is crucial for achieving a smooth and consistent texture.
- Sugar is added to adjust the solids content in the ice cream and to give it the sweetness which customers prefer. The ice cream mix normally contains between 10 and 18% wt. sugar. Many different types of sugar can be used, such as cane and beet sugar, glucose, lactose and invert sugar (a mixture of glucose and fructose).

- Sweetened condensed milk is sometimes used, contributing to both the sweetening effect and the solids-non-fat content. Ordinary sugar is sometimes dissolved in water; a concentration of 50 – 55% can be achieved at ambient temperature, and up to 70% at about 80° C. Liquid sugar is easier to handle than dry sugar. To satisfy dieters, among whom diabetics are an important category, sweeteners should be used. A sweetener has no nutritive value but tastes very sweet even in very small doses. Note that a sweetener cannot be used as a preservative for sweetened condensed milk.
- Emulsifiers/stabilizers. Emulsifiers are substances which assist emulsifying by reducing the surface tension of liquid products. They also help to stabilize the emulsion formed. Egg yolk is a well-known emulsifier, but is expensive and less effective than the most commonly used types, which are mainly non-ionic derivatives of natural fats which have been esterified to give them one or more water-soluble (hydrophilic) radicals bonded to one or more fat-soluble (Lipophilic) radicals. The emulsifiers used in ice-cream manufacture can be divided into four groups: glycerine esters, sorbitol esters, sugar esters and esters of other origins. The amount added is usually 0.3 - 0.5% of the volume of the ice cream mix.
- Stabilizer. A stabilizer is a compound that binds a significant amount of water molecules when dispersed in a liquid phase (e.g., water). This process, known as hydration, creates a network within the liquid that restricts the free movement of water molecules. Stabilizers play a crucial role in ice cream production by preventing ice crystal formation, improving texture, and enhancing the overall stability of the mix. Stabilizers can be categorized into two main types: protein-based and carbohydrate-based. Protein stabilizers include gelatine, casein, albumin, and globulin. Carbohydrate stabilizers encompass marine colloids (e.g., alginate, carrageenan), hemicellulose, and modified cellulose compounds (e.g., carboxymethyl cellulose). The recommended dosage of stabilizers in ice cream is typically around 0.2% to 0.4% of the total

volume of the mix, ensuring the desired consistency and texture while maintaining proper hydration.

- Flavouring agents. Flavoring additives play a vital role in influencing a customer's preference for ice cream. Commonly used flavors such as vanilla, nougat, chocolate, strawberry, and nut are often incorporated during the mixing stage of production. For larger flavoring components, such as nougat chunks, nuts, fruit pieces, or jam swirls, these are typically added after the ice cream mixture has been frozen to maintain their texture and integrity. Cocoa is a popular choice for enhancing ice cream products, especially as a chocolate coating for bars, cones, and bricks. To achieve the desired properties—such as the appropriate viscosity, elasticity, and consistency—the cocoa is combined with fat, often cocoa butter. This mixture ensures the coating adheres well to the ice cream and delivers the expected sensory experience.
- Colouring agents

  Coloring agents are incorporated into the ice cream mix to enhance its visual appeal and complement the appearance of fruit flavoring additives. These agents are typically introduced as concentrated solutions to ensure uniform distribution and vibrant hues. Only legally approved coloring substances and sterilants are permitted for use to guarantee safety and compliance with food standards. The selection and application of these agents play a critical role in making ice cream visually enticing to consumers while maintaining regulatory and health guidelines.

Formulation

The weight and/or volume of the individual ingredients must be carefully determined before they are mixed. To obtain a well-balanced mix it is essential to calculate the percentage of milk solids-nonfat (MSNF) to be used. This is done by subtracting the percentage of fats, sugar, emulsifiers and stabilisers (E/S) you wish to use from 100 and multiplying the remainder by 0.15. For example, to produce ice cream with 10% wt. fat, 14% wt. of sugar

and 0.4% wt. of E/S, the following calculation will give the required MSNF in percent by weight:

$$= (100 - 10 - 14 - 0.4) \times 0.15 = 11.34\% \text{ wt. of MNSF}$$

When the amount of MSNF is known, the total dry matter (DM) content of the mix is fixed and the amount of each ingredient to be used can be calculated. In addition, the overrun in a typical ice cream should be about 2.5 – 2.7 times the total DM of the mix. In the above example the overrun should thus be:

$$2.7 \times (10 + 14 + 0.4 + 11.34) = 96{,}5\%$$

A general flow chart for ice-cream manufacture.

