MICROBIOLOGY OF MILK AND ITS CONTAMINANTS

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Milk Microbiology

- Milk is the primary source of nutrient rich liquid food to humans.
- Milk provides a favorable environment for the growth of microorganisms.
- Most of the changes which take place in the flavour and appearance of milk, after it is drawn from udder are the results of the activities of microbes.
- Bacteria, yeasts and molds can grow in milk particularly at temperature above 16°c.

The important microbes found in milk are,

Bacteria:-

- Are microscopic, unicellular, occurs in the form of spherical, cylindrical or spiral cells. Size 1-5 microns.
- Spore-forming bacteria cause trouble in dairy industry because of their resistance to pasteurization & sanitization procedures.
- Greater the bacteriological count in milk, the lower is its bacteriological quality.

Coliforms:

- Rod shaped Gram-negative non-spore forming and motile or non-motile bacteria
- Facultative anaerobes
- Optimum growth @37^{o}c
- They ferment lactose with production of acid and gas
- Cause rapid spoilage of milk
- They are killed by pasteurization

The following bacteriological standards of raw milk are suggested as a guide for grading raw milk in India.

SPC/ml (org)	GRADE
Not exceeding 2,00,000	Very good
Between 2,00,000 and 10,00,000	Good
Between 10,00,000 and 50,00,000	Fair
Over 50,00,000	Poor

Pasteurized milk should have a SPC/ml (org) not exceeding 30,000.

Moulds:-

- Multi-cellular, at maturity are as “Mycelium”.
- Useful in cheese making which is responsible for defects in butter and other milk products.
- Most spores of moulds are destroyed by pasteurization.

Yeast:-

- Unicellular, larger than bacteria.
- Spores of yeasts are destroyed during pasteurization.

Viruses:-

- Ultra-microscopic forms.
- Viruses that are parasitic on lactic acid bacteria known as **starter bacteriophage.**
- Size 0.22 to 0.23 microns.
- Can not be destroyed by pasteurization but destroyed by higher heat treatment.

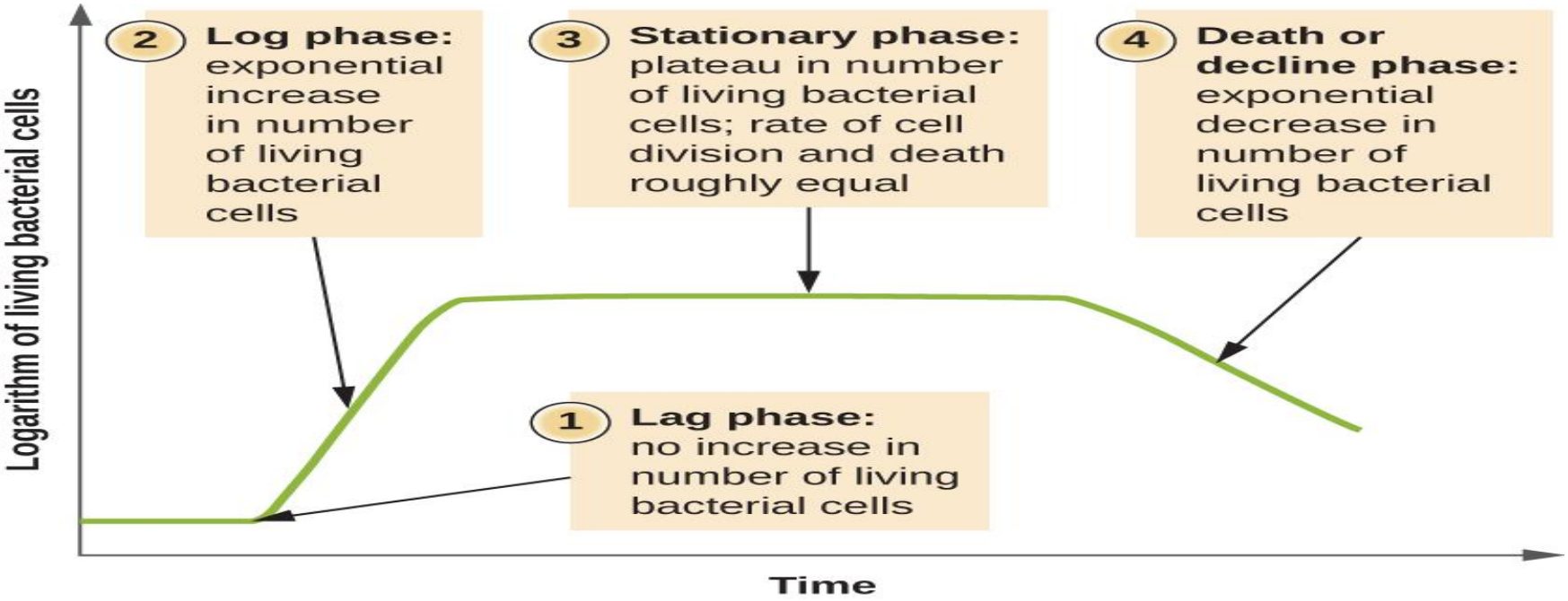
GROWTH OF MICRO-ORGANISMS:

