

# Preservation of Milk

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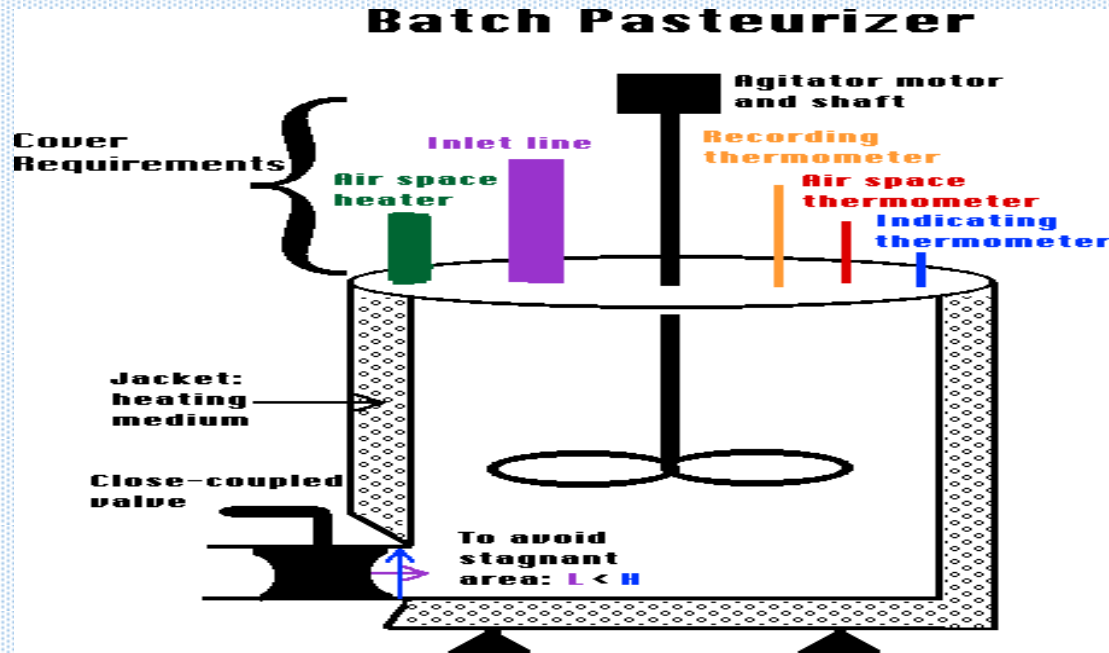
- **At room temperature milk can be stored only for 3 hr immediately after milking.**
- **The shelf life of milk can be extended to 24 hr, by cooling to 5°C.**
- **Its shelf life is further extended to 4 to 7 days need equipment and electricity,**
- **Whereas – by use of lactoperoxidase system milk can be preserved for 6-12 hr, without the need for equipment and electricity.**
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# Preservation of milk by chilling

- **Chilling of milk to 5°C or below for 24 hr and holding it at such a temperature will preserve the milk by preventing the multiplication of microorganisms but it does not destroy them as in pasteurization.**

# Pasteurization

- Batch pasteurization / low temperature long time pasteurization (LTLT) –
- High temperature short time pasteurization (HTST) –
- Ultra high temperature treatment (UHT) –



# Preservation of milk

- *Chemical methods*
- Milk can be preserved by addition of preservation such as **hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) and lacto peroxidase system** along with chilling.
- The preservative and bacteriostatic effect is **due to the nascent oxygen** released on oxidation of  $\text{H}_2\text{O}_2$  by the enzyme catalase, as well as the  $\text{H}_2\text{O}_2$  itself acts as a **bacteriostatic** agent.
- The permissible limits recommended by FAO (1957) for the use of  **$\text{H}_2\text{O}_2$  in milk is less than 800 ppm.**
- However, the use of  $\text{H}_2\text{O}_2$  is **not permitted** by Prevention of food Adulteration Act (PFA, 1954) because the flavour, body and marginal loss in biological value of made from treated milk are unsatisfactory.
- Besides, the marginal loss in biological value of **proteins especially the sulphur** containing amino acids in  $\text{H}_2\text{O}_2$  treated milk is also observed.

- **Germicidal period.**
- Fresh milk exhibits **germicidal properties** for some period during which the growth of bacteria is either inhibited or decreased. This is called as germicidal period.
- This period varies considerably in length, usually **shorter at higher temperatures and more prolonged at lower temperatures.**
- It varies with the milk obtained from different animals, at different times, and also milk drawn from different quarters of udder.
- **This germicidal activity is destroyed by heating milk to 60-80°C for 30 min.**
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# Naturally occurring inhibitory substances in milk.

- A variety of **naturally occurring inhibitory or antimicrobial substances are secreted** in milk.
- These substances help in the **prevention of mammary gland infection** or for providing **passive immunity to the new born**.
- Some of the substance also help in **preserving milk (for some time) in natural form**.
- One of the natural antimicrobial systems that has been thoroughly investigated as a possible preservative extending the shelf-life of raw milk is lactoperoxidase (LP) system.

# Lacto peroxidase/thiocyanate/hydrogen peroxide (LP) System:

- The three essential components of LP system are **lacto peroxidase (enzyme), thiocyanate (substrate) and hydrogen peroxide (promoter)**.
- If any one of these is absent, the LP- system fails to get activated in milk and does not exhibit its antibacterial activity.
- International Dairy Federation (1988) recommended the use of LP-system **for temporary preservation** of raw milk during collection and transportation to the processing plant.
- They have recommended the **addition of thiocyanate (14mg) and sodium percarbonate (30mg) per litre** of milk within 3hr of its production.

