
UNIT 3 CANNING OF FRUITS AND VEGETABLES

Structure

- 3.0 Objectives
- 3.1 Introduction
- 3.2 Canning Process for Fruits and Vegetables
 - Principles
 - Process
 - Tin Containers
 - Spoilage in Canned Fruits and Vegetables
- 3.3 Canning of Fruits
- 3.4 Canning of Vegetables
- 3.5 Aseptic Canning of Fruit and Vegetable Products
- 3.6 Let Us Sum Up
- 3.7 Key Words
- 3.8 Answers to Check Your Progress Exercises
- 3.9 Some Useful Books

3.0 OBJECTIVES

After reading this unit, you should be able to:

- state the principles of canning;
- explain the various unit operations involved in canning;
- describe the canning process of fruits and vegetables; and
- list the cans and types of spoilages of canned products.

3.1 INTRODUCTION

You know there are several methods of preservation of fruits and vegetables and canning is one of them. It is an important method of food preservation by heat. In this process, the foodstuff (fruits & vegetables) are placed in containers, and sterilized by placing them in hot water or steam. Canning is also known as appertizing in honour of its inventor. In 1804, Nicholas Appert, a confectioner in France, invented a process of sealing foods hermetically in containers and sterilizing them by heat. He had also published a book entitled, "The Art of Preserving Animal and Vegetable Substance for Many Years", which is the first known work on modern canning.

Canning is an important process of preservation of fruits and vegetables by application of heat. In this unit, we will discuss canning process for fruits and vegetables. Several unit operations are involved in the canning process. The process discusses the principles and purpose of canning, types and causes of spoilages. Tin cans are used in the canning of fruits and vegetables.

Fruits and vegetables are canned in the season when the raw material is available in plenty and at low price. The canned products are sold round the year and give better returns to the grower. Thus, canning of fruits and vegetables is an important industry.

3.2 CANNING PROCESS FOR FRUITS AND VEGETABLES

Canning is defined as the preservation of foods in the sealed containers and usually implies heat treatment as the principal factor in prevention of spoilage. Mostly the canning is done in tin cans but other containers like glass, plastics, etc. The fruits and vegetables used for canning should be as fresh as possible so that their quality could be retained. Fruits should be mature, firm ripe and free from all defects, while vegetables should be usually tender.

3.2.1 Principles

1. Destruction of spoilage organisms within the sealed containers by application of heat,
2. To improve the texture, flavour and appearance by cooking, and
3. To stop recontamination of food during storage.

You should be careful during heat application that palatability of food is least disturbed while all the microbial load is destroyed.

3.2.2 Process

Canning process includes the following steps or unit operations:

Selection of fruits & vegetables → Sorting & Grading → Washing → Peeling → Cutting → Blanching → Filling → Syruping/Brining → Lidding or Clinching → Exhausting → Seaming → Processing → Cooling → Testing for defects → Storage.

i) Selection of Fruits and Vegetables

We should select the fresh good quality fruits and vegetables for canning because quality of canned product is dependent on the quality of raw material. Fruits should be firm, mature and uniformly ripe. Over-ripe, insect infected and diseased fruits and vegetables should be rejected. Unripe and immature fruits should be rejected because they generally shrivel and toughened on canning. Vegetables should be tender. Fruits and vegetables should be free of dirt.

ii) Sorting and Grading

We should see that any spoiled, blemished, injured fruit or vegetable be discarded. Raw material should be sorted based on maturity and ripeness. Fruit and vegetables should be graded according to size and colour to obtain uniform quality of canned product. Grading can be done by hand or by machines. Screw type and roller type grader are generally used.

Fruits like berries, cherries, grape and plum are graded whole, while peach, pear, apricot, mango, pineapple, etc., are generally graded after cutting into pieces.

iii) Washing

Fruits and vegetables should be washed with water thoroughly. Washing will remove dust, dirt and any sprayed chemical residue. Any microorganism over the surface of the fruits or vegetables are also

washed out. Water used for washing may be cold or hot. We may employ chlorine (150ppm) or potassium permanganate (dilute solution) in water to disinfect fruits and vegetables. Fruits and vegetables are generally soaked in water tank before washing by hand. They can be washed by spraying water, which is the most effective method.

iv) Peeling

Washed fruits and vegetables are prepared for canning. The fruits and vegetables are peeled by hand with knife or machine, heat treatment or lye solution. Lye is a solution of caustic soda. For example, peaches and potatoes are scaled in steam or boiling water and put in cold water to soften and loosen or cracking of skin. Later the skin can easily be removed by hand or pressure spray of water.

