

DIRECTORATE OF DISTANCE & CONTINUING EDUCATION
MANONMANIAM SUNDARANAR UNIVERSITY
TIRUNELVELI- 627 012

OPEN AND DISTANCE LEARNING (ODL) PROGRAMMES
(FOR THOSE WHO JOINED THE PROGRAMMES FROM THE ACADEMIC YEAR 2023-2024)



B. Sc. Chemistry Course Material
Skill Enhancement Course - II
Dairy Chemistry

Course Code JSCH21

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Dairy Chemistry

UNIT I

Composition of Milk

Milk- definition- general composition of milk- constituents of milk - lipids, proteins, carbohydrates, vitamins and minerals - physical properties of milk - colour, odour, acidity, specific gravity, viscosity and conductivity -Factors affecting the composition of milk - adulterants, preservatives with neutralizer- examples and their detection- estimation of fat, acidity and total solids in milk.

UNIT II Processing of Milk

Microbiology of milk - destruction of micro - organisms in milk, physico – chemical changes taking place in milk due to processing - boiling, pasteurization – types of pasteurization - Bottle, Batch and HTST (High Temperature Short Time) – Vacuum pasteurization – Ultra High Temperature Pasteurization.

UNIT III Major Milk Products

Cream - definition - composition - chemistry of creaming process - gravitational and centrifugal methods of separation of cream - estimation of fat in cream. Butter - definition -composition - theory of churning – desi butter - salted butter, estimation of acidity and moisture content in butter. Ghee - major constituents - common adulterants added to ghee and their detection – rancidity - definition - prevention - antioxidants and synergists - natural and synthetic

UNIT IV Special Milk

Standardised milk - definition - merits - reconstituted milk - definition - flowdiagram of manufacture - Homogenised milk - flavoured milk – vitaminised milk - toned milk - Incitation milk - Vegetable toned milk - humanized milk - condensed milk - definition, composition and nutritive value.

UNIT V Fermented and other Milk Products

Fermented milk products – fermentation of milk - definition, conditions, cultured milk - definition of culture - example, conditions - cultured cream, butter milk - Bulgarian milk -acidophilous milk – Yoheer Indigeneousproducts- khoa and chhena definition - Ice cream -definition-percentagecomposition-types-ingredients-manufacture of ice – cream, stabilizers - Emulsifiers and their role-milk powder-definition need for making milk powder- drying process-types of drying.

Recommended Text

1. K. Bagavathi Sundari, Applied Chemistry, MJP Publishers, first edition, 2006.
2. K. S. Rangappa and K.T. Acharya, Indian Dairy Products, Asia Publishing House New Delhi, 1974.
3. Text book of dairy chemistry, M.P. Mathur, D. Datta Roy, P. Dinakar, Indian Council of Agricultural Research, 1st edition, 2008.
4. A Text book of dairy chemistry, Saurav Singh, Daya Publishing house, 1st edition, 2013.
5. Text book of dairy chemistry, P. L. Choudhary, Bio-Green book publishers, 2021.

Reference Books

1. Robert Jenness and S. Patom, Principles of Dairy Chemistry, S. Wiley, New York, 2005.
2. F.P. Wond, Fundamentals of Dairy Chemistry, Springer, Singapore, 2006.
3. Sukumar De, Outlines of Dairy Technology, Oxford University Press, New Delhi, 1980.
4. P.F. Fox and P.L.H. Mc Sweeney, Dairy Chemistry and Biochemistry, Springer, Second edition, 2016.
5. Dairy chemistry and biochemistry, P. F. Fox, T. Uniacke -Lowe, P.L.H. Mc Sweeney, J.A. OMahony, Springer, Second edition, 2015.

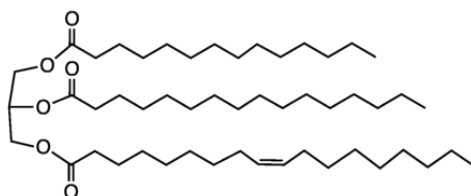
UNIT -I

COMPOSITION OF MILK

DEFINITION OF MILK

Milk is a white liquid food produced by the mammary glands of mammals and the caecilian *Siphonops annulatus*. It is the primary source of nutrition for young mammals (including breastfed human infants) before they are able to digest solid food. Immune factors and immune-modulating components in milk contribute to milk immunity. Early-lactation milk, which is called colostrum, contains antibodies that strengthen the immune system and thus reduce the risk of many diseases. Milk contains many nutrients, including protein and lactose.

GENERAL COMPOSITION OF MILK



Butterfat

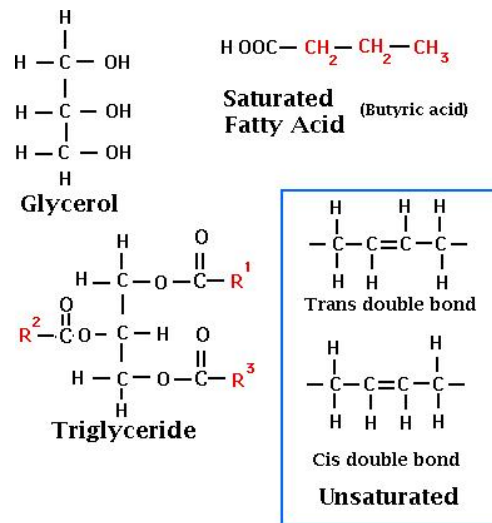
Milk is an emulsion or colloid of butterfat globules within a water-based fluid that contains dissolved carbohydrates and protein aggregates with minerals. Because it is produced as a food source for the young, all of its contents provide benefits for growth. The principal requirements are energy (lipids, lactose, and protein), biosynthesis of non-essential amino acids supplied by proteins (essential amino acids and amino groups), essential fatty acids, vitamins and inorganic elements, and water.

CONSTITUENTS OF MILK

1.LIPIDS:

Initially milk fat is secreted in the form of a fat globule surrounded by a membrane. Each fat globule is composed almost entirely of triacylglycerols and is surrounded by a membrane consisting of complex lipids such as phospholipids, along with proteins. These act as emulsifiers which keep the individual globules from coalescing and protect the contents of these globules from various enzymes in the fluid portion of the milk. Although 97–98% of lipids are triacylglycerols, small amounts of di- and monoacylglycerols, free cholesterol and cholesterol esters, free fatty acids, and phospholipids are also present. Unlike protein and

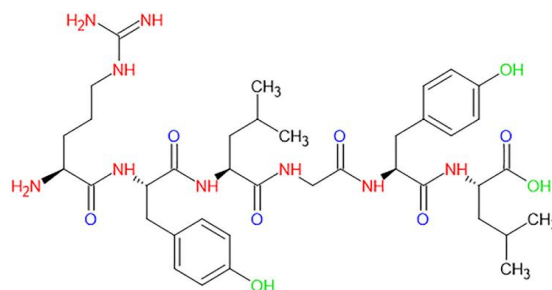
carbohydrates, fat composition in milk varies widely due to genetic, lactational, and nutritional factor difference between different species.



Fat globules vary in size from less than 0.2 to about 15 micrometers in diameter between different species. Diameter may also vary between animals within a species and at different times within a milking of a single animal. In unhomogenized cow's milk, the fat globules have an average diameter of two to four micrometers and with homogenization, average around 0.4 micrometers. The fat-soluble vitamins A, D, E, and K along with essential fatty acids such as linoleic and linolenic acid are found within the milk fat portion of the milk.

2.PROTEINS:

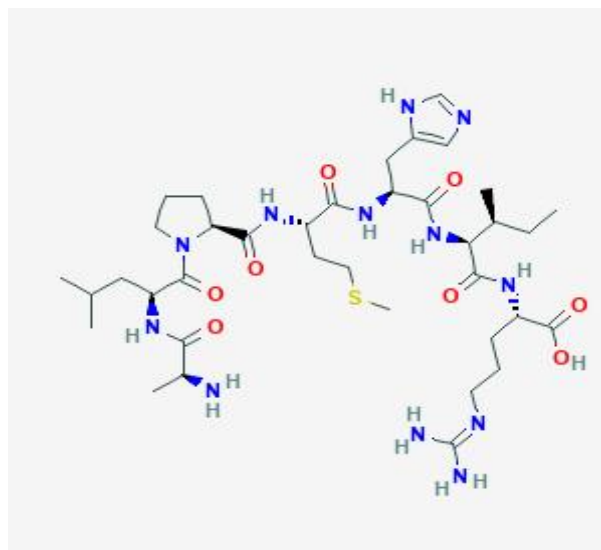
Normal bovine milk contains 30–35 grams of protein per liter, of which about 80% is arranged in casein micelles. Total proteins in milk represent 3.2% of its composition.



STRUCTURE OF CASEIN

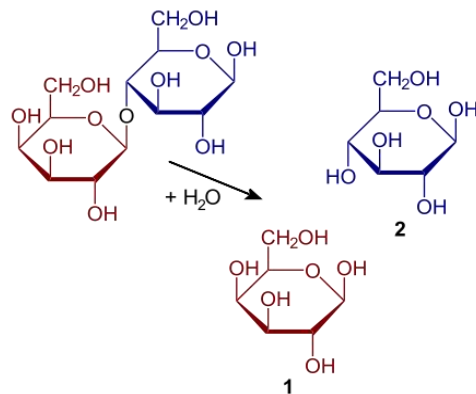
The largest structures in the fluid portion of the milk are “casein micelles”: aggregates of several thousand protein molecules with superficial resemblance to a surfactant micelle, bonded with the help of nanometer-scale particles of calcium phosphate. Each casein micelle is roughly spherical and about a tenth of a micrometer across. There are four different types of casein proteins: α s1-, α s2-, β -, and κ -caseins. Most of the casein proteins are bound into the micelles. There are several competing theories regarding the precise structure of the micelles, but they share one important feature: the outermost layer consists of strands of one type of protein, κ -casein, reaching out from the body of the micelle into the surrounding fluid. These kappa-casein molecules all have a negative electrical charge and therefore repel each other, keeping the micelles separated under normal conditions and in a stable colloidal suspension in the water-based surrounding fluid.

Milk contains dozens of other types of proteins beside caseins and including enzymes. These other proteins are more water-soluble than caseins and do not form larger structures. Because the proteins remain suspended in whey, remaining when caseins coagulate into curds, they are collectively known as whey proteins. Lactoglobulin is the most common whey protein by a large margin. The ratio of caseins to whey proteins varies greatly between species; for example, it is 82:18 in cows and around 32:68 in humans.



STRUCTURE OF LACTOGLOBULIN

3.CARBOHYDRATES:



A simplified representation of a lactose molecule being broken into glucose(2) and galactose(1)

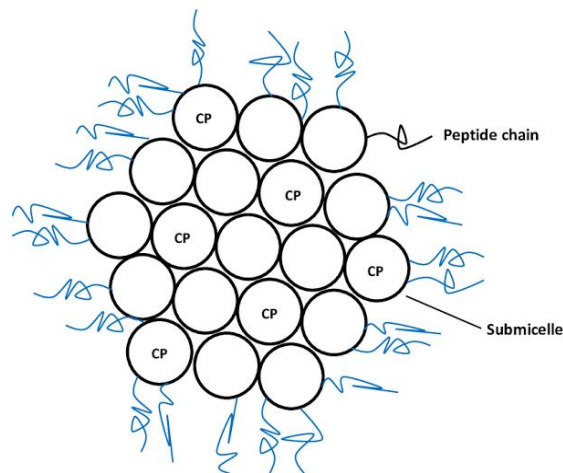
Milk contains several different carbohydrates, including lactose, glucose, galactose, and other oligosaccharides. The lactose gives milk its sweet taste and contributes approximately 40% of the calories in whole cow's milk's. Lactose is a disaccharide composite of two simple sugars, glucose and galactose. Bovine milk averages 4.8% anhydrous lactose, which amounts to about 50% of the total solids of skimmed milk. Levels of lactose are dependent upon the type of milk as other carbohydrates can be present at higher concentrations than lactose in milks.

4.VITAMINS AND MINERALS:

Bovine milk contains a variety of cations and anions traditionally referred to as "minerals" or "milk salts". Calcium, phosphate, magnesium, sodium, potassium, citrate, and chloride are all included and they typically occur at concentrations of 5–40 mM. The milk salts strongly interact with casein, most notably calcium phosphate. It is present in excess and often, much greater excess of solubility of solid calcium phosphate. In addition to calcium, milk is a good source of many other vitamins. Vitamins A, B6, B12, C, D, K, E, thiamine, niacin, biotin, riboflavin, folates, and pantothenic acid are all present in milk.

Calcium phosphate structure

For many years the most widely accepted theory of the structure of a micelle was that it was composed of spherical casein aggregates, called submicelles, that were held together by calcium phosphate linkages. However, there are two recent models of the casein micelle that refute the distinct micellular structures within the micelle.



The first theory, attributed to de Kruif and Holt, proposes that nanoclusters of calcium phosphate and the phosphopeptide fraction of beta-casein are the centerpiece to micellar structure. Specifically in this view unstructured proteins organize around the calcium phosphate, giving rise to their structure, and thus no specific structure is formed.

Under the second theory, proposed by Horne, the growth of calcium phosphate nanoclusters begins the process of micelle formation, but is limited by binding phosphopeptide loop regions of the caseins. Once bound, protein-protein interactions are formed and polymerization occurs, in which K-casein is used as an end cap to form micelles with trapped calcium phosphate nanoclusters.

Some sources indicate that the trapped calcium phosphate is in the form of $\text{Ca}_9(\text{PO}_4)_6$; whereas others say it is similar to the structure of the mineral brushite, $\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$.

PHYSICAL PROPERTIES OF MILK

1.COLOUR:

Milk appears turbid and opaque owing to light scattering by fat globules and casein micelles. Optical properties are influenced by the manner of scattering of light by the molecules. Light scattering occurs when the wavelength of light matches the magnitude of

the particle. Thus, smaller particles scatter light of shorter wavelengths and vice versa. Skim milk appears slightly blue because casein micelles scatter the shorter wavelengths of visible light (blue) more than the red. Beta-carotene, the carotenoid precursor of vitamin A, is responsible for the creamy colour of cow milk. The greenish tinge in whey is due to the presence of riboflavin. Refractive index of milk is an optical property and ranges from 1.3440 to 1.3485 at 20°C. The relation between solids content of milk and refractive index is linear, and the contributions of the several constituents is additive.

2.ODOUR:

The odor of milk can vary depending on factors such as its freshness, processing, and storage conditions. Fresh milk typically has a mild, slightly sweet scent. If milk has gone bad, it may develop a sour or rancid smell due to the presence of bacteria breaking down the lactose. It's important to always check the expiration date and smell milk before consuming it to ensure it's still good to use.

3.ACIDITY:

The acidity of milk refers to its pH level, which is influenced by factors such as the presence of lactic acid bacteria and the breakdown of lactose into lactic acid. Fresh milk typically has a pH around 6.7, but this can vary slightly depending on the type of milk (e.g., whole milk, skim milk) and other factors. As milk ages or spoils, its pH decreases due to the accumulation of lactic acid produced by bacteria, leading to increased acidity. Testing the pH level of milk is one way to assess its freshness and quality.

4.SPECIFIC GRAVITY:

Milk is heavier than water. The specific gravity of cow milk varies from 1.018 to 1.036 and of buffalo milk from 1.018 to 1.038. Though specific gravity varies with temperature, (lower at higher temperature and vice versa), the rate of this variation is not uniform.

The density of milk varies within the range of 1.027 to 1.033 kg/cm³ at 20°C. The density of milk is used to estimate the solids content, to convert volume into mass and vice versa and to calculate other physical properties such as dynamic viscosity. It is dependant on temperature at the time of measurement, temperature history of the sample, composition of the sample (particularly fat content) and inclusion of air.

5.VISCOSITY:

Viscosity of milk depends on the temperature and the amount and state of dispersion of the solid constituents, mainly casein and fat. Viscosity of the whole milk at 25°C is about 2.0 cP. Cooler temperatures increase viscosity due to the increased voluminosity of casein micelles whereas temperatures above 65°C increase viscosity due to the denaturation of whey proteins. An increase or decrease in pH of milk also causes an increase in casein micelle voluminosity. The effect of agitation on viscosity is not uniform. Sometimes, agitation causes partial coalescence of the fat globules, hence increasing the viscosity and at other times, agitation may disperse fat globules that have undergone cold agglutination, leading to a decrease in viscosity.

6.CONDUCTIVITY:

The conductivity of milk refers to its ability to conduct electrical current. Milk contains various electrolytes, such as calcium, potassium, and chloride ions, which contribute to its conductivity. Generally, the conductivity of milk increases with the concentration of these ions. Therefore, factors such as milk type (whole, skim, etc.), processing, and additives can influence its conductivity. Measuring the conductivity of milk is often used as an indicator of its composition and quality in dairy industry processes and quality control.

FACTORS AFFECTING THE COMPOSITION OF MILK

ADULTERANTS:

Adulterants are substances that are added to a product, often food or drink, to increase its quantity or to deceive consumers about its quality. In the case of milk, common adulterants include water, urea, detergent, formalin, starch, and even vegetable oil. These substances can alter the nutritional content of milk, dilute its natural components, and introduce harmful chemicals that pose health risks to consumers.

Adulterants in milk can significantly alter its composition by diluting the nutrients and introducing harmful substances. For example, adding water dilutes the protein, fat, and vitamin content, reducing the milk's nutritional value. Adulterants like urea, detergent, or formalin can pose serious health risks, affecting both short-term and long-term health. Additionally, adulterants can also affect the taste, texture, and shelf life of milk. Regular consumption of adulterated milk can lead to health problems such as digestive issues, toxicity, and even chronic diseases.

PRESERVATIVES WITH NEUTRALIZER:

Preservatives with neutralizers can affect the composition of milk in several ways:

Reduced Microbial Growth: Preservatives inhibit the growth of bacteria, fungi, and other microorganisms in milk, thereby extending its shelf life. This can help maintain the milk's freshness and prevent spoilage, but it does not directly affect its nutritional composition.

Neutralization of Preservative Effects: Neutralizers are substances added to counteract the effects of preservatives. In the context of milk, neutralizers may be added to balance the acidity or alkalinity introduced by certain preservatives. For example, if a preservative increases the acidity of milk, a neutralizer might be added to bring the pH back to a more neutral level.

Minimal Impact on Composition: Generally, preservatives and neutralizers are added in small quantities, and their primary function is to preserve the quality and safety of milk rather than alter its composition. Therefore, the direct impact on the nutritional composition of milk is minimal. However, prolonged use of preservatives and neutralizers may affect consumer perception and acceptance of the product.

Overall, while preservatives and neutralizers play important roles in extending the shelf life and ensuring the safety of milk, their direct influence on its composition is limited compared to other factors such as adulteration or processing methods.

DETECTION OF ADULTERANTS IN MILK

Detection of adulterants in milk typically involves various analytical techniques and testing methods. Some common methods include:

Chemical Tests: Chemical tests are used to detect the presence of specific substances in milk. For example, tests for detecting water adulteration may involve measuring the milk's density or conducting simple tests like the alcohol test or lactometer test.

Chromatography: Chromatography techniques such as gas chromatography (GC) or high-performance liquid chromatography (HPLC) can separate and identify different components in milk, allowing for the detection of adulterants like detergents, formalin, or antibiotics.

Spectroscopy: Spectroscopic techniques like infrared spectroscopy (IR) or mass spectrometry (MS) can provide detailed information about the molecular composition of milk, helping to identify adulterants or contaminants.

Microbiological Tests: Microbiological tests can detect the presence of harmful bacteria or pathogens in milk, which may indicate contamination or adulteration.