The ingredients come from the raw material stores to the mixing department, where they are weighed and blended to ice-cream mix. The line includes equipment for the batching of the various ingredients, for mixing and homogenization and also for pasteurization, cooling and ripening of the mix. The finished mix is pumped to the continuous freezers and then to the filling machines.

1. Weighing and mixing

   The ice cream production process begins with weighing and blending ingredients to form the ice cream mix. Dry ingredients are precisely weighed, while liquid components may be weighed or measured volumetrically. Accurate quantities ensure cost efficiency and consistent quality. Automated batching systems combine liquid and powder ingredients, facilitating simultaneous heating or cooling during mixing. Liquid ingredients are added sequentially into the weighing tank, followed by powdered materials, which are fed through hoppers and mixed using fluidizing nozzles to prevent clumping. The ingredients are blended in tanks equipped with agitators and circulated through a plate heat exchanger to achieve a uniform mix at 50-60°C before pasteurization.

2. Homogenisation and pasteurisation

   In large-scale production, the mix is preheated (73–75°C) before homogenization, which breaks down fat globules under high pressure (14–20 MPa). This ensures smooth texture and stability. After homogenization, the mix undergoes pasteurization at 83–85°C for 15 seconds to eliminate harmful microorganisms. In smaller-scale batch production, the mix is pasteurized directly in the processing tank at 70°C for 30 minutes, then homogenized and cooled to 5°C. Pasteurization ensures microbial safety and prepares the mix for aging.

3. Ripening

   The mix is stored in ripening tanks for 3–6 hours at about 5°C to allow fat crystallization and water binding by proteins and stabilizers. Gentle stirring during ripening helps improve the ice cream's texture and consistency. Depending on the facility, tanks may be chilled by ice water jackets or placed in refrigerated rooms (1–2°C) for optimal temperature control.

4. Addition of flavouring and colouring agent

   Once ripening is complete, the mix is pumped to continuous freezers. Flavorings and colorings can be incorporated at this stage, either by mixing in a tank or injecting directly into the line before freezing. This step customizes the mix with the desired sensory attributes.

5. Continuous freezing

   The continuous freezer simultaneously introduces air into the mix and freezes the water content to form fine ice crystals. This dual process creates the desired texture and volume in the final ice cream product. The controlled freezing environment ensures uniform crystal size and smooth consistency.

The final product is subject to rigorous quality control, with factors such as fat content, overrun, and flavor consistency carefully monitored to meet industry standards.

D. CONCLUSION

Milk production is a complex biological process regulated by hormonal and enzymatic systems in dairy animals. The key hormones involved, such as prolactin and oxytocin, play essential roles in milk synthesis and ejection. The physical properties of milk are fundamental to understanding its behavior during processing. These properties, including density, appearance, freezing point, pH, taste and smell are crucial when inspecting milk quality.

In addition to physical characteristics, milk's chemical properties are equally important. The primary components of milk, namely proteins, fats, and lactose, each contribute to its nutritional profile and functionality. Milk proteins, especially caseins and whey proteins, are vital in dairy product formation. The interaction between these chemical components affects milk's texture, taste, and digestibility, making it a versatile ingredient in dairy manufacturing. Furthermore, the presence of bioactive peptides in milk offers potential health benefits, such as improving the overall health.

To extend the shelf-life of milk and maintain its quality, various treatment methods are employed. Heat treatments such as pasteurization and ultra-high temperature (UHT) processing are essential for killing harmful microorganisms and preventing spoilage. Pasteurization typically involves heating milk to 72°C for 15 seconds, while UHT treatment raises the temperature to 135-150°C for a few seconds to ensure long-term stability. These methods not only enhance safety but also influence the flavor and nutritional profile of milk. Storage conditions, including refrigeration at temperatures below 4°C, further help in preserving milk's freshness.

