FRUITS AND VEGETABLES PROCESSING

The fruits and vegetables have comparatively higher value than cereals and are more perishables. Losses in the fruits and vegetables are high and chances to reduce the waste and enhancing the employability through post harvest processing are more. The processing includes pre-processing of fruits and vegetables before these are fit to final conversation into processed foods. The food preservation and processing industry has now become of a necessity than being a luxury. It has an important role in conservation and better utilization of fruits and vegetables. In order to avoid the glut and utilize the surplus during the season, it is necessary to employ modern methods to extend storage life for better distribution and also processing techniques to preserve them for utilization in the off season on both large scale and small scale.

Food processing therefore refers to the application of techniques to foods in a systematic manner for preventing losses through preservation, processing, packaging, storage and distribution, ultimately to ensure greater availability of a wide variety of foods which would help to improve the food intake and nutritional standards during the periods of low availability. The main objective of fruits and vegetables processing is to supply wholesome safe, nutritious and acceptable food to consumers throughout the year.

Fruits and vegetables are the most perishable commodities and are important ingredients in the human dietaries. Fruits and vegetables are seasonal in nature and prices go down considerably during the glut period and production becomes uneconomical due to distress sale. Thus an increase in production of fruits and vegetables will have little value if the produce is not properly handled, processed or utilized. The costs involved in preventing the losses are always cheaper that the cost of production; hence, processing receives greater attention in recent years.

The fruits and vegetable processing industry in India is highly unorganized. The prominent proceeds items are fruit pulps and juice, fruit based ready–to-serve beverages, canned fruits and vegetables, jams, squashes, pickles, chutneys, dehydrated vegetables, etc. More recently, products like frozen pulps and vegetables, frozen dried fruits and vegetables, fruit juice concentrates and vegetable curries in restorable pouches, canned mushroom and mushroom products have also been taken up for manufacture by the industry. Preservation effects involve complex methods such as physical, physicochemical, chemical and biochemical phenomena and these phenomena never work in isolation. Certain processes for preservation of fruits and vegetable, the equipments required and other well established

details for a fruit and vegetables processing unit are discussed here. Prerequisites of preservation are cleaning, grading and sorting as per maturity.

1. Cleaning:

It is a unit operation in which contaminating materials are removed from the food material and separated to leave the surface of the food in a suitable condition for further processing. In vegetable processing, blanching also helps to clean the product. In addition, the early removal of small quantities of food contaminated by micro-organisms prevents the subsequent loss of the remaining bulk by microbial growth during storage or delays before processing.

Wet cleaning:

Wet cleaning is more effective than dry methods for removing soil from root crops or dust and pesticide residues from soft fruits or vegetables. It is also dustless and causes less damage to foods than dry methods.

Dry cleaning:

Dry cleaning procedures are used for products that are smaller, have greater mechanical strength and possess lower moisture content (for example grains and nuts). After cleaning, the surfaces are dry, to aid preservation or further drying. The main groups of equipment used for dry cleaning are;

- Air classifiers
- Magnetic separators
- Separators based on screening of foods

Removing contaminants and foreign bodies:

Physical separation of contaminants from food is possible when the food has regular well defined shape. e.g. round foods are separated from contaminants by exploiting their ability to roll down in inclined, upward moving conveyor belt.

2. Sorting:

Sorting is the separation of foods into categories on the basis of a measurable physical property. Like cleaning, sorting should be employed as early as possible to ensure a uniform product for subsequent processing. The four main physical properties used to sort foods are size, shape, weight and color.

Shape and size sorting:

The particle size distribution of a material is expressed as either the mass fraction of material that is retained on each sieve or cumulative percentage of material retained. Size

sorting is the separation of solids into two or more fractions on the basis of differences in size.

Color sorting:

Small particulate foods may be automatically sorted at high rates using microprocessor controlled color sorting equipment. Particles are fed into chute one at a time. The angle, shape and lining material of chute are altered to control the velocity of pieces as the pass a photo detector. Photo detectors measure the reflected color of each piece and compare it with preset standards, and defective foods are separated by a short blast of compressed air.

Weight sorting:

Weight sorting is more accurate than other methods and is therefore used for more valuable foods. Aspiration and flotation sorting use differences in density to sort food and are similar in principle and operation to aspiration and flotation cleaning.

3. Grading:

This term is often used interchangeably with sorting but strictly means 'the assessment of overall quality of a food using a number of attributes'. Grading is carried out by machines or operators who are trained to simultaneously assess a number of variables.

The basic principles of preserving bio-materials and their respective methods are given in the following table.

S. No.	Principles	Methods
1	Reducing temperature so that deteriorating reactions occurring within the bio materials are minimized	Evaporating Cool Chamber Refrigerated Storage Cold storage Freezing
2	Creation of an environment of gases such deteriorating bio chemicals reduce their activities.	Hermetic Storage Controlled Storage and Modified Packaging
3	Reduce chemical potential of water (water activity reduction) 1. Application of heat 2. Addition of solute so that water is strongly bound	Drying and Dehydration, Convective microwave drying, pasteurization and sterilization Osmo-dehydration
4	Production of chemicals through fermentation which will be detrimental to the microbes causing food spoilage	Pickling Controlled fermentation Aerobic, Anaerobic
5	Innovative methods	Irradiations, Dielectric, infrared and Ohmic heating

FREEZING:

Freezing is a low temperature preservation process where the product is frozen at -38°C and stored -18°C. Freezing is cheaper than canning and frozen products are close to fresh products and of better quality the metabolic activity and spoilage due to post harvest chemical are retarded by freezing. Through the product preserved by freezing retains their quality appreciably, the major disadvantage of the process is that the low temperature has been maintained during handling, transportation and storage before the product is finally consumed. Suitable fruits and vegetables for freezing are mango slices, pulp, pineapple slices, guava slices, orange segments, peas, carrot, cauliflower, beans, etc.

When compared to the most other food preservation methods, freezing requires the least amount of food preparation before storage and under optimum conditions it has the best nutrient, flavour, and texture retention. Since food remains microbiologically safe during freezing, its shelf life is determined by chemical and physical changes that occur during storage.

Freezing is the reduction in temperature generally by super cooling followed by crystallization of water, nucleation and finely crystal growth.

Equipments of freezing

a. Freezer/cold room
b. Quick freezing Equipments- fluidized bed freezer, automatic package freezer, continuous plate freezer, continuous can freezer
c. Direct Immersion equipments- Brine Freezer, Frog freezer, and Bartlett freezer
d. Rotating cold drum
e. Foot operated polythene bag sealer- sealing polyethylene bags of different gauges after filling of fruits and vegetables

Methods of freezing

i. Quick (0 to -40°C for 30 min.)
ii. Sharp (-15 to -29°C for 3-72 h)
iii. Cryogenic (-196°C)
iv. Dehydro-freezing (50% moisture removed)

Quick freezing

- Freezing by indirect contact with a refrigerant
- Freezing in a blast of cold air
- Freezing by direct immersion in a refrigerating medium

Freezing by indirect contact with refrigerant:

Food may be frozen by being placed in a contact with a metal surface which is cooled by a refrigerant or packaged or packed in a can and cooled by immersion in a refrigerant. Also food packaged in paper boxes may be frozen by contact with refrigerated metal plate which may be moving or stationary.

Air Blast freezing:

To obtain very cold air, a blast of air is directed through refrigerating coil. For greater effect, the cold air blast is confined in an insulated tunnel. The material to be frozen may be placed on a moving belt within variable of moved countercurrent and the air blast.

Freezing by direct immersion (FBDI):

FBDI in low temperature drying was the beginning of quick freezing. Since liquid are good heat conductors, a product can be frozen rapidly by direct immersion in low temperature liquid for example brine and sugar solutions.

Super Cooling:

Occurs when temperature of water is lowered below the freezing point and crystallization does not occur. The super cooling provides the means of determining the in depth effect of a reduction in temperature relative to the initial freezing point.

Individual Quick Freezing:

IQF refers to Individual Quick Freezing of every particle/aggregate using fluidization in a stream of very cold air. Fluidization leads to high heat transfer co-efficient and therefore very rapid freezing and hence better quality. For example, freezing of green peas in an air blast freezer may take 3-4 h whereas it is only 10-12 min by IQF. This results in for better texture and there is no hump or block formation. Some of other important IQF products are frozen fruit dices and cut vegetables.

