

A close-up photograph of a glass pitcher pouring milk into a clear glass. The milk is captured mid-pour, creating a thick, white stream that falls into the glass, forming a frothy head. The background is a plain, light blue-grey color.

# **Microbial Spoilage of Milk**

Microbiological changes in milk and milk products are produced as a result of fermentation of one or more of milk constituents by causative microorganisms. Milk fermentations may be of **normal type (curdling of milk)** or **abnormal type (gassiness, proteolysis, lipolysis, sweet curdling)**. When two or more fermentations occur simultaneously in product, it is called **mixed fermentations (production of both acid and gas by coliforms)**.



## **Natural souring:**

**1. Fresh milk has normal acidity ranging from 0.14-0.19%. The acidity at which milk sours is usually in the range of 0.20-0.25%, the milk usually curdles when acidity further reaches to 0.50-0.65%. Generally acidity continues to increase even after coagulation of casein till the LAB is inhibited by accumulation of acid or whole of lactose is exhausted.**

**2. Mechanism of acid coagulation:**

**Interaction of lactic acid produced with calcium bound to casein thus leading to precipitation of casein which appears as curd. Casein starts precipitating in the pH range of 4.64-4.78.**

**Causative organisms: Lactic streptococci, *Lactobacillus***

Coagulum formed by **lactic streptococci, lactobacilli** is smooth with typical clean sour flavour (preferred for desirable fermentations in dairy industry). Organisms like ***B. coagulans*, coliforms** produce a coagulum along with other undesirable flavours due to the liberation of certain volatile flavouring substances from lactose and proteins.



## **Significance**

- Raw milk giving positive clot-on-boiling test is rejected at platform.
- Masking developed acidity by adding caustic soda which is undesirable from public health point of view.

## **Control measures**

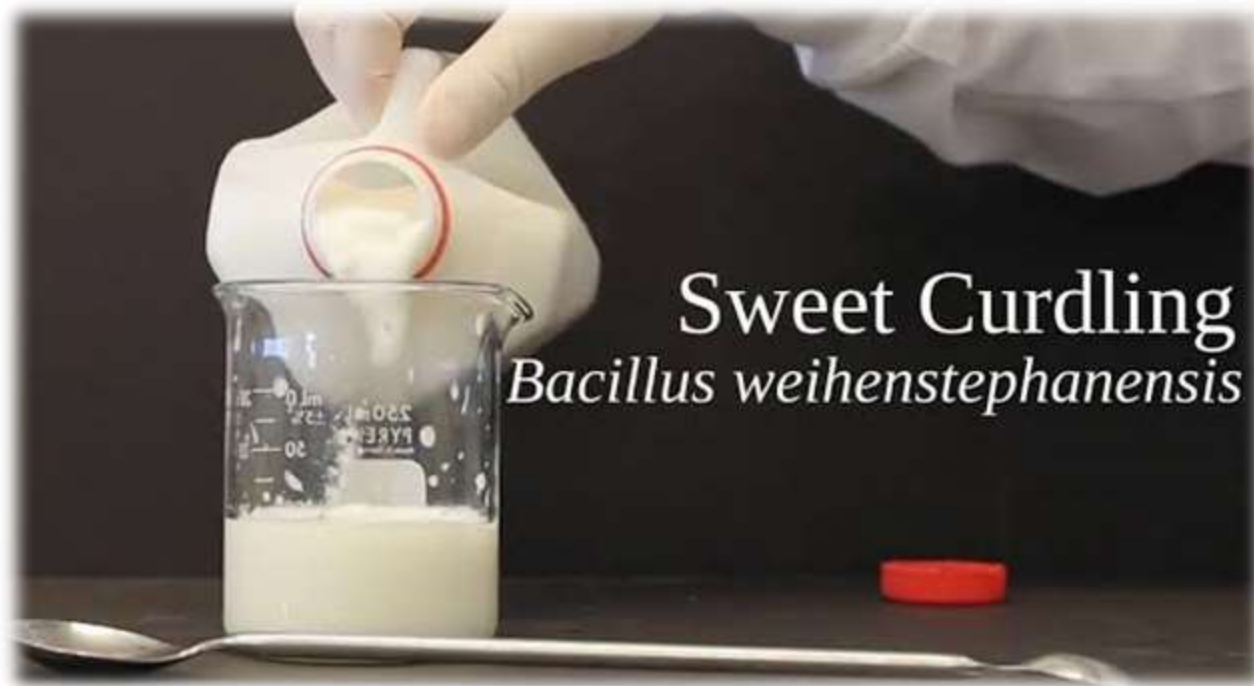
- Immediate chilling of raw milk
- Adequate pasteurization of milk followed by cooling
- Milk production in hygienic conditions
- Sanitized utensils

