UNIT 9 JUICE AND BEVERAGES

Structure

9.0 OBJECTIVES

By the time you have studied this unit, you should be able to:

- prepare various fruit beverages;
- learn principles of various preservation techniques;
- know equipment used in the processing of fruit beverages;
- explain quality aspects and standards of product; and
- describe packaging requirements and types of packaging material.

9.1 INTRODUCTION

Fruit beverages are easily digestible, highly refreshing, thirst- quenching, appetizing and nutritionally far superior to synthetic and aerated drinks. The fruit beverage include natural and sweetened juices, squash, syrup, fruit juice concentrate and fruit juice powder.

In this unit we will study the various steps in the preparation of fruit beverages, and their preservation methods for extending their shelf life. Measures taken to improve the quality of the final product by Fruit Products Order (FPO) is also given in this unit. Apart from this, you will learn the importance of packaging and different packaging materials used in the processing industry.

9.2 FRUIT JUICE

The concept of fruit juices has gained immense consumer popularity. Fruit juices are products for direct consumption and are obtained by the extraction of cellular juice from fruit, this operation can be done by pressing or by diffusion. The fruit juice processing technology employed for different fruits and the various equipments required during different stages of processing has been covered here.

9.2.1 Preparation of Fruit Juice

Fruit juices must be prepared from sound, mature fruits only. Soft fruit varieties such as grapes, tomatoes and peaches should only be transported in clean boxes, which are free from mould and bits of rotten fruit. The flow chart for fruit juice production is given in Figure 9.1.

Fruits
↓
Receiving the material
↓
Washing
↓
Sorting
↓
Crushing/Grinding/Disintegration
↓
Enzyme treatment
↓
Extraction/ Expression
↓
Straining/Filtration
↓
Clarification (Optional)
↓
De-tartarisation (Optional)
↓
Preservation of fruit juice
↓
Filling in sterilized bottles
↓
Corking
↓
Pasteurization
↓
Labelling and Storage

Figure 9.1: Flow chart for fruit juice production

Washing: Fruit must be thoroughly washed. Generally, fruits are submitted to pre-washing before sorting and a washing step just after sorting. Washing can be done either by water or by dilute hydrochloric acid (1 part acid : 20 part water).

Sorting: Removal of partially or completely decayed fruit is the most important operation in the preparation of fruit for production of first quality fruit juices; sorting is carried out on moving inspection belts or sorting tables.

Crushing/Grinding/Disintegration: This is applied in different ways and depends on fruit types: Crushing for grapes and berries; Grinding for apples, pears; Disintegration for tomatoes, peaches, mangoes, apricots etc. This processing step will need specific equipments, which differs from one type of operation to another.

Enzyme treatment: The enzyme treatment of crushed fruit mass is applied to some fruits by adding 0.2-0.8% pectolitic enzymes at about 50° C for 30 minutes. This optional step has the following advantages: extraction yield will be improved, the juice colour is better fixed and taste of finished product is improved.

Expression/extraction*:* Generally juice is expressed from the crushed/disintegrated fruit pulp. During expression, juices should not be unnecessarily exposed to air as it will spoil the colour, taste and aroma and also reduce the vitamin content.

The equipments used for the juice extraction are screw type juice extractors, basket presses or fruit pulpers (shown in figure). All equipments used in the preparation of fruit juices and squashes should be rust and acid proof. Copper and iron vessels should be strictly avoided as these metals react with fruit acids and cause blackening of the product. Machines and equipments made of aluminium, stainless steel, etc can be used.

Straining/Filtration*:* The extracted juice contain some amount of suspended matter. The suspended matter consists of broken fruit tissue, seed, skin, gums, pectic substances and protein in colloidal suspension. These materials can be removed by straining through a thick cloth or sieve. Removal of all suspended matter improves the appearance but often results in disappearance of fruity character and flavour. The present practice is to let fruit juices and beverages retain a cloudy or pulpy appearance to some extend (Figure 9.2).

Clarification: It is the process of complete removal of all suspended material from the juice**.** This can be performed by many methods viz. centrifugation, enzyme treatment, settling, filtration, freezing(-18^{o}C), use of high temperature (nearly 82^{o}C) and low temperature(-2 to –3 ^{o}C). The chemical treatments like addition of gelatin, albumin, casein, or a mixture of tannin and gelatin are also used for the removal of suspended particles.

Centrifugation is carried out in centrifugal separators with a speed of 6000 to 6500 rpm. Enzyme clarifying is based on pectic substance hydrolysis; this will decrease the viscosity of juice and facilitate their filtration. The treatment is the addition of pectolitic enzyme preparations in a quantity of 0.5 to 2 g/l. This will last for 2 to 6 hours at room temperature, or less than 2 hours at 50° C, a temperature that must not be exceeded.

De-tartarisation is applied only to raisin juice and is aimed to eliminate potassium bi-tartrate from solution. This step can be performed by the addition of 1% calcium lactate or 0.4% calcium carbonate.

9.2.2 Preservation of Fruit Juices

Fruit juice is preserved to prevent the decay/spoilage and to extend the shelf life of the juice in a good condition for future use. This is generally done by the use of high temperature (pasteurization and flash pasteurization), use of low temperature (refrigeration and freezing), preservation with chemicals (sulphur dioxide and benzoic acid), drying, filtration, carbonation, and by using sugar. The methods used for the preservation are follows:

Pasteurization

Preservation by heat is the most common method. It is the process of heating fruit juice at boiling temperature or slightly below it for a sufficient length of time to kill the microorganisms that cause spoilage. The juice is hermetically sealed in containers before being pasteurized. Usually the fruit juices are pasteurized at about 85°C for 25 to 30 minutes according to the nature of the juice and size of the container.

Flash Pasteurization

In this method, fruit juice is heated for a short time at a temperature higher than the pasteurization temperature and held at that temperature for about a minute and then filled into containers which are sealed air tight under cover of steam to sterilize the seal and then, cooled. For the maintenance of the product quality, the rate of heat transfer in these pasteurizers are kept high. The heat transfer depends on the viscosity of the juice, specific heat of the juice and temperature difference. This method has many advantages viz., minimum loss of flavour, preservation of vitamins, economy of time and space, uniformity in body of juice, and minimum cooked flavour.

Preservation by Chemicals

Microbial spoilage of fruit beverages is also controlled by using chemical preservatives. The inhibitory action of preservative is due to their interfering with the mechanism of cell division, permeability of cell membrane and activity of enzymes. Pasteurized fruit beverages undergo spoilage once opened. To avoid this it is necessary to use chemical preservatives. Chemically preserved beverages can be kept for a fairly long time even after opening the seal of the bottle. The two important chemical preservatives permitted in our country by FPO are sulphur dioxide (including sulphites) and benzoic acid (include benzoates).

