

# **FOOD TECHNOLOGY**

## **UNIT V: Dairy products**

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# Dairy products - milk processing, cheese, butter, ice-cream.





# MILK PRODUCTION



# INTRODUCTION

- Milk is a nutritive beverage obtained from various animals and consumed by humans. Most milk is obtained from dairy cows, although milk from goats, water buffalo, and reindeer is also used in various parts of the world.
- In many industrialized countries, raw cow's milk is processed before it is consumed. During processing the fat content of the milk is adjusted, various vitamins are added, and potentially harmful bacteria are killed.
- In addition to being consumed as a beverage, milk is also used to make butter, cream, yogurt, cheese, and a variety of other products.

# HISTORY

- Cattle were first brought to the United States in the 1600s by some of the earliest colonists.
- Prior to the American Revolution most of the dairy products were consumed on the farm where they were produced. By about 1790, population centers such as Boston, New York, and Philadelphia had grown sufficiently to become an attractive market for larger-scale dairy operations.
- To meet the increased demand, farmers began importing breeds of cattle that were better suited for milk production.
- The first Holstein-Friesians were imported in 1795, the first Ayrshires in 1822, and the first Guernseys in 1830.

- With the development of the dairy industry in the United States, a variety of machines for processing milk were also developed.
- In 1856, Gail Borden patented a method for making condensed milk by heating it in a partial vacuum.
- Not only did his method remove much of the water so the milk could be stored in a smaller volume, but it also protected the milk from germs in the air. Borden opened a condensed milk plant and cannery in Wassaic, New York, in 1861.

In **1863, Louis Pasteur** of France developed a method of heating wine to kill the microorganisms that cause wine to turn into vinegar. Later, this method of killing harmful bacteria was adapted to a number of food products and became known as pasteurization





- First pasteurizing equipment- US Sheffield Farms Dairy in Bloomfield- imported German-made pasteurizer in 1891
- One of the first glass milk bottles was patented in 1884 by Dr. Henry Thatcher, after seeing a milkman making deliveries from an open bucket into which a child's filthy rag doll had accidentally fallen.
- By 1889, his Thatcher's Common Sense Milk Jar had become an industry standard.

# Thatcher's Milk Bottle



- It was sealed with a waxed paper disc that was pressed into a groove inside the bottle's neck.
- In 1990, the annual production of milk in the United States was about 148 billion lb (67.5 billion kg).
- This is equivalent to about 17.2 billion U.S. gallons (65.1 billion liters). About 37% of this was consumed as fluid milk and cream, about 32% was converted into various cheeses, about 17% was made into butter, and about 8% was used to make ice cream and other frozen desserts. The remainder was sold as dry milk, canned milk, and other milk products

- Prior to 1998, the federal standards required

<b>Whole milk</b>	<b>Not less than 3.25% milk fat</b>
<b>Low- fat milk</b>	<b>0.5-2.0% milk fat</b>
<b>Skim milk</b>	<b>0.5% milk fat</b>

- Labelling of milk

<b>AMOUNT OF MILK FAT</b>	<b>LABELLING</b>
<b>2%</b>	<b>Reduced fat</b>
<b>1%</b>	<b>Low fat</b>

## **TYPES OF MILK:**

- **GRADE A MILK:**

It refers to milk produced under sufficiently sanitary conditions to permit its use as fluid milk.

About 90% of the milk produced in the United States is Grade A milk.

- **GRADE B MILK :**

It is produced under conditions that make it acceptable only for manufactured products such as certain cheeses, where it undergoes further processing. Certified milk is produced under exceedingly high sanitary standards and is sold at a higher price than Grade A milk.

- **SPECIALTY MILKS:**

It include flavored milk, such as chocolate milk, which has had a flavoring syrup added.

Other specialty milks include Golden Guernsey milk, which is produced by purebred Guernsey cows, and All-Jersey milk, which is produced by registered Jersey cows.

