Principles of Food Preservation

Food Microbiology (MIC4003a)

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Introduction

In this section we outline the principles, especially those of a microbiological nature, involved in the various methods of the food preservation. As a result of improved methods of preservation and transportation, out diet has become more varied and better balanced, perishable foods have been made available year-round instead of only seasonally, the preparation of meals has been made easier, and foods in general are being produced in a cleaner and more sanitary manner than before. In addition, these improved methods of preservation and transportation have made it possible for countries with excesses in certain commodities to help needs countries by providing food supplements of high quality.

Foods for human consumption can be divided into eight main groups, four of plant and four of animal origin, and several lesser groups. The eight main classes of foods are as follows:

Foods from plants	Foods from animals
Cereals and cereal products	Meats and meat products
Sugar and sugar products	Poultry and eggs
Vegetables and vegetable products	Fish and other seafood
Fruits and fruit products	Milk and milk products

- To the list of foods of plant origin could be added spices and other flavoring materials, nutmeats, and fungi grown for food (yeasts, molds, mushrooms, etc.).

- Sodium chloride is a mineral food, a flavoring material, an essential nutrient, and a chemical preservative.

- Some foods may be fortified with minerals, e.g., iron and calcium compounds added to flour.

- Some of the coloring and flavoring materials used in foods are synthetic.

- Vitamins usually are present in foods but may be added or consumed separately after chemical synthesis or production by microorganisms.

METHODS OF FOOD PRESERVATION

The chief methods of food preservation are as follows:

1. Asepsis, or keeping out microorganisms.
2. Removal of microorganisms.
3. Maintenance of anaerobic conditions, in a sealed, evacuated container.
4. Use of high/low temperatures.
6. Drying- this includes the tying up of water by solutes, hydrophilic colloids, etc.
7. Use of chemical preservatives either developed by microorganisms or added.
8. Irradiation.
9. Mechanical destruction of microorganisms by grinding, high pressures.
10. Combinations of two or more of the above methods.

PRINCIPLES OF FOOD PRESERVATION

In accomplishing the preservation of foods by the various methods, the following principles are involved:

1. Prevention or delay of microbial decomposition

a. By keeping out microorganisms (asepsis)
b. By removal of microorganisms, e.g., by filtration
c. By hindering the growth and activity of microorganisms, e.g., by low temperatures, drying, anaerobic conditions, or chemicals
d. By killing the microorganisms, e.g., by heat or radiation

2. Prevention or delay of self-decomposition of the food

a. By destruction or inactivation of food enzymes, e.g., by blanching
b. By prevention or delay of purely chemical reactions, e.g., prevention of oxidation by means of an antioxidant

3. Prevention of damage because of insects, animals, mechanical causes

The methods used to control the activities of microorganisms usually are effective against enzymatic activity in the food or chemical reactions. Methods such as drying and the use of low temperatures, however, permit autodecomposition to continue unless special precautions are taken. For example, most vegetables are balanced (heated) to inactivate their enzymes before being frozen.

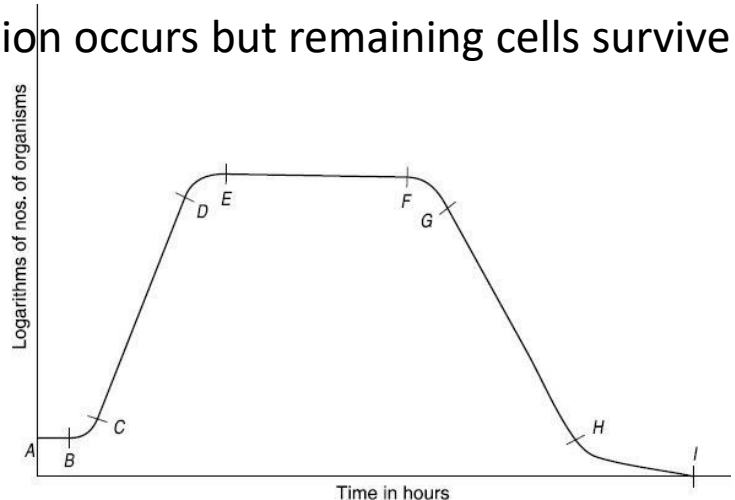
Delay of Microbial Decomposition

Many common methods of food preservation depend not on the destruction or removal of microorganisms but on delay in the initiation of growth and hindrance to growth once it has begun. A summary of the major preservation factors and their mode of action and achievement is presented in Table.

