PRACTICAL MANUAL
HORT-366

Date

Exercise No 1

Application of different types of packaging containers for shelf life extension

The increased production of fruits and vegetables will have significance only when which they reach the consumer in good condition at a reasonable price. The existing post-harvest losses of fruits and vegetables could be considerably reduced by adopting improved packaging.

Packaging of fruits and vegetables is undertaken primarily to assemble the produce in convenient units for marketing and distribution.

Objects of packaging

1. To protect the produce from hazards of transport

2. Preventing microbial and insect damage

3. Minimizing the physiological loss in weight

Characteristics of packages

a) The package must have sufficient mechanical strength to protect the contents during handling, transporting and staking.
b) The packaging material must be free of chemical substances that could transfer to the produce and become toxic to man.
c) The package must meet handling and marketing requirements in terms to weight, size and shape.
d) The package should allow rapid cooling of the contents. Furthermore, the permeability of plastic films to respiratory gases could also be important..
e) Mechanical strength of the package should be largely unaffected by moisture content (when wet) or high humidity conditions.
f) The security of the package or ease of opening and closing might be important in some marketing situations.
g) The package must either exclude light or be transparent.
h) The package should be appropriate for retail presentations.

i) The package should be designed for ease of disposal, re-use, or recycling.

j) Cost of the package in relation to value and the extent of contents protection required should be as low as possible.

Different packaging for important frits and vegetables

Sr. No.	Types of packing	Commodity packed
1.	Flexible sacks (gunny bags)	Ber, lemon, lime, mango (raw), pear, sweet orange and different vegetables
2.	Bamboo baskets	Grape, guava, mango, papaya, tomato
3.	Earthen pots	custard apples, grapes
4.	Wooden boxes	Apple, apricots, cherry, litchi, mango, mandarin, pear, plum, sapota, capsicum
5.	Corrugated fibre box (CFB)	Apple, cherry, grape, pomegranate, all fruits and vegetables for export.
6.	Rigid plastic crates	Loose fruits and vegetables for cold storage, processing plants, nearby local markets and public distribution system.

New Packaging Material

Sr. No.	Types of packing	Speciality
1.	Corrugated fibre board (CFB) boxes	These are light in weight, easy to handle, hygienic and recyclable. These can be turned water resistant by the use of a suitable adhesive or was coating or a plastic film.
2.	Combination boxes	These are mad with plywood and CFB and give a high stack load capacity
3.	Corrugated polypropylene board boxes	These are light in weight, hygienic, water resistant, sturdy and have a light busting strength. These are useful in the multi-trip packaging.
4.	Plastic trays or crates	These are hygienic, light in weight, sturdy and recyclable and useful in the multi-trip packaging.
5.	Plastic woven sacks	These bags are made of high density polyethylene or polypropylene, light in weight and can be reused.

		These are used for packaging hard fruits to transport them over short distances.
6.	Moulded pulp trays or thermoformed plastic trays	These trays have the facility of cavities to hold individual apple fruit which prevents the fruit from rubbing against each other that often leads to bruising or surface cracks.
7.	Stretch wrapping	It is used for retail marketing of fresh produce in the form of cling plastic films for stretch wrapping
8.	Modified atmospheric packaging	In this packaging, the internal atmosphere can be manipulated with a combination of certain gases (O_2 & CO_2)and selection of suitable packaging material

Ventilation

Adequate ventilation should be given to the boxes which used to pack the fruits and vegetables. Holes should be provided on the surface (top and sides). This prevent the heat generation which can cause rapid product deterioration.

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Exercise No 2

Effect of temperature on shelf life and quality of produce

Temperature is the characteristic of the postharvest environment that has the greatest impact on the storage life of vegetables. All vegetable deteriorate after they are harvested; only the rate at which the deterioration occurs can be changed.

It is well established that the deterioration of most agricultural products is a direct unction of temperature. Within the rage of temperatures bounded on the lower end by chilling injury or freezing and on the upper by heat injury. Deterioration of vegetables caused by physiological, pathological, or physical factors is a function of time and environment.

Postharvest losses of horticultural crops are estimated to be as high as 25% to 50% of the production due to poor postharvest handling techniques, mainly poor temperature management. Especially in some region of the globe such as tropical and subtropical regions and where refrigeration facilities are not available. A large quantity of onions (*Allium cepa* L.) is lost between the field and the consumer in India due to lack of adequate postharvest handling procedures. Good temperature management is, in fact, the most important and simplest procedure for delaying product deterioration. In addition. Optimum temperature storage retards the aging of vegetables. Softening, and textural and colorchanges as well as slowing undesirable metabolic charges, moisture loss, and losses due to pathogen invasion. Temperature is also the factor that can be most easily and promptly controlled. Optimum preservation of vegetable quality can only be achieved when the produce is promptly cooled to its optimum temperature as soon as possible after harvest.

