Important Bacteria Genera

Lactic Acid Bacteria

Lactic acid bacteria are among the most important groups of microorganisms used in food fermentations. They contribute to the taste and texture of fermented products and inhibit food spoilage bacteria by producing growth-inhibiting substances and large amounts of lactic acid. They have the ability to ferment sugars to lactic acid.

lactic acid bacteria are those of the Lactobacillales order, including many genera such as: Lactobacillus, Streptococcus and Leuconostoc

Streptococcaceae: differentiate them by lactic acid

1- ***Streptococcus lactis*:** Nisin production of antibiotic which is used in food preservation against bacteria *Clostridium botulinum* (botulinum poisoning).
2- ***Streptococcus thermophiles***: Used to make Swiss cheese because it endures high temperatures up to 45 Celsius and is resistant to pasteurization process.
3- ***Leuconostoc Species*** Desirable in most foods because of their involvement in flavour development and preservation.

Enterobacteriaceae

The genera of this family has no role in the food industry, but on the contrary they cause damage or contamination of food and food poisoning. It includes the following:

1- *E. coli*: It causes severe diarrhea due to an intestinal toxin excretion at eat contaminated food. Food quality evidence of faecal contamination of these foods.
2- *Salmonella enterica*: Causing food poisoning (Salmonellosis)
3- *Shigella dysentery*: Causes of food poisoning (Shigellosis)
4- *Serratia marcescens*: Spoiled the bread where around it to red and is called Red bread (Produces internal dyes Endo pigments).

Bacillaceae

Bacillus bacterial family is one of the most important families and having very great importance are Bacillus and Clostridium where this genus's formed internal Endospores that feature it's resistant to temperatures used in the food industry these bacteria are therefore responsible President of food spoilage thermal treatment like canned foods.

You can differentiate between Bacillus and Clostridium under normal optical microscope through normal size of the spore relative to the size of bacterial cell. *The size of the spore smallest than bacterial cell size (any bacterial cell is bloated

and normal size) as the species belonging to the genus Bacillus. This species lives in aerobic obligate.

*The size of the spore is larger than the size of the bacterial cell (i.e. swollen bacterial cell) as the species of the genus Clostridium. This species lives in anaerobic obliged.

The most important Bacillus bacterial family

1- *Bacillus anthracis*: Causing anthrax to animal and human.
2- *Bacillus subtilis*: Damaged sugary and starchy foods and protein contain enzymes amylase and proteinase sticky materials on starchy foods and cause of rubber.
3- *Bacillus cereus*: Causing food poisoning in starchy foods cooked in restaurants such as rice and potatoes, beans, peas. when left operating hours in hot kitchen condition.
4- *Bacillus stearothermophile*: This type is used as a Bioassay for detecting efficiency of the work of (Autoclave) where his boards are resistant to boiling. It resists the heat used in the canning process and cause damage, sour flat without gas on the contrary acid damage others flat with gas where the enclosure is swollen). The optimal thermal class to grow this kind of 60-70 ^{O}C.
5- The bacteria that cause damage, sour flat without gas due to absence of Formic acid dehydrogenase which produce Co_2 and H_2 (the gas swell canning food as a result).
6- *Clostridium butyricum* damaged sugary food it produces acid Butyric acid is a very stinky.

7- *Clostridium nigrificans*: (newly renamed to *Desulfatomaculun nigrificanse*): analyses and destroy protein foods and produces a compound hydrogen sulfide H_2S (because it contains the enzyme Cysteine desulfurase) who interacts with the iron in the box and have a black sludge and especially in canned food such as peas and beans and canned meat.
8- *Clostridium botulinum*: cause food poisoning Botulism in canned food.
9- *Clostridium perfringense*: cause poisoning in meat, poultry, fish and cheese, and features a special type of fermentation called (Stormy fermentation) to produce massive amounts of gases and acids.

Micrococcaceae

Feature species belonging to this family as widespread in food where food poisoning damage caused as a result of intestinal toxins (Enterotoxins) and the most important of this family: *Micrococcus varians*, *Micrococcus leteus*, *Micrococcus rosous* and they recognize resistance to radiation used in -food industries, notably the Gamma rays and cause damage to refrigerated food and pasteurization process.

