Paper No.: 02

Paper Title: The Principles of the Food Processing & Preservation

Module No :08

Module Title:General principles of canning and bottling of foods

8.1 Introduction

Canning is process of preservation by sealing and sterilization of food in air tight container. The main aim of canning is to create aseptic conditionsand prevent recontamination. Heat is most common agent used to destroy the micro-organism. Canning process was first invented after prolonged research by Nicolas Appert and further in 1810 Peter Durand of England patented the use of tin-coated iron cans instead of bottles.A typical commercial canning operation may employ the following general processes: washing, sorting/grading, peeling, coring, cutting, container filling, exhausting, container sealing, heat sterilization, cooling, labeling, and storage for shipment. Typical canned products include beans (cut and whole), beets, carrots, corn, peas, spinach, tomatoes, apples, peaches, pineapple, pears and apricots. Juices are also preserved by canning like orange, pineapple, grapefruit, tomato, and cranberry. Canned vegetables generally require more severe processing than fruits because the vegetables have much lower acidity and contain more heat-resistant soil organisms. Methods used for cooking vary widely like in some fruits preliminary treatments steps occur prior to heating but in vegetable preliminary steps done after blanching. Peeling is done either by steam or lye peeling.The principle of canning is same as the process was invented but production and processing of canned foods have changed considerably over the past decades.Technically bottling refers to storing in glass bottles and canning refers to storing in tin cans, although mode of preservation is same in both.

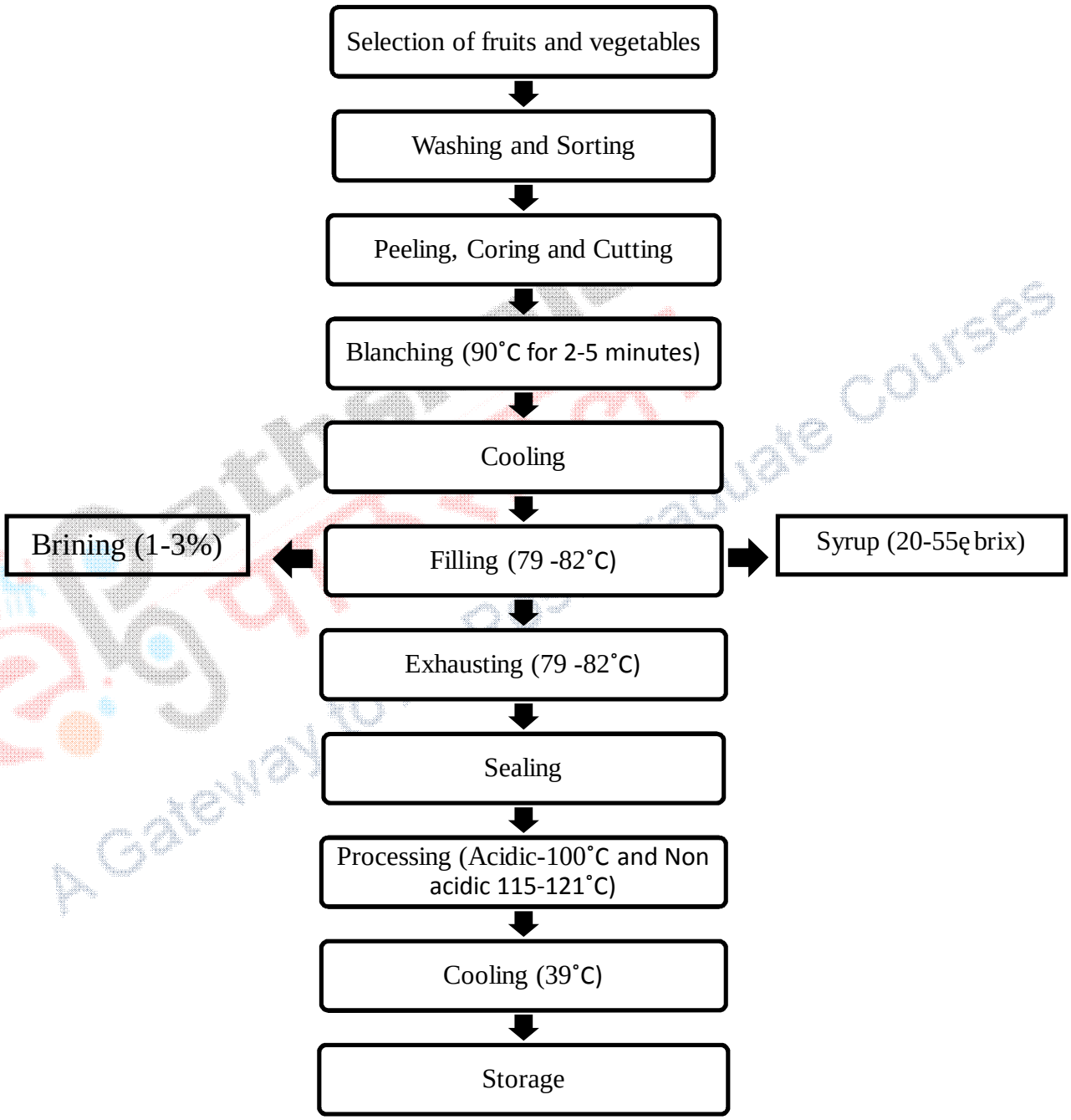
8.2 Preparation for canning

8.2.1 Selection of fruits and vegetables: Fruits and vegetables selected for canning should be fresh. Fruits usedfor canning should be ripe, firm and evenly matured, and vegetables should be tender. Fruits and vegetables should be stored at cool place and free from dirt, mechanical injury and insect damage. The main processes for canning are described in this chapter.

