

Microorganisms associated with raw milk and their significance

Sources



Milk-associated microorganisms



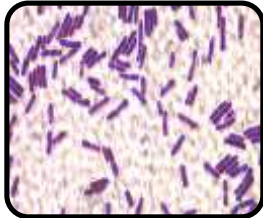
Role/ Significance

	<p>Food Technology</p> <ul style="list-style-type: none"> <i>Lactococcus</i> <i>Lactobacillus</i> <i>Streptococcus</i> <i>Leuconostoc</i> <i>Enterococcus</i> <i>Propionibacterium</i>
	<p>Health Promotion</p> <ul style="list-style-type: none"> <i>Lactococcus</i> <i>Lactobacillus</i> <i>Streptococcus</i> <i>Leuconostoc</i> <i>Enterococcus</i> Some yeasts
	<p>Spoilage</p> <ul style="list-style-type: none"> <i>Pseudomonas</i> <i>Acinetobacter</i> <i>Chryseobacterium</i> <i>Clostridium</i> Phage
	<p>Illness</p> <ul style="list-style-type: none"> <i>Listeria</i> <i>Staphylococcus</i> <i>Escherichia coli</i> <i>Campylobacter</i> <i>Mycobacterium</i> Fungi - Aflatoxins

Milk contains bacteria that can be classified into three categories



Beneficial bacteria



Spoilage bacteria



Pathogenic bacteria

○ **Beneficial bacteria:** Help in making food products (cheese, yoghurt, and buttermilk).

○ **Spoilage bacteria:** Produces bad smell/taste and poor look of the product. Most bacteria in fresh milk from healthy animals are usually harmless but rapid changes in animal health or of the handler, or contaminants from polluted water, dirt, manure, air, cuts and wounds can make raw milk potentially dangerous. Milk is sterile, when it is secreted in udder but gets contaminated after leaving udder. Contaminating bacteria can lead to different spoilage problems. Microorganisms causing spoilage: psychrotrophs, mesophiles or thermophiles which are of great significance in milk.

Pathogenic bacteria in raw milk:

1. Microbial pathogens enter raw milk either from the surroundings (i.e. contaminated utensils, feces, water, handlers) or from the infected udders/ tissues of the producing animals.

Pathogenic microbial agent	Disease associated with microbe
<i>Campylobacter jejuni</i>	Campylobacteriosis
<i>Corynebacterium diphtheria</i>	Diphtheria
<i>Coxiella burnetii</i>	'Q' fever
<i>Escherichia coli</i> O157: H7	EHEC - Enterohaemorrhagic <i>E. coli</i>
Hepatitis A	Jaundice
<i>Listeria monocytogenes</i>	Listeriosis
<i>Mycobacterium tuberculosis</i>	Tuberculosis
<i>Salmonella typhi</i>	Typhoid fever
<i>Salmonella</i> spp.	Salmonellosis
<i>Shigella dysenteriae</i>	Shigellosis
<i>Yersinia enterocolitica</i>	Yersinosis

Microflora of Raw Milk

- 1. Raw milk can harbour dangerous microorganisms posing serious health risks to the consumers.**
- 2. Raw, unpasteurized milk can carry dangerous bacteria (*Salmonella*, *E. coli*, and *Listeria*) responsible for causing numerous food-borne illnesses as it contains all essential nutrients, pH and water activity for growth of microbes. Hence, there is a high risk for these products to get contaminated with spoilage causing microbes.**
- 3. Milk when secreted into the udder of an animal is sterile; and it gets contaminated from the microflora residing in the udder tissues. These contaminants are non-infectious except in case of mastitis.**

4. Presence of non-pathogenic microbes in milk is not very serious, but multiplication may cause souring, putrefaction, undesirable flavours and colours of milk and milk products.

Name of micro-organism	Activity associated
Pseudomonas	Spoilage
Brucella	Pathogenic
Enterobacteriaceae	Pathogenic and spoilage both
Staphylococci	
<i>Staphylococcus aureus</i>	Pathogenic
Streptococcus	
<i>S. agalactiae</i>	Pathogenic
<i>S. thermophilus</i> ; <i>L. lactis</i> ssp. <i>lactis</i>	Acid fermentation
<i>L. lactis</i> ssp. <i>lactis</i> biovar <i>diacetylactis</i>	Flavour production
<i>L. lactis</i> ssp. <i>cremoris</i> ; <i>Leuconostoc lactis</i>	Acid production
<i>Bacillus cereus</i>	Spoilage
Lactobacillus	
<i>L. lactis</i> ; <i>L. bulgaricus</i> ; <i>L. acidophilus</i>	Acid production
<i>Propionibacterium</i>	Acid production
<i>Mycobacterium tuberculosis</i>	Pathogenic

Microbial Contaminants from the Surroundings

Animal and its udder

- Animal and its teats contribute greatly to the microflora of milk that includes skin and present in niche of animal, where it is reared or milked.