Both command a premium price because of their higher milk fat content and creamier taste.

- **CONCENTRATED MILK PRODUCTS:**

It have varying degrees of water removed from fluid milk.

They include, in descending order of water content, evaporated milk, condensed milk, and dry milk.

The average composition of cow's milk is

☐87.2% water,

☐3.7% milk fat,

☐3.5% protein,

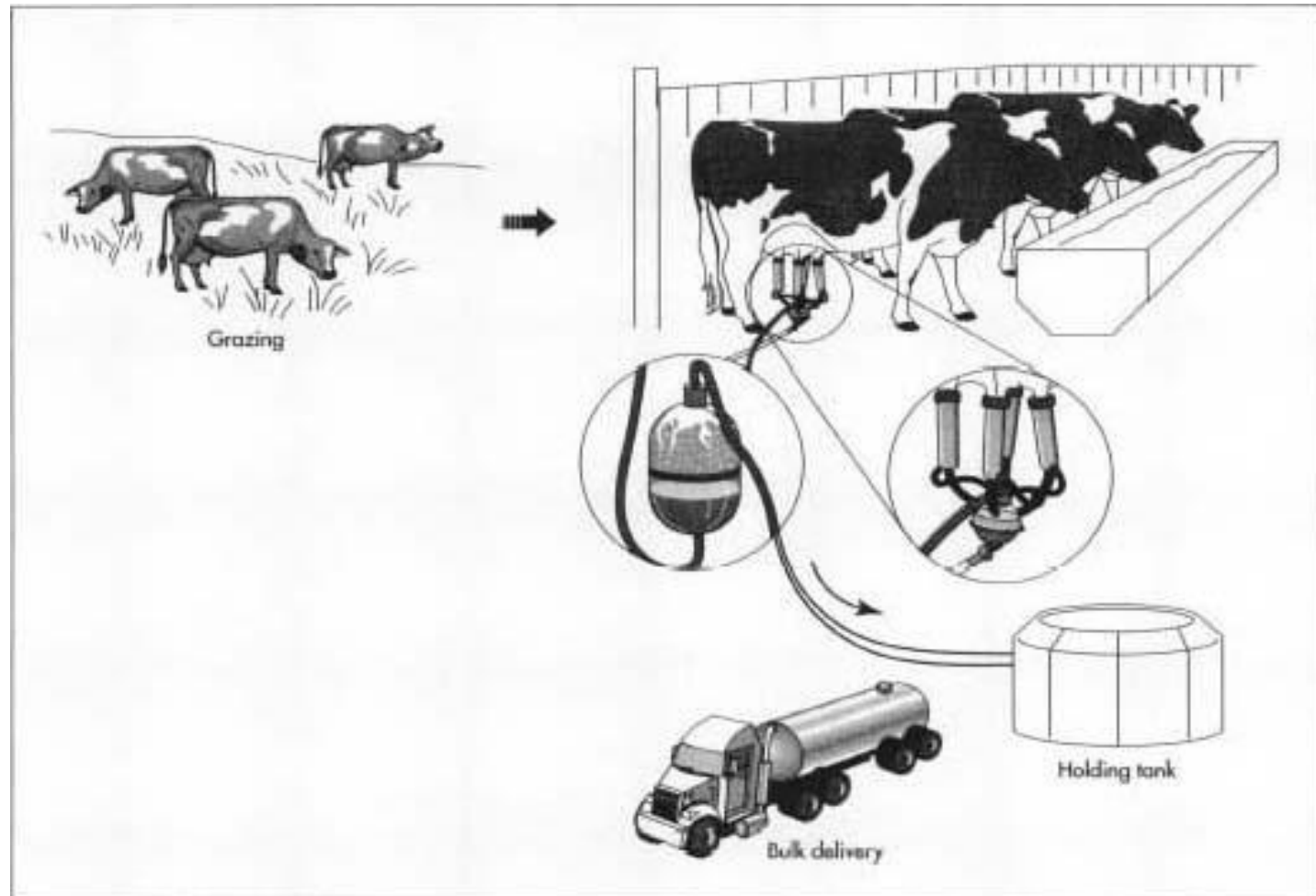
☐4.9% lactose, and

☐0.7% ash.