## **Sweet curdling:**

- 1. Curdling without pronounced acid (little or no acid) production is sweet curdling.** This defect is due to the production of an extracellular enzyme similar to rennin by bacteria that precipitate casein before the development of sufficient acidity.
- 2. Observed in milk and cream particularly that are moderately heat treated particularly when held at higher temperatures during summer months.**
- 3. Rennin like is produced generally by aerobic spore formers. Activity of this enzyme is known to increase at higher temperature.**
- 4. Boiled milk if allowed to cool and stand in same container for long time, it will undergo sweet curdling.**

Causative microorganisms: **Cocci** - *Streptococcus liquefaciens*; **Aerobic sporeformers** – *B. cereus*;  
**Psychrotrophic spore formers**- *B. cereus*, *B. licheniformis*;  
**Non-spore forming rods**: *Proteus* spp., **Yeasts and molds**

**Significance:** Sweet curdling is prevalent in heat treated products, particularly in summer.



## Factors affecting sweet curdling

1. **High temperature: More prevalent in summer**
2. **Age of milk: Milk held at ambient temperature for more than 24 h due to production of more rennin by *Bacillus mycooides*. It does not grow rapidly, as it may be inhibited by lactic acid bacteria.**
3. **Pasteurization: It kills most of the bacteria, especially lactic acid bacteria.**

