UNIT 6

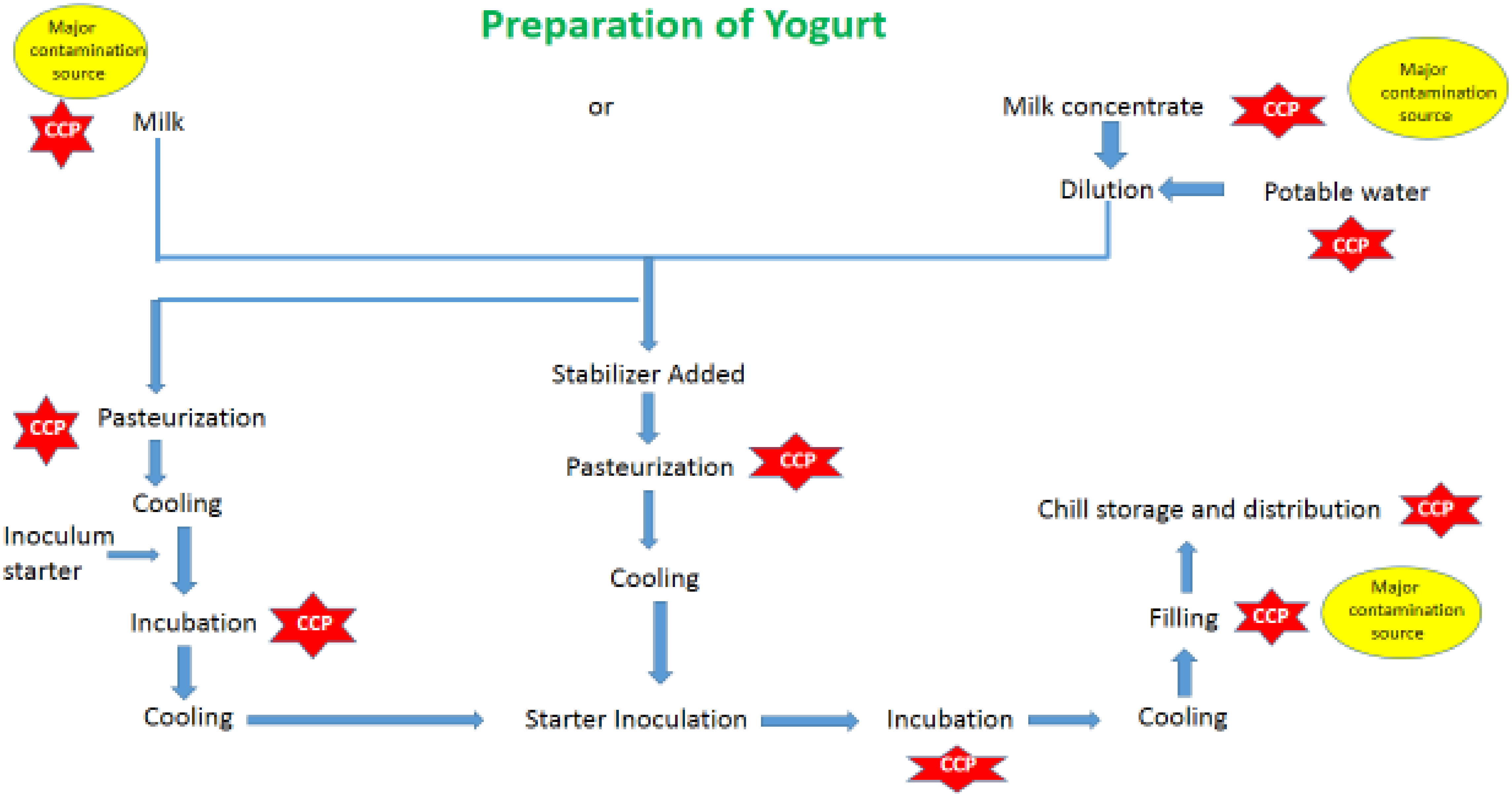
FOOD SANITATION AND CONTROL

HACCP [Hazard Analysis and Critical Control Point]

The 7 principles of HACCP-

1. Conduct a hazard analysis
2. Identify critical control points
3. Establish critical limits for each critical control point
4. Establish critical control point monitoring requirements
5. Establish corrective actions
6. Establish procedures for ensuring the HACCP system is working as intended
7. Establish record keeping procedures

Preparation of Yogurt



Benefits of HACCP

- Increase customer and consumer confidence.
- Maintain or increase market access.
- Improve control of production process.
- Reduce costs through reduction of product losses and rework.
- Increase focus and ownership of food safety.
- Improve product quality and consistency.

