IMPORTANT MICROORGANISMS IN FOOD

A. IMPORTANT BACTERIAL GROUPS IN FOODS

Among the microorganisms found in foods, bacteria constitute major important groups. This is not only because many different species can be present in foods but also becuase of their rapid growth rate, ability to utilize food nutrients, and ability to grow under a wide range of temperatures, aerobiosis, pH, and water activity, as well as to better survive adverse situations, such as survival of spores at high temperature. For convenience, bacteria important in foods have been divided into several groups on the basis of similarities in certain characteristics. Some of these groups and their importance in foods are listed here.

1. Lactic Acid Bacteria

They are bacteria that produce relatively large quantities of lactic acid from carbohydrates. Species mainly from genera *Lactococcus, Leuconostoc, Pediococcus, Lactobacillus*, and *Streptococcus thermophilus* are included in this group.

2. Acetic Acid Bacteria

Most of the acetic acid belong to two genera *Acetobacter* and *Gluconobacter*. Both oxidize ethyl alcohol to acetic acid, but *Acetobacter* is capable of oxidizing acetic acid further to CO_2.

3. Propionic Acid Bacteria

They are bacteria that produce propionic acid and are used in dairy fermentation. Species such as *Propionibacterium shermanii* are included in this group.

4. Butyric Acid Bacteria

They are bacteria that produce butyric acid in relatively large amounts. Some *Clostridium* spp. such as *Clostridium butyricum* are included in this group.

5. Proteolytic Bacteria

They are bacteria that can hydrolyze proteins because they produce extracellular proteinases. Species in genera *Micrococcus, Staphylococcus, Bacillus, Clostridium,Pseudomonas, Alteromonas, Flavobacterium, Alcaligenes*, some in *Enterobacteriaceae*, and *Brevibacterium* are included in this group. Some bacteria are putrefactive , they decompose proteins anaerobically to produce foul smelling compounds such as H_2S, mercaptans, amines, indole. Ex: *Clostridium, Proteus, Pseudomonas*.

6. Lipolytic Bacteria

They are bacteria that are able to produce lipases which catalyze the hydrolysis of fats to fatty acids and glycerol. Many of the aerobic, actively proteolytic bacteria also are lipolytic.

Species in genera *Micrococcus, Staphylococcus*, *Pseudomonas, Alcaligenes*, *Serratia* , *Alteromonas,* and *Flavobacterium* are included in this group. *Pseudomonas fluorescens* – Strongly lipolytic

7. Saccharolytic Bacteria

They are bacteria that are able to hydrolyze complex carbohydrates (disaccharides or polysaccharides) to simpler sugars. Species in genera *Bacillus, Clostridium, Aeromonas*, *Pseudomonas,* and *Enterobacter* are included in this group. Amylolytic bacteria possess amylase to bring about the hydrolysis of starch outside the cell. Amylolytic bacteria are *Bacillus subtilis* and *Clostridium butyricum*.

8.Pectinolytic Bacteria:

Pectins are complex carbohydrates that are responsible for cell wall rigidity in vegetables and fruits. Species in genera *Erwinia, Bacillus, Clostridum, Achromobacter, Aeromonas, Arthrobacter, Flavobacterium* are included in this group.

9. Thermophilic Bacteria

Optimum temperature required for these bacteria 45°C - 55°C .Species from genera *Bacillus*, *Clostridium, Pediococcus, Streptococcus,* and *Lactobacillus* are included in this group.. *Bacillus stearothermophilus* – thermophilic flat sour spoilage of low acid canned foods.

10.Thermoduric Bacteria

They are bacteria that are able to survive pasteurization temperature treatment. Some species from *Micrococcus, Enterococcus, Lactobacillus, Pediococcus, Bacillus* (spores), and *Clostridium* (spores) are included in this group.

Some thermoduric bacteria like Bacillus and enterococci can also be psychrotrophic.

11. Psychrotrophic Bacteria

They are bacteria that are able to grow at refrigeration temperature. Unlike psychrophiles, psychrotrophs do not have their optimal temperature for growth at refrigeration temperature and their optimum between 25°C and 30°C.