1- *Micrococcus varians*: are resistant to pasteurization process and cause damage to pasteurized milk and pasteurized milk have yellow spots.
2- *Micrococcus luteus*: cause damage to the refrigerated food such as meat and cheese and have yellow spots on them.
3- *Micrococcus rosous*: damage the refrigerated food such as meat and cheese and have pink and red spots.

4- *Staphylococcus aureus*: it's positive for Coagulase plasma rennet examination ability brewing sugar mannitol and gas production aerobically and anaerobically and be golden yellow colonial subjects (including the label came aureus). The most that know it is production of intestinal toxins (Enterotoxins) to resist boiling for 30 minutes and causing food poisoning.

Pseudomonadaceae

They are analysed and damage all sorts of sugary food and petroleum products as the cold-loving (Psychrophile) thus causing refrigerated food spoilage. You have configured tints (Exopigments) secrete extracellular bacterial food and thus give the food color.

• Blue pigment Pyocyanin produced by *Pseudomonas aeruginosa*

• Yellow tint green Fluorescein produced by *Pseudomonas fluorescens*

• Black pigment Melanin produced by *Pseudomonas nigrificans*

Example (Pseudomonadaceae)

1. *Pseudomonas fluorescens*: fat and protein analyses in refrigerated foods and reviles its Rancidity. It is produce a yellow food dyes.

2. *Pseudomonas nigrificans*: black dyes special refrigerated cheeses and butter.

Halobacteriaceae

Limited presence in salted food because their need for high concentration of salt, cause damage to fish and cheeses.

Corynebacterium

1- **Propionibacterium**: Ferment sugars and produce propionic acid. Used in
   a- Swaziland cheese
   b- propionic acid Production
   c- Food Preservers
2- **Acetobacter:**
   a- Used in acetic acid production
   b- Spoilage the food that is grow on it because acetic acid production
3- ***Corynebacterium diphtheria***: Causes (Diphtheria) for children after drink contamination milk.

Deferent Bacteria

1- Mycobacterium contamination milk with these type of bacilli bacteria causes diseases
   a- *Mycobacterium tuberculosis*: causes human tuberculosis diseases
   b- *Mycobacterium bovis* causes caw tuberculosis diseases
2- *Vibrio cholera*: Causes of cholera disease due to contaminated food and presence of this bacteria.
3- *Brucella melitensis*: Causing Undulating fever or Malta fever which is due to eating cheese or milk or other dairy products contaminated with these bacteria.
4- *Photobacterium phosphorus*: it is photo bacterium because it has enzyme (Luciferinase) which is:

a- Oxidize the luciferin and generate light.

b- Causes spoilage to Marin fish.

• Factors combine to determine which microbes grow in food

1. Intrinsic factors

Multiplication of food greatly influenced by inherent characteristics of food Microbes multiply most rapidly in moist, nutritionally rich, pH neutral foods.

Intrinsic factors include

1. Water activity
2. pH
3. Nutrients content of the food
4. Biological structures
5. Antimicrobial chemicals

1. Water activity (Water availability OR Moisture content)

• The effect of moisture is in terms of water activity: -the amount of free water in a food medium. The amount of free water is important for growth of microorganisms. If there is lack of this free water microorganisms will not grow. Water activity is defined as the vapour pressure of a food substance to that of water at the same temperature. (Aw = VPFood/VPWater)

• The Pure water activity is therefore equal to 1.0.

• Most bacteria require aw of above 0.90

• Most fungi require aw of above 0.80

• Food products have a water activity of less than 1.0.

• A saturated salt solution has a water activity of 0.75.

• Salting and drying reduces the water activity of a food product

• Growth of microorganisms is greatly affected by the level of water activity(Aw) in the food.

Fresh meats and milk have high water content supports microbial growth Breads, nuts and dried foods have low water availability

• In general, lower water activity inhibits microbial growth. Every organism has minimum level of water activity that is necessary for growth. Microorganisms have varied minimum water activity requirements that supports their growth in food. Water activity lowered by drying and addition of salt or sugar.

