Unit II - Topic 6

NON-THERMAL PROCESSING OF FOODS

13.1 Introduction

The application of extreme heat treatments used for food preservation affect the nutritional and organoleptic properties of food. In recent years, the consumers demand for fresher, higher quality and safe food has increased. Therefore, nonthermal methods of food preservation for the inactivation of microorganisms and enzymes as an alternative to thermal processes are being used. However, the high resistance of certain enzymes and microorganisms to nonthermal processes, especially bacterial spores, limit their application. During nonthermal processing, the temperature of foods is held below the temperature normally used in thermal processing; therefore, a minimal degradation of food quality is expected. Nonthermal process of food preservation improves food quality and enhances safety levels. Overall, most nonthermal preservation techniques are highly effective in inactivating vegetative cells of bacteria, yeast, and molds. Bacterial spores and most enzymes are however, difficult to inactivate with these procedures. Thus their use is limited to foods where enzymatic reactions do not affect food quality or where spore germination is inhibited by other prevailing conditions, such as low pH.

13.2 Low Temperature Preservation

Storage at low temperatures prolongs the shelf life of many foods. In general, low temperatures reduce the growth rates of microorganisms and slow many of the physical and chemical reactions that occur in foods. Low temperatures are used to preserve food by lowering microbial activity through the reduction of microbial enzyme activity. However, psychrophic bacteria are known to grow even at commercial **refrigeration** temperatures (7°C). These bacteria include members of the genera *Pseudomonas, Alcaligenes, Micrococcus* and *Flavobacterium*. Some of the fungi also grow at refrigeration temperatures. Slow freezing and quick freezing are used for long-term preservation. **Freezing** reduces the number of microorganisms in foods but does not kill all of them . In microorganisms, cell proteins undergo denaturation due to increasing concentrations of solutes in the unfrozen water in foods, and damage is caused by ice crystals.

13.2.1 Refrigeration

Refrigeration slows down the biological, chemical, and physical reactions that shorten the shelf life of food. Exposure of microorganisms to low temperatures reduces their rates of growth and reproduction. This principle is used in refrigeration and freezing. Microbes are not killed at refrigeration temperature for a considerable period of time. In refrigerators at 5°C, foods remain unspoiled but in a freezer at -5°C the crystals formed tear and shred microorganisms. It may kill many of the microbes. However, some are able to survive. *Salmonella* spp. and *Streptococcus spp.* Survive freezing. For these types of microorganisms rapid thawing and cooking is necessary.

Refrigerators should be set to below 12°C to control the growth of micro-organisms in foods. This lowered temperature also reduces the respiration rate of fruits and vegetables, which retards reactions that promote spoilage. All perishable foods should be refrigerated as soon as possible, preferably during transport, to prevent bacteria from multiplying. Refrigeration is generally used to: i) reduce spoilage during distribution of perishable foods, ii) increase the holding period between harvesting and processing; and iii) extend the storage life of commercially processed foods. All foods are not benefited from cold temperatures. For example, bananas turn black and bread goes stale when refrigerated.

13.2.2 Freezing

Freezing is also one of the most commonly used processes commercially and domestically for preserving a very wide range of food stuffs including prepared food stuffs which would not have required freezing in their unprepared state. For example, potato waffles are stored in the freezer, but potatoes themselves require only a cool dark place to ensure many months storage. Freezing makes water unavailable to microorganisms. The chemical and physical reactions leading to deterioration are slowed by freezing. White or grayish patches on frozen food caused by water evaporating into the packages air spaces called freezer burn occurs which causes deterioration of taste and appearance. This occurs in fruits, vegetables, meat, poultry and fish. While many home freezers are held at -10°C, commercial freezers are under -18°C. At this temperature, the growth of micro-organisms is almost stopped. Deteriorative microbial reactions will still occur, but over a much longer time. In addition, deteriorative enzymatic reactions will still take place during frozen storage. Uncooked fruits and vegetables must be blanched before freezing to prevent these reactions. During freezing, the water in food forms ice crystals. The rate of this phenomenon has a big impact on the quality of frozen foods:

Slow freezing

Slow freezing (e.g. home freezer) forms large ice crystals which puncture cell walls and cellular fluid is released and also results in shrunken appearance of thawed food. In this process the freezing is done for 3-72 h. This method is used in home freezer and temperature is lowered to -15 to -29°C.

Rapid freezing

During rapid freezing small, numerous ice crystals are formed and cell structure is not changed. In this process the temperature of food is lowered to about -20°C within 30 min. This process blocks or suppresses the metabolism.

The shelf life of frozen foods is largely dependent on storage conditions. Under ideal conditions, frozen foods can have a shelf life of one year. However, if foods are continuously exposed to warmer temperatures, such as the opening and closing of freezer doors, then heat shock occurs. Heat shock is when ice melts and re-forms into larger ice crystals. The best example is ice cream, which has a gritty texture if large ice crystals have developed.

Advantages of freezing are generally good retention of nutrients and prevention of microbial growth by low temperature and unavailability of water. However, disadvantages of freezing are loss of some B-Group vitamins and vitamin C due to blanching of vegetables prior to freezing and unintended thawing can reduce product quality.

13.2.3 Preservation by freeze drying

The process of freeze drying or lyophilization is commonly used these days for preservation. The food is deep frozen, after which the water is drawn off by a vacuum pump in a machine. The dry product is then sealed in foil and is reconstituted with water. This method is very useful for storing, transporting and preserving bacterial cultures. Drying or dehydration involves the removal of water from the food by controlled processes. This may be done by evaporation due to heating of the product, e.g., drying of fruits, osmotic dehydration, e.g. brining of fish and sublimation, or freeze drying e.g. in the drying of coffee.

There are two distinct stages in this technology. In the first stage, the removal of surface water depends solely on the state of the air surrounding the food, such as its temperature, relative humidity and speed. In the second phase of drying, the moisture within the food moves to the surface. As the air is heated, its relative humidity decreases, resulting in more absorption of water. Here the rate of drying is dependent on the time the moisture takes to get to the surface. The heating of the air around a food product can, therefore, cause it to dry more quickly. The principle of sublimation is used in freeze drying and lyophilization. This is the process in which a solid changes directly to a vapor without passing through the liquid phase.

Osmotic Pressure

The principle of osmosis is applied. Foods are preserved by adding salts and sugars to them. These chemicals remove the water out of microbial cells causing them to shrink in hypertonic environment, thus stopping their metabolism. Jams, jellies, fruit syrups, honey etc. are preserved by high sugar concentration. Fish, meat beef and vegetable products are preserved with salt.