SPOILAGE OF STORAGE FOODS

TODAY'S TOPIC:
SPOILAGE OF STORAGE FOODS

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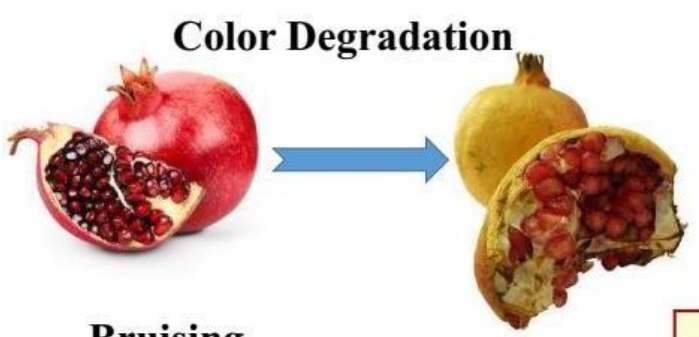
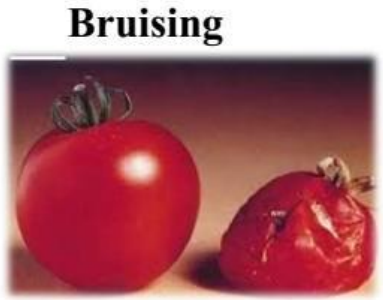
CONCEPT ON FOOD SPOILAGE

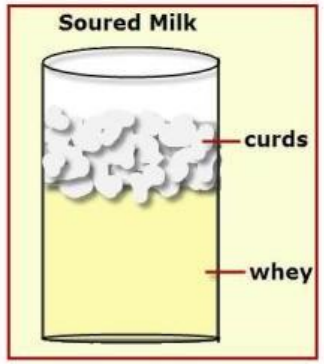
- **Food spoilage is defined as damage or injury to food rendering in unsuitable for human consumption.**
- Food spoilage means the original nutritional value, texture, flavor of the food are damaged, the food become harmful to people and unsuitable to eat.
- **Food must be considered spoiled if it is contaminated with pathogenic microorganisms or various poisonous agents, such as pesticides, heavy metals etc.**
- Spoiled food considered unsafe ---- food borne pathogen may be present
- Any changes in the visual ,smell and texture of food that makes it unacceptable for consumption.

Factors affecting Food Storage

- ***Micro Organisms (Fungi, Bacteria and yeast)***
- Activities of Microorganisms results
  - Color degradation
  - Off flavor
  - Moisture upgrading, wet spot







Insects, Mites and Pests:

- Activities of Insects, Mites & Pests
  - Insects, mites and pests attack both the stored material and wooden components of the storage structure.
  - Weevils are the common insects in grains. They attack seeds and bore through them, and lay eggs in the seeds and storage structures.
  - They reduce seed weight, quality, and nutritional value.

Rodents:

Rodents are mammals that parasite on stored materials and attack storage structures.

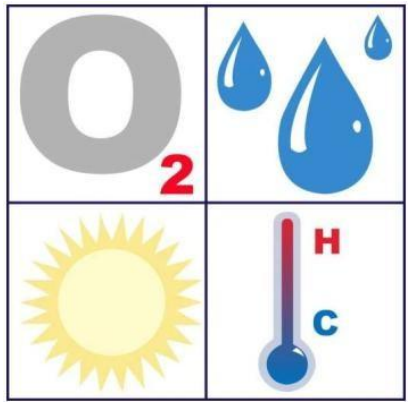
- They eat germs of grains and waste the remaining parts.
- They are vectors.
- They contaminate stored materials with their faces, urine and carcasses.

- ***Environmental factors***

- **Temperature:** The temperature at which food is stored is very critical to shelf life. United States Department of Agriculture, USDA, states that for every 10.8 degrees in temperature rise you decrease the shelf life of stored food by half. The best range for food storage is a constant temperature between 40-60 degrees. Avoid freezing temperatures.

- **Moisture:** It is recommended to remove moisture when storing foods. For long term storage foods should have a 10% or less moisture content.

- **Oxygen:** Foods store best when oxygen free. Removing oxygen will prevent oxidation of compounds in foods. Ways to remove oxygen:
  - ***Displacing oxygen*** – Purge air from product with an inert gas (nitrogen). Dry ice is often used giving off carbon dioxide gas which displaces oxygen.
  - **Oxygen absorber** – Air contains about 78% nitrogen and 21% oxygen, leaving about 1% for the other gasses. If the oxygen is absorbed, what remains is 99% pure nitrogen in a partial vacuum.
- **Light:** Light, a form of energy that can degrade the food value of foods. Store food in dark areas.