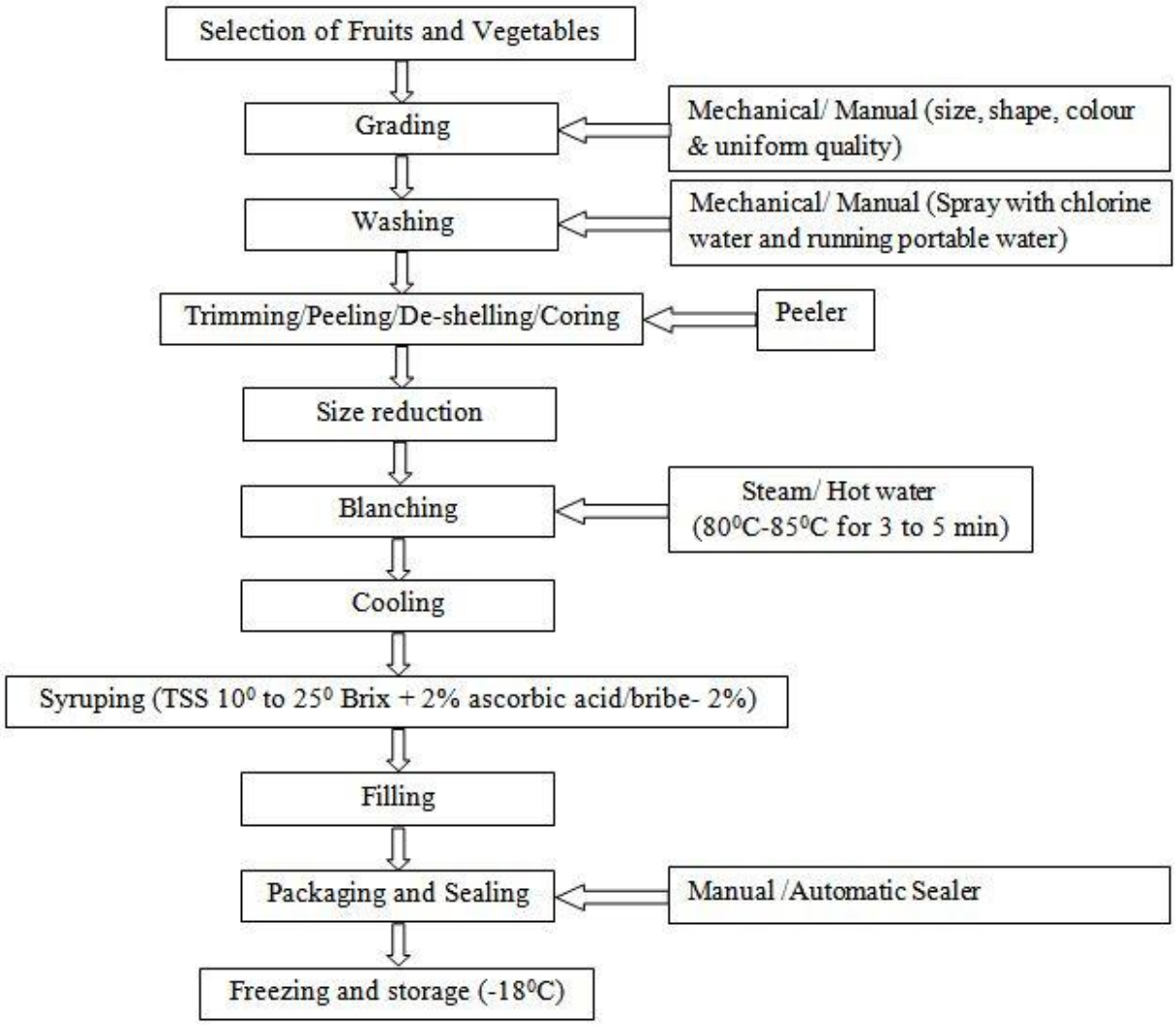
Refrigeration:

This is the process by which heat is removed from a confined place and material for the purpose of maintaining a lower temperature. The standard unit of generating heat capacity is 1 tone of refrigeration. This is derived on the basis of removal of latent heat of fusion of 1 tone of water at 32°F or 0°C to produce 1 tons of ice.

Freezing time:

The definition of freezing time is a function of two instances i.e. when freezing starts and when it stops. It is very difficult to determine the freezing time (q) since freezing will occur at different rate and at different point in a piece of food. The freezing will be faster at

some point on the surface and in the body of the piece of food, there is a point which cools slowest. The highest temperature at which ice crystals have a stable existence in a food material is known as the freezing point of that material and this signals the starts of freezing time. Because of the nature of materials of food and the presence of water soluble constituents, all water does not crystallize at this temperature, this is known as cryoscopy effect.



Flow Chart for Preparation of Frozen Fruits and Vegetables

DEHYDRATION

Dehydration is the removal of moisture from fruits and vegetables by artificially produced heat under controlled condition of temperature, relative humidity and air flow. In dehydration, sufficient moisture is removed so that the product is free from spoilage; but this must be done in such a way to preserve food value as far as possible. Rate of dehydration is so done in hygienic condition to have products of uniform colour than sun dried. Dehydration reduces the bulk, requires less storage space and usually cheaper than the other methods of

preservation. The suitable fruits and vegetables for dehydration are grape, date, fig, raw mango, anola, ber, litchi, apricot, banana, apple, carrot, leafy vegetables, etc. FPO specification for dehydrated fruits and vegetables are;

a. Moisture content shall not exceed 20 per cent and 24 per cent (w/w) respectively.
b. Fruits and vegetables used for drying be clean, wholesome and shall be practically free from insect or fungal attack.
c. Dehydrated products may contain permitted preservations.

Equipments used for Dehydration

Blanching unit:

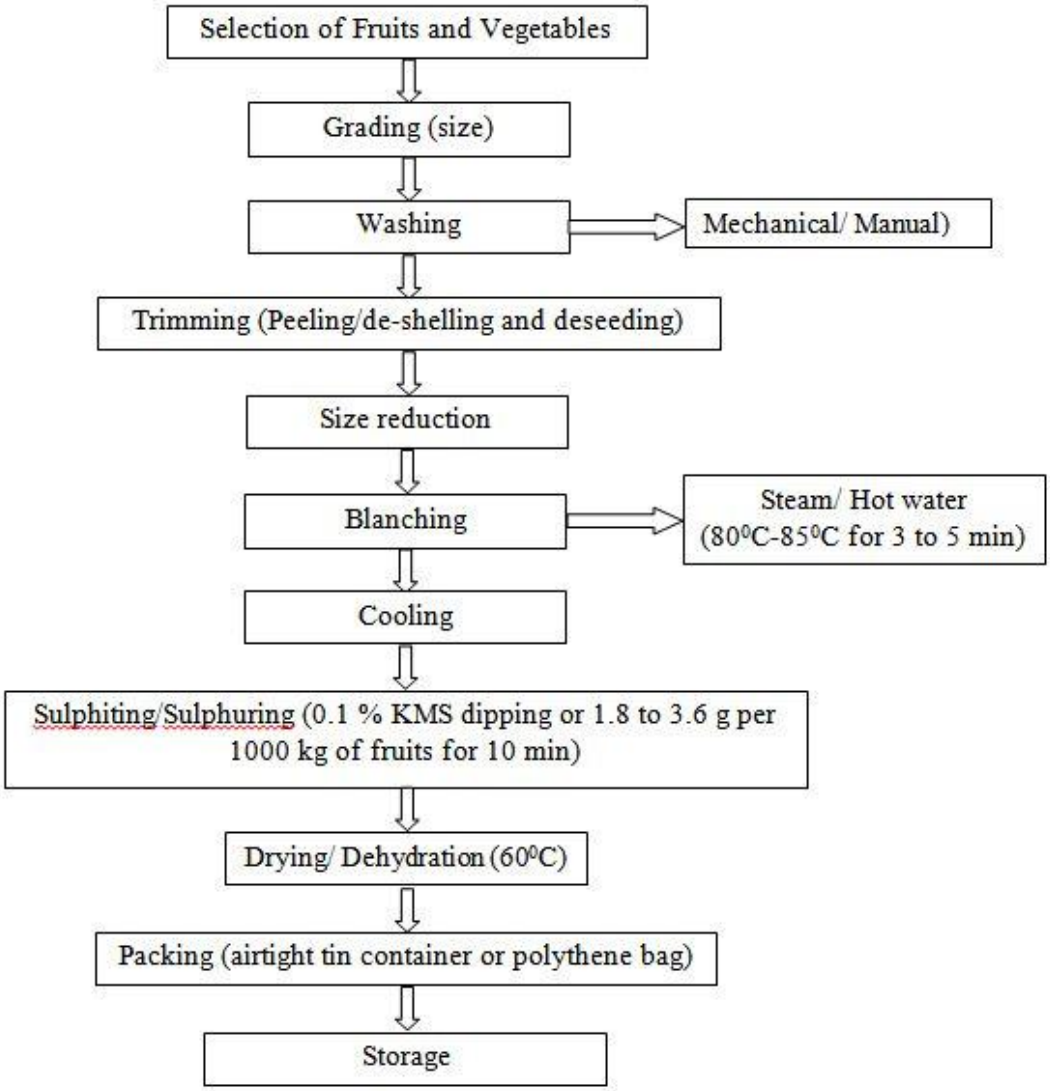
It can be used for pre-treatment (steam blanching) of fruits and vegetables before processing.