DNA Testing: DNA testing can be used to identify the species of origin in milk, which is useful for detecting the addition of foreign substances like vegetable oils or animal-based adulterants.

Sensor-Based Technologies: Rapid detection methods based on sensors or biosensors are being developed to quickly identify adulterants in milk. These methods often rely on specific interactions between the adulterant and a sensor element to produce a detectable signal.

Immunological Tests: Immunological methods such as enzyme-linked immunosorbent assay (ELISA) can detect the presence of specific proteins or antibodies in milk, aiding in the identification of certain adulterants or contaminants. Overall, a combination of these techniques is often used to comprehensively assess the quality and authenticity of milk and to detect any potential adulteration or contamination.

DETECTION OF PRESERVATIVES WITH NEUTRALIZER IN MILK

Detecting preservatives with neutralizers in milk requires careful analysis to identify both the preservative and the neutralizer. Here are some methods commonly used for detection:

Chemical Analysis: Chemical tests can help identify the presence of specific preservatives and neutralizers in milk. For example, titration techniques can determine the concentration of preservatives such as hydrogen peroxide or formaldehyde. Neutralizers like sodium hydroxide or citric acid can also be detected using appropriate chemical tests.

Chromatography: Chromatographic techniques such as gas chromatography (GC) or high-performance liquid chromatography (HPLC) can separate and identify different compounds in milk, including preservatives and neutralizers. By comparing the retention times and spectra of unknown substances with those of known standards, the presence of preservatives and neutralizers can be confirmed.

Spectroscopy: Spectroscopic methods like infrared spectroscopy (IR) or nuclear magnetic resonance spectroscopy (NMR) can provide information about the molecular composition of milk and help identify preservatives and neutralizers based on their characteristic spectra.

Mass Spectrometry: Mass spectrometry (MS) can be used to detect and identify preservatives and neutralizers in milk by measuring the mass-to-charge ratios of ions

produced from the sample. This technique is highly sensitive and can provide detailed information about the chemical composition of milk.

Immunoassays: Immunoassay techniques such as enzyme-linked immunosorbent assay (ELISA) can detect specific preservatives or neutralizers in milk by using antibodies that bind to these compounds. ELISA kits can be designed to target specific preservatives or neutralizers, providing a rapid and sensitive detection method.

By employing a combination of these analytical techniques, it is possible to detect preservatives and neutralizers in milk and ensure its safety and quality.

ESTIMATION OF FAT IN MILK

GERBER METHOD OF DETERMINING FAT IN MILK:

The Gerber Method is a primary and historic chemical test to determine the fat content of substances, most commonly milk. The Gerber Method was developed and patented by Dr. Niklaus Gerber of Switzerland in 1891. In this method milk fat is separated from proteins by adding sulfuric acid (1.820-1.825 sp. Gr. At 60°F). The separation is facilitated by using amyl alcohol and centrifugation. The fat content is read directly via a special calibrated butyrometer.

The theory behind using 10.75 ml milk in the pipette is as follows:

- Gerber butyrometer is graduated on 0-10 scale and calibrated in such a way that each 1% division represents 0.125 ml of fat.
- The weight of the fat in the area is equal to $\text{Volume} \times \text{Density} = \text{Mass}$; $0.125 \times 0.9 = 0.1125$ (because density of fat = 0.9 g/lit)
- If 1 % represents 0.1125 then 100 % will be represented 11.25 g.
- As per this, we should be pipetting 11.25 g of milk, but there are certain impurities due to iso-amyl alcohol, which affects the fat reading. These impurities are estimated at 2.5-3% (average $(2.5+3)/2 = 2.667\%$).
- So the fat is $1.125 - (1.125 \times 2.667/100) = 1.095$ g.
- According to this we should be pipetting 10.95 g of milk.
- This is equivalent to 10.65 ml of milk ($10.95/1.02547$, the denominator being the density of milk).
- Since 0.1 ml residual milk remains in the glass pipette sticking to the walls, we take 10.75 ml of milk.

ESTIMATION OF ACIDITY IN MILK

TITRABLE ACIDITY OF MILK:

The titrable acidity test is employed to ascertain if milk is of such a high acidity as to reduce its keeping quality and heat stability. The acidity of milk is of two kinds.

1. Natural acidity which is due to citrates and phosphates present in the milk and dissolved CO₂ during the process of milking and thereafter.

2. Developed acidity which is due to lactic acid produced by the action of bacteria on lactose in milk.

Generally the acidity of milk means the total acidity (Natural + developed) or titrable acidity. It is determined by titrating a known volume of milk with standard alkali to the point of an indicator like phenolphthalein. The titrable acidity test measures the amount of alkali which is required to change the pH of milk from its initial value of about 6.6 to 6.8, to the pH of the colour change of phenolphthalein added to milk to indicate the end point (pH 8.3). In fact, the method measures the buffering capacity of milk and not the true acidity.

Procedure:

1. Fill the burette with N/10 NaOH solution.
2. Mix the milk sample thoroughly by avoiding incorporation of air.
3. Transfer 10 ml milk with the pipette in conical flask.
5. Add equal quantity of glass distilled water.
6. Add 3-4 drops of phenolphthalein indicator solution* and stir with glass rod.
7. Take the initially reading of the alkali in the burette at the lowest point of meniscus.
8. Rapidly titrate the contents with N/10 NaOH solution continue to add alkali drop by the drop and stirring the content with glass rod till first definite change to pink colour which remains constant for 10 to 15 seconds.
9. Complete the titration within 20 seconds.
10. Note down the final burette reading.

Phenolphthalein Indicator Solution – Dissolve one gram of phenolphthalein in 100 ml of 95 % ethyl alcohol. Add 0.1 N sodium hydroxide solution until one drop gives a faint pink colouration. Dilute with distilled water to 200 ml.

Calculation:

$$\% \text{ Lactic acid} = \frac{\text{No of ml. of 0.1 N NaOH solution required for neutralization} \times 0.009}{\text{Weight of Sample} \times 100}$$

(Weight of sample = Volume of milk × specific gravity)

ESTIMATION OF TOTAL SOLIDS IN MILK

To estimate the total solids in milk, you can use a refractometer or a lactometer. These tools measure the density of the milk, which correlates with the total solids content. Another method is to use a milk analyzer, which provides more accurate results by measuring various components in the milk, including total solids. Alternatively, you can perform a gravimetric analysis by evaporating a known volume of milk to dryness and weighing the residue.

Refractometer: This device measures the refractive index of a liquid, which can be correlated with the concentration of dissolved solids. By placing a drop of milk on the refractometer's prism and looking through the eyepiece, you can read the refractive index and then convert it to total solids content using a conversion chart or equation.

Lactometer: A lactometer measures the density or specific gravity of milk. The specific gravity of milk is influenced by the total solids content. By comparing the specific gravity of the milk sample to a standard scale, you can estimate the total solids content.

Milk Analyzer: This is a sophisticated instrument that directly measures various components in milk, including fat, protein, lactose, and total solids. Milk analyzers provide accurate and reliable results by utilizing methods such as infrared spectroscopy or conductivity measurement.

Gravimetric Analysis: This method involves evaporating a known volume of milk to dryness in a pre-weighed dish. Once all the liquid has evaporated, the remaining residue represents the total solids content of the milk. By dividing the weight of the residue by the volume of milk used, you can calculate the total solids content as a percentage.

Each method has its advantages and limitations, so the choice depends on factors such as the level of accuracy required, the availability of equipment, and the resources available.

UNIT-II

PROCESSING OF MILK

MICROBIOLOGY OF MILK

Milk, a cornerstone of human nutrition, has been revered for its nutritional value and versatility for centuries. Beyond its rich content of proteins, vitamins, and minerals, milk is also a complex microbial ecosystem teeming with an array of microorganisms that play a crucial role in its composition, flavor, and safety. The study of the microbiology of milk offers insights into the intricate interactions between microbes and milk components, shedding light on the significance of these microorganisms in both traditional dairy production and modern food science.

Milk serves as a unique habitat for a diverse community of microorganisms, primarily bacteria, yeasts, and molds. These microorganisms originate from various sources, including the udder of the lactating animal, the environment in which the animal resides, and the equipment and utensils used during milk collection and processing.

Bacterial abundance and diversity

Bacteria are the most prominent members of the milk microbiota. Lactic Acid Bacteria (LAB) are of particular importance, as they play a pivotal role in transforming lactose (milk sugar) into lactic acid through fermentation. This process not only contributes to the characteristic tangy flavor of dairy products but also acts as a natural preservation mechanism by lowering the pH and inhibiting the growth of harmful pathogens. *Streptococcus*, *Lactobacillus*, and *Lactococcus* are common genera of LAB found in milk.

Yeasts and molds

Yeasts and molds, though present in lower numbers than bacteria, also influence milk quality. Yeasts can ferment lactose and produce carbon dioxide and ethanol, contributing to the effervescence and flavor of certain dairy products. Molds, on the other hand, can grow on the surface of cheeses, contributing to the development of unique textures and flavors through the secretion of enzymes that break down milk proteins and fats.

Factors altering the milk microbiome

Several factors influence the composition and dynamics of the milk microbiome. The health of the lactating animal, the cleanliness of the milking environment, and the processing methods employed all contribute to the types and numbers of microorganisms present in milk. Modern dairy practices often involve pasteurization and other forms of heat treatment to eliminate harmful pathogens while preserving beneficial microbes. However, traditional and artisanal dairy practices may intentionally incorporate specific microbial strains to enhance flavor and texture.

Functional significance of milk microorganisms

Fermentation and flavor development: Microbial fermentation in milk leads to the production of various flavor compounds, contributing to the distinctive taste of dairy products like yogurt, cheese, and sour cream.

Texture and consistency: Enzymes produced by microbes can alter the texture and consistency of dairy products, giving rise to the diverse array of cheeses and other milk-based foods.

Health benefits: Certain microbial strains in milk have been associated with probiotic properties, offering potential health benefits by promoting gut health and boosting the immune system.

Food safety: Beneficial microorganisms present in milk can outcompete harmful pathogens, enhancing the safety of dairy products.

Challenges and opportunities

While the milk microbiome offers numerous benefits, it also presents challenges in terms of food safety and quality. Contamination by pathogenic microorganisms can occur during milking, processing, and storage, necessitating strict hygiene practices. Researchers and dairy producers are exploring innovative methods, such as using bacteriophages (viruses that infect bacteria) to target specific pathogenic strains, to enhance food safety while preserving the beneficial aspects of the milk microbiome.

DESTRUCTION OF MICRO-ORGANISMS IN MILK

The destruction of microorganisms in milk is a critical aspect of ensuring its safety for consumption. Milk, a nutrient-rich liquid, is an ideal environment for the growth of various microorganisms, including bacteria, viruses, and fungi. However, some of these microorganisms can pose serious health risks to consumers if consumed in contaminated milk.

To mitigate these risks, various methods are employed to destroy or inhibit the growth of microorganisms in milk while preserving its nutritional quality and sensory characteristics. These methods, including pasteurization, ultra-high temperature (UHT) treatment, filtration techniques, high-pressure processing (HPP), and irradiation, are designed to eliminate harmful microorganisms while minimizing the impact on the milk's taste, texture, and nutritional content.

Ultra-High Temperature (UHT) Treatment: This involves heating milk to a very high temperature (around 280°F or 138°C) for a short period (a few seconds) to kill microorganisms. UHT treatment ensures a longer shelf life for milk without the need for refrigeration until opened.

Ultrafiltration: This process involves passing milk through a membrane with very fine pores, which allows smaller molecules like water and dissolved salts to pass through while retaining larger molecules such as proteins and microorganisms. Ultrafiltration can effectively remove bacteria and other microorganisms from milk.

Microfiltration: Similar to ultrafiltration, microfiltration involves passing milk through a membrane with larger pores, which selectively removes bacteria and other microorganisms while allowing other components to pass through. Microfiltration is often used in conjunction with pasteurization to further reduce the microbial load in milk.

High-Pressure Processing (HPP): In this method, milk is subjected to high levels of hydrostatic pressure to destroy microorganisms. HPP does not involve heating, so it preserves the nutritional and sensory qualities of milk better than heat-based methods.

Irradiation: Irradiation involves exposing milk to ionizing radiation, which damages the DNA of microorganisms, thereby preventing their growth and reproduction. Irradiation is less commonly used for milk compared to other food products due to consumer concerns about its safety and potential effects on food quality.

Each of these methods has its advantages and limitations, and their suitability depends on factors such as the desired shelf life, nutritional quality, and consumer preferences.

PHYSICO-CHEMICAL CHANGES TAKING PLACE IN MILK DUE TO PROCESSING

Processing of milk involves various physicochemical changes that alter its composition, taste, texture, and shelf life. Some of these changes include:

Homogenization: During homogenization, milk is forced through a fine nozzle under high pressure, which breaks down the fat globules into smaller particles. This process prevents the cream from rising to the top of the milk, resulting in a more uniform distribution of fat throughout the milk. As a result, the milk has a smoother texture and a more consistent appearance.

Pasteurization: Pasteurization involves heating milk to specific temperatures (usually around 161°F or 72°C) and holding it at that temperature for a set period (typically 15-30 seconds). This process kills harmful bacteria such as *E. coli*, *Salmonella*, and *Listeria*, as well as reducing the number of spoilage bacteria. Pasteurization helps extend the shelf life of milk while preserving its nutritional content and sensory properties.

Ultra-high temperature (UHT) treatment: In UHT treatment, milk is heated to temperatures above 275°F (135°C) for a very short period (2-5 seconds), effectively killing all bacteria and spores present in the milk. This process allows milk to be stored at room temperature for several months without refrigeration, making it convenient for long-distance transportation and storage in areas where refrigeration is not readily available.

Fortification: Milk fortification involves the addition of vitamins and minerals to enhance its nutritional value. Common fortificants include vitamin D, which helps promote calcium absorption and bone health, and calcium, which is essential for bone and teeth development. Other nutrients that may be added include vitamin A, vitamin B12, and iron, depending on regional dietary needs and regulations.

Evaporation and Condensation: Evaporation and condensation processes involve removing water from milk to produce condensed milk or evaporated milk. These processes involve heating milk to evaporate a portion of its water content, resulting in a thicker, more concentrated product with a longer shelf life. Condensed milk typically contains added sugar,

while evaporated milk is unsweetened. These products are commonly used in baking, cooking, and as coffee creamers.

Fermentation: Fermentation of milk involves the addition of specific bacterial cultures, such as *Lactobacillus bulgaricus* and *Streptococcus thermophilus*, to produce cultured dairy products like yogurt, kefir, and cultured buttermilk. During fermentation, bacteria metabolize lactose (milk sugar) into lactic acid, which gives these products their characteristic tangy flavor and thickened texture. Fermentation also increases the digestibility of lactose for individuals with lactose intolerance and enhances the shelf life of the products due to the acidic environment created by lactic acid.

These processing techniques play a crucial role in improving the safety, shelf life, nutritional value, and sensory characteristics of milk, making it suitable for consumption and various food applications.

BOILING OF MILK

Boiling milk is a common household practice that involves heating milk to its boiling point, which is around 212°F (100°C) at sea level. Here's what happens during the boiling process:

Denaturation of Proteins: Heating milk causes the proteins present in milk, such as casein and whey proteins, to denature. Denaturation alters the protein's structure, resulting in changes to its functional properties, such as its ability to form curds and affect the milk's texture.

Formation of Skin: When milk is boiled, a skin or film may form on the surface due to the concentration of proteins and fats. This skin is composed mainly of denatured proteins and lipids and can be removed or stirred back into the milk.

Reduction of Bacteria: Boiling milk kills most of the bacteria and microorganisms present in it, making it safer to consume. However, it's essential to note that boiling milk for a prolonged period can lead to nutrient losses, particularly heat-sensitive vitamins like vitamin C and B vitamins.

Reduction of Water Content: Boiling milk causes some of the water to evaporate, leading to a reduction in the milk's volume and an increase in its concentration of solids, including proteins, sugars, and minerals.

Change in Taste: Boiling milk can also affect its taste, giving it a slightly cooked or caramelized flavor due to the Maillard reaction, a chemical reaction between amino acids and reducing sugars at high temperatures.

Overall, boiling milk is a simple yet effective method to enhance its safety by reducing bacterial contamination and extending its shelf life, especially in regions where refrigeration may not be readily available. However, it's essential to avoid boiling milk excessively to prevent nutrient losses and undesirable changes in taste and texture.

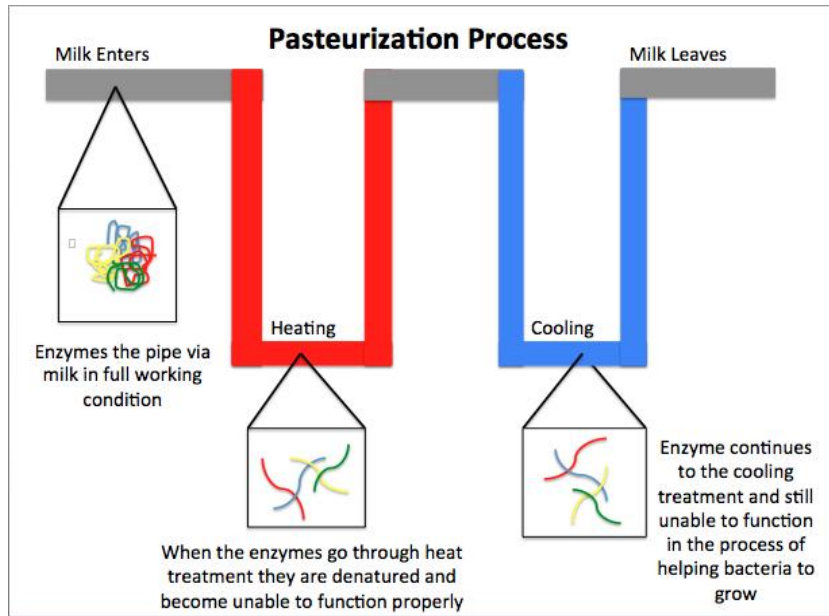
PASTEURIZATION

In the field of food processing, pasteurization (also pasteurisation) is a process of food preservation in which packaged and unpacked foods (e.g., milk and fruit juices) are treated with mild heat, usually to less than 100 °C (212 °F), to eliminate pathogens and extend shelf life. Pasteurization either destroys or deactivates microorganisms and enzymes that contribute to food spoilage or the risk of disease, including vegetative bacteria, but most bacterial spores survive the process.

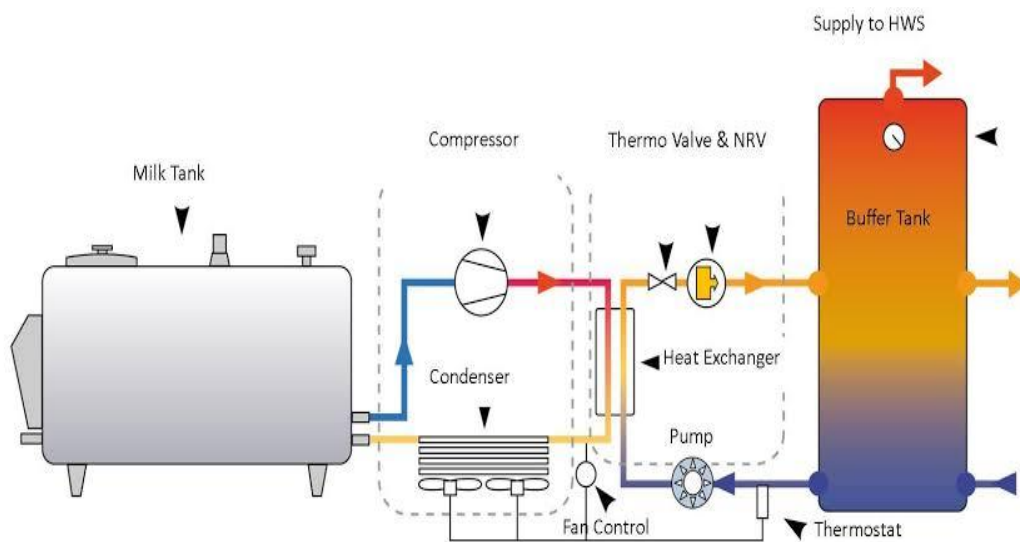
The process of pasteurization is named after the French microbiologist Louis Pasteur, whose research in the 1860s demonstrated that thermal processing would deactivate unwanted microorganisms in wine. Spoilage enzymes are also inactivated during pasteurization. Today, pasteurization is used widely in the dairy industry and other food processing industries to achieve food preservation and food safety.