Drawbacks of HACCP

- This may be due to improperly trained or untrained personnel not following the principles correctly.
- It may be that the implemented system fails though lack of maintenance, e.g. if a company implements a system and stops there paying little or no heed to changes that occur in the operation, then new hazards may be dismissed.
- The effectiveness may also be lost if the company carries out the hazard analysis and then tries to make its findings fit existing controls.
- Other problems may arise if HACCP is carried out by only one person, rather than a multi-disciplinary team or where it is done at the corporate level with little or no input from the processing facility.
- Poor design and facilities, ineffective cleaning and disinfection

Indices of food sanitary quality and sanitizers

INTRODUCTION

Food quality and safety are important consumer requirements.

Indicator organisms can be employed to reflect the microbiological quality of foods relative to product shelf life or their safety from foodborne pathogens.

In general, indicators are most often used to assess food sanitation.

Three groups of microorganisms are commonly tested for and used as ***indicators*** of overall food quality and the hygienic conditions present during food processing, and, to a lesser extent, as a marker or ***index*** of the potential presence of pathogens (i.e. food safety): coliforms, *Escherichia coli* (*E. coli;* also a coliform) and *Enterobacteriaceae.*

Microbiological indicator organisms can be used to monitor hygienic conditions in food production. The presence of specific bacteria, yeasts or molds is an indicator of poor hygiene and a potential microbiological contamination.

Index Microorganisms

- Microbiological criteria for food safety which defines an appropriately selected microorganism as an index microorganisms suggest the possibility of a microbial hazard without actually testing for specific pathogens.
- Index organisms signal the increased likelihood of a pathogen originating from the same source as the index organism and thus serve a predictive function.
- Higher levels of index organisms may (in certain circumstances), correlate with a greater probability of an enteric pathogen(s) being present.
- The absence of the index organism does not always mean that the food is free from enteric pathogens.

Indicator Microorganisms

The presence of indicator microorganisms in foods can be used to:

- assess the adequacy of a heating process designed to inactivate vegetative bacteria, therefore indicating process failure or success;
- assess the hygienic status of the production environment and processing conditions;
- assess the risk of post-processing contamination; assess the overall quality of the food product.

A number of factors must be considered before testing for a particular indicator organism or group of organisms:

- the physio-chemical nature of the food; the native microflora of the food (fresh fruit and vegetables often carry high levels of *Enterobacteriaceae* and/or coliforms as part of their normal flora)
- the extent to which the food has been processed; the effect that processing would be expected to have on the indicator organism(s)
- the physiology of the indicator organism(s) chosen.

CRITERIA FOR IDEAL INDICATORS FOR PATHOGENIC MICROORGANISMS IN FOOD

- The indicator should preferably contain a single species or a few species with some common and identifiable biochemical characteristics.

- The indicator should be of enteric origin, that is, it should share the same habitat as the enteric pathogens.

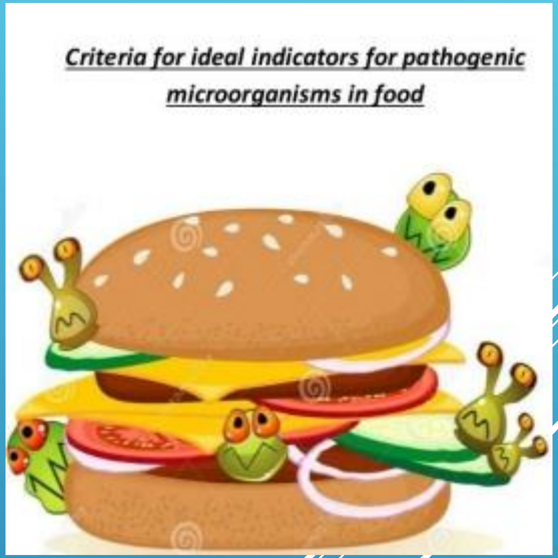
- The indicator should be nonpathogenic so that its handling in the laboratory does not require safety precautions.

- The indicator should be present in the fecal matter in much higher numbers than the enteric pathogens so they can be easily detected.

