

## ***Food spoilage***

### **What is Food spoilage?**

Spoilage is the process in which food deteriorates to the point in which it is not edible to humans or its quality of edibility becomes reduced.

Various external forces are responsible for the spoilage of food. Food that is capable of spoiling is referred to as perishable food. A food is considered spoiled when it loses its acceptance qualities. The factors considered in judging the acceptance qualities of a food include color, flavor, odor, texture and /or appearance of abnormalities. **e.g** : sour milk, moldy cheese, slimy & rancid meat, mushy& discolored vegetables.

Loss of one or more normal characteristics in a food is considered to be due to spoilage.

Spoilage by microbial growth occurs much **faster** than spoilage by microbial Extra - or Intracellular enzymes in the absence of viable microbial cells. Microorganisms have to get into the food from one or more sources: the food environment should favor growth of one or more types of these contaminating microorganisms; the food must be stored (or abused) at a temperature that enables one or more types to multiply; and finally, the food must be stored under conditions of growth for sufficient length of time for the multiplying microbial types to attain the high numbers necessary to cause the detectable changes in a food.

### ***What are the steps of food spoilage??***

- Introduce microbes to food
- Food environment is favorable for growth
- Food is stored at a temperature that favors growth
- Enough time elapses
- Thermoduric microbes survive heat treatment
- Heat-stable enzymes can degrade food
- Bacteria, yeasts, and molds cause most food spoilage

***Causes of Food Spoilage:*** The major causes of food spoilage include:

1. Microorganisms, their growth and activity
2. Action of native enzymes
3. Chemical reactions of the constituents of food
4. Environmental factors such as temp., moisture, air and light
5. Insects, rodent and parasites
6. Time

### ***Activity of Microorganism***

#### **- Microbial types**

Raw and most processed foods normally contain many types of bacteria, yeasts, and molds, capable of multiplying and causing spoilage (Viruses and parasites do not multiply in foods). As multiplications an important component in spoilage, bacteria, followed by yeasts, are in favorable positions over molds to cause rapid spoilage of foods. However, in foods where bacteria or yeasts do not grow favorably and the foods are stored for a relatively longer period of time, such as breads, hard cheeses, fermented dry sausages, and acidic fruits and vegetables, spoilage due to mold growth is more prevalent. Thus, among the three microbial groups, the highest incidence of spoilage, especially rapid spoilage, of processed foods is caused by bacteria, followed by yeasts and molds.

#### **- Microbial numbers:**

To produce detectable changes in color, odor, and texture of a food accompanied with slime formation or gas and liquid accumulation, microorganisms (mainly bacteria and yeasts) must multiply and attain certain levels, often referred to as the "spoilage detection level." Although it varies with the type of foods and microorganisms, bacteria and yeasts need to grow and reach to  $10^7$  cells/g, /ml, or /cm<sup>2</sup>, of a food from the level present normally in a food. Depending on the specific nature of spoilage and microbial types, the spoilage detection level can range from  $10^{6-8}$  cells/g, /ml, or /cm<sup>2</sup>. Spoilage associated with H<sub>2</sub>S, some amines, and H<sub>2</sub>O<sub>2</sub> formation can be detected at a lower microbial load, whereas formation of lactic acid may be detected at a higher microbial load. Slime formation, associated with accumulation of microbial cells, is generally detected at  $\geq 10^8$  cells/g, /ml, or /cm<sup>2</sup> of a food.

The primary sources of microorganisms in food include: Soil and water, plant and plant products, food utensils, intestinal tract of man and animals, food handlers, animal hides and skins, air and dust.

- **Food types:**

Foods differ greatly in their susceptibility to spoilage by microorganisms. This is mainly because of their differences in intrinsic factors ( $a_w$ , pH, O-R potential, nutrient content, antimicrobial substances, and protective structures). A food with a lower  $a_w$  (~ 0.90) or a lower pH (~5.3) is less susceptible to bacterial spoilage than one with a  $a_w$  of 0.98 or pH of 6.4.

In addition to intrinsic parameters, extrinsic parameters (storage conditions) play important roles in determining the ease of microbial spoilage of many foods.

On the basis of susceptibility of spoilage, foods can be grouped as:

- *High Perishable* : (spoil quickly, in days),  
e.g: Meat, fruit, milk, vegetables & eggs
- *Semi-perishable*: (have a relatively long shelf life, few weeks or months),  
e.g: Potatoes, nuts & flour.
- *Nonperishable*: (have a very long shelf life, many months or years), e.g:  
Rice & dry beans.

**Types of food decay:**

Most foods serve as good growth medium for many different microorganisms. Microbial growth in a food is associated with the metabolism of some food carbohydrates; proteinaceous and non-protein nitrogenous (NPN) compounds; and lipids by specific pathways and produce metabolites as following:

**\*\* Putrefaction:**

Anaerobic breakdown of protein, with production of foul-smelling (milk, fish, egg, meat). *Formula of putrefaction:*

**Protein foods + proteolytic microorganisms -----» amino acids  
+ amine + ammonia + H<sub>2</sub>S**

**\*\*Fermentation:**

Chemical changes in organic substances produced by the action of enzymes.