- This composition varies from cow to cow and breed to breed.
- For example, Jersey cows- 85.6% water & 5.15% milk fat. These figures also vary by the season of the year, the animal feed content, and many other factors.
- Vitamin D concentrate may be added to milk in the amount of 400 international units (IU) per quart. Most low fat and skim milk also has 2,000 IU of Vitamin A added.

# The Manufacturing Process

Dairy cows are milked twice a day using mechanical vacuum milking machines. The raw milk flows through stainless steel or glass pipes to a refrigerated bulk milk tank.





- Milk is a perishable commodity.
- For this reason, it is usually processed locally within a few hours of being collected.
- In the United States, there are several hundred thousand dairy farms and several thousand milk processing plants.
- Some plants produce only fluid milk, while others also produce butter, cheese, and other milk products.

**Collection of milk**



**Separation**



**Pasteurization**



**Homogenization**



**Packaging**



**Cleaning**



**Quality Control**

## COLLECTING:

- Dairy cows are milked twice a day using mechanical vacuum milking machines.
- The raw milk flows through stainless steel or glass pipes to a refrigerated bulk milk tank where it is cooled to about 40° F (4.4° C).
- A refrigerated bulk tank truck makes collections from dairy farms in the area within a few hours. Before pumping the milk from each farm's tank, the driver collects a sample and checks the flavor and temperature and records the volume.
- At the milk processing plant, the milk in the truck is weighed and is pumped into refrigerated tanks in the plant through flexible stainless steel or plastic hoses.



