Consortium for Educational Communication

Module on

Canning

By

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Text

History of canning

Canning is an art of preserving foods and the industry has expanded based on trial and error basis and skill of individual canners. The canning process dates back to the late 18th century in France when the Emperor Napoleon Bonaparte, concerned about keeping his armies fed, offered a cash award of 12,000 francs to any inventor who could devise a cheap and effective method of preserving large amounts of food. The larger armies of the period required increased and regular supplies of quality food. Limited food availability was among the factors limiting military campaigns to the summer and autumn months. In 1809, Nicolas Appert, a French confectioner and brewer, observed that food cooked inside a jar did not spoil unless the seals leaked and developed a method of sealing food in glass jars. Appert was awarded the prize in 1810 by Count Montelivert, a French minister of the interior.

Based on Appert's methods of food preservation, the tin can process was allegedly developed by two individuals in England, Bryan Donkin and Peter Durand. Bryan Donkin, an associate of John Hall's at his Dartford Iron Works, realized in 1811 that iron containers could be used instead of the fragile glass and in 1812 the factory began to produce canned food such as meat. In 1810, Peter Durand patented the use of metal containers, which were easier to make and harder to break than glass jars (the glass jars used by Appert frequently broke). He covered iron cans, which were prone to rust, with a thin plating of tin (which is not adversely affected by water), and invented the "tin can." By 1813, Durand was selling canned meat to the Royal Navy. The British admiralty bought these foods as part of the medical stores for distribution to sick men as well as to supply expeditions. By 1819 canning had arrived in the United States, but no one wanted canned food until the Civil War started. In 1821, the William Underwood Company in Boston introduced commercial canning in the United States. For a long time, people regarded canned foods with suspicion, and for good reasons. In the middle of the nineteenth century, the foods produced by the canning industry were as likely to spoil as not because of inadequate heating techniques (Morris, 1958). Then, beginning in 1868, first in the United States and later in Europe, handmade cans were replaced by machine-cut types. The new technology made it possible for giant meat-canning firms like P. D. Armour to emerge in Chicago and Cincinnati. The product, however, was packed in big, thick, clumsy red cans and was not very appetizing.

The American Gail Borden was a pioneer in food canning. In 1856 he successfully produced sweetened condensed milk in cans and was granted a patent on the process. With financial support, the New York Condensed Milk Company was established in 1857. The demand for condensed milk was at first limited, but during the American Civil War (1861–1865) it was introduced on a large scale. The Civil War contributed significantly to the popularization of canned foods in general (Clark, 1977). The army had to be fed and the government contracted with firms to supply food. Under difficult circumstances, people learned that canned foods such as condensed milk can be tasty and nourishing. The invention of practical can openers at the end of the nineteenth century made cans easier to open, making them even more convenient for consumers.

In the early twentieth century, the heavy cans were replaced by those made of lighter materials, and manufacturers could stress that their products were hygienically processed and, therefore, safer to eat than the traditionally unpackaged products that had been sold in bulk. Originally, the nutritional value of food preserved by canning was not high, mainly due to the length of time required by the heating techniques. From the 1920s onward, however, the nutritional value of canned foods gradually approached that of the fresh product. Finally, in the 1960s, Reynolds and Alcoa companies succeeded in making all-aluminum cans out of one piece of metal, thereby solving the problem of the weight of the cans; only the lid needed to be attached. At the same time, the invention of the rip-off closure and the pop-top lid on aluminum cans made them even more convenient, and made can openers unnecessary. For consumers, the choice between fresh or canned food became largely a question of taste, convenience, and preference.

General process of canning foods

The canning process involves pre-treatment of food materials, preparation of cans, filling and closure of the cans, technique of heating the filled cans to kill micro-organisms without damage to food materials, finally cooling, cleaning and storage of the product. The raw material should be absolutely fresh for canning. For example for fruits and vegetables an hour from the field to can is an accepted ideal. The raw materials selected for canning pass through several processes before they are turned out as finished products. Various steps involved in canning process are given below:

Sorting

After receiving the raw material at cannery, it is first sorted e.g., damaged or bruised fruits and vegetables are sorted first of all. Only sound fruits and vegetables are used for canning. They are then sorted for size and maturity.