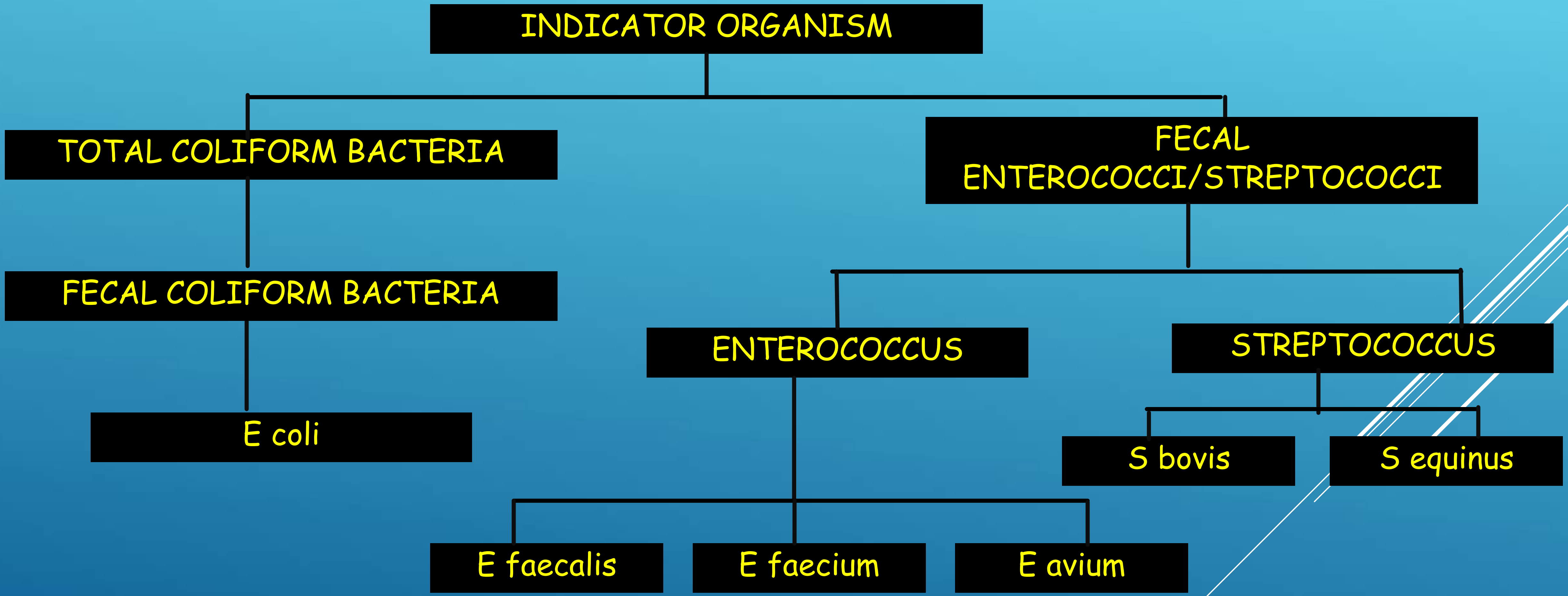
- The indicator should be detected and identified within a short time.

- The indicator should have a growth and survival rate in a food as that of the enteric pathogen.

- The indicator should preferably be present when the pathogens are present in food; conversely, it should be absent when the enteric pathogens are absent. It is apparent that no single bacterial group or species will be able to meet all the criteria of an ideal indicator. Several bacterial groups or species satisfy many of these criteria.



POSSIBLE INDICATOR ORGANISMS



Streptococci

- Since 1985, members of the diverse genus *Streptococcus* have been reclassified into *Lactococcus, Vagococcus, Enterococcus* and Streptococcus, based on biochemical characteristics as well as ssRNA analysis.

- Historically, streptococci were segregated into groups based on the presence of specific carbohydrate antigens. Antigenic groups or Lancefield groups (named for Rebecca Lancefield, a pioneer in *Streptococcus* taxonomy), are designated by letters A through O.

- The β-hemolytic streptococci found in humans contain the group A antigen, while 'fecal streptococci' (enterococci) contain the group D antigen. Group B streptococci usually found in animals are a cause of mastitis in cows and have been implicated in human infections.

- Lactic streptococci (streptococci and lactococci) contain the group N antigen and are non pathogenic.