Osmophilic microorganisms (70-80% water) prefer high osmotic pressure Xerophilic or dry loving microorganisms are mainly molds prefer low water activity and spoilage dried food.

2. Hydrogen ion concentration (pH)

A. Important in determining which organisms can survive and thrive on specific foods.
B. Many microorganisms inhibited by acid conditions

C. Exception include lactic acid bacteria

D. Lactic acid bacteria used in fermentation process of food production

E. Also prime cause of spoilage of unpasteurized milk and other foods

F. pH can determine bacteria's ability to produce toxin

G. Toxin production of many organisms is inhibited by acid pH

H. Most bacteria grow best at neutral or weakly alkaline pH usually between 6.8 and 7.5

• Some bacteria can grow within a narrow pH range of 4.5 and 9.0, e.g. Salmonella.

• Other microorganisms especially yeasts and molds and some bacteria grow within a wide pH range, e.g. molds grow between 1.5 to 11.0, while yeasts grow between 1.5 and 8.5.

• Microorganisms that are able to grow in acid environment are called acidophilic microorganisms.

• These microorganisms are able to grow at pH of around 2.0.

• Yeasts and molds grow under acid conditions.

• Most acid foods spoil from fungal contamination as opposed to bacteria

• Other microorganisms such as vibrio cholerae are sensitive to acids and prefer alkaline conditions.

• Most bacteria are killed in strong acid or strong alkaline environment except Mycobacteria.

3- Nutrient content of the food

• Nutrients present in food determine organisms that can grow in foods

• Microorganisms require proteins, carbohydrates, lipids, water, energy, nitrogen, sulphur, phosphorus, vitamins, and minerals for growth.

• Various foods have specific nutrients that help in microbial growth.

• Foods such as milk, meat and eggs contain a number of nutrients that are required by microorganisms.

• These foods are hence susceptible to microbial spoilage.

4- Biological structures

• Some foods have biological structures that prevent microbial entry.

• For example, meat has fascia, skin and other membranes that prevent microbial entry.

• Eggs have shell and inner membranes that prevent yolk and egg white from infection.

5- **Antimicrobial Chemicals**: -Some foods contain natural antimicrobial chemicals that inhibit growth of organisms responsible for spoilage. Such as:

• coumarins – fruits and vegetables

• lactinin and anti-coliform factors - milk.

• lysozyme – eggs.

• aldehydic and phenolic compounds – herbs and spices

• allicin – garlic

• polyphenols – green and black teas

2. Extrinsic factors

• Extent of microbial growth largely dependent on storage of food

• Microbes multiply rapidly in warm, oxygen-rich environments

Extrinsic factors include

1. Storage temperature and the effect of temperature on microbial growth

2. Atmosphere

1. Storage temperature and the effect of temperature on microbial growth

Storage temperature affects rate of microbial growth

• Below freezing water availability is significantly decreased

• Water crystallizes and is unavailable halting microbial growth

• At low temperature (above freezing) enzymatic action is very slow or nonexistent

• Results in inability of microbe to grow The growth of microorganisms is affected by the environmental temperatures.

• Various microorganisms are able to grow at certain temperatures and not others.

• Bacteria can therefore be divided into the following groups depending upon their optimum temperature of growth.

(i). Pyshrophilic microorganisms

• Those microorganisms are grown between the temperature ranges of 2 to 20-30 ^{o}C.

• These Psychrophilic found most commonly on food are those that belong to the genera Pseudomonas and Enterococcus.

• grow best at about 20^{o}C but also down to -10^{o}C in unfrozen media.

• Psychrophilic bacteria can cause food spoilage at Refrigerator Temperature and cause spoilage at 5-7 ^{o}C of meat, fish, poultry, eggs, and other food normally held at this temperature.

(ii). Mesophilic bacteria

• These organisms grow between 25^{o}C and 40^{o}C, with an optimum growth temperature close to 37^{o}C

• Some such as Pseudomonas aeruginosa may grow at even lower temperatures between 5-43^{o}C

• None of the mesophilic bacteria are able to grow below 5^{o}C or above 45^{o}C.

• Most pathogenic bacteria belong to this group.

(iii). Thermophilic bacteria.