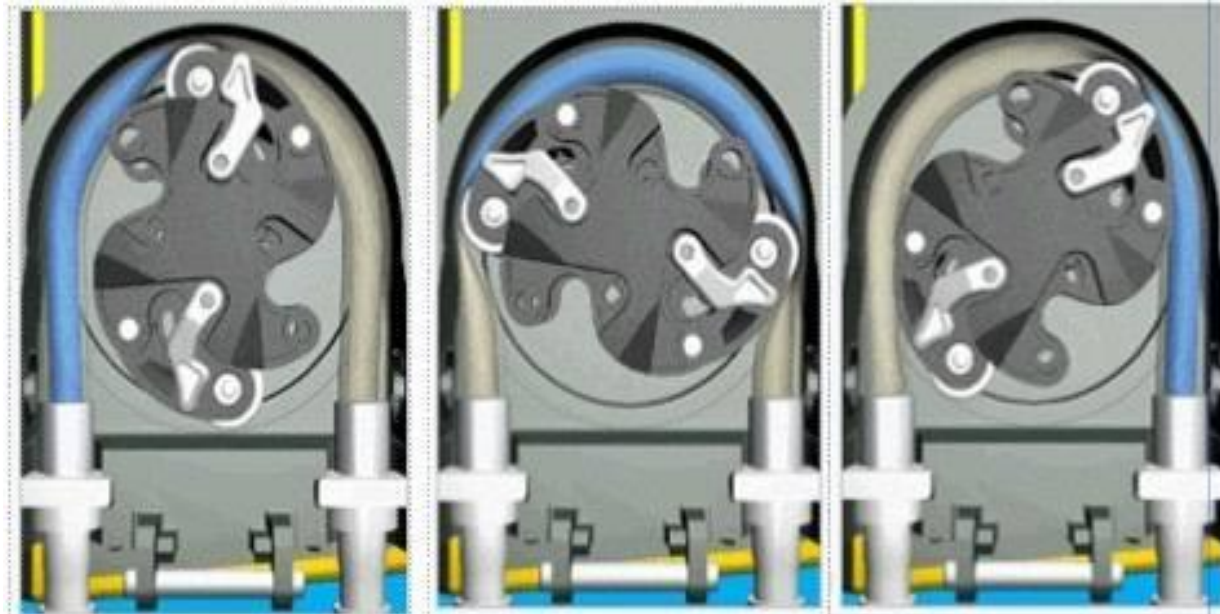
## SEPARATING

- The cold raw milk passes through either a clarifier or a separator, which spins the milk through a series of conical disks inside an enclosure.
- A clarifier removes debris, some bacteria, and any sediment that may be present in the raw milk.
- A separator performs the same task, but also separates the heavier milk fat from the lighter milk to produce both **cream** and **skim milk**.
- Some processing plants use a standardizer-clarifier, which regulates the amount of milk fat content in the milk by removing only the excess fat.
- The excess milk fat is drawn off and processed into cream or butter.



## FORTIFYING

- Vitamins A and D may be added to the milk at this time by a peristaltic pump, which automatically dispenses the correct amount of vitamin concentrate into the flow of milk.



## PASTEURIZING

- The milk—either whole milk, skim milk, or standardized milk—is piped into a pasteurizer to kill any bacteria.
- There are several methods used to pasteurize milk. The most common is called the high-temperature, short-time (HTST) process in which the milk is heated as it flows through the pasteurizer continuously.
- Whole milk, skim milk, and standardized milk must be heated to 161° F (72° C) for 15 seconds. Other milk products have different time and temperature requirements.
- The hot milk passes through a long pipe whose length and diameter are sized so that it takes the liquid exactly 15 seconds to pass from one end to the other.
- A temperature sensor at the end of the pipe diverts the milk back to the inlet for reprocessing if the temperature has fallen below the required standard.



## HOMOGENIZING

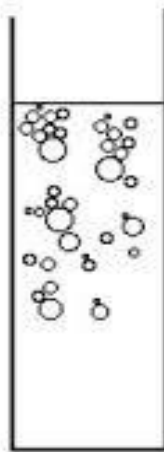
- Most milk is homogenized to reduce the size of the remaining milk fat particles. This prevents the milk fat from separating and floating to the surface as cream.
- It also ensures that the milk fat will be evenly distributed through the milk. The hot milk from the pasteurizer is pressurized to 2,500-3,000 psi (17,200-20,700 kPa) by a multiple-cylinder piston pump and is forced through very small passages in an adjustable valve.
- The shearing effect of being forced through the tiny openings breaks down the fat particles into the proper size.
- The milk is then quickly cooled to 40° F (4.4° C) to avoid harming its taste.

# Homogenization

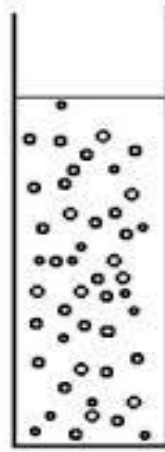
- Process of breaking up and dispersing milk-fat throughout the milk, resulting in a smooth uniform texture.



**Raw milk**



**Cold, raw milk  
after 1 hour**



**Homogenized milk  
during storage**

## PACKAGING

- The milk is pumped into coated paper cartons or plastic bottles and is sealed.
- In the United States most milk destined for retail sale in grocery stores is packaged in one-gallon (3.8-liter) plastic bottles.
- The bottles or cartons are stamped with a "sell by" date to ensure that the retailers do not allow the milk to stay on their shelves longer than it can be safely stored.
- The milk cartons or bottles are placed in protective shipping containers and kept refrigerated.
- They are shipped to distribution warehouses in refrigerated trailers and then on to the individual markets, where they are kept in refrigerated display cases.



## CLEANING

- To ensure sanitary conditions, the inner surfaces of the process equipment and piping system are cleaned once a day.
- Almost all the equipment and piping used in the processing plant and on the farm are made from stainless steel.
- Highly automated clean-in-place systems are incorporated into this equipment that allows solvents to be run through the system and then flushed clean.
- This is done at a time between the normal influx of milk from the farms.