By the year 1999, most liquid products were heat treated in a continuous system where heat can be applied using a heat exchanger or the direct or indirect use of hot water and steam. Due to the mild heat, there are minor changes to the nutritional quality and sensory characteristics of the treated foods. Pascalization or high pressure processing (HPP) and pulsed electric field (PEF) are non-thermal processes that are also used to pasteurize foods.

PASTERURIZATION PROCESS

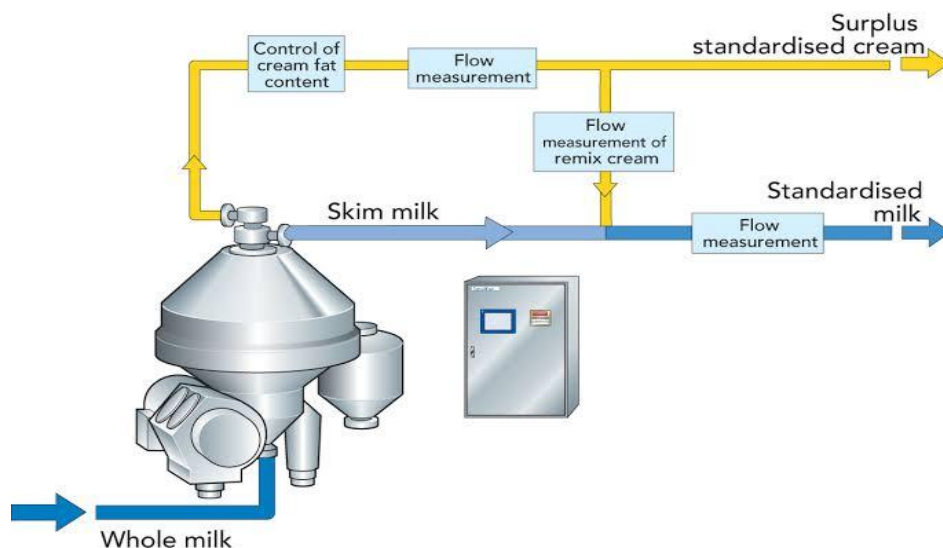


1. Milk chilling



- Chilling is not a pasteurization process but it is a necessary step when dealing with large volumes of milk.
- Milk leaves the cow's udder at temperatures above the ambient, which encourages rapid bacterial multiplication that speeds up spoilage.
- However, reducing the temperatures to between 2° C to 5° C arrests bacterial growth and metabolism.
- This provides a head start at keeping the quality before proper pasteurization commences.

2.Pre-heating (regeneration) and Standardization Stage



- After bulking, the chilled milk is heated to about 40°C to facilitate easy separation of butterfat during standardization.
- The system uses regenerative heating, i.e., it uses the heat of the already pasteurized milk to heat up the incoming chilled milk. The chilled milk, in a counter-current flow, cools down the pasteurized milk.
- The purpose of standardization is to obtain a product with uniform content of butterfat.

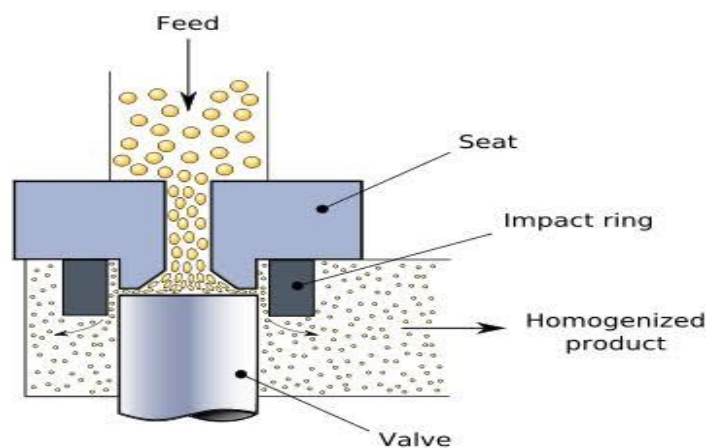
3. Clarification stage

- Clarification is essential for removing all foreign matter from the product.
- Large solid particles are removed by straining the milk through tubular metallic filters.
- A centrifugal clarifier (not the one used for standardization) is used to remove all soil and sediments from milk.
- The filters, usually fitted in parallel twins permits continuous processing as one can be cleaned while the other is running.
- Clean the filters regularly (between 2 to 10 operational hours depending on the level of dirt) to avoid the growth of bacteria.

4. Standardization stage

- It is important to standardize milk fat to ensure that you end up with a product of consistent quality in the market. Different consumers prefer different products.
- There are customers who will consume skim milk only while there are those who will take low-fat milk. There are those who will take standardized milk while there are those who prefer high-fat milk.
- Standardization is necessary to ensure that all the customers are catered for. Again, it is during the process of standardization that you get to separate the butterfat that is used for making cream and other fat-based products such as butter and ghee.

5. Homogenization stage



- Homogenization is a physical process of breaking down the milk fat globules into tiny droplets to discourage cream separation.
- Tiny droplets of fat do not rise in a milk column since reducing their sizes also increases their density in the milk.
- A milk homogenizer working at between 100 to 170 bars splits all the fat globules into very tiny droplets that increase the level of integration of the fat in the milk.

As a result, the milk fat remains uniformly distributed in the milk.

6.Heating section

- Utilizes heat from steam to raise the temperatures of the milk from about 60°C to the required 72°C that is effective to kill the Clostridium botulinum spores.
- The steam exchanges heat with the milk across the PHE plates in a counter-current motion.
- In the end, if this section, there is a temperature sensor, which controls the flow diversion valve.
- Any milk that does not attain the required temperature is diverted back to the heating section until it attains the required temperatures

7.Holding section

- After heating, milk flows into the holding tubes whose lengths have been calibrated with the milk flow rate to ensure that milk takes at least 16 seconds in the tubes. All the milk must maintain the required pasteurization temperatures at the end of the tubes.
- In case of a breach, a sensor will trigger the flow diversion valve to take the milk back to the heating section to bring the milk to the required temperature.
- Once the milk has attained the required temperatures at the end of the holding tubes, milk flows back to the regeneration section to heat the incoming chilled milk while in itself being cooled down to about 30°C.

8.Cooling/chilling section

- After regenerative cooling of pasteurized milk, it moves to the cooling section of the PHE where chilled water/PHE coolant lowers the temperature of pasteurized milk to 4°C.

- The chilled milk is then pumped to the packaging machines for aseptic packaging and subsequent storage in the cold room.

SIGNIFICANCE OF PASTEURIZATION

Proper pasteurization is necessary for the following reasons:

The chief objective of milk pasteurization is to destroy pathogenic bacteria that could have a public health concern. By destroying these microorganisms, the product becomes safe for public consumption.

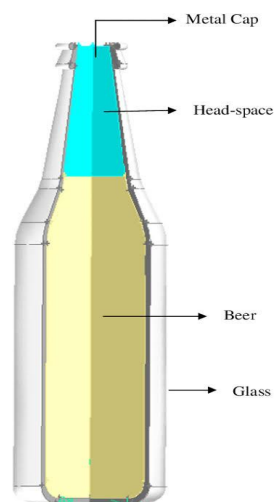
Secondly, pasteurization eliminates destructive bacteria and enzymes that could cause spoilage of the product. This leads to the prolonged shelf life of the milk.

There is a need to ensure that the product can keep for longer periods without expensive storage equipment. Pasteurization will eliminate spoilage bacteria and enzymes and extend the shelf life of the product.

TYPES OF PASTEURIZATION

BOTTLE PASTEURIZATION:

Bottle pasteurization refers to the pasteurization process applied specifically to bottled liquids, such as milk, juices, or sauces. It involves heating the bottled product to a specific



temperature for a set duration to kill bacteria and pathogens, ensuring the safety and preservation of the contents.

Preparation: Bottles containing the liquid product are filled and sealed under sanitary conditions to prevent contamination.

Heating: The sealed bottles are then placed into a pasteurization machine, which typically uses hot water or steam to heat the bottles and their contents. The temperature and duration of heating depend on the type of product being pasteurized.

Temperature Control: The liquid inside the bottles is heated to a specific temperature, typically ranging from around 145°F to 165°F (63°C to 74°C), depending on the requirements for the specific product.

Holding Time: Once the desired temperature is reached, the bottles are held at that temperature for a predetermined period, typically ranging from a few seconds to several minutes. This holding time is crucial for effectively killing harmful bacteria and pathogens.

Cooling: After the holding time is completed, the bottles are rapidly cooled to stop the heating process. This can be achieved using cold water or air, ensuring that the product doesn't overheat or degrade during cooling.

Quality Control: Throughout the pasteurization process, strict quality control measures are in place to monitor temperature, pressure, and other factors to ensure the safety and quality of the product.

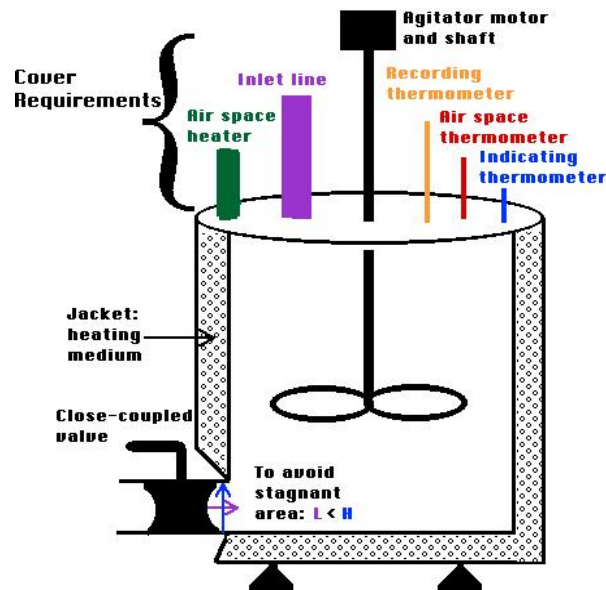
Packaging: Once pasteurized and cooled, the bottles are inspected for any defects or issues before being labeled and packaged for distribution.

Bottle pasteurization effectively extends the shelf life of perishable liquids by killing harmful bacteria while preserving the flavor, texture, and nutritional content of the product. It's an essential step in food and beverage processing to ensure consumer safety and product quality.

BATCH PASTEURIZATION:

Batch pasteurization is a method of pasteurizing food or beverages in small, discrete batches rather than continuously. This process is commonly used for products like dairy, juices, and sauces. Here's how batch pasteurization typically works:

Batch Pasteurizer



Preparation: The product is filled into containers, such as bottles, jars, or pouches, and sealed.

Heat Treatment: The sealed containers are placed in a pasteurization vessel, which can be a tank, kettle, or chamber. The vessel is then heated to the appropriate pasteurization temperature, usually between 145°F to 165°F (63°C to 74°C), depending on the product.

Holding Time: Once the desired temperature is reached, the product is held at that temperature for a specific duration, typically ranging from several minutes to half an hour. This holding time ensures that any harmful bacteria or pathogens are effectively killed.

Cooling: After the holding time is completed, the containers are rapidly cooled to stop the heating process and prevent overcooking or degradation of the product. Cooling can be achieved using cold water, air, or a combination of both.

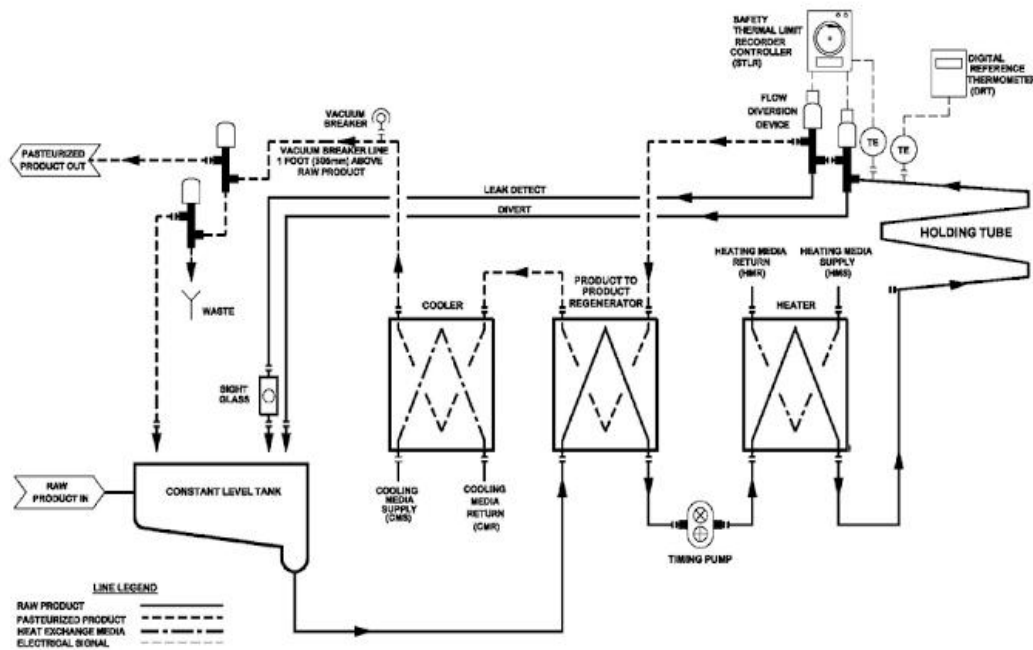
Quality Control: Throughout the process, strict quality control measures are in place to monitor temperature, pressure, and other factors to ensure the safety and quality of the product.

Packaging: Once pasteurized and cooled, the containers are inspected for any defects or issues before being labeled and packaged for distribution.

Batch pasteurization is well-suited for small-scale production or for products that require specific processing conditions. It allows for greater control over the pasteurization process and is often used by artisanal producers or specialty food manufacturers.

HIGH TEMPERATURE SHORT TIME PASTEURIZATION:

High-Temperature Short-Time (HTST) pasteurization is a method of pasteurizing liquids, typically milk, juice, or other beverages, by rapidly heating them to a high temperature for a short duration. The process involves heating the liquid to at least 161°F (71.7°C) and holding it at that temperature for around 15 seconds before rapidly cooling it. This method effectively kills harmful bacteria and pathogens while preserving the taste, nutritional value, and quality of the liquid. HTST pasteurization is widely used in the food and beverage industry to ensure



product safety and extend shelf life.

High-Temperature Short-Time (HTST) pasteurization is a widely used method for pasteurizing milk and other beverages. Here's how HTST pasteurization works:

Preparation: Raw milk or the beverage to be pasteurized is pumped into a heat exchanger.

Heat Treatment: The milk passes through the heat exchanger, where it is rapidly heated to a high temperature, typically around 161°F (71.7°C), and held at that temperature for a short duration, usually around 15 seconds.

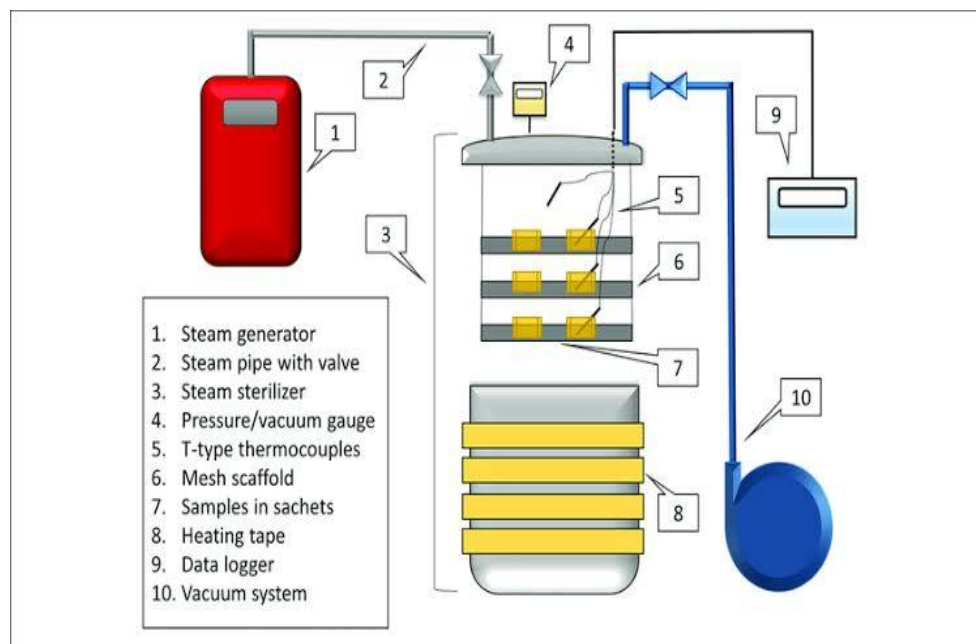
Cooling: After the heating phase, the milk is quickly cooled to below 40°F (4.4°C) to stop the pasteurization process and prevent overcooking.

Packaging: Once pasteurized and cooled, the milk is usually packaged in sterile containers, such as cartons or bottles, and sealed for distribution.

HTST pasteurization effectively kills harmful bacteria and pathogens while preserving the flavor, texture, and nutritional properties of the milk. It's an efficient method that allows for high throughput and maintains product quality.

VACCUM PASTEURIZATION

Vacuum pasteurization, also known as low-temperature vacuum pasteurization (LTVP), is a method used to pasteurize food products at lower temperatures and under reduced pressure.



Here's how it typically works:

Preparation: The food product is placed in a vacuum chamber or container.

Pressure Reduction: The pressure inside the chamber is reduced to create a vacuum. This lowers the boiling point of water in the food product, allowing pasteurization to occur at lower temperatures.

Heat Treatment: The food is heated to a specific temperature, typically below the boiling point of water, but high enough to kill harmful bacteria and pathogens. This temperature can vary depending on the specific requirements of the product.

Holding Time: Once the desired temperature is reached, the food is held at that temperature for a predetermined period to ensure thorough pasteurization.

Cooling: After the holding time, the product is rapidly cooled to stop the heating process and prevent overcooking or degradation.