In case of lye peeling of fruits and vegetables, e.g., peaches, apricots, orange and sweet potatoes are dipped in boiling lye (1-2% caustic soda) for ½ to 2 minutes. Any trace of alkali is removed by washing fruits and vegetables in running cold water; sometimes they are also washed in water containing 0.5 per cent citric acid or hydrochloric acid.

v) Cutting

We should cut the fruits and vegetables depending upon the requirement like slice, dice, finger etc either by knife or by machine. At the same time seed, stone and core are also removed by special coring knife.

vi) Blanching

In blanching operations the prepared fruits and vegetables are kept in boiling water or exposed to steam for 2 to 5 minutes followed by cooling in running cold water. The time and temperature of blanching vary depending on the type of raw material. Inactivation of peroxidase enzyme is used as an index adequacy of blanching. The purposes of blanching are: (1) to inactivate the enzymes, which cause discolouration and off-flavour, (2) to reduce the volume by shrinkage, making their packing easier, (3) to reduce the microbial load on raw materials, (4) to enhance the green colour of vegetables like peas and spinach, (5) to remove undesirable acids and astringent taste of the peel resulting improved flavour, and (6) to remove occluded gases for reducing strain on the seam of can during processing.

vii) Filling

Tin cans are used as containers for canning. The cans can be opened from any end as they are called open top sanitary can. Cans are washed with hot water. Prepared fruits and vegetables are filled into cans either by hand or by machine. Plain cans are used generally, although in case of coloured fruits like black grapes, red plum, strawberries, etc., lacquered cans are employed.

In case of canned fruits the drained weight should not be less than 50% and for berry fruits not less than 40%. Similarly for canned vegetables the drained weight should not be less than 55% but in case of tomatoes limit is the 50%. Therefore, fruits and vegetables are filled about 60 per cent of the filling capacity of a can.

viii) Syruping

A solution of sugar in water is called syrup. Generally the fruits are covered with sugar syrup. Cans are filled with hot (79°–82°C) sugar syrup, leaving a headspace of 0.3 to 0.5cm. Syrup of 10° to 55° Brix (per cent sucrose) is generally used. We can prepare sugar syrup of 20° Brix by dissolving 250 g sugar in one-liter water and of 50°Brix by dissolving one kg of sugar in one litre water. Sometimes citric acid and ascorbic acid are also mixed with the syrup to improve flavour and nutritional value, respectively. The purpose of adding syrup to fruits is (1) to improve taste, (2) to fill up the interspaces in can, and (3) to facilitate further processing.

ix) Brining

Brine is a solution of common salt in water. Brine is used in canning of vegetables. A brine of 1 to 3% salt is used at 79°-82°C, leaving a headspace of 0.3 to 0.5 cm in the can. The objectives of brining are to improve the taste of vegetables and to facilitate further processing by filling the interspaces of vegetables in the can.

x) Lidding or Clinching

Now the filled cans are covered loosely with the lid before exhausting. It has some disadvantages such as spilling of the contents and toppling of the lids. In modern canning, lidding has been replaced by clinching operation. In this case, lid is partially seamed. The lid remains sufficiently loose to permit the escape of gases, air and vapour formed during exhausting operation.

xi) Exhausting

There are respiratory gases and air remain in the cans, which are to be removed before processing. The method of removing these gases is known as exhausting. Containers are exhausted by heating or mechanically. In heat exhausting, the cans are passed through a tank of hot water or exhaust box under steam. The fruit cans are exhausted at 82 to 100°C for 7-10 minutes or until temperature at the centre of the can reaches 74°C. The vegetable cans are exhausted at 90 to 100°C for 7-10 minutes or until temperature at the centre of the can reaches 77°C. The proper exhausting reduces the strain on the seam of the can.

The time and temperature of exhausting vary with the size and contents of can, but it should be sufficient to ensure a vacuum of 12 to 15 inch Hg in processed and cooled can.

xii) Sealing or Seaming

After exhausting, the cans are sealed by double seaming machine and the method is called seaming. In sealing lids on cans, a double seam is created, and the method of sealing or closing is also known as seaming.

xiii) Processing

Process of heating and cooling of canned food to inactivate bacteria and to preserve food is also called as commercial sterilization. Many bacterial spores are heat resistant, which can only be killed either by very high or by very low temperature treatment or prolonged cooking. Such drastic treatment, however, affects the quality of food. Thus,

processing time and temperature should be adequate to eliminate all bacterial growth. We must not over-cook the canned foods otherwise it will spoil the flavour, appearance and texture of the product.

All fruits and acid vegetables can be processed satisfactorily at a temperature of 100°C, i.e., in boiling water. The acid present in fruits and acid vegetables retards the growth of bacteria and spores. These bacteria and spores do not thrive in heavy sugar syrups, which are normally used in canning fruits. Vegetables, generally non acidic (except tomato and rhubarb), are processed at a higher temperatures of about 115 to 121°C.

Bacterial spores usually do not grow below pH 4.5 as you have read in previous chapters. We, generally process the canned products having pH less than 4.5 in boiling water but products with pH higher than 4.5 require processing at 115 to 121°C. The higher temperature can be obtained by processing in a retort under a pressure of 0.70 to 1.05 kg/cm² (10 to 15 lb/sq. inch). The centre of can should attain these high temperatures.

The temperature and time of processing vary with the size of the can, the larger the can, the greater is the processing time. Fruits and acid vegetables are generally processed in open type cookers, continuous non-agitating cookers and continuous agitating cookers.

The open cookers are galvanized iron tank of desired capacity. Sealed cans are placed in iron crates and immersed in the tank containing boiling water. In continuous cookers, the cans travel in boiling water in crates carried by overhead conveyors. In continuous agitated cookers, the cans are rotated by special mechanical devices to agitate the contents of the cans. Agitation reduces the processing time considerably.