Different Types of dryers:

Kiln drier- pieces; Cabinet/tray drier- pieces; purees, liquids; tunnel- pieces; continuous conveyer belt-purees, liquids; Belt trough-pieces; air lift- granules; spray- liquid; vacuum-purees, liquid, pieces; Fluidized bed-small pieces; Drum or roller-Liquid, purees.

Vacuum drier:

It is generally used for dehydration of fruits and vegetables without any change in sensory attributes.



Flow chart for Dehydration of Fruits and Vegetables

CANNING

Canning is a method of food preservation. Canning may be defined as heating and sealing of food material in a hermetically sealed container.

a) Fruit Canning:

The most important fruits for canning are mango, pineapple, guava, litchi, cherry. Strawberry, jackfruit, etc.

Requirements:

- The head space in the can shall not be more than 1.6 cm.
- The drained weight of the fruit shall not be less than 50 per cent and fruit should be firm
- No preservative shall be added
- No artificial colour shall be present

- The can shall not show any positive pressure at sea level and shall not show any sign of bacterial growth when included at 37°C for a week.

Equipments required for canning:

a. Fruit cutter/ slicer
b. Blancher (water/steam)
c. Canning equipments (double seamer, flanger, can reformer)
d. Retorting equipment
e. Can opener
f. Exhaust Unit
g. Canning material (Tin plate can, Aluminium can, TFS can)

b) Vegetable Canning:

In vegetable canning, the specific requirements for brine strength, exhaust, processing temperature, time and types of cans, etc., are needed. Suitable vegetables for canning are cauliflower, carrot, peas, okra, beans, cabbage, etc. Mushrooms can also be canned.

Requirements:

- The head space in the can shall not be more than the 1.6 cm.
- The drained weight of preservative of the vegetables shall not be less than 55 percent except in tomato (50%)
- No addition of preservative and no artificial colour shall be present except in the case of peas.
- The can shall not show any sign of bacterial growth when incubated at 37°C for a week.

Process of Canning

1) Selection of fruits and vegetables:

i. Fruits and vegetables should be absolutely fresh.
ii. Fruits should be ripe, but firm, and uniformly mature. Over-ripe fruits should be rejected because they are infected with microorganisms and give a poor quality product.
iii. Unripe fruits should be rejected because they generally shrivel and toughen on canning.
iv. All vegetables except tomatoes should be tender.
v. Tomatoes should be firm, fully ripe and of deep red colour.
vi. Fruits and vegetables should be free from dirt.

vii. They should be free from blemishes, insect damage or mechanical injury.

2) Grading:

The selected fruits and vegetables are graded according to size and colour to obtain uniform quality. This is done by hand or by machines such as screw grader and roller grader. Fruits like berries, plums and cherries are graded whole, while peaches, pears, apricots, mangoes, pineapples, etc., are generally graded after cutting into pieces or slices.

3) Washing:

It is important to remove pesticide spray residue and dust from fruits and vegetables. One gram of soil contains 1012 spores of microorganisms. Therefore, removal of microorganisms by washing with water is essential. Fruits and vegetables can be washed in different ways. Root crops that loosen in soil are washed by soaking in water containing 25 to 50 ppm chlorine (as detergent). Other methods of washing are spray washing, steam washing, etc.

4) Peeling:

The objective of peeling is to remove the outer layer. Peeling may be done in various ways (hand peeling, steam peeling, mechanical peeling, lye peeling, flame peeling).

5) Cutting:

Pieces of the size required for canning are cut. Seed, stone and core are removed. Some fruits like plum from which the seeds cannot be taken out easily are canned whole.

6) Blanching:

It is also known as scalding, parboiling or precooking. Fruits are generally not blanched leaving the oxidizing enzyme system active. Sometimes fruit is plunged for a given time-from half to, say, five minutes, according to variety-into water at from 180°F to 200°F, and then immediately cooled by immersion in cold water. The object is to soften the texture and so enable a greater weight to be pressed into the container without damage to the individual fruit. Blanching is usually done in case of vegetables by exposing them to boiling water or steam for 2 to 5 minutes, followed by cooling. The extent of blanching varies with the toed. This brief heat treatment accomplishes the following:

a) Inactivates most of the plant enzymes which cause toughness, discolouration (polyphenol oxidase). mustiness, off-flavour (peroxidase), softening and loss of nutritive value.
b) Reduces the area of leafy vegetables such as spinach by shrinkage or wilting, making their packing easier.

c) Removes tissue gases which reduce sulphides.
d) Reduces the number of microorganisms by as much as 99%.
e) Enhances the green colour of vegetables such as peas, broccoli and spinach.
f) Removes saponin in peas.
g) Removes undesirable acids and astringent taste of the peel, and thus improves flavour.
h) Removes the skin of vegetables such as beetroot and tomatoes which helps in their peeling.

7) Cooling:

After blanching, the vegetables are dipped in cold water for better handling and keeping them in good condition.

8) Filling:

Before filling, cans are washed with hot water and sterilized but in developing countries these are subjected to a jet of steam to remove dust and foreign material. Automatic, large can-filling machines are used in advanced countries but choice grades of fruits are normally filled by hand to prevent bruising in India. Hand filling is the common practice. After filling, covering with syrup or brine is done and this process is called syruping or brining.

9) Exhausting:

The process of removal of air from cans is known as exhausting. After filling and lidding or clinching, exhausting is essential. The major advantages of exhausting are as under:

i) Corrosion of the tinplate and pin holing during storage is avoided.
ii) Minimizes discolouration by preventing oxidation.
iii) Helps in better retention of vitamins particularly vitamin C.
iv) Prevents building of cans when stored in hot climate or at high altitude.
v) Reduces chemical reaction between the container and the contents.
vi) Prevents development of excessive pressure and strain during sterilization.

Containers are exhausted either by heating or mechanically. The heat treatment method is generally used. The cans are passed through a tank of hot water at 82 to 87°C or move on a belt through a covered steam box. In the water exhaust box, the cans are placed in such a manner that the level of water is 4-5 cm below their tops. The exhaust box is heated till the temperature of water reaches 82 to 100°C and the centre of the can shows a temperature of about 79°C. The time of exhausting varies from 6 to 1 a minutes, depending

on the nature of the product. In the case of glass jars or bottles, vacuum closing machines are generally used. The bottles or jars are placed in a closed chamber in which a high vacuum is maintained.

It is preferable to exhaust the cans at a lower temperature for a longer period to ensure uniform heating of the contents without softening them into pulp. Exhausting at high temperature should be avoided because. The higher the temperature, the more is the volume of water vapour formed, and consequently the greater the vacuum produced in the can.

10) Sealing:

Immediately after exhausting the cans are sealed airtight by means of a can sealer. In case of glass jars a rubber ring should be placed between the mouth of the jar and the lid, so that it can be sealed airtight. During sealing the temperature should not fall below 74°C.