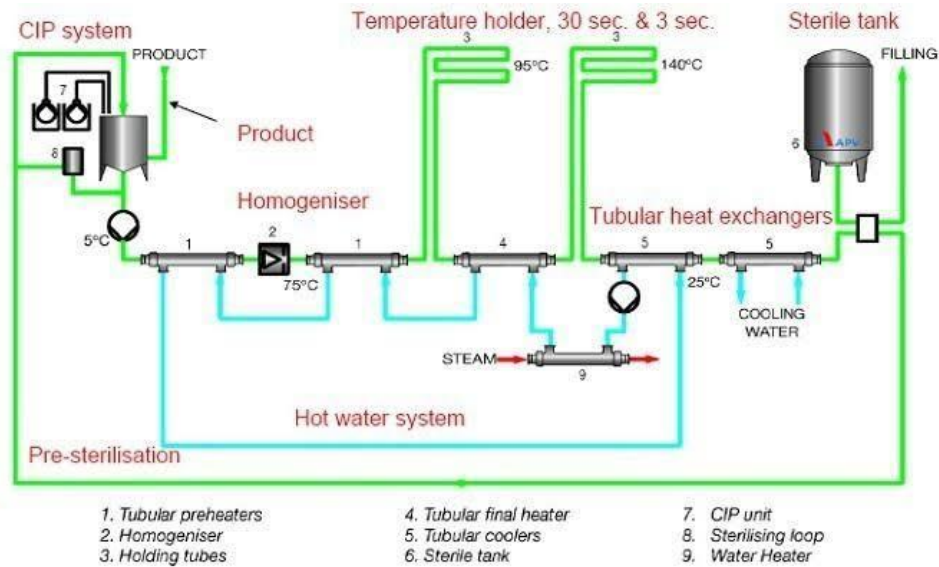
Packaging: Once pasteurized and cooled, the food product is packaged in sterile containers to maintain its safety and quality.

Vacuum pasteurization is often used for heat-sensitive foods or those that require gentle processing to preserve their quality, flavor, and nutritional value. It offers an alternative to traditional high-temperature pasteurization methods while still ensuring food safety and shelf stability.

ULTRA- HIGH TEMPERATURE PASTEURIZATION

Ultra High Temperature (UHT) pasteurization is a method used to pasteurize liquids, such as milk and dairy products, at an extremely high temperature for a short period. This process involves rapidly heating the liquid to temperatures ranging from 280°F to 302°F (138°C to 150°C) for 2 to 5 seconds. The high temperature is sufficient to kill harmful bacteria and pathogens, ensuring the safety of the product. After heating, the liquid is quickly cooled to room temperature or below to stop the heating process. UHT pasteurization extends the shelf life of the liquid product, allowing it to be stored without refrigeration for several months while preserving its flavor, texture, and nutritional value.

Ultra High Temperature (UHT) pasteurization, also known as ultra-pasteurization, is a process used to pasteurize liquids, particularly milk and dairy products, at a very high temperature for a short period. Here's how it works:



Heating: The liquid is rapidly heated to a temperature ranging from 280°F to 302°F (138°C to 150°C) for a very short duration, typically 2 to 5 seconds. This high temperature is well above the boiling point of water and is sufficient to kill harmful bacteria and pathogens.

Holding Time: After heating, the liquid is held at this high temperature for a few seconds to ensure complete pasteurization.

Cooling: The liquid is then rapidly cooled to room temperature or below to stop the heating process and prevent overcooking or degradation of the product.

Packaging: Once pasteurized and cooled, the liquid is aseptically packaged in sterile containers, such as cartons or bottles, to prevent recontamination.

UHT pasteurization extends the shelf life of the liquid product, allowing it to be stored without refrigeration for several months. It preserves the flavor, texture, and nutritional value of the liquid while ensuring its safety for consumption. UHT pasteurization is commonly used for milk, cream, juices, and other dairy and beverage products.

UNIT-III

MAJOR MILK PRODUCTS

CREAM

The fat contents play an important role in pricing of milk. Cream is the fat rich portion of milk; it is extracted from milk as part of milk processing. At household level it is obtained as Malai from boiled and cooled milk. In the market, the cream is available with varying fat levels – low fat, medium fat, and high fat. Different types of cream are required for different purposes. All the commercially available cream is obtained by mechanical separation. Cream is used for making ice cream, butter, ghee and butter oil in the commercial dairy plant. Some portion of cream is utilized for dressing the products in bakery and coffee making. Cream is one of the important dairy products. If milk is allowed to stand undisturbed, the portion that rises naturally to the surface and forms a layer is known as cream. Separation produces two fractions. The fraction, which contains fat in highly concentrated form, is called cream. Another fraction, which is a non-fat fraction, is termed as skim milk. Cream is rich in butterfat. It also contains other constituents of milk but in lower proportion than milk. Milk can be separated either by gravity separation method or by mechanical separation method. In the dairy industry, cream is separated by mechanical method employing centrifugal cream separator.

DEFINITION

Cream is defined as the fat rich portion of milk obtained by gravity or mechanical method of separation. It is the light weight portion of milk which still contains all the main constituents of milk, but in different proportions. The fat content of cream varies widely in the range of 18- 85 % depending upon the method of separation.

Malai is obtained by hand skimming of heated and cooled milk. Usually it is prepared by housewives at home and by halwais in shops.

COMPOSITION

The composition of cream can vary depending on factors such as the animal it comes from (e.g., cow, goat, sheep) and the processing method used. However, in general, cream contains

Constituents	Average composition (Value in %)		
	Half-half cream	Table cream	Whipping cream
Moisture	80.3	73.8	57.7
Protein	3.0	2.7	2.0
Fat	11.5	19.3	37.0
Carbohydrate	4.3	3.6	2.8
Ash	0.7	0.6	0.5

the following components:

Milk Fat: This is the primary component of cream and gives it its rich, creamy texture and flavor. The amount of milk fat in cream can vary depending on the type of cream. For example, heavy cream contains around 36-40% milk fat, while light cream contains around 18-30% milk fat.

Water: Cream also contains water, which makes up the liquid portion of the product. The amount of water in cream can vary depending on factors such as the type of cream and how it is processed.

Proteins: Cream contains proteins, which are important for various functions in the body. The protein content of cream is generally lower than that of milk, as cream is primarily composed of milk fat.

Lactose: Lactose is the natural sugar found in milk and dairy products. Cream contains lactose, although the exact amount may vary depending on factors such as the type of cream and how it is processed.

Vitamins and Minerals: Cream contains various vitamins and minerals, including vitamin A, vitamin D, calcium, and phosphorus. These nutrients are important for overall health and well-being.

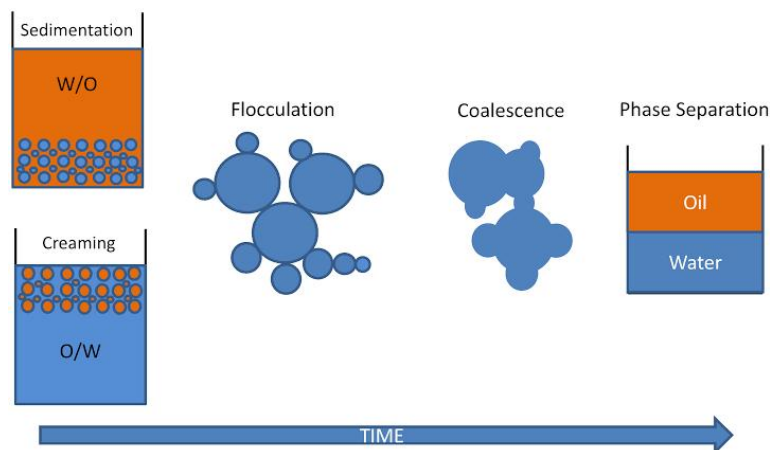
Emulsifiers and Stabilizers (optional): Some creams may contain emulsifiers and stabilizers to improve texture, consistency, and shelf life. These additives are typically used in processed creams and may not be present in natural or organic creams.

Overall, cream is a rich and flavorful dairy product that adds a luxurious touch to many dishes and desserts. Its composition may vary slightly depending on factors such as type, fat content, and processing methods, but it generally consists of milk fat, water, proteins, lactose, vitamins, and minerals.

CHEMISTRY OF CREAMING PROCESS

The creaming process in dairy science involves complex chemistry, primarily focusing on the physical and chemical interactions occurring within the cream. Here's a detailed explanation of the chemistry behind the creaming process:

Emulsification: Creaming begins with the emulsification of fat globules in milk. Milk contains millions of tiny fat globules suspended in an aqueous phase. These fat globules are covered with a layer of phospholipids and proteins, which help stabilize the emulsion. The emulsification process involves breaking down the fat globules into smaller droplets and



dispersing them evenly throughout the milk.

Fat Globule Aggregation: Despite the stabilizing effect of phospholipids and proteins, fat globules have a natural tendency to aggregate due to attractive forces between their surfaces. This aggregation is influenced by factors such as pH, temperature, and the presence of salts and other solutes in the milk.

Cream Formation: Over time, fat globules start to rise to the surface of the milk due to their lower density compared to the aqueous phase. This upward movement is known as creaming. As fat globules accumulate at the surface, they form a layer of cream, which can be skimmed off to produce cream products of varying fat content.

Role of Proteins and Emulsifiers: Proteins in milk, such as caseins and whey proteins, play a crucial role in stabilizing the emulsion and preventing excessive creaming. Casein proteins adsorb to the surface of fat globules, forming a protective layer that inhibits fat globule aggregation. Additionally, emulsifiers present in milk, such as phospholipids and lipoproteins, help stabilize the emulsion by reducing surface tension at the fat-water interface.

Cream Composition: The composition of cream depends on the extent of creaming and the fat content desired. Heavy cream, for example, contains a higher proportion of fat compared to lighter creams like half-and-half or light cream. The creaming process allows dairy producers to obtain cream products with different fat contents to meet consumer preferences.

Effect of Processing: Processing techniques such as homogenization and pasteurization can influence the creaming process. Homogenization involves subjecting milk to high pressure to reduce the size of fat globules and achieve a more uniform distribution of fat. This process helps prevent creaming and creates a more stable emulsion. Pasteurization, on the other hand, involves heating milk to kill harmful bacteria, which can alter the properties of milk proteins and affect the creaming behavior.

Overall, the creaming process in dairy science involves a complex interplay of physical and chemical factors, including emulsification, fat globule aggregation, protein stabilization, and processing effects. Understanding the chemistry behind creaming is essential for dairy producers to control the properties of cream products and meet consumer demand for high-quality dairy products.

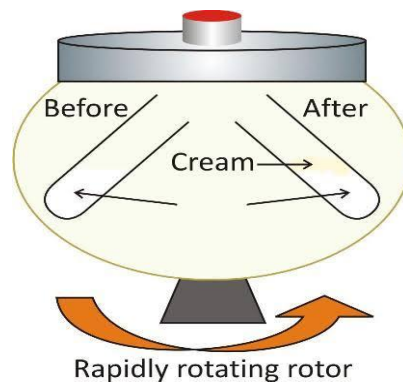
GRAVITATION METHODS OF SEPARATION OF CREAM

There are a few methods of separating cream using gravity:

Settling: This method relies on the natural separation of cream due to the difference in density between cream and milk. When milk is left undisturbed, the cream gradually rises to the surface over time. The process can take several hours, or even overnight, depending on

the temperature and fat content of the milk. Once the cream has risen to the top, it can be carefully skimmed off using a spoon or ladle.

Gravity Separators: Gravity separators, also known as cream separators, are mechanical devices that utilize centrifugal force to separate cream from milk. The milk is fed into a spinning drum or bowl, and the rapid rotation creates a centrifugal force that causes the cream to separate and rise to the top. The cream is then collected from the top of the separator, while



the skim milk is discharged from the bottom or sides.

Gravity separators are commonly used in dairy processing facilities to separate large quantities of cream from milk efficiently.

Cream Skimming: Cream skimming is a manual method of separating cream from milk by physically removing the cream that rises to the surface. After allowing the milk to settle, the cream can be skimmed off using a ladle, spoon, or specialized skimming tool.

This method is often used in small-scale or home dairy operations where equipment like gravity separators may not be available. Cream skimming requires careful attention to avoid mixing the cream with the underlying milk.



Each method offers its own advantages and limitations. Gravity separators are efficient for large-scale production but require specialized equipment, while settling and cream skimming are simpler methods suitable for smaller operations. Additionally, the fat content of the cream may vary slightly depending on the separation method used.

CENTRIFUGAL METHODS OF SEPARATION OF CREAM

Centrifugal methods of separating cream primarily involve the use of centrifugal force to separate cream from milk. Here's a detailed explanation:

Centrifugal Cream Separators: These are mechanical devices specifically designed for separating cream from milk using centrifugal force. The process involves spinning the milk rapidly inside a centrifuge, typically a bowl or drum-shaped container. As the milk spins, the heavier skim milk is forced outward towards the edges of the centrifuge, while the lighter cream collects in the center.

The cream is then extracted from the center of the centrifuge, either continuously or periodically, depending on the design of the separator. Centrifugal cream separators are widely used in dairy processing plants due to their efficiency and ability to handle large volumes of milk.

High-Speed Centrifugation: In laboratory or industrial settings, high-speed centrifugation can also be used to separate cream from milk. This method involves spinning the milk at very high speeds in a specialized centrifuge machine. The centrifugal force generated causes the cream to separate and form a distinct layer at the top of the centrifuge tube or container. The cream can then be carefully removed using a pipette or other extraction method. High-speed centrifugation is particularly useful for precise separation of cream in scientific research or

specialized industrial applications.

Both of these centrifugal methods offer efficient and relatively quick separation of cream from milk compared to gravity-based methods. They are commonly used in dairy processing facilities, laboratories, and other settings where precise separation of cream is required.



ESTIMATION OF FAT IN CREAM

Estimating the fat content in cream can be done using various methods, depending on the equipment and resources available. Here are a few common methods:

Gravimetric Method: This method involves separating the fat from the cream and then weighing it to determine its percentage. One common approach is to use a Babcock test, where sulfuric acid is added to the cream to dissolve non-fat components, leaving behind the fat. The fat is then separated, washed, dried, and weighed. The percentage of fat can be calculated based on the weight of the fat compared to the weight of the original sample.

Butyrometer Method: This method utilizes a butyrometer, a specialized glass tube with calibrated markings, to measure the fat content in cream. The cream is mixed with sulfuric acid and a butyric acid solution, causing the fat to separate and rise to the top of the

butyrometer. The volume of fat is then read directly from the calibrated scale on the butyrometer, and the fat percentage is calculated accordingly.

Ultrasonic Method: Ultrasonic technology can be used to estimate the fat content in cream by measuring the speed of sound through the sample. Since the speed of sound is affected by the composition of the material it passes through, variations in fat content will cause changes in the speed of sound. By correlating the speed of sound with known fat content standards, the fat percentage in the cream can be estimated.

Near-Infrared (NIR) Spectroscopy: NIR spectroscopy is a non-destructive technique that analyzes the interaction of near-infrared light with molecules in the sample. By measuring the absorption of light at various wavelengths, NIR spectroscopy can provide quantitative information about the composition of the sample, including fat content. This method is often used in industrial settings for rapid and non-destructive analysis of cream and other dairy products.

These methods vary in complexity, cost, and accuracy, so the choice of method will depend on factors such as the level of precision required and the available resources. In commercial dairy production, gravimetric methods such as the Babcock test or butyrometer method are commonly used for accurate determination of fat content.

BUTTER

DEFINITION

Butter is a dairy product made from the fat and protein components of churned cream. It is a semi-solid emulsion at room temperature, consisting of approximately 80% butterfat. It is used at room temperature as a spread, melted as a condiment, and used as a fat in baking, sauce-making, pan frying, and other cooking procedures.

Butter is a water-in-oil emulsion resulting from an inversion of the cream, where the milk proteins are the emulsifiers. Butter remains a firm solid when refrigerated but softens to a spreadable consistency at room temperature and melts to a thin liquid consistency at 32 to 35 °C (90 to 95 °F). The density of butter is 911 g/L . It generally has a pale yellow color but varies from deep yellow to nearly white. Its natural, unmodified color is dependent on the source animal's feed and genetics, but the commercial manufacturing process sometimes alters this with food colorings like annatto or carotene.

COMPOSITION

Butter's chemical composition is quite complex, as it contains various components including fats, water, proteins, and other minor constituents. Here's a detailed breakdown of its chemical composition:

Fats (Lipids):

Triglycerides: These are the main fats in butter, making up the majority of its lipid content. Triglycerides consist of three fatty acid molecules attached to a glycerol backbone. The composition of fatty acids in butter can vary, but common ones include:

Saturated fatty acids: Palmitic acid, stearic acid.

Monounsaturated fatty acids: Oleic acid.

Polyunsaturated fatty acids: Linoleic acid, linolenic acid.

Phospholipids: These are another class of lipids present in butter, albeit in smaller quantities compared to triglycerides. Phospholipids, such as phosphatidylcholine and phosphatidylethanolamine, contribute to the emulsifying properties of butter and help stabilize its texture.

Water: Butter typically contains around 15% to 17% water, although this can vary depending on factors such as manufacturing methods and storage conditions.

Proteins:

Casein: Butter contains small amounts of casein, which is the primary protein found in milk. Casein helps give butter its creamy texture and contributes to its nutritional profile.

Whey Proteins: Whey proteins, such as β -lactoglobulin and α -lactalbumin, are also present in butter, albeit in smaller amounts compared to casein. These proteins play a role in the flavor and functional properties of butter.

Milk Solids:

Lactose: Lactose is the primary carbohydrate found in butter, although it is present in relatively small quantities compared to fats and proteins. Lactose contributes to the slightly sweet taste of butter.

Minerals: Butter contains various minerals, including calcium, potassium, magnesium, and phosphorus, which are naturally present in milk and milk-derived products.

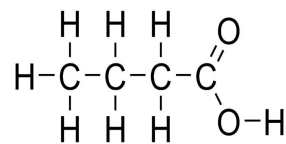
Vitamins: Butter is a good source of fat-soluble vitamins such as vitamin A, vitamin D, vitamin E, and vitamin K.

Minor Constituents:

Sterols: Butter contains small amounts of sterols, such as cholesterol and phytosterols, which are important for various physiological functions.

Carotenoids: These are natural pigments found in butter, which contribute to its yellow color. Beta-carotene is the most common carotenoid present in butter.

Overall, the chemical composition of butter contributes to its unique flavor, texture, and nutritional properties, making it a versatile ingredient in cooking and baking.



Structure Of Butyric Acid

THEORY OF CHURNING

The theory of churning butter involves the physical and chemical processes that occur when cream is agitated to separate the fat globules from the water phase. Here's an overview of the theory:

Emulsification: Cream is an emulsion of fat globules dispersed in a water-based solution containing proteins, lactose, and minerals. During churning, the agitation causes the fat globules to collide and coalesce, forming larger fat globules. These fat globules are surrounded by a membrane composed of phospholipids and proteins.

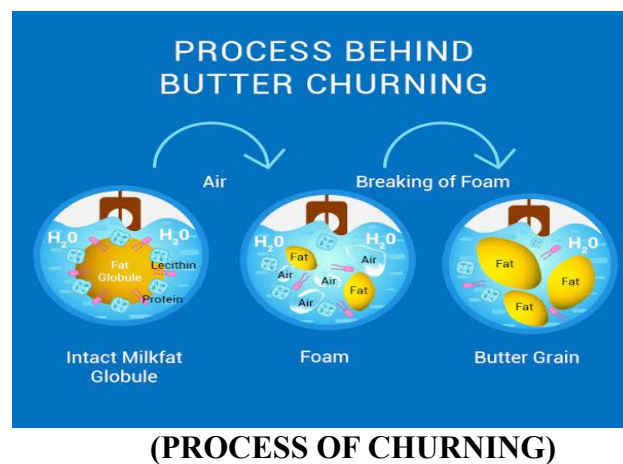
Agglomeration: As churning continues, the fat globules begin to cluster together, forming solid masses of butterfat. The agitation causes the fat globules to break open, releasing fat droplets and exposing more surface area to the surrounding liquid.