## Quality Control

- The federal Food and Drug Administration (FDA) publishes the Grade A Milk Ordinance which sets sanitation standards for milk production in most states and for all interstate milk shippers.
- The composition of milk and milk products is specified in *Agricultural Handbook 52* published by the United States Department of Agriculture.
- It lists both federal and state standards.
- Testing of milk products includes tests for fat content, total solids, pasteurization efficiency, presence of antibiotics used to control cow disease, and many others.

# **BENEFITS OF MILK:**

- Helps boost metabolism
- Strengthens immune system
- Rich in antioxidant properties
- Reduces muscles and joint pains
- Prevents cancer and heart diseases

# CHEESE PRODUCTION





- Cheese is a dairy product derived from milk that is produced in a wide range of flavors, textures, and forms by coagulation of the milk protein casein.
- It comprises protein and fat from milk, usually the milk of cows, buffalo, goats, or sheep.
- During production the milk is usually acidified, and adding the enzyme rennet causes coagulation.
- The solids are separated and pressed into final form. Some cheeses have molds on the rind, the outer layer, or throughout.
- Most cheeses melt at cooking temperature.

## **1. Standardize Milk**

- ❖ Milk is often standardized before cheese making to optimize the protein to fat ratio to make a good quality cheese with a high yield

## **2. Pasteurize/Heat Treat Milk**

- ❖ Depending on the desired cheese, the milk may be pasteurized or mildly heat-treated to reduce the number of spoilage organisms and improve the environment for the starter cultures to grow.
- ❖ Some varieties of milk are made from raw milk so they are not pasteurized or heat-treated.
- ❖ Raw milk cheeses must be aged for at least 60 days to reduce the possibility of exposure to disease causing microorganisms (pathogens) that may be present in the milk.

### **3. Cool Milk**

- ❖ Milk is cooled after pasteurization or heat treatment to 90°F (32°C) to bring it to the temperature needed for the starter bacteria to grow.
- ❖ If raw milk is used the milk must be heated to 90°F (32°C).

### **4. Inoculate with Starter & Non-Starter Bacteria and Ripen**

- ❖ The starter cultures and any non-starter adjunct bacteria are added to the milk and held at 90°F (32°C) for 30 minutes to ripen.
- ❖ The ripening step allows the bacteria to grow and begin fermentation, which lowers the pH and develops the flavor of the cheese.

## **5. Add Rennet and Form Curd**

- ❖ The rennet is the enzyme that acts on the [milk proteins](#) to form the curd.
- ❖ After the rennet is added, the curd is not disturbed for approximately 30 minutes so a firm coagulum forms.

## **6. Cut Curd and Heat**

- ❖ The curd is allowed to ferment until it reaches pH 6.4.
- ❖ The curd is then cut with cheese knives into small pieces and heated to 100°F (38°C).
- ❖ The heating step helps to separate the whey from the curd.

## **7. Drain whey**

- ❖ The whey is drained from the vat and the curd forms a mat.

## 8. Texture curd

- ❖ The curd mats are cut into sections and piled on top of each other and flipped periodically. This step is called **cheddaring**.
- ❖ Cheddaring helps to expel more whey, allows the fermentation to continue until a pH of 5.1 to 5.5 is reached, and allows the mats to "knit" together and form a tighter matted structure.
- ❖ The curd mats are then milled (cut) into smaller pieces.

## 9. Dry Salt or Brine

- ❖ For cheddar cheese, the smaller, milled curd pieces are put back in the vat and salted by sprinkling dry salt on the curd and mixing in the salt.
- ❖ In some cheese varieties, such as mozzarella, the curd is formed into loaves and then the loaves are placed in a brine (salt water solution).

## **10. Form Cheese into Blocks**

The salted curd pieces are placed in cheese hoops and pressed into blocks to form the cheese.