CAUSES OF FOOD SPOILAGE

The major causes of food spoilage include

1) Growth and activity of Microorganisms
2) Action of native enzymes
3) Chemical reactions of the constituents of food
4) Vermin
5) Mechanical damage and
6) Storage conditions

CAUSES OF FOOD SPOILAGE(CONT.)

Growth and activity of microorganisms

- Bacteria, yeasts and molds are microorganisms that cause food spoilage. They produce various enzymes that decompose the various constituents of food.
- Bacteria, yeasts and molds.

Bacteria

Mold

Yeast

CAUSES OF FOOD SPOILAGE(CONT.)

Growth and activity of microorganisms

- Bacteria: Bacteria (singular bacterium) are prokaryotic microscopic organism that lacks a nuclear membrane around their single circular chromosome. Reproduction is done by simple fission.
- Mold: Mold is the multicellular filamentous fungi whose growth on foods usually is recognized by its fuzzy or cottony appearance. Reproduction is done by asexual & sexual reproduction.
- Yeast: A microscopic fungus consisting of single oval cells that reproduce by budding, and capable of converting sugar into alcohol and carbon dioxide.

EXAMPLES OF EACH GROUP MICROORGANISM

Bacteria	Mold	Yeast
Escherichia coli	*Penicillium roqueforti*	***Saccharomyces cerevisiae***
Lactobacillus acidophilus	*Aspergillus oryzae*,	***Cryptococcus neoformans***
Lactobacillus bulgaricus	*Rhizopus oryzae*	*Saccharomyces pastorianus*
Lactobacillus fermentum	*Penicillium chrysogenum*	*Candida stellata*
Clostridium botulinum	*Penicillium notatum*	***Candida albicans***

(B). ENZYME ACTIVITY:

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

Browning:

When you cut or bruise food such as apple or yam, the exposed surface will discolor and turn brownish due to the activity of enzymes (phenolase, peroxidase and polyphenol oxidase).

Ripening:

Enzymes are involved in the process that causes ripening in certain foods such as fruits and vegetables. For example, unripe bananas contain starch which is gradually converted to sugars.

CAUSES OF FOOD SPOILAGE(CONT.)

(C). CHEMICAL REACTIONS:

These are reactions that are not catalysed by enzymes.,e.g. oxidation of fat.

- The qualities of foods deteriorate due to chemical reactions of the constituents of food.
- The unsaturated fatty acid components undergo oxidation due to exposure to atmospheric air.(Rancidity)
- Free fatty acids released due to hydrolytic reactions causing odor as well as undesirable changes in the texture of food.
- Chemical reactions also include losses of vitamins due to oxidation or light.
- Chemical reactions can be prevented by using antioxidants and proper packaging.

CAUSES OF FOOD SPOILAGE(CONT.)

(D). VERMIN:

Vermin includes ants, rats, cockroaches, mice, birds, larval stages of some insects.

- Vermins are particularly destructive to fruits and vegetables.
- The loss of food due to vermins varies from 5 to 30% depending upon the care taken during storage.
- Insects cause greater damage by brusing and cutting, thus exposing them to microbial atatck.
- On the otherhand, rodent consuming considerable quantity of food also contaminate the food through their droppings, urine and filth. Rodents are also carries of pathogenic bacteria.
- Insect infestations in grains, dry fruits, spices are generally controlled by fumigation with methyl bromide, ethylene oxide or propylene oxide.

CAUSES OF FOOD SPOILAGE(CONT.)

(E)MECHANICAL DAMAGE

- Mechanical damage of fruits and vegetables may be resulted during harvesting.
- Mechanical damage also caused during post harvest handling, mainly transportation.
- Proper packaging and post-harvest handling with care are recommended to reduce post-harvest loss due to mechanical damage.

CAUSES OF FOOD SPOILAGE(CONT.)

(F) STORAGE CONDITIONS

Temperature

- Temperature of storage chamber plays important role in deteriorating quality of foods. The rate of a chemical reaction doubles for every 10^{o}C rise in temperature

Oxygen

- Atmospheric oxygen has detrimental effects on vitamin A, C, food color, flavor and other constituents.

Light

- Light destroys riboflavin, vitamin A, Vitamin C and also promotes light induced oxidation reactions affecting flavor and color of food

Duration

- Deterioration of food is time-dependent. The longer the storage time the greater the deterioration


WELCOME
BACK

WHEN FOOD SPOILS, THE FOLLOWING MAY CHANGE:

appearance

taste

texture

odour

Food may become unsafe to eat.