- Bacteria multiply during production and holding of milk, depending on storage time and conditions.
- The changes take place in the physico-chemical properties of milk are result of the activities of the individual microbial cells during their period of growth and reproduction or of substances produced during such activity.
- Microbial growth can be controlled by cooling the milk. Cooling milk also slows chemical deterioration.
- The temperature of freshly drawn milk is about 38°C. Bacteria multiply very rapidly in warm milk and milk sours rapidly if held at these temperatures.
- Natural souring of milk may be advantageous: for example, in smallholder butter-making, the acid developed assists in the extraction of fat during churning.

- The low pH retards growth of lipolytic and proteolytic bacteria and therefore protects the fat and protein in the milk. The acidity of the milk also inhibits the growth of pathogens.
- Naturally soured milk is used to make many products, e.g. yoghurt, sour cream, ripened buttermilk and cheese.
- The microflora in milk when it leaves the farm is determined by the temperature to which it has been cooled and stored.
- The initial bacterial count of milk may range from less than 1000 cells/ml to 106/ml. High counts (more than 105/ml) are evidence of poor production hygiene.

1. Stages of growth:-

i. Initial stationary phase
ii. Lag phase (Phase of adjustment)
iii. Accelerated growth phase (log phase)
iv. Maximum stationary phase
v. Phase of accelerated death.



2. Factors Influencing Growth:-

- **Food supply** – Milk and its products are good food source, provides all food requirements.
- **Moisture** – Milk contains adequate moisture to development.
- **Air** – Supplies Oxygen to aerobic bacteria and moulds.
- **Acidity or pH** – Preferably range 5.6 to 7.5.
- **Preservatives** – Check growth depending upon concentration.
- **Light** – More or less harmful.
- **Concentration** – High sucrose or salt content check growth.
- **Temperature** – Important means for controlling growth.

According to their optimum growth temperature, bacteria can be classified into :

1. **Psychotropic** – can grow at refrigeration temp. (5-7^{0}C)
2. **Mesophilic** – can grow at temp. (20-40^{0}C)
3. **Thermophilic** (heat loving) – can grow at temp above 50^{0}C.

3. Products of Microbial Growth:-

- Enzymes
- Decomposition products (fats, proteins, sugars)
- Pigments
- Toxins
- Miscellaneous changes.

4. Results of Microbial Growth in Milk:-

- **Souring:-** Most common, due to transformation of lactose into lactic acid & other volatile acids & compounds, principally by lactic acid bacteria.
- **Souring & gassiness:-** Caused by coil group, indicates contamination of milk and its products.
- **Aroma production:-** Due to production of desirable flavour compounds such as diacetly.
- **Proteolysis:-** Protein decomposition leading to unpleasant odours.
- **Ropiness:-** Long threads of milk are formed while pouring.
- **Sweet curdling:-** Due to production of a remain like enzyme, which curdles milk without souring.

Action of Microbes on Milk

Microbes	Action	Result
Streptococcus lactis	Souring	Lactose-lactic acid casein precipitation
St. bulgaricus	Souring	Lactose-lactic acid casein precipitation
Lactobacillus casei	Cheese ripening	Controls intestinal fermentation
E coil	Souring & gasiness	Lactic acid & gases Affects cheese ripening
Bacillus substallis	Protecolysis	off flavours
Alkaligenes viscus	Ropiness	Ropi milk
St. liquifiecence	Bitter Flavour	Bitter flavour to cream &butter
B. Substallis	Sweet curdling	Curd formation
St. paracitrovorus	Attacks citric acid	Flavours curd

Destruction of Micro-organisms:-

- **Heat** – Most widely used. Pasteurization & sterilization.
- **Ionizing radiation** – Such as ultraviolet rays etc.
- **High frequency sound waves** – Supersonic and ultrasonic.
- **Electricity** – Micro-organisms are destroyed actually by heat generated.
- **Pressure** – Should be about 600 times greater than atmospheric pressure.
- **Chemicals** – Includes acids, alkalis, hydrogen peroxide, halogens etc.

