

Subject- Technology of Fruits and Vegetables

Fruits and vegetables as living commodity

Fruits and vegetables, fresh or processed, form an important component of our diet and there is an ever increasing demand for these. Fruits are harvested at slightly immature or mature greens stages and yet their physiological activities continue. Harvesting of fruits and vegetables at appropriate maturity level is important and one of the basis of close observations, maturity indices is fixed for various commodities. These maturity indices are based on physicochemical characteristics, like their weight, fullness of finger, total soluble solids, sugar to acid ratio and certain arbitrary units like colour, heat units, and period after blooming. Commonly following criteria have been utilized for fixing maturity standards: □

- Computation of days from bloom to harvest □
- Measurement of heat units
- Visual means- skin colour, persistence or drying of parts of plant, fullness of fruit
- Physical methods- ease of separation, pressure test, density, grading etc.
- Chemical methods- total solids, sugars, acid, sugar-to-acid ratio, starch content etc.
- Physiological methods- respiration methods etc.

chemical composition

Compositions of vegetables and fruit not only vary for a given kind in according to botanical variety, cultivation practices, and weather, but change with the degree of maturity prior to harvest, and the condition of ripeness, which is progressive after harvest and is further influenced by storage conditions. Nevertheless, some generalisations can be made.

Most fresh vegetables and fruit are high in water content, low in protein, and low in fat. In these cases water contents will generally be greater than 70% and frequently greater than 85%.

Commonly protein content will not be greater than 3.5% or fat content greater than 0.5 %. Exceptions exist in the case of dates and raisins which are substantially lower in moisture but cannot be considered fresh in the same sense as other fruit. Legumes such as peas and certain beans are higher in protein; a few vegetables such as sweet corn which are slightly higher in fat and avocados which are substantially higher in fat.

Subject- Technology of Fruits and Vegetables

Vegetables and fruit are important sources of both digestible and indigestible carbohydrates. The digestible carbohydrates are present largely in the form of sugars and starches while indigestible cellulose provides roughage which is important to normal digestion.

Fruit and vegetables are also important sources of minerals and certain vitamins, especially vitamins A and C. The precursors of vitamin A, including beta-carotene and certain other carotenoids, are to be found particularly in the yellow-orange fruit and vegetables and in the green leafy vegetables.

Citrus fruit are excellent sources of vitamin C, as are green leafy vegetables and tomatoes. Potatoes also provide an important source of vitamin C for the diets of many countries. This is not so much due to the level of vitamin C in potatoes which is not especially high but rather to the large quantities of potatoes consumed.

Pre and post harvest changes and maturity standards for storage (Desirable characteristics of fruits and vegetables for processing)

Post-harvest physiologists distinguish three stages in the life span of fruits and vegetables: maturation, ripening, and senescence. Maturation is indicative of the fruit being ready for harvest. At this point, the edible part of the fruit or vegetable is fully developed in size, although it may not be ready for immediate consumption. Ripening follows or overlaps maturation, rendering the produce edible, as indicated by taste. Senescence is the last stage, characterized by natural degradation of the fruit or vegetable, as in loss of texture, flavour, etc. (senescence ends at the death of the tissue of the fruit). Some typical maturity indexes are described in following sections.

Skin colour:

This factor is commonly applied to fruits, since skin colour changes as fruit ripens or matures. Some fruits exhibit no perceptible colour change during maturation, depending on the type of fruit or vegetable. Assessment of harvest maturity by skin colour depends on the judgment of the harvester, but colour charts are available for cultivars, such as apples, tomatoes, peaches, chilli peppers, etc.

Optical methods:

Light transmission properties can be used to measure the degree of maturity of fruits. These methods are based on the chlorophyll content of the fruit, which is reduced during maturation. The fruit is exposed to a bright light, which is then switched off so that the fruit is in total darkness. Next, a sensor measures the amount of light emitted from the fruit, which is proportional to its chlorophyll content and thus its maturity.

Shape:

Subject- Technology of Fruits and Vegetables

The shape of fruit can change during maturation and can be used as a characteristic to determine harvest maturity. For instance, a banana becomes more rounded in cross-sections and less angular as it develops on the plant. Mangoes also change shape during maturation. As the mango matures on the tree the relationship between the shoulders of the fruit and the point at which the stalk is attached may change. The shoulders of immature mangoes slope away from the fruit stalk; however, on more mature mangoes the shoulders become level with the point of attachment, and with even more maturity the shoulders may be raised above this point.

Size:

Changes in the size of a crop while growing are frequently used to determine the time of harvest. For example, partially mature cobs of *Zea mays saccharata* are marketed as sweet corn, while even less mature and thus smaller cobs are marketed as baby corn. For bananas, the width of individual fingers can be used to determine harvest maturity. Usually a finger is placed midway along the bunch and its maximum width is measured with callipers; this is referred to as the calliper grade.

Aroma:

Most fruits synthesize volatile chemicals as they ripen. Such chemicals give fruit its characteristic odour and can be used to determine whether it is ripe or not. These odours may only be detectable by humans when a fruit is completely ripe, and therefore has limited use in commercial situations.

Fruit opening:

Some fruits may develop toxic compounds during ripening, such as ackee tree fruit, which contains toxic levels of hypoglycine. The fruit splits when it is fully mature, revealing black seeds on yellow arils.

Leaf changes:

Leaf quality often determines when fruits and vegetables should be harvested. In root crops, the condition of the leaves can likewise indicate the condition of the crop below ground. For example, if potatoes are to be stored, then the optimum harvest time is soon after the leaves and stems have died. If harvested earlier, the skins will be less resistant to harvesting and handling damage and more prone to storage diseases.

Abscission:

As part of the natural development of a fruit an abscission layer is formed in the pedicel.