Separation: Eventually, the fat globules coalesce to form a continuous phase of butterfat, while the liquid phase, known as buttermilk, contains water, whey proteins, and other water-soluble components. The buttermilk is drained off or removed, leaving behind the solid butter.

Butter Formation: The solid butter is then kneaded or worked to remove any remaining liquid and to distribute any remaining water evenly throughout the butter. This process helps to improve the texture and consistency of the butter.

Flavor Development: During churning, the agitation also causes the release of flavor compounds from the fat globules and other components in the cream. This contributes to the characteristic flavor and aroma of butter.

Overall, the theory of churning involves the physical processes of emulsification, agglomeration, and separation, as well as the chemical processes of flavor development. Churning transforms cream into butter by separating the fat from the water phase and creating a smooth, creamy product with a rich flavor and texture.



DESI BUTTER

“Desi butter” refers to butter that is made using traditional methods and ingredients, often in rural or village settings. It is commonly associated with South Asian countries such as India, Pakistan, Bangladesh, and others, where traditional methods of churning butter have been practiced for centuries.

Desi butter is typically made from the cream collected from cow’s milk, although buffalo milk may also be used in some regions. The cream is allowed to naturally rise to the surface of the milk and is then churned using traditional equipment such as a wooden churn or

“madhani.” This process involves agitating the cream until the fat globules separate from the liquid buttermilk, resulting in the formation of butter.

Desi butter is known for its rich, creamy texture and distinct flavor, which can vary depending on factors such as the breed of the cow, the diet of the animal, and regional variations in production methods. It may have a slightly tangy or nutty flavor compared to commercially produced butter, due to the presence of natural enzymes and flavor compounds from the milk.

In many cultures, desi butter holds cultural and culinary significance and is used in traditional dishes such as dal (lentils), roti (flatbread), and various sweets and desserts. It is valued not only for its flavor and texture but also for its connection to traditional farming practices and local communities.

DESI PROCESS OF CHURNING THE BUTTER

The traditional “desi” process of churning butter involves a simple yet effective method passed down through generations in many cultures. Here’s a step-by-step overview:

Collecting Cream: Cream is first collected from milk, typically by allowing the milk to stand undisturbed in a shallow container. Over time, the cream naturally rises to the surface due to its lower density compared to the rest of the milk.

Gathering Equipment: In traditional settings, a churn or “madhani” is used for churning butter. This may be a wooden churn with a handle attached to a cylindrical container, or it could be a pottery vessel or other suitable container.

Filling the Churn: The collected cream is poured into the churn, filling it to a certain level. The churn is then sealed to prevent spillage during churning.

Churning: The churn is grasped firmly, and the handle is rotated in a circular motion. This agitation causes the cream to be whipped and churned, leading to the separation of butterfat from the liquid portion.

Observing Changes: As churning continues, the sound and feel of the churn will change. Initially, there may be a sloshing sound as the cream is whipped, followed by a thickening and stiffening of the mixture as butterfat begins to separate.

Formation of Butter: After a period of churning, the butterfat begins to clump together and form solid masses, while the liquid buttermilk separates out. The butterfat may appear as

small yellow granules or larger cohesive masses, depending on the thoroughness of the churning process.

Draining Buttermilk: Once the butter has formed, the churn is opened, and the liquid buttermilk is drained off. The butterfat is then collected and transferred to a separate container.

Working the Butter: The collected butter is kneaded or worked to remove any remaining buttermilk and to improve its texture. This may be done by hand or using a wooden paddle or utensil.

Storage: The finished butter is typically stored in a cool place or refrigerated to prevent spoilage.

This traditional process of churning butter by hand not only yields a delicious and creamy product but also preserves cultural heritage and traditional methods of food preparation.

SALTED BUTTER

Salted butter is a type of butter that has had salt mixed into it during the churning process or added afterwards. Here are some key points about salted butter:

Ingredients: Salted butter typically contains two primary ingredients: cream and salt. Cream is churned to separate the butterfat from the liquid buttermilk, and salt is added either during or after the churning process. Some varieties of salted butter may also contain additional ingredients for flavor or preservation, depending on the brand or manufacturer.

Salt Content: The amount of salt added to salted butter can vary, but it is generally around 1% to 2% of the total weight of the butter. This small amount of salt helps enhance the flavor of the butter and acts as a natural preservative, extending its shelf life.

Flavor: The addition of salt to butter enhances its flavor profile, adding a savory or slightly salty taste. The salt helps balance the richness of the butterfat and can accentuate its natural sweetness. Salted butter is often preferred for spreading on bread, toast, or crackers, as well as for cooking and baking savory dishes.

Versatility: Salted butter is a versatile ingredient used in a wide range of culinary applications. It can be used for cooking, baking, sautéing, and frying, as well as for spreading on bread or melting over vegetables and popcorn.

Storage: Salted butter has a longer shelf life compared to unsalted butter due to the preservative effect of salt. It can be stored in the refrigerator for several weeks or even months, depending on the packaging and storage conditions. However, it is still important to check the expiration date and store the butter properly to maintain its freshness.

Overall, salted butter is a popular choice for its enhanced flavor, versatility, and longer shelf life compared to unsalted butter. It adds depth and richness to both sweet and savory dishes and is a staple ingredient in many kitchens around the world.

ESTIMATION OF ACIDITY IN BUTTER

The acidity in butter is typically measured in terms of the amount of free fatty acids present, which is expressed as a percentage of oleic acid. The acidity level in butter can be estimated using a method known as acid value determination. Here's an overview of how it's done:

Preparation of Butter Sample: A representative sample of butter is prepared for analysis. This sample should be homogenized to ensure uniformity and accuracy in the results.

Extraction of Fatty Acids: The fatty acids present in the butter sample are extracted using a suitable solvent, such as ethanol or diethyl ether. This extraction process separates the fatty acids from other components of the butter.

Titration: The extracted fatty acids are then titrated with a standardized solution of potassium hydroxide (KOH) or sodium hydroxide (NaOH). The titration is typically carried out in the presence of a pH indicator, such as phenolphthalein, which changes color at the endpoint of the reaction.

Calculation of Acid Value: The amount of KOH or NaOH required to neutralize the fatty acids in the butter sample is determined from the titration. The acid value, which represents the amount of free fatty acids in the butter, is calculated using the following formula:

Acid Value (AV) = (Volume of KOH or NaOH used in titration × Normality of KOH or NaOH) / Weight of butter sample (in grams)

Expression of Results: The acid value is typically expressed as milligrams of potassium hydroxide (KOH) or sodium hydroxide (NaOH) required to neutralize one gram of butter sample. It can also be expressed as a percentage of oleic acid, which is the most abundant fatty acid in butter.

By determining the acid value of a butter sample, one can estimate its acidity level and assess its quality and stability. Higher acidity levels may indicate the presence of rancidity or spoilage in the butter, while lower acidity levels are generally indicative of fresher and higher-quality butter.

ESTIMATION OF MOISTURE CONTENT IN BUTTER

The moisture content in butter can be estimated using various methods, including gravimetric and instrumental techniques. Here's an overview of a common gravimetric method for estimating moisture content in butter:

Sample Preparation: A representative sample of butter is weighed accurately. The sample should be homogenized to ensure uniformity and accuracy in the moisture analysis.

Drying: The butter sample is placed in an oven set at a specific temperature, typically around 100°C (212°F) or slightly higher. The sample is dried for a predetermined period of time to remove all moisture.

Weighing: After the drying period, the sample is removed from the oven and allowed to cool in a desiccator to prevent moisture absorption from the atmosphere. Once cooled, the sample is reweighed to determine its final weight after drying.

Calculation of Moisture Content: The moisture content of the butter sample is calculated using the following formula:

$$\text{Moisture Content (\%)} = \left(\frac{\text{Initial weight of sample} - \text{Final weight of sample after drying}}{\text{Initial weight of sample}} \right) \times 100$$

In this formula:

Initial weight of sample is the weight of the butter sample before drying.

Final weight of sample after drying is the weight of the butter sample after it has been dried to remove all moisture.

Expression of Results: The moisture content is typically expressed as a percentage of the weight of the original butter sample. This value represents the proportion of water present in the butter.

It's important to note that accurate moisture content determination is crucial for assessing the quality, shelf life, and stability of butter products. Higher moisture content can lead to

microbial spoilage, rancidity, and decreased product shelf life, while lower moisture content may affect the texture and spreadability of the butter. Therefore, precise measurement of moisture content is essential for quality control and product development in the dairy industry.

GHEE

Ghee is a type of clarified butter that has been heated and simmered to remove moisture and milk solids, resulting in a pure butterfat with a rich, nutty flavor and a high smoke point. Here are some key characteristics and features of ghee:

Production Process: Ghee is traditionally made by heating butter to melt it, then simmering it over low heat until the water evaporates and the milk solids separate and caramelize. The clarified butter is then filtered to remove the milk solids, resulting in a clear, golden liquid.

Nutritional Profile: Ghee is primarily composed of saturated fats, with small amounts of monounsaturated and polyunsaturated fats. It is rich in fat-soluble vitamins such as vitamins A, D, E, and K, as well as antioxidants and other beneficial compounds.

Flavor and Aroma: Ghee has a distinctive nutty flavor and aroma, which develops during the clarification process as the milk solids caramelize. It is often described as having a rich, buttery taste with hints of sweetness and a slightly nutty undertone.

Versatility: Ghee has a high smoke point, making it ideal for cooking at high temperatures such as frying and sautéing. It has a long shelf life and does not require refrigeration, making it suitable for storage at room temperature. Ghee is also commonly used in traditional Indian cuisine, as well as in other cuisines around the world, for its flavor-enhancing properties and culinary versatility.

Health Benefits: While ghee is high in saturated fats, it is also rich in fat-soluble vitamins and antioxidants. Some studies suggest that moderate consumption of ghee may have health benefits, such as supporting heart health, improving digestion, and boosting immunity. However, like any fat, it should be consumed in moderation as part of a balanced diet.

Overall, ghee is valued for its rich flavor, high smoke point, and culinary versatility, making it a popular ingredient in cooking, baking, and traditional medicine practices in various cultures.

MAJOR CONSTITUENTS OF GHEE

The major constituents of ghee are primarily composed of fats, water, and milk solids. Here's a breakdown of the main components of ghee:

Fat (Butterfat): The predominant component of ghee is fat, specifically butterfat. This fat is derived from the milk fat present in butter. Butterfat consists of triglycerides, which are composed of fatty acids such as butyric acid, palmitic acid, oleic acid, and stearic acid. These fats give ghee its characteristic rich flavor and smooth texture.

Water: Ghee contains a small amount of water, typically less than 1%. During the process of clarifying butter to make ghee, the water content of the butter is reduced as it evaporates during heating. The removal of water helps increase the shelf life of ghee and enhances its flavor and aroma.

Milk Solids: Ghee also contains milk solids, although in significantly lower amounts compared to butter. Milk solids consist of proteins, sugars (lactose), and minerals that are naturally present in butter. During the process of making ghee, the milk solids are caramelized and then strained out, resulting in a clear, golden liquid.

Vitamins and Antioxidants: Ghee contains fat-soluble vitamins such as vitamins A, D, E, and K, which are naturally present in butterfat. It also contains antioxidants and other beneficial compounds, which may have health-promoting properties.

Overall, the major constituents of ghee contribute to its rich flavor, smooth texture, and nutritional profile. Ghee is valued for its culinary versatility, high smoke point, and potential health benefits, making it a popular ingredient in cooking, baking, and traditional medicine practices in various cultures.

COMMON ADULTERANTS ADDED TO GHEE AND THEIR DETECTION

Adulteration of ghee with various substances is unfortunately a concern in some regions. Common adulterants added to ghee may include:

Vegetable Oils: Cheaper vegetable oils such as palm oil, soybean oil, or cottonseed oil may be added to ghee to increase volume and reduce costs.

Animal Fats: Cheaper animal fats, such as lard or tallow, may be added to ghee as a substitute for butterfat.

Artificial Colors: Synthetic colors may be added to ghee to enhance its golden color and make it appear more visually appealing.

Flavor Enhancers: Artificial flavoring agents may be added to ghee to mask any off-flavors resulting from the use of inferior ingredients.

To detect adulterants in ghee, various analytical methods can be employed. Some common techniques include:

Physical Examination: Visual inspection of ghee can sometimes reveal adulteration, such as the presence of artificial colors or abnormal texture. However, this method alone may not be sufficient to detect all types of adulterants.

Chemical Tests: Chemical tests can be performed to detect the presence of specific substances in ghee. For example, tests for the presence of unsaturated fatty acids can indicate the addition of vegetable oils, while tests for cholesterol can indicate the presence of animal fats.

Gas Chromatography (GC): GC analysis can be used to analyze the fatty acid composition of ghee and detect the presence of adulterants such as vegetable oils or animal fats. This technique separates and identifies individual components based on their retention times.

Mass Spectrometry (MS): MS analysis can be coupled with GC to provide additional information about the molecular structure of compounds present in ghee, helping to confirm the presence of specific adulterants.

DNA Analysis: DNA analysis can be used to detect the presence of DNA from specific plant or animal sources, providing evidence of adulteration with vegetable oils or animal fats.

Overall, a combination of different analytical techniques is often required to effectively detect adulterants in ghee and ensure its authenticity and quality. Regular monitoring and testing by regulatory authorities can also help prevent adulteration and ensure consumer safety.

RANCIDITY

DEFINITION

Rancidity refers to the development of off-flavors and odors in fats and oils due to the degradation of lipids. It occurs when fats and oils undergo oxidative or hydrolytic reactions, leading to the formation of volatile compounds that impart unpleasant tastes and smells.

There are two main types of rancidity:

Oxidative Rancidity: This type of rancidity occurs when fats and oils react with oxygen in the air, resulting in the formation of volatile oxidation products such as aldehydes and ketones. Oxidative rancidity is accelerated by exposure to heat, light, and metals, as well as by the presence of trace amounts of water and certain contaminants. Common signs of oxidative rancidity include a stale or cardboard-like taste and a rancid odor resembling paint or varnish.

Hydrolytic Rancidity: Hydrolytic rancidity occurs when fats and oils undergo hydrolysis, a chemical reaction in which water molecules break down ester bonds in triglycerides, releasing free fatty acids. Hydrolytic rancidity is catalyzed by enzymes present in the fats and oils or by external factors such as heat and alkaline conditions. The presence of free fatty acids contributes to a soapy or metallic taste and a sour or unpleasant odor in the affected fats and oils.

Rancidity can affect various food products containing fats and oils, including butter, margarine, cooking oils, nuts, and fried foods. It can significantly alter the flavor, aroma, and overall quality of these products, leading to consumer dissatisfaction and food waste.

Preventing rancidity involves proper storage and handling of fats and oils to minimize exposure to factors that promote oxidation and hydrolysis. This includes storing fats and oils in airtight containers in a cool, dark place, avoiding prolonged exposure to heat and light, and minimizing contact with oxygen by sealing containers tightly. Additionally, antioxidants such as vitamin E (tocopherol) and butylated hydroxytoluene (BHT) can be added to fats and oils to inhibit oxidation and prolong their shelf life.

PREVENTION

Preventing rancidity in fats and oils involves several key strategies aimed at minimizing exposure to factors that promote oxidation and hydrolysis. Here are some effective prevention methods:

Proper Storage: Store fats and oils in airtight containers to minimize exposure to oxygen, which accelerates oxidative rancidity. Choose opaque or tinted containers to protect against light exposure, as light can also promote oxidation. Store fats and oils in a cool, dark place, away from heat sources such as stoves and ovens, to slow down oxidation reactions.

Limited Air Exposure: Minimize the amount of air that comes into contact with fats and oils during storage and use. Keep containers tightly sealed when not in use, and avoid transferring fats and oils between containers unnecessarily.

Avoid Heat: Heat can accelerate both oxidative and hydrolytic rancidity reactions. Avoid exposing fats and oils to high temperatures during cooking, frying, and processing. Use gentle cooking methods such as steaming or baking instead of frying whenever possible, and monitor cooking temperatures to prevent overheating.

Use Fresh Ingredients: Use fresh fats and oils to minimize the risk of rancidity. Check expiration dates and storage conditions when purchasing fats and oils, and discard any products that show signs of spoilage or have passed their expiration dates.

Antioxidants: Consider using natural or synthetic antioxidants to inhibit oxidation and extend the shelf life of fats and oils. Common antioxidants used in food products include vitamin E (tocopherol), ascorbic acid (vitamin C), and butylated hydroxytoluene (BHT). These antioxidants scavenge free radicals and prevent them from initiating oxidation reactions.

Hygiene and Quality Control: Maintain good hygiene and sanitation practices when handling fats and oils to prevent contamination with water, dirt, or other contaminants that can accelerate rancidity. Implement quality control measures to monitor the quality and freshness of fats and oils throughout the production, storage, and distribution process.

By following these prevention methods, you can minimize the risk of rancidity and ensure the quality and freshness of fats and oils in your food products.

ANTIOXIDANT AND SYNERGISTS

Antioxidants are compounds that inhibit or delay the oxidation of other molecules by neutralizing free radicals, thereby preventing oxidative damage. In the context of food preservation, antioxidants are used to prevent the rancidity of fats and oils by inhibiting lipid oxidation. Some common antioxidants used in the food industry include:

Tocopherols (Vitamin E): Tocopherols are a group of naturally occurring antioxidants that are commonly used to prevent lipid oxidation in fats and oils. They work by scavenging free radicals and breaking the chain reaction of lipid oxidation.

Ascorbic Acid (Vitamin C): Ascorbic acid is another natural antioxidant that is effective in inhibiting lipid oxidation. It reacts with free radicals to form stable products, thereby preventing oxidative damage to fats and oils.

Butylated Hydroxytoluene (BHT): BHT is a synthetic antioxidant that is commonly used in the food industry to prevent lipid oxidation. It works by donating hydrogen atoms to free radicals, thereby neutralizing them and preventing them from initiating oxidation reactions.

Butylated Hydroxyanisole (BHA): BHA is another synthetic antioxidant that is similar to BHT in its mechanism of action. It inhibits lipid oxidation by scavenging free radicals and breaking the chain reaction of oxidation.

Synergists are compounds that enhance the effectiveness of antioxidants by potentiating their antioxidant activity or by stabilizing the antioxidants themselves. Some common synergists used in combination with antioxidants include:

Citric Acid: Citric acid is often used as a synergist with antioxidants such as ascorbic acid. It helps to regenerate oxidized antioxidants and stabilize their activity, thereby prolonging their effectiveness in inhibiting lipid oxidation.

EDTA (Ethylenediaminetetraacetic Acid): EDTA is a chelating agent that is used to sequester metal ions, which can catalyze lipid oxidation reactions. By removing metal ions from the system, EDTA helps to prevent oxidation and enhance the effectiveness of antioxidants.

Phosphates: Phosphates are commonly used as synergists in meat products to enhance the effectiveness of antioxidants and stabilize their activity. They help to maintain the pH and reduce the pro-oxidant effects of certain metal ions.

Overall, antioxidants and synergists play an important role in preventing the rancidity of fats and oils in food products by inhibiting lipid oxidation and prolonging their shelf life.

NATURAL AND SYNTHETIC ANTIOXIDANTS

Antioxidants can be categorized into two main types based on their source: natural antioxidants and synthetic antioxidants. Here's an overview of each type:

Natural Antioxidants:

Tocopherols (Vitamin E): Tocopherols are naturally occurring antioxidants found in vegetable oils, nuts, seeds, and leafy green vegetables. They are effective in inhibiting lipid oxidation and are commonly used in food products as antioxidants.