Sulfur dioxide: It is widely used throughout the world in the preservation of fruit juice and other beverages. It has good preserving action against bacteria, moulds and inhibits enzymes. In addition, it acts as an antioxidant and bleaching agent. It is generally used in the form of it's salts such as sulphite, bisulphite and metabisulphite.

The advantages of using sulphur dioxide are:

1. It has better preserving action against bacterial fermentation
2. It helps to retain colour
3. It ensures better mixing and hence their preservation

4. It helps in preserving the surface layer of juices.
5. Excess amount can be removed by heating or by vacuum

The limitations of sulphur dioxide are:

1. It can't be used in some coloured juices like those of jamun, strawberry etc on account of its bleaching action.
2. It corrodes the tin containers.
3. Some consumers may be sensitive to sulphur dioxide.

Benzoic acid: It is only partially soluble in water and hence it's salt, namely sodium benzoate is used as preservative. Pure sodium benzoate is tasteless and odourless. The antibacterial action of benzoic acid is increased in the presence of CO_2 and acid. Benzoic acid is more effective against yeast than against moulds. The quantity of benzoic acid depends on the acidity of the products. In case of fruit juices with pH of 3.5-4, addition of 0.06% of sodium benzoate is recommended.

By Addition of Sugar

Syrups containing 66 % or more of sugar do not ferment. Sugar absorbs most of the available water with the result that there is very little water for the growth of microorganisms. This reduction in water will inhibit the multiplication of microorganisms and gradually they die out from the product.

By Freezing

Microbial growth and enzymatic reactions are retarded in juice stored at low temperatures. The lower the storage temperature the slower will be the rate of a chemical or enzyme reaction. Freezing is the process in which the temperature of a food is reduced below the freezing point, and a proportion of the water undergoes a change in state to form ice crystals. Under the usual condition of storage of frozen foods, microbial growth is prevented completely and the action of food enzymes greatly retarded. The best way of preserving pure fruit juice is by freezing. Properly frozen juice retains its freshness, colour and aroma for a long time. This method is particularly useful in case of juices whose flavour is adversely affected by heating. Preservation by freezing is carried out at about –30° C, after a preliminary de-aeration. Then storage is done at –15 to –20° C.

By Drying

Drying is the processes of removal of moisture to a pre determined level. You know that the growth of microorganisms is directly dependent upon the concentration of water present in the food. So a reduction in moisture will reduce the growth of microorganisms. Moisture can be removed by the application of heat. The details regarding the methods of drying are given in the Unit 4.

By Carbonation

It is the process of dissolving sufficient carbon dioxide in fruit juice so that the product when served gives off the gas as fine bubbles and has characteristic taste. Carbonation is done at a concentration of 1.5% CO_2 under a pressure of 7 kg/cm^2. Another advantage of carbonation is the removal of air from the fruit juice, which reduces the oxidation of ascorbic acid, prevents browning and microbial growth. High carbonation should be avoided as it usually destroys

the delicate flavour of the juice. The keeping quality of carbonated fruit beverages is enhanced by adding about 0.005 % of sodium benzoate.

By Filtration

In this method, the juice is first clarified through ordinary filters and then passed through special filters. These special filters retain yeast and bacteria. Various types of germ-proof filters are used for this purpose. This requires elaborate precautions to ensure complete sterility in the bottled product.

By Irradiation

The irradiation process involves passing of fruit juice through a radiation field allowing the juice to absorb desired amount of radiation energy. The juice itself never comes in contact with radioactive material. The gamma radiations from the radioactive material will disinfest, sterilize and preserve the fruit juice. The dose required to provide stability is partly determined by the solid content of the juice. Generally irradiation lightens the colour of the juice. On storage, however, darkening occurres and stored irradiated apple juice shows little difference from the original colour. Flavour changes caused by the irradiation are less. The dose required to obtain stability may be reduced by heating the juice to a higher temperature ($50^{o}C$) prior to irradiation. In this way, a dose of 3 kilo Grey is adequate to secure stability at ambient temperature for more than a year.

9.2.3 Bottling

Bottles are thoroughly washed with hot water and drained before filling. A 1.5 to 2.5 cm head space is left during filling. They are then sealed either with crown corks (by crown corking machine) or with caps (by capping machine).A typical corking machine is shown in Figure 9.2.

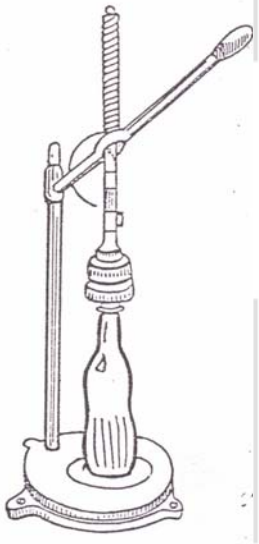


Figure 9.2: Crown corking machine

9.3 EQUIPMENTS FOR THE PRODUCTION OF JUICE AND PULPS

Different types of equipments are used in the juice processing plant, starting from equipments for washing, sorting, extracting to pasteurizers. While

selecting an equipment the material of construction is very important. Glass-lined equipment, or equipment made of metals like stainless steel, monel metal, nickel, aluminium or bronze should be used because such equipment is not readily acted upon the fruit or vegetable juices. A unit of machinery made of different metals should also be avoided because is similar metals in the system or unit will lead to the setting up of small electrical couples and consequently corrosion will take place. Use of rubber in the equipments should be avoided as far as possible.

9.3.1 Washing Equipments

Different types of equipments are available for washing of fruits and vegetables. Tender fruits are usually washed with a fine overhead spray of water, while the fruits travel on a continuous woven wire belt. On small scale processing plants washing is carried out in cement or galvanized iron tanks.

9.3.2 Sorting Equipments

In large factories, a continuous broad belt, made of woven metal, is generally employed for sorting the fruits. In smaller factories, however, batch sorting will be sufficient. A schematic diagram of belt and roller sorter and screen sorter are shown in Figure 9.3a and 9.3b.