11) Processing:

Heating of foods for preserving is known as processing, however, in canning technology processing means heating or cooling of canned foods to inactivate bacteria. Many bacterial spores can be killed by either high or very low temperature. Such drastic treatment, however, affects the quality of food. Processing time and temperature should be adequate to eliminate all bacterial growth. Moreover, over-cooking should be avoided as it spoils the flavour as well as the appearance of the product. Almost all fruits and add vegetables can be processed satisfactorily at a temperature of 100°C, i.e., in boiling water.

The presence of acid retards the growth of bacteria and their spores. Further, they do not thrive in heavy sugar syrup which is normally used for canning of fruits. Vegetables (except the more acid ones like tomato and rhubarb) which are non-acid in nature, have a hard texture, and proximity to soil which may infect them with spore-bearing organisms are processed at higher temperatures of 115 to 121°C.

The sourness of fruits and vegetables is due to their acid content (measured in pH) which has a great influence upon the destruction of microorganisms. The lower the pH the greater is the ease with which a product can be processed or sterilized. Fruits and vegetables can be classified into the following four groups according to their pH value.

Bacterial spores can be more easily destroyed at pH 3.0 (fruits) than at pH 5.0 to 6.0 (vegetables, except tomato and rhubarb). Bacterial spores do not grow or germinate below. pH 4.5. Thus, a canned product having pH less than 4.5 can be processed in boiling water but a product with pH above 4.5 requires processing at 115 at 121°C under a pressure of 0.70 to

1.05 kg/cm^2 (10 to 15 lb/sq inch). It is essential that the centre of the can should attain these high temperatures.

The temperature and time of processing vary with the size of the can and the nature of the food: 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, while vegetables (non-acid) are processed under steam pressure in closed retorts known as automatic pressure cookers. In India, small vertical stationary retorts (frontispiece) are generally used for canned vegetable processing. The sealed cans are placed in the cookers, 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 heated to the desired temperature. The period of sterilization (processing) should be counted from the time the water starts boiling. After heating for the required period the cooker is removed from the fire and the petcock is opened. When the pressure comes down to zero the cover is removed and the cans are taken out.

12) Cooling:

After processing the cans are cooled rapidly to about 39°C to stop the cooking process and to prevent stack-burning. Cooling is done by the following methods:

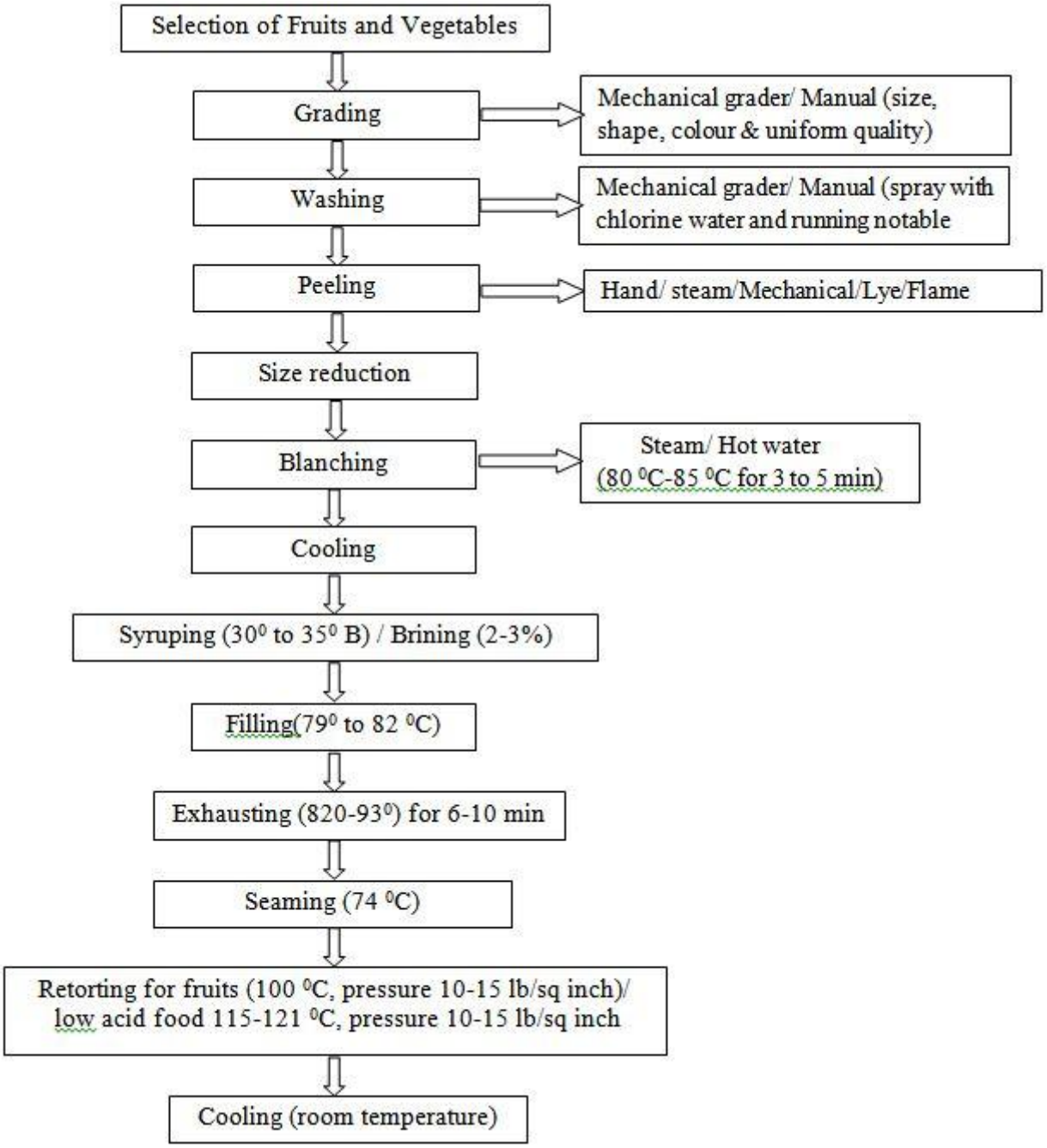
i. dipping or immersing the hot cans in tanks containing cold water;
ii. letting cold water into the pressure cooker specially in case of vegetables;
iii. Spraying cans with jets of cold water; and
iv. exposing the cans to air.

Generally, the first method, i.e., dipping the cans in cold water, is used. If canned products are not cooled immediately after processing, peaches and pears become dark in colour, tomatoes turn brownish and bitter in taste, peas become pulpy with cooked taste and many vegetables develop flat sour (become sour).

13) Storage:

After labeling the cans, they should be packed in strong wooden cases or corrugated cardboard cartons and stored in a cool and dry place. The outer surface of the cans should be dry as even small traces of moisture sometimes induce rusting. Storage of cans at high temperature should be avoided, as it shortens the shelf-life of the product and often leads to the formation of hydrogen swell. The marketable life of canned products varies according -to the type of raw materials used. Canned peach, grapefruit, pineapple, beans, spinach, pea etc.,

can be stored for about two years, while pear, apricot, carrot, beetroot, tomato, etc., can be stored for a comparatively short period only.



