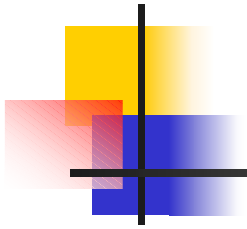


LECTURE 3

FOOD DETERIORATION(Decay)

AND

ITS CONTROL

Ch. 7, pp.113-137

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

- All foods undergo varying degrees of deterioration during storage.

  Deterioration include losses in:

  - Organoleptic(taste-aroma) desirability
  - Nutritional value
  - Safety
  - Aesthetic appeal

- Foods may change in color, texture, flavor, or another quality attribute.

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

Expected Storage Life of Plant and Animal Tissues

Food Product	Storage life(days) at room temperature(21°C)
Meat, fish, poultry	1-2
Dried, salted, smoked meat and fish	360 and more
Fruits	1-7
Dried fruits	360 and more
Leafy vegetables	1-2
Dried seeds	360 and more

Slower rates of deterioration occur with foods that are low in moisture, high in sugar, salt or acid or with foods modified in other ways.

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

Food Science:Understanding of food deteriorative factors and theorising for their control

FOOD TECHNOLOGY: Attempts to slow down deteriorative processes

Formulate New Products:(Cheese, smoked fish, dried fruits, fermented foods)

- ✓ Develop preservation methods
- ✓ Prolong storage life by packaging applications

SHELF-LIFE AND DATING OF FOODS

- Shelf-life: The time it takes a product to decline to an unacceptable level. It is a required judgement that must be made by food manufacturer or retailer. It has become a wide-spread practice to add some form of dating system to retail packages of foods to give an indication of freshness and shelf-life of products to consumers.

Date of manufacture - "pack date"
Date the product was displayed – "display date"
Date by which the product should be sold – "sell by date"
Last date of maximal quality – "best used by date"
Date beyond which the product is no longer accepatable – "use by date" or "expiration date

MAJOR CAUSES OF FOOD DETERIORATION

Major factors affecting food deterioration include:

(1) Growth and activities of microorganisms (bacteria, yeast and molds)
(2) Activities of food enzymes and other chemical reactions within food itself
(3) Infestation by insects, parasites and rodents
(4) Inappropriate temperatures for a given food
(5) Either the gain or loss of moisture
(6) Reaction with oxygen
(7) Light
(8) Physical stress or abuse
(9) Time

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

- The ideal preservation method should take into account all of the major factors in food deterioration.

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

1 BACTERIA, YEASTS AND MOLDS

- There are thousands of genera and species of microorganisms(m.o.)
- Several hundreds are associated with food products

They can :

- ✓Cause a disease
- ✓Cause food spoilage
- ✓Some m.o. are desirable because they are used to make and preserve foods (i.e. Lactic acid producing bacteria used to make cheese, sauerkraut, sausages etc. Others used for alcohol production in making wine or beer, flavor production in other foods)

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

- Microorganism multiplication on or in foods frequently is the major cause of food deterioration.

- Microorganism capable of spoiling food are found everywhere:

•in the soil, water and air,
•on the skins of cattle and the feathers of poultry,
•in the intestines and other cavities of the body,
•on the skins and peels of fruits and vegetables,
•on the hulls of grain and the shells of nuts
•on food processing equipment that is not sanitized
•on the hands, skin and clothing of food-handling personnel

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

- In nearly all cases, the presence of spoilage organisms in foods is a result of contamination.

Therefore, one of the major strategies in reducing food spoilage due to microorganisms is:

To reduce contamination

by ensuring good sanitation practice

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

Bacteria (Fig. 7.1,2)

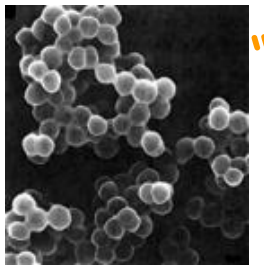
Single celled organisms

All bacteria associated with foods are small.