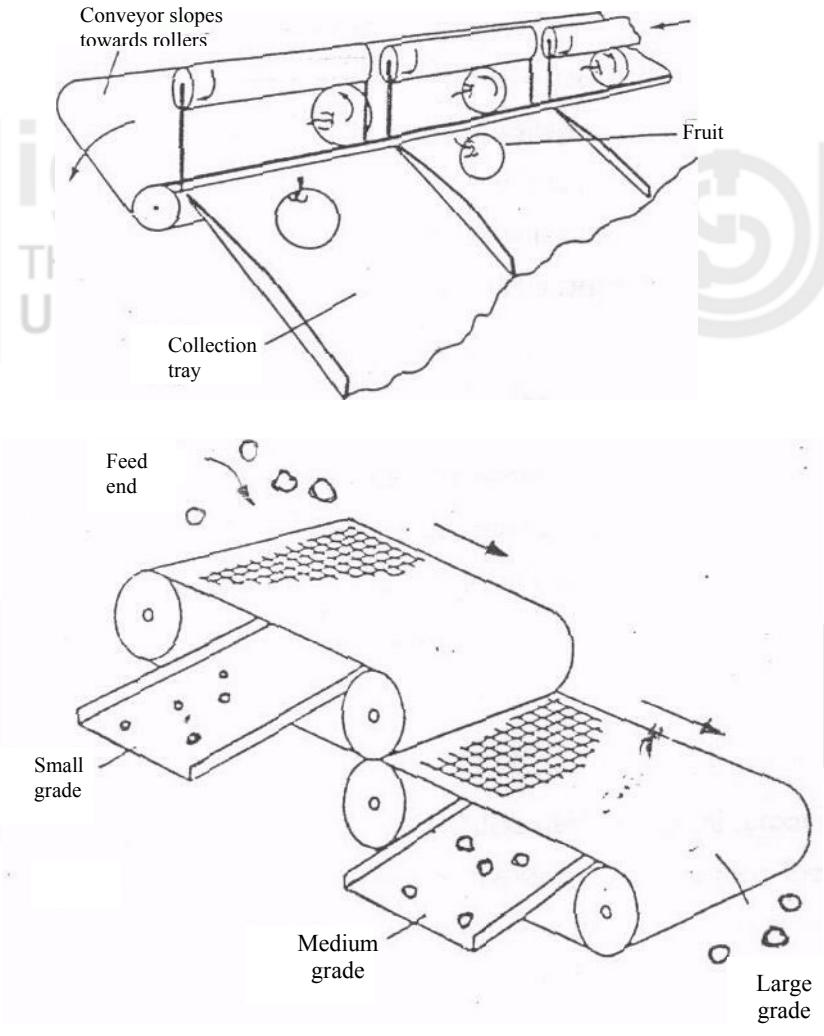
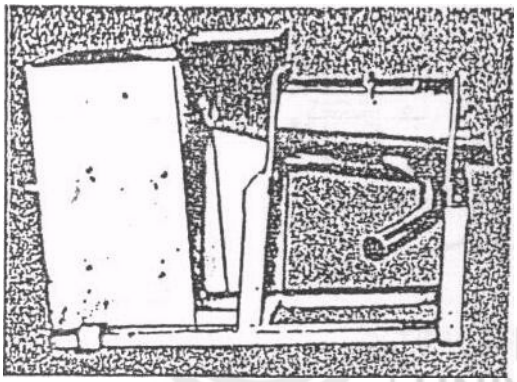


Figure 9.3: Sorting machines: a) Belt and roller sorter; b) Screen grader

9.3.3 Pulping/Grinding Equipments

There are two types of extractions. In the first case, the fruits are crushed and pressed continuously in one operation (Figure 9.4). In the second case, the fruits are crushed or cut into small pieces or comminuted in a mill, and these are subsequently pressed in a suitable press. Some of the crushing/ extraction equipments are discussed here.



Pulper

Figure 9.4: Fruit pulper

Hammer mills: These are devices to pulp/crush the whole fruit in preparation for extraction. Hammer mills consist of heavy stainless steel bars spinning from a common axis under a high speed of rotation. The fruit is disintegrated until it will pass out through a screen of specific size mounted in the bottom of the mill (Figure 9.5). The mash will be of finer particle size and the smaller particle size will allow greater yields in case of firm fruits. Softer fruit presses with more difficulty, and a larger particle size in the mash will enhance ease of pressing.

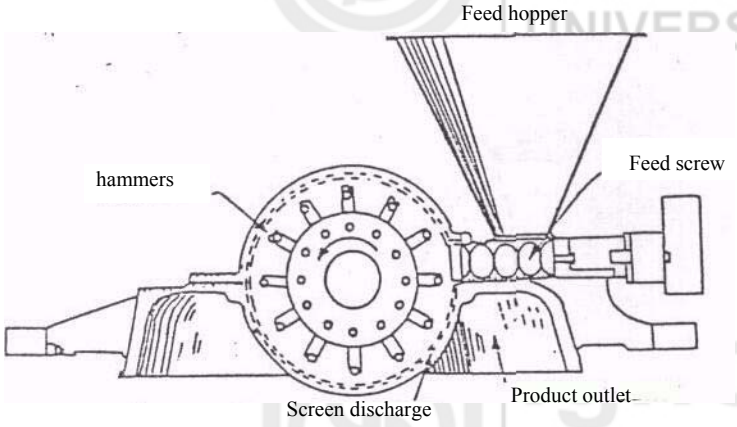


Figure 9.5: Sectional view of hammer mill

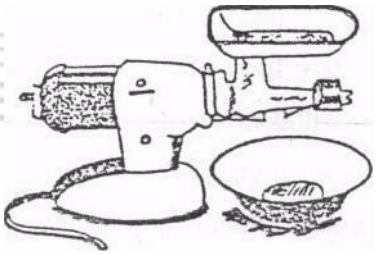
Grating mills: These offer an alternative method for disintegrating fruits. In grating mill, the fruit is drawn past fixed knifes mounted on a cylinder. Control of the grind is accomplished by adjusting the depth of the knifes and thus the size of cut from the fruit

Crusher: In grape juice processing, a stemmer/crusher removes residual stems, leaves, and petioles from the grapes and does the initial crush of the fruit after arrival at the plant. This unit is designed around a rotating drum perforated with holes of approximately 2.5 cm diameter. In the process of traversing the rotating drum, grapes are caught by the perforated drum and knocked from the

stems. The individual grapes are broken open or crushed in the process and drop through the drum.

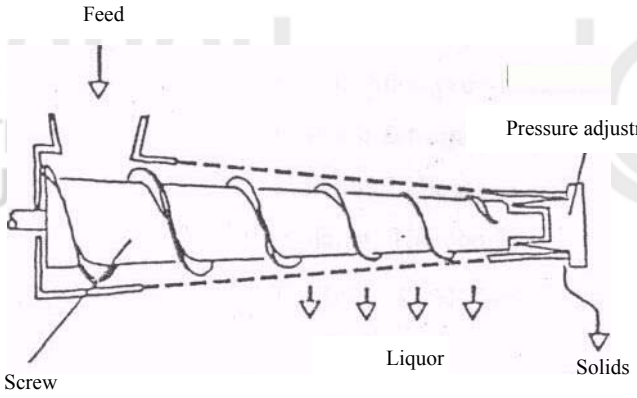
9.3.4 Screw Press

A typical screw press consists of a reinforced stainless steel cylindrical screen enclosing a large bore screw with narrow clearance between the screw and the screen. Breaker bars are located between the screw intervals in order to disrupt the compressing mash. Working principle of a typical screw extractor is shown in Figure 9.6a and Figure 9.6b. Back pressure is provided at the end of the chamber and is usually adjustable. The segments of the fruit are fed through a hopper at one end of a feeding screw, revolving inside the perforated screen. The juice flows out through the perforations and the pomace comes out through the other end. Capacities for screw press with a 30.5 cm and 41 cm diameter are 5,080 kg and 15,240 kg per hour.