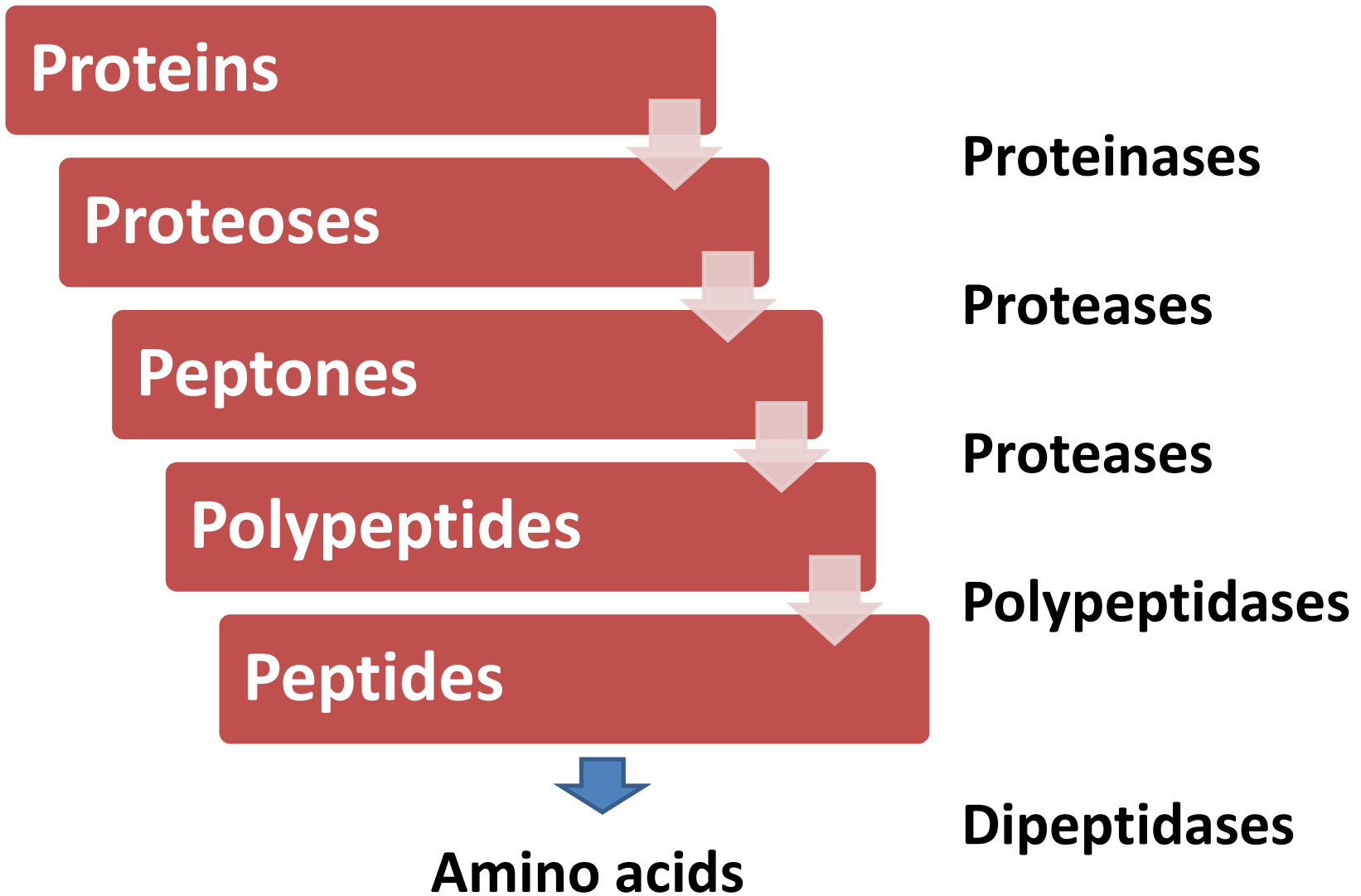
## Precaution and Control

- **Avoid contamination**
- **Control storage temperature (milk cooled at farm level)**
- **Pasteurization at a temperature higher than normal**



## **Proteolysis:**

- 1. Casein or some insoluble casein derivatives are broken down to water soluble compounds through action of microorganisms/enzymes.**
- 2. Milk contains different proteolytic enzymes that may bring about alterations of milk constituents. Some of these are naturally present in milk, while others are elaborated by microorganisms.**
- 3. Changes in milk proteins, as a result of psychrotrophic growth or enzymatic action, are important in keeping quality of milk and milk products.**
- 4. Heat stable proteases that attack caseins and whey proteins leads to coagulation of milk and development of bitter taste.**