• These grow at temperatures above 45^{o}C. Often their optimum growth temperatures is between 50^{o}C and 70^{o}C.

• Growth of some bacteria occur at 80°C. Bacteria in this group are mainly spore formers and are of importance in the food industry especially in processed foods. (Bacillus and Clostridium species)

2. Atmosphere

• Various microorganisms require for growth, either high oxygen tension (aerobic), low oxygen tension (micro aerobic) or absence of oxygen (anaerobic).

• Some microorganisms may grow either in high oxygen tension, or in the absence of oxygen (facultative anaerobes).

Foods affected by various groups

• Anaerobic or facultatively anaerobic spore formers are most likely to grow in canned foods.

• Microaerophilic bacteria are most likely to grow in vacuum packed foods since they have low oxygen tension.

• Aerobic bacteria are likely to grow on the surface of raw meat.

• Aerobic molds will grow in insufficiently dried or salted products

• Obligate aerobes cannot grow under anaerobic conditions

• Obligate anaerobes will grow in anaerobic conditions

• Including certain foodborne pathogens

Food Spoilage Microorganisms Microbial Flora of Foods

Classification of Food

Based on the spoilage, the food can categorize into three types:

1. Non-perishable food has no water content and can be stored for a long time. These are having a long shelf life. E.g. Sugar, flour, bean.
2. Semi-perishable food has less water content and can be stored for some time. These are having a medium shelf life. E.g. Onion, Garlic, Potato.
3. Perishable food has high water content and cannot store for a longer period. These are having a short shelf life. E.g. Milk, Meat, Fruit, Vegetable.
4. The high water or moisture content is a factor which will directly influence the microbial growth, as water promotes the growth of all living beings. Therefore, the food which is susceptible to the spoilage process refers to Perishable food.

Food Spoilage Microorganisms

Microorganisms can be put to good use for the production of fermented foods, but that they can also be the causes of spoilage and food borne diseases. Bacteria, yeasts and molds may contribute to fermented foods, as well as food spoilage and food borne disease. Viruses can be agents of food borne disease but do not cause food spoilage, nor are they used to produce fermented foods.

Causes of food spoilage

Food Spoilage Due to:

1- Insects & Rodents Damage Foods

1. Insect damage: Physical damage to food items indirectly causes food spoilage

2. Physical injury: Action of enzymes found inherently in plant or animal tissues start the decomposition of various food components after death of plant or animal.

3. Activity of enzymes: Action of enzymes found inherently in plant or animal tissues start the decomposition of various food components after death of plant or animal.

4. Chemical changes: Action of enzymes found inherently in plant or animal tissues start the decomposition of various food components after death of plant or animal.

5. Activity of microorganisms

The Metabolites that are produced during microbial spoilage

1. Alcohols

2. Sulphur compounds

3. Ketones

4. Hydrocarbons

5. Fluorescent pigments

6. Organic acids

7. Esters

8. Carbonyls

9. Diamines

Food Microbial spoilage manifest itself as the following:

1. Visible growth – e.g. Molds often produce large, pigmented colonies (visible bacterial and yeast colonies are less common).

2. Gas production

3. Diffusible pigment and enzymes- which may produce softening and rotting (proteolysis)

4. Off – odors

5-Off – flavors

6- Slime

The Sequence of Events in Food Spoilage

A- Microorganisms have to get into the food from a source or more

B- Food environment should favour the growth of microbes

C- Food needs to be stored under the growth condition for a sufficient length of time:

1. To allow sufficient number necessary to cause spoilage or changes in food.

2. To allow the produced enzyme to spoil the food.

The Preventions of Microbial Spoilage

1. Use of quality raw materials
2. Correct storage for the food type
3. Allocation of appropriate shelf- life
4. HACCP and other quality systems
5. Hygiene of processing environment
6. Use of predictive methods
7. Training and education

The Sources of the Food Spoilage Microorganisms

1. Soil and water
2. Plants and plant products
3. Air and dust
4. Animal hides
5. Gastro intestinal tract of animals and humans
6. Food handlers
7. Food utensils and processing equipment.