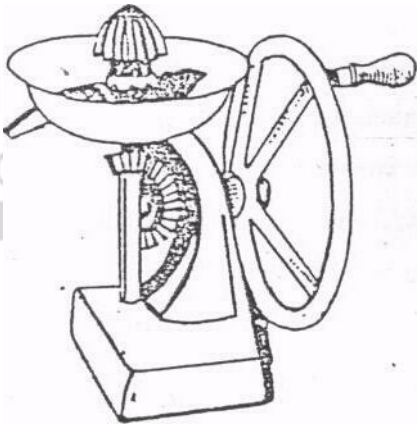


Screw Type Juice Extractor

(a)



(b)



Lime Juice Extractor

(c)

Figure 9.6: a) Screw extractor; b) Working principle of screw press; and c) Lime juice extractor

9.3.5 Basket Press

These are of various designs and capacities and are worked manually by hydraulic pressure. The manually operated press consists of a strong cylindrical basket which is made of wooden slates. It rests on a wooden or metallic base. There is strong screw at the top of this frame. The mash is folded in a strong cloth and placed inside the basket. By turning the screw by hand or with a hydraulic pump, the juice is pressed out. A schematic diagram of basket press shown in Figure 9.7.

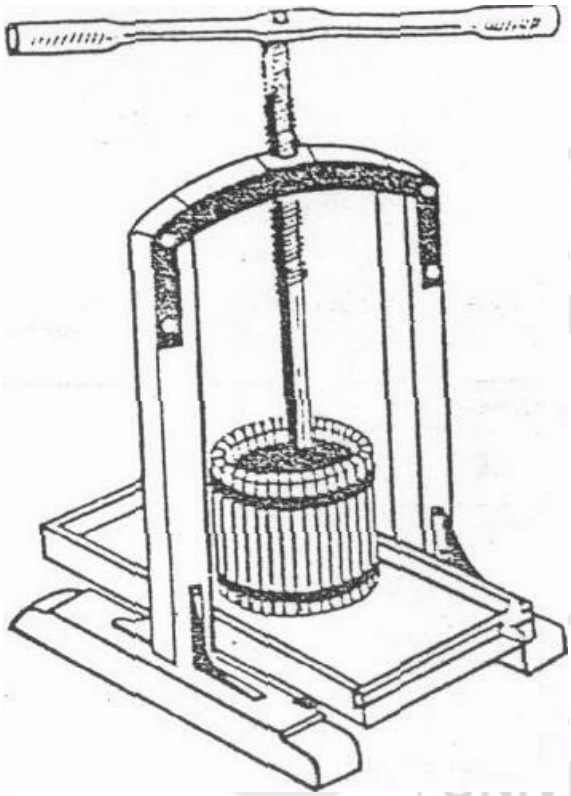


Figure 9.7: A typical basket press

9.3.6 Rack and Frame Hydraulic Press

The hydraulic rack and frame press is a very common press system found in small juice operations. It was the primary method of fruit juice pressing operations for many years. Heavy cotton or nylon cloths are filled with a set amount of mash and then folded to produce what is called a cheese. The individual cheese is stacked and separated by a wooden, stainless steel, or plastic spacer platen. The combined stack is then compressed using a hydraulic ram, during which the juice is expressed. A typical hydraulic juice press is shown in Figure 9.8.

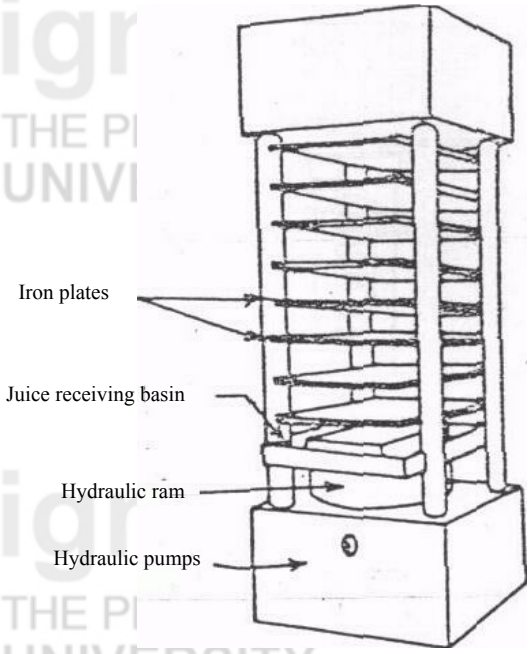


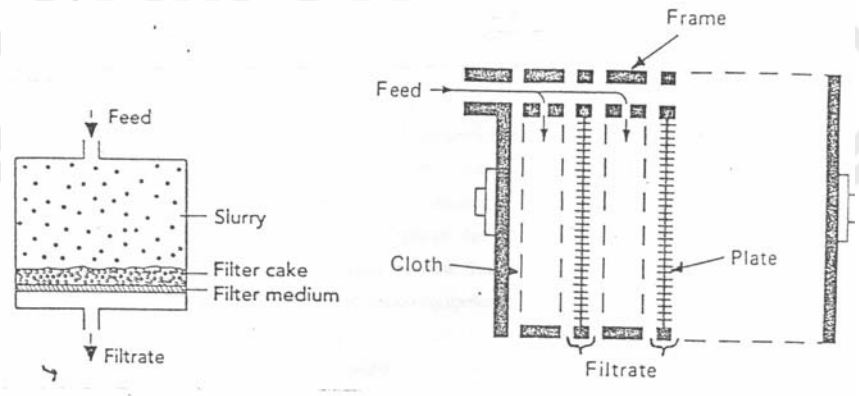
Figure 9.8: Schematic diagram of a hydraulic juice press

9.3.7 Decanter

A high solid stream can be partially clarified using decanters and finishers. Both pieces of equipment operate on the principle of a spinning central cone, drum, or set of paddles pushing the juice through a screen of some type. The unit is typically mounted horizontally, and throughput is relatively high. Total suspended solids may be reduced to 1% or less during operation, depending upon characteristics of the feed stream and operating conditions of the separator.

9.3.8 Filtration Equipment

Finely suspended particles in the juice are removed with a special equipment known as filter press. Filter presses are available with various designs and capacities. The filtering media may be finely woven cloth, canvas, fibre, asbestos pads, cotton or wood pulp discs, porous porcelain wares etc. The frame and filter press is highly effective for clarification of lime juice required for the preparation of lime juice cordial. A schematic diagram, explaining the working principle of frame and filter press is shown in Figure 9.9a and Figure 9.9b.