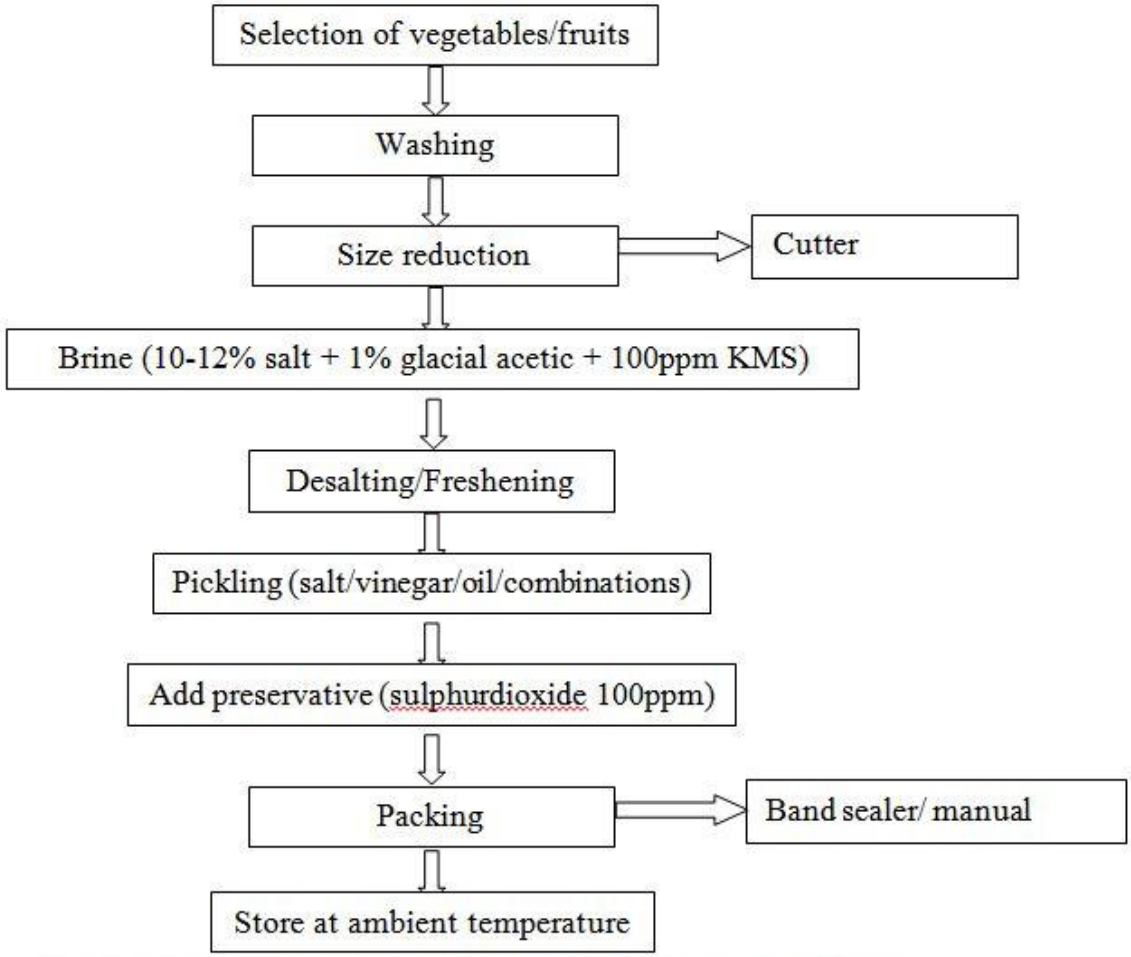
Flow Chart for Canning of Fruits and Vegetables

PROCESSED PRODUCTS FROM FRUITS AND VEGETABLES

Processing of Pickles:

The preservation of food in common salt is known as pickling. It is one of the most ancient methods of preserving vegetables. Pickles are good appetizers and add to the

palatability of a meal. Mango pickle ranks first followed by cauliflower, onion, turnip and lime pickles. The growth of a majority of spoilage organisms is inhibited by brine containing 10-12 per cent salt. Pickling is the result of fermentation by lactic acid-forming bacteria which are generally present in large numbers on the surface of fresh vegetables and fruits. Class I preservatives improves the taste and flavour and hardness of the tissue of vegetables and controls fermentations.

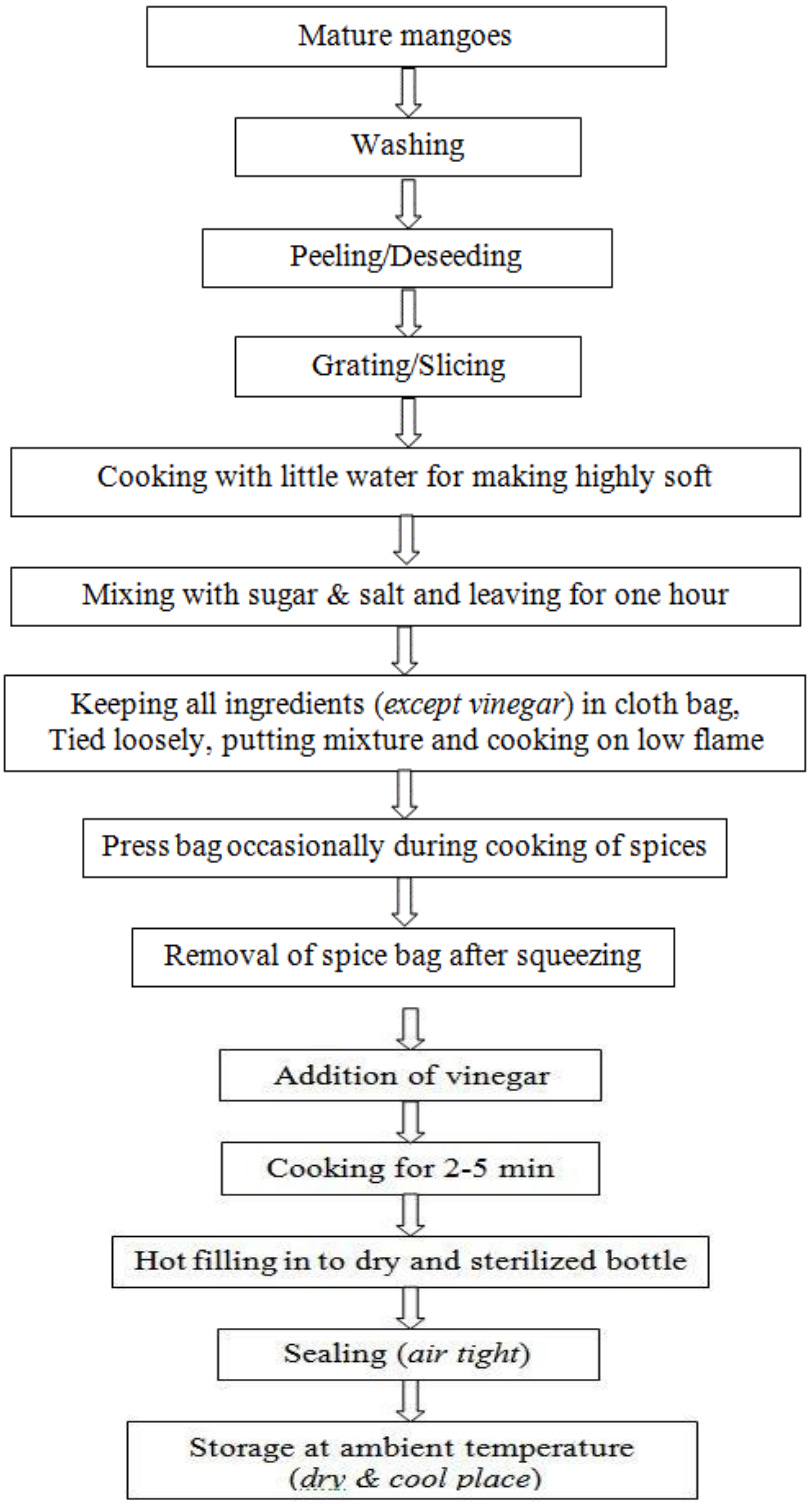


Flow Chart of Pickling Process from Fruits and Vegetables

Processing of Chutneys

Good quality chutney should be palatable and appetizing. Mango chutney is an important food product exported from India to many countries. Apple and apricot chutneys are also very popular in the country. The method of preparation of chutney is similar to that for jam except that spices, vinegar and salt are added. The fruits/vegetables are peeled, sliced or grated, or cut into small pieces and cooked in water until they become sufficiently soft. The quality of chutney depends to a large extent on its cooking which should be done for a long time at a temperature below the boiling point. To ensure proper thickening, cooking is

done without a lid even though this results in some loss of volatile oils from the spices. Chopped onion and garlic are added at the start to mellow their strong flavours. Spices are coarsely powdered before adding. Vinegar extract of spices may be used instead of whole spices. Spice and vinegar are added just before the final stage of cooking, because prolonged boiling cause loss of some of the essential oils of spices and of vinegar by volatilization.