The non-acid vegetables are processed under steam pressure in closed retorts. The sealed cans are placed in the retort, keeping the level of water 2.5 to 5.0 cm above the top of the cans. The cover of the cooker is then screwed down tightly and the cooker is heated by steam to the desired temperature. The period of processing (sterilization) should be counted from the time the water starts boiling or steaming. After heating for the required period, heating is stopped and the petcock or vent is opened. When the pressure comes down to zero the cover is removed and the cans are taken out.

xiv) Cooling

After processing, the cans are cooled rapidly to about 39°C to stop the cooking process. Cooling can be done by several methods such as (1) immersing the hot cans in tank containing cold water, (2) spraying cold water, (3) turning in cold water into the pressure cooker, and (4) exposing the cans to air. Generally the first method is practiced. Cooling water may be kept sterile with 1 or 2 per cent chlorine. If canned products are not cool immediately after processing, the quality is deteriorated, e.g., peaches and pears become dark in colour, tomatoes turn brownish and become bitter in taste, while peas become mashy with a cooked taste.

xv) Testing for Defects

Before the canned products are marketed, we should test them for any defect. The finished cans are tested for leak or imperfect seals. We should tap the top of the can with a short steel rod. A clear ringing sound indicates a perfect seal, while a dull and hollow sound shows a leaky or imperfect seal. Leaky cans should be removed from the lot.

xvi) Storage, labelling and packing

Before storage, the cans should be completely dry, small traces of moisture are likely to induce rusting. They should be stored in a cool and dry place. Storage of cans at high temperature should be avoided, as it shortens the shelf life of the product. The high temperature may lead to hydrogen swell and perforation during extended storage. The basement stores are useful, especially during summer months. The temperature in these stores is lower by about 6° to 8°C, compared to outside temperature. Before dispatch, the cans are labelled and packed either in wooden or cardboard boxes, and are ready for marketing. The cans may be stored for 1 to 2 years depending upon the type of raw materials used and the shelf life of the product.

3.2.3 Tin Containers

The cans are made of thin steel plate of low carbon content, lightly coated on both sides with tin metal. Sometimes discolouration of the product or corrosion of the tin plate takes place. In order to avoid corrosion, these cans are coated inside and or outside with lacquer, the process is known as “lacquering”. There are two types of lacquers used.

1. Acid-resistant-Acid-resistant lacquer is a golden colour enamel, cans coated with it are called R enamel or A.R. cans. The lacquered cans are used for packing fruits having water soluble colour (anthocyanins) for example raspberry, strawberry, red plum, coloured grapes, pomegranate, etc. Fruits having water insoluble colour, for example pineapple, mango, grapefruit, etc., are packed in plain cans only.
2. Sulphur-resistant – This lacquer is also of a golden colour, cans coated with it are called C. enamel or S.R. cans. These cans are used for packing pea, corn, lima beans, etc.

The tin cans are supplied to the canning factory in flattened form, where they are reformed using a machine, reformer, into cylindrical shape. After that, they are flanged by using flanger, which curls the rings outwards at each end. The one end of the cylindrical can is then fixed, before filling it, using a machine known as double seamer. After filling, processing and exhausting the can, the lid is fixed using the same machine.

Table 3.1: Commercial can sizes and capacities

Sl. No.	Trade name of can	Size (mm)	Capacity (in cubic cm)
1.	A1	68 × 102	316
2.	1-1b Jam	78 × 90	356
3.	A1-T	78 × 119	479
4.	A2	87 × 114	579

5.	1-1b Butter	103 × 70	470
6.	A2-1b Jam	103 × 102	721
7.	A2½	103 × 119	848
8.	7-1b Jam	157 × 148	2543
9.	A10	157 × 178	3069

3.2.4 Spoilage in Canned Fruits and Vegetables

Canned products are liable to spoilage for various reasons. Spoilage in canned food may be caused due to two reasons:

A) Spoilage due to physical and chemical changes:

1. Swell – Swell or bulge in cans caused due to the positive internal pressure of gases formed by microbial or chemical action. Hydrogen Swell – This type of swelling is due to the hydrogen gas produced by the action of food acids on the metal of the can. The swelling ranges from flipper – springer, soft swell or hard swell.
2. Overfilling – Overfilling should be avoided.
3. Faulty retort operation – It gives cans look like swells.
4. Under exhausting – It causes severe strain during heat processing.
5. Panelling – It is seen in large sized cans that the body is pushed inward due to high vacuum inside.
6. Rust – Rust is mostly seen under the label and subsequently affects the label. Cans lacquered externally do not rust.
7. Leakage – Cans generally leak due to defective seaming and nail holes.
8. Bursting – Cans may burst due to excess pressure of gases produced by decomposition of the food.
9. Discolouration – This may be due to enzymatic and non – enzymatic browning. Enzymatic discolouration can be avoided by placing the peeled and cut pieces of fruits and vegetables in 2% salt solution.
10. Stack burning – The contents in the can if remain hot for a long time during storage result in stack burning. It may cause discolouration. To avoid stack burning cans should be cooled quickly to about 39°C before storage.

B) Spoilage by microorganisms

The time gap between filling and heat processing may cause microbial spoilage. If cans are not processed properly they may result in spoilage by bacteria and the spoilage is termed as “Under processed” spoilage.