(a) **(b)**

Figure 9.9: Filters: a) Schematic representation of filtration; b) Plate and frame filter press

9.3.9 Deaerator

Freshly extracted and screened juice contain large amount of oxygen, which should be removed before packing. Most of the air is present on the surface of the juice and some is dissolved in it. The air as well as other gases are removed by subjecting the fresh juice to a high vacuum. This method is highly expensive due to the vacuum creation. The equipment used for the removal of oxygen from the fruit juice is called deaerator. The deaerated juice is heated in a flash pasteurization equipment.

9.3.10 Flash pasteurizer/Rapid Pasteurizer

In this equipment, the juice is heated rapidly to a temperature of about 5.5°C higher than the pasteurization temperature and kept at this temperature for about 10-60 second. By this technique, the loss of flavour and vitamin destruction is minimum and the juice keep a uniformly cloudy appearance. A schematic diagram of flash pasteurization equipment is shown in Figure 9.10.

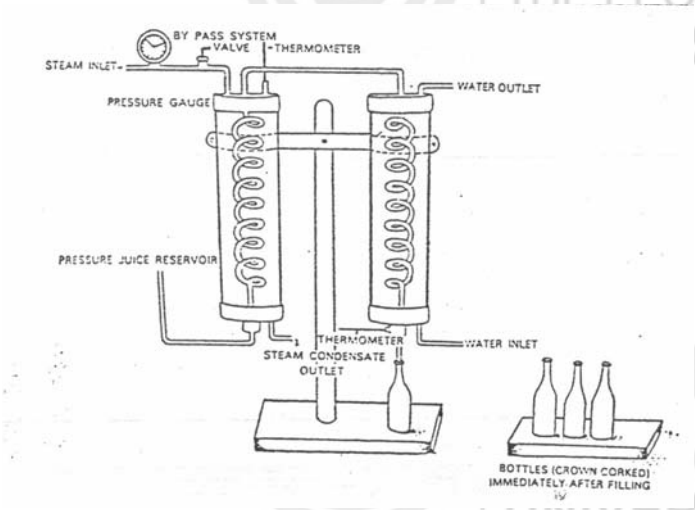


Figure 9.10: Schematic representation of a flash pasteurizer

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. Explain clarification process.

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2. What is the role of enzymes in juice processing?

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3. What is the difference between pasteurization and flash pasteurization?

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4. What are the methods used for the preservation of juice?

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9.4 SQUASHES

Squash essentially consists of juice containing moderate quantity of fruit pulp to which cane sugar is added for sweetening. According to FPO this type of fruit beverage should contain at least 25% fruit juice or pulp and 40-50 % total soluble solids on weight basis. It also contains about 1.0 % acid and 350-ppm sulphur dioxide or 600 ppm sodium benzoate. It is diluted before serving.

Juice or pulp of fruits is extracted in different ways as discussed earlier. This juice is used for the preparation of squash. Sugar, citric acid, flavouring materials, colour and preservatives are added to the juice in correct proportion. Sugar, citric acid and water are mixed and heated. The dirt is skimmed-off. The clean syrup is blended with the juice. After mixing all the ingredients, a calculated amount of chemical preservative, namely, sodium benzoate or potassium metabisulphite (KMS) is added. Colour and essence can be added to the squash, but should be fairly resistant to the action of preservatives.

The bottles should be cleaned and well sterilized before filling. There should be about 1.2-2.5 cm of head-space in bottles. Bottles are closed with pilfer proof closures, which should be dipped in 1% potassium metabisuphite solution. The bottles are washed, dried and labelled. The product keeps well for more than one year without much change in colour, taste and flavour.

9.5 CORDIAL

This is a sparkling, clear sweetened fruit juice from which pulp and other suspended materials have been completely removed. It contains at least 25% juice and 30% total soluble solids. It also contains about 1.5% acid and 350ppm sulphur dioxide. This is very suitable for blending with wines.

Juice is stored in barrels which are lined with microcrystalline wax. KMS is added as preservative during storage. During storage, the sediment settles and forms a compact layer at the bottom and clear juice remains at the top. Clarification process takes 2-3 months. The clear juice is siphoned off. This method is slow. To make it fast, gelatin and tannin can be added. In clear juice, sugar, water, colour and preservatives are added and the mixture is filtered by means of a filter press. The clear cordial is then bottled.

9.6 SYRUPS

This type of fruit beverage contains at least 25% fruit juice or pulp and 65% total soluble solids. Since the syrup strength is very high, to avoid crystallization, sugar is inverted by adding a small quantity of citric acid and heating in water. It also contains 1.3-1.5% acids and is diluted before serving. Syrups with 65 ^{o}Brix TSS can retain their fresh flavour for over four years. The condition required for this is that a juice should be filtered to a brilliant condition for making the syrup.

9.7 CARBONATED BEVERAGES

The use of fruit juices in the preparation of carbonated drinks is practically unknown in our country. Mostly, artificially flavoured drinks which have no nutritive value are prepared by this method. The use of fruit juices would increase the nutritive value of carbonated beverages.

One of the most important factors that relates to the taste of the bottled fruit juice beverage is carbon dioxide gas content or degree of carbonation. Carbonation is the process of dissolving or incorporating carbon dioxide in a beverage so that when served, it gives off the gas in fine bubbles and has the characteristic pungent taste suitable to the carbonated beverage.

In beverage manufacture, CO_2 not only provides the distinctive taste of carbonated drinks but also inhibits the growth of certain microorganisms. Fruit juices can be carbonated directly or preserved in the form of concentrates for subsequent carbonation. Clarification of such juice is essential prior to carbonation. Carbonated beverage can keep well for about a week without addition of any preservative. For longer storage of carbonated drink, use of preservative (0.05 % sodium benzoate) is necessary.

9.8 FRUIT JUICE CONCENTRATES

Fruit juice concentration offers significant advantages to the processor. Juices obtained by removal of a major part of their water by vacuum evaporation or fractional freezing is termed as "concentrated juices". By concentrating the juice, the processor reduces the bulk of the juice, thereby reducing storage volume requirement and transportation costs. The process starts with pressing fruits and obtaining pure fruit juice. This is then stabilized by heat treatment which inactivates enzymes and micro-organisms. The next processing step is concentration under vacuum up to 40-65° Brix or 4-7 fold. The concentrates are then blended for standardisation and stored. Many methods are adopted for concentrating fruit juice. They are discussed below:

Evaporation: Evaporation is the most important process for concentration of fruit juices. Production of concentrated juices by evaporation is performed under vacuum (less than 100 mm Hg residual pressure) up to a concentration of 65-70% total sugar which assures preservation without further pasteurization. Modern evaporation installations recover flavours from juices which are then reincorporated in concentrated juices.