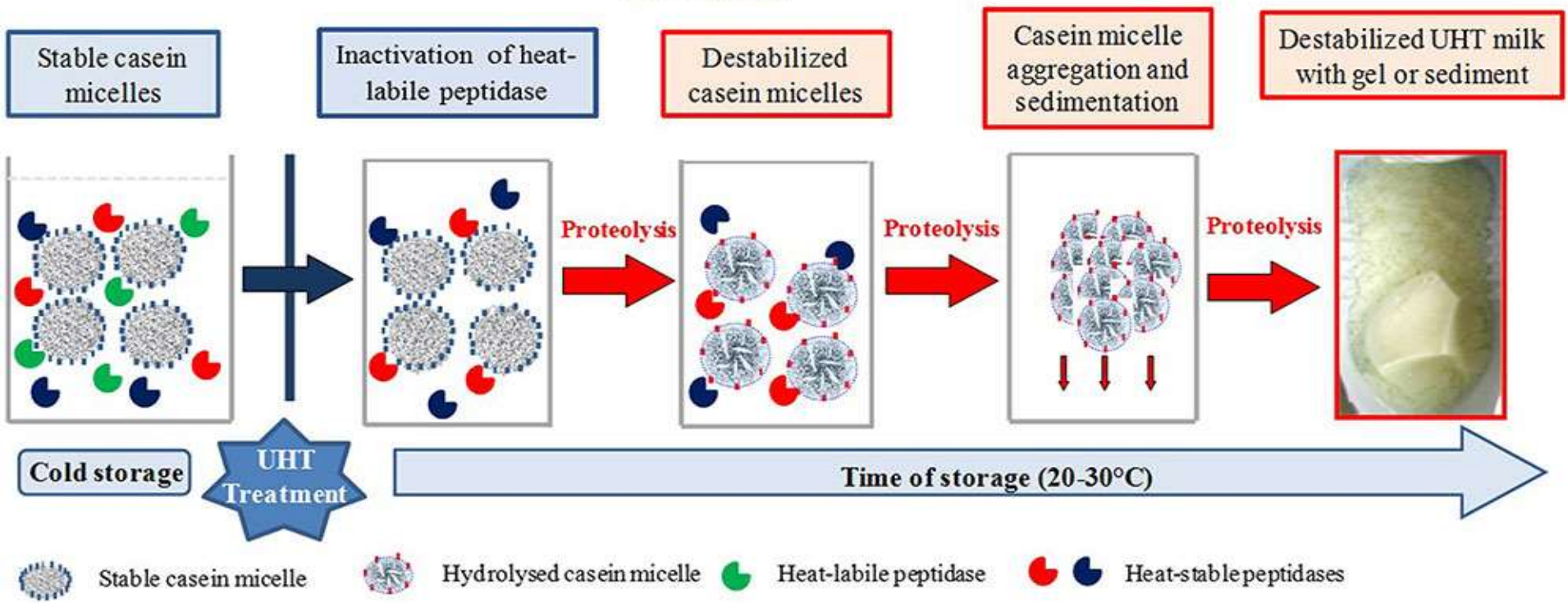
## **Causative organisms:**

**Psychrotrophs are active proteolytic and grow at 7°C or less (*Pseudomonas fluorescens*, *Acinetobacter* etc.).**

## **Significance of Proteolysis:**

- 1. With the extended period of refrigerated storage, psychrotrophs become important to the quality of fluid milk.**
- 2. Psychrotrophic proteinases act during the refrigerated handling of raw milk before heat treatment.**

# UHT milk

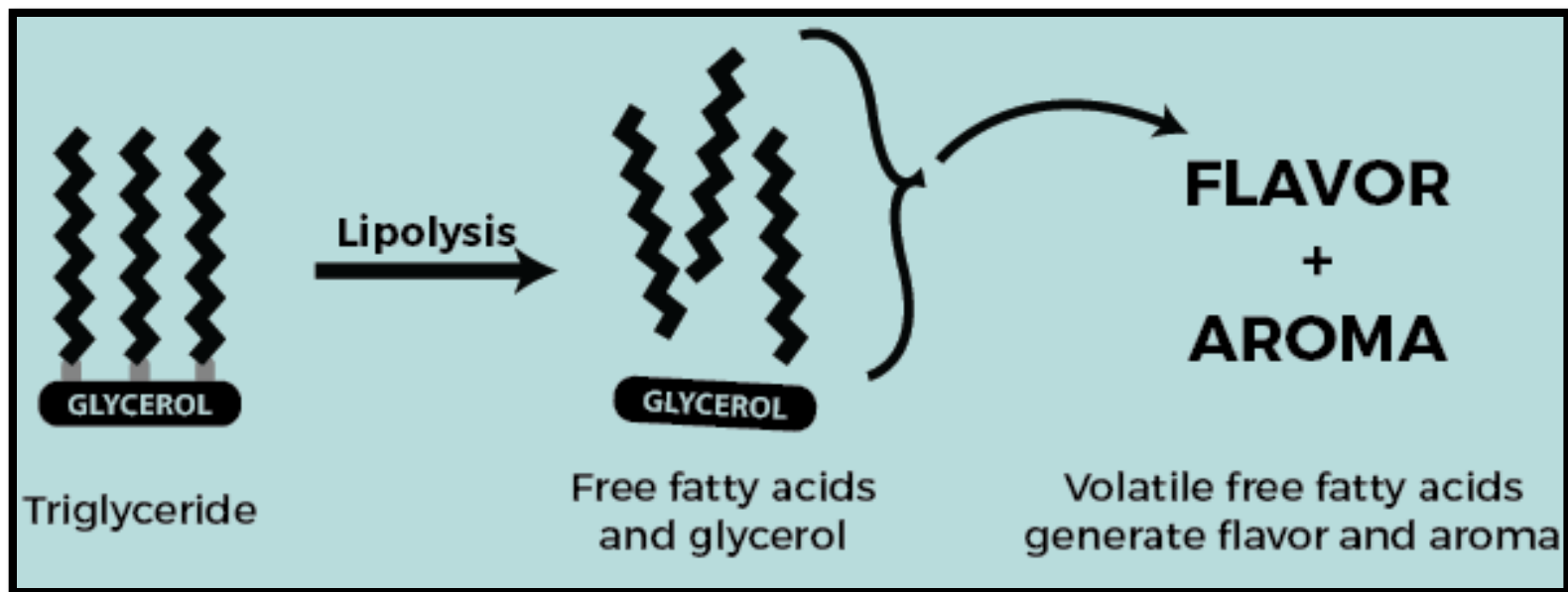


## **Lipolysis:**

- 1. Hydrolysis of milk fat and subsequent production of off-flavours in dairy products.**
- 2. Lipolysis is carried out by lipase resulting into accumulation of free fatty acids. Lower chain fatty acids (**butyric and caproic**) are responsible for lipolytic off-flavours.**
- 3. Lipolysis in milk at any stage from milking, storing and processing should be avoided, since rancid milk/cream will not yield high flavour quality products.**
- 4. Lipolytic microorganisms and their enzymes produced in bulk cooled milk/cream survives HTST pasteurization and UHT sterilization, causing lipolysis during subsequent storage of heat processed milk at low temperature.**



Lipolysis is favorable for cheese flavor. Addition of lipase of *Candida lipolytica* improve quality of blue veined cheese made from raw/pasteurized milk.