*Formula of fermentation:*

**Carbohydrate foods + saccharolytic microorganisms -----» organic acid  
+ alcohol + gases.**

**\*\* Rancidity:**

Is the development of unpleasant smells in fats and oils, which are often accompanied by changes in their texture and appearance. *Formula of microbial rancidity:*

**Fatty foods + lipolytic microorganisms -----» fatty acids + glycerol.**

***Examples Spoilage of Various Food and Food Products***

***1- Spoilage of fresh and ready-to-eat meat products***

**Raw Meat:**

Meats are the perishable of all important foods because of high water activity and abundant nutrients make meat an excellent medium to support microbial growth. Fresh meats from food animals and birds contain a large group of potential spoilage bacteria that include species of :

*Pseudomonas, Acinetobacter, Moraxella, Shewanella, Aeromonas, Escherichia, Enterobacter, Proteus, Micrococcus, Enterococcus, Lactobacillus, Leuconostoc, and Clostridium*, as well as yeasts and molds .

Meat is rapidly contaminated when it is ground for hamburger or sausage because the bacteria normally present on the outside of the meat move into the chopped meat where there are many air pockets and a rich supply of moisture. Fish tissues are contaminated more readily than meat because they are of a looser consistency and are easily penetrated.

The kind and amount of spoilage of meat depends upon:

- 1-The availability of nutrients
- 2-Presence of oxygen,
- 3-Temperature of storage,

4- pH,

5- The storage time of the product,

6- Generation time of the spoilage microorganisms under a given environment.

### **To reduce spoilage of fresh meats:**

- Initial microbial level should be reduced-----storage at low temperatures (close to 0 to -1 °C),
- Modified atmosphere packaging, and vacuum packaging should be done.
- Several other methods to reduce initial microbial load and slow growth rate of Gram-negative rods are being either used or tested. These include the addition of small amounts of organic acids to lower the pH of meat (slightly above pH 5.0),
- Drying of meat surfaces (to reduce  $a_w$ ),
- And a combination of the factors given previously, including lower storage temperature.

### **Ready-to-Eat Meat Products:**

This group includes high-heat-processed and low-heat-processed uncured and cured meat products. High-heat-processed cured and uncured meats are given heat treatment to make them commercially sterile. Thus, they may only have some thermophilic spores surviving, which will not germinate unless the products are temperature abused.

Low heat-processed uncured meats, such as roasts, are given heat treatment ranging from internal temperature (60 to 71°C) for 1h or more depending upon the size of the meat. Under this condition, only the spores of *Bacillus* and *Clostridium* spp. and some extremely thermotolerant species like *Lactobacillus viridescens*, some *Enterococcus*, *Micrococcus* can survive. Sources of microorganisms are; raw meat, spices and other ingredients & Natural casings. Spoilage in ready to eat meat products include:

- 1- Slimy spoilage:** Occurs on the outside of casing (Yeast, *Lactobacillus*)
- 2- Souring:** Occurs underneath the casing, due to growth of *Lactobacillus*.
- 3- Greening:** Due to  $H_2O_2$  production (*Lactobacillus*) & due to  $H_2S$  production (*Pseudomonas* sp.) This reacts with myoglobin to form sulphmyoglobin.

## ***2-Spoilage of fish:***

Fish of both fresh-water and salt-water contain high levels of proteins and nitrogenous constituent with low fat content and practically no carbohydrates

Fresh fish and iced fish are spoiled by bacteria while salted and dried fish are spoiled by fungi

*Pseudomonas*, *Acinetobacter* and *Moraxella* species are involved in the bacterial spoilage. In addition intestinal bacteria of the fish and native proteolytic enzymes also contribute to the spoilage and develop off-odours and sliminess.

Shell fish such as shrimp, lobster, crab, crayfish undergo bacterial spoilage by *pseudomonas*, *acinetobacter*, *moraxella* species, similar to that of fresh fish.

## ***3-Spoilage of egg:***

Internally the egg white is not susceptible to microbial spoilage because of its high pH of about 9.3 and because of the presence of ingredients which function as antimicrobial agents, these include lysozyme which is effective against gram positive bacteria, avidin which forms a complex with biotin rendering the vitamin unavailable to microbes, and conalbumin which forms a complex with iron preventing its use microorganism

Egg yolk is an excellent medium for the growth of most microorganism because of its neutral pH (6.8) and nutrient content. Bacteria grow in the yolk producing hydrogen sulphide and other foul smelling compounds and also cause the yolk to become runny and discolored. Storing eggs in highly humid conditions favors the growth of microorganisms on the surface and facilitates microbial penetration. At very low humidity egg lose water and become undesirable. Most common bacterial spoilage of egg is rotting.

Green rot caused by *Pseudomonas* sp., black rot by *Aeromonas*, *Pseudomonas proteus* sp., colourless rot by *Acinetobacter* and *Pseudomonas*, red rot by *Serratia* and custard rot by *Acinetobacter* and *Pseudomonas*.

Molds cause pinspots due to mycelial growth which can be seen by candling *Penicillium* and *Cladosporium* sp. Cause the pinspots and fungal spoilage of eggs.