Evaporator generally consists of a heat transfer surface, a feed distribution device, a liquid vapour separator and a condenser. A schematic diagram of an evaporator is shown in Figure 9.11. With most of the juices, it is desirable to

heat the juice for as short time as possible and rapidly cool the product. This minimizes the effect on flavour, aroma, and sugar components.

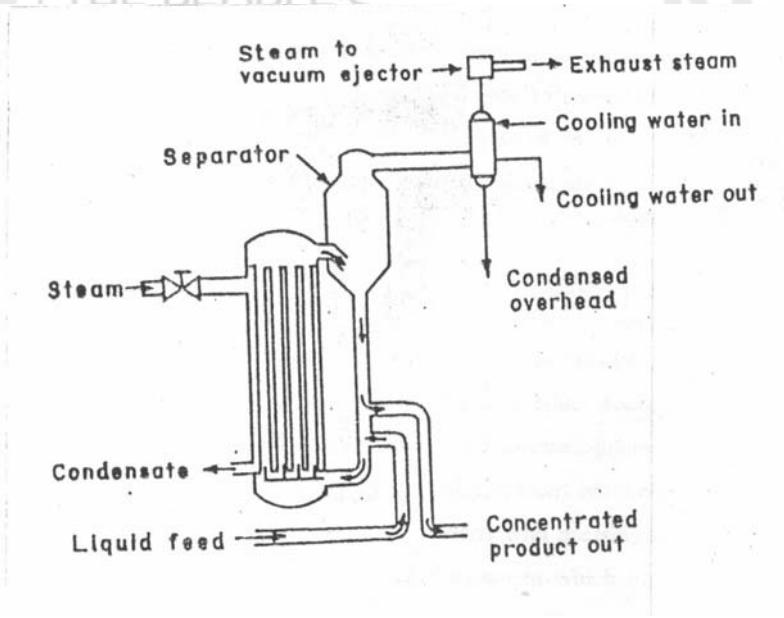

Figure 9.11: Diagram of a typical evaporator

Membrane concentration: Membranes are available that can effectively separate water molecules from other food constituents. Concentration of juice is also possible by using combination of reverse osmosis and evaporation. Specific membranes are used for this purpose. The principle involved is the interposition of a membrane between the feed stream and a transfer stream, and the establishment of conditions providing a driving force for the transport of water across the membrane from the feed to the transfer stream. A schematic diagram explaining the working principle of membrane concentration is shown in Figure 9.12.

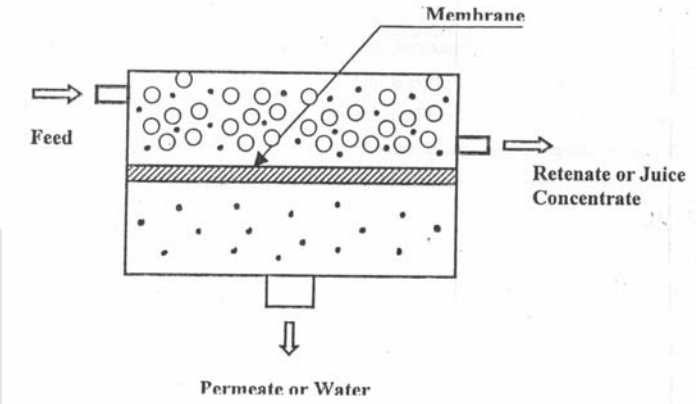

Figure 9.12: Schematic representation of ultrafiltration process

The reverse osmosis technology is effective in concentrating a low solid juice (7-8 ^{o}Brix) two or three fold. From there, use of evaporation technology would be appropriate. Recently, a new reverse osmosis design has claimed effectiveness in achieving a 50-60 ^{o}Brix concentrate. These fruit juice concentrates are often further stabilised by the addition of sodium benzoate and potassium sorbate and are usually stored away from light and are refrigerated or frozen.

Membrane concentration has many advantages over the other concentration techniques. Since the temperature of the processing is less, product quality is maintained. Lower energy requirements, lower labour costs, lower floor space, and wide flexibility are other advantages.

Freeze concentration: This process is based on freezing point depression. Pure water freezes at a temperature of 0^{o}C. However, if dry solid is dissolved, freezing take place at further low temperatures. In this process a freezer is used to produce ice crystals out of fresh juice and a device is used for separating these ice crystals. The separation of ice crystals from the juice slurry is done by using a centrifuge or filter press.

Freeze concentration avoids the problems associated with evaporation methods that depend upon the heat. It is capable of concentrating most juices to 50^{o}Brix without appreciable loss of taste, aroma, colour or nutritive value.

9.9 FRUIT JUICE POWDERS

In this method juices are preserved in the form of powder. The juice is sprayed as mist into an evaporating chamber and the flow of air is so regulated that dried juice falls to the floor of the chamber in the form of dry powder. The powder is then separated and packed air tightly. The powder, when dissolved in water makes a fruit drink almost similar to its original fresh juice.

Many fruit juices can be dehydrated to powders or crystals for reconstituting into beverages and are available at prices comparable with quality frozen concentrates. These powdered products are available in several sizes of package. Additives which are permitted by FDA are usually included. These powdered products are also considered as "sports drink", which requires mixing by the individuals and avoids the inconvenience of transporting large volume of liquid.

These powders are highly hygroscopic in nature and hence require proper packaging. Fruit juice powder from fruits like oranges, mangoes, jackfruit, guava etc. are prepared from strained fruit juices either by spray drying or puff drying and pulp can be used as the base material for baby foods. The powders can be made by vacuum drying, spray drying, freeze drying, drum drying or by foam-mat drying. The moisture content of powdered juice varies from 3-5%. The methods and principles of these drying processes are explained in unit 4 (Section 4.9).

9.10 QUALITY

The term 'quality' is one of the most defined terms in use in the food industry today. Quality may be defined as 'The totality of features and characteristics of a product that bear on its ability to satisfy a given need'. The first part, 'The totality of features and characteristics of a product…..'concerns objective factors related to the product. The second part, '……to satisfy a given need', concerns subjective factors related to the user or the consumer of the goods.

9.10.1 Factors Influencing Product Quality

To produce high-quality products, the processor needs to be aware of the quality attributes which the consumer discerns as most important and which are most relevant in determining acceptability. Most consumers would initially

judge the acceptability of products on their appearance, flavour, texture and perceived nutritional benefits. Each of these attributes is a function of the bio-chemical and physico-chemical composition of the fruit or vegetable. This is influenced by various factors viz:

1. The quality and composition of the raw materials,
2. The effects of processing,
3. The effects of environmental factors, such as temperature, oxygen, light and moisture, encountered during storage and distribution,
4. Customer handling and use, and
5. The barriers to these factors provided by the packaging.