CONTAMINATION

- ***Milk can be contaminated at any point in the milk production process. It is the responsibility of the food business operator (milk producer) to identify these points and implement control measures to protect milk from contamination.***

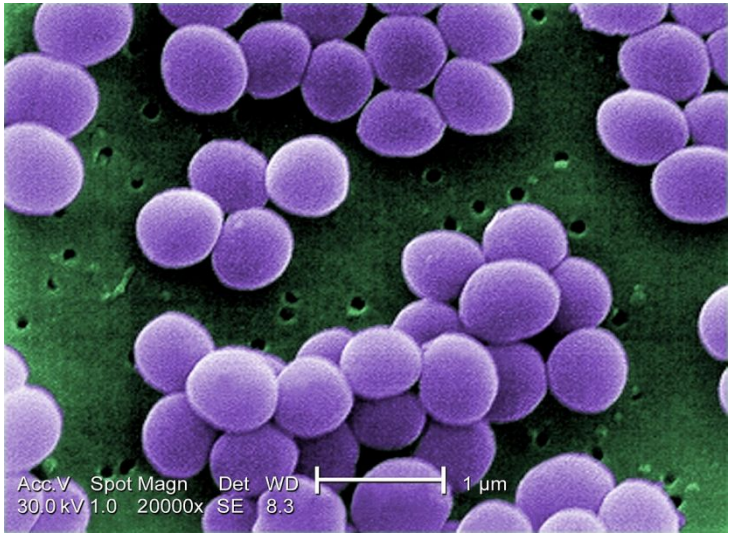
The key sources of contamination are:

- Faecal contamination from soiled animals, especially teats, udders and tails.
- Bacterial contamination from poor milking practices, soiled hands, soiled equipment and failure to clean and disinfect teats prior to milking.
- Contamination due to failure to detect abnormal milk (mastitis pathogens, blood and clots).
- **Physical contamination**, especially from perished components in milking machines and bulk tanks, dust, bedding materials, dung, insects and animal hair.
- **Bacterial contamination** from inadequate cleaning and disinfection of milking equipment and bulk milk tanks.
- **Chemical contamination** from veterinary product residues, cleaning chemicals and use of non food-grade equipment.









Staphylococcus aureus

Streptococcus agalatiae

Contagious Pathogens

- *Staphylococcus aureus*
- *Streptococcus agalatiae*
- *Corynebacterium bovis*

Environmental Pathogens

- *Streptococcus uberis*
- *Streptococcus dysgalactiae*
- *Escherichia coli*
- *Klebsiella spp*

TO REDUCE THE RISK OF CONTAMINATION

Animal Cleanliness:

- All animals should be kept clean.
- All lying areas should be of sufficient size and should be kept clean and dry.
- Passageways and access routes should be free from accumulations of dung and slurry.
- Fields, tracks and gateways should be well maintained and kept free from accumulations of dung, slurry and mud.

Milking Practices:

- Milk from each animal must be examined for physical/chemical/organoleptic abnormalities and where abnormal milk is detected this milk must be rejected.
- Teats, udders and adjacent parts must be clean before milking.
- Hands, contact surfaces and milking equipment must be kept clean at all times.

Milking Equipment:

- Milk contact surfaces must be appropriately cleaned and disinfected immediately after each milking.
- All equipment must be kept clean and in good condition.

Milk Storage and Cooling:

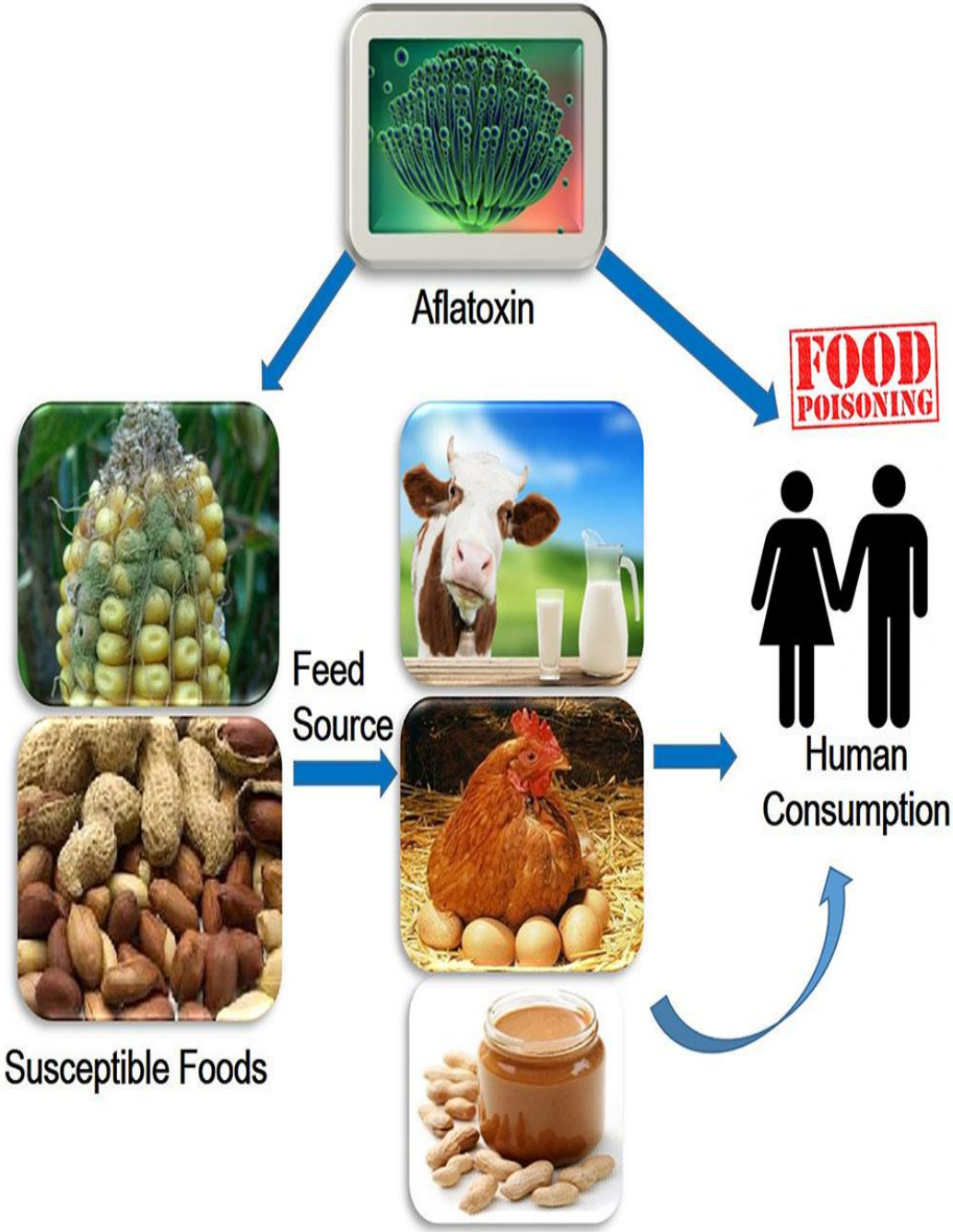
- Milk must be protected from contamination during transfer and storage.
- Milk must be cooled quickly to minimize bacteria multiplication.
- Bulk tanks must be cleaned and disinfected after each milk collection and kept in good condition.

Contaminants in Feed

Many compounds can gain entrance into the milk through the feed, though the cow may act as a filter.

- ***Chlorinated hydrocarbons:***
  - Pesticides Sprayed on feed vegetables –DDT (Dichloro diphenyl trichloro ethane), Aldrin, Dieldrin
  - Feed Silo coating material – PCBs (polychlorinated biphenyls)
    - Harmful at very low concentration and Toxic or carcinogenic

- *Other pesticides, herbicides, and fungicides*
  - Phosphoric esters and carbamates
  - Most of these components are broken down by the cow
- *Mycotoxins*
  - *O*riginate from molds growing on concentrates fed to cows
  - Main contaminant is aflatoxin – Aflatoxins are poisonous carcinogens that are produced by certain molds (*Aspergillus flavus and Aspergillus parasiticus*) which grow in soil, decaying vegetation, hay, and grains.


Aflatoxin
FOOD POISONING
Feed Source
Human Consumption
Susceptible Foods

- *Heavy metals*
  - Pb, Hg, and Cd are especially suspect, but toxic levels have virtually never been found in milk
  - Most heavy metals do not gain entrance into the milk, because the cow acts as a filter, unless extremely high quantities are fed.


thank
you