FECAL ENTEROCOCCI/STREPTOCOCCI

The fecal streptococci are a group of gram-positive Lancefield group D streptococci. The fecal streptococci belong to the genera *Enterococcus* and *Streptococcus*. The genus *Enterococcus* includes all streptococci that share certain biochemical properties and have a wide range of tolerance of adverse growth conditions.

They are differentiated from other streptococci by their ability to grow in 6.5% sodium chloride, pH 9.6, and 45°C and include *Ent. avium*, *Ent. faecium*, *Ent. durans*, *Ent. facculis*, and *Ent. gallinarium*.

10⁰C

Of the genus *Streptococcus*, only *S. bovis* and *S. equinus* are considered to be true fecal streptococci. These two species of *Streptococcus* are predominately found in animals; *Ent. faecalis* and *Ent. faecium* are more specific to the human gut. Fecal streptococci are considered to have certain advantages over the coliform and fecal coliform bacteria as indicators.

- They rarely multiply in water.
- They are more resistant to environmental stress and chlorination than coliforms.
- They generally persist longer in the environment

Coliform

- The coliform group is defined on the basis of biochemical reactions, not genetic relationships, and thus the term "coliform" has no taxonomic validity. Coliforms are aerobic and facultatively anaerobic, gram negative, non-sporeforming rods that ferment lactose, forming acid and gas within 48 hours at $35^{0}C$.

- In the case of refrigerated ready-to-eat products, coliforms are recommended as indicators of process integrity with regard to reintroduction of pathogens from environmental sources and maintenance of adequate refrigeration. The source of coliforms in these types of products after thermal processing is usually the processing environment, resulting from inadequate sanitation procedures and/or temperature control.

- Coliforms are ubiquitous in nature, therefore a number of factors should be considered when testing for a particular indicator organism such as the native microflora of the food, the extent to which the food has been processed, and the effect that processing would be expected to have on the indicator organisms.

E. coli

- A gram negative rod-shaped bacterium that is commonly found in the lower intestine of warm-blooded organisms (endotherms). Most *E. coli* strains are harmless, but some, such as serotype O157:H7 can cause serious food poisoning in humans. The harmless strains are part of the normal flora of the gut, and can benefit their hosts by producing vitamin K, and by preventing the establishment of pathogenic bacteria within the intestine. *E. coli* are easily destroyed by heat, and cell numbers may decline during freezing and frozen storage of foods.

- *E. coli* is the only member of the coliform group that unquestionably is an inhabitant of the intestinal tract and it has become the definitive organism for the demonstration of fecal pollution of water and food not undergoing any processing which would kill the organism.

- In cases where it is desirable to determine whether fecal contamination may have occurred, at present, *E. coli* is the most widely used indicator of such, the presence of which implies a risk that other enteric pathogens may be present in the food. In many raw foods of animal origin, small number of *E. coli* can be expected because of the close association of these foods with the animal environment and the likelihood of contamination of carcasses from fecal material, hides, or feathers during slaughter-dressing procedures

- Dairy microbiologists use *E .coli* as a true indicator organism to assess post-pasteurization contamination in milk. The presence of *E. coli* in pasteurized milk may indicate inadequate pasteurization, poor hygienic conditions in the processing plant, and/or post-processing contamination because proper pasteurization inactivates levels of *E. coli* anticipated in raw milk.

Enterobacteriaceae: The taxonomically defined family, *Enterobacteriaceae*, includes those facultatively anaerobic gram-negative straight bacilli which ferment glucose to acid, are oxidase-negative, usually catalase-positive, usually nitrate-reducing, and motile by peritrichous flagella or nonmotile.

The *Enterobacteriaceae* group does include many coliforms, with the addition of other microorganisms which ferment glucose instead of lactose (i.e. *Salmonella*). Common foodborne genera of the Family *Enterobacteriaceae* include *Citrobacter*, *Enterobacter*, *Erwinia*, *Escherichia*, *Hafnia*, *Klebsiella*, *Proteus*, *Providencia*, *Salmonella*, *Serratia*, *Shigella*, and *Yersinia*.