9.10.2 Measurement of Product Quality

One obvious way of measuring product quality is to monitor sales and customer complaints; the higher the sales and the fewer the complaints, the more likely one is to be satisfying the consumer requirements. However, no responsible food manufacturer would rely on this as their only method of quality control. Various methods used for the evaluation are:

1. Instrumental,
2. Immunoassay,
3. Near infrared spectroscopy, and
4. Sensory evaluation.

9.10.3 Quality Control Measures

Some of the important points to be considered for maintaining good quality products are as follows:

1. Only sound fruits or vegetables of sufficient maturity are to be used for processing.
2. Adequate hygienic practices should be followed during the processing of the product.
3. The inspector must be aware of the pesticides and other chemicals used in the production of the raw materials. Necessary laboratory analyses can then be arranged to ensure residue levels in the final product.
4. At the commencement of and during processing, the inspector should pay attention to the state of raw materials, the preparation of raw materials for processing (peeling, slicing, dicing, blanching, etc.), preparation and density of packing medium (sugar syrup, salt brine, etc.), the state of containers to be used (cleanliness and strength), the pasteurization or freezing process (time/temperature relationship), bottle filling and capping and bottle/container storage.
5. The people who work in the processing plant must maintain a high degree of personal cleanliness and conform to hygienic practices while on duty.
6. Persons who are monitoring the sanitation programs must have the education and/or experience to demonstrate that they are qualified.

7. Plant construction and design shall provide enough space for sanitary arrangement of equipments. The equipments must be self-cleanable as far as possible. Cleaning operations must be conducted in a manner that will minimize the possibility of contaminating foods or equipment surfaces that contact food.
8. Check the final product to ensure the vacuum and headspace, packing medium strength and container conditions. Statistically based sampling plans should be adopted for the examination of final product to ensure that it meets the requirements of the export regulations.
9. Each processing unit should have its own sufficiently equipped laboratory and staff to carry out physical, chemical and microbiological quality examinations of the goods.
10. Practice proper sanitary handling procedures. Cleaning operations must be conducted in a manner that will minimize the possibility of contaminating foods or equipment surfaces that contact food

9.10.4 Labelling

Customers and consumers expect the labelling on food to be a true description of what they are buying. Misleading or fraudulent labelling is an unfair trade practice that cannot be tolerated. The important requirements of a label are as follows:

1. A statement of identity,
2. A declaration of net contents (weight or volume),
3. The name and address of the manufacturer, packer, and
4. A list of ingredients (in descending order of volume or weight).

In addition, labels may also be required to include, amongst other things, the country of origin, date of manufacture or packing, a use-by or expiry date, nutritional qualities or values of the food, storage directions, a quality grade and directions for consumption.

9.11 STANDARDS

Government of India has made statutory provision for the control of quality. This has been made to maintain the quality of food, to prevent exploitation of the consumer by the sellers, to safeguard the health of consumers and to establish a criteria for the quality of food products. By this provision we can easily identify the quality of the processed products.

Fruit Products Order (FPO) – 1955, promulgated under Section 3 of the Essential Commodities Act – 1955, aims at regulating sanitary and hygienic conditions during the manufacture of fruit products. It is mandatory for all manufacturers of fruit and vegetable products to obtain a license under this Order. This act regulates the manufacture, storage and sale of fruit and vegetable products.

The FPO 1955 was issued by the Department of Food, Ministry of Food Processing Industries under the powers vested in the government under the Essential Commodities Act to ensure the quality of fruit and vegetable products. This order controls the production, distribution and quality of the

fruits and vegetable products manufactured in the country as well as registration, licensing and operation of manufacturing units.

The FPO mark is given to the processor after the grant of license for manufacturing fruit or vegetable product, after the inspection of factory for hygiene and sanitation. FPO mark and license number is required by law to be exhibited on labels of each processed item along with the other information as laid down in the FPO rules.

The FPO specifications includes methods of preservation, permissible colours in the preparations and also the minimum quality requirements of the final products. Fruit and vegetable products which do not conform to the FPO specifications are considered adulterated.

FPO specifications for fruit beverages are as follows:

Sl. No.	Particulars	Specifications	
		Minimum % of TSS in final product	Minimum % of fruit juice or prepared fruit in final product
1.	Fruit Syrup	65	25
2.	Squash	40	25
3.	Cordial	30	25
4.	Unsweetened Juice	Natural	100
5.	Sweetened Juice	10	85
6.	Fruit Juice concentrate	32	100

Permissible limits of preservatives in fruit beverages:

Sl. No.	Fruit beverage	Preservative	Maximum level permitted (mlp)
1.	Fruit juice concentrate	Sulfur dioxide	1500
2.	Squashes, fruit syrups, cordials, fruit juices	Sulfur dioxide or Benzoic acid	350 600

9.12 PACKAGING

Packaging is an integral part of food processing. It performs two main functions: to protect the processed product from surroundings and to advertise the product at the point of sale. The main factors that cause deterioration of product during storage are as follows.

1. Mechanical forces (Impact, vibration, compression etc.),
2. Climatic influences that cause physical or chemical changes (UV light, moisture, oxygen, temperature changes),
3. Contamination (by microorganism, insects, or soil), and
4. Pilferage, tampering or adulteration.

9.12.1 Requirements and Functions of Packaging Materials

The following are among the more important general requirements and functions of food packaging materials/ containers:

1. They must be non-toxic and compatible with the specific foods.
2. Sanitary protection and light protection.
3. Moisture, gas, odour and fat protection.
4. Resistance to impact or other external forces.
5. Transparency.
6. Ease of opening and ease of disposal.
7. Pouring features and reseal features.
8. Size, shape, weight limitations.
9. Appearance and printability.
10. Low cost and other special features.
11. Eco-friendly.

9.12.2 Types of Packaging Materials

There are two main groups of containers: i) Shipping containers, and ii) Retail containers. Shipping containers are containers which contain and protect the contents during transport and distribution (e.g. Wooden, metal or fibreboard cases, crates, barrels, drums and sacks). Where as the retail containers are consumer units which protect and advertise the food in convenient quantities for retail sale and home storage.(e.g.: metal cans, glass bottles, jars, rigid and semi-rigid plastic tubs, collapsible tubes, paperboard cartons and flexible plastic bags).

Wooden containers: Wood offers good mechanical protection and good stacking characteristics. The bottles of fruit beverages are transported by the use of wooden crates. Boxes, crates, casks, kegs, pallets, and few other types of containers made of wood are used on a limited scale to package food products.

Textiles: Cotton bags, sacks and bales are also used in the shipping of food products. They have limited use in the packaging of larger quantities of some products. Open mesh bags are frequently used to pack products such as fresh vegetables, which require complete ventilation in transport and storage.