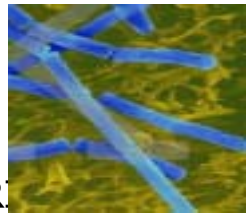
One to a few micrometers (μm) in length.

Can be classified according to shape

Spherical shapes "cocci"



Rod shape "bacilli"

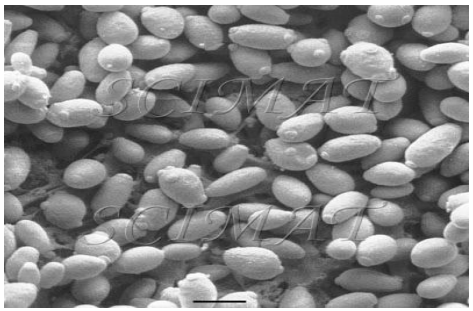


Spiral forms "spirilla and vibrios"

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

Yeasts

Somewhat larger of the order of 20 μm . Most of them are spherical or ellipsoidal.



Saccharomyces cerevisiae yeast

Molds(moulds)(Fig. 7.3)

Larger and more complex in structure

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

- Some bacteria, yeasts and all molds produce spores, which are seedlike packets and which under proper conditions can germinate into full-sized cells called "vegetative cells"
- Sterilization processes are designed to inactivate these highly resistant bacterial spores.

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

Bacteria, yeasts and molds can attack all food constituents.

- Ferment sugars and hydrolyze starches and cellulose
- Hydrolyze fats and produce rancidity
- Digest proteins and produce putrid and ammonia like odors.
- Form acid and make food sour
- Produce gas and make food foamy
- Form pigments and discolor foods
- A few produce toxins and cause food poisoning

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

- Bacteria, yeasts and molds like warm and moist conditions.

Most bacteria multiply best at temperatures between 16-38°C .....mesophilic

Down to freezing point of water.....psychrotrophic or psychrophilic

As high as 82 °C .....thermophilic

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

Some bacteria and all molds require oxygen for growth.....aerobic

Other bacteria will not grow unless oxygen is absent .....anaerobic

Others can grow under either aerobic or anaerobic conditions.....facultative

Food-born pathogens and associated illnesses are given in Table 7.2!

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

Bacteria multiply by cell division.

1 bacteria → 2 bacteria → 4 bacteria

Under favorable conditions bacteria can double their numbers every 30 minute.

Milk with an initial bacterial count of 100.000/ml (before pasteurization) can reach to 25 million in 24 h and over 5 billion/ml in 96 h.

So on in exponential fashion

2 INSECTS, PARASITES AND RODENTS

✓Insects are particularly destructive to cereal grains and to fruits and vegetables both in the field and during storage.

✓When insects eat thay damage the food and open it to bacterial, yeast and mold infection causing further destruction.

✓Insects have been controlled in stored grain, fruit and spices by the use of pesticides, inert atmospheres or cold temperatures.

✓ Use of chemical pesticides may have possible toxic effects and maximum safe levels should be in concern.

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

- An important food-borne parasite (Trichinella) can enter hogs(pigs) eating uncooked food wastes
- If the meat is not thoroughly cooked, the live worm can infect man.
- It is also possible to destroy it by frozen storage.
- Infected water and poor hygiene also spread parasite.

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

- The problems with rodents involve not only the quantity of food they may consume but also the filth with which they contaminate food.
- Rodent urine and droppings harbor several kinds of disease-producing bacteria, and rats spread such human diseases as salmonellosis, typhus fever etc.

3 FOOD ENZYMES

✓Healthy uninfected food plants and animals have their own enzymes, the activity of which survives harvest and slaughter, just as microorganisms' enzymes that ferment, rancidify and putrefy foods.

✓Unless these enzymes are inactivated by heat, chemicals, radiation or some other means, they continue to catalyze chemical reactions within foods after slaughter and harvest.

4 MOISTURE AND DRYNESS

- ✓Excessive moisture pick up or loss causes deteriorative changes in food.
- ✓Moisture is required for chemical reactions and for microorganism growth. Excessive moisture accelerate these types of deterioration.
- ✓Excessive loss of moisture can have affects on appearance and texture.