Psychrotrophic strains of *Enterobacter*, *Hafnia*, and *Serratia* may grow at temperatures as low as 0C.
If the meat ecosystem favors their growth, genera in the family *Enterobacteriaceae* may be important in muscle food spoilage. Conditions allowing growth of *Enterobacteriaceae* include limited oxygen and low temperature. Members of this family produce ammonia and volatile sulfides, including hydrogen sulfide and malodorous amines, from amino acid metabolism.
The *Enterobacteriaceae* have been used for years in Europe as indicators of food quality and indices of food safety.

SANITIZER

- Food contact surfaces
- Importance of cleaning and sanitizing
- Effectivity of sanitizers
- Difference between sanitizers and disinfectants

Types of Sanitization-

1. Hot water/heat sanitizer
2. Chemical sanitizer

Factors affecting the effectiveness of chemical sanitizers- Surface characteristics

Exposure time

Temperature

Concentration

Soil

Physical

Chemical → pH, water properties, inactivators

Biological factors

TYPES OF CHEMICAL SANITIZERS

Chlorine bases sanitizers- Commonly used chlorine compounds include liquid chlorine, hypochlorites, inorganic chloramines and organic chloramines.

Chlorine based sanitizers form hypochlorous acid (HOCl) in solution.

Permissible limit-200 ppm for 1 min (chloramines) and 50 ppm for 1 min (hypochlorites)

Mode of action- Acts on microbial membrane
Inhibit cellular enzymes involved in glucose metabolism
Lethal effect on DNA
Oxidize cellular proteins

Advantages- Has activity at low temperature, is relatively cheap and leaves minimal residue or film on surfaces. It is less affected by water hardness than other sanitizers.

Disadvantages- Corrosiveness to many metal surfaces
Health and safety concerns, activity of chlorine is dramatically affected by factors like pH, temperature and organic load.

Chlorine dioxide- It is more environmental friendly
ClO_2 has 2.5 times the oxidizing power of chlorine
Permissible limit- 1-10 ppm

Disadvantages- Worker safety and toxicity
Rapid decomposition in the presence of light or at temperatures greater than 50^{0}C

IODINE

Iodophore

Permissible limit- 12.5-25 ppm for 1 min

Mode of action-Halogenation of proteins, cell wall damage and destruction of microbial enzyme activity

Advantages- Active against bacteria, viruses, yeasts, molds, fungi and protozoans.
Less affected by organic matter and water hardness than chlorine.

Disadvantage- Staining on some surfaces (especially plastics), loss of activity is pronounced at high pH

Quaternary Ammonium Compounds

The properties of these compounds depend upon the covalently bound alkyl group.

Since they are positively charged cations, their mode of action is related to their attraction to negatively charged materials such as bacterial proteins.

They have the dual property of detergent and sanitizer

Mode of action- They denature proteins, interfere with glycolysis and damage membrane. They damage the cytoplasmic membrane and alter the vital permeability features.

Advantages- Active against bacteria, yeasts, mold and viruses, they possess some detergency so they are less affected by light soil than other sanitizers.

Disadvantages- Not highly effective against bacteriophages
Some cause foaming problems, lack of tolerance to hard water

Acid-anionic sanitizers

Inorganic acid plus a surfactant
Dual function of acid rinse and sanitization

Advantages- Moderately affected by water hardness
Detergency
Stability
Low odour potential
Non-corrosiveness

Disadvantages- Relatively high cost
pH range of activity (2-3)
Low activity on molds and yeasts

Fatty acid sanitizers

Fatty acid plus other acids (phosphoric acids, organic acids)
Dual function of acid rinse and sanitization
Lower foaming potential
Broad range of activity
Highly stable in dilute form
Stable to organic matter
Stable to high temperature application

Disadvantages- Low activity above pH-3.5-4.0
Not very effective against yeast and molds
Lose activity below 10^0C
Corrosive to soft metals and can degrade certain plastics and rubber

Peroxides

They are divided into 2 groups- the inorganic group (hydrogen peroxide)
the organic group (peroxyacetic acid) [PAA]

H_2O_2 used for sterilizing equipment and packages

Mode of action- generation of singlet or superoxide oxygen

Disadvantages- High concentration (5% or above) can be an eye and skin irritant
Limited application in the food industry

PAA- used as chlorine replacement
Stable at strengths of 100 to 200 ppm
Absence of foam
Low corrosiveness
Tolerance to hard water
Useful in removing biofilms

Mode of action- same as H_2O_2

Disadvantages-Pungent odor
Concentrated product (40%) is highly toxic and potent irritant