Grading

After preliminary sorting, the raw material is graded, because the processing requirements may differ with different grades. Thus, it is important to obtain a product of uniform quality. The grading is done manually by hand or mechanically using different types of grading machines. Different types of graders used in fruits and vegetables are screen graders, roller graders, rope or cable graders.

Washing

One of the important steps in canning is through cleaning of raw materials. Running water or high pressure water sprays can be used for washing in case of fruits. A thorough wash is very essential. Vegetables may be soaked in a dilute solution of potassium permanganate or chlorinated water containing up to 150 ppm total chlorine can be used for washing.

Peeling, coring, pitting, slicing and cutting

These can be done manually or with machines. Peeling can be done by hand knife or by machines, by heating or by hot lye treatment using 1-2% lye solution or by flame depending upon the nature of raw materials. Some fruits and vegetables are cut into pieces while others are canned whole. The fish and meat are cut into small slices and uniform cuts before filling into cans.

Blanching

Blanching is done for fruits and vegetables by immersing them in hot water or by exposing them to live steam or hot air for a proper period of time followed by cooling. Microwave blanching can also be used. Hot air and microwave blanching have been proposed as means of reducing cannery water use and waste disposal problems. The time and temperature for blanching of different fruits and vegetables vary with the type of raw material. Inactivation of peroxidase enzyme is used as an index of adequacy of blanching.

Filling

Empty cans should be packed carefully by employing the manual labour or through mechanical device. While packing, care should be taken to see that no air pockets are left which cannot be removed by exhausting. At the same time too tight packing should be avoided. It is always better to leave some space at the top for accommodating gas released while processing. Prepared raw materials are filled into cans of specific quality with one end fixed.

Syruping and brining

In canning, syrups are added to fruits whereas brine (salt solution) is added to the vegetables. However in case of fish and meat hot sauce, oil, brine or prepared gravy is used. Purpose of adding syrups or brine or other medium is to improve the flavor, fill the space between the pieces of canned product and aid in the heat transfer during sterilization. Cane sugar, glucose syrup, invert sugar and high fructose corn syrups are used for canning. Brine containing 1 to 2 percent of common salt is generally used for vegetables. Strength of syrup is measured by using hydrometer or a refractometer while strength of brine is measured by salometer or salinometer. The syrup, brine, hot sauce, oil or prepared gravy should be added to the can at a temperature of about 90 ^{o}C, leaving suitable headspace in the can.

Exhausting

Exhausting usually means heating the can and can contents before sealing. Sometimes it may also refer to the treatment of the container under a mechanically produced vacuum. But in either case it is done to remove air from the can interior and prevent corrosion. It also prevents undue strains upon the can during sterilization and prevents overfilling of can contents. Removing of air also helps in better retention of vitamins especially of vitamin C. The other advantages of the exhaust process are prevention of bulging of the can when stored at high altitudes or in hot climates. In heat exhaust method, the cans are generally passed through a tank of hot water at about 92-97^{o}C or on a moving belt through a covered steam box. The time of exhaust varies between 5 to 25 minutes. After exhausting cans are immediately sealed with the help of double rolling operation of seamer.

Processing of the cans

The term processing as used in canning technology, means heating of canned foods (fruits, vegetables and other food stuffs) to inactivate bacteria. This is also called as retorting. Processing consists of determining just the temperature and the extent of cooking that would be sufficient to eliminate all possibilities of bacterial growth. In retort, saturated steam is supplied to heat the product. Time-temperature combination of processing depends upon the type and physical state of the product, the heat resistance of microorganisms or enzymes likely to be present in the food, the heating conditions, pH of the food and size of the can to get complete sterility. In low acid foods (pH > 4.5), *Clostridium botulinum* is the most dangerous heat resistant spore forming pathogen likely to be present. Under anaerobic conditions inside a sealed can it can grow to produce a powerful exotoxin, botulin, which is sufficiently potent to be 65% fatal to humans. Because of the extreme hazard from botulin, the destruction of this microorganism is therefore a minimum requirement of heat processing (i.e. in canning and sterilization). Normally foods receive more than this minimum treatment as other more heat-resistant spoilage bacteria may also be present. In acidic foods (pH 4.5 - 3.7), other microorganisms (e.g. yeast and fungi) or heat-resistant enzymes are used to establish processing times and temperatures. In more acidic foods (pH < 3.7), enzyme inactivation is the main reason for processing and hence, heating conditions are less severe. The preservative effect of heat processing is due to the denaturation of proteins, which destroys enzyme activity and enzyme-controlled metabolism in microorganisms.