Firmness:

Subject- Technology of Fruits and Vegetables

A fruit may change in texture during maturation, especially during ripening when it may become rapidly softer. Excessive loss of moisture may also affect the texture of crops. These textural changes are detected by touch, and the harvester may simply be able to gently squeeze the fruit and judge whether the crop can be harvested.

Chapter-2

Post harvest handling of fresh fruits and vegetables for processing

Physical and chemical treatment to increase the shelf life conditions for transportation and storage

Fruits and vegetables are processed by various methods like low temperature, thermal treatment, concentration, freezing and irradiation. But prior to subjecting fruits and vegetables to such treatments, all fruits and vegetables undergo some preliminary operations. Each processing method is based on certain principles and each has its own advantages and disadvantages.

The preliminary processing operations of fruits and vegetables are sorting, grading, washing, peeling, sizing, blanching, etc.

Subject- Technology of Fruits and Vegetables

1. Sorting and grading- Sorting is a separation based on a individual physical properties of raw materials such as weight, size, shape, density, photo metric property, etc. while grading is classification on the basis of quality incorporating commercial value, end use and official standards. The selection of fruits and vegetables is important from processing point of view for the manufacture a particular end product. The fruit should be ripe, but firm and evenly matured while vegetable should be tender and reasonably free from soil, dirt, etc. They should be free from blemishes, insect damage and malformation. Over ripe fruit is generally infected with microorganisms and would yield a poor quality finished product. After this preliminary sorting, the fruits and vegetables are graded. This is necessary to obtain a pack of uniform quality as regards size, colour, etc. It is done manually or with the help of grading machines.

2. Washing- The graded fruits and vegetables are washed with water in different ways, such as soaking and subsequent washing in running water or sprayed with water or dry air to remove surface adhering material. A thorough wash is very essential for improved microbiological quality of final product. Vegetables may preferably be soaked in a dilute solution (0.1%) of potassium permanganate or sodium hypochlorite solution to disinfect them. Agitation of the washing water is effected generally by means of compressed air or a force pump or propeller-type equipment. Among all, spray washing is the most efficient method.

3. Size reduction -Fruits and vegetables are processed either as whole or into small pieces by size reduction. Size reduction involves peeling, coring and sizing. Peeling is done to remove unwanted or inedible material and to improve the appearance of the final product using a peeler while coring is done to remove central inedible portion using a corer. There are five main methods of peeling. They are flash peeling (e.g. for root crops), knife peeling (e.g. for citrus fruits), abrasion peeling (e.g. for potato), caustic peeling (e.g. for guava, orange segments) and flame peeling (e.g. onion and garlic).

4. Blanching- Blanching refers to the mild heat treatment given to fresh produce such as vegetables to inactivate enzymes. Blanching also improves colour, flavour and nutritional quality. Usually it is done with boiling water or steam for short periods, followed by cooling. In small scale industries, the fruit or vegetable to be blanched is placed in a wire of perforated basket, which is first dipped in hot water (88-99°C) for about 2-5 minutes.

5. Ripening -Ripening before processing may be required for certain fruits such as avocado, banana, kiwifruit, mango, nectarine, papaya, peach, pear, plum, melons, etc. that are picked immature. Ethylene treatment can be used to obtain faster and more uniform ripening. The optimum temperature range for ripening is 15-25°C and

Subject- Technology of Fruits and Vegetables

within this range, the higher the temperature the faster the ripening. Relative humidity should be maintained between 90 and 95% during ripening. It is essentially a plant growth regulator with systemic properties. It penetrates into the tissues and is trans located. It decomposes into ethylene which is the active metabolite.

Controlled and modified atmosphere storage

Normal atmospheric air contains about 78.08% of nitrogen (N₂), 21% of oxygen (O₂), 0.04% of carbon dioxide (CO₂) and remaining other gases. A reduction in the concentration of O₂ and/or an increase in CO₂ concentration of the storage atmosphere surrounding fresh fruits and vegetables reduce the rate of respiration and also inhibits microbial and insect growth. The terms “controlled atmosphere” (CA) and “modified atmosphere” (MA) mean that the atmospheric composition surrounding a perishable product is different from that of normal air. Both CA and MA commonly involve manipulation of CO₂, O₂ and N₂ levels. The principle of CA or MA involves the complete or partial removal of air from the storage are and its replacement with a single gas or mixture of gases by either passive or active methods. Passive modification is a slow process. It requires reactions between the fruit or vegetable and its surrounding gases to take place, and the package to play the role of a regulator. On the contrary, active modification is faster and can be achieved by gas flushing, vacuum application or by using gas scavengers / emitters. Passive MA relies on the selective permeability of the packaging materials to different gases and on product respiration and is traditionally used with fresh and minimally processed fruits and vegetables. Gas-flush MA involves the establishment of a specific gas composition within the package in a single stage during the packaging operation, by flushing with the selected gas mixture before sealing. Depending on the desired residual O₂, a vacuum operation may be needed prior to gas flushing. The gas mixture used is dependent on the type of fruit or vegetable. MA differs from CA only in how precisely gas partial pressures are controlled; CA is more precise than MA. When combined with chilling, CA or MA are increasingly important methods of maintaining high quality in processed foods during an extended shelf life.

Benefits of CA storage -

1. Very low levels of O₂ (<2%) and high CO₂ level (≥60%) can control insects. □
2. A considerable decrease in respiration rate, in climacteric maximum, accompanied by an expansion of both pre-climacteric and post-climacteric period. □
3. Reduction in effect of C₂H₄ due to its interaction with O₂ and hence delay in development and appearance of the symptoms of senescence. □
3. Increased flesh firmness due to inhibition of enzymes responsible for damage of cellular membrane, at high CO₂ level. □

Subject- Technology of Fruits and Vegetables

4. High turgidity and hence more juicy & crisp fruits., Superior sensory and nutritional quality. □
5. A limited degradation of chlorophyll resulting in greater colour stability. □
6. Some physiological disorders, such as chilling injury, spot, decay, browning, water core and scald are greatly reduced. □
7. Mould growth is low due to less O₂ and high CO₂. □
8. Longer storage life.