## **11. Store and Age**

The cheese is stored in coolers until the desired age is reached. Depending on the variety, cheese can be aged from several months to several years.

## **12. Package**

Cheese may be cut and packaged into blocks or it may be waxed.

CAN YOU FIND WHAT TYPE OF CHEESE IT IS?

**A.**



**B.**





C.



**D.**



**E.**



# Answers:

A. Feta

B. Goat cheese

C. Ricotta

D. Blue cheese

E. Mozzarella

# **BENEFITS OF CHEESE**

- Boost immunity
- Strengthens bones
- Better sleep
- Gives glowing skin
- Reduce pre menstrual syndrome (PMS)
- Prevents cavities

# BUTTER PRODUCTION



It is essentially the fat of milk. It is usually made from sweet cream and is salted. Saltless

(sweet) butters are also available.

Butter can also be made from acidulated or bacteriologically soured cream.

Butter is produced through a **phase inversion of an emulsion**. The cream is indeed an emulsion of fat in water, as a result butter is an emulsion of water in fat.

### **Principal constituents of butter**

<b>Main Constituent</b>	<b>Normal salted butter</b>	<b>Indian butter</b>
Fat	80 – 82 %	80.2%
Water	15.6 - 17.6%	16.3%
Salt	about 1.2%	2.5%
Protein, Ca, P	about 1.2%	1.0%

## **Traditional technique lactic butter:**

**Long biological and physical maturing process** for the cream after addition of lactic ferments.

**Constant churning** (buttermaking machines or in churns).

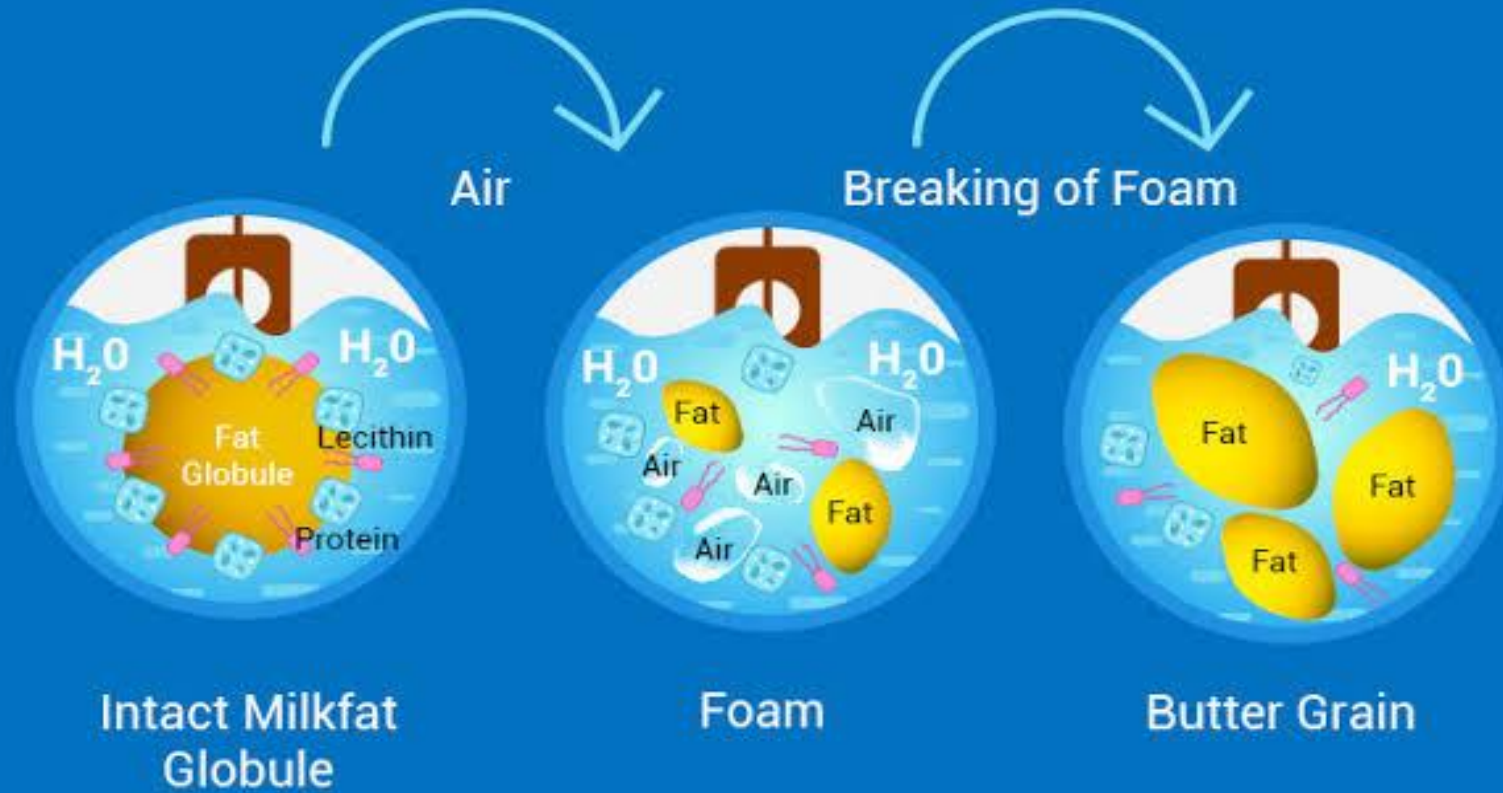
Advantage: to improve organoleptic properties.