Utensils and sanitary practices

- Milk residues left on equipments may support the growth of different microbes leading to milk spoilage.

Psychrotrophic Bacteria

1. Psychrotrophs are the microorganisms that have the ability to grow near freezing temperature in the range of 0-7°C. Typical representatives are both Gram negative and positive microorganisms.
2. Gram negative includes *Pseudomonas*, *Achromobacter*, *Aeromonas*, *Serratia*, *Alcaligenes*, *Chromobacterium* and *Flavobacterium* spp.
3. Gram positive includes *Bacillus*, *Clostridium*, *Corynebacterium*, *Streptococcus*, *Lactobacillus* and *Microbacterium* spp.
4. Quality of raw milk has been considerably maintained by refrigeration on farms, and in processing plants.

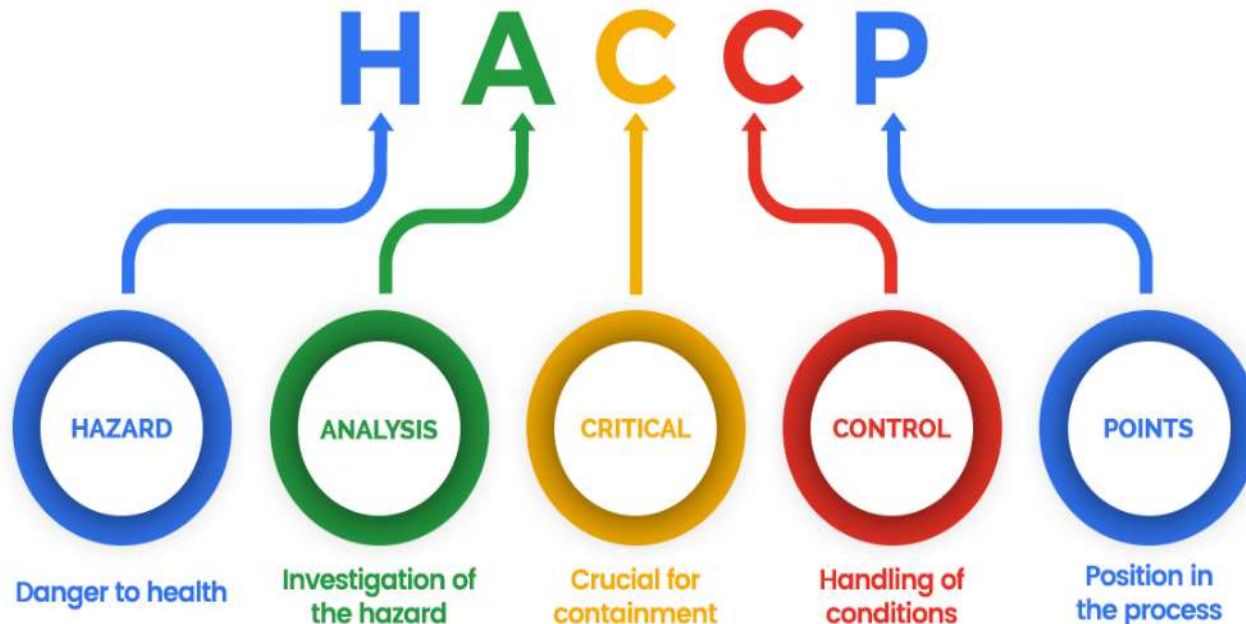
4. Besides, their rapid growth ability in refrigerated milk, psychrotrophs produces heat stable extracellular proteases, lipases, phospholipases etc.
5. Proteases and lipases contribute to spoilage of dairy products. Extracellular enzymes can resist pasteurization (72°C for 15 s) and even ultra-high temperature (138°C for 2 s) processing. Proteases are associated with bitterness in milk, gelation of sterilized milk, and reduced yields of soft cheese.
6. Lipases hydrolyze triglycerides causing flavour defects associated with fat breakdown in cream, butter and cheese.
7. *Pseudomonas* is the most prevalent psychrotroph in raw milk.

Significance of psychrotrophs in milk:

- ❑ Psychrotrophic pathogens (*Listeria monocytogenes*, *Yersinia enterocolitica*) are of major concern. Listeriosis has become a major food-borne disease, as *L. monocytogenes* can cause meningitis, septicemia, and abortion.
- ❑ Cold storage of milk favours growth of psychrotrophs. Following pasteurization/other heat treatment of raw milk to destroy microbes, spore germination or recontamination can still cause quality deterioration.
- ❑ Heat-resistant extracellular proteinases and lipases produced by psychrotrophs before processing are a major spoilage factors during storage of milk.
- ❑ *Arthrobacter*, *Microbacterium*, *Flavobacterium*, *Acinetobacter* and *Alcaligenes*. *Bacillus* spp. (sporeformer) dominates and secretes extracellular heat resistant proteinases, lipases and phospholipases.