WHEN A FOOD "LOOKS BAD," WHAT IS THIS REFERRING TO?

1. Appearance

   Microbial growth

   - mycelia or colonies visible on surface (vegetative part of a fungus/fungus-like bacterial colony)
   - development of cloudiness in liquids
   - Changes in food color due to heme or chlorophyll breakdown

2. Textural changes

   - Slime formation
     - due primarily to surface accumulation of microbial cells
     - also be a manifestation of tissue degradation
     - Tissue softening due to enzymatic degradation (e.g. soft rot in veggies)

3. Changes in taste and odor

   Development of:

   - nitrogenous compounds (ammonia, amines, etc.)
   - sulfides
   - organic acids

Do you know which is responsible for meat color?

Hemoglobin (Not)

Correct Answer:?????

INFORMATION FOR PREVIOUS SLIDE.

- Heme (from the Greek for blood) is the basic chemical structure (Fig. 1) responsible for the red color of two important animal pigments:
- hemoglobin, the red pigment of blood, and myoglobin, the red pigment of muscles.
- Practically all the red color of red meat is due to myoglobin,
- since the hemoglobin is removed with the bleeding of the slaughtered animal.
- Other colored muscle compounds (cytochromes, vitamin B_{12}, flavoproteins) do not contribute significantly to the color of red meat.

INTRINSIC FACTORS :

These are inherent in the food. They include:

Hydrogen ion concentration (pH) water activity

Nutrient content

antimicrobial substances

Biological structure

HYDROGEN ION CONCENTRATION (PH)

- 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.
- 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.

CLASSIFY FOOD ON THE BASIS OF PH

Table 3: Minimum and maximum pH for growth of some specific microorganism

Microorganism	Minimum	Maximum
Escherihia coli	4.4	9.0
Salmonella typhi	4.5	8.8
All bacteria	4.0	9.0
Molds	1.5	11.0
Yeast	1.5	8.5

WATER ACTIVITY

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 vapor pressure of water in food substance to vapor pressure of pure water at the same temperature. (Aw = Vp of Water in Food/Vp of Pure Water)
- The water activity is therefore equal to 1.0.
- 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.

Classify Microorganism On the basis of Water Activity Level

WATER ACTIVITY

Table 4: Water activity of some food products.

Food Product	Water activity
Raw meat and milk	0.99- 1.0
Luncheon meat	0.95
Boiled ham, sliced bacon	0.90
Dried grains	0.80

Table 5: Minimum water activity that supports growth of some microorganisms

Microorganism	Water activity
Clostridium botulinum,	0.95
Bacillus cereus,	0.95
Pseudmonas aeroginosa,	0.95
Salmonella spp.	0.95
Staphylococcus aureus (anaerobic), Candida spp., Saccharomyces	0.90
Staphylococcus aureus (aerobic)	0.86
Penicillium spp.	0.82
Most spoilage yeast	0.88
Most spoilage molds	0.80
Osmotic yeast	0.70

NUTRIENTS CONTENT OF THE FOOD

- 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.

ANTIMICROBIAL SUBSTANCES AND BIOLOGICAL STRUCTURE

Antimicrobial substances

- Antimicrobial substances in food inhibit microbial growth.

•Various foods have inherent antimicrobial substances prevent (inhibit) microbial attack.