The rate of destruction is a first-order reaction; that is when food is heated to a temperature that is high enough to destroy contaminating microorganisms, the same percentage die in a given time interval regardless of the number present initially. This is known as the logarithmic order of death and is described by *thermal death rate* curve (Fig. 1). The time needed to destroy 90% of the microorganisms (to reduce their numbers by a factor of 10) is referred to as the decimal reduction time or D-value. D-values differ for different microbial species and a higher D-value indicates greater resistance. The thermal destruction of microorganisms is temperature dependent and cells die more rapidly at higher temperature. By collating D-values at different temperatures, a *thermal death time* (TDT) curve is constructed (Fig. 2). The thermal death time or F-value is used as a basis for comparing heat sterilization procedures. F-value is the time required to achieve a specified reduction in microbial numbers at a given temperature and it represents the total time-temperature combination received by a food. The slope of the TDT curve is termed the z-value and is defined as the number of degrees Celsius required to bring about a 10-fold change in decimal reduction time. F-value is quoted with suffixes indicating the retort temperature and the z value of the target microorganism. For example, a process operating at 110°C based on a microorganism with a z-value of 10°C would be expressed as F^{10}_{110}. Hence, D-value and z-value are used to characterize the heat resistance of a microorganism and its temperature dependence, respectively while F-value is used for comparing sterilizing procedures.