Drawback: difficulty to use acid buttermilk and to control fat crystallization.





# PROCESS BEHIND BUTTER CHURNING



- **NIZO technique:**

- Short physical maturing process without cream acidification.
- Ferments are added after churning directly in the butter.

Advantage: better parameter control especially crystallization.

Drawback: lower organoleptic qualities.

Continental Europe people eat and use **lactic butter** (with an acid pH and a characteristic tangy taste).

People from Great Britain usually prefer **sweet cream butter** (with a neutral pH and a creamy taste).

The technique to obtain the latter is a physical maturation without addition of ferments .

TYPE OF BUTTER	FAT CONTENT	PASTEURISATION
<b>lactic butter/ sweet cream butter</b>	82%	-
<b>lightened butter</b>	60 – 62%	the cream is pasteurized beforehand
<b>light butter or half butter</b>	39 – 41%	the cream is pasteurized beforehand

TYPE OF BUTTER	SALT CONTENT
<b>Salted butter</b>	ABOVE 3%.
<b>Semi-salted butter</b>	0.8% - 3%.

# Benefits of butter:

- Regulates hormones and thyroid function
- It is vitamin and mineral rich.
- Combats fungal infection
- Prevents night blindness
- Boost immunity
- Gives you energy
- Prevents oxidative stress.
- Prevents cancer

# ICECREAM PRODUCTION



- Ice-cream is mixture of milk, cream, sugar, and sometimes other ingredients, that has been frozen into a soft , creamy delight using special techniques.
- Ice-creams has been a popular treat for hundred of years but only became commonplace since the widespread use of refrigeration.

## • **General Ice Cream Processing Steps**

- Blend Ingredients
- Pasteurize Mix
- Homogenize
- Age Mix
- Add Liquid Flavors and Colors
- Freeze
- Add Fruits, Nuts, and Bulky Flavorings
- Package
- Harden

## 1. Blend the Ice Cream Mixture

- The milk fat source, nonfat solids, stabilizers and emulsifiers are blended to ensure complete mixing of liquid and dry ingredients.

## 2. Pasteurize Mix

- Ice cream mix is pasteurized at 155°F (68.3°C) for 30 minutes or 175°F (79.4°C) for 25 sec.
- The conditions used to pasteurize ice cream mix are greater than those used for fluid milk because of increased viscosity from the higher fat, solids, and sweetener content, and the addition of egg yolks in custard products.