Freezing of fruits and vegetables

Several methods of cooling are applied to produce after harvesting to extend shelf life and maintain a fresh-like quality. Some of the low temperature treatments are unsuitable for simple rural or village treatment but are included for consideration as follows:

Precooling- Fruit is precooled when its temperature is reduced from 3 to 6°C (5 to 10°F) and is cool enough for safe transport. Precooling may be done with cold air, cold water (hydrocooling), direct contact with ice, or by evaporation of water from the product under a partial vacuum (vacuum cooling). A combination of cooled air and water in the form of a mist called hyaircooling is an innovation in cooling of vegetables.

Air precooling- Precooling of fruits with cold air is the most common practice. It can be done in refrigerator cars, storage rooms, tunnels, or forced air-coolers (air is forced to pass through the container via baffles and pressure differences).

Icing- Ice is commonly added to boxes of produce by placing a layer of crushed ice directly on the top of the crop. An ice slurry can be applied in the following proportion: 60% finely crushed ice, 40% water, and 0.1% sodium chloride to lower the melting point. The water to ice ratio may vary from 1:1 to 1:4.

Room cooling- This method involves placing the crop in cold storage. The type of room used may vary, but generally consists of a refrigeration unit in which cold air is passed through a fan. The circulation may be such that air is blown across the top of the room and falls through the crop by convection. The main advantage is cost because no specific facility is required.

Forced air-cooling- The principle behind this type of precooling is to place the crop into a room where cold air is directed through the crop after flowing over various refrigerated metal coils or pipes. Forced air-cooling systems blow air at a high velocity leading to desiccation of the crop. To minimize this effect, various methods of humidifying the cooling air have been designed such as blowing the air through cold water sprays.

Subject- Technology of Fruits and Vegetables

Hydrocooling- The transmission of heat from a solid to a liquid is faster than the transmission of heat from a solid to a gas. Therefore, cooling of crops with cooled water can occur quickly and results in zero loss of weight. To achieve high performance, the crop is submerged in cold water, which is constantly circulated through a heat exchanger. When crops are transported around the packhouse in water, the transport can incorporate a hydrocooler. This system has the advantage wherein the speed of the conveyer can be adjusted to the time required to cool the produce. Hydrocooling has a further advantage over other precooling methods in that it can help clean the produce. Chlorinated water can be used to avoid spoilage of the crop. Hydrocooling is commonly used for vegetables, such as asparagus, celery, sweet corn, radishes, and carrots, but it is seldom used for fruits.

Vacuum cooling- Cooling in this case is achieved with the latent heat of vaporization rather than conduction. At normal air pressure (760 mmHg) water will boil at 100°C. As air pressure is reduced so is the boiling point of water, and at 4.6 mmHg water boils at 0°C. For every 5 or 6°C reduction in temperature, under these conditions, the crop loses about 1% of its weight (Barger, 1961). This weight loss may be minimized by spraying the produce with water either before enclosing it in the vacuum chamber or towards the end of the vacuum cooling operation (hydrovacuum cooling). The speed and effectiveness of cooling is related to the ratio between the mass of the crop and its surface area. This method is particularly suitable for leaf crops such as lettuce. Crops like tomatoes having a relatively thick wax cuticle are not suitable for vacuum cooling.

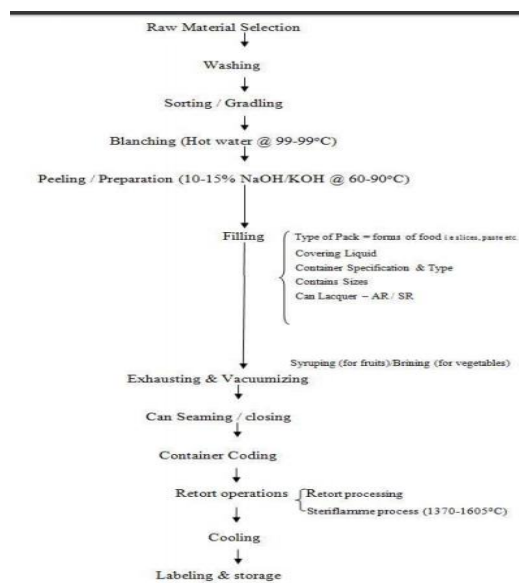
Subject- Technology of Fruits and Vegetables

Chapter- 3

Canning and bottling

Canning

The process of sealing fruits and vegetables or any other foodstuffs hermetically (air tight) in containers and sterilizing them by heat for long storage is known as canning. In 1904, Nicholas Appert of France invented this process and he is called as “Father of Canning”. The process of canning is also known as Appertization. Fruits and vegetables are canned in the season when the raw material is available in plenty. The canned products are sold in off-season and give better returns to the grower. The process flow diagram for canning is given-



Most of the preliminary operations of canning such as selection of the raw material, washing, sorting and grading, blanching have already been discussed in previous lesson and hence not repeated.

Can filling

Subject- Technology of Fruits and Vegetables

Can filling is the process of aseptically filling whole or sized fruit or vegetables into the containers. The cans are washed with water or subjected to steam jet to remove any adhering dust or foreign matter. Tin cans made of thin steel plate of low carbon content, lightly coated on either side with tin metal to a thickness of about 0.25 mm are usually used in canning. The thickness of coating varies from 0.31 mm to 1.54 mm.

