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PRESERVATION OF MILK AND MILK PRODUCTS

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Introduction:

Milk and its products consist of numerous nutrient content, it serves as an excellent growth medium for all of the microorganisms. Thus**,** various preservation methods are used to eliminate the growth of spoilage-causing microorganisms and maintain the nutritional properties of milk. Several techniques have been used to limit the growth of organisms in milk and milk products.

1. Thermisation
2. Pasteurisation
3. Sterilization or UHT
4. Dehydration
5. Use of preservative agents

1. Thermisation:

- It is the most commonly used method for milk preservation by heating the milk at a mild temperature at 57 – 68 °C for 15 – 20 seconds and rapidly cooling at <6 °C.
- This method is effective against spoilage-causing bacteria however it doesn't eliminate pathogens such as *L. monocytogenes.*
- The main objective of thermisation is to reduce the growth of psychrotrophic bacteria and extend the shelf-life of milk.

2. Pasteurisation:

- Pasteurization is a method of food preservation that involves the application of heat, usually below 100° at a certain time. It aims to reduce the number of viable pathogens and spoilage-causing microorganisms (e.g., *Coxiella burnettii, Brucella abortis, Mycobacterium tuberculosis)* to extend the shelf-life of milk without harming the milk quality. In milk, thermoduric species such as *Micrococcus spp., Enterococcus faecium, Enterococcus faecalis, Bacillus subtilis, Bacillus cereus,* and *certain lactobacilli*. are killed by the process of pasteurization.
- Four common types of milk pasteurization vary with the temperature and time the milk is held at that temperature.

a. Vat Pasteurization/Low temperature, long-time pasteurization in which the milk is heated at 63°C for 30 min.

b. High Temperature/Short Time (HTST),

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milk is heated at 72°C for 15 sec.

c. Ultra-pasteurization (UP) in which the milk is heated at 138°to 150° C for one or two seconds

d. Ultra-high-temperature (UHT) in which the milk is heated at 280° F for only two seconds.

The objectives of pasteurization are:

- To destroy pathogenic organisms, present in milk.
- To ensure the quality of milk and milk products.
- To destroy the unwanted organisms, present in milk and milk products.

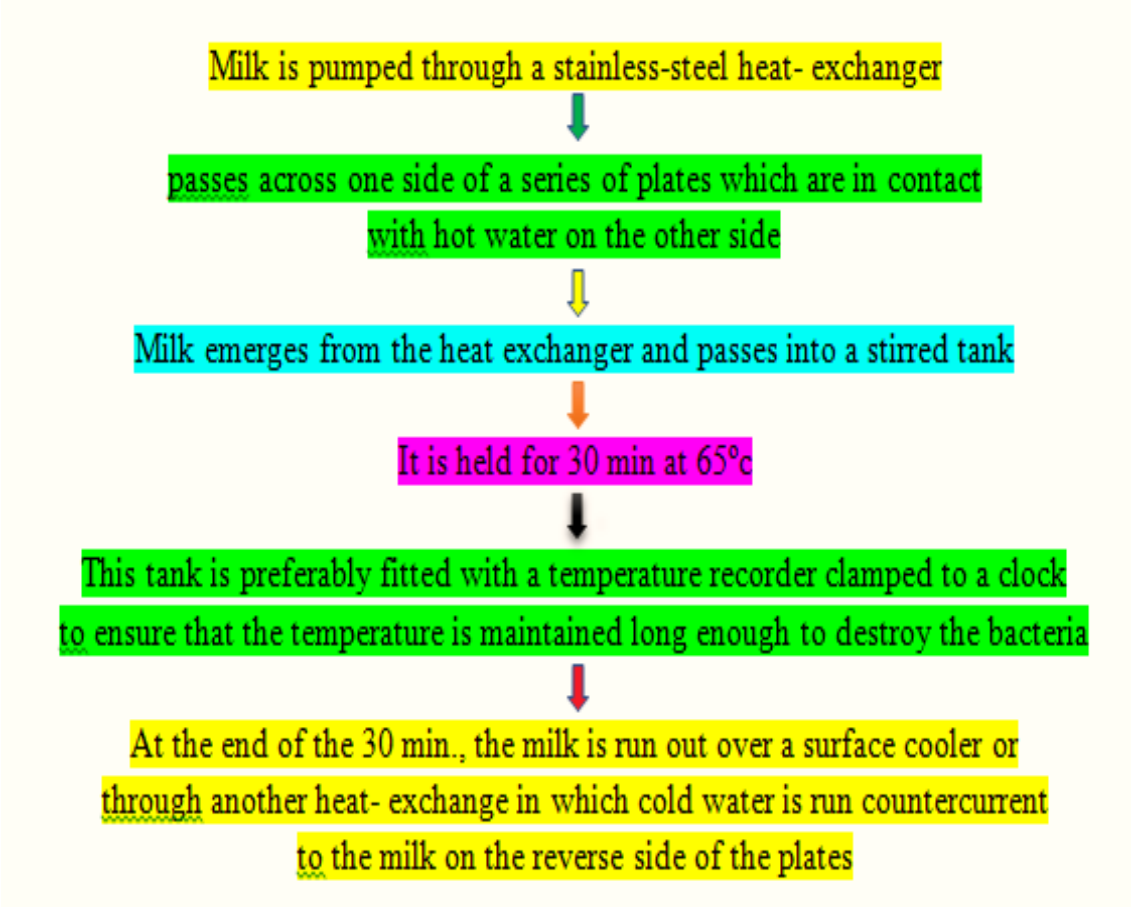
a. VAT Pasteurization/ Low temperature:

The first widely used pasteurization process for milk involved heating the milk in large tanks or vats to 60˚C for at least 20 minutes. The holding method was subsequently changed to 61.7˚C for 30 minutes. This was not a continuous process and was referred to as vat pasteurization.

b. Low-Temperature Long Time (LTLT) Method/Batch method

- ❖ Milk is heated to 63^0C for 30 minutes
- ❖ Heating is indirect
- ❖ Heat moves through a metal wall

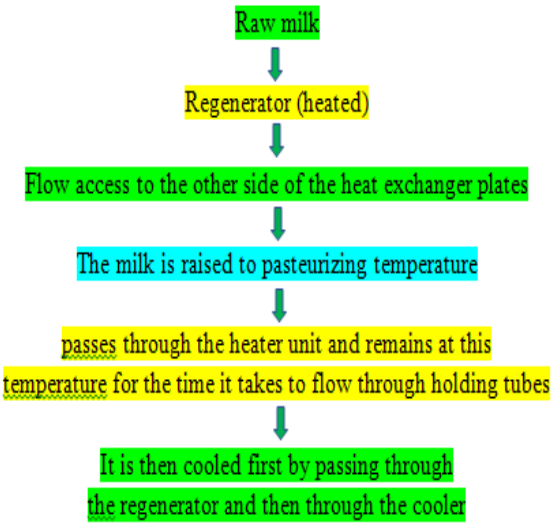
➡ This involves the following steps:



c. High-temperature Short Time (HTST)

- The HTST pasteurization standard was designed to achieve a five-log reduction, killing 99.999% of the number of viable micro-organisms in milk.
- This method requires that the milk be held at 161 degrees for 16 seconds. This process, also referred to as continuous flow pasteurization, requires the milk to be forced through metal pipes that are heated from the outside.

- This involves following steps



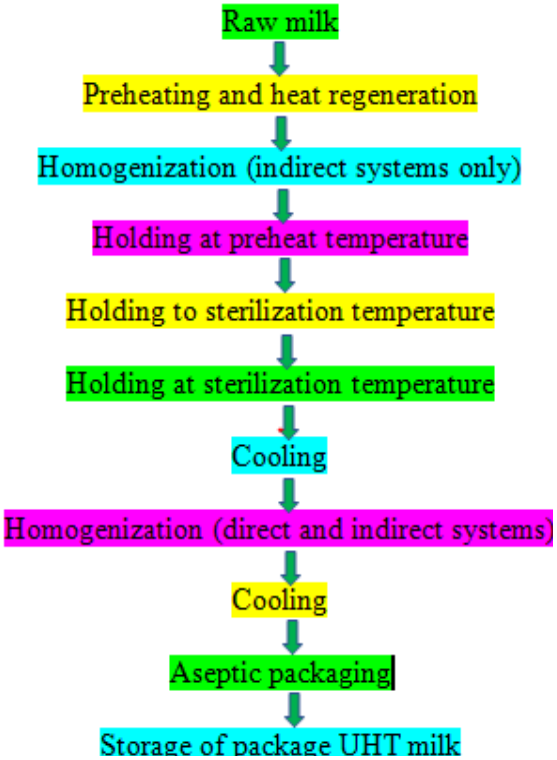
d. Ultra-pasteurization (UP)