Various spoilages caused due to different microorganisms are:

1. Flat sour – The non-acid vegetables spoiled by *Bacillus coagulans* and *Bacillus sterothermophilus*.
2. Thermophilic acid spoilage – Cans swell due to production of carbon dioxide and hydrogen by *Clostridium thermosaccharolyticum*.

- 3. Sulphide spoilage – Caused by Clostridium nignificans in low acid foods.

So, we should process cans properly to avoid any type of spoilage.

Check Your Progress Exercise 1



- Note:** a) Use the space below for your answer.
b) Compare your answers with those given at the end of the unit.

- 1. Define principles of processing.

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- 2. List the name of unit operations involved in the canning process.

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- 3. State the differences between processing of fruits and vegetables in a can.

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4. Describe the causes and types of spoilages of canned foods?
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3.3 CANNING OF FRUITS

The fruits are exhausted at 82 to 100°C for 7-10 minutes or until the centre of the can reaches at least 74°C temperature. The types of can, strength of covering sugar syrup and time-temperature for No.2½ and No.10 cans are summarised in Table 3.2.

Table 3.2: Canning time table for fruits and tomatoes

Sl. No.	Fruit	Type of can	Strength of syrup (Degree Brix)	Processing time (min) in boiling water at 100°C	
				No.2½	No. 10
1.	Apple	Plain	Water or light syrup	12	25
2.	Apricot	Plain	55	35	50
3.	Banana	Plain	30+0.2% citric acid	20	–
4.	Blackberry	Fruit lacquered	55	20	30
5.	Cherry (sweet)	Fruit lacquered	40	20	25
6.	Cherry (sour)	Fruit lacquered	45	20	25
7.	Fig	Plain	55	15	35
8.	Grape (coloured)	Fruit lacquered	40	12	15
9.	Grape (white)	Plain	40	12	15
10.	Grape fruit	Plain	60	30to 40	

11.	Guava	Plain	40	20	–
12.	Jack fruit	Plain	50	30	–
13.	Litchi	Plain	40	30	–
14.	Mango	Plain	40	30	–
15.	Mulberry (coloured)	Fruit lacquered	40	12	–
16.	Musk Melon	Plain	40+0.3% Citric acid	30	–
17.	Orange	Plain	50	15 to 20	
18.	Papaya	Plain	45	30	–
19.	Peach	Plain	55	30	50
20.	Pear	Plain	40	35	60
21.	Pineapple	Plain	40	30	60
22.	Plum, red	Fruit lacquered	40	20	30
23.	Raspberry	Fruit lacquered	45	12	25
25.	Strawberry	Fruit lacquered	50	15	20
26.	Tomato	Plain	Only tomato juice in the case of standard pack	30	70
27.	Fruit Cocktail (Fruit salad)	Plain	45	30	90

i) Apple

Apples are generally not canned. However, canned apples available in the large sizes of cans are used in pies. The varieties used for canning are: Golden Delicious, Yellow Newton, Baldwin, Jonathan, and Ambri.

The fruits should be washed in warm dilute hydrochloric acid (0.5%) solution to remove any residue of lead or arsenic sprays. And then washed thoroughly in cold water to remove traces of acid. The apples are peeled by hand or machine and cut into 0.3 to 0.6 cm thick slices. The prepared fruits should be kept in 2 to 3 per cent common salt solution to avoid darkening due to enzyme action. The prepared fruits are blanched in hot water at 71 to 81° C for 3 to 4 minutes and then cooled in water. Blanching removes the air and gases and inactivates enzymes. The blanched fruits are filled into cans, covered with hot water or thin sugar syrup, exhausted, sealed and processed.

ii) Apricot

Apricots are mostly grown in Kashmir, Himachal Pradesh and Uttaranchal, where a great scope exists for their canning. Charmagz and Shakarkand are white sweet varieties which are good for canning. Apricots are either canned whole or halves.

iii) Banana

South Indian varieties of banana, viz. Pachabale, Chandrabale, Nendran, Poovan and Vannan are good for canning. Fully ripe bananas are selected for canning. Fruits are peeled by hand and then cut into long slices of 1 to 2 cm thickness. The slices are filled into cans and covered with a sugar syrup of 25 to 30° Brix containing 0.2 per cent citric acid. Then the cans are exhausted, sealed and processed.

iv) Ber

Umran and *Katha* varieties of *ber* are good for canning. Fully mature fruits are selected for canning. Peel is removed by hand with the help of stainless steel knife or by dipping in 5 per cent boiling hot caustic soda solution for 2 minutes and then washed in running tap water. Second washing is done in water containing 0.1 per cent citric acid in order to remove any traces of caustic soda solution. The fruits are cut into slices. The slices are filled into one lb Jam size can, exhausted; sealed, processed in boiling water for 20 minutes and cooled.

v) Berry Fruits

Among berry fruits, strawberry, loganberry, black berry, raspberry, mulberry and black and red currants are popular for canning. White heart cherry and red cherry having creamy white flesh, are good for canning. Maraschino cherries are canned for mixing with other fruits and for fruit cocktails.

