

Psychrotrophs in Milk

As per the estimates world's one-fourth of the food produced is spoiled by the microbial activities alone. Spoilage is mainly caused by the psychrotrophic, molds and yeasts, while in developing world it is mostly due to the power failure and severe lacking of proper storage facilities. Psychrotrophs can grow in the range of **0-7°C** or below, irrespective of their optimal growth temperature. Psychrotrophic spoilage of milk and milk products is a quite complex event of both microbial and biochemical activities. However, most of the spoilage in dairy products is caused by **non-pathogenic psychrotrophic strains** such as ***Pseudomonas***.

Major psychrotrophs involved in the spoilage of milk and milk products

Gram-Negative: Major psychrotrophs of raw milk are Gram-negative rods (*Pseudomonas* spp., individually contributes to the extent of 50 % of total genera involved. Genera involved in spoilage include *Achromobacter*, *Aeromonas*, *Alcaligenes*, *Chromobacterium* and *Flavobacterium*. Many of these produce heat resistant proteases and lipases that have deleterious effect on the quality of the final product. Coliforms contribute to the extent of 5-33 % of total psychrotrophic microflora of the raw milk.

Gram-Positive: Less in numbers than Gram-negative sp. in raw milk. Genera includes *Arthrobacter*, *Bacillus*, *Clostridium*, *Corynebacterium*, *Lactobacillus*, *Listeria*, *Microbacterium*, *Micrococcus*, *Sarcina*, *Staphylococcus* and *Streptococcus*. *Bacillus* and *Clostridium* are spore formers which can survive even after pasteurization treatment. The leading spoilage contributors of hygienic milk and milk products stored at longer period is Gram-positive spore formers (*Bacillus cereus*).

Pathogenic psychrotrophs: *L. monocytogenes*, *Y. enterocolitica* and *B. cereus* are the most potential psychrotrophs of importance to the dairy industry.

Conditions of Psychrotrophs responsible for the spoilage of milk and milk products



Growth of psychrotrophs prior to pasteurization process

Activity of thermoresistant enzymes

Growth of thermoresistant psychrotrophs

Post pasteurization contamination

Microbial Contaminants in Raw Milk (psychrotrophs)

Source/Factors	Organisms	Quantitative Aspects
Interior of normal udder	Micrococci, Streptococci, <i>Corynebacterium</i>	These bacteria enter through teat opening and spread in the interior of udder by their physical movement and multiplication.
Exterior of normal udder and teats	Staphylococci, Streptococci	Bacterial count in milk obtained from cows with unwashed teats (teats are soiled with bedding materials)
Milker and Handlers	<i>S. aureus</i> , Coliforms	The number of microorganisms derived from milker/handlers is more when hand milking is practiced.
Aerial contamination	Micrococci, Coryneforms, <i>Bacillus</i> spores	Not a significant source of contamination of raw milk. However, small numbers may gain entry both during hand milking and machine milking.

Source/Factors	Organisms	Quantitative Aspects
<p>Milking equipment and other containers</p>	<p>Mastitic pathogens (<i>Streptococcus agalactiae</i>, <i>Staphylococcus aureus</i>)</p>	<p>After leaving the udder, milk is mainly contaminated from improperly sanitized milking equipment. The residual milk solids on such equipments support the growth of organisms and form bacterial clusters which contaminated the subsequent supplies.</p>
<p>Storage and transport</p>	<p>Psychrotrophic and thermoduric bacteria from unclean milking cans. <i>Pseudomonas</i> (0-5 C), <i>Micrococcus</i> and <i>Alcaligenes viscolactis</i> (5-10 C), <i>S. agalactiae</i> (10-15 C), <i>S. lactis</i> (15-30 C), <i>L. bulgaricus</i> (30-40 C)</p>	<p>The improperly cleaned/sanitized equipments used for storage and transport of raw milk might increase the bacterial count depending on the hygienic condition. Improper cooling/refrigeration (4 C) of raw milk during storage and transport leads to increase in the bacterial number.</p>

Influence of Psychrotrophs in Milk

Raw milk

1. **Rancid flavor:** Due to the production of lipase, formation of free fatty acids; rancid flavor may be increased by the action of phospholipase enzyme.
2. **Unclean soapy flavor:** Due to the production of lipases, formation of free fatty acids; rancid flavor (C10-C12 chain length)
3. **Metallic flavors:** Due to the production of lipases; released unsaturated fatty acids are oxidized to aldehydes and ketones

UHT milk

4. **Rancidity (1-7 month storage):** due to the production of heat resistant lipases
5. **Gelation:** due to the production of heat resistant proteases

Pasteurized milk

6. **Formation of precipitate (bitty cream):** Due to the production of phospholipase and proteases from *Bacillus*
7. **Gelation:** thermo-resistant proteases; requires 8.7×10^8 CFU/ml
8. **Fruity smell:** Due to the synthesis of esters
9. **Sweet curdling:** Protein hydrolysis
10. **Fouling in heat exchangers:** Proteases decrease heat stability of the proteins

Control of Psychrotrophs

Method used	Mode of action of different factors
Low temperature	Slowing down the growth of psychrotrophs
High temperature	Denatures vital cell-components; hence, temperatures lower than pasteurization can be applied
H ₂ O ₂	Activation of lactoperoxidase system 8 to 12 ppm of H ₂ O ₂ is sufficient
Glucose oxidase	Enzyme generate H ₂ O ₂ that activates lactoperoxidase

Lactic acid bacteria	Generate H ₂ O ₂ that activates lactoperoxidase
Mixed culture of lactic and propionic acid bacteria	A combined action of propionic and acetic acid
Chlorine	It is added to acid-wash water used in cottage cheese manufacturing; which can kill contaminant psychrotrophs
CO ₂ injection in milk	Influences the membrane permeability and decarboxylating enzymes
Sorbate	Inhibits enzymes; that are active against catalase positive bacteria
Lactoferrin	Combines iron in milk, consequently depriving bacteria that requires it for growth
Lysozyme	It attacks cell-wall components, induces cell-lysis
Spore germination activators	Hippuric acid