- The milk is heated to 138 ºC (280 ºF) for 2 seconds.
- Note this is above boiling, which means that high pressure must be applied to the milk to achieve this temperature, and is destructive to its nutritional quality.
- This method is used because it extends the refrigerated shelf-life of the milk to 60 - 90 days, and is the method of choice for national or regional milk brands because it allows time for warehousing and shipment of milk.

e. Ultra-High Temperature (UHT)

- It produces a product that has a stable shelf life of up to two months.
- UHT processing holds the milk at a temperature of 138°C (280°F) for a minimum of two seconds.
- After treatment it can pass through a heat- exchanger or by direct ingestion of live steam so called tetra pack process.

- This technique involves the following steps:



3. Sterilization:

Sterilization is a method of food preservation that involves the application of heat, usually more than 100° at a certain time to kill almost all bacteria followed by packaging in air-tight containers either before or after heat treatment. The sterilized milk can be stored at room temperature for a longer period.

- There are two methods of sterilization:-
  1. **Conventional method / In-bottle sterilization** method in which the product is packed before heat treatment and the packed product is heated at 105-110°C for 30-45 min.
  2. **UHT method / Aseptic method** in which the product is heated at 135-150°C for 1-20 seconds followed by instant aseptic filling into sterile containers.
- The objectives of sterilization are:
  - To ensure the quality of milk and milk products at room temperature without refrigerated storage making it safe for human consumption.
  - To ensure the destruction of microorganisms (pathogenic and spoilage-causing microorganisms, vegetative and spore forms, viruses).

4. Dehydration:

It is defined as the process of removal of water normally present in milk by the application of heat under controlled conditions by evaporation. In this method, the water activity of milk is reduced to prevent the growth of spoilage-causing microorganisms.

- The objectives of this method are:
  - To reduce the growth of spoilage-causing and pathogenic organisms and extend the shelf-life of milk.
  - To reduce the volume and weight of milk without compromising the nutritive value.
- The methods of dehydration used in milk preservation are:
  1. **Spray-drying**: in this process, the pre-concentrated liquid food is dispersed into a stem of hot gas that results in evaporation of water content resulting in instantaneous drying.
  2. **Drum drying**: In this process, the pre-concentrated product is applied as a thin film on the outer surface of an internally heated rotating metal drum.
  3. **Fluid bed drying** processing involves drying, cooling, agglomeration, granulation, and coating of particulate materials. The gas (usually air) is passed through a product layer under controlled velocity conditions to create a fluidized state.

5. Use of Preservative Agents:

Preservatives are substances that are capable of inhibiting or retarding the growth of

microorganisms. Such preservatives used in food can be divided into three types:

1. **Natural preservatives**
2. **Bio preservatives**
3. **Chemical preservatives**

Product	Type of preservative	Preservatives used
MILK	Natural preservatives	Honey, lecithin
	Bio preservatives	LAB, bacteriocin, hydrogen peroxide
	Chemical preservatives	Benzoic acid, Sorbic acid, nisin, sodium diacetate, boric acid, formaldehyde
CHEESE	Natural preservatives	Salt, essential oils (Thyme, Ginger, Cayenne, Clove, Cinnamon, Garlic, Lemongrass, Oregano, Basil), Lime juice
	Bio preservatives	Lysozyme, Nisin, LAB,
	Chemical preservatives	Sorbic acid, Potassium sorbate, propionic acid, Natamycin
ICE CREAM	Natural preservatives	Amyl acetate (banana oil), Piperonal (vanilla bean), corn starch, Soy lecithin
	Chemical preservatives	Butyraldehyde, Diethyl glycol, Polysorbate 80, Potassium sorbate
BUTTER	Natural preservatives	Salt, thymine, cumin
	Chemical preservatives	BHA(butylated hydroxyl anisole, BHT(butylated hydroxyl toluene), rosmaricin acid, gallic acid
YOGURT	Chemical preservatives	Sodium benzoate, Potassium sorbate, and Natamycin

