GENERAL PRINCIPLES OF FOOD PRESERVATION-

PHYSICAL METHODS

Introduction

Foods are mainly composed of biochemical compounds which are derived from plants and animals. Carbohydrates, proteins and fats are the major constituents of food. In addition, minor constituents such as minerals, vitamins, enzymes, acids, antioxidants, pigments, flavours are present. Foods are subject to physical, chemical, and biological deterioration. The major factors affecting food spoilage are

1) Growth and activities of microorganisms (bacteria, yeasts, and molds)

2) Activities of food enzymes and other chemical reactions within food itself

3) Infestation by insects, rodents

4) Inappropriate temperatures for a given food

5) Either the gain or loss of moisture

6) Reaction with oxygen

7) Light

The vast majority of instances of food spoilage can be attributed to one of two major causes: (1) the attack by microorganisms such as bacteria and molds, or (2) oxidation that causes the destruction of essential biochemical compounds and/or the destruction of plant and animal cells. Chemical and/or biochemical reactions results in decomposition of food- due to microbial growth. There is a adverse effect on appearance, flavour, texture, colour, consistence and/or nutritional quality of food.

Food Preservation

Food preservation is the process of treating and handling food to stop or greatly slow down spoilage (loss of quality, edibility or nutritive value) caused or accelerated by micro-organisms. Preservation usually involves preventing the growth of bacteria, fungi, and other micro-organisms, as well as retarding the oxidation of fats which cause rancidity. It also includes processes to inhibit natural ageing and discolouration that can occur during food preparation such as the enzymatic browning reaction in apples after they are cut. Preservative for food may be defined as any chemical compound and/or process, when applied to food, retard alterations caused by the growth of microorganisms or enable the physical properties, chemical composition and nutritive value to remain unaffected by microbial growth.

Principles of Food Preservation

The principles of various methods for food preservation are as

1) Prevention or delay of microbial decomposition

• By keeping out microorganisms (asepsis)

• By removal of microorganisms

• By hindering the growth and activity of microorganisms (e.g. by low temperatures, drying, anaerobic conditions, or chemicals)

• By killing the microorganisms (e.g. by heat or radiation)

2) Prevention or delay of self decomposition of the food

• By destruction or inactivation of food enzymes (by blanching)

• By prevention or delay of chemical reactions (By using antioxidant)

Methods of Food Preservation

Preservation of food is achieved by application of physical, chemical and/or biological methods are as follows:

Physical methods

• Cooling to

→ Low temperature refrigeration (0 to 7°C) - preserves for shorter period (days) → Freezing - preserves for several months

• Heating → pasteurization, cooking, sterilization etc

• Exposure to ionizing radiation → U.V., γ, etc

• Application of high pressure

• Drying → removal of water to a level which does not support the growth of microorganism

Chemical methods

• Quite often it is either impossible or undesirable to employ conventional physical methods of the preservation.

• In such situation one has to opt for chemical methods of preservation.

• It involves application of chemical additives which act as antimicrobial agents.

Biological methods

Souring (fermentation) lactic and acetic acid, e.g. cheese and cultured milk.

Thermal treatment

The term "thermal" refers to processes involving heat. Heating food is an effective way of preserving it because the great majority of harmful pathogens are killed at temperatures close to the boiling point of water. In this respect, heating foods is a form of food preservation comparable to that of freezing but much superior to it in its effectiveness. A preliminary step

in many other forms of food preservation, especially forms that make use of packaging, is to heat the foods to temperatures sufficiently high to destroy pathogens.

In many cases, foods are actually cooked prior to their being packaged and stored. In other cases, cooking is neither appropriate nor necessary. The most familiar example of the latter situation is pasteurization. Conventional methods of pasteurization called for the heating of milk to a temperature between 145 and 149 °F (63 and 65 °C) for a period of about 30 minutes, and then cooling it to room temperature. In a more recent revision of that process, milk can also be "flash-pasteurized" by raising its temperature to about 160 °F (71 °C) for a minimum of 15 seconds, with equally successful results. A process known as ultra high pasteurization uses even higher temperatures of the order of 194 to 266 °F (90 to 130°C) for periods of a second or more.