The cherries for canning are generally decolourised during curing in brine for 4-6 weeks. During curing cherries are kept in a brine, which is made up of about 0.75 to 1.0 per cent sulphur dioxide (SO₂) and about 0.4 to 0.6 per cent slaked lime. The cured cherries are washed well in water and dyed with a red dye like Erythrosine, and the colour is fixed with citric acid. These cherries are used for canning.

vi) Citrus Fruits

Generally grape fruit and oranges are canned. Grape fruit varieties Marsh Seedless, Duncan and Foster are good for canning. The fruit is immersed in hot water (93 to 96°C) for 2 to 5 minutes. It softens the peel, which can easily be removed by hand. The peeled fruit is further hand peeled or lye-peeled to remove the white rag portion called albedo. For lye peeling, the whole fruit is immersed in hot lye solution containing 1.5 to 2.0 per cent caustic soda (NaOH) for 20 to 30 seconds. It is then washed with cold water and the segments are separated. The membranes and seeds are removed with the help of knife. The prepared segments are filled into plain cans, and then filled with 60° Brix syrup. The filled cans are exhausted for 25 to 30 minutes at 82 to 87°C, then sealed and processed for 30 to 40 minutes at the same temperature. The cans are cooled immediately after processing.

Satsuma, Mandarin and Unshu (in Japan) are employed for canning. Malta and Sathgudi, which are tight skin, and loose jacket Nagpur and Coorg oranges also yield good canned products.

The peel of loose jacket orange is removed by hand easily. The peel of tight skin oranges is removed and prepared similar to grape fruit. The filled cans are exhausted for 15 to 20 minutes at 82 to 87°C, sealed and

pressed for another 15 to 20 minutes at the same temperature in open cooker. After processing, the cans are cooled immediately in cold water.

vii) Grape

Grape varieties such as Thompson Seedless and Muscat are good for canning. Only large sized berries are used for canning. Washed berries are filled into cans and covered with syrup of 20 to 40° Brix. The cans are exhausted, sealed and processed. The coloured grapes should be canned in lacquered cans.

viii) Guava

Fully ripe but firm fruit, with white flesh, are selected for canning. Fruits are peeled by knife or by lye solution as described above. Peeled fruits are cut into halves and seeds are scooped out with a spoon-shaped knife. The prepared fruit should be immersed in 1 to 2 per cent common salt solution. It helps to prevent the fruit from browning. Either halved or quarters are canned. The peel and core with seeds can be used for making guava jelly or guava cheese. Canned guava has a taste and aroma better than those of fresh fruits.

ix) Jack-Fruit

Jackfruit is mostly available in Maharashtra, Bihar, Orissa, Karnataka, Kerala and Tamilnadu. In these states, certain sections of the people use it as an important staple food. All parts of the fruit can be used in one or the other form of food. The green and immature fruit can be canned as a curried vegetable. The ripe fruit with the crisp bulb after seed removal is used for canning in sugar syrup.

The fruit is washed, cut into several large pieces and the bulbs are removed with hand. The fruit contains a white, highly sticky, latex so, a little vegetable oil such as til or gingelly oil, is smeared on the hand and the knife to prevent the latex from sticking on them. The latex is soluble in oil. The bulb after seed removal is canned as a whole, halved or quarter. Generally syrup of 50° Brix having 0.5 to 0.75 per cent citric acid is used for canning of jackfruit bulb.

x) Litchi

Litchis are mostly cultivated in Bihar, Orissa, Uttaranchal and Uttar Pradesh. Tree-ripened fruit is selected for canning. Fruit is washed, skin is removed, and aril is separated from stones. The aril is filled in cans, and aril covered with sugar syrup of about 40° Brix containing 0.5 per cent citric acid. The filled cans are exhausted, sealed and then processed as mentioned earlier. After processing, cans are cooled promptly and thoroughly in running cold water to prevent development of pink colour in the product.

xi) Mango

In India, Uttar Pradesh, Tamil Nadu, Andhra Pradesh, Karnataka, Bihar, Maharashtra and West Bengal lead in mango cultivation. Dashehari, Alphonso, Badami, Baneshan, Raspuri, Neelam, Mulgoa and Totapuri or Bangalora are the most important mango varieties for canning. Juicy and fibrous varieties are not suitable for canning.

Fully developed and mature fruits are harvested and ripened. Canning ripe (just ripe but firm) fruits are selected, washed with water and peeled by hand with the help of knife. The pulp is either cut into two broad side (Chick) or quartered or 6 to 8 cm longitudinal slices.

The prepared fruit is placed in two per cent common salt solution to prevent enzymatic browning. The fruit has slightly higher pH than the critical pH of 4.2 so it is necessary to add 0.3 to 0.5 per cent citric acid in the syrup in order to process in open cookers. The trimmings of the slices, pulp adhering to the peel and stone can be used profitably for the preparation of mango juice or beverages and mango jam.

xii) Papaya

Fruit is washed, peeled, seed removed and cut into slices or cubes for canning. The fruit pulp has a high pH value so it is necessary to add 0.5 per cent citric acid in the syrup to reduce the pH below 4.5. Sometimes papaya is canned with other fruits like pineapple, mango, banana, etc., to produce fruit cocktails.

xiii) Peach

There are two types of peaches, one the clingstone, where the pulp adheres to the stone tightly, and the other freestone where the pulp adheres to the stone loosely or freely. Among the clingstone peaches, Tuscan, Palora and Philips Cling are the varieties good for canning. Among the freestone peaches, Elberta, Lovell and J.H. Hale are suitable varieties for canning.

