

Sources of contamination in milk

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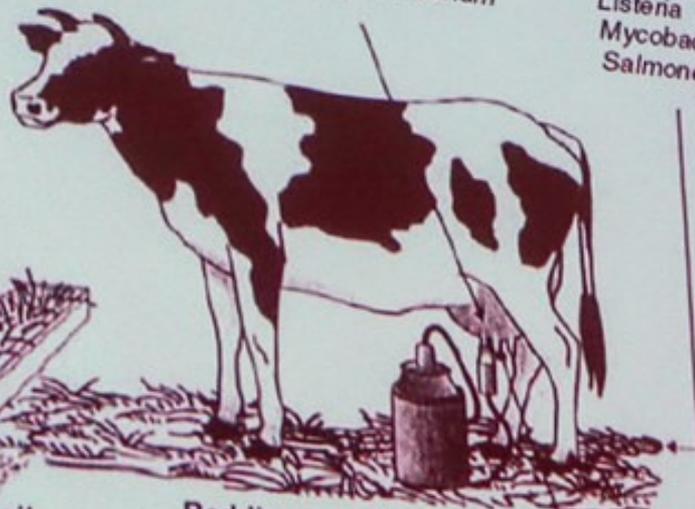
Human
 Coliforms
 Salmonella
 Enterococcus
 Staphylococcus



Air
 Streptococci
 Micrococci
 Coryneforms
 Bacillus
 Yeasts and moulds

Inside udder
 Streptococcus
 Micrococcus
 Corynebacterium

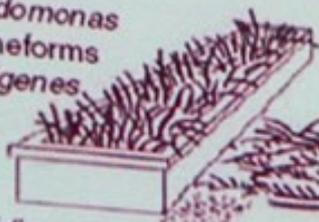
Faeces
 Escherichia coli
 Staphylococcus
 Listeria
 Mycobacterium
 Salmonella



Water
 Coliforms
 Pseudomonas
 Coryneforms
 Alcaligenes



Feed
 Clostridium
 Listeria
 Bacillus
 Lactic acid bacteria



Soil
 Clostridium
 Bacillus
 Pseudomonas
 Mycobacterium
 Yeasts and moulds

Bedding
 Clostridium
 Bacillus
 Klebsiella

Milking Machine
 Micrococcus
 Streptococci
 Bacillus
 Coliforms

Outside udder and teats
 Micrococcus
 Staphylococcus
 Enterococcus
 Bacillus

1. Interior of udder:

- Varying numbers of bacteria are found in aseptically drawn milk with the reported counts of <math><100-10,000\text{ CFU/ml}</math> from normal udder, but an anticipated average is 500-1000 CFU/ml in advanced countries.
- Microorganisms enter the udder through the duct at the teat tip that varies in length (from 5-14 mm) and its surface is heavily keratinized.
- This keratin layer retains the milk residues and exhibit antimicrobial activity.
- During progress of a milking, bacteria are present in the largest numbers at the beginning and then gradually decrease. This is mainly due to the mechanical dislodging of bacteria, particularly in teat canal, where the numbers are probably highest.
- Discarding of first few streams of milk helps in lowering the counts of microbes in milk.

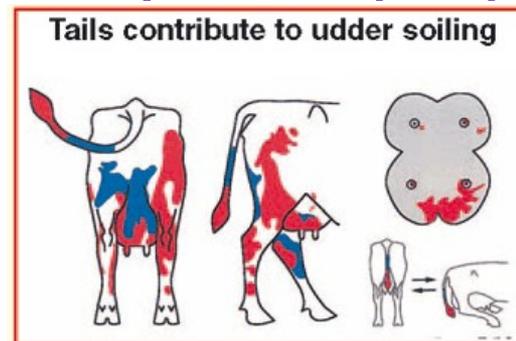
Presence of different microbial groups in raw milk

Group of microbes	Percent range
Micrococci	30-99
Streptococci	0-50
Asporogenous Gram positive rods	<10
Gram negative rods	<10
Bacillus spores	<10
Other groups of microbes	<10

