Food preservation methods

Food preservation is aimed at extending the shelf life of foods. In most cases, it is the growth of either spoilage or disease-causing microorganisms that limits the length of time that a food can be kept, and most preservation techniques are primarily based on reducing or preventing this growth. However, there are other factors that limit shelf life, such as the action of naturally occurring enzymes within the food, or natural chemical reactions between the constituents of the food, and these also have to be taken into consideration.

1. High temperature methods

Manufacture of a heat-preserved packaged food can be broken down into two basic processes: (a) heating the food to reduce the numbers to an acceptably small statistical probability of pathogenic and spoilage organisms capable of growing under the intended storage conditions, and (b) sealing the food within an hermetic package to prevent re-infection. Preservation methods, such as traditional canning, seal the food in its package before the application of heat to the packaged food product, whereas other operations such as aseptic, cook-chill and cook-freeze, heat the food prior to dispensing into its pack.

a) Blanching:

Blanching is a process designed to inactivate enzymes and is usually applied immediately prior to other thermal preservation processes either using high temperatures (e.g. thermal processing) or low temperatures (e.g. freezing). Blanching is not designed to reduce the microbial population on the surface of foods, but it will nevertheless reduce the numbers of organisms of lower heat resistance, such as yeasts, moulds and certain bacteria (e.g. Listeria, Salmonella, E. coli). Without a blanching step, the shelf life of, for example, frozen vegetables would be substantially reduced as a result of chemical breakdown during storage. Freezing does not totally eliminate reactions at the storage temperatures used in commercial and domestic practice, but it does slow down those that rely on ionic transport. If enzymes were present in foods during their frozen storage life, the chemical reactions that cause food spoilage could occur, albeit at a slow rate. Inactivating the enzymes, will prevent such reactions from occurring and shelf life is extended. In thermal processing of fruits and vegetables, the blanching step is similar, but its objective is to prevent further enzymic breakdown of the foods if delays occur prior to processing the foods. One further advantage of this treatment is that a proportion of the air enclosed within cellular material (e.g. in strawberries) is removed and in doing so the tendency for the fruit or vegetable to float is diminished.

b) Thermal processing

Can retorting or processing is a term that is still widely used in the food industry to describe a wide range of thermal processes where the food is heated within the pack to achieve a commercially sterile packaged food. The heating takes place in retorts that are basically batchtype or continuous hot water and/or steam-heated pressure cookers. The principal concept of food canning is to heat a food in a hermetically sealed container so that it is commercially sterile at ambient temperatures, in other words, so that no microbial growth can occur in the food under normal storage conditions at ambient temperature until the package is opened. Once the package is opened, the effects of canning will be lost, the food will need to be regarded as perishable and its shelf life will depend on the nature of the food itself. Various packaging materials are used in the canning process and includes tin-plate, glass, plastic pots, trays, bottles and pouches, and aluminium cans. Most canned foods are sterilized, but there is a growing trend towards applying additional hurdles to microbial growth that allow the processor to use a milder heat treatment referred to as pasteurization.

In practical terms, the thermal process applied must reduce the probability of a single spore surviving in a can of low-acid product to one in one million million (i.e. 1 in 1012). This is called a botulinum cook, and the standard process is 3min equivalent at 121.1°C, referred to as F03. F03 is regarded as the absolute minimum, but most canned foods receive a much higher heat treatment (F06 or more) to ensure a good level of safety against possible spoilage due to any uncertainties over variations in product and/or thermal process control.

In the traditional food canning process, the filled aluminium or tinplate cans are hermetically sealed, with can ends attached by a double seaming operation, and the cans heated in a batch retort. Heating is usually achieved by steam or water, and care must be taken to ensure that the heat penetrates to the slowest heating point in the can, so that no part of the food is left under-processed. At the same time, it is desirable not to overcook the food, as this will result in reduction in the quality of the food. In contrast to thicker plastic and glass packs that permit slower heat transfer, the thin-walled metal can is a good conductor of thermal energy from the heating and to the cooling media.

After heating, the food needs to be cooled, and it is vital that no post-process contamination occurs through the package seals or seams. Therefore, the seal integrity is vital, and there are strict regimes for container handling to minimize abuse to the seals. Cooling water must be of high quality microbiologically, and the containers must not be handled while wet, as this could potentially result in contamination. Good practice in canneries avoids manual handling of hot and wet cans to reduce the risk of post-process introduction of microbial contaminants into the container. Thermal processing can be achieved using either batch retorts or continuous cooker-coolers.

c) Continuous thermal processing (aseptic)

The term UHT (ultra high temperature or ultra heat treatment) has been used to describe food preservation by in-line continuous thermal processing. In the aseptic packaging process UHT treatment is followed by packing in a sterilized container in a sterilised environment. The major difference here is that the package and food are sterilised separately and then the package is filled and sealed in a sterile environment, i.e. the aseptic form, fill and seal (FFS) process. The liquid food or beverage is sterilised or pasteurised in a continuous process in which it travels through a heat exchanger before being filled cold into the package.

One potential advantage of UHT processing is that of enhanced food quality, as the problem of overcooking can be significantly reduced.This technique is particularly suitable for liquid foods such as soups, fruit juices, milk and other liquid dairy products. Aseptic packaging has been carried out with metal cans, plastic pots and bottles, flexible packaging and foil-laminated paperboard cartons. Since air overpressure is not required in this process the range of suitable containers is greater than that with thermally processed foods. Suitable heat exchangers for heating and cooling the foods are plate packs for thin liquids, tubular heat exchangers for medium viscosity foods and scraped surface heat exchangers for high-viscosity foods that may contain particulates.

Generally high temperature short time (HTST) process is used for sterilization which includes following steps in case of milk.

Stage 1: the cold incoming milk is warmed by heat transfer from the freshly pasteurized milk. This raises te temperature of incoming milk about 57^0 C.

Stage 2: the temperature of the milk is now raised to 72^0 C by hot water pipes and passes to the holding stage.

Stage 3: a holding time of exactly 15 seconds is the optimum. Modern practice generally passes the milk through a pipe and arranges the flow to achieve the correct time at 72^0 C. the milk then passes to the other side of the system in stage 1 where it is cooled to about 57^0 C.

Stage 4: in the heat interchange the hot milk is cooled to about 57^0 C.

Stage 5: the cooling process in continued by water to about 24^0 C, depending on the water supply and the time of the year.

Stage 6: the final stage consists of cooling the milk to about 3^0 C so that in practice the milk after bottling will leave the dairy at between 4 - 6^0 C. Normally the chilling is done using chilled water.

d) Pasteurisation

This is a heating regime (generally below 105°C) that primarily aims to achieve commercial sterility by virtue of additional factors that contribute towards preserving the food. The actual degree of heat process required for an effective pasteurisation will vary depending on the nature of the food and the types and numbers of microorganisms present. In certain cases, an extended pasteurisation treatment may be required to inactivate heat-resistant enzymes.

Pasteurisation is used extensively in the production of many different types of food, including fruit products, pickled vegetables, jams and chilled ready meals. Food may be pasteurised in a sealed container. It is important to note that pasteurised foods are not sterile and will usually rely on other preservative mechanisms to ensure their extended stability for the desired length of time. Chilled temperatures are often used, but some foods have a sufficiently high salt, sugar or acid content to render them stable at room temperature