Metal Can: Metal cans have a number of advantages over other types of containers. These includes protection, convenience for ambient storage and tamper proof. However the cost and weight of metal containers are relatively high. The usual metal cans used are three piece cans, two-piece cans, aerosol cans and aluminum cans.

Tinplate is the common material used for metal cans. It is a rigid and impervious material, consisting of a thin sheet of low carbon steel coated with a very thin layer of tin. Tin is not completely resistant to corrosion but its rate of reaction with many food materials is considerably slower than that of steel. Some organic coatings are provided to protect the tin surface. The FDA

approved coating used for the fruit beverage is known as "Beverage can enamel" The coatings not only protect the metal from corrosion by food constituents but also protect the foods from metal contamination.

Glass: There is more use of glass in food industry. Glass containers are chemically inert and do not react with or migrate into food products. They are resealable, recyclable, reusable and are transparent to microwaves. They are transparent to display the contents and impervious to moisture, gases, odours and microorganisms. The principal limitation of glass is its susceptibility to breakage, which may be from internal pressure, impact, or thermal shock, all of which can be greatly minimised by proper matching of the container to its intended use and intelligent handling practices. Main classes of glass receptacles are:

1. Jars which are resistant to heat treatments,
2. Jars, glasses, etc. for products not submitted to heat treatment (marmalades, acidified vegetables, etc.),
3. Glass bottles for pasteurized products (tomato juice, fruit juices, etc.) or not pasteurized (syrups), and
4. Receptacles with higher capacity.

Flexible Films: Flexible packaging describes any type of material that is not rigid. In general they are heat sealable, suitable for high speed filling, suitable for printing and add little weight to the product. They fit closely to the shape of the food, thereby wastage of space is less during transportation and storage. In most cases, such films are used in the construction of inner containers. Since they are non-rigid, their main functions are to contain the product and protect it from contact with air or water vapour. Their capacity to protect against mechanical damage is limited, particularly when thin films are considered.

Flexible films includes single films (e.g.: poly ethylene, poly ester, etc.), coated films (e.g.: films coated with aluminium), laminated films (lamination of two or more films) and co-extruded films.

Paper and paper board: Paper and paper board are used in a variety of package types and forms. Paper from wood pulp and reprocessed waste paper will be bleached and coated or impregnated with such materials as waxes, resins, lacquers, plastics, and laminations of aluminium. This is to improve water vapour and gas impermeability, flexibility, tear resistance, burst strength, wet strength, grease resistance, sealability, appearance, printability, etc.

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. Differentiate between fruit juice and squash.

……

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2. How is syrup different from cordial?

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3. What are the different methods to produce juice concentrate?

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4. How is juice powder made?

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9.13 LET US SUM UP

The fruit beverage industry is gaining popularity because of nutritional superiority of these beverages to synthetic and aerated drinks. We have discussed in detail about the preparation of a variety of fruit beverages viz., juices, squash, syrup, fruit juice concentrate and fruit juice powder.

The various methodologies adopted in preservation and the working principles of different equipments used in processing of fruit beverages are briefly described in this unit. In addition, the packaging requirements, types of packaging materials, quality aspects and standards of fruit beverages are explained in detail.

9.14 KEY WORDS

Disintegration : Size reduction of fruit

Enzyme : Enzymes are organic biocatalysts which govern, initiates and control biological reactions important for life processes.

Expression : Separation of liquids from solids by applying pressure.

Filtration : Separation of solids from liquids by passing the mixture through a bed of porous material.

Brix : Unit for the measurement of Total Soluble Solids present in fruit beverage.

TSS	:	Total Soluble Solids is the amount of sugars and water soluble substances present in fruit and vegetables.
Clarification	:	It is the process of complete removal of all suspended material from the juice
Centrifugation	:	The separation of immiscible liquids, or solids from liquids by the application of centrifugal force.
De-tartarisation	:	Elimination of potassium bi-tartrate from fruit beverage.
Pasteurization	:	It is the process of heat treatment used to reduce the total microflora, especially pathogenic bacteria.
Flash pasteurization	:	It is the process of heating fruit juice for a short time at a temperature higher than the pasteurization temperature and held at that temperature for about one minute.
Carbonation	:	It is the process of dissolving sufficient carbon dioxide in fruit juice
Decanter	:	It is the process of removal of suspended material from the juice.
Deaerator	:	The equipment used for the removal of oxygen from the fruit juice.
Squash	:	Fruit beverage which contain at least 25% fruit juice or pulp and 40-50 % TSS.
Cordial	:	Fruit beverage which contain at least 25% juice and 30% TSS.
Syrups	:	Fruit beverage which contains at least 25% fruit juice or pulp and 65% TSS.
Evaporation	:	It is the partial removal of water from liquid foods by boiling.

9.15 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress Exercise 1

1. Clarification is the process of complete removal of all suspended material from the juice**.** This can be performed by many methods viz. centrifugation, enzyme treatment, settling, filtration, freezing(-18^{o}C), use of high temperature (nearly 82^{o}C) and low temperature(-2 to –3 ^{o}C). The chemical treatments like addition of gelatin, albumin, casein, or a mixture of tannin and gelatin is also used for the removal of suspended particles.

2. The enzyme treatments during crushing process will enhance the extraction yield, the juice colour is better fixed and finished product taste is improved.

3. Pasteurization is the process of heating fruit juice at boiling temperature or slightly below it for a sufficient length of time to kill the microorganisms which cause spoilage. Whereas flash pasteurization is the process of heating fruit juice for a short time at a temperature higher than the pasteurization temperature and held at that temperature for about one minute.

4. Preservation of fruit juice can be done by addition of sugar, pasteurization, flash pasteurization, freezing, drying, carbonation, filtration, irradiation and by adding chemicals like sulfur dioxide or Benzoic acid.

Check Your Progress Exercise 2

1. Fresh fruit juice contain 100 % fruit juice, where as fruit beverage which contain at least 25% fruit juice or pulp and 40-50 % TSS is known as squash.

2. Cordial is a fruit beverage which contain at least 25% juice and 30% TSS, where as syrups contains at least 25% fruit juice or pulp and 65% TSS.

3. Various methods used for fruit juice concentration are: Evaporation, Freeze concentration and Membrane concentration.

4. Fruit juice powders are prepared from strained fruit juices by spray drying, vacuum drying, freeze drying, drum drying or by foam-mat drying. However spray drying is the most common method. The juice is sprayed as mist into an evaporating chamber and the flow of air is so regulated that dried juice falls to the floor of the chamber in the form of dry powder.

9.15 SOME USEFUL BOOKS

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3. Srivastava, R.P. and Kumar, Sanjeev (1998). Fruits and Vegetable Preservation – Principles and Practices, International Book Distributing Co., Lucknow.