Ascorbic Acid (Vitamin C): Ascorbic acid is a water-soluble vitamin found in fruits and vegetables such as citrus fruits, strawberries, and bell peppers. It is a potent antioxidant that scavenges free radicals and prevents oxidative damage to fats and oils.

Polyphenols: Polyphenols are a diverse group of compounds found in plants, including flavonoids, phenolic acids, and tannins. They have antioxidant properties and are found in foods such as fruits, vegetables, tea, and red wine.

Rosemary Extract: Rosemary extract contains several natural antioxidants, including carnosic acid and rosmarinic acid, which are effective in inhibiting lipid oxidation. It is commonly used as a natural antioxidant in food products.

Astaxanthin: Astaxanthin is a carotenoid pigment found in seafood such as shrimp, salmon, and lobster. It has strong antioxidant properties and is used as a natural antioxidant in food and dietary supplements.

Synthetic Antioxidants:

Butylated Hydroxytoluene (BHT): BHT is a synthetic antioxidant that is commonly used in the food industry to prevent lipid oxidation. It is effective in inhibiting oxidation reactions by scavenging free radicals and breaking the chain reaction of oxidation.

Butylated Hydroxyanisole (BHA): BHA is another synthetic antioxidant that is similar to BHT in its mechanism of action. It is widely used in food products to prevent oxidative rancidity and extend shelf life.

Propyl Gallate: Propyl gallate is a synthetic antioxidant that is commonly used in fats, oils, and processed foods to prevent oxidation. It works by scavenging free radicals and inhibiting lipid oxidation reactions.

TBHQ (Tertiary Butylhydroquinone): TBHQ is a synthetic antioxidant that is often used in fats, oils, and snack foods to prevent oxidative rancidity. It is effective in inhibiting oxidation reactions by trapping free radicals and preventing them from initiating oxidation.

Both natural and synthetic antioxidants play important roles in preventing oxidative rancidity and extending the shelf life of food products. While natural antioxidants are often preferred by consumers seeking clean-label products, synthetic antioxidants are valued for their stability, effectiveness, and cost-effectiveness in food preservation.

NATURAL AND SYNTHETIC SYNERGISTS

Synergists are compounds that enhance the effectiveness of antioxidants by potentiating their antioxidant activity or by stabilizing the antioxidants themselves. Similar to antioxidants, synergists can be categorized into natural and synthetic types. Here's an overview of each:

Natural Synergists:

Citric Acid: Citric acid is a naturally occurring organic acid found in citrus fruits such as lemons, limes, oranges, and grapefruits. It is commonly used as a synergist with antioxidants such as ascorbic acid (vitamin C) to enhance their effectiveness in inhibiting lipid oxidation. Citric acid helps to regenerate oxidized antioxidants and stabilize their activity, thereby prolonging their effectiveness in preserving food products.

Ascorbic Acid (Vitamin C): In addition to its role as an antioxidant, ascorbic acid can also act as a synergist with other antioxidants. It enhances the effectiveness of antioxidants such as tocopherols (vitamin E) and polyphenols by regenerating their oxidized forms and maintaining their antioxidant activity.

EDTA (Ethylenediaminetetraacetic Acid): EDTA is a chelating agent that is found in certain plants and is also produced synthetically. It is used as a synergist in food products to sequester metal ions, which can catalyze lipid oxidation reactions. By removing metal ions from the system, EDTA helps to prevent oxidation and enhance the effectiveness of antioxidants.

Phosphates: Phosphates are naturally occurring compounds found in various foods, including meat, poultry, seafood, and dairy products. They are commonly used as synergists in meat products to enhance the effectiveness of antioxidants and stabilize their activity.

Phosphates help to maintain the pH and reduce the pro-oxidant effects of certain metal ions, thereby preventing oxidative rancidity in meat products.

Synthetic Synergists:

Propyl Gallate: Propyl gallate is a synthetic antioxidant that is also used as a synergist in combination with other antioxidants such as BHT (butylated hydroxytoluene) and BHA (butylated hydroxyanisole). It enhances the effectiveness of antioxidants by stabilizing their activity and preventing oxidation reactions.

Calcium Disodium EDTA: Calcium disodium EDTA is a synthetic chelating agent that is commonly used as a synergist in food products to sequester metal ions and prevent oxidation. It enhances the effectiveness of antioxidants by removing metal ions from the system and reducing their pro-oxidant effects.

Sodium Citrate: Sodium citrate is a synthetic salt derived from citric acid. It is used as a synergist in food products to enhance the effectiveness of antioxidants such as ascorbic acid and tocopherols. Sodium citrate helps to maintain the pH and stability of antioxidants, thereby prolonging their effectiveness in inhibiting lipid oxidation.

Both natural and synthetic synergists play important roles in enhancing the effectiveness of antioxidants and preventing oxidative rancidity in food products. They help to maintain the quality, freshness, and shelf life of food products by inhibiting lipid oxidation and preserving their sensory properties.

UNIT-IV

SPECIAL MILK

STANDARDIZED MILK

DEFINITION

Standardized milk is a term used in the dairy industry to refer to milk that has had its fat content adjusted to a specific level through a process known as standardization. This process involves separating cream from whole milk and then adding or blending it back in to achieve the desired fat content.

STANDARDIZATION PROCESS:

Separation of Cream: Initially, whole milk undergoes centrifugal separation to separate the cream, which contains a higher concentration of fat, from the skim milk. This cream can be used to produce other dairy products such as butter, cream, or ice cream.

Adjustment of Fat Content: Once the cream has been removed, the fat content of the skim milk is adjusted to the desired level by adding back a calculated amount of cream. This can be done by measuring the fat content of both the skim milk and the cream, and then blending them together in the appropriate proportions.

Homogenization (Optional): In some cases, standardized milk may undergo homogenization, a process that breaks down the fat globules in the milk to prevent cream from separating out and forming a layer on top. This results in a uniform distribution of fat throughout the milk.

Quality Control: Throughout the standardization process, quality control measures are implemented to ensure that the fat content of the milk meets regulatory standards and consumer expectations. This may involve regular testing of fat content and other parameters to verify consistency and accuracy.

Standardized milk is commonly available in various fat percentages, such as whole milk (3.25% fat), 2% milk, 1% milk, and skim milk (0.5% or less fat). This allows consumers to choose milk with the fat content that best suits their dietary preferences and needs.

Overall, standardized milk plays an important role in the dairy industry by providing consumers with milk that has a consistent fat content, ensuring uniformity in flavor, texture, and nutritional content across different batches and brands.

MERITS

Standardized milk offers several merits, both for consumers and the dairy industry:

Consistency: By adjusting the fat content to a specific level, standardized milk ensures consistency in flavor, texture, and nutritional content across different batches and brands. This allows consumers to know what to expect when purchasing standardized milk, regardless of where or when it was produced.

Flexibility: Standardized milk is available in various fat percentages, such as whole milk (3.25% fat), 2% milk, 1% milk, and skim milk (0.5% or less fat). This allows consumers to choose milk with the fat content that best suits their dietary preferences and needs, whether they prefer richer whole milk or lower-fat options.

Nutritional Balance: Standardized milk provides consumers with options to meet their nutritional requirements while controlling their fat intake. For example, individuals who are watching their fat consumption can opt for lower-fat varieties like 1% or skim milk, while those who need more calories and fat can choose whole milk.

Regulatory Compliance: Standardized milk ensures compliance with regulatory standards for milk fat content, helping to maintain consumer confidence and trust in the dairy industry. Regulatory agencies may set minimum and maximum limits for milk fat content to ensure product quality and safety.

Versatility: Standardized milk can be used in a wide range of culinary applications, from drinking and cooking to baking and dessert making. Its consistent fat content makes it suitable for various recipes and ensures reliable results.

Economic Efficiency: Standardization allows dairy processors to optimize the use of milk components, such as cream, to produce a range of dairy products with different fat contents. This can help reduce waste and improve efficiency in milk processing operations.

Overall, standardized milk offers consumers a convenient and reliable option for meeting their dairy needs while providing the dairy industry with a flexible and efficient way to produce milk products with consistent quality and nutritional profiles.

RECONSTITUTED MILK

DEFINITION

Reconstituted milk refers to milk that has been made by adding water to a dry milk powder or concentrated milk product. This process is commonly used to extend the shelf life of milk, reduce transportation costs, and provide a convenient and shelf-stable alternative to fresh milk in certain situations.

Key points about reconstituted milk:

Dry Milk Powder: Reconstituted milk is typically made from dry milk powder, which is produced by evaporating milk to remove moisture. The resulting powder can be stored for longer periods without refrigeration and can be rehydrated with water when needed to make liquid milk.

Concentrated Milk: In addition to dry milk powder, concentrated milk products such as evaporated milk and condensed milk can also be reconstituted with water to make liquid milk. These concentrated milk products have had some of the water removed through evaporation, resulting in a thicker consistency and a longer shelf life.

Water Addition: To make reconstituted milk, water is added to the dry milk powder or concentrated milk product in the appropriate ratio specified by the manufacturer. The mixture is then stirred or agitated to ensure thorough mixing and dissolution of the milk solids.

Shelf Stability: Reconstituted milk has a longer shelf life compared to fresh milk, as it has been heat-treated during the drying or concentration process to kill bacteria and enzymes that can cause spoilage. However, once reconstituted, it should be stored in the refrigerator and consumed within a few days to maintain freshness.

Nutritional Content: Reconstituted milk generally retains most of the nutritional content of fresh milk, including proteins, vitamins, and minerals. However, some vitamins, such as vitamin C, may be lost during the drying or concentration process.

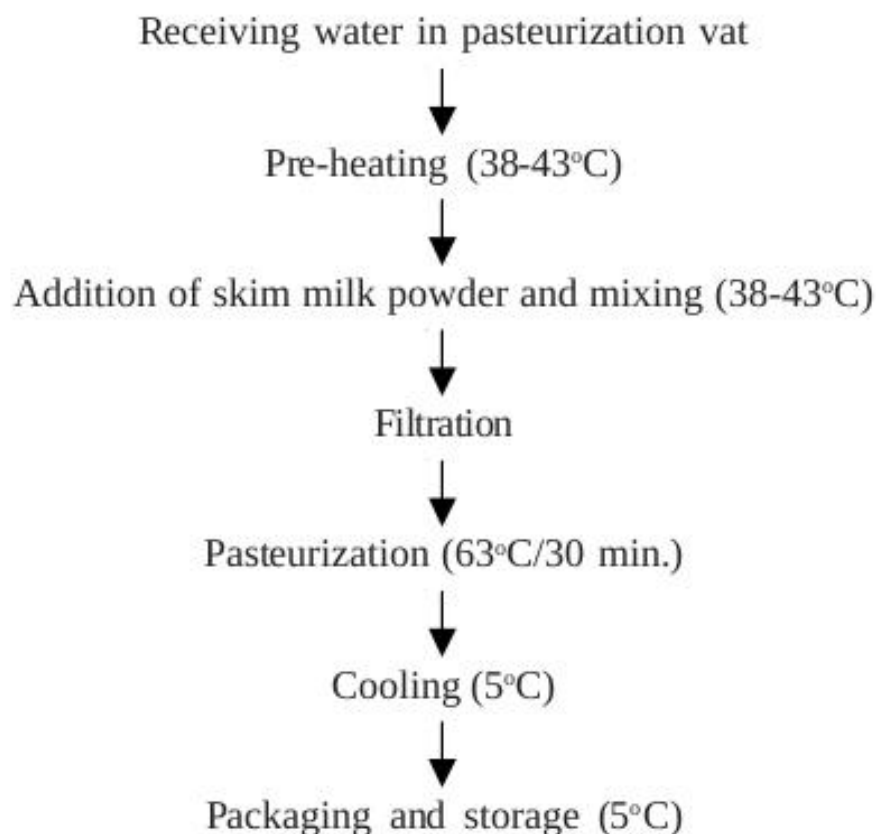
Usage: Reconstituted milk can be used in the same way as fresh milk in cooking, baking, and beverage preparation. It can also be consumed directly as a beverage or added to cereals, smoothies, and other recipes.

Overall, reconstituted milk provides a convenient and versatile alternative to fresh milk, offering longer shelf life and easier storage while maintaining most of the nutritional benefits.

of fresh milk. It is commonly used in households, foodservice operations, and food manufacturing settings.

FLOW DIAGRAM OF MANUFACTURE

Here's a simplified flow diagram of the manufacture of reconstituted milk from dry milk powder:



Receiving and Inspection: Dry milk powder is received from suppliers and undergoes inspection to ensure it meets quality and safety standards.

Storage: The dry milk powder is stored in a designated area, preferably in a cool, dry environment, until it is needed for production.

Weighing and Mixing: The required amount of dry milk powder is weighed and transferred to a mixing tank. Water is added to the mixing tank in the appropriate ratio to reconstitute the milk to the desired fat content and solids concentration.

Mixing and Dissolution: The dry milk powder and water are mixed together in the mixing tank until the powder is completely dissolved and a homogeneous milk mixture is formed.

Heat Treatment: The milk mixture may undergo heat treatment, such as pasteurization or ultra-high temperature (UHT) treatment, to kill any bacteria and ensure product safety and shelf stability.

Homogenization (Optional): The milk mixture may be homogenized to break down fat globules and ensure uniform distribution of fat throughout the milk. This step is optional and depends on the desired consistency of the reconstituted milk.

Cooling: The milk mixture is cooled to the desired temperature to prepare it for packaging.

Packaging: The reconstituted milk is packaged into containers, such as cartons, bottles, or pouches, using automated filling and sealing equipment. The packaging material is chosen based on factors such as product shelf life, storage conditions, and consumer preferences.

Labeling and Coding: The packaged reconstituted milk is labeled with product information, including the product name, ingredients, nutritional content, and expiration date. Barcodes or other coding systems may also be applied for inventory and traceability purposes.

Quality Control: Throughout the manufacturing process, quality control measures are implemented to ensure the consistency, safety, and quality of the reconstituted milk. This may include testing for fat content, solids concentration, microbial contamination, and sensory attributes.

Storage and Distribution: The packaged reconstituted milk is stored in a warehouse or distribution center before being shipped to retailers or other distribution channels for sale to consumers.

Consumer Use: The reconstituted milk is purchased by consumers and used for various purposes, including drinking, cooking, baking, and beverage preparation.

This flow diagram outlines the basic steps involved in the manufacture of reconstituted milk from dry milk powder. The specific process may vary depending on factors such as the type of milk powder used, the desired fat content and consistency of the reconstituted milk, and the manufacturing practices of the dairy facility.

HOMOGENIZED MILK

Homogenized milk undergoes a process known as homogenization, which is a mechanical treatment that breaks down the fat globules in milk to create a uniform dispersion throughout the liquid. Here's a simplified explanation of the process and its benefits:

Separation and Collection: Initially, milk is collected from dairy farms and transported to processing plants. At this stage, milk typically contains fat globules that vary in size and tend to rise to the surface, forming a layer of cream.

Homogenization: The milk is pumped through a homogenizer, which forces it through a series of narrow channels or valves under high pressure. This process breaks down the fat globules into smaller droplets, dispersing them evenly throughout the milk. As a result, the fat is prevented from separating and forming a layer of cream on top.

Uniform Texture: Homogenization creates a uniform texture and consistency in milk, giving it a smooth and creamy mouthfeel. This uniform dispersion of fat globules also enhances the appearance of milk, making it visually appealing to consumers.

Extended Shelf Life: Homogenization can help extend the shelf life of milk by preventing the separation of cream and delaying the onset of spoilage. With the fat evenly distributed throughout the milk, there are fewer opportunities for bacteria to grow and cause spoilage.

Improved Nutrient Absorption: Some studies suggest that homogenized milk may improve the absorption of certain nutrients, such as calcium and vitamin D, by increasing the surface area of the fat globules and promoting their digestion and absorption in the digestive tract.

Versatility: Homogenized milk is versatile and can be used in various culinary applications, including drinking, cooking, baking, and beverage preparation. Its smooth texture and consistent composition make it suitable for a wide range of recipes and food products.

Overall, homogenized milk offers several benefits, including a uniform texture, extended shelf life, improved nutrient absorption, and versatility in culinary applications. It is a popular choice among consumers for its convenience and consistent quality.

FLAVOURED MILK

Flavored milk is a dairy beverage that has been infused with additional flavorings to enhance its taste. It typically starts with regular milk, which can be whole, low-fat, or skim milk, and then flavorings such as cocoa, vanilla, strawberry, or other fruit extracts are added to create different varieties of flavored milk. Here are some key points about flavored milk:

Variety of Flavors: Flavored milk comes in a variety of flavors to suit different preferences and tastes. Some common flavors include chocolate, vanilla, strawberry, banana, and caramel. These flavors can be natural extracts or artificial flavorings, depending on the product.

Nutritional Content: Flavored milk retains most of the nutritional benefits of regular milk, including essential nutrients such as calcium, protein, vitamins, and minerals. However, the added flavorings may also contribute additional sugar and calories, depending on the type and amount of flavoring used.

Sweeteners: Flavored milk may contain added sweeteners such as sugar, corn syrup, or artificial sweeteners to enhance the sweetness and palatability of the beverage. Some flavored milk products are available in reduced-sugar or sugar-free varieties to cater to consumers looking for lower-calorie options.

Packaging: Flavored milk is typically packaged in cartons, bottles, or pouches similar to regular milk. It may be sold in single-serve containers for convenience or larger containers for home use. Packaging may also feature colorful labels and graphics to appeal to consumers, especially children.

Usage: Flavored milk can be consumed on its own as a refreshing beverage or used as an ingredient in various recipes, such as smoothies, milkshakes, desserts, and baked goods. Its sweet and creamy flavor makes it a popular choice for both children and adults.

Availability: Flavored milk is widely available in supermarkets, convenience stores, and foodservice outlets. It is commonly sold alongside regular milk and other dairy products in the dairy aisle or refrigerated section of grocery stores.

Nutritional Benefits: Flavored milk can be a nutritious option for meeting daily dairy requirements, especially for individuals who may be reluctant to consume plain milk. It provides essential nutrients in a tasty and convenient form, making it an appealing choice for consumers of all ages.

Overall, flavored milk offers a flavorful and convenient way to enjoy the nutritional benefits of milk while satisfying taste preferences and cravings for sweetness. However, it's important to be mindful of added sugars and calories when choosing flavored milk products and to enjoy them as part of a balanced diet.

VITAMINISED MILK

Vitaminized milk, also known as enriched or fortified milk, is milk that has been supplemented with additional vitamins to enhance its nutritional content. The purpose of adding vitamins to milk is to address nutritional deficiencies, improve overall health, and provide consumers with a convenient source of essential nutrients. Here are some key points about vitaminized milk:

Types of Vitamins: Vitaminized milk may be fortified with various vitamins, including vitamin A, vitamin D, vitamin B12, and vitamin C, among others. These vitamins are chosen based on their importance for overall health and their role in supporting various bodily functions.

Nutritional Benefits: Vitaminized milk provides an additional source of essential vitamins, helping to meet daily dietary requirements and prevent deficiencies. For example, vitamin D-fortified milk can help support bone health and calcium absorption, while vitamin A-fortified milk can support vision and immune function.

Regulatory Requirements: In many countries, the fortification of milk with certain vitamins is regulated by government authorities to ensure that products meet minimum standards for nutritional content and safety. This may include specific guidelines for the types and amounts of vitamins that can be added to milk.

Targeted Populations: Vitaminized milk may be targeted towards specific populations who are at risk of nutrient deficiencies, such as children, pregnant or lactating women, the elderly, or individuals with certain medical conditions. Fortified milk can help ensure that these vulnerable groups receive adequate nutrition.