The fruits are cut into two halves and the pits removed. In large canneries, mechanically operated knives are used to cut fruit into halves and to remove the pits. The cut halves are peeled by immersing them in boiling lye solution containing 1 to 2 per cent caustic soda for ½ to 1 minute. The loosened peel is removed by washing with water. The prepared halves are filled in cans, covered with syrup, exhausted and processed in open cooker. Sometimes peach slices are also canned. Peaches are also used as an important constituent of fruit cocktail.

xiv) Pear

Pears are cultivated in Himachal Pradesh, Kashmir, Uttaranchal and hilly areas of South India. Pears are harvested fully mature, firm but green. The fruits are ripened at room temperature (23 – 26° C) and soft fruits are used for canning.

The fruit is peeled with a knife and cut longitudinally into two halves. The core is removed by coring knife. The prepared fruit is placed in 1 to 2 per cent common salt solution to prevent browning. The halves are then filled into cans, covered with hot sugar syrup, exhausted, seamed and processed as usual. The cans should be cooled immediately in cold water to prevent development of pink discolouration of the fruit during storage.

xv) Pineapple

Pineapple is mostly grown in Assam, West Bengal, the West Coast of India, Andhra Pradesh and Karnataka states. Giant Kew and Queen are the two important varieties of pineapple employed for canning.

The fully mature and just ripe fruit is selected for canning. Uniform size graded fruits are peeled, cored and sliced on a Ginaca machine in foreign countries. In India, the fruits are sliced, and then core and peel is removed by hand with the help of coring and punching knife. Slices are graded usually for size. Since the fruit contains highly active proteolytic enzymes, injurious to skin, the workers should wear rubber gloves. The slices are filled into cans, covered with syrup, exhausted, seamed, processed and cooled as usual.

xvi) Plum

The Red Victoria and the Yellow Pershore plums are important canning varieties. The Alubukhara plum generally grown in North India, also gives a fairly good canned product.

Generally whole plum with stone is canned. Since plum contains water-soluble red colour, which is due to the presence of anthocyanins, is canned in lacquered cans. Washed fruits are filled into can, either as discrete number or by weight, covered with syrup and processed as usual.

xvii) Other Fruits

There are some minor and lesser-known fruits such as. Date, Pomegranate, Mulberry, Musk melon, Water Melon, Aonla, Carambola, Tamarind, Avocado, Custard Apple, Karonda, etc. which may also be canned as usual. These fruits may be canned as slices, cubes or juice and pulp or beverages.

Check Your Progress Exercise 2



- Note:** a) Use the space below for your answer.
 b) Compare your answers with those given at the end of the unit.

1. Why citric acid is added to covering syrup?

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2. State reason for placing the prepared fruits in common salt solution.

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3. Why fruits are processed in open cooker?
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3.4 CANNING OF VEGETABLES

The vegetables are exhausted at 90-100°C for 7-10 minutes or until the centre of the can reaches at least 77°C temperature. The types of can, strength of covering brine and time-temperature for No.2½ and No.10 cans are summarised in Table 3.3.

Table 3.3: Canning time table for non-acid vegetables

Sl. No.	Vegetables	Type of can	Strength of Brine (common salt)	Processing time min. at 0.7 kg per cm ² steam pressure	
				No. 2½ Can	No. 10 Can
1.	Asparagus	Plain	2.25%	24	40
2.	Bean	Plain	2.25%	40	75
3.	Beet-root	Sulphur resistant	Water or 1.5% Brine	30	40
4.	Cabbage	Plain	2%	40	60
5.	Carrot	Plain	2%	25	50
6.	Cauliflower	Plain	2%	20	–
7.	Curried vegetables	Plain	–	60 to 70	
8.	Mushroom	Plain	2% “	25	40
9.	Okra	Plain	2% “	35	–

10.	Pea, garden	Sulphur resistant	2% Brine & 2.5% sugar solution	45	60
11.	Potato	Plain	2%	45	–
12.	Turnip	Plain	2%	35	50

i) Asparagus

The asparagus shoots are green and white. The tender shoots are used for canning. Just after harvesting the shoots are washed and graded for size and cut according to the height of the can. Shoots are blanched in boiling water for 2-3 minutes then placed in cold water. The blanched shoots are filled into sulphur-resistant cans, covered with 2.0 per cent common salt solution, exhausted, seamed and processed as usual.

ii) Beans

French beans, which are tendered and stringless are used for canning. The beans are washed thoroughly with water and cut into slices about 2.5 cm in length. The slices are blanched in boiling water, drained and filled into plain cans. The beans in the cans are covered with 2 per cent brine, exhausted, closed and processed under pressure in retorts. Sometimes diced beans with diced carrots and garden peas are also canned as mixed vegetables.

iii) Beetroot

Beetroot is washed with water thoroughly. The top and roots are removed with a stainless steel knife. The vegetable is cut in the form of discs or cubes and placed in 1 to 2 per cent common salt solution to preserve the colour. The prepared pieces are filled into vegetable lacquered cans, covered with 2 per cent brine, exhausted, seamed and processed as usual.

