FOOD DETERIORATION AND ITS CONTROL

Food deterioration may includes losses in

- Changes in organoleptic quality
- Nutritional value
- Aesthetic appeal
- Color
- Texture
- Flavour

Food deterioration is controlled by regulating

- Heat
- Cold
- Light and other radiation
- Oxygen
- Moisture

❖ Meat, fish and poultry can become inedible in less than a day at room temperature. This is also true for several fruits and leafy vegetables, raw milk, and many other products. Room temperature or field temperature can be much higher than 21^{o}C during much of the year in many parts of the world.

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

❖ Dryness, natural food enzymes, microorganisms and macro organisms, industrial contaminants, some foods in the presence of others, and time-all can adversely affect foods.

Shelf Life of some food materials at 21^{o}C

Food product	Generalized storage life 21 ^{o}C (days)
Meat	1-2
Fish	1-2
Poultry	1-2
Dried, salted, smoked meat and fish	360 and more
Fruits	1-7
Dried fruits	360 and more
Leafy vegetables	1-2
Root crops	7-20

Dried seeds	360 and more
Source:Desrosier and Desrosier (1977).	

Shelf life and Dating of Foods:

The shelf life of a food is sometimes defined as the time it takes a product to decline to an unacceptable level. Of course, what is “acceptable” varies from one person to another. Shelf life is taken as the time a product remains salable. In the final analysis, shelf life is a judgement that must be made by the food manufacturer or retailer.

In many cases, the manufacturer must define a minimum acceptable quality (MAQ) for the product. The MAQ will depend on what degree of degradation will be allowed before the manufacturer no longer wants to sell the product.

The actual length of the shelf life of any given product will depend on a number of factors such as processing method, packaging, and storage conditions. For example, one cannot accurately say what the shelf life of fresh milk is without indicating the conditions. Milk held at room temperature will have a different shelf life than milk held under good refrigeration. Of course, canned and processed milk stored at room temperature will outlast pasteurized milk held at refrigeration temperature.

It has become a widespread practice to add some form of dating system to retail packages of foods so that consumers may have some indication of the shelflife or freshness of the products they buy. Several types of code dates have emerged including the date of manufacture (“Pack date”) the date the product expiry etc.

Major Causes of Food Deterioration

The major factors affecting food deterioration include the following

(1) growth and activities of microorganisms, principally bacteria, yeasts, 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.

These factors can be divided into biological, chemical, and physical factors. Often these factors do not operate in isolation. Bacteria, insects, and light, for example, can all be operating simultaneously to spoil food in the field or in a warehouse. Similarly, heat, moisture, and air simultaneously affect the multiplication and activities of bacteria, as well as the chemical activities of food enzymes. Effective preservation must eliminate or minimize all of these factors in a given food.

Bacteria, yeast, mold

Thousands of species of microorganisms exist, and a few hundred are associated with foods. Not all are bad; in fact, some are desirable in food preservation. The lactic acid-producing organisms used to make cheese, sauerkraut, and certain types of sausage are examples. Others are used for alcohol production in making wine or beer, or for flavour production in other foods. However, except where these microorganisms are especially cultivate by selective inoculation or by controlled conditions to favour their growth over the growth of less desirable types, microorganism multiplication on or in foods frequently is the major cause of food deterioration. Microorganisms are found in the soil, water and air; on animal skins, fruit and vegetable surfaces and on the hulls of grain and shells of nuts. They are found on food processing equipment that has not been sanitized, as well as on the hands, skin and clothing of food-handling personnel.

A most important point, however, is that microorganisms generally are not found within healthy living tissue-such as within the flesh of animals, or the flesh or juice of plants. But they are always present to invade the flesh of plants or animals through a break in the skin, or if the skin is weakened by disease or death. In this case they may digest the skin and penetrate through it to the tissue below. 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 practices.

Milk from a healthy cow is sterile as secreted, but becomes contaminated as it passes through the teat canals, which are body cavities. Milk becomes further contaminated from dirt on the cow’s hide, from the air, from dirty utensils and containers, and so on. Fruits, vegetables, grains, and nuts become contaminated when the skins or shells are broken or weakened.

Bacterial spores are more resistant to heat, chemicals, and other adverse conditions than yeast or mold spores, and more resistant to most processing conditions than vegetative cells. Sterilization processes are designed specifically to inactivate these highly resistant bacterial spores.

Heat:

Most bacteria, yeasts, and molds grow best in the temperature range of about 16-38 ^{o}C. Thermophiles will grow in the range 66-82 ^{o}C. Most bacteria are killed in the 82-93 ^{o}C, but many bacterial spores are not destroyed even by boiling water at 100 ^{o}C for 30 min. To ensure sterility, that is total destruction of microorganisms including spores, a temperature of 121 ^{o}C (wet heat) must be maintained for 15 min or longer. This is generally done with steam under pressure, as in laboratory autoclave or commercial retort. These and other temperature effects on microorganisms are listed in Table 2. Commercial pressure retorts of the kind used in the canning industry operate at temperatures and for time intervals adequate to destroy large numbers of highly resistant bacterial spores within the canned food. Sterility or "commercial sterility," to be defined later, is essential because the food may be stored in the can for a year or longer.

Not all foods require the same amount of heat for sterilization. When foods are high in acid, such as tomatoes or orange juice, the killing power of heat is increased. A temperature of 93 ^{o}C for 15 min may be enough to gain sterility if sufficient acid is present.