Packaging and Labeling: Vitaminized milk is typically labeled to indicate the added vitamins and their respective amounts per serving. Packaging may also feature labels or logos to highlight the nutritional benefits of the product and attract consumers.

Availability: Vitaminized milk is widely available in supermarkets, grocery stores, and other retail outlets. It is commonly sold alongside regular milk and other dairy products, making it easy for consumers to incorporate into their daily diet.

Usage: Vitaminized milk can be used in the same way as regular milk and incorporated into various recipes, including beverages, cereals, smoothies, and baked goods. It provides an easy and convenient way to boost the nutritional value of meals and snacks.

Overall, vitaminized milk offers a convenient and accessible source of essential vitamins, helping to support overall health and well-being. It can be an important component of a balanced diet, especially for individuals who may have limited access to nutrient-rich foods or who have increased nutrient needs.

TONED MILK

Toned milk is a type of milk that has a lower fat content than whole milk but higher fat content than skimmed milk. It is made by mixing together whole milk and skimmed milk in specific proportions to achieve the desired fat content, typically around 3% to 4%. Here are some key points about toned milk:

Fat Content: Toned milk contains less fat than whole milk but more fat than skimmed milk. While the exact fat content may vary slightly depending on the specific product and regional regulations, toned milk generally has a fat content of around 3% to 4%.

Preparation: Toned milk is prepared by combining whole milk, which contains approximately 3.5% fat, with skimmed milk, which contains negligible fat (usually less than 0.5% fat). The proportions of whole milk and skimmed milk are adjusted to achieve the desired fat content in the final product.

Nutritional Content: Toned milk retains most of the nutritional benefits of whole milk, including essential nutrients such as protein, calcium, vitamins, and minerals. However, it has a lower fat content, which reduces its calorie and saturated fat content compared to whole milk.

Regulatory Standards: In many countries, including India, toned milk is regulated by government authorities to ensure that it meets specific standards for fat content and nutritional composition. These standards may vary depending on regional regulations and consumer preferences.

Usage: Toned milk can be used in the same way as whole milk in cooking, baking, and beverage preparation. It can be consumed on its own or used as an ingredient in recipes such as cereal, coffee, tea, smoothies, and desserts.

Benefits: Toned milk offers a middle ground between whole milk and skimmed milk, providing a balance of flavor, texture, and nutritional content. It appeals to consumers who prefer milk with a lower fat content than whole milk but more richness and creaminess than skimmed milk.

Availability: Toned milk is widely available in supermarkets, grocery stores, and dairy outlets, often alongside other varieties of milk such as whole milk, skimmed milk, and flavored milk. It is packaged in cartons, bottles, or pouches and may be sold in different sizes to suit consumer preferences.

Overall, toned milk provides a nutritious and versatile option for consumers seeking a balance between the flavor and creaminess of whole milk and the lower fat content of skimmed milk. It is a popular choice for everyday use in households and foodservice establishments.

IMITATION MILK

Imitation milk refers to non-dairy milk alternatives that are made to resemble the taste, texture, and appearance of dairy milk but are derived from plant-based sources or other non-dairy ingredients. These alternatives are popular among individuals who are lactose intolerant, have dairy allergies, or follow a vegan or plant-based diet. Here are some common types of imitation milk:

Soy Milk: Made from soybeans, soy milk is one of the most widely consumed non-dairy milk alternatives. It has a creamy texture and is often fortified with vitamins and minerals, making it nutritionally similar to dairy milk.

Almond Milk: Almond milk is made from ground almonds and water. It has a slightly nutty flavor and a thinner consistency compared to dairy milk. Almond milk is low in calories and is often fortified with calcium and vitamin D.

Coconut Milk: Coconut milk is made from the flesh of coconuts and has a rich, creamy texture and a subtle coconut flavor. It is commonly used in Asian and tropical cuisines and can be found in both canned and carton forms.

Oat Milk: Oat milk is made from oats and water and has a mild, slightly sweet flavor. It has a creamy texture similar to dairy milk and is often fortified with vitamins and minerals.

Rice Milk: Rice milk is made from milled rice and water and has a mild, slightly sweet flavor. It has a thinner consistency compared to dairy milk and is often fortified with calcium and vitamin D.

Cashew Milk: Cashew milk is made from blended cashews and water and has a creamy texture and a rich, nutty flavor. It is often used in creamy sauces, desserts, and beverages.

Hemp Milk: Hemp milk is made from hemp seeds and water and has a slightly nutty flavor. It is rich in omega-3 fatty acids and is often fortified with vitamins and minerals.

These are just a few examples of imitation milk alternatives, but there are many other options available, including pea milk, quinoa milk, and flax milk. Each type of imitation milk has its own unique flavor, texture, and nutritional profile, allowing consumers to choose the one that best suits their taste preferences and dietary needs.

VEGETABLE TONED MILK

Vegetable toned milk typically refers to a type of milk alternative that is made from plant-based ingredients and has a reduced fat content compared to whole dairy milk. It is often fortified with vitamins and minerals to enhance its nutritional profile. Here's how vegetable toned milk is typically produced:

Base Ingredients: Vegetable toned milk is made from plant-based ingredients such as nuts, seeds, grains, or legumes. Common sources include almonds, soybeans, oats, rice, coconut, and hemp seeds.

Processing: The plant-based ingredients are soaked, ground, and blended with water to create a liquid base. Depending on the type of vegetable used, the mixture may undergo additional processing steps such as straining or filtering to remove solids and create a smoother texture.

Fortification: To enhance the nutritional content of vegetable toned milk and make it more comparable to dairy milk, vitamins and minerals may be added. Common fortifications include calcium, vitamin D, vitamin B12, and vitamin E.

Toning: The term “toned” in vegetable toned milk refers to the adjustment of the fat content to achieve a desired level. While traditional toned milk is made by mixing whole milk with skimmed milk, in the case of vegetable toned milk, the fat content is adjusted by controlling the amount of fat-containing ingredients added to the base mixture.

Packaging: Once the vegetable toned milk has been prepared and fortified, it is packaged into containers such as cartons or bottles for storage and distribution.

Usage: Vegetable toned milk can be used in a similar way to dairy milk in cooking, baking, and beverage preparation. It can be consumed on its own as a beverage or used as an ingredient in recipes such as smoothies, cereals, and desserts.

Vegetable toned milk offers a dairy-free alternative for individuals who are lactose intolerant, have dairy allergies, or follow a vegan or plant-based diet. It provides a source of essential nutrients while offering a lower fat content compared to whole dairy milk.

HUMANIZED MILK

Humanized milk typically refers to milk that has been modified or supplemented to resemble the composition of human breast milk. This term is often used in the context of infant formula or specialized milk products designed for infants or individuals who require specific nutritional needs.

Here are some key points about humanized milk:

Infant Formula: Humanized milk may refer to infant formula that is formulated to mimic the composition of human breast milk as closely as possible. This includes adjusting the levels of proteins, fats, carbohydrates, vitamins, minerals, and other nutrients to match those found in breast milk.

Specialized Nutrition: Humanized milk may also be used to describe specialized milk products designed for individuals with specific nutritional requirements or medical conditions. For example, there are formulas designed for premature infants, infants with allergies or intolerances, and individuals with digestive disorders.

Fortification: Humanized milk products are often fortified with additional vitamins, minerals, and other nutrients to ensure that they provide adequate nutrition for growth and development. These fortifications are carefully regulated and standardized to meet the nutritional needs of the target population.

Research and Development: The development of humanized milk products involves extensive research and development to understand the nutritional composition of human breast milk and how it supports infant growth and development. This research helps inform the formulation of infant formula and other specialized milk products.

Regulation: Humanized milk products are subject to strict regulations and guidelines set by government authorities to ensure their safety, quality, and nutritional adequacy. These regulations govern aspects such as ingredient sourcing, manufacturing processes, labeling, and marketing.

Usage: Humanized milk products are typically used as a substitute for or supplement to breastfeeding in cases where breastfeeding is not possible or insufficient. They are commonly recommended by healthcare professionals for infants who cannot breastfeed or for individuals with specific medical conditions.

Overall, humanized milk plays an important role in providing nutritionally complete and balanced alternatives to human breast milk for infants and individuals with specific nutritional needs. It helps support healthy growth and development during critical stages of life.

CONDENSED MILK

DEFINITION

Condensed milk is a sweetened dairy product that is made by evaporating most of the water content from fresh milk and then adding sugar to the concentrated milk. The result is a thick, viscous liquid with a high sugar content and a rich, creamy flavor.

Here are some key points about condensed milk:

Production: Condensed milk is typically made by heating fresh milk to remove approximately 60% of its water content through evaporation. This concentrated milk is then mixed with sugar in a specific ratio, usually about 45-50% sugar by weight, to create a thick and sweetened product.

Sweetening: The addition of sugar to condensed milk serves multiple purposes. It helps to preserve the milk by reducing water activity, inhibiting the growth of microorganisms, and extending shelf life. The sugar also contributes to the sweet taste and creamy texture of the condensed milk.

Versatility: Condensed milk is a versatile ingredient that is used in a wide range of culinary applications. It is commonly used as a sweetener and flavoring agent in desserts, such as cakes, cookies, puddings, and ice creams. It can also be used to make beverages, such as coffee, tea, and hot chocolate, or as a topping for fruits and pancakes.

Types: There are two main types of condensed milk: sweetened condensed milk and unsweetened condensed milk. **Sweetened condensed milk**, as described above, contains added sugar and is sweet and thick. **Unsweetened condensed milk**, also known as evaporated milk, is simply fresh milk that has been partially evaporated to remove some of the water content, without the addition of sugar.

Storage: Condensed milk is typically sold in cans or tubes and has a long shelf life when stored in a cool, dry place. Once opened, it should be refrigerated and consumed within a few days to prevent spoilage.

Cultural Significance: Condensed milk has cultural significance in many countries and is a staple ingredient in traditional recipes around the world. It is particularly popular in desserts and beverages in Southeast Asian, Latin American, and Eastern European cuisines.

Overall, condensed milk is a sweet and creamy dairy product that adds richness and flavor to a wide variety of culinary creations. Its versatility, long shelf life, and distinctive taste make it a beloved ingredient in kitchens worldwide.

COMPOSITION

The composition of condensed milk typically consists of two main ingredients: milk and sugar. Here's a breakdown of the composition of condensed milk:

Milk: The primary ingredient in condensed milk is fresh milk, which can come from cows, goats, or other mammals. The milk used is typically whole milk, which contains a higher fat content, although low-fat or skimmed milk can also be used. Milk is a rich source of protein, calcium, vitamins, and minerals.

Sugar: Sugar is added to the concentrated milk to sweeten the product and create its characteristic sweet and creamy taste. The sugar used is typically sucrose, which is derived from sugar cane or sugar beet. The amount of sugar added can vary, but it generally constitutes about 45-50% of the total weight of the condensed milk.

In addition to milk and sugar, condensed milk may also contain small amounts of other ingredients such as emulsifiers, stabilizers, and flavorings, depending on the specific product and manufacturer. These ingredients help to maintain the texture and stability of the condensed milk and ensure a consistent quality product.

It's important to note that the nutritional composition of condensed milk can vary depending on factors such as the type of milk used (whole, low-fat, or skimmed), the amount of sugar added, and any additional ingredients included in the product. However, condensed milk is generally high in calories, sugars, and fats, making it a rich and indulgent ingredient in recipes and beverages.

NUTRITION VALUE

The nutritive value of condensed milk varies depending on factors such as the type of milk used (whole, low-fat, or skimmed), the amount of sugar added, and any additional ingredients included in the product. However, condensed milk is generally high in calories, sugars, and fats. Here's a general overview of the nutritive value of condensed milk per 100 grams:

Calories: Condensed milk is energy-dense, with approximately 330-340 calories per 100 grams.

Protein: Condensed milk contains protein, with around 8-9 grams per 100 grams. However, the protein content may be lower compared to regular milk due to the dilution of milk solids during the evaporation process.

Fat: Condensed milk is high in fat, with approximately 7-8 grams of fat per 100 grams. The fat content depends on the type of milk used and whether it is whole, low-fat, or skimmed milk.

Carbohydrates: Condensed milk is rich in carbohydrates, primarily from added sugars. It typically contains around 55-60 grams of carbohydrates per 100 grams, with most of it coming from sugar.

Vitamins and Minerals: Condensed milk may contain some vitamins and minerals naturally present in milk, such as calcium, phosphorus, vitamin D, and vitamin B12. However, the concentration of these nutrients may be lower compared to fresh milk due to the removal of water during the evaporation process.

Other Nutrients: Condensed milk may also contain small amounts of other nutrients such as potassium, magnesium, and vitamin A, depending on the type of milk used and any fortification or enrichment.

It's important to consume condensed milk in moderation due to its high calorie, sugar, and fat content. While it can be a convenient and tasty ingredient in recipes and beverages, excessive consumption of condensed milk may contribute to weight gain and other health issues if not balanced with a healthy diet and lifestyle.

UNIT -V

FERMENTED AND OTHER MILK PRODUCTS

FERMENTED MILK PRODUCTS

Fermented milk products include yogurt, kefir, buttermilk, and various types of cheese. These products undergo fermentation by adding bacterial cultures, which convert lactose into lactic acid, giving them their characteristic taste and texture. They are known for their probiotic benefits and are popular in many cultures worldwide.

Yogurt: Yogurt is made by fermenting milk with specific bacteria cultures, typically *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. These bacteria convert lactose (milk sugar) into lactic acid, which gives yogurt its tangy flavor and thick texture. Yogurt is rich in probiotics, which are beneficial bacteria that support digestive health.

Kefir: Kefir is a fermented milk drink made by adding kefir grains to milk. Kefir grains are a combination of bacteria and yeast that ferment the milk, similar to the process of making yogurt. However, kefir grains contain a wider variety of bacteria and yeast strains. Kefir has a tangy flavor and a slightly effervescent texture. It's also rich in probiotics and may offer additional health benefits compared to yogurt.

Buttermilk: Traditional buttermilk is the liquid left behind after churning butter from cream. However, in modern usage, buttermilk is often made by fermenting low-fat milk with lactic acid bacteria. It has a tangy flavor and is commonly used in baking, marinades, and dressings.

Cheese: Cheese is made by coagulating milk proteins and then fermenting the resulting curds with bacteria and/or mold. The specific bacteria strains and fermentation process vary depending on the type of cheese being made. Cheese can be aged for different lengths of time to develop its flavor and texture. Common types of cheese include cheddar, mozzarella, feta, brie, and blue cheese.

Fermented milk products are not only delicious but also provide various nutrients such as protein, calcium, and vitamins. Additionally, their probiotic content may offer benefits for gut health and digestion.

FERMENTATION OF MILK

DEFINITION

Fermentation of milk is a natural biochemical process where certain bacteria, primarily lactic acid bacteria, metabolize the lactose present in milk to produce lactic acid. This process leads to a decrease in pH, curdling of proteins, and the development of characteristic flavors and textures in dairy products such as yogurt, kefir, buttermilk, and cheese. Fermented milk products are known for their probiotic properties and are consumed worldwide for their nutritional benefits and culinary versatility.

Brief overview of the fermentation process:

Inoculation: To start the fermentation process, specific bacterial cultures are introduced into the milk. These cultures typically include lactic acid bacteria such as *Lactobacillus bulgaricus*, *Streptococcus thermophilus*, *Lactobacillus acidophilus*, and others, depending on the desired product.

Incubation: Once the bacterial cultures are added, the milk is kept at a controlled temperature for a period of time to allow the bacteria to multiply and ferment the lactose. The temperature range for fermentation varies depending on the type of product being made. For example, yogurt is typically fermented at temperatures around 110°F to 115°F (43°C to 46°C), while cheeses may require different temperature ranges and durations of fermentation.

Lactic Acid Production: As the bacteria consume the lactose in the milk, they produce lactic acid as a byproduct. This acidification process lowers the pH of the milk, which curdles the proteins and thickens the texture. The lactic acid also contributes to the characteristic tangy flavor of fermented milk products.

Maturation: After fermentation, some products may undergo further maturation to develop their flavor and texture. For example, yogurt may be chilled to halt the fermentation process and then allowed to mature for a certain period to enhance its flavor. Cheeses are often aged for varying lengths of time under controlled conditions to develop their unique characteristics.

Overall, the fermentation of milk is a controlled process that relies on specific bacteria to transform the milk into a wide range of delicious and nutritious products, including yogurt, kefir, buttermilk, and various types of cheese.

CONDITIONS

The fermentation of milk typically occurs under controlled conditions to ensure the growth and activity of desirable bacteria while minimizing the growth of harmful microorganisms. Here are the key conditions involved in the fermentation of milk:

Temperature: The temperature range for milk fermentation varies depending on the specific product being made. For example, yogurt is typically fermented at temperatures between 110°F to 115°F (43°C to 46°C), while other products like cheese may require different temperature ranges. Maintaining the appropriate temperature is crucial for the optimal growth and activity of the bacteria involved in fermentation.

pH: The initial pH of the milk and the final desired pH of the fermented product are important factors in milk fermentation. Lactic acid bacteria thrive in slightly acidic environments, so the pH of the milk may need to be adjusted before fermentation begins. As fermentation progresses, the production of lactic acid lowers the pH of the milk, creating an environment that inhibits the growth of undesirable bacteria.

Time: The duration of fermentation varies depending on the specific product and the desired characteristics. Fermentation times can range from a few hours to several days, depending on factors such as temperature, bacterial culture used, and desired flavor profile. Monitoring the fermentation time is important to ensure that the product reaches the desired level of acidity and flavor development without over-fermenting.

Aeration: In some fermentation processes, such as making yogurt or kefir, aeration or agitation may be necessary to distribute bacteria evenly throughout the milk and promote fermentation. Aeration can also help control the texture and consistency of the final product.

Hygiene and Sanitation: Maintaining clean and sanitary conditions throughout the fermentation process is essential to prevent contamination by harmful bacteria or pathogens. This includes sanitizing equipment, utensils, and surfaces, as well as ensuring proper handling of milk and bacterial cultures.

Overall, controlling these conditions during the fermentation of milk is critical to producing high-quality fermented dairy products with desirable flavors, textures, and nutritional properties.

CULTURED MILK

Cultured milk refers to milk that has undergone fermentation with specific bacterial cultures, resulting in the formation of various fermented dairy products. These products include yogurt, kefir, buttermilk, and sour cream, among others. The term “cultured” signifies that the milk has been inoculated with live bacterial cultures, which metabolize lactose (milk sugar) into lactic acid, altering the taste, texture, and nutritional properties of the milk.

During the fermentation process, the bacterial cultures proliferate and produce lactic acid, which lowers the pH of the milk, curdles the proteins, and imparts a tangy flavor to the final product. Cultured milk products are often valued for their probiotic properties, as they contain live and active bacterial cultures that can confer health benefits, particularly for digestive health.

Cultured milk products are consumed worldwide and are used in various culinary applications, including as standalone snacks, ingredients in recipes, and bases for sauces and dressings. They are also available in a wide range of flavors and varieties to suit different tastes and preferences.

DEFINITION OF “CULTURE” IN CULTURED MILK

In the context of cultured milk or fermented dairy products, the term “culture” refers to a specific combination of live bacteria that are added to milk to initiate the fermentation process. These bacteria are known as starter cultures or fermentation cultures. They typically include strains of lactic acid bacteria such as *Lactobacillus bulgaricus*, *Streptococcus thermophilus*, *Lactobacillus acidophilus*, and others, depending on the desired product.