Finally, dairy products which include cheese, yogurt, butter, and ice cream, all undergo unique transformations of milk through processes such as fermentation, coagulation, and freezing. Cheese production involves curd formation through bacterial cultures and rennet, while yogurt production relies on specific strains of bacteria to ferment lactose. Ice cream requires a combination of air incorporation and freezing to create its creamy texture.

E. PRACTICE

1. What is the definition of milk?
    a. Milk is an emulsion of fat in aqueous solution secreted by mammalian glands due to the presence of the hormone dopamine.
    b. Milk is an emulsion of water in fat solution secreted by mammalian glands due to the presence of the hormone prolactin.
    c. Milk is an emulsion of fat in aqueous solution secreted by mammalian glands due to the presence of the hormone prolactine.
    d. Milk consists of about 87% dry substance and 13% water

2. Siti kept the fresh milk at room temperature for 1 day. Siti then realised that the milk was spoiling, characterised by separated fat and milk liquid and a pungent smell. This is mainly caused by...
    a. Increased activity of spoilage bacteria
    b. High protein and fat content in milk
    c. Milk being a colloidal liquid
    d. Milk that is a fluid from the mammary gland

3. Siti kept the fresh milk at room temperature for 1 day. Siti then realised that the milk was spoiling, characterised by separated fat and milk liquid and a pungent smell. To extend the shelf life of the milk, Siti should...
    a. Storage of milk at < 4°C
    b. Storage of milk in a closed place and not exposed to the sun
    c. Milk storage in an airtight room
    d. All answers are incorrect

4. A student wanted to see the quality of fresh milk, so she conducted an experiment by taking a 10ml sample of cooled milk and mixing the sample with resazurin solution, the colour of the milk immediately turned blue. Within 2.5 hours, the blue colour faded. This was caused by...
    a. the milk was not fresh and could not be consumed in the first place
    b. milk is exposed to sunlight and metal contamination

c. the colour of the resazurin solution lasts only 1 hour
d. metabolic activity of bacteria that break down the blue colour

5. Protein found in milk consist of...
   a. Casein and lactose
   b. Galactose and casein
   c. Casein and whey protein
   d. Albumin and casein

6. What is the role of lactoferrin as a bioactive peptide in milk?
   a. Enhancing flavor and texture by acting as a stabilizer
   b. Providing antimicrobial properties and aiding in iron absorption
   c. Acting as a coagulant during curd formation
   d. Improving the emulsification process during mixing

7. David made a milk-derived product by removing water from butter. This product is called...
   a. Ghee
   b. Butter
   c. Camembert
   d. Yoghurt

8. The following is processed milk produced by separating the curd from the whey and then fermented is....
   a. Yoghurt
   b. Soyghurt
   c. Cheese
   d. Kefir

9. What is included in the yoghurt fermentation?
   a. Lowering pH of milk to about 4.6
   b. Transforming lactose into lactic acid

c. Pasteurizing milk\
d. All steps mentioned are required

10. Which of the following steps is critical in determining the final texture and consistency of ice cream during the manufacturing process?
    a. Adding colorants and flavoring agents before freezing
    b. Calculating and balancing the proportions of milk solids-nonfat (MSNF), fats, sugars, and stabilizers
    c. Homogenizing the mixture at room temperature
    d. Adding whey proteins after freezing

KEY ANWERS

1. **B**
2. **A**
3. **A**
4. **D**
5. **C**
6. **B**
7. **A**
8. **C**
9. **D**
10. **B**

E. WORKSHEET

1. Fresh milk organoleptic observation

This observation aims to differentiate sensory attributes of milk from different sources (cow, buffalo, sheep, and goat), such as appearance, smell, taste, and texture. Skim milk will also be tested as a comparison.