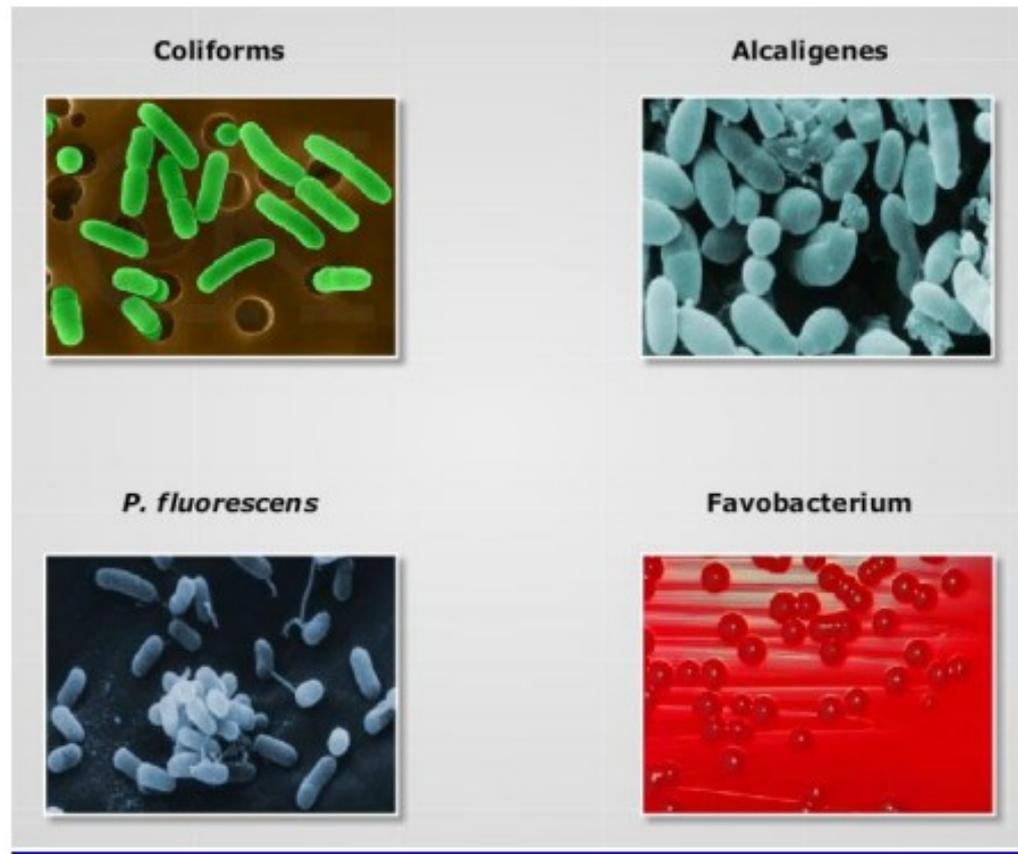
Though micrococci (non-pathogenic) are slow growing, but if allowed to grow, they cause acid formation and proteolysis. Streptococci are less frequent than micrococci. *S. agalactiae* may be present even in non-clinical mastitis and thus it appears to be a natural inhabitant of udder. *Corynebacterium bovis* has been found in large numbers. It is non-pathogenic, but if grown causes rancidity. If an animal is infected from mastitis, microbial contamination from within the udder of animal contributes notably to the total numbers of microbes in the bulk milk, when compared with the milk originated from a healthy animal.