iv) Cabbage

Cabbage head with tender yellow leaves is used for canning. After washing, the head is cut into 4 to 8 pieces or shredded into 2.5 cm thick pieces. The pieces are generally blanched in boiling water for 5 to 7 minutes. The blanching water may preferably contain 1 per cent citric acid. After blanching it is cooled in 2 per cent brine to prevent discolouration. The prepared vegetable is filled into plain cans, covered with 2 per cent brine and processed as usual.

v) Carrot

Generally yellow varieties of carrot are used for canning. Tender and small carrots are selected for canning. The carrots are washed well and skin is scrapped with a knife. For large-scale work, mechanical peeler is employed. The peeled carrot is graded for size and used as such or cut into discs or cubes for canning. The carrot is blanched in boiling water for 8 to 12 minutes and packed into plain cans. Brine is used for canning.

vi) Cauliflower

In case of cauliflower, compact flower head is selected and cut into pieces of suitable size. The pieces are canned similar to that of cabbage.

vii) Mushroom

Edible mushrooms, which are not poisonous, are selected for canning. Button mushroom is generally canned whole. Sometimes, mushroom is bleached to a pale colour in a solution of sodium sulphite and citric acid. They are washed with water and blanched in boiling water for 4 to 5 minutes and subsequently dipped in cold water to prevent discolouration. Blanched mushrooms are filled into plain cans, covered with 2 per cent hot brine, exhausted, seamed, processed as usual.

viii) Okra

Okra is also known as Lady's finger. Tender green okras of uniform size are selected. Okra is canned as a whole or as slices. These are washed and blanched in boiling water for 1 to 2 minute and then cooled in brine containing 1.5 per cent common salt. This helps in removal of mucilage. The blanched okras are filled into plain cans and covered with 2 per cent brine, exhausted, seamed and processed as usual. Sometimes, the okras are also canned with thick tomato sauce in order to overcome the mucilaginous property.

ix) Peas

Bonneville is the most popular pea variety for canning in India. We should see that the peas for canning are uniformly ripe and should retain the green colour even after processing. They should also possess good texture and flavour. Large size peas are generally preferred for canning.

Peas are shelled by pea-podding machine and graded by size using sieves with mesh ranging from 0.7 to 1.0 cm. The graded peas are blanched in boiling water for 2 to 5 minutes, and rinsed in cold water. They are filled into plain cans by hand or machine and covered with 2 per cent brine. Sometimes, 2 per cent cane sugar is also added in brine to improve the flavour of the peas. An edible and FPO permitted green colour also may be added to the brine. The cans are exhausted, closed and processed in a retort as usual. Canned fresh peas are generally known as 'green peas' or 'garden peas'. Dried peas are also canned. The dried peas, which are soaked in water, are canned similar to fresh peas. The dried canned peas are known as 'processed' peas.

x) Potato

Potatoes are canned either whole or slices. Good starchy and firm potatoes are selected and washed to remove the adhered soil. Potatoes are peeled with a knife or by potato peeler, a machine having abrasive surface to remove peel. Peeled potatoes are kept in 2 per cent common salt solution to prevent discolouration. Peeled potatoes are blanched in boiling water for 5 to 7 minutes. Blanched pieces are filled into plain cans, covered with 2 per cent brine, exhausted, seamed, processed and cooled as usual. Some varieties of potato turn bitter after canning, which should not be used.

xi) Tomato

Tomatoes for canning should be firm ripe, medium in size, regular in shape, and of uniform red colour. Tomatoes should have plenty of pulp and free from blemishes.

Tomatoes after washing are placed in boiling water or steam for 2 to 3 minutes to crack the skin and then washed in cold water to remove peel easily. Any green patch is trimmed out. The peeled and trimmed tomatoes are filled into plain cans and covered with tomato juice; and after exhausting and seaming processed in open cooker. It's processing is different from other vegetables as it is acid food.

xii) Turnip

Turnips are red, white and yellow in colour but generally white turnips are canned. Select fibre free tender turnips. They are washed thoroughly with water and cut into about 1 cm thick slices. The pieces are blanched in boiling water for 3 to 5 minutes and cooled. The blanched turnips are filled into cans, covered with 2 per cent brine and processed in retort as usual.

xiii) Other Vegetables

There are several other vegetables, which may be canned similar to the methods given above. They are Karela, Tinda and Parwal. Spinach (Palak) is also canned as puree.

Sarson-ka-Saag (Mustard Green)

Sarson-ka-saag is generally prepared from mustard leaves and spinach in the ratio of 4:1. It has good demand as canned product in India and abroad. The tender shoots of green mustard and spinach are washed, chopped and cooked with salt for 40-45 min. Then mashing is done along with the addition of corn flour or Bengal gram flour (besan). The mass, then fried along with other ingredients and filled into cans, exhausted for 10 minutes and sealed. The cans are processed for 50 minutes in a retort at 0.7 kg/cm² and cooled to room temperature. A general recipe for canning of sarson-ka-saag is given below:

Mustard green chopped	800g
Spinach chopped	200g
Tomato	100g
Onion	100g
Garlic	20g
Ginger	80g
Ghee/Oil	100g
Salt (to taste)	15g
Chilli	10g
Corn flour or besan	50g

xiv) Curried Vegetables

Canning of vegetables in brine is a western way of preserving and consuming. There are certain vegetables that are canned as we cook them along with spices and condiments. Certain vegetables like potato, cauliflower, peas, tomatoes are cooked in combination or alone and canned as curried vegetables. Curried vegetables are those vegetables, which are canned along with spices and condiments such as mustard,

coriander, red chilli, turmeric, common salt and vegetable oil in form of gravy. The curried vegetables are readily consumed after heating in the cans. In order to prepare the curried vegetables, the oil is heated in a pan, the mustard seed is fried in it, then other ingredients in powder form are added to taste (as done at home while cooking vegetables) and heatings continued. Then required amount of water is added and brought to boil. The curried vegetables are filled into can along with gravy, closed and processed for 60 to 70 minutes at 0.7 kg/cm^2 in a retort.