Lacquering

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

Syruping and brining

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

Exhausting

Exhausting usually means heating the can and can contents before sealing. Sometimes it is may also refer to the treatment of the container under a mechanically produced vacuum. But in either case it is done to remove air from the can interior and prevent corrosion. It also prevents undue strains upon the can during sterilization and prevents overfilling of can contents. Removing of air also helps in better retention of vitamins

Subject- Technology of Fruits and Vegetables

especially of vitamin C. The other advantages of the exhaust process are prevention of bulging of the can when stored at high altitudes or in hot climates. In heat exhaust method, the cans are generally passed through a tank of hot water at about 92-97°C or on a moving belt through a covered steam box. The time of exhaust varies between 5 to 25 minutes. After exhausting cans are immediately sealed with the help of double rolling operation of seamer.

Processing of the cans

The term “processing” as used in canning technology, means heating of canned foods (fruits, vegetables and other food stuffs) to inactivate bacteria. This is also called as “retorting”. Processing consists of determining just the temperature and the extent of cooking that would suffice to eliminate all possibilities of bacterial growth.

Chapter- 4

Preserve candies and crystallize fruits

Preserves

They are whole fruits or large pieces of fruit in thick sugar syrup, often slightly jellied. Preserves are made from practically all fruits including peaches, pears, plums, aonla, strawberries, grapes, muscadines, quinces and tomatoes. The fruit for preserving should be in a firm-ripe rather than a soft-ripe stage. By using up to 25.0% of firm-ripe fruit, the tartness is increased and less pectin is required in the formula. The fruit should be uniform in size and uniform pieces so as to cook evenly. The examples of Preserves include Fig preserve, Watermelon rind preserve, etc.

Preliminary Processing The fruit should be washed thoroughly. If the fruit had been sprayed with insecticide to check blight, it should be washed with dilute HCl, especially if the peel is not removed from the fruit for preparation of the preserve. The preliminary treatment varies with the variety of fruit taken. For instance, apples and pears are just peeled and pricked if they are to be kept whole, otherwise they are peeled, halved or quartered, cored and punctured. Mangoes are peeled, sliced and pricked. Peaches are destoned and lye peeled. Apricots, cherries are only pitted and destoned. Oranges, lemons, grape fruits and citrus fruits are halved and the pulpy portions removed from the cut fruit. Pumpkins are sliced, peeled, pricked and placed in dilute lime water for few hours to harden the texture. Strawberries and Raspberries are used as such, without any preliminary treatment. The fruit is first cooked slightly in water to make it soft enough to absorb sugar. Cooking of the fruit in syrup is rather a difficult process, because the syrup is to be maintained at a proper degree of consistency so that it can permeate the entire body of the fruit, without causing it

Subject- Technology of Fruits and Vegetables

either to shrink or to toughen. The fruit should be boiled initially in water before transferring it to the syrup or cooked first in a dilute syrup with low sugar concentration. Highly juicy fruits may, however, be placed directly in a thick syrup at the very outset, because the excess of juice present in the fruit would serve to dilute the syrup. The examples of sugar preserves include Aonla preserve, Apple preserve, Bael preserve, Carrot preserve, Cherry preserve, etc.

Candied Fruit

The process is similar to the one employed in preparing fruit preserves, but here the fruit is impregnated with a higher percentage of sugar or glucose; the total sugar content is about 75.0%. A certain amount of invert sugar or glucose is substituted in place of cane sugar. The fruits suitable for such preparation are those that possess pronounced flavor, such as pineapple, peach, peels of orange, lemon, grapefruit, citrus, cherry, etc. Use of slightly underripe fruit helps in preventing formation of jam-like consistency in the syrumping process. The sweeteners used maybe Confectioner's glucose (corn syrup, crystal syrup or commercial glucose), dextrose, invert sugar, etc.

Examples of Candied Fruit Product-

Candied citrus peels- Candied citrus peels are highly popular for festive occasions like Christmas, Diwali, etc. They are manufactured and sold in large quantities in several parts of the world. They are useful as flavouring materials in cakes, puddings, etc. Citrus peels, especially orange peels, are waste products in the manufacture of orange juice, squash, segments, etc. Thick rinds of citrus fruits like orange, lemon, grape fruit, citrus, and pummelo are used for candying. After the peels are prepared, they are covered with a cold syrup of 30oBrix in a vessel and left for 48 h. On the 3rd day, the strength will be less than 30 oBrix, which is raised by 10oBrix and the peels boiled in this syrup for about 5 min. The process is repeated until the strength reaches 60oBrix. At this stage, citric or tartaric acid is added at the rate of 1.25 g for every kg of peels. Alternatively, glucose or invert syrup may be added up to a maximum of 50.0% of the cane sugar used. The strength of the syrup is then raised to 75oBrix by 5oBrix every succeeding day. The peels are then left in this syrup for 2-3 weeks. Finally, they are taken out from the syrup and dried on wire mesh tray.

Glazing of Fruit

The syrup needed for glazing process is made by boiling a mixture of cane sugar and water in the proportion of 2:1, in a steam pan at 113-114oC and skimming the impurities as they surface. Heat is stopped and the syrup cooled to 93oC. Granulation of the sugar is achieved by rubbing the syrup with a wooden ladle on the side of the pan. Dried candied fruit are passed through the granulated portion of the syrup, one by one, by means of a form, and then placed on trays that are kept in a warm, dry room. To hasten the process, the fruit may be dried in a drier at 49oC for 2-3 h. When it becomes crisp, it is packed in air-tight containers.

Subject- Technology of Fruits and Vegetables

Chapter- 5

Jams, jellies and marmalades

Jam

Jam means the product prepared from sound, ripe, fresh, dehydrated, frozen or previously packed fruits including fruit juices, fruit pulp, fruit juice concentrate or dry fruit by boiling its pieces or pulp or puree with nutritive sweeteners namely sugar, dextrose, invert sugar or liquid glucose to a suitable consistency. It may also contain fruit pieces and any other ingredients suitable to the products. It may be prepared from any of the suitable fruits, singly or in combination. It shall have the flavour of the original fruit(s) and shall be free from burnt or objectionable flavours and crystallization. The specific requirements for Jam are as follows: Total soluble solids (m/m) - Min. 65.0 % The product shall be manufactured from minimum 45.0% by weight, of original prepared, fruit, exclusive of any added sugar or optional ingredients of finished product, except for Strawberry or Raspberry fruit, where it shall contain minimum 25.0% fruit.