Low-temperature treatment

- The foods are stored at temperatures 0–5 °C.
- It causes minimal changes to the nutritional properties of food.
- The main objective of chilling is to reduce the rate of microbial growth and its enzymatic activities which extends the shelf life of milk and milk products.
- It has been used in combination with other methods of food preservation such as irradiation, and pasteurization to extend the shelf life of milk and milk products.
- Milk, cheese, yogurt, butter, etc. are stored in chilled storage.

Other Methods of Treating Milk

1. **Microfiltration**
   - It is used to remove significant numbers of bacteria from milk and extend its shelf life.
   - It can be used in combination with HTST pasteurization.
2. **Bactofugation**
   - It is a centrifugation process that removes the bacteria present in milk.
   - It has been used in the cheese industry to minimize milk spoilage by clostridia that cause ‘late blowing’.

3. **Ohmic heating**
   - ❖ Ohmic heating is the process of heating the product by passing it through an alternating electric current.
   - ❖ It is a direct heating method in which the food is in direct contact with the electrode and food itself is a part of an electric circuit.
4. **Microwave heating**
   - ❖ Microwave heating is a method in which electromagnetic waves are used to generate heat in food.
   - ❖ Microwaves used in the food industry for heating are of frequencies 2450 or 900 MHz.
   - ❖ It has been in commercial practice for milk pasteurization for quite a long time.
5. **Pulse Electric Field**
   - ❖ The pulsed electric field is one of the non-thermal food preservation technologies in which food is subjected to short pulses (1-100 µs) of high electric fields with a duration of nano to milliseconds and intensity of 10 – 80 kV/cm to foods placed between two electrodes.
   - ❖ It has a lethal effect on vegetative bacteria, mold, and yeasts.
6. **High-pressure process (HPP)**
   - ❖ It is a non–thermal pasteurization process in which food is subjected to high pressure in the region of 3300 - 600 Mpa for about 10 minutes.
   - ❖ The components of microorganisms are destroyed by high pressure that can inactivate pathogenic and saprophytic microorganisms.
7. **Ultrasound**
   - ❖ Ultrasonic is a high-power sound wave at frequencies between 16 kHz and 100 MHz.
   - ❖ In this method, the sonic wave is passed through the milk and the changes occur in the pressure which leads to cavitation, which causes gas bubbles in the liquid causing a bactericidal effect.
   - ❖ An ultrasound application has been conducted on the *B. subtilis* spores in milk at a temperature range of 70-95 °C.
8. **UV Radiation and Irradiation**
   - ❖ Ultraviolet (UV) radiation is electromagnetic radiation having a wavelength of about 10-400 nm.
   - ❖ Gamma rays, X-rays, and accelerated electron beams are the sources of ionizing radiation used for the preservation of foods.
   - ❖ It is applied in combination with the pasteurization of brine during cheese production.

- Irradiation can be used in dairy products to destroy pathogens or all microorganisms.

Conclusion:

Preserving milk is essential for ensuring its safety, quality, and longevity. Through various preservation methods, we can extend the shelf life of milk and minimize the risk of bacterial contamination, spoilage, and nutrient degradation. From pasteurization to ultra-high temperature (UHT) treatment, and from refrigeration to freezing, each preservation technique serves to maintain the nutritional integrity and freshness of milk while meeting diverse consumer preferences and needs. Moreover, advancements in packaging technology, such as aseptic packaging, further contribute to the preservation of milk by preventing exposure to light, air, and external contaminants. By employing a combination of these preservation methods and adhering to stringent hygiene standards throughout the milk supply chain, we can ensure a safe and sustainable milk supply for consumers worldwide, promoting health and well-being for all.