Mode of action	Preservation factor	Mode of achievement
Inactivation of microorganisms	Heat	Pasteurization Sterilization
	Radiation	Radicidation Radurization Radappertization
Inhibition or slowing of growth of microorganisms	Cool	Chill Freeze
	Restrict water (reduce water activity)	Dry Add salt Add sugar Add glycerol Add other solutes or use combinations of the above
	Restrict oxygen	Vacuum pack Nitrogen pack
	Increase carbon dioxide	CO_2 pack
	Acidity	Add acids Lactic fermentation Acetic fermentation
	Alcohol	Fermentation Fortification
	Add preservatives	Inorganic (e.g., sulphite, nitrite Organic (e.g., sorbate, benzoate, parabens, etc.) Antibiotics (e.g., nisin) Smoke
Restriction of access of microorganisms to product	Microstructure control Decontamination	Emulsion (w/o) Ingredients Packaging materials, e.g., by chemicals (HCI, H_2O_2) heat, irradiation (ionizing or X; nonionizing)
	Aseptic or clean handling	Superclean processing Aseptic processing Aseptic or clean packaging
	Packaging	

Growth Curve of Microbial Cultures

Whenever microorganisms are added to a food and conditions are favorable, the organisms will begin to multiply and will pass through a succession of phases. This curve ordinarily is divided into phases
(1) the initial lag phase *(A to B), during which there is no growth or even* a decline in numbers,
(2) the phase of positive acceleration *(B to C), during which the rate of* growth is continuously increasing,
(3) the **logarithmic or exponential phase of growth (*C to D),*** during which the rate of multiplication is most rapid and is constant,
(4) the phase of **negative acceleration (*D to E), during which the rate of multiplication is decreasing,***
(5) the maximal* stationary phase (*E to F), where numbers remain constant,
(6) the accelerated death phase (F to *G),*
(7) the ***death phase or phase of decline (G to H), during which numbers decrease at a*** faster rate than new cells are formed, and
(8) the **survival phase (*H to I), during which no cell*** division occurs but remaining cells survive on endogenous nutrients.



Applications to Food Preservation

Especially important in food preservation (**i.e., prevention of spoilage**) is the **lengthening, as much as possible, of the lag phase and the phase of positive acceleration**. This can be accomplished in different ways:

1. By introducing as few spoilage organisms as possible, i.e., by reducing the amount of contamination; the fewer organisms present, the longer the lag phase.
2. By avoiding the addition of actively growing organisms (from the logarithmic phase of growth). Such organisms might be growing on unclean containers, equipment, or utensils that come in contact with foods.
3. By one or more unfavorable environmental conditions: unfavorable foods, moisture, temperature, pH, or O-R potential, or presence of inhibitors. The more unfavorable the conditions, the longer the delay of the initiation of growth.
4. By actual damage to organisms by processing methods such as heating or irradiation. Thus, for example, bacteria or their spores subjected to sub lethal heat treatments have been found to require a better culture medium for growth than do the unheated organisms. Often a combination of methods for delaying the initiation of growth is enough to give a food the desired storage life.

Prevention of Microbial Decomposition

Microbial decomposition of foods will be prevented if all spoilage organisms are killed (or removed) and recontamination is prevented. Merely stopping the multiplication of microorganisms, however, does not necessarily prevent decomposition, for viable organisms or their enzymes may continue to be active.

Vegetative cells of organisms in their logarithmic phase of growth are least resistant to lethal agencies, and they are more resistant in their late lag or maximal stationary phase of growth.

ASEPSIS

In nature there are numerous examples of asepsis, or **keeping out microorganisms**, as a preservative factor. The inner tissues of healthy plants and animals usually are free from microorganisms, and if any microorganisms are present, they are unlikely to initiate spoilage. If there is a protective covering about the food, microbial decomposition is delayed or prevented. Examples of such coverings are the shells of nuts, the skins of fruits and vegetables, the husks of ear corn, the shells of eggs, and the skin, membranes, or fat on meat or fish.

Following are some examples of aseptic methods in industries-

- Packaging of food
- In dairy industry
- In canning industry
- In the meat packing industry

REMOVAL OF MICROORGANISMS

For the most part the removal of microorganisms is not very effective in food preservation, but under special conditions it may be helpful. Removal may be accomplished by means of

a. filtration
b. centrifugation (sedimentation or clarification)
c. washing
d. trimming.

The liquid is filtered through a previously sterilized **“bacteriaproof”** filter made of sintered glass, diatomaceous earth, unglazed porcelain, membrane pads, or similar material, and the liquid is forced through by positive or negative pressure. This method has been used successfully with fruit juices, beer, soft drinks, wine, and water.

Maintenance of anaerobic condition.