Characteristics of jam- The amount of pectin in the gel is quite small (< 1.0% of the weight of jam); sugar content is very high (60- 70%). Of the remainder, the bulk is

Subject- Technology of Fruits and Vegetables

water with a small amount of fibrous matter and seeds. For a chunky texture, some pieces of fruit are added about 5 minutes before the cooking is finished. If a stiffer or sweeter jam is desired, more thickener or pectin, honey or sugar may be added.

Fruit or fruit combinations Some fruits such as lemons and bitter oranges are rich in both acid and pectin and can be easily made into jam. Some popular combinations include: pineapple and paw paw, orange and banana, apple and plum.

Sugar 55 parts of sugar is required for every 45 parts of fruit. With excess sugar, the jam becomes gummy and sticky. The finished jam should have 30-50% invert sugar / glucose to avoid crystallization of cane sugar during storage.

Acid Acidity can be supplemented by use of citric, tartaric or malic acid. The pH influences inversion of sugar and setting of the jam. For pectin jam, pH of 3.3 gives a good set. For Apple and Plum jam, the pH range of 3.2-3.5 is desirable; optimum being 3.35.

Preparation of Jam

Subject- Technology of Fruits and Vegetables

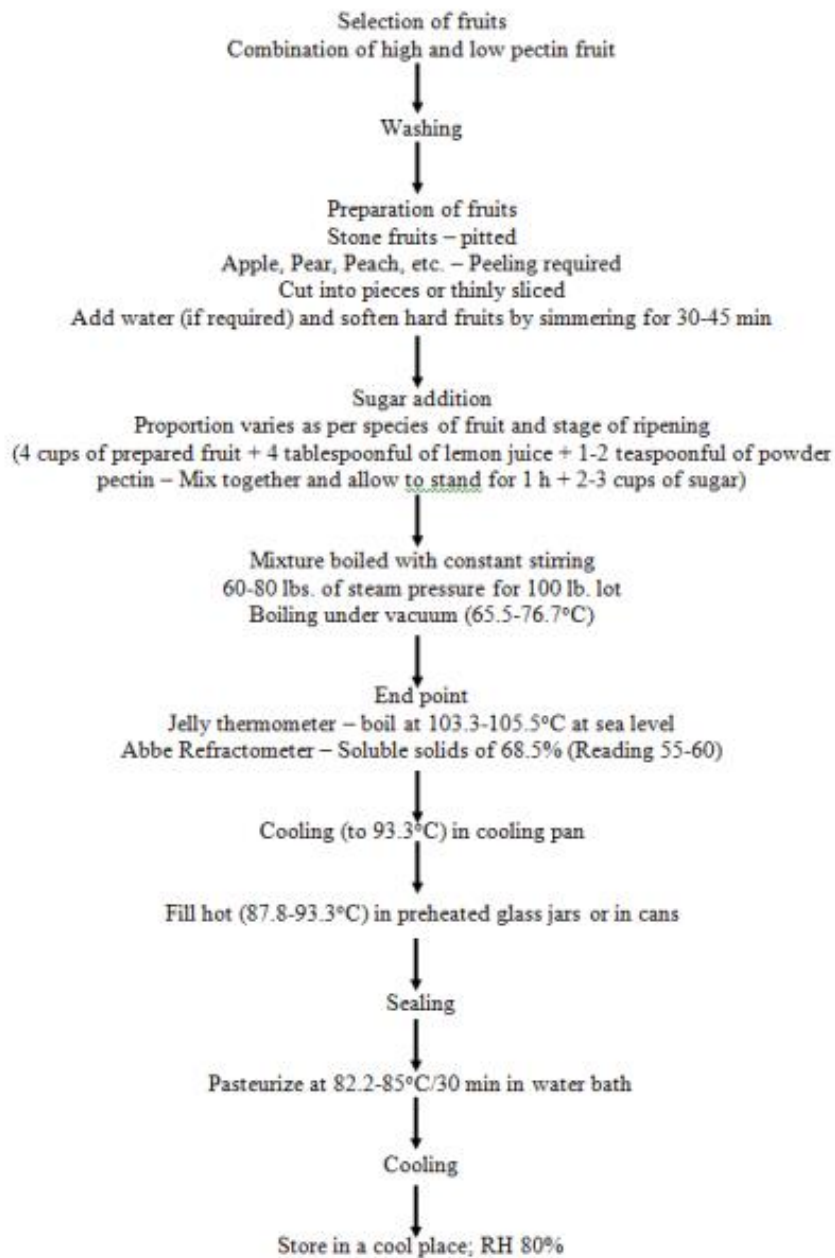


Figure 18.1 Flow chart for preparation of Jam

Judging the end-point or point at which boiling is stopped.

1. Determining the boiling point with thermometer- Thermometers or thermocouples are used to indicate the temperature which should be approximately the boiling point of a 65% sugar solution (103.9-105oC), when the process is complete. A 65% solids boils at 104.8oC at sea level. It should be 8-9 oC higher than the boiling point of water at that place.

2. Hydrometers- They help in determining the specific gravity of material.

Subject- Technology of Fruits and Vegetables

3. Refractometer- We can determine the percentage solids i.e. TSS read directly on scale.

Storage of jam

The surface of jam is susceptible to mold growth; yeast cannot grow or thrive. There is risk of mold development and fermentation, with alteration in the taste. Permitted preservatives may be used at levels sufficient to inhibit the growth of yeast and molds. Jam should be stored in a fairly cool place or else some moisture evaporates resulting in surface graining and shrinkage of jam. It should be stored in a place having RH of ~ 80%.