Another fundamental point on the use of heat and other means of preservation: it is not always necessary to kill all microorganisms and produce a sterile product. 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-producing organisms that might be present in the milk are destroyed by pasteurization at 63 ^{o}C for 30 min, but the milk is not sterile. Nor need it be, since it will be held in a refrigerator and consumed generally within a few days.

Effects of Temperature on Microorganisms

^{o}C	Temperature effects
121	Steam temperature at 1.05 kg/cm^2 pressure kills all forms including spores in 15-20 min
116	Steam temperature at 0.70 lb pressure kills all forms including spores in 30-40 min
110	Steam temperature at 0.42 kg/cm^2 pressure kills all forms including spores in 60-80 min
104	Steam temperature at 0.14 kg/cm^2 pressure
100	Boiling temperature of pure water at sea level; kills in vegetative stage quickly but not spores after long exposure
82-93	Growing cells of bacteria, yeasts, and molds usually killed

66-82	Thermophilic organisms grow
60-77	Pasteurization of milk in 30 min kills all important bacteria
16-38	Active growing range for most bacteria, yeasts, and molds
10-16	Growth retarded for most organisms
4-10	Optimum growth of psycrophilic organisms (10-4 ^oC). Some food borne pathogens still grow
0	Freezing; usually the growth of all organisms stopped
-18	Bacteria preserved in latent state
-251	Many species of bacteria not killed by the temperature of liquid hydrogen

Cold:

Most microbial growth slows at temperatures less than. Some bacteria, called psychrophiles, actually thrive at relatively low temperatures and will continue slow growth. Foods frozen at less than -10 ^oC usually do not have any free water, so these foods also benefit from low water activity to help protect against microbial growth. Freezing may kill some but not all of the microorganisms.

Oxygen:

Whereas nitrogen, which makes up 79% of air, is insert from the perspective of foods the 20% oxygen in the air is quite reactive and causes substantial deteriorative effects in many foods. Besides the destructive effects due to chemical oxidation of nutrients (especially vitamins A and C), food colours, flavours, and other food constituents, oxygen is also essential for mold growth. All molds are aerobic and this is why they are found growing on the surface of foods and other substances or within cracks in these materials.

Atmospheric oxygen is excluded from foods by vacuum de-aeration or inert gas purging in the course of processing, by vacuum-packaging or by flushing containers with nitrogen or carbon dioxide, and in some instances by adding to foods and containers oxygen scavengers, which promote removal of residual trace oxygen through chemical reaction.

In recent years, positive use has been made of the fact that certain gases influence the rate of deterioration of foods. Several products which are often stored under refrigeration have been packaged in containers in which the air has been removed and replaced with some other gas or gas mixture. Often this mixture is made up of all nitrogen or a mixture of nitrogen and carbon dioxide. These mixtures can reduce the rate of deterioration and substantially increase shelf life. This is known as modified atmosphere packaging. The high-moisture-content pastas that are now sold are packaged in modified atmospheres that are devoid of oxygen which inhibits the growth of mold.

<u>Light</u>

Light destroys some vitamins, notably riboflavin, vitamin A, and vitamin C, and causes deterioration of many food colours. Milk in bottles exposed to the sun develops "sunlight" flavour due to light-induced fat oxidation and changes in the protein. Not all wavelengths making up natural or artificial light are equally absorbed by food constituents or are equally destructive. Surface discolourations of sausages and meat pigments are different under natural light and under fluorescent light that may be encountered in display cases. Sensitive foods often can be protected from light by opaque packaging or by incorporating compounds into glass and transparent films that screen light of specific wavelengths.

<u>Time</u>

After 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. Fresh corn and peas are notable examples. The growth of microorganisms, destruction by insects, action of food enzymes, non-enzymatic interaction of food constituents, loss of flavour volatiles, and the effects of heat, cold, moisture, oxygen, and light all progress with time. This is not to say that certain cheeses, sausages, wines, and other fermented foods are not improved with ageing upto a point. But for the vast majority of foods, quality decreases with time and major goals of food-handling and preservation practices are to capture and maintain freshness. Adequate processing, packaging, and storage may prolong the shelflife of foods considerably but cannot extend it indefinitely. Eventually, the quality of any food product decreases. This is the reason for considerable interest in shelflife dating of processed foods.

Methods of reducing deterioration

A knowledge of deterioration factors and the way they act, including the rates of deterioration to a specific category of food, means that it is possible to list the ways of lowering or stopping the action and obtaining fruit and vegetable preservation.

In order to maintain their nutritional value and organoleptic properties and because of technical-economical considerations, not all the identified means against deterioration actually have practical applications for fruit and vegetable preservation.

Technical methods of reducing food deterioration

These technical means can be summarised as follows:

Physical	Heating
	Cooling
	Lowering of water content Drying/dehydration. Concentration
	Sterilising filtration
	Irradiation
	Other physical means (high pressure, vacuum, inert gases)
Chemical	Salting
	Smoking
	Sugar addition
	Artificial acidification
	Ethyl alcohol addition
	Antiseptic substance action
Biochemical	Lactic fermentation (natural acidification)
	Alcoholic fermentation

This classification of methods of reducing deterioration presents some difficulties because their preservation effects are physical, physico-chemical, chemical and biochemical complex phenomena which rarely act in isolation. Normally they take place together or one after the other.