Some species from *Pseudomonas, Alteromonas, Alcaligenes, Flavobacterium, Serratia, Bacillus, Clostridium, Lactobacillus, Leuconostoc, Carnobacterium, Brochothrix, Listeria, Yersinia*, and *Aeromonas* are included in this group.

12.Halophilic Bacteria

Halophilic Bacteria require certain minimal concentrations of dissolved sodium chloride for growth. Ex: *Pseudomonas, Moraxella, Acinetobacter, Flavobacterium, Vibrio* spp. which grow best in media with 0.5 – 3.0 % salt. These are **slightly halophilic**. These bacteria are isolated from fish, shell fish.

Moderate halophiles are grown in the media containing 3.0 – 15% salt, such as salted fish, brined fish, brined meats and some salted vegetables.

Extreme halophiles grow in the heavily brined foods 15 – 30% salt. EX: *Halobacterium, Halococcus.*

13.Halotolerant Bacteria

Halotolerant bacteria can grow with or without salt. Usually they are capable of growing in foods containing 5.0% salt or more. Ex: *Bacillus, Micrococcus, Corynebacterium, pediococcus.*

14. Aciduric Bacteria

Acidoduric bacteria are able to survive at low pH (<4.0). Some species from *Lactobacillus, Pediococcus, Lactococcus, Enterococcus,* and *Streptococcus* are included in this group.

15.Osmophilic or Saccharophilic Bacteria:

Osmophilic bacteria are those which grow in high concentrations of sugar. Ex: *Leuconostoc.*

16. Gas-Producing Bacteria

They are bacteria that produce gas (CO_2, H_2, H_2S) during metabolism of nutrients.

Species from genera *Leuconostoc, Lactobacillus* (heterofermentative), *Propionibacterium, Escherichia, Enterobacter, Clostridium, Bacillus* and *Desulfotomaculum* are included in this group.

Leuconostoc, Lactobacillus, Propionibacterium, produces only CO_2. *Desulfotomaculum* produce H_2S . Other genera produce both CO_2 and H_2.

17. Slime forming bacteria:

They are bacteria that produce slime because they synthesize polysaccharides. Some species or strains from *Xanthomonas, Leuconostoc, Alcaligenes, Enterobacter, Lactococcus,* and *Lactobacillus* are included in this group.

Alcaligenes viscolactis, *Enterobacter aerogenes* producing slime in milk and *Leuconostoc* spp. producing slime in sucrose solutions . *Micrococcus* makes

curing solutions for meats ropy. *Lactobacillus plantarum* and Lactobacilli may produce slime in various fruit, vegetable and grain products e.g. in cider, sauerkraut and beer.

18. Pigmented Bacteria:

Colors produced by pigmented bacteria growing on or in foods.
Flavobacterium – Yellow to orange; *Serratia* – Red; *Halobacterium* – Pink

19. Coliform and Fecal coliform group:

Coliforms are short rods that are defined as aerobic and facultative anaerobic, gram negative, non spore forming bacteria. Ex: *Escherichia coli, Enterobacter aerogenes*.
Fecal coliform group includes coliforms capable of growing at 44 - 45°C. They are used as an index of sanitation.
Some of the characteristics that make the coliform bacteria important in food spoilage are:
1. Their ability to grow well in a variety of substrates and synthesize most of the necessary vitamins.
2. Their ability of the group to grow well over a fairly wide range of temperatures from below 10°C to about 46°C.
3. Their ability to produce considerable amounts of acid and gas from sugars.
4. Their ability to cause off – flavours often described as unclean or barny.
5. Their ability of *E. aerogenes* to cause sliminess or ropiness of foods.

20. Enteric Pathogenic bacteria

Pathogenic *Salmonella, Shigella, Campylobacter, Yersinia, Escherichia, Vibrio, Listeria* and others that can cause gastrointestinal infection are included in this group.