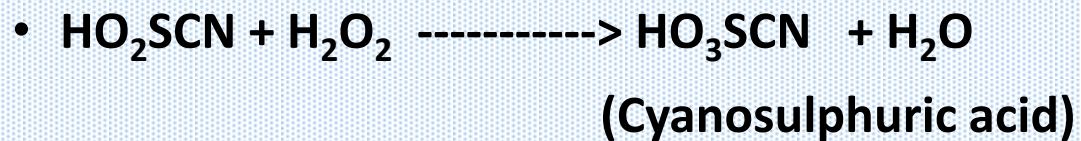
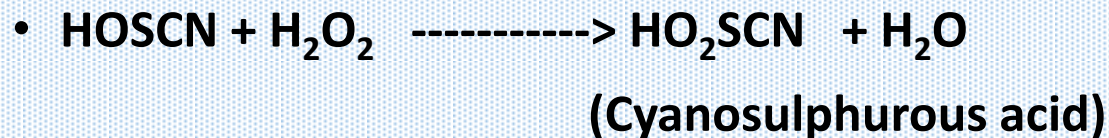


- Lacto peroxidase is normally **synthesized within the mammary gland** and is always present in bovine milk (30ug/ml) but is absent in the human milk.
- The level needed for the LP- System to get activated in milk is **0.5-1.0 ug/ ml**.
- Thiocyanate is the substrate for this enzyme to act and is present in varying concentration of 1 to 10 ppm depending on the feeding of the animal.
- The third component of the system, hydrogen peroxide, may be supplied by the organisms within the udder (e.g. streptococci) or by the PMN.
- Sodium thiocyanate and hydrogen peroxide when added @ 30:30mg/litre improves the keeping quality of milk to **10 hr at 37°C**.

- When all the three components are available, the system gets activated and produces unstable substances which are bacteriostatic.



- The hypothiocyanate ions **adversely affect the cell membrane causing inactivation of several vital metabolic enzymes**, and leakage of potassium ions and amino acids. When  $\text{H}_2\text{O}_2$  is available, the reaction proceeds further as under:



- The ionic forms of above compounds possess bactericidal activity.

- The unstable oxidation product formed due to oxidation of SCN (Sulphacyanides) in the presence of  $H_2O_2$  is bactericidal to enteric pathogens including **multiple antibiotic resistant strains of *E.coli* and *K. aerogenes***.
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- The inhibitory substance may be sulphurdicyanides, cyanosulfurous acid or cyanosulfuric acid, and hypothiocyanate ion was found as the active agent.
- Antimicrobial agents of LP-system in milk cause **inhibition of various spoilage and pathogenic organisms**, thus enhancing the microbiological quality of milk.
- **LP system is bactericidal to gram negative organisms and bacteriostatic to gram positive organisms.**
- The difference in the behaviour of gram positive and gram negative bacteria towards LP-system could be attributed to the structure and composition of the wall of gram positive and outer membrane of gram negative organisms respectively.

- **Both specific and non-specific types of antimicrobial substances secreted in milk are:-**
- *Immunoglobulins:*
- **The immunoglobulins (Ig) to potentially pathogenic bacteria are often present in milk. They may be produced locally within the udder (IgA) or transferred to milk from the circulation (IgG).**
- **The primary function of these antibodies is to protect the new born through passive transfer of immunity.**
- **The udder is protected from infection by strains of coliform bacteria which are susceptible to complement/ antibody killing by the complementary body system.**
- **Antibody may also serve to reduce the severity of udder disease by neutralizing the toxins or by acting as opsonins to facilitate the phagocytosis of bacteria by polymorphonuclear leucocytes (PMN).**
- **They may also serve to prevent adhesion of bacteria to mucosal surface.**

- *Leucocytes / phagocytes.*
- It is generally accepted that protection of the udder from mastitis rests primarily on the efficiency of phagocytosis and the destruction of invading bacteria by PMN.
- The total cell count of milk obtained from uninfected udders ranges from 1 to 5 lakh cells/ml, of which approximately 10% are PMN.
- Infected quarters may secrete milk containing 100 lakh cells/ ml of which 90% are PMN.
- Phagocytosis and killing by PMN is less effective in milk than in blood, largely because the PMN ingest large quantities of fat and casein.
- Increasing PMN content of milk has been shown to increase resistance of the udder to infection.

- *Complement.*

- About 9 components of complement are found to be present in human milk and they are associated with bacterial properties of milk.

- *Bifidus factor.*

- Bifidus factor is a nitrogen containing oligosaccharide present in the human milk, which supports the growth of Bifidobacteria in infants.
- Bifidobacteria helps in the maintenance of intestinal health.

- *Lactoferrin.*

- Lactoferrin (LF) is an iron binding protein similar to serum transferrin.
- Its concentration is markedly increased in the secretion of un milked or infected animals.
- **It inhibits the multiplication of bacteria by depriving them of iron** and may protect the dry udder from infection with *E.coli*.
- Although LF is present in bovine milk, the high citrate and low bicarbonate concentration reduces the iron binding and, therefore, the inhibitory properties of LF.
- It has **bacteriostatic activity** against organisms like *Staphylococcus aureus*, *S. albus*, *Pseudomonas aeruginosa* and *Vibrio cholerae*.

- *Lysozyme.*

- Gram positive bacteria are sensitive to lytic action of lysozyme which is present in much higher concentration (approx. **30 mg/100 ml**) in human milk than bovine milk (**0.01 mg/100 ml**).

- *Miscellaneous substances.*
- The other inhibitory substances found in milk include **vitamin binding protein (for vit. B and folate), fatty acids and enzymes.**
- Sometimes **non inherent substances like antibiotics, pesticides or sanitizer** can also be found in milk.