These bacterial cultures play a crucial role in transforming the milk by metabolizing lactose, the primary sugar in milk, into lactic acid. This process alters the taste, texture, and nutritional properties of the milk, resulting in the formation of various fermented dairy products such as yogurt, kefir, buttermilk, and cheese.

CONDITIONS

The conditions required for culturing milk depend on the specific cultured dairy product being produced, such as yogurt, kefir, or buttermilk. However, there are some common conditions that apply to most cultured milk products:

Temperature: The temperature for culturing milk typically ranges between 100°F to 115°F (37°C to 46°C). This temperature range is ideal for the growth and activity of the bacterial cultures used in fermentation. Maintaining a consistent temperature is crucial throughout the culturing process.

pH: The initial pH of the milk and the final desired pH of the cultured product are important factors in culturing milk. Lactic acid bacteria thrive in slightly acidic environments, so adjusting the pH of the milk before culturing may be necessary to create an optimal environment for bacterial growth and acidification.

Bacterial Cultures: Specific bacterial cultures, often referred to as starter cultures, are added to the milk to initiate fermentation. These cultures typically include strains of lactic acid bacteria such as *Lactobacillus bulgaricus*, *Streptococcus thermophilus*, and *Lactobacillus acidophilus*. The choice of bacterial cultures depends on the desired product and flavor profile.

Time: The duration of culturing varies depending on the type of cultured milk product and desired characteristics. Culturing times can range from a few hours to several hours or even overnight. Monitoring the culturing time is essential to achieve the desired flavor, texture, and acidity.

Hygiene and Sanitation: Maintaining clean and sanitary conditions throughout the culturing process is critical to prevent contamination by undesirable bacteria or pathogens. This includes sanitizing equipment, utensils, and surfaces, as well as ensuring proper handling of milk and bacterial cultures.

By controlling these conditions carefully, producers can create high-quality cultured milk products with desirable flavors, textures, and nutritional properties.

CULTURED CREAM

Cultured cream, also known as sour cream, is a dairy product made by fermenting cream with specific bacterial cultures. The fermentation process typically involves adding lactic acid bacteria to pasteurized cream, which metabolize the lactose in the cream and produce lactic acid. This acidification process thickens the cream and gives it a tangy flavor.

The conditions for culturing cream are similar to those for other cultured dairy products:

Temperature: Cream is typically cultured at temperatures ranging from 70°F to 77°F (21°C to 25°C). Maintaining a consistent temperature is important to promote the growth and activity of the bacterial cultures.

Bacterial Cultures: Specific lactic acid bacteria strains, such as *Lactococcus lactis* or *Lactobacillus* species, are used as starter cultures for culturing cream. These bacteria are added to the cream to initiate fermentation.

Time: The duration of culturing can vary depending on factors such as the desired flavor and texture of the sour cream. Culturing times typically range from 12 to 24 hours.

Hygiene and Sanitation: As with other cultured dairy products, maintaining clean and sanitary conditions throughout the culturing process is essential to prevent contamination. This includes sanitizing equipment, utensils, and surfaces, as well as ensuring proper handling of cream and bacterial cultures.

Cultured cream, or sour cream, is commonly used as a condiment or ingredient in cooking and baking. It adds richness, tanginess, and creaminess to dishes such as soups, sauces, dips, and baked goods. Additionally, it can be served as a topping for dishes like baked potatoes, tacos, and nachos.

BUTTER MILK

Buttermilk is a dairy product that's typically thin in consistency and has a tangy flavor. It's traditionally made as a byproduct of churning butter from cream. When cream is churned to make butter, the fats in the cream begin to separate from the liquid. The liquid that remains after the butter is formed is what we call buttermilk.

Historically, buttermilk was made from the liquid left over from the churning process. This liquid would naturally ferment due to the presence of lactic acid bacteria, which would consume the milk sugars and produce lactic acid. This fermentation process gives buttermilk its tangy flavor and slightly thickened texture.

Today, there are two main types of buttermilk:

Traditional buttermilk: This is the liquid left over from churning butter. It's naturally thickened and fermented.

Cultured buttermilk: This type is made by adding lactic acid bacteria to pasteurized milk. The bacteria ferment the milk sugars, producing lactic acid and giving the milk its characteristic tangy flavor and thicker consistency.

Buttermilk is commonly used in cooking and baking because its acidity can react with leavening agents like baking soda to produce carbon dioxide, which helps baked goods rise. It's often used in recipes for pancakes, biscuits, cakes, and marinades.

Additionally, buttermilk is enjoyed as a refreshing beverage on its own, especially in regions where it's popular, like the Southern United States. It's low in fat and calories compared to whole milk, making it a healthier alternative for those watching their calorie intake.

Overall, buttermilk is a versatile dairy product with a unique flavor profile, making it a popular ingredient in both sweet and savory dishes.

BULGARIAN MILK

“Bulgarian yogurt” or “Bulgarian buttermilk,” which is a type of cultured dairy product originating from Bulgaria. Bulgarian yogurt is similar to regular yogurt but is known for its distinctively thick and creamy texture, as well as its slightly tangy flavor.

Bulgarian yogurt is made by fermenting milk with specific strains of bacteria, including *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. These bacteria are responsible for the yogurt's characteristic taste and texture.

This type of yogurt is often enjoyed on its own or used in cooking and baking. It's rich in probiotics, which are beneficial bacteria that support gut health, and it's also a good source of protein and calcium.

Bulgarian buttermilk, on the other hand, is similar to traditional buttermilk but may have a different flavor profile due to the specific bacteria strains used in fermentation. It's often used in cooking and baking, similar to other types of buttermilk, and can also be enjoyed as a beverage.

Both Bulgarian yogurt and Bulgarian buttermilk are popular in Bulgaria and are gaining popularity in other parts of the world due to their unique taste and potential health benefits.

ACIDO PHILOUS MILK

Acidophilus milk is a type of cultured dairy product that has been fermented with *Lactobacillus acidophilus* bacteria, a probiotic strain known for its health benefits.

This type of milk is similar to regular milk but has been inoculated with acidophilus bacteria, which ferment the milk sugars, producing lactic acid. The result is a tangy-flavored milk with increased levels of beneficial bacteria.

Acidophilus milk is often consumed for its potential health benefits, as it contains probiotics that support gut health and may help improve digestion and boost the immune system. It's also a good source of protein, calcium, and other essential nutrients found in milk.

You can find acidophilus milk in some grocery stores or health food stores, and it can be enjoyed on its own or used in cooking and baking just like regular milk. It's especially popular among those looking to incorporate more probiotics into their diet.

KHOA AND CHHENA

Khoa and chhena are both traditional dairy products commonly used in Indian cuisine.

Khoa: Also known as khoya or mawa, khoa is a type of concentrated milk product made by simmering full-fat milk in a large, open pan until most of the water content evaporates, leaving behind the milk solids. The resulting khoa is thick, granular, and slightly caramelized, with a rich, creamy flavor. Khoa is widely used in Indian sweets and desserts, such as gulab jamun, peda, and barfi.

Chhena: Chhena is a fresh, unripened cheese made by curdling milk with an acidic ingredient, such as lemon juice or vinegar, and then straining out the whey. The resulting curds are pressed to remove excess moisture, resulting in a soft, crumbly cheese with a mild, slightly tangy flavor. Chhena is a versatile ingredient used in a variety of Indian sweets, including rasgulla, sandesh, and chhena poda.

Both khoa and chhena are integral components of many Indian desserts, providing richness, texture, and flavor to traditional sweets.

ICE CREAM

DEFINITION

Ice cream is a frozen dessert made from cream, sugar, and often flavorings and additives, such as fruit, nuts, chocolate, or other ingredients. It's churned and frozen to create a creamy and smooth texture.

The basic Ingredients in ice cream include cream, milk, sugar, and sometimes egg yolks. These ingredients are mixed together and then churned in an ice cream maker to incorporate air, which helps create a light and creamy texture. Flavorings and additives, such as vanilla extract, cocoa powder, fruit puree, or nuts, are often added to enhance the taste and texture of the ice cream.

There are many variations of ice cream, including gelato, sorbet, sherbet, and frozen yogurt, each with its own unique ingredients and preparation methods. Ice cream is a popular dessert enjoyed around the world, available in countless flavors and enjoyed in various forms, such as cones, cups, sundaes, and milkshakes.

PERCENTAGE OF COMPOSITION

The composition of ice cream typically varies depending on the specific recipe and brand. However, here's a general breakdown of the percentage composition of common ingredients found in ice cream:

Cream: Around 10% to 18% of the total composition. Cream gives ice cream its rich and creamy texture.

Milk: Approximately 9% to 12% of the total composition. Milk adds liquid volume and contributes to the smoothness of the ice cream.

Sugar: Usually makes up 12% to 16% of the total composition. Sugar adds sweetness and helps lower the freezing point of the mixture, preventing it from becoming too hard when frozen.

Egg yolks (if included): Typically around 1% to 3% of the total composition. Egg yolks add richness and help emulsify the mixture.

Flavorings and additives: Varies depending on the recipe and desired flavor. These can include fruits, nuts, chocolate, vanilla extract, cocoa powder, stabilizers, and emulsifiers. They generally make up the remaining percentage of the composition.

Keep in mind that these percentages are approximate and can vary based on the specific recipe and manufacturing process used by different ice cream producers. Additionally, some variations of ice cream, such as gelato or sorbet, may have different compositions.

TYPES IN INGREDIENTS

Here are some common types of ingredients used in ice cream:

Dairy Products:

Cream: Provides richness and creaminess to the ice cream.

Milk: Adds liquid volume and contributes to the smooth texture.

Sweeteners:

Sugar: Adds sweetness and helps lower the freezing point of the mixture.

Corn syrup, honey, or other sweetening agents may also be used.

Flavorings:

Vanilla extract: A classic flavoring for ice cream.

Cocoa powder: Adds chocolate flavor.

Fruits: Fresh or pureed fruits like strawberries, bananas, or mangoes can be used to add natural flavor.

Nuts: Almonds, walnuts, peanuts, and other nuts can provide crunch and flavor.

Flavor extracts: Such as mint, almond, or coconut.

Stabilizers and Emulsifiers:

Guar gum, carrageenan, xanthan gum: Help improve texture and prevent ice crystal formation.

Egg yolks: Act as emulsifiers and add richness to the ice cream.

Inclusions:

Chocolate chips, chunks, or shavings.

Candy pieces, such as cookies, brownies, or candy bars.

Marshmallows, caramel swirls, or fudge ripple.

Acidifiers:

Lemon juice or other acidic ingredients may be used to balance sweetness and add flavor complexity.

Natural and Artificial Colors:

Some ice creams may include natural colorings from fruits or vegetables, while others may use artificial colors to enhance visual appeal.

Preservatives:

Some commercial ice creams may include preservatives to prolong shelf life.

These ingredients are often combined in various proportions to create a wide range of ice cream flavors and textures. Additionally, many ice cream manufacturers offer specialty or artisanal varieties with unique and creative ingredient combinations.

TYPES OF ICE CREAM

There are several types of ice cream, each with its own characteristics and ingredients. Here are some common types:

Regular Ice Cream: This is the standard type of ice cream, made with cream, milk, sugar, and flavorings. It has a creamy texture and can come in various flavors like vanilla, chocolate, strawberry, and more.

Gelato: Originating from Italy, gelato has a lower butterfat content and less air churned into it compared to regular ice cream, resulting in a denser and smoother texture. It's typically served at a slightly warmer temperature than regular ice cream, which enhances its flavor.

Sorbet: Sorbet is a dairy-free frozen dessert made from fruit puree or juice, water, and sugar. It has a refreshing, fruity flavor and a smooth texture. Sorbet is often served as a palate cleanser between courses or as a light dessert option.

Sherbet: Sherbet is similar to sorbet but contains a small amount of dairy, usually milk or cream. It has a creamy texture and is slightly lighter than regular ice cream. Sherbet comes in various fruit flavors and is known for its refreshing taste.

Frozen Yogurt: Frozen yogurt, or “froyo,” is made from yogurt instead of cream. It has a tangy flavor and a lighter texture compared to regular ice cream. Frozen yogurt is often marketed as a healthier alternative to traditional ice cream due to its lower fat content and the presence of probiotics.

Soft Serve: Soft serve ice cream is made with similar ingredients to regular ice cream but is served at a warmer temperature, which gives it a softer, smoother texture. It’s commonly dispensed from soft serve machines and is available in various flavors.

Ice Cream Bars and Sandwiches: These are frozen treats made by sandwiching or coating ice cream with chocolate, cookies, or other ingredients. They come in a variety of flavors and are often individually packaged for convenience.

These are just a few examples of the types of ice cream available. There are also many specialty and artisanal varieties, as well as regional variations from around the world.

MANUFACTURE OF ICE CREAM

The manufacture of ice cream involves several key steps:

Mixing Ingredients: The first step is to mix together the ingredients, which typically include cream, milk, sugar, flavorings, stabilizers, and emulsifiers. The mixture is heated to dissolve the sugar and other dry ingredients.

Pasteurization: The mixture is then pasteurized to kill any harmful bacteria and ensure food safety. Pasteurization involves heating the mixture to a specific temperature and holding it there for a set period of time before rapidly cooling it down.

Homogenization: After pasteurization, the mixture is homogenized to break down the fat molecules and ensure a smooth texture. This process helps prevent the formation of large fat globules, resulting in a creamy consistency.

Aging: Some ice cream mixtures are aged for several hours or overnight to allow the flavors to develop and the ingredients to fully blend together.

Chilling: The mixture is chilled to a specific temperature, typically around 4°C (39°F), before it’s ready for freezing. Chilling the mixture helps improve the texture and consistency of the ice cream.

Freezing: The chilled mixture is pumped into a continuous freezer, where it's rapidly frozen while being churned to incorporate air. This process creates a smooth and creamy texture by preventing the formation of large ice crystals.

Flavor Addition: If additional flavorings or inclusions are desired, such as chocolate chips, fruit pieces, or nuts, they can be added during the freezing process or after the ice cream is partially frozen.

Packaging: Once the ice cream reaches the desired consistency, it's pumped into containers or molds for packaging. It's important to package the ice cream quickly to prevent ice crystal formation and maintain freshness.

Hardening: After packaging, some ice cream may undergo a hardening process in a blast freezer to further solidify the product and improve its texture.

Storage: The packaged ice cream is stored in a freezer at a temperature of around -18°C (0°F) or lower to maintain its quality and prevent melting.

Throughout the manufacturing process, strict quality control measures are implemented to ensure that the ice cream meets safety standards and has the desired taste, texture, and appearance. Additionally, variations in ingredients and processing techniques can result in different types and flavors of ice cream.

STABILIZER – EMULSIFIERS AND THEIR ROLE

Stabilizers and emulsifiers are important additives used in the manufacture of ice cream to improve its texture, consistency, and shelf stability. Here's a breakdown of their roles:

Stabilizers:

Stabilizers help prevent the formation of large ice crystals during freezing, resulting in a smoother texture.

They also help maintain the structure of the ice cream and prevent it from melting too quickly when exposed to warmer temperatures.

Common stabilizers used in ice cream production include:

Guar gum

Carrageenan

Xanthan gum

Locust bean gum

Cellulose gum (carboxymethyl cellulose)

Emulsifiers:

Emulsifiers help bind together ingredients that don't naturally mix well, such as water and fat.

In ice cream, emulsifiers help create a stable mixture by dispersing fat molecules evenly throughout the base.

This results in a smoother texture and prevents the separation of fat and water during freezing and storage.

Emulsifiers also contribute to the creaminess and mouthfeel of the ice cream.

Common emulsifiers used in ice cream production include:

Egg yolks: Natural emulsifiers found in egg yolks help stabilize the mixture and add richness to the ice cream.

Mono- and diglycerides: Synthetic emulsifiers derived from vegetable oils are often used in commercial ice cream production.

Polysorbate 80: Another synthetic emulsifier that helps stabilize the mixture and improve texture.

Both stabilizers and emulsifiers are typically used in small amounts in ice cream formulations and are considered safe for consumption. They play a crucial role in ensuring that ice cream maintains its desired texture, consistency, and appearance throughout storage and distribution.

MILK POWDERS

Milk powder, also known as powdered milk or dried milk, is a dairy product made by evaporating milk to remove the moisture content. The resulting powder is shelf-stable and has a longer storage life compared to liquid milk. Here are some key points about milk powder:

Production: Milk powder is produced by evaporating liquid milk in a process known as spray drying or roller drying. In spray drying, the milk is sprayed into a hot chamber where the water evaporates, leaving behind fine milk particles. In roller drying, the milk is spread thinly on heated rollers, and the dried milk is scraped off.

Types: There are several types of milk powder, including:

Whole milk powder: Made from whole milk and contains all the milk fat.

Skim milk powder: Made from skim milk, which has had the fat removed.

Buttermilk powder: Made from the liquid left over after churning butter.

Whey powder: Made from the liquid remaining after cheese production.

Uses: Milk powder has many culinary applications and is used in both commercial food production and home cooking. It can be reconstituted with water to make liquid milk or used as an ingredient in recipes for baked goods, desserts, soups, sauces, and beverages. Milk powder is also used in the manufacture of chocolate, confectionery, and dairy products.

Storage: Milk powder has a long shelf life when stored properly in a cool, dry place away from moisture and sunlight. Once reconstituted, it should be refrigerated and consumed within a few days.

Nutritional Value: Milk powder retains most of the nutritional properties of liquid milk, including protein, calcium, vitamins, and minerals. However, some nutrients, such as vitamin C, are reduced during the drying process.

Overall, milk powder is a convenient and versatile dairy product that offers a longer shelf life and can be used in various culinary applications.

DRYING PROCESS AND ITS TYPES

The drying process for milk powder involves evaporating the moisture content from liquid milk to create a powder form. There are several methods used to achieve this, including spray drying and roller drying:

Spray Drying:

Spray drying is the most common method used to produce milk powder.

In this process, liquid milk is first concentrated to increase its solids content.

The concentrated milk is then sprayed into a heated chamber or tower.

As the milk droplets fall through the chamber, hot air is circulated to evaporate the moisture, leaving behind fine milk particles.

The dried milk particles are collected at the bottom of the chamber and then further processed to achieve the desired particle size and moisture content.

Advantages: Spray drying is a highly efficient method that produces milk powder with good solubility, flowability, and flavor retention. It can handle large volumes of liquid milk and is suitable for producing various types of milk powders, including whole milk powder, skim milk powder, and whey powder.

Applications: Spray drying is widely used in the dairy industry for producing milk powders used in food and beverage products, such as infant formula, bakery products, confectionery, and dairy-based beverages.

Roller Drying:

Roller drying is an older method of producing milk powder and is less commonly used today.

In this process, liquid milk is spread thinly onto heated rollers.

The milk forms a thin film on the rollers, and as it passes through the rollers, the moisture is evaporated, leaving behind dried milk particles.

The dried milk is then scraped off the rollers and collected as powder.

Advantages: Roller drying is a simpler and less expensive method compared to spray drying. It is suitable for producing milk powders with larger particle sizes and can be used for heat-sensitive materials. However, it generally produces milk powders with lower solubility and flowability compared to spray drying.

Applications: Roller drying is less common in the dairy industry today but may still be used for producing specific types of milk powders or as part of integrated manufacturing processes for dairy-based products.

Both spray drying and roller drying result in milk powder with a long shelf life and are suitable for large-scale production. The choice of drying method may depend on factors such as the desired characteristics of the final product, the available equipment, and economic considerations. Spray drying is generally preferred for its efficiency and ability to produce a finer powder with better solubility.