Flow Chart for Processing of Sweet Mango Chutney

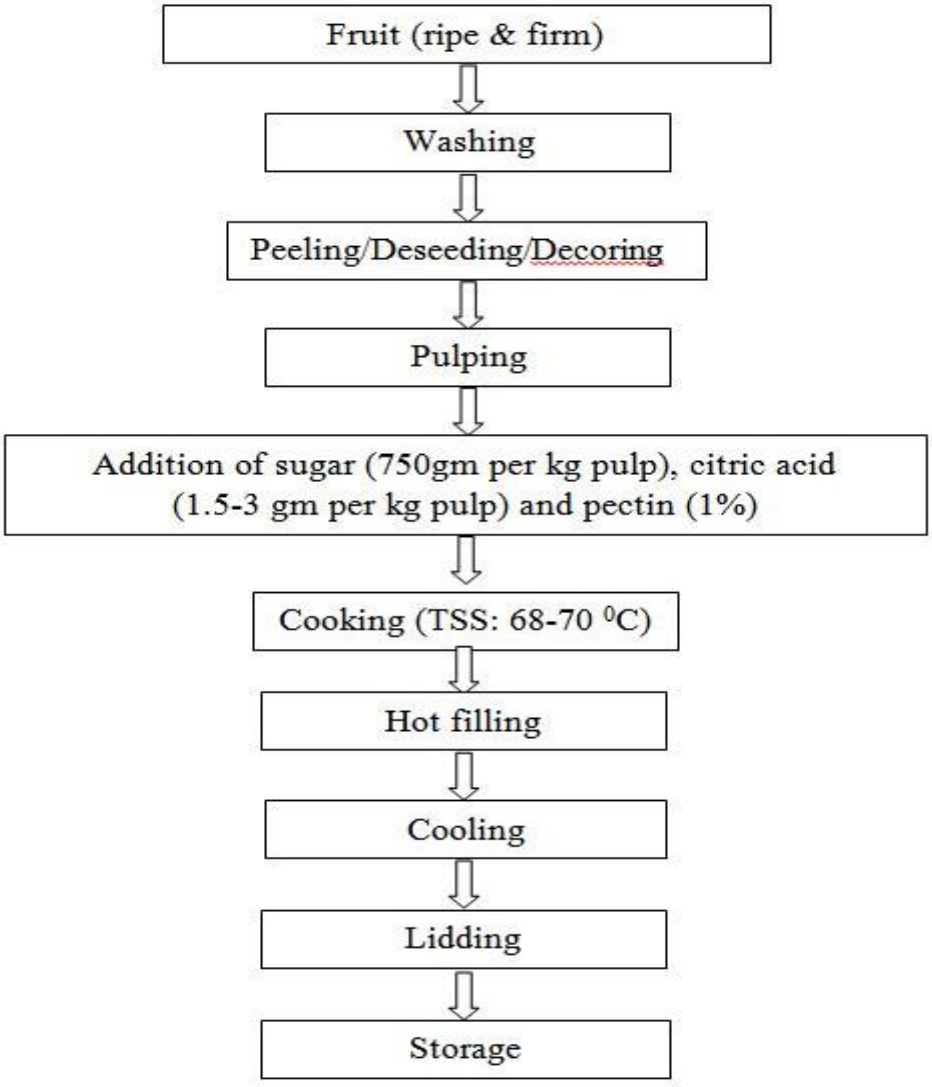
Processing of Jam:

Jam is a product obtained by cooking fruit pulp with sugar and acid to desired consistency. Jam contains 0.5-0.6 per cent acidity and 68 per cent total solids. Apple, pear, tomato, sapota, apricot, loquat, peach, papaya, karonda, carrot, plum, straw berry, raspberry, mango, tomato, grape and muskmelon are used for preparation of jams. It can be prepared from one kind of fruit or two or more kind.

i) Machines and equipments made of stainless steel can be used for fruits and vegetables processing and preservation

ii) SS steam jacketed kettle for cooking and concentration

iii) Fruit Pulpers- Brushes and SS sieves of various sizes are provided which are used for complete extraction from fruits.



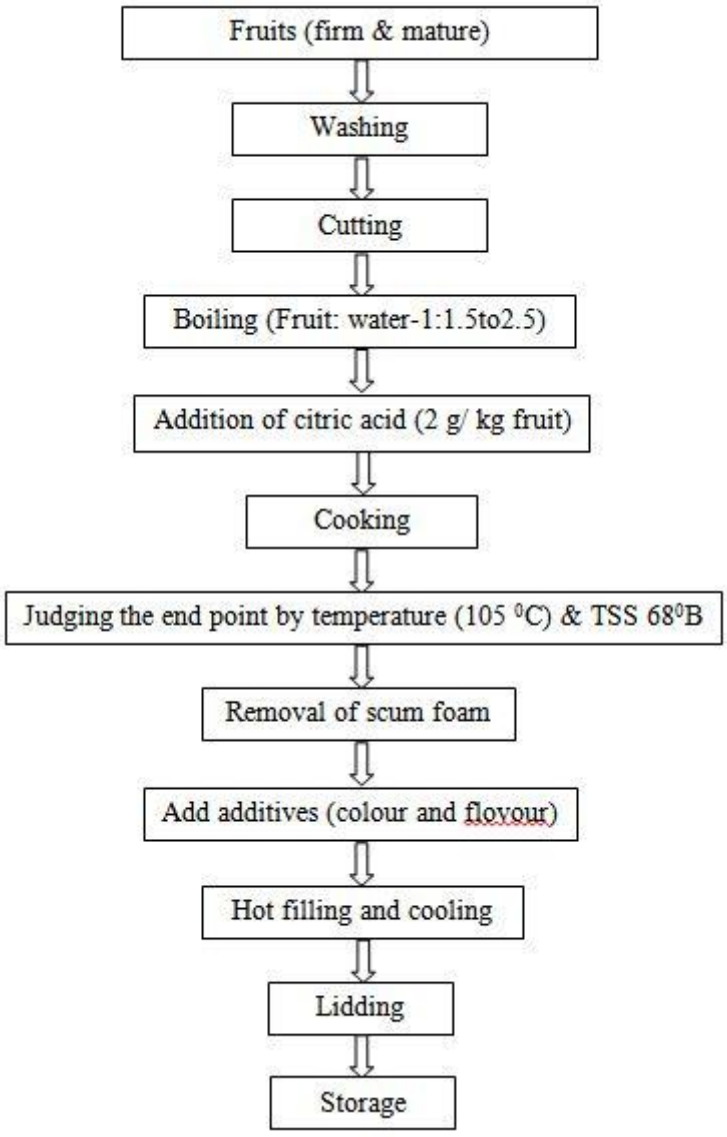
Flow Chart for Processing of Jam

Processing of Jelly:

Jelly is semi solid products obtained by boiling a clear, strained fruit juice with sugar and acid to a thick consistency, jelly total soluble solids not less than 65% and acidity 05-0.7 percent.

Qualities of Jelly:

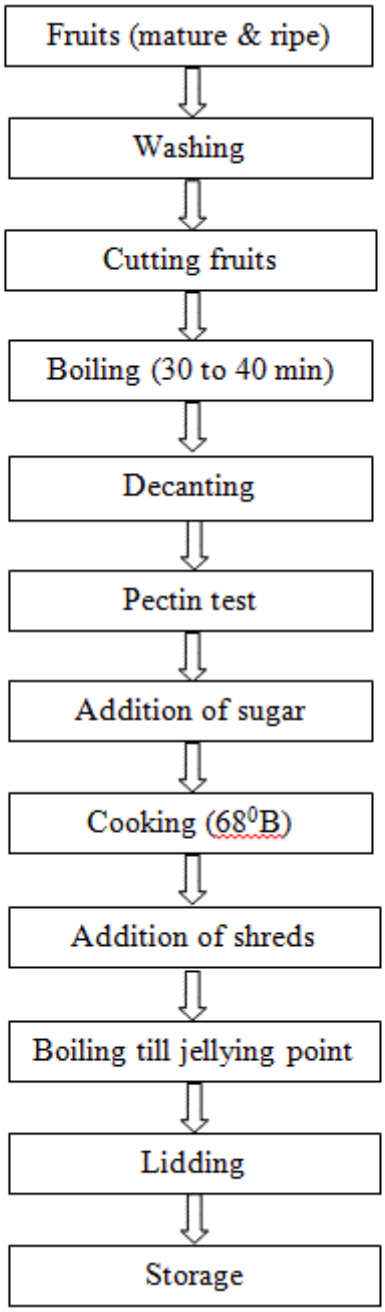
i) Clear
ii) Transparent
iii) Sparkling
iv) Attractive colour
v) Keep its shape in which it is cut not breaking.