Fruit Jelly

Fruit Jelly means the product prepared by boiling fruit juice or fruit(s) of sound quality, with or without water, expressing and straining the juice, adding nutritive sweeteners, and concentrating to such a consistency that gelatinization takes place on cooling. The product shall not be syrupy, sticky or gummy and shall be clear, sparkling and transparent. The specific requirements are as shown below: Total soluble solids (m/m) - Min. 65.0 % The product shall be manufactured from minimum 45.0%, by weight, of original prepared fruit, exclusive of any added sugar or optional ingredients of finished product.

Subject- Technology of Fruits and Vegetables

Manufacture of jelly

Subject- Technology of Fruits and Vegetables

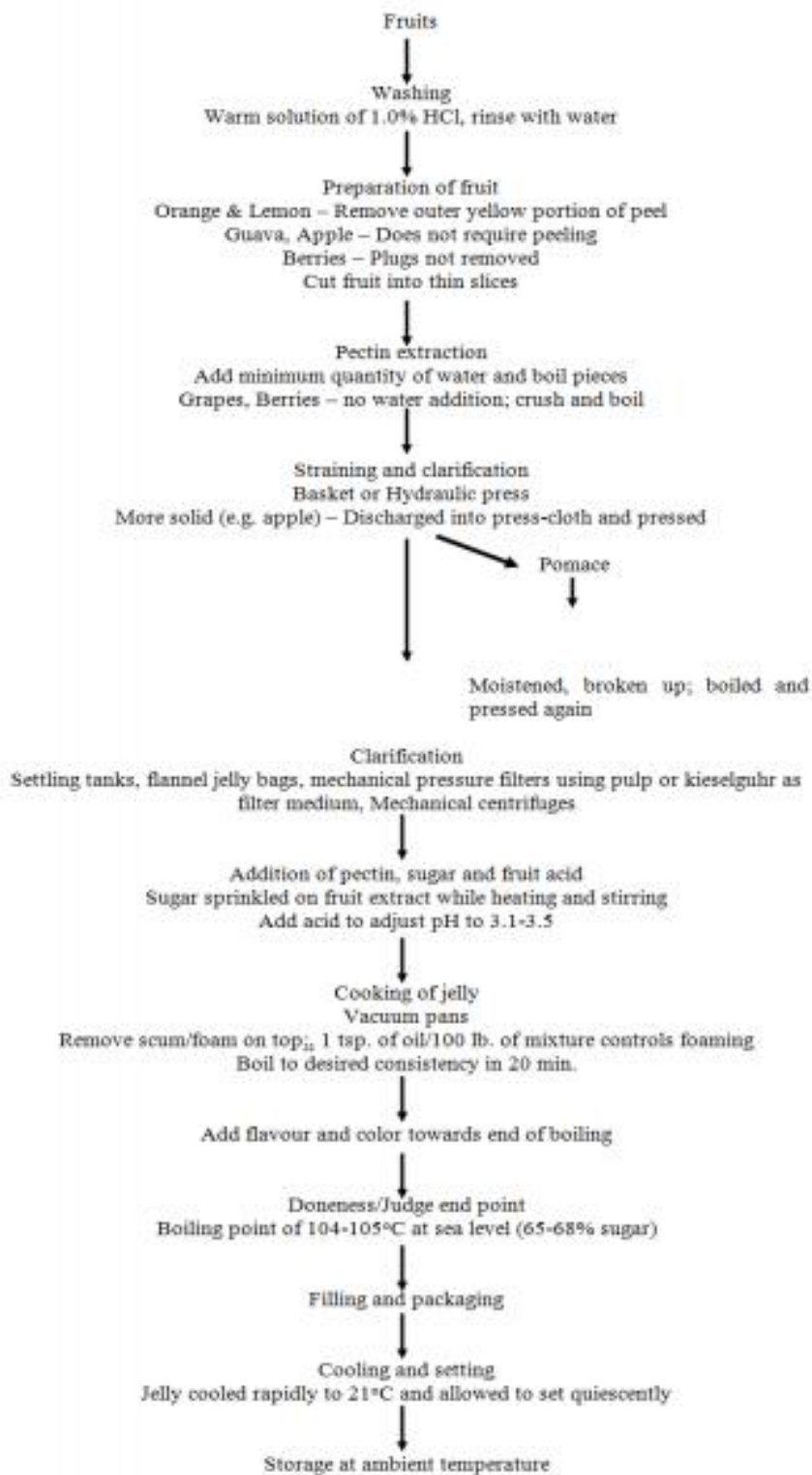


Fig. 18.2 Flow chart for preparation of jelly

Subject- Technology of Fruits and Vegetables

Defects in jelly

Crystals in Jelly Sugar crystallization may result from:

- (a) Too much sugar
- (b) Too little acid
- (c) Overcooking of jelly
- (d) Too long a delay in sealing the container of jelly.

Crystals may sometimes be found in jelly because during the boiling, syrup spatters on the side of the pan and dries up. In subsequent pouring of the finished product, these crystals (act as seed material) are carried into the glasses of jelly.

Cloudy jelly

Usually occurs with the red juices. It is caused by imperfect straining. Restraining of juice without pressure brings a lower yield, but ensures a clear product.

Failure to gel a) Causative factors Improper balance of pectin, acid, sugar and mineral salts, which may come about in several ways: Fruit used may lack sufficient pectin or acid or both. Overcooking may destroy so much pectin that a gummy mass is formed. Undercooking, due to insufficient concentration. Too much water used for extraction of juice, so that the proportion of sugar is too great for the pectin and the long time required for evaporation may destroy some of the pectin.

Tough Jelly

The jelly becomes tough or stringy when too little sugar is used for the quantity of fruit juice used or when boiling is continued after the jellifying point has been reached.