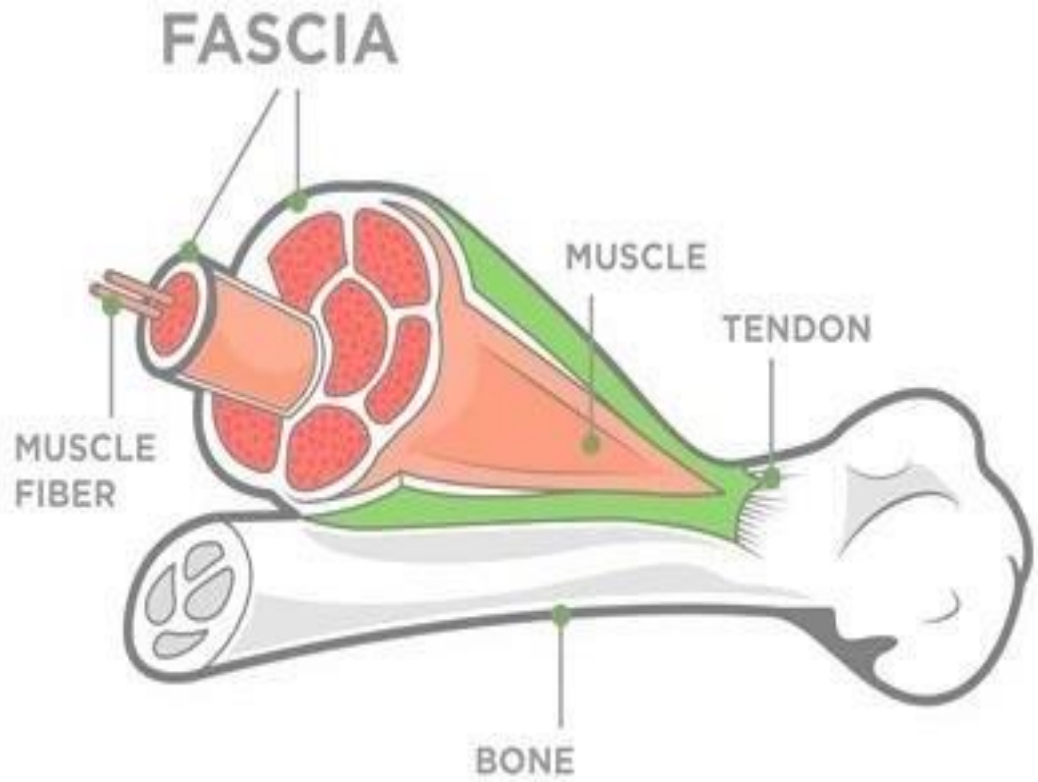
•Such inhibitors are like lactinin and anti- coliform factors in milk and lysozyme in eggs.

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.


FASCIA
MUSCLE
TENDON
MUSCLE
FIBER
BONE

ANTIMICROBIAL SUBSTANCES

- **Coumarins** – fruits and vegetables
- **lysozyme** – cow's milk and eggs
- **Aldehydic and phenolic compounds** – herbs and spices
- **Allicin** – garlic
- **Polyphenols** – green and black teas

EXTRINSIC FACTORS

Extrinsic factors : Are factors external to the food that affect microbial growth. They include:

1. Temperature of storage,
2. Presence and concentration of gases in the environment
3. Relative humidity of food storage environment

Temperature

•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.

CLASSIFICATION OF M.O ON THE BASIS OF TEMPERATURE

(i) Psychrophilic microorganisms :

- These grow best at about 20o C but also down to -10o C in unfrozen media. Psychrophilic bacteria can cause food spoilage at low temperatures.
- Several of the microorganisms found in the soil and water belong to this group.

(ii) Mesophilic bacteria:

- These organisms grow between 25o C and 40o C, with an optimum growth temperature close to 37o C
- Some such as *Pseudomonas aeroginosa* may grow at even lower temperatures between 5- 43o C
- None of the mesophilic bacteria are able to grow below 5o C or above 45o C.
- Most pathogenic bacteria belong to this group.

(iii) Thermophilic bacteria:

- These grow at temperatures above 45o C. Often their optimum growth temperatures is between 50o C and 70o C.
- Growth of some bacteria occur at 80o C.
- Bacteria in this group are mainly spore formers and are of importance in the food industry especially in processed foods.

NOTE THAT:

The effect of temperature on microbial growth also depends upon other environmental conditions such as:

- Growth factors in the nutrient medium,
- pH of the food, and
- Water activity

EXTRINSIC FACTORS

2.Concentration of gases in the environment

- This relates to the presence and concentration of gases in the food environment.
- 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 facultative anaerobic spore formers are most likely to grow in canned foods.
- Micro aerophilic bacteria are most likely to grow in vacuum packed foods since they have low oxygen tension, while
- Aerobic bacteria are likely to grow on the surface of raw meat.
- Aerobic molds will grow in insufficiently dried or salted products.

EXTRINSIC FACTORS

3. Relative humidity

- Relative humidity is the amount of moisture in the atmosphere or food environment.

- Foods with low water activity placed at high humidity environment take up water, increase their water activity and get spoiled easily.

- For example, dry grains stored in a environment with high humidity will take up water and undergo mold spoilage.

PREVENTION OF SPOILAGE

Store food in the right place

- Check labels for where they should be stored.
- Check date marks on food labels.
- Do not leave foods out – they could get warm or be contaminated with microbes from an insect or pest.

Prepare and cook food hygienically

- Get ready to cook – hands, aprons …
- Prepare raw foods away from cooked foods – do not mix up.
- Cook foods thoroughly, e.g. no raw areas in roast chicken.
- Clean up and be tidy all the time


THANKS