Flow Chart for Processing of Jelly

Processing of Marmalade:

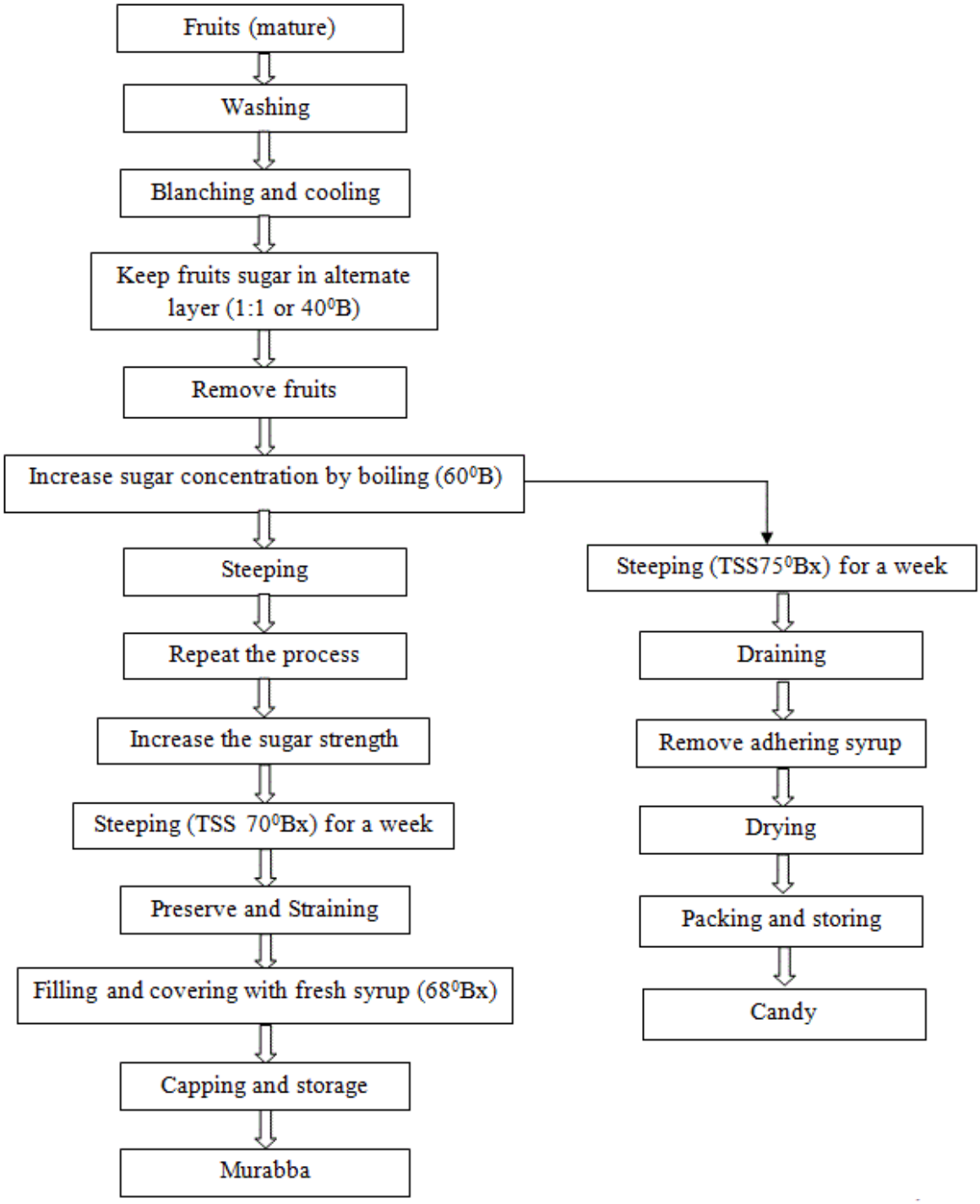
Marmalade is a fruit jelly in which peels are suspended. Marmalades are prepared usually from citrus fruits. The protein content of marmalade is slightly higher. FPO specification for marmalade area same as mentioned for jelly.



Flow Chart for Processing of Marmalade

Processing of Murabba and Candy:

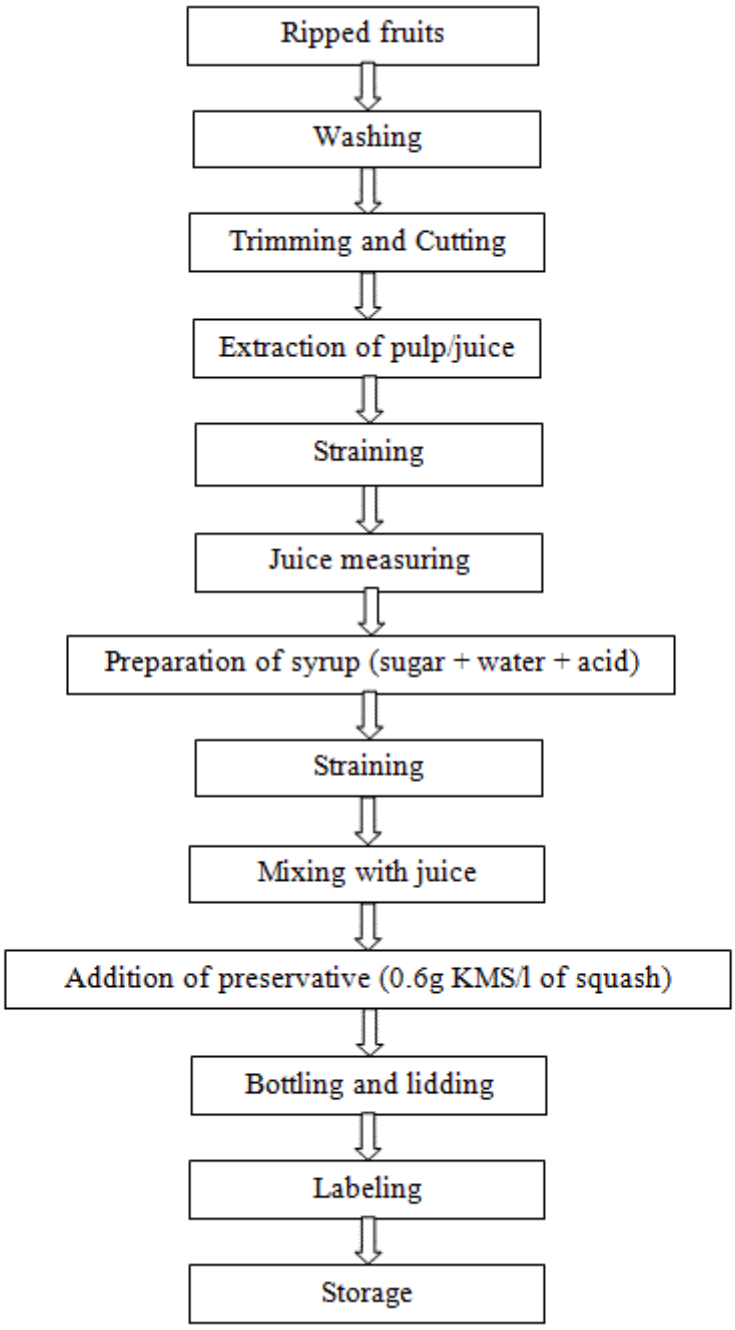
A mature fruit/ vegetable or its pieces impregnated with heavy sugar syrup till it becomes tends and transparent is known as preserve or murabba.



Flow Chart for Processing of Murabba and Candy

Processing of Squash:

A type of fruit beverage which contains at least 25 percent juice and 45 percent total soluble solids is called as squash. It also contains about 1 percent acidity and 350 ppm sulphur dioxide or 600ppm sodium benzoate. It is diluted being served. Squash can be prepared from a wide variety of fruits of viz., mango, mandarin orange, lime, guava, anola, pineapple, papaya, bael, litchi, phalsa, jamun, pomegranate, plum, etc.