Low temperature

The lower the temperature, the slower will be chemical reactions, enzyme action, and microbial growth. Each microorganism present has an optimal temperature for growth and a minimal temperature below which it cannot multiply. As the temperature drops from this optimal temperature toward the minimal, the rate of growth of the organism decreases and is slowest at the minimal temperature. Cooler temperatures will prevent growth, but slow metabolic activity may continue. Most bacteria, yeasts, and molds grow best in the temperature range 16-38^{o}C (except psychrotrophs). At temperatures below 10^{o}C, growth is slow and becomes slower the colder it gets. The slowing of microbial activity with decreased temperatures is the principal behind refrigeration and freezing preservation.

Drying

One of the oldest methods of food preservation is by drying, which reduces water activity sufficiently to prevent or delay microbial growth. The term water activity is related to

relative humidity. Relative humidity refers to the atmosphere surrounding a material or solution. Water activity is the ratio of vapour pressure of the solution to the vapour pressure of pure water at the same temperature. Under equilibrium conditions water activity equals RH/100. At the usual temperatures permitting microbial growth, most bacteria require a water activity as low as 0.90-1.00. Some yeasts and molds grow slowly at a water activity as low as 0.65. Food is dried either partially or completely to preserve it against microbial spoilage.

Irradiation

The lethal effects of radiation on pathogens has been known for many years. The radiation used for food preservation is normally gamma radiation from radioactive isotopes or machine-generated x rays or electron beams. One of the first applications of radiation for food preservation was in the treatment of various kinds of herbs and spices, an application approved by the United States Food and Drug Administration (FDA) in 1983. In 1985, the FDA extended its approval to the use of radiation for the treatment of pork as a means of destroying the pathogens that cause trichinosis. Experts predict that the ease and efficiency of food preservation by means of radiation will develop considerably in the future.

Preservation of Food through Irradiation

Radiation processing of food involves exposure of food to short wave radiation energy to achieve a specific purpose such as extension of shelf-life, insect disinfestation and elimination of food borne pathogens and parasites. In comparison with heat or chemical treatment, irradiation is considered a more effective and appropriate technology to destroy food borne pathogens. It offers a number of advantages to producers, processors, retailers and consumers. Radiation processing of food involves exposure of food to short wave radiation energy to achieve a specific purpose such as extension of shelf-life, insect disinfestation and elimination of food borne pathogens and parasites.

Type of Radiation

The type of radiation used in processing materials is limited to radiations from high energy gamma rays, X-rays and accelerated electrons. These radiations are also referred to as ionizing radiations because their energy is high enough to dislodge electrons from atoms and molecules and to convert them to electrically-charged particles called ions.

Gamma rays and X-rays, like radiowaves, microwaves, ultraviolet and visible light rays, form part of the electromagnetic spectrum and occur in the short-wavelength, high-energy region of the spectrum and have the greatest penetrating power. They have the same properties and effects on materials, their origin being the main difference between them. X-rays with varying energies are generated by machines. Gamma rays with specific energies come from the spontaneous disintegration of radionuclides.

Naturally occurring and man-made radionuclides, also called radioactive isotopes or radioisotopes, emit radiation as they spontaneously revert to a stable state. The time taken by a radionuclide to decay to half the level of radioactivity originally present is known as its half-life, and is specific for each radionuclide of a particular element. Only certain radiation sources can be used in food irradiation. These are the radionuclides cobalt-60 or cesium-137; X-ray machines having a maximum energy of five million electron volts (MeV) (an electron volt is the amount of energy gained by an electron when it is accelerated by a potential of one volt in a vacuum); or electron accelerators having a maximum energy of 10 MeV. Energies from these radiation sources are too low to induce radioactivity in any material, including food.