5 OXYGEN

✓20% oxygen in the air is quite reactive and causes substantial deteriorative effects in many foods.

Destructive effects:

- o Chemical oxidation of nutrients (vitamin A and C)
- o Chemical oxidation of Food colors
- o Chemical oxidation of Flavors
- o Chemical oxidation of Other food constituents
- o Mold growth

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

Atmospheric oxygen is excluded from foods by:

- Vacuum deaeration
- Inert gas purging
- Vacuum packaging
- Flushing containers with nitrogen or carbon dioxide (Modified Atmosphere Packaging)
- Adding oxygen scavengers (removes residual oxygen through chemical reaction)

6 LIGHT

- ✓Destroys some vitamins, notably riboflavin, vitamin A and vitamin C.
- ✓Deteriorates many food colors.
- ✓Milk in bottles exposed to the sun develops "sunlight" flavor due to light-induced fat oxidation and changes in the protein
- ✓Sensitive foods can be protected from light by opaque packaging or by incorporating compounds into glass and tranparent films that screen out light of specific wavelengths.

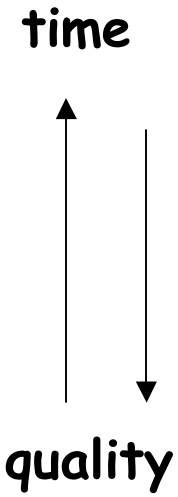
3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

7 TIME

- After slaughter, harvest or food manufacture there is a time when the quality of food is the highest.In many products this quality peak can be passed in the field in a day or two, or after harvest in a matter of hours.
- the growth of microorganisms,
- destruction by insects,
- action of food enzymes,
- nonenzymatic interaction of food constituents,
- loss of flavor volatiles
- the effects of heat, cold, moisture, oxygen and light

all progress with time ...

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION



- For the majority of foods quality decreases with time. Major goals of food-handling and preservation practices are to capture and maintain firmness.

Exceptions: Wine, Sausages, Cheeses, Other fermented foods

- Adequate processing, packaging, and storage may prolong the shelf-life of foods considerably but cannot extend it indefinitely.

SOME PRINCIPLES OF FOOD PRESERVATION

If foods are to be kept only for short periods of time, then there are two very simple rules:

(1) Keep food alive as long as possible; kill the animal or plant just before it is to be used.

(2) If the food must be killed, clean it, cover it, and cool it as quickly as possible. These will only delay deterioration for a short time.

PREVENTION and CONTROL OF FOOD DECAY

Controlling bacteria, yeasts and mold:

- Heat
- Cold
- Drying
- Acid
- Sugar and salt
- Smoke
- Air
- Chemicals
- Radiation

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

HEAT

- Most bacteria, yeasts and molds grow best in the temperature range of about 16-38°C.
- Thermophiles can grow in the range 66-82 °C.
- Most bacteria are killed in the range 82-93 °C
- But many bacterial spores are not destroyed even at 100 °C for 30 min.
- To ensure sterilisation(total destruction of microorganisms including spores), a temperature of

121 °C must be maintained for 15 min or longer.Then sterilised product will last over a year or longer .

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

- It may be necessary to employ only sufficient heat to destroy disease-producing organisms in the food.
- This is done in the case of pasteurized milk.
- Most of the bacteria and all of the disease-causing organisms that might be present in milk are destroyed by pasteurization at 63°C for 30 min, but the milk is not sterile. Pasteurised milk should be held in a refrigerator and consumed generally within a few days.

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

COLD

- Most bacteria, yeasts and molds grow best at temperature range 16-38°C.
- Psychrotrophs will grow down to 0 °C and below.
- At temperatures below 10 °C growth is low and becomes slower the colder it gets.
- When the water in food is completely frozen, there is no multiplication of microorganisms.
- But in some foods all of the water is not frozen until a temperature of -10 °C or lower is reached, because of dissolved sugars and other constituents which depress freezing point.