B. Important Mold Genera

Molds are important in foods because they can grow even in conditions in which many bacteria cannot grow, such as low pH, low water activity (a_w), and high osmotic pressure. Many types of molds are found in foods. They are important spoilage microorganisms. Many strains also produce mycotoxins and have been implicated in foodborne intoxication. Many are used in food bioprocessing. Finally, many are used to produce food additives and enzymes. Some of the most common genera of molds found in food are listed here.

1- *Aspergillus*. It is widely distributed and contains many species important in food . Many are xerophilic (able to grow in low a_w) and can grow in grains,

causing spoilage. They are also involved in spoilage of foods such as jams, nuts, and fruits and vegetables (rot). Some species or strains produce mycotoxins (e.g., *Aspergillus flavus* produces aflatoxin). Many species or strains are also used in food and food additive processing. *A. niger* is used to process citric acid from sucrose and to produce enzymes such as B-galactosidase.

2- *Alternaria*. Members are septate and form dark-colored spores on conidia. They cause rot in tomatoes and rancid flavor in dairy products. Some species or strains produce mycotoxins.
3- *Fusarium*. Many types are associated with rot in citrus fruits, potatoes, and grains. They form cottony growth .
4- *Geotrichum*. They grow, forming a yeast like cottony, creamy colony. They establish easily in equipment and often grow on dairy products (dairy mold). Species: *Geotrichum candidum*.
5- *Mucor*. They produce cottony colonies. Some species are used in food fermentation and as a source of enzymes. They cause spoilage of vegetables. Species: *Mucor rouxii*.
6- *Penicillium.* It is widely distributed and contains many species. Some species are used in food production, such as *Penicillium roquefortii* and *Pen. camembertii* in cheese. Many species cause fungal rot in fruits and vegetables. They also cause spoilage of grains, breads, and meat. Some strains produce mycotoxins
7- *Rhizopus*. They cause spoilage of many fruits and vegetables. *Rhizopus* spp. is the common black bread mold.

C. Important Yeast Genera

Yeasts are important in food because of their ability to cause spoilage. Many are also used in food bioprocessing. Some are used to produce food additives.

1- *Saccharomyces.* Cells are round, oval, or elongated. It is the most important genus. *Saccharomyces cerevisiae* are used in baking for leavening bread and in alcoholic fermentation. They also cause spoilage of food, producing alcohol and CO_2.
2- *Pichia.* They form pellicles in beer, wine, and brine to cause spoilage. Some are also used in food fermentation.
3- *Rhodotorula.* They are pigment-forming yeasts and can cause discoloration of foods such as meat, fish, and sauerkraut.
4- *Torulopsis*. They cause spoilage of milk because they can ferment lactose. They also spoil fruit juice concentrates and acid foods.
5- *Candida.* Many species spoil foods with high acid, salt, and sugar and form pellicles on the surface of liquids. Some can cause rancidity in butter and dairy products (e.g., *Candida lipolyticum*).

6- *Zygosaccharomyces*. Cause spoilage of high-acid foods, such as sauces, ketchups, pickles, mustards, mayonnaise.

D. Important Viruses

Viruses are important in foods, some are able to cause enteric disease, and thus, if present in a food, can cause foodborne diseases. Hepatitis A have been implicated in foodborne outbreaks. Several other enteric viruses, such as poliovirus, echo virus, and Coxsackie virus, can cause foodborne diseases. In some countries where the level of sanitation is not very high, they can contaminate foods and cause disease.

Some bacterial viruses (bacteriophages) are used to identify some pathogens (*Salmonella* spp., *Staphylococcus aureus* strains) on the basis of the sensitivity of the cells to a series of bacteriophages at appropriate dilutions. Bacteriophages are used to transfer genetic traits in some bacterial species or strains by a process called transduction (e.g., in *Escherichia coli* or *Lactococcus lactis*).

Finally, some bacteriophages can be very important because they can cause fermentation failure. Many lactic acid bacteria, used as starter cultures in food fermentation, are sensitive to different bacteriophages. They can infect and destroy starter-culture bacteria, causing product failure.