Unit of Radiation Dose

Radiation dose is the quantity of radiation energy absorbed by the food as it passes through the radiation field during processing. It is measured using a unit called the Gray (Gy).

In early work the unit was the rad (1 Gy = 100 rads; 1 kGy =1000 Gy).

Application of Radiation processing of food

Interest in the practical application of the process is emerging for many reasons. High food losses caused by insect infestation, microbial contamination and spoilage; mounting concern over food borne diseases, harmful residues of chemical fumigants and the impact of these chemicals on the environment, the stiff standards of quality and quarantine restrictions in international trade are some of the reasons. Though irradiation alone can not solve all the problems of food preservation, it can play an important role in reducing post-harvest losses and use of chemical fumigants.

FOOD PROCESSING

Food Processing is the process of transforming food items into a form that can be used. It can cover the processing of raw materials into food via different physical and chemical processes. Various activities covered in this process are mincing, cooking, canning, liquefaction, pickling, macerating and emulsification.

It takes clean, harvested crops, or butchered and slaughtered animal products to produce attractive, marketable, and in several cases, life-long food products. However, food processing can also lower the nutritional value of the food and might include additives that might adversely affect health.

Objectives of Food Processing

Food technology is a very vast domain concerning with the production and processing of food. Food processing has certain objectives, such as:

- It boosts the shelf life of food products.
- Prevent food-contamination.
- Food storage and Transportation.
- Turns raw food materials into attractive, marketable products.
- Provide employment to a large population.

Food processing Methods

There are certain criteria that have to be compiled for the appropriate processing of food, right from the possibility of a pest or bacteria to invade and multiply on foods to the biological activity of foods. The following methods are applied for the proper processing of food:

- Peeling off the outer layers of the raw materials.
- Chopping or slicing
- Mincing
- Liquefaction
- Fermentation
- Emulsification
- Cooking
- Mixing
- Gasification such as the addition of a gas in bread or soft drinks.
- Proofing
- Spray drying

- Pasteurization
- Packaging

Other Methods of Food Processing

Food preservation is a process involved in food processing employed to prevent the growth of fungi, bacteria, and many other microorganisms. It involves the process of slowing down the oxidation of fats that would lead to rancidity. There are several food preservation methods that are designed specifically to preserve food. Some of the selected few preservation methods are stated below:

Drying

It is one of the traditional techniques that are employed to decompose food products. Exposure of food particles to sunlight to dry them is one such method done naturally. This process would result in the evaporation of moisture content from food, thus preventing microorganisms from invading the food. Moisture from food could also be removed by using hot air

Cooling

It is a technique of preserving food by slowing down the growth of microorganisms and action of an enzyme that is responsible for the rotting of food. Some of the food products such as meat, dairy products, and fish could be stored in a refrigerator thus increasing the shelf-life of the products.

Freezing

It is one of the regular processes that has been under use domestically and commercially to preserve a wide range of foods. Rapid freezing might have an adverse effect on the texture of food.

Heating

The majority of microorganisms and spores could be destroyed by applying sufficient heat to food items. One of the known examples includes boiling of milk.

Pickling

It is a process of preserving food in an edible and antimicrobial liquid. Pickling could be categorized into two types, namely fermentation and thermal pickling.

In fermentation pickling, bacteria present in a liquid produces organic agents which would act as preservation agents.

In chemical pickling, the food is preserved in an edible liquid that destroys microorganisms and bacteria.

Benefits of Food processing

The important benefits of food processing include:

1. Food processing reduces the number of harmful bacteria in food that can cause diseases. For eg., drying, pickling dehydrates the food product and alters the pH that prevents the growth of harmful microorganisms.
2. It also improves the shelf-life of food products.
3. It reduces health inequalities and major health concerns.

Drawbacks of Food Processing

The important drawbacks of food processing include:

- Processed food contains artificial ingredients.

- A large number of resources are spent in making the food pleasant to the brain that leads to overconsumption.
- Processed foods are the biggest source of added sugar that is very unhealthy.