

Paper No.: 02

Paper Title: The Principles of the Food Processing & Preservation

Module No. : 03

Module Title: Food Deterioration and Control

3.0 Introduction

Food is considered spoiled when an undesirable change in the color, flavor, odor or texture has occurred. The onset of food spoilage is rather indefinite. It is a gradual process occurring because of poor sanitation, enzymatic or chemical reactions, improper temperature controls, microbial growth or physical abuse.

Foods are described as spoiled if organoleptic changes make them unacceptable to the consumer. These organoleptic characteristics may include changes in appearance (discoloration), the development of off-odours, slime formation, changes in taste or any other characteristic which makes the food undesirable for consumption. Whilst endogenous enzymatic activity within muscle tissue post-mortem can contribute to changes during storage, it is generally accepted that detectable organoleptic spoilage is a result of decomposition and the formation of metabolites caused by the growth of microorganisms.

The signs that food is spoiling are:

- **Odour:** "off odours" are smells (sometimes like rotten eggs) that are produced when bacteria break down the protein in food, (usually fatty foods). This process is called putrefaction. Taints due to flavour change may also occur.
- **Sliminess:** Food becomes slimy as the bacterial population grows. Molds may also form slimy whiskers.
- **Discolouration:** Foods can become discoloured by microbial growth. Some molds have coloured spores that give the food a distinctive colour, for example, black pin mold on bread, or blue and green mold on citrus fruit and cheese.
- **Souring:** Foods go sour when certain bacteria produce acids. A common example is when milk sours from the production of lactic acid.
- **Gas:** Bacteria and yeasts often produce gaseous by-products that can affect food. It may be noticed that meat becoming spongy, or packages and cans swelling or having a popping or fizzing sound on opening.

According to the cause of the spoilage, types of food spoilage fall into two major categories. Microbial spoilage is caused by microorganisms and their products; non-microbial spoilage can be caused by foreign material in the foodstuff or by enzymes that occur in the foodstuff naturally

3.1 Types of deterioration

An understanding of the various factors that cause food to deteriorate is helpful to ensure that the correct processing and packaging is selected. The main causes of deterioration of foods are as follows:

- micro-organisms
- enzymes

- chemical changes due to water, heat, metals, air or light, contamination by soils, stones, insects etc.
- physical (or mechanical) damage.

3.1.1 Micro-organisms

All fresh foods have micro-organisms on their surfaces, often in enormous numbers, and these can grow rapidly to spoil foods. A main purpose of processing foods is to destroy unwanted micro-organisms. Packaging prevents recontamination and together processing and packaging prevent micro-organisms from spoiling the product during distribution and storage (that is to give the food the shelf-life that is expected).

Micro-organisms may be divided into general groups such as bacteria, yeasts or molds, each of which may be further divided into sub-groups. Of the many microorganisms, the main types of interest are those that cause food spoilage and those that cause food poisoning. When food is processed correctly, the number of spoilage micro-organisms and their activity is reduced and controlled at known levels. It is when there is a failure in processing conditions or packaging materials that spoilage micro-organisms can have an effect on the food. They can result in the food going moldy, developing an off-smell or fermenting. The different types of spoilage depend to a large extent on the nature of the food and in particular its acidity and its moisture content.

3.1.2 Enzymes

Enzymes are naturally occurring proteins that act on foods to cause changes in flavour, colour or texture. There are many hundreds of different enzymes but some of the more important spoilage changes include softening of fruits, rancidity of oils, browning of cut fruit or root crops and loss of green colour in vegetables. In general enzymes are either destroyed by heating or prevented from acting by changing the acidity or water content of the food.

3.1.3 Water

Enzymes and micro-organisms can only spoil foods if water is present. If the water is removed or made unavailable they cannot act. Different foods have different water contents (Table 3.1). Some, for example grains, are relatively dry when harvested and these can be easily preserved by removing the remaining water by drying. Other fresh foods such as fruits, vegetables and meat have a much higher water content and this should be made unavailable by either drying or concentration (water removed) or by freezing (water held as ice, which together with the low temperature, prevents micro-organisms and enzymes from acting).

However, removing water only prevents the action of enzymes and micro-organisms, it does not destroy them. They can act again when water returns, for example during re-hydration of dried food, thawing of frozen food. Foods are therefore often heated (blanched) to destroy some of the enzymes and micro-organisms before drying or freezing.

Fresh food	Water content (%)	Shelf-life at room
	temperature (days)	
Fruits	80 - 95	1 - 30
Meat/Fish	55 - 70	2 - 7
Vegetables	75 - 90	2 - 20
Grains	8 - 14	more than 175

Table 3.1: Water content of some foods

The normal moisture content of a processed food should be maintained during storage. This is a main function of packaging for some foods. If the moisture content falls below an acceptable level in moist foods, the food dries out, shrivels and is seen as spoiled by consumers. Similarly if the moisture content of a dry food is allowed to rise above an acceptable level it will first lose its crispness and become unacceptable to consumers, but it may also gain sufficient moisture to allow micro-organisms to grow and cause further spoilage. The acceptable range of moisture contents is different for each processed food and for some it is a critical factor. Higher temperatures increase the rate of spoilage by micro-organisms and enzymes, up to a maximum above which they are destroyed (Figure 3.2).