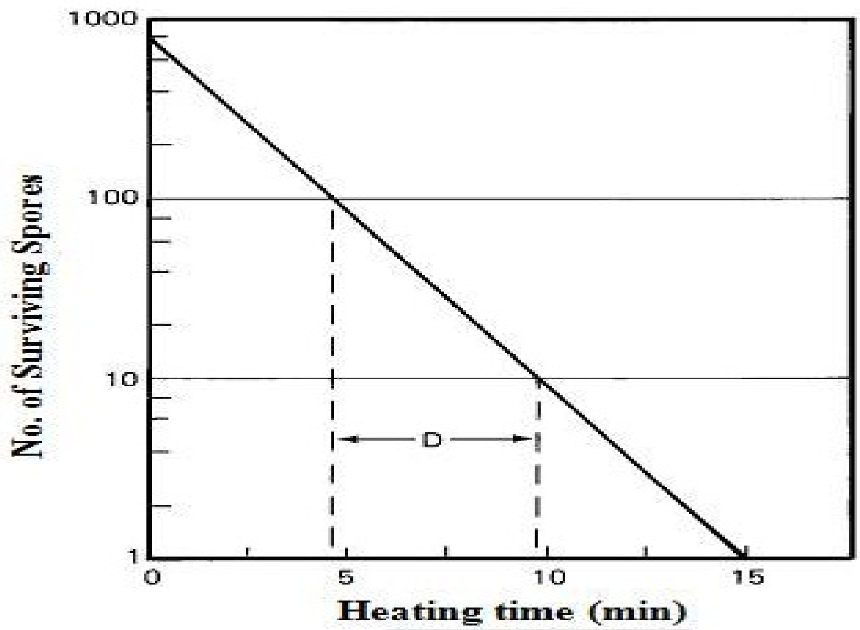

Fig. 1: Thermal death rate curve

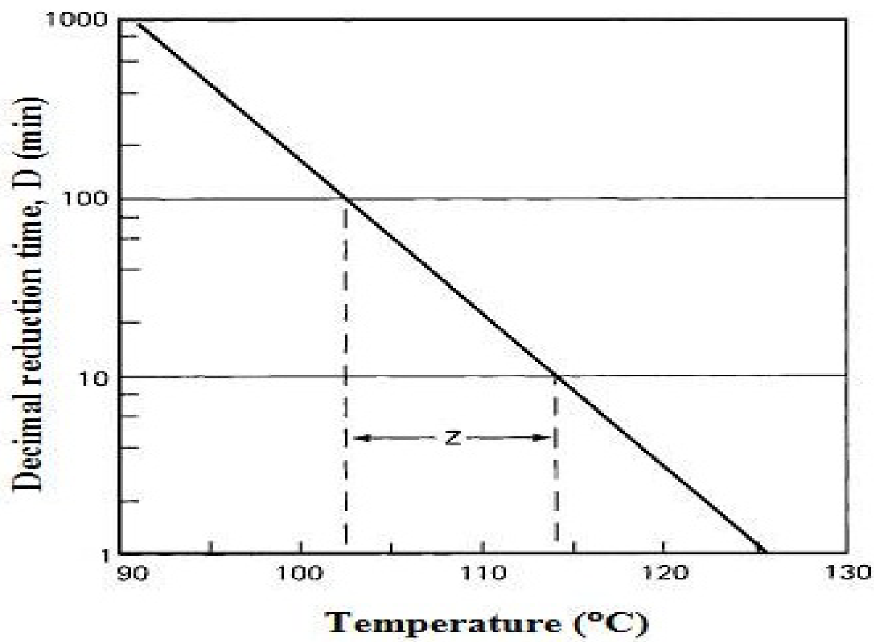

Fig. 9.2 Thermal death time curve

Rate of heat penetration in processing

Heat is transferred from steam or pressurized water through the container and into the fruit or vegetable or any other canned food. The rate of heat penetration is measured by placing a thermocouple at the thermal centre of a container (the point of slowest heating) to record temperatures in the food during processing. It is assumed that all other points in the container receive more heat and are therefore adequately processed. The zone of slowest heating in a container is called as cold point, which is most difficult to sterilize. In cylindrical containers the thermal centre is at the geometric centre for conductive heating foods and approximately one third up from base of the container for convective heating foods. The important factors that influence the rate of heat penetration into a food are given below:

- **Type of product**: Liquid or particulate foods (for example peas in brine) in which natural convection currents are established heat transfers faster than in solid food in which heat is transferred by conduction (for example pastes or purees). The low thermal conductivity of foods is a major limitation to heat transfer in conduction.
- **Size of the container**: Heat penetration to the centre is faster in small containers than in large containers.
- **Agitation of the container**: End-over-end agitation and to a lesser extent, axial agitation increases the effectiveness of natural convection currents and thereby increases the rate of heat penetration in viscous or semi-solid foods (for example beans in tomato sauce).
- **Temperature of the retort**: A higher temperature difference between the food and the heating medium causes faster heat penetration.
- **Shape of the container**: Tall containers promote convection currents in convective heating.
- **Type of container**: Heat penetration is faster through metal than through glass or plastics owing to differences in their thermal conductivity.

Cooling

Immediately after processing, cans are cooled quickly to prevent overcooking and stock burning. Cooling has sterilizing effect by giving thermal shock to thermophillic microorganisms. The processed cans are usually cooled to 37 ^{o}C, so that surface moisture dries out.

Testing of defects

After cooling the cans are tested for leaks or imperfect seals. A simple way of doing this is to tap the top of the can with a short steel rod. A clear ringing sound indicates a perfect seal while a dull hollow sound shows a leaky or imperfectly sealed can. Wax both which has a very high temperature 115.5 ^{o}C can also be used to test the cans. The cans containing the product are placed in bath; any leakage is indicated by bubbles coming out of the wax bath. A vacuum guage can also be used. A good quality can should have a vacuum not less than 8 inches of Hg.