Check Your Progress Exercise 3

- Note:** a) Use the space below for your answer.
b) Compare your answers with those given at the end of the unit.

1. Why non-acidic vegetables are processed at high temperature in a retort?

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2. Why certain vegetables are not packed in plain cans. Give names and reasons?

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3.5 ASEPTIC CANNING OF FRUIT AND VEGETABLE PRODUCTS

Fruit and vegetable products are packed by using the latest developed technique known as aseptic canning. As you know that this system is basically

a high temperature short time (HTST) sterilizing process. This method combines flash sterilization and cooling with aseptic methods of packaging for fluid and semi-fluid products, thus eliminating retorting and cooling. It is being used commercially particularly for bulk packing of products. This system has advantage that quality of the product is maintained better. The nutrient losses are minimum due to HTST processing and shelf life of the product is more.



3.6 LET US SUM UP

Canning is a method of preservation of fruits and vegetables by heat application. The main principle of canning is the destruction of spoilage microorganisms. The canning process includes several unit operations, viz. selection, sorting, grading, washing, peeling, cutting, blanching, filling, syruping or brining, lidding or clinching, exhausting, seaming, processing, cooling and storage. Fruits and vegetables differ in the canning process due to their acid value.

Tin cans of different sizes are used for packing of fruits and vegetables. For some fruits and vegetables lacquer cans are used. If cans are not processed adequately they develop some defects. The defects may be caused by physical and chemical changes, and by microorganisms. Canned products can be stored for 1 to 2 years depending on the quality of raw materials.

3.7 KEY WORDS

Blanching	:	Blanching is done by immersing fruits and vegetables in hot water or by exposing to steam followed by cooling.
Syruping or brining	:	After placing prepared fruits or vegetables in can, syrup or brine is added, respectively is called syruping or brining.
Exhausting	:	The vacuum in the can obtained by heat treatment or by mechanical means is known as exhausting.
Seaming	:	It is sealing or closing of lids on cans by double seamer. Interlocking of curl of the lid and flange of the can creates double seam.
Processing	:	The application of heat to fruits and vegetables after hermetic (air tight) sealing in containers is called processing.
Commercial sterilization	:	It is the term used for those thermally processed products in which microorganisms and their spores do not grow under normal conditions of storage.
Principle purpose of canning	:	Destruction of spoilage or pathogenic microorganisms and retention the original characteristics of food.

Unit operation : It is one of the steps in a complete process or a physical change in form or place, for example, peeling, cutting, grading, etc.

3.8 ANSWERS TO CHECK YOUR PROGRESS EXERCISES



Check Your Progress Exercise 1

Your answer should include the following points:

1.
 - Destruction of microorganisms, which may cause spoilage of foods.
 - Improve the flavour, texture and appearance of food by cooking.
 - Prevent recontamination.
2. Selection of fruits and vegetables → Sorting and Grading → Washing → Peeling → Cutting → Blanching → Filling → Syruping → Lidding/Brining or Clinching → Exhausting → Seaming → Processing → Cooling → Testing for defects → Storage
3.
 - Fruits are covered with sugar syrup while vegetables are covered with brine
 - Fruits are processed at 100°C while vegetables are processed at 115° to 121°C.
 - Fruits are processed in open cookers while vegetables are processed in retort under pressure(0.7kg/cm²)
4. i) Spoilage due to physical and chemical changes:
 - Swell – Hydrogen swell; Flipper, Springer, etc.
 - Overfilling, faulty retort operation, under exhausting, panelling, rust, leakage, bursting, discolouration and stack burning
- ii) Spoilage by microorganisms
 - Flat sour.
 - Thermophilic acid sour
 - Sulphur spoilage, etc.

Check Your Progress Exercise 2

1. Your answer should include the following points:
 - To lower the pH of canned fruit
 - To improve the palatability of canned product
2. Your answer should include the following points:
 - To prevent enzymatic browning
 - To prevent darkening
 - To prevent discolouration
3. Your answer should include the following points:

- In open cooker, normal atmosphere is maintained
- In open cooker temperature of boiling water remain & below 100°C and never increases.
- The fruits and tomato (acidic vegetables) are cooked generally in the open cooker.

Check Your Progress Exercise 3

1. Your answer should include the following points:

- Vegetables are generally non acidic in nature
- The pH of non acidic vegetables are above 4.5
- Non-acidic vegetables are processed at high temperature
- High temperature can only be attained when processed under pressure in a retort.

2. Your answer should include the following points:

- Certain vegetables contain water soluble colour
- Presence of anthocyanins
- Presence of sulphur compound
- Asparagus, Beetroot, Peas are packed in lacquered cans

3.9 SOME USEFUL BOOKS

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