A. Materials required:

1. 50 ml each of fresh milk samples from cow, buffalo, sheep, goat, and skim milk
2. Clean glass beakers or containers for each milk type
3. Four spoons for tasting
4. Clean cloths
5. Water to cleanse before tasting other samples

B. Procedure:

1. Prepare samples in identical containers and make sure to put label on them
2. Observe the color of each milk type on a white background
3. Observe the aroma by gently sniff each milk sample
4. Taste each milk sample to differentiate the flavors
5. Asses the texture (density) by gently swirling the milk in the mouth
6. Make sure to drink water before moving to another sample
7. Record results

C. Report:

Milk types	**Appearance (Colour)**	**Smell**	**Taste**	**Texture**
Skim milk (Insert image)				
Cow's milk (Insert image)				

Buffalo's milk (Insert image)				
Goat's milk (Insert image)				
Sheep's milk (Insert image)				

2. Heat treated milk organoleptic observation

This observation aims to differentiate sensory attributes of milk from different heat treatments (pasteurized, UHT, sterilized, evaporated), such as appearance, smell, taste, and texture. Fresh milk will also be assed as a comparation.

A. Materials required:

1. 50 ml each of milk samples from fresh cow milk, pasteurized cow milk, UHT cow milk, evaporated cow milk
2. Clean glass beakers or containers for each milk type
3. Four spoons for tasting
4. Clean cloths
5. Water to cleanse before tasting other samples

B. Procedure:

1. Prepare samples in identical containers and make sure to put label on them
2. Observe the color of each milk type on a white background
3. Observe the aroma by gently sniff each milk sample
4. Taste each milk sample to differentiate the flavors
5. Asses the texture (density) by gently swirling the milk in the mouth
6. Make sure to drink water before moving to another sample
7. Record results

C. Report:

Milk types	**Appearance (Colour)**	**Smell**	**Taste**	**Texture**
Fresh Cow's milk (Insert image)				
Pasteurized milk (Insert image)				

UHT milk (Insert image)				
Sterilized milk (Insert image)				
Evaporated milk (Insert image)				

3. Dairy products organoleptic observation

This observation aims to differentiate sensory attributes of different dairy products such as appearance, smell, taste, and texture.

A. Materials required:

1. 35 g each of cheese samples: cheddar, mozzarella, edam, parmesan, camembert, cream cheese
2. 60 g Plain yoghurt
3. 60 g Plain kefir
4. Clean glass beakers or containers for each sample
5. Four spoons for tasting
6. Clean cloths
7. Water to cleanse before tasting other samples

B. Procedure:

1. Prepare samples in identical containers and make sure to put label on them
2. Observe the color of each milk type on a white background
3. Observe the aroma by gently sniff each sample
4. Taste each sample to differentiate the flavors
5. Asses the texture of each sample
6. Make sure to drink water before moving to another sample
7. Record results

C. Report:

Note: Insert image of every dairy product

Dairy products	**Appearance (Colour)**	**Smell**	**Taste**	**Texture**
Cheddar cheese				
Mozarella cheese				
Edam cheese				

Parmesan cheese				
Camembert cheese				
Plain yoghurt				
Plain kefir				

4. Milk storage observation

This experiment aims to compare the quality and stability of fresh milk, pasteurized milk, and ultra-high-temperature (UHT) treated milk under varying storage conditions (room temperature and refrigeration). The observation identifies changes in sensory attributes.

A. Materials required:

1. Samples of 50 ml fresh milk, 50 ml pasteurized milk, and 50ml UHT milk.
2. Six sterile containers for sample storage.
3. Refrigerator for cold storage (4°C)
4. Room temperature storage area (20–25°C**)**

B. Procedure:

1. Sample preparation: Divide the fresh, pasteurized, and UHT milk samples into two sets each.
2. Place one set of each milk type at room temperature (20–25°C).
3. Store the second set in a refrigerator (4°C).
4. Examine and test the samples at predefined time intervals (e.g., 4, 8, 24, 48, and 72 hours).
5. Document changes in taste, smell, and appearance (e.g., curdling, off-odors).