1. **Sorting and grading:**Sorting for same kind of items is done by passing through series of moving screens. After sorting fruits and vegetables are graded for uniform quality of size and color. Different types of grading machines are used such as screen grader, roller grader, rope and cable grader. Hand picking methods is generally used for soft fruits and berries.
2. **Washing:** Fruits and vegetables are washed through high pressure sprays, steam, by soaking or agitating in water. Vegetables soaked in a dilute solution of potassium permanganate and root crops soaked in chlorine water (25-50 ppm).
3. **Peeling, Coring and Cutting:** Hand peeling, heat peeling, steam peeling, mechanical peeling and lye peeling methods are used. Hand peeling is done in case of irregular shape fruits and vegetables. In heat peeling fruits and vegetables are exposed to a high temperature of 40˚C for 10-60 seconds. In steam peeling, steam is used to loosen the skin which is then removed by mechanical means. Fruit are immersed in 1- 2% lye solution for 30 seconds to 2 minutes in lye peeling. Mechanical peeling is done in case of fruits like peaches, apricots, sweet orange and vegetables like carrot, sweet potatoes. Coring is the process of removing centre of various fruits and vegetables such as apple, pears, pineapple, lettuce and cabbage, done by a hydraulic powered device with turbine wheels. A special blade mounted on the turbine wheel spins and removes the core. Cutting is done according to the requirement of process.
4. **Blanching:** Blanching is done by dipping fruits and vegetables in hot water at temperature 82-90˚ C for 2-5 minutes and then immediately cooled by immersion in cold water. Main objective of blanching is to inactivate the enzyme,to soften the texture, to loosen skin, to reduce the number of micro-organism, to enhance the green color of vegetables, to remove acid and astringent taste. Hard water cause toughening of tissue and destroys the natural texture, so it should be avoided.

5. **Cooling:** To keep fruits and vegetable into good condition, cooling is done after blanching.

Flow Chart for canning



6. **Filling:** Before filling cans are subjected to steam jet or hot water to remove dust and foreign material. Automatic can filing machine is used by canning industry. Generally for fruits filling is done by hand to prevent the bruising. After filling syrup or brine is added.

    a.) Syruping: Syrup is a solution of sugar in water, done only for fruits. Syrup is added to improve the flavor and serve as a heat transfer medium for facilitating processing. Strained, hot syrup of concentration 20 to 55ę brix is used and filled at about 79 to 82ęC, leaving head space of 0.3 to 0.5cm.

    b.) Brining: Brine is a solution of salt of concentration 1-3%, used for vegetables. The brine should be filtered through a thick cloth before filling.

    After Syruping or brining the cans are loosely covered with lids and exhausted. Lidding has certain disadvantages such as spilling of the contents and toppling of the lids. Hence lidding has now been replaced by clinching in which lids is partially seamed.

7. **Exhausting:** Exhausting is the process of removal of air from the cans. It is very essential as it avoids the corrosion of tinplate and pinholing during the storage. Exhausting is done to minimize discoloration, to reduce chemical reaction between the container and the contents. It alsohelps in better retention of vitamin and prevents development of excessive pressure during sterilization. For exhausting heating method is generally used but can also be done bymechanical means. The can are passed through a tank of hot water at 82 to 87ęC for 5-10 minutes. At the end of exhausting temperature at the centre of can should be about 79 ˚C.
8. **Sealing:** After exhausting can are sealed immediately with the help of can sealer and temperature should not fall below 74ęC during sealing.
9. **Processing:**It is heating or cooling of canned foods to inactivate the bacteria. Processing time and temperature should be adequate to eliminate all bacteria and to minimize quality damage. Fruits and vegetables processed at temperature of 100ęC as presence of acid retards the bacteria and their spores. Non-acid vegetables are processed at high temperature 115-121ęC. Temperature and processing time vary with size of can and nature of food. Temperature at the centre of can, should be maintained for long period of time to ensure the

destruction of most heat resistant bacteria. Fruits and vegetables are classified into groups depend on pH value given in Table 1.