Why spoilage is most rapid in proteinaceous chilled fresh foods (e.g. red meats, poultry, fish and dairy products)? This Due to:

1. Highly nutritious
2. High moisture content/ Aw. 3. Relatively neutral PH

The Deferent Between Food Microbial Spoilage (Fruit spoilt and Vegetables spoilt)

Fruit spoilt subject to both yeasts and molds (The low PH prevents bacterial growth)

Vegetables spoilt subject to both bacterial and fungal spoilage

A- Spoilage of Dairy Products:

a. Dairy Products are ideal growth medium Normaly* m/o = 100-10,000 **cfu/ml from cow and equipment

b. Pseudomonas, Alcaligenes, Aeromonas, Acinetobacter, Moraxella, Flavobacterium, Micrococcus, Streptococcus, Corynebacterium and Lactobacillus

c. Psychrotrophilic m/o □ heat stable lipase and proteases (not denatured during pasteurization)

*m/o: microorganism **cfu: colony form unit

Lipase □ short-chain fatty acid□ rancid Proteases □ bitter peptides

d. Pasteurization kills pathogens such as Mycobacterium tuberculosis, Salmonella and Brucella spp.

e. Thermoduric m/o survive □ Streptococcus thermophilus, Enterococcus faecalis, Micrococcus luteus.

B- Spoilage of Meat and Poultry Products

1. Meat and Poultry Products are Highly (perishable, Aw, Protein, Buffer) and stable pH).

2. Meat and Poultry Products Sterile inside become contaminated during slaughter, processing and storage such as

a. Cutting board contamination

b- Conveyor belts

c. Temperature

d. Failure to distribute quickly

e. Fecal bacteria from intestines

3. Pseudomonas, Brochothrix thermophacta and LAB - Pathogens: *Salmonella, Escherichia coli, Listeria monocytogenes, Clostridium perfringen and Streptococcus aureus, Campylobacter jejuni*

C- Spoilage of Fish

• Fish skin normally has 103 – 105 cfu/cm2

• Gills: 103 – 104 cfu/g

• Intestine: 102 – 109 cfu/g

• Psychrotrophs: Pseudomonas, Alteromonas, Shewanella, Acinetobacter

• mesotrophs: micrococci, coryneforms

• Can be rapidly spoilage

• Faster than meat spoilage

• Off-odor: Pseudomonas spp. Produces volatile ester (ethyl acetate), volatile supplied compound (methyl mercaptan, dimethyl sulphide)

• Spoiled fish odor: trimethylamine oxide is reduced by Shewanella putrefacien

d- Egg spoilage

• Natural antimicrobial agents: iron chelating agents (conalbumin) and lysozyme in the albumen (egg white)

• Shell is covered with a water repellent cuticle and two inner membranes

• Pseudomonas spp., Proteus vulgaris, Alteromonas spp., Serratia marcescens

Shelf-Life Indicators

• Time between the production and the packaging of product and the point at which it becomes unacceptable to the consumer

• Depends on intrinsic and extrinsic factors

• Shelf-life determination

1. Direct determination and monitoring: take sample at intervals equal to 20% of expected shelf-life to give samples of six different ages. Samples are stored under controlled conditions until their quality becomes unacceptable. Evaluated smell, texture, flavor, color and viscosity. Not ideal method for canned foods.

2. Accelerated estimation: Store at high temperature. However different m/o may require different temperature to growth.

The Sources of the Food Spoilage Microorganisms

1- Plants (Fruits and Vegetables)

Fruits and vegetables harbor microorganisms on the surface; their types and level vary with:

a- soil condition

b- type of fertilizer

c- water used

d- air quality

Examples of Microorganisms in Plants Molds, Yeasts lactic acid bacteria, Pseudomonas, Alcaligenes, Micrococcus, Erwinia, Bacillus, Clostridium, Enterobacter.

Factors Increasing the number of Microorganisms in the Plant

1. diseases of the plant.

2. damage of the surface.

3. long delay between harvesting and washing.

4. unfavorable storage and transport before processing and improper storage after processing.

Reduction of Microbial Load in Foods of Plant Origin

1. Use of treated sewage for fertilizers

2. Damage reduction during harvesting

3. Quick washing with good quality water to remove soil and dirt.

4. Storage at low temperature before and after processing.