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

✓The slowing of microbial activity with decreased temperatures is the principal behind refrigeration and freezing preservation.

✓Cold storage and freezing fail to sterilize foods.

✓When the food is taken from cold storage and thawed, the surviving microorganism often resume rapid growth since the food may be damaged from cold or frozen storage.

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

DRYING

✓Microorganisms in a healthy growing state may contain in excess of 80 % of water. They get this water from the food in which they grow.

✓If the water is removed from the food, water is also removed from the bacterial cells and multiplication will stop.

➢"Water activity" (a_w) of foods is related to both water content of food and to relative humidity of environment.

➢Relative humidity: The ratio of the partial pressure of water vapor in the air to the vapor pressure of pure water at the same temperature.

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

- At the usual temperatures permitting microbial growth, most bacteria require a water activity in the range a_w =0.9-1.00.
- Some yeasts and molds may grow slowly at a water activity as low as $a_{w=}$ 0.65.
- Partial or complete drying of food does not kill all microorganisms. When the food is remoistened or reconstituted bacterial growth may resume.

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

ACID

✓Sufficient strength of acidity affects bacterial proteins as it denatures food proteins and so microorganisms are quite sensitive to acid. Some m.o. are much more sensitive than others; also acidity produced by one organism during fermentation often will inhibit growth of another type of organism. **Acids may be produced in foods by adding acid-producing bacterial cultures(like lactobacilli).** This is one of the principles of controlled fermentation as a means of preserving foods against growth of spoilage organisms.

✓**Sometimes acids may be directly added to foods (Citric acid and phosphoric acid to soft drinks)**

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

SUGAR & SALT

✓Fruits may be preserved by placing them in a sugar syrup:jams and marmelades.Certain meat products are preserved by placing them in a salt brine.

✓Bacteria, molds and yeasts contain cell membranes. These membranes allow water to pass in and out of the cells. When they are placed in a heavy sugar or salt solution, water in their cells moves out through the membrane.This is called the process of **osmosis**.

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

✓Tendency to equalise water concentration inside and outside the cell causes dehydration of cell , called "**plasmolysis**", which interferes with m.o. multiplication.

✓Solutions high in solute(i.e. Salt and sugar) concentration have high osmotic pressure and low water activity(a_w).

✓Yeasts and molds are more tolerant than most bacteria. This is why molds and yeasts often are found growing on fruit jam and bacon, where bacteria are inhibited.

3 FOOD DECAY AND TRADITIONAL METHODS FOR ITS PREVENTION

SMOKE

- In preserving foods such as meats and fish with smoke obtained by burning wood the preservative action comes from a combination of factors:
- Smoke contains preservative chemicals such as small amounts of formaldehyde
- Heat associated with smoke destroys microorganisms also through drying the food.
- Smoke combined with other preservatives is used today more for its flavor than for its preservative action.

ATMOSPHERE COMPOSITION

oTo control organisms that require oxygen(aerobics), air is removed; on the other hand , for organisms that cannot tolerate oxygen(anaerobics), air is provided.

oWax coating of cheese

oOxygen-impermeable skin-tight plastic films

CHEMICALS

✓Many chemicals will kill or inhibit the growth of microorganisms, but most of these are not permitted in foods.Permitted chemicals are classified as "antimicrobials" under food additive groups. Examples:

Sodium benzoate

Sorbic acid

Sodium and calcium propionate

Ethyl formate

Sulfur dioxide

RADIATION

- Microorganisms are inactivated to various degrees by different kinds of radiation:X-rays

Microwaves

Ultraviolet light

Ionizing radiations

Each of these are a type electromagnetic radiation which differs in wavelength and energy. All may be used to preserve foods. There is no significant temperature rise from "ionizing radiation" applications(irradiation), so this is called "cold sterilization" and is presently being applied to spices, poultry, fruits and vegetables, pork.

CONTROL OF ENZYMES AND OTHER FACTORS

Principal means to control and inactivate damaging food enzymes:

Heat

Cold

Drying

Certain chemicals

Radiation

END OF LECTURE 3