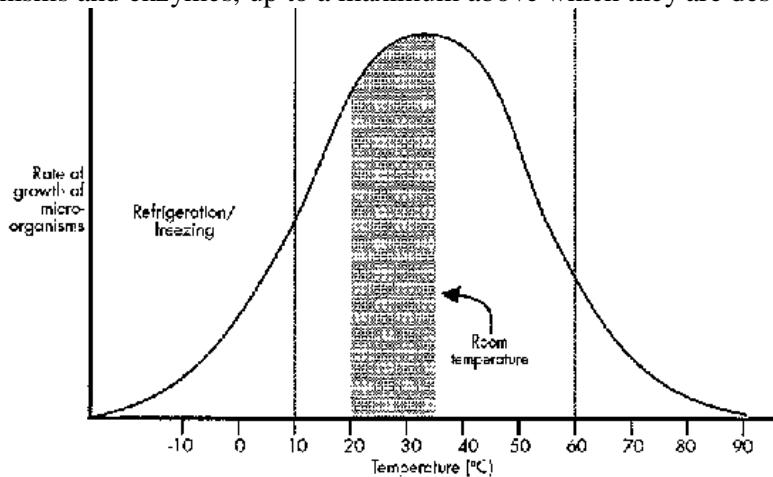


Figure 3.2: Rate of growth of micro-organisms

3.1.4 Heat

When foods are heated above 60°C most enzymes and micro-organisms are destroyed - the higher the temperature the faster they are destroyed. This is one of the easiest methods of preservation and includes boiling, frying, baking and pasteurization. However, cooked food can be easily re-contaminated if it is not properly packaged. Heat can also spoil packaged food. It can melt fats, cause a loss of texture or flavour and cause more rapid changes such as development of rancidity in oils and movement of moisture within a food which in turn leads to spoilage.

3.1.5 Light

Sunlight contains ultra-violet (UV) rays which cause rapid deterioration of some foods (especially oils and fatty foods) or specific components of a food such as certain vitamins. UV can also cause packaging materials to fade or to become brittle and lose their properties. In general all foods should be stored in the shade away from direct sunlight. Electric lights do not have the same effects on foods because they do not contain the UV component.

3.1.6 Air

Some foods, especially those that have a high fat content or those with delicate flavours and aromas, are susceptible to oxidation (attack by air which causes off flavours to develop, known as rancidity). Biscuits, cooking oils, dried fish and other fatty foods are liable to spoilage by rancidity. These foods should therefore be protected from contact with air by storing them in airtight containers.

3.1.7 Contamination

Foods are often contaminated when harvested or slaughtered and most processing involves a cleaning stage to remove these contaminants. However foods may also be contaminated after processing and this is more serious because the contamination will not be removed before the customer buys the food. The main types of post-processing contamination and possible sources are shown in Table 3.3.

Contaminant	Possible source
Hair	Operators, animals
Dust, soil, stones	Workplace, equipment, transport
Bacteria, molds	Air, operators, animals, insects, birds, dust
Excreta	Animals, insects, birds
Oil, grease	Equipment, transport
Wood, glass, paper, cloth, leaves etc	Workplace, transport
Metal	Equipment, workplace, transport
Insects	Air, workplace, transport

Table 3.3: Types of post-processing contamination and possible sources

One of the main functions of packaging is to protect foods against contamination from the time it has been processed until it is consumed. It should be noted that the contamination described above is accidental contamination. Contamination that is done deliberately to increase profitability or from malice is named adulteration.

3.1.8 Mechanical damage

Foods are frequently fragile and easily crushed, scratched, split or otherwise damaged during storage and distribution. Damage is caused in four ways:

- by pressure such as that caused by stacking or piling foods too high
- by impact from hitting or dropping the food
- by vibration from transport
- by foods rubbing against each other or against container sides.

Another main function of packaging is to minimise these types of physical damage to foods during transport and storage.

3.1.9 Physical Spoilage: Physical damage to the protective outer layer of food during harvesting,

processing or distribution increases the chance of chemical or microbial spoilage. Examples of physical spoilage include:

- Staling of bakery products and components
- Moisture migration between different components
- Physical separation of components or ingredients
- Moisture loss or gain

3.1.10 Chemical Spoilage

When animal or vegetable material is removed from its natural source of energy and nutrient supply, chemical changes begin to occur which lead to deterioration in its structure. The two major chemical changes which occur during the processing and storage of foods and lead to a deterioration in sensory quality are lipid oxidation (rancidity) and enzymic browning. Chemical reactions are also responsible for changes in the colour and flavour of foods during processing and storage.

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 food preservation.

3.2 Technical methods to control food deterioration

These technical means can be summarized as follows:

Physical	Heating
	Cooling
	Lowering of water content Drying/dehydration. Concentration
	Sterilizing 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.