Labeling and storage

The outer surface of cans is then dried and labeled. The cans should be stored in cool and dry place. The shelf life of a product differs with nature of canned material.

Type of containers used for canning

Containers for heat-preserved food must be hermetically sealed and airtight to avoid recontamination from environmental microflora. Mostly metal containers (cans) are used for canning of foods. However, in some cases glass jars or aluminum containers are also used. The metal cans or "tins" are produced from tinplate. They are usually cylindrical. However, other shapes such as rectangular or pear-shaped cans also exist. Tinplate consists of steel plate which is electrolytically coated with tin on both sides. The steel body is usually 0.22 to 0.28 mm in thickness. The tin layer is very thin (from 0.38 to 3.08 μm). In addition, the interior of the cans is lined with a synthetic compound to prevent any chemical reaction of the tinplate with the enclosed food.

Tin cans consist of two or three elements. In the case of three-piece steel cans, they are composed of the body and two ends (bottom and lid). The body is made of a thin steel strip, the smaller ends of which are soldered together to a cylindrical shape. Modern cans are induction-soldered and the soldering area is covered inside with a side-strip coating for protection and coverage of the seam. The use of lead soldered food cans was stopped decades ago. Hence the risk of poisonous lead entering canned food no longer exists. Two-piece steel cans have a lid similar to the three-piece cans but the bottom and body consist of one piece, which is moulded from a circular flat piece of metal into a cup. These cup-shaped parts may be shallow-drawn (with short side wall) or deep-drawn (with longer side walls). However, the length of the side walls is limited through the low moulding ability of steel (example: tuna tins 42/85mm, i.e. side wall: diameter =1:2)

Aluminium is frequently used for smaller and easy-to-open cans. Aluminium cans are usually deep-drawn two-piece cans, i.e. the body and the bottom end are formed out of one piece and only the top end is seamed on after the filling operation. The advantages of aluminium cans compared to tin cans are their better deep-drawing capability, low weight, resistance to corrosion, good thermal conductivity and easy recyclability. They are less rigid but more expensive than steel plate cans. Glass jars are sometimes used for meat products but are not common due to their fragility. They consist of a glass body and a metal lid. The seaming panel of the metal lid has a lining of synthetic material. Glass lids on jars are fitted by means of a rubber ring.

Tin cans made of thin steel plate of low carbon content, lightly coated on either side with tin metal to a thickness of about 0.25 mm are usually used in canning. The thickness of coating varies from 0.31 mm to 1.54 mm. The following are the different types of base plates used for can manufacture:

A) Type L: It is a high purity steel with low metalloid and residual content. This kind of base plate is used for highly acidic foods.

B) Type MR: It is a low metalloid steel with no severe restriction on residual content. It is used for moderate acid foods.

C)Type MC: It is similar to MR type but has high phosphorus content to give mechanical strength or stiffness. It is usually used for low acid foods.

Lacquering

It is difficult to coat steel plate uniformly with tin during the process of manufacture. Small microscopic spaces are always left uncoated, although the coating may appear perfect to the naked eye. The content of the can may react with the exposed parts of container and cause discolouration of the product or corrosion of the tin plate. When the corrosion is severe, the steel is attacked and black stains of iron sulphide are produced. Hence, it is necessary to coat the inside of the can with some material like lacquer, which would prevent discolouration, but would not impart its own flavor or injure the wholesomeness of the contents. The process of coating of inner side of the can to prevent discolouration of the product is called as lacquering. Lacquers include oleo-resinous material, synthetic resins, phenolic resins, epoxy resins and vinyl resins. There are two types of lacquers: (a) acid resistant and (b) sulphur resistant. The acid-resistant lacquer is ordinary gold coloured enamel and the cans treated with it are called as R-enamel cans. The sulphur-resistant lacquer is also of golden colour and the cans coated with it are called C-enamel cans or S.R. cans. Acid-resistant cans are used for packing of fruits of the acid group with soluble colouring matter such as raspberry, strawberry, red plum, coloured grapes, etc. Sulphur-resistant cans are used for non-acid products like peas, corn, beans, meat, fish, etc.