## Causes of lipolysis:

1. **Intrinsic milk lipase:** Present in sufficient quantities to cause hydrolysis of milk fat. However, fat globule membrane protects milk triglycerides from attack by lipase and hence, little or no lipolysis occurs.
2. **Lipolytic microbes or enzymes:** Psychrotrophs (*Pseudomonas fragi*), Other types (*B. subtilis*), Yeast and molds (*Geotrichum candidum*)

## Precaution and control

1. **Clean milk production practices**
2. **Cooling of milk as per recommendation**

## **Bitty cream (Broken cream):**

- 1. Bitty cream is due to effect of spore formers on milk.**
- 2. Occurs in pasteurized and raw cream.**
- 3. Characterized by appearance of flakes in the cream layer that do not mix even when milk is shaken. If such milk is used in tea, flakes float on surface making it unacceptable.**
- 4. Flakes are of two types: Mechanical/ physical origin and there flakes occur when fat globule membrane is partly disrupted and globule stick together occurring as cream plug. Second type is of bacterial origin and is produced partly by lecithinase enzyme of *B. cereus var mycoides* that attacks phospholipid part of fat globule membrane and partly from the coagulation of casein associated with membrane.**

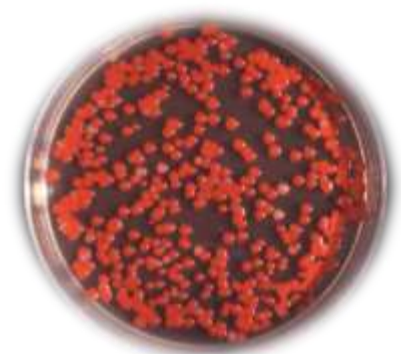


- 5. Bacterial flakes do not change materially, when heated to 100°C, whereas mechanical flakes change at 40–45°C.**
- 6. Major spoilage problem of pasteurized milk.**

**Reasons: failure of refrigeration, seasonal variation, prolonged storage etc.**

- 5. First, all the spores present in milk collect in the cream layer where they develop into microcolonies. Flocks form around these and at the beginning of appearance of bitty cream, each micro colony has formed one flock.**
- 6. Milk is not a favorable sporulation medium for many sporeformers but, if diluted 1 to 50 with water, conditions may become conducive for rapid sporulation of some strains.**

## Abnormal colours (discolouration):



Colour of milk is largely controlled by feed but the milk of certain breeds is always more coloured due to the fact that milk fat contains more carotene and less vitamin A.

Colours	Organism responsible
Blue	<i>Pseudomonas syncyanea</i>
Yellow	<i>Pseudomonas synxantha</i>
Red	<i>Serratia marcescens</i>
Greenish	<i>Pseudomonas fluorescens</i>

## Abnormal flavours (off-flavours):

Microbial off-flavours are invariably encountered in raw milk through occasional neglect or failure in refrigeration.

❑ **Fruity Flavour:** It is due to ethyl ester formation usually catalyzed by esterases produced by psychrotrophs or lactic acid bacteria.

❑ **Malty flavour:** Caused by malty strains of *Lactococcus lactis ssp. lactis var maltigenes*.

❑ **Bitter flavour:** Caused by proteolytic microorganisms especially *Pseudomonas* spp.

❑ **Fishy flavour:** Caused by *Pseudomonas ichthyosmius*, due to conversion of lecithin to trimethylamine.

- ❑ **Musty potato flavour:** Caused by *Pseudomonas mucidolens*.
- ❑ **Phenolic flavour:** Caused by *Bacillus circulans*. Cresols are responsible for this defect.
- ❑ **Unclean flavour:** Increase in the production of dimethyl sulphide caused by rod shaped Gram-negative psychrotroph.
- ❑ **Medicinal flavour:** Caused by *Aerobacter aerogenes* in pasteurized market milk.



WHY DOES MY **RAW MILK** TASTE "OFF"?