2. Exterior of udder:

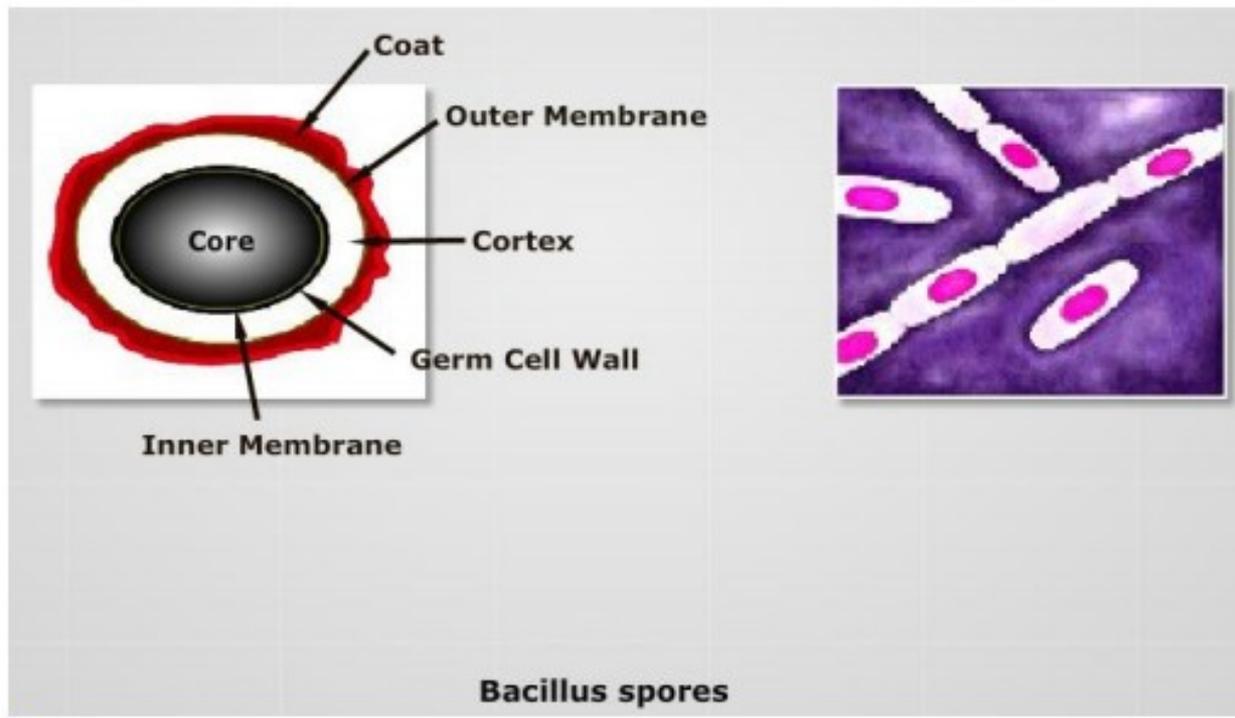
- In addition to udder infections, unclean udder and teats of animal also contribute significantly to the total bacterial counts of milk.
- The microbes that are naturally associated with the skin of the animals as well as those derived from the environment, where the cow is housed and milked are predominant in the milk.
- The environmental conditions such as soil, manure, mud, feed or bedding; determines what kind of microbes will dominate in milk.
- Udder and teat become soiled with dung, mud, bedding material such as saw dust, straw etc. With heavily soiled udder teats the counts may be 1,00,000 cfu/ml.
- The bedding material in winter has high number of bacteria, mainly psychrotrophs, coliforms and *Bacillus* spp.
- Udder microflora is not affected much by simple washing. Economy washing with sodium hypochlorite accompanied by drying, helps in reducing the number of microbes.



- Microbes that occurs in the exterior of udder are predominantly micrococci and coagulase negative staphylococci, on the teat surface are faecal streptococci, aerobic thermotolerant organisms are entirely *Bacillus* spp. (*B. licheniformis*, *B. subtilis*, *B. pumilis* and less frequent ones are *B. cereus*, *B. circulans* and *B. firmus*), teat surface may also contain clostridial spores that are usually found in cows fodder, bedding and faeces.