C. Report:

Milk type	**Storage temp.**	**0 hours**	**4 hours**	**24 hours**	**48 hours**	**72 hours**
Fresh Milk	20-25°C	Image: Sensory attributes Taste: Smell: Appearance:	Image: Sensory attributes Smell: Appearance:	Image: Sensory attributes Taste: Smell: Appearance:	Image: Sensory attributes Taste: Smell: Appearance:	Image: Sensory attributes Taste: Smell: Appearance:
Fresh Milk	4°C	Image: Sensory attributes Taste: Smell: Appearance:	Image: Sensory attributes Taste: Smell: Appearance:	Image: Sensory attributes Taste: Smell: Appearance:	Image: Sensory attributes Taste: Smell: Appearance:	Image: Sensory attributes Taste: Smell: Appearance:

Pasteurized milk	20-25°C	Image: Sensory attributes Taste: Smell: Appearance:	Image: Sensory attributes Taste: Smell: Appearance:	Image: Sensory attributes Smell: Appearance:	Image: Sensory attributes Smell: Appearance:	Image: Sensory attributes Smell: Appearance:
Pasteurized milk	4°C	Image: Sensory attributes Taste: Smell: Appearance:	Image: Sensory attributes Taste: Smell: Appearance:	Image: Sensory attributes Taste: Smell: Appearance:	Image: Sensory attributes Taste: Smell: Appearance:	Image: Sensory attributes Taste: Smell: Appearance:
UHT milk	20-25°C	Image:	Image:	Image:	Image:	Image:

		Sensory attributes: Taste: Smell: Appearance:	Sensory attributes: Taste: Smell: Appearance:	Sensory attributes: Taste: Smell: Appearance:	Sensory attributes: Taste: Smell: Appearance:	Sensory attributes: Taste: Smell: Appearance:
UHT milk	4°C	Image: Sensory attributes: Taste: Smell: Appearance:	Image: Sensory attributes: Taste: Smell: Appearance:	Image: Sensory attributes: Taste: Smell: Appearance:	Image: Sensory attributes: Taste: Smell: Appearance:	Image: Sensory attributes: Taste: Smell: Appearance:

5. Methylene Blue Reduction Test (MBRT)

This test aims to evaluate the quality of cow's milk.

A. Required materials include:

- fresh cow's milk samples,
- a 1/1000 methylene blue solution,
- 33% ammonium sulfate
- a volumetric pipette
- filter paper
- a glass funnel
- a water bath
- and a vortex mixer.

B. Procedure:

1. Add 10 ml of fresh milk to a sterile test tube.
2. Mix 1 ml of methylene blue solution into the milk until homogenized.
3. Incubate the sample at 37°C and inspect it every 30 minutes.
4. Record the time when the blue color starts to disappear. Faster color loss indicates poorer milk quality due to higher microbial content (microbes reduce methylene blue, causing color loss).
5. If the blue color disappears within 2 hours, the milk quality is poor.
6. If the blue color remains for more than 8 hours, the milk quality is excellent.

C. Report:

First observation	Time:
(Image)	Interpretation: Conclusion:
Second observation	Time:
(Image)	Interpretation: Conclusion:
Third observation	Time:
(Image)	Interpretation:

	Conclusion:
Fourth observation	Time:
(Image)	Interpretation: Conclusion:
Fifth observation	Time:
(Image)	Interpretation: Conclusion:
Sixth observation	Time:
(Image)	Interpretation: Conclusion:
…. observation	Time:
(Image)	Interpretation: Conclusion:
…. observation	Time:
(Image)	Interpretation: Conclusion:

6. Turbidity Test

This test determines whether the milk sample has been pasteurized or sterilized.

A. Materials required:

2. 20 ml milk samples:
3. Ammonium Sulfate Solution
4. two sterilized test tubes
5. Filter Paper:
6. Glass Funnels.
7. Water Bath
8. Pipettes
9. volumetric cylinders
10. A vortex mixer.

B. Procedure:

1. Boil 10 ml milk and prepare it in test tube
2. Pasteurize 10 ml milk and prepare it in another test tube
3. Add ammonium sulfate to both tubes until the final concentration reaches 30%, then mix thoroughly.
4. Filter the mixture through filter paper into a separate tube.
5. Place the tubes in a water bath for 5 minutes.
6. Observe the clarity of the milk:

   Clear solution = sterilized milk.

   Cloudy solution = pasteurized milk.

C. Report:

First sample observation	Interpretation:
(Image)	Conclusion:
Second sample observation	Interpretation:
(Image)	Conclusion:

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