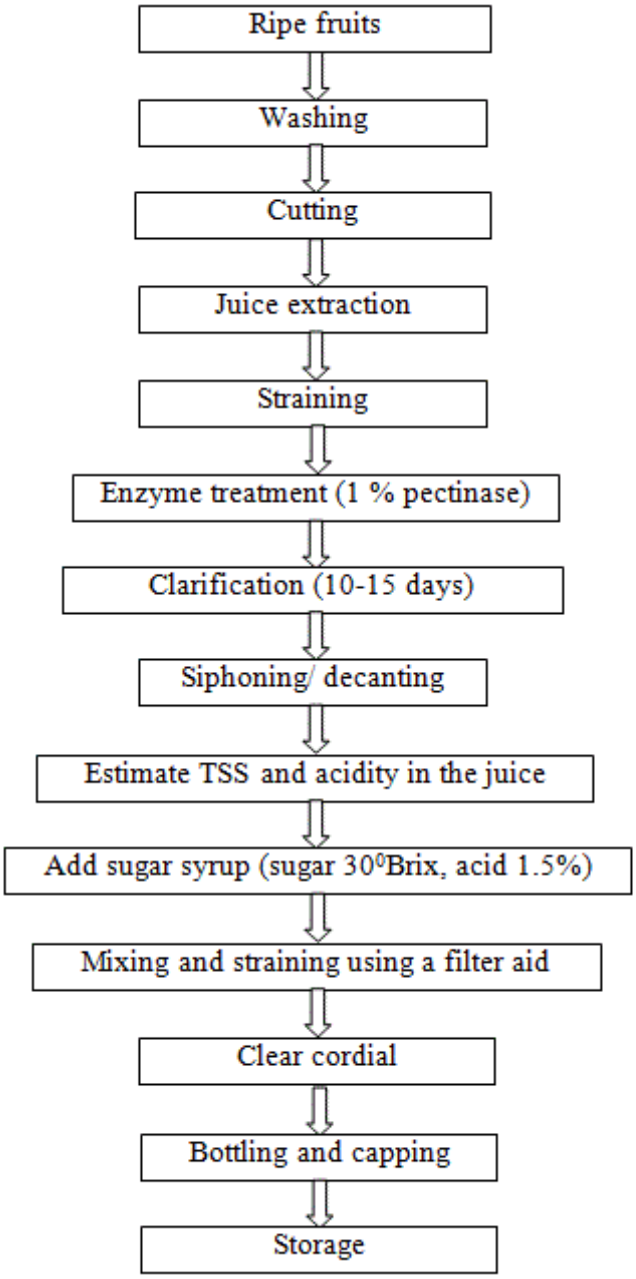


Flow Chart for Processing of Squash

Processing of Cordial:

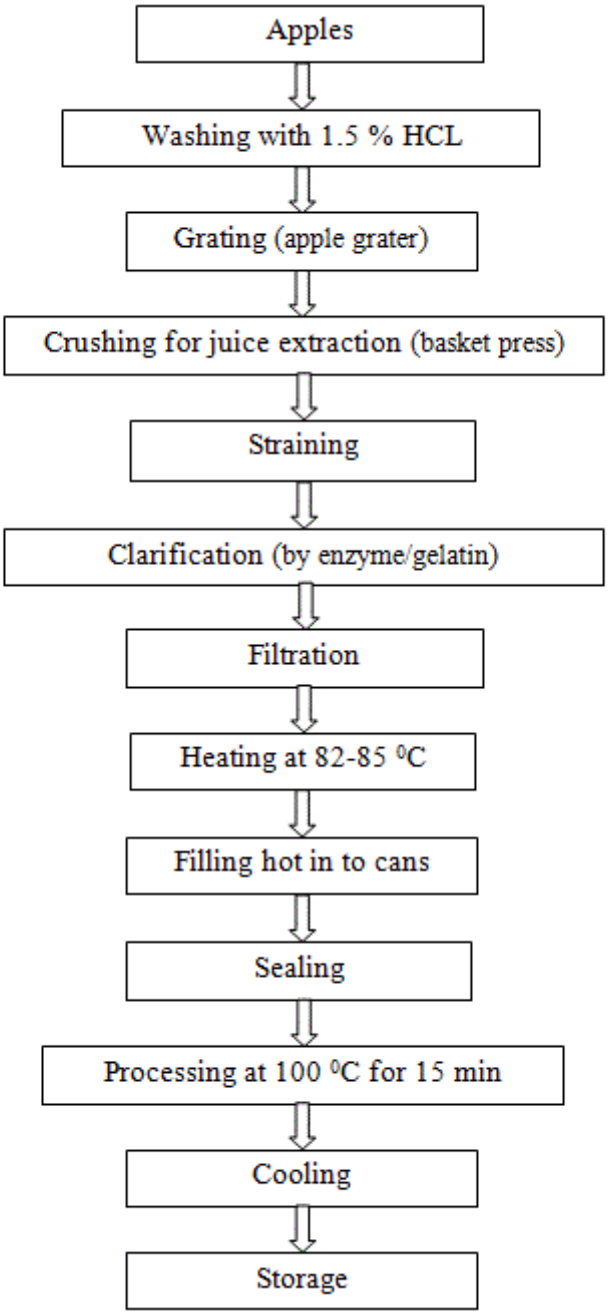
Cordial is a sparkling clear sweetened fruit juice from which pulp and other suspended materials are completely eliminated. Cordial contains at least 25% fruit juice and 30% total soluble solids with 1.5% per cent acidity. Lime and lemons are most suitable fruits for preparation of cordial. This can also be prepared from other fruits as guava, grape, phalsa, etc.

Minimum percentage of total soluble solids is 30% and of fruit juice 25%. The permissible limits of the preservative as sulphur dioxide or benzoic acid are same as mentioned for squash. The techniques used for preparation of cordial beverages are given as below:



Flow Chart for Processing of Cordial

Processing of Apple Juice:



Flow Chart for Processing of Apple Juice

Sauces and Ketchups:

There is no essential difference between sauce and ketchup. However, sauces are generally thinner and contain more total solids (minimum 30%) than ketchups (minimum 28%). Tomato, apple, papaya, walnut, soybean, mushroom, etc., are used for making sauces.

Sauces are of two kinds: (i) *Thin sauces* of low viscosity consisting mainly of vinegar extract of flavoring materials like herbs and spices, and (ii) *Thick sauces* that are highly viscous.

Sauces/ketchups are prepared from more or less the same ingredients and in the same manner as chutney, except that the fruit or vegetable pulp or juice used is sieved after cooking to remove the skin, seeds and stalks of fruits, vegetables and spices and to give a smooth consistency to the final product. However, cooking takes longer time as fine pulp or juice is used.

Tomato puree and paste:

Tomato pulp without skin or seeds, with or without added salt, and containing not less than 9.0 per cent of salt-free tomato solids, is known as 'medium tomato puree'. It can be concentrated further to 'heavy tomato puree' which contains not less than 12 per cent solids. If this is further concentrated so that it contains not less than 25 per cent tomato solids, it is known as tomato paste. On further concentration to 33 per cent or more of solids, it is called concentrated tomato paste. Tomato pulp is prepared from ripe tomatoes in the same manner as tomato juice. Cooking for concentration of the pulp can be done either in an open cooker or a vacuum pan. In the former most of the vitamins are destroyed and the product become brown. On the other hand, use of vacuum pans, which are expensive, help to preserve the nutrients and also reduce the browning to a great extent. In vacuum pans the juice is boiled at about 71°C only. Ordinarily tomato juice can be concentrated to 14-15 per cent solids in an open cooker, but for obtaining higher concentrations a vacuum pan is required. Moreover, sterilization of the product is also possible in a vacuum pan. While cooking in an open cooker, a little butter or edible oil is added to prevent foaming, burning and sticking. If, after cooking, the total solids content of the juice is higher than required, more juice is added to lower it, if it is lower, cooking is continued till the desired concentration is reached. The end-point of cooking puree and paste can be determined either with a hand refractometer or by measuring the volume (a known volume of juice is concentrated to a known volume of final product) with the help of a measuring stick.

Tomato sauce/ketchup:

It is made from strained tomato juice or pulp and spices, salt, sugar and vinegar, with or without onion and garlic, and contains not less than 12 per cent tomato solids and 25 per cent total solids.