Marmalade

Marmalade means a product prepared by boiling sound fruits with peel, pulp and juice, with or without water, added nutritive sweeteners and concentrating to such a consistency that gelatinization takes place on cooling of the product. It shall not be syrupy, sticky or gummy and shall be clear and transparent.

Subject- Technology of Fruits and Vegetables

The specific requirements are as follows:

- (i) Total soluble solids (m/m) - Min. 65.0 %
- (ii) Fruit content except peel (m/m) - Min. 45.0 %
- (iii) Peel in suspension - Min. 5.0 % The container shall be well filled with the product and shall occupy not less than 90% of the net weight of the container, when packed in the rigid containers.

Chapter- 6

Dehydration of fruits and vegetables

Drying and dehydration of fruits and vegetables is an age old method to preserve these products. Removal of the water (75-90%) present in fresh commodity results in reduction in the water activity and ultimately resistance against most of the deteriorative agents. The removal of water is carried out by the application of heat and this heat is usually supplied in the form of solar energy or artificially generated hot air. Removal of moisture and exposure of heat often results in poor textural attributes, loss in nutritive value (vitamins), discolouration and loss of flavouring components. Although both drying and dehydration are interchangeably used, drying is referred to removal of water to an equilibrium moisture content while dehydration is removal of water to an almost bone dry condition. A number of processing steps are carefully designed to check all these adverse effects of drying. Some of the new technologies have been introduced in recent years to produce a wholesome and nutritive product. Partial dewatering by osmosis and impregnation soaking process before drying saves energy during drying and improves quality of dried product. Osmotic dehydration is gaining popularity, as the dehydrated product is more stable during storage due to low water activity by solute gain and water loss. The low water activity resulted in fewer rates of chemical reactions avoiding deterioration of the food. Osmotic dehydration in many cases is employed to increase sugar to acid ratio of acidic fruits, thereby to

Subject- Technology of Fruits and Vegetables

improve the taste, texture and appearance of dried product. The processing steps involve in drying of fruits and vegetables are summarized here.

Drying

Drying of the fruits and vegetables is usually carried out in cabinet dryer. The material is loaded over perforated aluminium trays and dried using hot air. The temperature, velocity and the humidity of the air are important for drying process. It usually varies from commodity to commodity. A lower drying temperature is generally used for fruits, as there may be chances of case hardening. The temperature varies from 55-80°C. To create perforation initially temperature is maintained towards higher side and then it is reduced. Some vegetables those are light, cylindrical or spherical like peas are dried in fluidized bed dryer. This improves the rehydration characteristic and the nutritive value of the product, as it takes lesser time and more uniform drying.

Chapter- 7

Pickles and chutneys

Principle of Pickling

Subject- Technology of Fruits and Vegetables

There are mainly two methods of preserving fruits and vegetables namely (i) by killing all the microorganisms responsible for spoilage, by heat or other means and then checking the entry of fresh microorganisms into the preserved product

(ii) by making the conditions most unfavourable for the growth and multiplication of microorganisms. The first method is generally employed in the preservation of fruits and vegetables for making fruit juices, fruit powders, etc. and the second method in the preparation of pickles. The process of preservation of food in common salt or vinegar is called as pickling. Spices and edible oils also may be added to the product. Salt, vinegar, lactic acid and oil are the important ingredients used in pickle production. These substances when used in sufficient quantities, act as preservatives either singly or in combination. The preservative action of these substances are given below:

Salt

Vegetables do not ferment when they are covered with strong brine or packed with a fairly large quantity of salt. Spoilage is prevented by adding sufficient common salt, bringing its final concentration in the material from 15 to 20 percent. At this high salt concentration, mould and even lactic acid-forming bacteria do not grow. This method of preservation is only applicable to vegetables which contain very little sugar because sufficient lactic acid cannot be formed by fermentation to act as preservative.

Vinegar

In vinegar pickles, vinegar acts as a preservative. In order to ensure satisfactory results, the final concentration of acid as acetic acid, in the finished product should not be less than 2 percent. To avoid dilution of the vinegar by the water liberated from the tissues, the vegetables are generally placed in strong vinegar of about 10 percent acidity for several days before final packing. This treatment also helps to expel the gases present in the intercellular spaces of the vegetable tissue.

Lactic acid

Bacteria prefer for their growth media with little or no acid. The lactic acid bacteria, however, can grow in acid media and can also produce acid through their action on the substrate. They can grow in the presence of 8 – 10 percent salt. The growth of undesirable organisms is inhibited by adding salt while allowing the lactic fermentation to proceed. In fermented pickles, microorganisms ferment sugars to lactic acid. When vegetables are placed in brine, the soluble material present in them diffuses into the salt water owing to osmosis and the liquid penetrates into the tissues. The soluble material, besides containing mineral matter, contains fermentable sugars. These sugars serve as food for lactic acid bacteria, which convert them into lactic and other volatile acids.

Oil

Subject- Technology of Fruits and Vegetables

In oil-based pickles, fruits or vegetables are completely immersed in the edible oil. It acts as a barrier for air and creates an anaerobic condition which is utilized by the native bacteria for the production of lactic acid. Oil prevents growth of spoilage yeasts and moulds. Generally mustard oil is used.

Definition and Specifications

In India, the Food Safety and Standards (FSS) Rules (2006) defines pickles as “preparation made from fruits and vegetables or other edible plant material including mushrooms free from insect damaged or fungal infection, singly or in combination preserved in salt, acid, sugar or any combination of the three. The pickle may contain onion, garlic, ginger, sugar, jaggery, edible vegetable oil, green or red chillies, spices, spice extracts/oil, lime juice, vinegar/acetic acid, citric acid, dry fruits and nuts. It shall be free from copper, mineral acid, alum, synthetic colours and shall show no sign of fermentation”. Pickles may be of following combinations conforming to the requirements as given below:

Pickles in citrus juice or brine

- a) Drained weight: Not less than 60 percent
- b) Sodium Chloride content when packed in brine: Not less than 12 percent c)
- Acidity as Citric acid when packed in Citrus Juice: Not less than 1.2 percent

Pickles in oil

- a) Drained weight: Not less than 60 percent
- b) Fruit and vegetable pieces shall practically remain submerged in oil

Pickles in vinegar

- a) Drained weight: Not less than 60 percent
- b) Acidity of vinegar as acetic acid: Not less than 2.0 percent

Subject- Technology of Fruits and Vegetables

Chapter- 8

Tomato Products

Manufacturing of Tomato Puree and Paste

The pulp which is obtained by hot or cold break method is concentrated to manufacture puree and paste. Fully mature and deep red coloured tomatoes are preferred for the manufacture of tomato puree and paste.