- Psychrotrophic and thermotolerant bacteria predominate on the teat surfaces. The psychrotrophs are *P. fluorescens*, followed by *Alcaligenes*, *Flavobacterium* and coliforms. Thermotolerants on teat surfaces are often bacterial spores (a dormant and non-reproductive structure; highly resistant to radiations, desiccation, lysozymes, high temperature, starvation and disinfectants) that are typically found in the soil. When these spores enter the bulk milk, they may survive during pasteurization and cause a number of post-pasteurization problems.



3. Coat of cow:

- The coat serves as a vehicle to contribute bacteria directly to milk.
- The hairs around udder, flanks and tail contribute to the higher bacterial count in milk. The coat may indirectly contribute microbes into air, especially *Bacillus* spp.
- The coat may carry bacteria from the stagnant water pools, especially ropiness causing milk microbes.

4. Animal shed and surroundings:

- Milk produced on farms with poor hygiene practices may undergo significant spoilage and have a shorter shelf-life, when compared to milk produced under hygienic conditions.
- Microbes associated with the bedding materials include coliforms, Spore-formers, Staphylococci, Streptococci and other Gram negative bacteria.

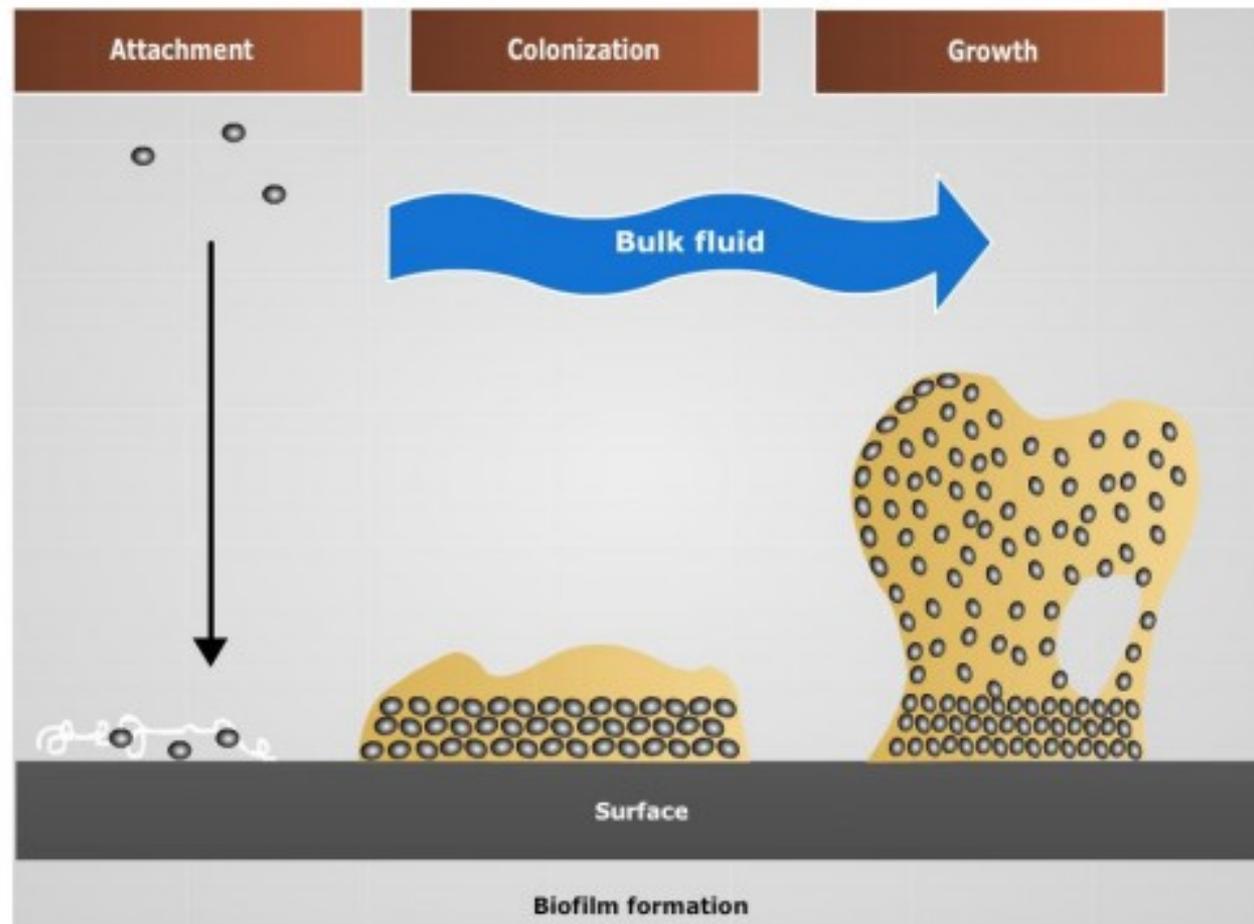
5. Milking staff:

- The hand contacts or dislodging of dust and dirt particles by milker may add varieties of microbes to milk.
- Risks of contamination from milker are definitely higher, when cows are hand milked in comparison to when they are machine-milked.
- Soiled clothes and hands increase the risk of contamination of milk and milking equipments.
- Milker with infected wounds on hands contributes pathogenic *Streptococcus* spp. and micrococci.
- If wet hand milking is practiced, the microorganisms present in lubricants like fore-milk, water or saliva of the milker and bacteria from hands and teats will enter the milk.
- The common microbial pathogens from humans causing diseases such as typhoid, paratyphoid and dysentery may contaminate the milk. Microbial pathogens causing scarlet fever, septic sore throat, diphtheria, cholera etc. contaminate the milk.

6. Milking equipments:

- Improperly cleaned milking and cooling equipments are one of the main sources of milk contamination.
- Milk residues left on the equipment contact surfaces supports the growth of a variety of microbes.
- Although natural inhabitants of the teat canal and skin; microorganisms associated with contagious mastitis do not grow well on these equipments, certain strains associated with environmental mastitis may grow to a significant level.
- Since, it is very difficult to remove all milk residues and deposits from the milk contact surfaces of milking equipments; hence equipment with smooth surfaces and minimal joints should be used.
- The tanker and collecting pipes are potential sources of contamination, if not adequately cleaned. In addition, biofilms can easily build up on the enclosed, hard to clean surfaces

- Unclean or improperly cleaned milk cans and lids if they are still moist, results in multiplication of thermophilic bacteria like *Bacillus cereus*.
- Improperly sterilized milking machines contain thermotolerant micrococci, *Bacillus* spp. and *Microbacterium* spp. predominantly compared to coliforms and streptococci.



7. Water supplies:

- At dairy-farms, the water can be a predominant source of microbial contamination.
- Water used in production should be of good bacteriological quality.
- Inadequately uncleaned, storage tanks, untreated water supplies from natural sources like bore wells, tanks and rivers, may also be contaminated with the faecal microbes (e.g. Coliforms, Streptococci and Clostridia).
- A wide variety of saprophytic bacteria (i.e. *Pseudomonas*, coliforms, other Gram negative rods, *Bacillus* spores and lactic acid bacteria) may also be present in water and may contaminate the milk potentially.
- The warm water used for udder washing is potent source of *Pseudomonas* and Coliforms which may even cause mastitis.

8. Airborne contamination:

- Aerial contamination of milk by bacteria is insignificant, in comparison to microbes with those that are derived from the teat surfaces.
- The microbial counts of air in sheds rarely exceed 200 cfu/l. Micrococci account for >50% of the aerial microflora.
- Micrococci, Coryneforms, *Bacillus* spores, streptococci, and Gram negative rods are the major genera present in air.
- More air incorporated into milk leads to the faster growth of bacteria. Practices that increase aerial counts in milk:
 - Sweeping of floors just before milking process
 - Handling hay and feed shortly before milking process
 - Brushing of animals prior to milking process
 - Having the dusty bedding materials for animals
 - Allowing dust and dirt to accumulate on the walls or ceiling of sheds