Table-1. Classification of Fruits and Vegetables according to pH

Class	pH	Product
Low acid	Above 5.0	Peas, lima bean, asparagus, cauliflower, potato, spinach, beet, corn, French beans
Medium acid	4.5-5.0	Turnip, carrot, cabbage, pumpkin
Acid	3.7-4.5	Tomato, pear, banana, mango, jackfruit, pineapple
High acid	Below 3.7	Citrus juice, rhubarb, prune, sauerkraut, pickle, chutney

Processing methods: Generally three types of processing methods are used for canning like open cookers, continuous non-agitating and continuous agitating cookers. Open cookers are made up on wooden tubs or galvanized iron tanks of desired capacity. In continuous non-agitating cookers, cans travel on a continuous moving belt in boiling water crates. Processing time reduced by using continuous agitating cookers.

10. **Cooling:** Cans are cooled rapidly to 39ęC to stop the process and to prevent the stack burning. Cooling is done either by dipping or immersing can in cold water tank or by spraying jet of cold water. In case of canned vegetables, cooling is done by turning in cold water into pressure cooker.
11. **Storage:** After labelling cans are packed in strong wooden cases and stored in cool and dry place. Storage at high temperature should be avoided as it shortens the shelf-life of the product.

8.3 Type of containers

8.3.1 Tin container: Tin cans are made up of thin steel plate of low carbon content, lightly coated on both sides with tin metal. Coating may not be uniform that result in discoloration of

products or corrosion of tin plate. This situation can be avoided by lacquering of cans. There are two types of lacquering.

a) Acid-resistant: It is golden coloured enamel and can coated with it called R or A.R. cans. It is used for high acidic fruits and vegetables e.g., peach, pineapple, grapefruit, strawberry and raspberry.

b) Sulphur resistant: This enamel is also of golden colour and cans arecoated with it called C or S.R. cans. It is used for non- acidic products e.g., pea, corn, lima bean, red kidney bean.

8.3.2 Glass container: Contents are visible in glass container and reusable. They do not contaminate the contents but highly fragile in nature.

8.4 Bottling of fruits and vegetables

Bottles have high initial cost but reusable, and also proved to be very good containers for home preservation. Glass containers provides very attractive look and resistant to the development of metallic flavor. Although glass containers have high cost so they are not suitable for manufacturerôs point of view. General steps followed in processing are same as that of canning. Bottles are thoroughly washed and sterilized before filling and 1-1.5 cm head space should be left. There is no need of exhausting separately as it is done simultaneously with sterilization by putting a false bottom under bottles. Water temperature should be raised slowly as too much fluctuation in temperature leads to breakage. At the time of sterilization lids are left open and boiling water for sterilization should be filled up to the neck of bottles. After completion of sterilization bottles are closed immediately.

8.5 Spoilage in canned foods

Generally there are two reasons for the spoilage of canned food

1.) Microorganism
2.) Spoilage due to physical and chemical changes

8.5.1 Microbial Spoilage

Thermophilic and mesophilic organism are responsible for canned food spoilage. Thermophilic bacteria can survive at a high temperature of 100˚C. Facultative thermophiles can grow at 43˚C and obligate thermophiles grow at 43-77˚C. Spoilage by mesophilic organism is the indication of under processing. Generally *Clostridium*, *Bacillus*, yeast and fungi cause spoilage of can due to formation of carbon dioxide and hydrogen. Thermophiles can cans three types of spoilage:

a) **Flat sour**: Flat sour spoilage occurs mostly in non-acidic foods by *Bacillus* such as *B. coagulans* and *B. sterothermophilus*which produce acid without gas formation. Flat sour spoiled product is unfit for consumption as it has sour odour and highly acidic.
b) **Themophilic acid spoilage**: *Clostridium thermosaccharolyticum*, an obligate thermophile, is responsible for TA spoilage in which cans swell due to production of carbon dioxide and hydrogen.
c) **Sulphide spoilage:** Also known as sulphur stinker is caused by *Clostridium nigrificans* in low acid foods and occurs in case of under processing of canned foods.

8.5.2 Spoilage due to physical and chemical changes:

2.1) **Swell:** It is bulging of can due to pressure of gases formed by microbial and chemical action.

a) **Hydrogen Swell:** Hydrogen gas produced by the action of food acids on metal of can that can cause bulging of can. Canned food remains fit for consumption as it is free of microorganism.
b) **Flipper:** Swelling of can when both ends become convex and flips out, but when can push back to normal condition by little pressure. Flipper caused by overfilling, under-exhausting and gas pressure due to spoilage.
c) **Springer:** It occurs when the can swells at both end due to insufficient exhausting or overfilling.
d) **Soft swell:** It is more or less similar to that of flipper in which both ends of can swell. When can is pressed, the end returned back to the normal position and springs back when pressure is removed.

e) **Hard swell**: It is a final stage of swell in which bulged end cannot be pressed back to normal position and can ultimately burst.

2.2) **Leakage:** Leakage is due to defective seaming, nail holes caused by faulty nailing of cases, excessive internal pressure, corrosion and mechanical damage during handling.

2.3) **Breathing:** It is a very tiny leak in can through which air can pass in and destroy the vacuum.

2.4) **Stack browning:** When cans are not allowed to cool properly before storing stack browning takes place which results in discoloration, cooked flavor and soft product. So, it is necessary to cool product to 39˚C before storage.