Control of psychrotrophs and their enzymes in milk can be achieved by:

- ✓ Hygienic practices in different aspects of milk handling
- ✓ Minimizing storage time of milk
- ✓ Following effective HACCP system
- ✓ Strict maintenance of refrigeration at 4°C
- ✓ Heat treatment with aseptic filling or packaging
- ✓ Treatment of milk with carbon dioxide or nitrogen



Mesophilic Bacteria

Mesophiles grows best in moderate temperature, optimally between 25-40°C. Important applications in food preparation, especially in cheese and yoghurt making.

Group	Genera
Micrococci	<i>M. varians</i> , <i>M. luteus</i> , <i>M. roseus</i>
Streptococci	<i>S. agalactiae</i> , <i>S. dysgalactiae</i> , <i>S. uberis</i> , <i>S. faecalis</i> , <i>S. zymogenes</i> , etc.
Gram positive rods	<i>L. casei</i> , <i>L. plantarum</i> , <i>Corynebacterium</i> spp., <i>Microbacterium</i> spp., <i>Arthrobacter</i> spp., <i>Bacillus</i> spp.
Gram negative rods	<i>Pseudomonas</i> spp., <i>Alcaligenes</i> spp., <i>Coliforms</i> , <i>Flavobacterium</i> etc.

Microbiological standards for raw milk (BIS Standards)

Direct Microscopic Clump Counts/ml	Grading of milk
<5,00,000	Good
5,00,001 - 4,000,000	Fair
4,000,001 - 20,000,000	Poor

Thermoduric Bacteria

- ❑ Microorganisms that can survive pasteurization but cannot grow at high temperatures are called thermodurics. Hence, these are carried into the pasteurized product, where these may promote health hazard risks when standard growth conditions are prevalent.
- ❑ Widely distributed in animal feeds, bedding, soil and feces. These contaminate animal teats and milking equipments. Difficult to completely eradicate these microbes from the milk processing system. eg., *Micrococcus*, *Microbacterium*, *Bacillus* and some *Coryneforms*.
- ❑ **Control measures:**
 1. Implementation of hygienic milking practices
 2. Use of clean and hygienic milk equipments
 3. Proper fecal disposal system

Genus	Important Features
<i>Microbacterium</i>	<i>Microbacterium</i> is derived from milking equipment.
<i>Bacillus</i> (spores)	<i>Bacillus</i> spore count is higher in winter than in summer because spores are mainly derived from the teat surfaces spoiled with bedding materials. Eg., <i>B. licheniformis</i>
<i>Clostridium</i> (spores)	Spore count of raw milk is higher in winter because these are derived from silage and bedding materials.eg., <i>C. tyrobutyricum</i>
<i>Micrococcus</i> (100%)	Exclusively derived from milking equipment and utensils.eg., <i>M. freudenreichii</i>

Coliforms

- ❑ Gram-negative, rod shaped, non-spore former that ferment lactose to produce acid and gas at 35-37°C/ 24-48 h. Their presence in food indicates the sanitary quality of production. So, called as an **'index of direct fecal contamination'** in product.
- ❑ A toxin producing strain, *E. coli* O157: H7 that presents serious health issues, especially in children.
- ❑ **Sources:** Faeces of healthy livestock including dairy cattle, utensils, contaminated water, and unhygienic milk production practices, animal suffering with coliform mastitis, handlers and contaminated utensils.
- ❑ Example: *E. coli*, *Salmonella*, *Enterobacter aerogenes*.
- ❑ Coliforms count for raw milk should not be more than 10/ml.

Significance of Coliforms in Raw Milk:

- ❑ Presence of coliforms in milk indicates a possible fecal contamination, especially when these are handled under unsanitary conditions.
- ❑ These microorganisms are undesirable because they produce acid, gas and taints in milk products.
- ❑ Destroyed during pasteurization and hence, their presence in pasteurized milk indicates **post pasteurization contamination**.
- ❑ Absence of coliforms in 1:100 dilution in raw milk is accepted as a criteria of satisfactory quality.

Thermophilic Bacteria

- ❑ Obligate thermophiles have a temperature range as high as 85°C, while some facultative thermophiles grow as low as 20°C and as high as 60°C.
- ❑ Heterogeneous group of microbes which not only survive pasteurization but also grow at high temperatures.
- ❑ Common members belong to aerobic or facultatively anaerobic sporeforming rods eg., *Bacillus stearothermophilus*, *Bacillus circulans* and *Lactobacillus thermophilus*.
- ❑ Standard method of enumeration is to incubate agar plates at 55 C.
- ❑ **Sources:** Thermophiles may gain access into raw milk mainly from soil, bedding, feeds, and rarely from water supplies. Number increases due to their multiplication if raw milk is stored under warmer ambient conditions.

- **In pasteurizing plant, plant may receive an unusual contamination; walls of pasteurizer may have a thin layer of cooked milk where thermophiles may grow; construction of the pasteurizer may be defective so that some of the milk fails to reach the required temperature; there may be an excessive amount of foam that is not heated properly; or the vats may not be cleaned between the successive runs.**