## 3. Homogenize

- Ice cream mix is homogenized (2500 to 3000 psi) to decrease the milk fat globule size to form a better emulsion and contribute to a smoother, creamier ice cream.
- Homogenization also ensures that the emulsifiers and stabilizers are well blended and evenly distributed in the ice cream mix before it is frozen.



## **4. Age the Mix**

- Ice cream mix is aged at 40°F (5°C) for at least 4 hours or overnight. Aging the mix cools it down before freezing, allows the milk fat to partially crystallize and the gives the proteins stabilizers time to hydrate.
- This improves the whipping properties of the mix.

## **5. Add Liquid Flavors and Colors**

- Liquid flavors and colors may be added to the mix before freezing.
- Only ingredients that are liquid can be added before the freezing, to make sure the mix flows properly through the freezing equipment.

## 6. Freeze

- The process involves freezing the mix and incorporating air. Ice cream mix can be frozen in batch or continuous freezers and the conditions used will depend on the type of freezer. Batch freezers consist of a rotating barrel that is usually filled one-third to one-half full with ice cream mix.
- As the barrel turns, the air in the barrel is incorporated into the ice cream mix. Ice cream freezers designed for home use are batch freezers.
- Continuous freezers consist of a fixed barrel that has a blade inside that constantly scrapes the surface of freezing barrel.
- The ice cream mix is pumped from a bulk tank to the freezing barrel and the air is incorporated with another pump just before it enters the freezing barrel. The continuous freezing process is much faster than the batch freezing process.
- The addition of air is called overrun and contributes to the lightness or denseness of ice cream. Up to 50% of the volume of the finished ice cream (100% overrun) can be air that is incorporated during freezing.
- The overrun level can be set as desired to adjust the denseness of the finished product. Premium ice creams have less overrun (approximately 80%) and are more dense than regular ice cream.
- At the point of discharge from the freezer (draw temperature), only about 50% of the water in ice cream is frozen. Soft serve ice cream is generated at this point in the freezing process.

## **7. Add Fruits, Nuts and Bulky Flavorings (candy pieces, etc.)**

- Fruits, swirls, and any bulky type of flavorings (nuts, candy pieces, etc.) are added at this point.
- These ingredients can not be added before freezing or they would interfere with the smooth flow of the mix through the freezer.
- The ice cream at this point is soft and it is easy to mix in the bulky flavorings so they are uniformly distributed throughout the ice cream.
- Mixing in bulky flavorings after freezing also prevents damage to the pieces and allows them to remain whole or in large chunks.

## **8. Package**

- As desired, depending on the product.

## 9. Harden

- The ice cream is cooled as quickly as possible down to a holding temperature of less than  $-13^{\circ}\text{F}$  ( $-25^{\circ}\text{C}$ ). The temperatures and times of cooling will depend on the type of storage freezer.
- Rapid cooling will promote quick freezing of water and create small ice crystals. Storage at  $-13^{\circ}\text{F}$  ( $-25^{\circ}\text{C}$ ) will help to stabilize the ice crystals and maintain product quality. At this temperature there is still a small portion of liquid water.
- If all the water present in the ice cream were frozen, the ice cream would be as hard as an ice cube.

## **INTRESTING FACT ABOUT ICECREAM**



**chocolate & icecream can  
reduce mental stress**

# BENEFITS OF ICECREAM

- Good source of vitamins
- Stimulates hormones
- Provides energy
- Reduce risk of cancer

Find out?



THANK YOU

A watercolor illustration of a branch with several leaves in shades of red and pink, and small green berries. The branch is positioned horizontally across the center of the image, framing the text 'THANK YOU'. The leaves have detailed vein patterns, and the berries are small and clustered. The text 'THANK YOU' is written in a black, serif font, with 'THANK' on the top line and 'YOU' on the bottom line. Small decorative marks resembling three radiating lines are placed near the beginning and end of the text.