Tomato Puree

Subject- Technology of Fruits and Vegetables

Tomato juice or pulp as obtained by cold or hot extraction method is concentrated to about 9.0 percent to 12.0 percent total solids to prepare tomato puree. Commercial tomato puree can be defined as concentrated tomato juice or pulp without skin or seeds, with or without added salt and containing not less than 9.0 percent salt free tomato solids, is “medium tomato puree”. Further concentration to 12.0 percent solids will yield “heavy tomato puree”.

Tomato Paste

Tomato paste can be defined as concentrated tomato juice or pulp without skin and seeds, and containing not less than 25 percent of tomato solids. If the tomato paste is further concentrated to a tomato solid levels of 33 percent or more then it is called as concentrated tomato paste.

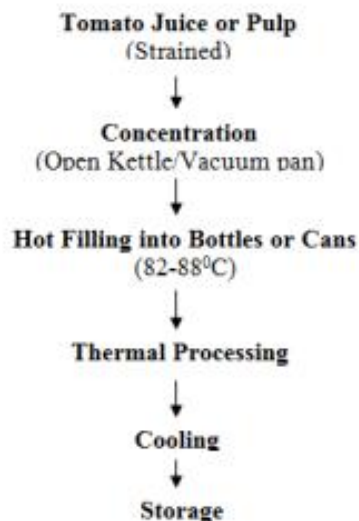


Fig.22.1 Process flow diagram for tomato puree or paste manufacture

Tomato juice or pulp is strained or filtered to remove portions of skin, seeds and large coarse pieces to get uniform juice or pulp. The juice or pulp is concentrated in open kettle or vacuum kettle to evaporate water and the process of evaporation in case of puree is continued till the volume reduced to equal or one-half of original. The end point is determined by the hand refractometer to measure the total soluble solids and expressed as degree Brix. Alternatively it can also be determined by using specific gravity bottle or by drying the juice or pulp under vacuum at 70°C. The puree of desired total soluble solids is then filled into cans (temperature of filling 82-88°C) and processed in boiling water for 20 min. The processed cans are cooled immediately either by dipping them in cold water or sprinkled with cold water. The cans are then stored in dry and cool place. For the manufacture of tomato paste, tomato juice or

Subject- Technology of Fruits and Vegetables

pulp is first concentrated in open steam jacketed kettle to total solid levels in the range of 14-15 percent and subsequent concentration is carried out in vacuum pan. During cooking in open kettle common salt, basil leaf or sweet oil of basil leaf may also be added to prevent the excessive foaming, burning and sticking. In vacuum pan, the water present in pulp or juice starts evaporating at 710C. It assists in retention of bright red colour and flavour. The removal of air also check any oxidative reaction that may adversely affect the nutritional value i.e. vitamin C. For sterilization of the product, vacuum is removed and the temperature is raised to 1000C and held at that temperature for about 10 min.

Technology of Tomato Ketchup and Sauce Among the tomato products, in India tomato sauce and ketchup are very popular and are being manufactured on an increasingly large scale. It is one of the simplest ways of conserving the tomato solids. As per FSSAI standards “Tomato ketchup and sauce means the product prepared by blending tomato juice/puree/paste of appropriate concentration with nutritive sweeteners, salt, vinegar, spices and condiments and any other ingredient suitable to the product and heating to the required consistency. Tomato paste may be used after dilution with water suitable for the purpose of maintaining the essential composition of the product. The finished product should contain not less than 25.0 percent total soluble solids (salt free basis) and acidity not less than 1.0 percent as acetic acid. The product should also meet the given microbiological criteria.

Tomato ketchup and sauce can be made from freshly extracted juice or pulp or using tomato puree or paste. Strained tomato juice or pulp along with spices, salt, sugar and vinegar is cooked or concentrated to the extent that ketchup and sauce contains not less than 12 percent tomato solids, 25 percent total solids and minimum acidity as 1% acetic acid. The TSS content in tomato ketchup should be 25-29 for grade C, 29-33 for grade B and over 33 for grade A. Basically there is no difference between tomato ketch-up and tomato sauce. Tomato sauce has thinner consistency and it is blended with juice or pulp from other vegetable sources including potato puree, cucumber juice or carrot pulp.

Defects in Ketchup The two most common observed defects in ketchup are: serum separation and blackening specially around the neck. The latter defect is referred as “Black neck defect”. The tannins present in spices get extracted into the ketchup and when these phenolic compounds come in contact with iron leached out either from processing vessels or from the closure of ketchup bottles, they form ferrous tannate. This compound undergoes oxidation and form ferric tannate and it is a black coloured compound. To check it one should not use iron or copper utensils and headless clove should be used. The inner lining of bottle cap should be of PVC. Problem of serum separation as already been discussed in Section 2.4.5. Among the microbiological problem mold growth is the most serious one. Microbial growth can be taken care by adding chemical preservatives specially benzoic acid. Benzoic acid is added in the

Subject- Technology of Fruits and Vegetables

form of its sodium or potassium salt because of almost 54 times higher solubility of salt as compared to benzoic acid. As per FSSAI guidelines the maximum permissible limit of benzoic acid is 750 ppm.