Low temperature during the storage of fresh vegetables depress both the physiological activity of vegetable tissue and the activity of micro-organisms capable of causing spoilage of the product. In general, the lower the storage temperature, within the limits acceptable for each type of commodity (above the freezing point or chilling injury threshold,) the longer the storage life. For each horticultural commodity there is presumed to be an optimal postharvest storage temperature at which the rate of product

deterioration is minimized. Vegetables are, in fact highly perishable products and losses due to inadequate temperature management are found to be mainly due to water loss and decay carrots (*Dacus carota*L.) should be stored at 0 to 1^0 C in order to maintain quality during long-term storage (between 150 and 190 days.) They also added that the carrot temperature should be reduced to about 0^0 C as soon as possible after harvest. And that the temperature should be maintained constant during the storage period. The optimum temperature for reducing decay of beets (*Beta vulgaries*) was 4 to 5^0 C rather that 0 to 1^0 C of 2^0 C to 3^0 C the storage life of cabbage is limited to 4 to 5 months when storage temperature is maintained at 7 to 8^0 C.

Effects of Storage Temperature on the Quality of Vegetables

The visible quality of the product that is the appearance of the product is perhaps the most important factor that determines the market value of fresh vegetables. When consumers were asked about fresh fruits and vegetables, ripeness, freshness, and taste were named by 96% as the most important selection criteria. While appearance and condition of the product came in second in order of importance.

1) Appearance and Texture of Vegetables

Colour, one of the major factor of product appearance, is a primary indicator of maturity or ripeness and is due to the presence of particular pigments in the product. Undesirable changes in the uniformity and intensity of colour can be observed when fruits and vegetables are not stored at recommended temperatures. Temperature can therefore have a direct effect on colour changes during storage of fruits and vegetables. For example, loss of chlorophyll in mango and tomato, yellowing of green vegetables such as broccoli is considered undesirable.

2) Compositional Characteristics of Vegetables; nutritional Value

Fruits and vegetables are rich sources of vitamins, particularly, Vitamin C and Vitamin A required in the human diet. However, the nutritional value of fruits and vegetables can also be greatly affected by storage temperature. In general, Vitamin C degradation is very rapid after harvest and increases as the storage time and temperature increases. The concentration of carbohydrates, sugars as well as organic acids in fruits and vegetables can also decrease when temperature increases. It is due to fact that, when temperature increases, the respiration rate of the product increases and complex

carbohydrates and organic acids are transformed into glucose to provide substrate for respiratory processes.

In conclusion, good temperature management is recommended for fresh fruits and vegetables since it retards aging due to ripening, softening, textural and colour changes, undesirable metabolic changes and respiratory heat production that results from moisture loss, spoilage due to invasion by bacteria, fungi and yeast.

Optimum cold storage conditions & approximate storage life of fruits and vegetables

Passion fruit	6-7	85-90	3
	Temp (°C)	**RH (%)**	**Approx. storage life(weeks)**
Fruits			
Apple	0-2	85-90	20-30
Avocado			
Chilling tolerant varieties	4.4	85-90	4
Chilling sensitive varieties	12.5	85-90	2
Banana			
Cavendish green	13	85-90	3-4
Cavnedish ripe	12	85-90	1-5
Ney Poovan green	12	85-90	2-3
Ney poovan ripe	8	85-90	1
Ber	5-6	85-90	4
Citrus			
Coorg mandarin (main crop)	8	85-90	8
Coorg mandarin (rainy season)	8	85-90	6
Sathgudi orange (Moosambi)	8	85-90	16
Lime yellow	12-13	85-90	8
Lime green	12-13	85-90	7
Grape fruit	13-14	85-90	12
Custard apple	15	85-90	1.5
Date	6-7	85-90	2
Fig	1-2	85-90	6
Guava	10	85-90	2-5
Jackfruit	11-12	85-90	6
Litchi	2	85-90	8-10
Alphonso	12-13	85-90	4
Banganapalli	12	85-90	5-6
Papaya green	10	85-90	3-4
Papaya turning	9	85-90	2-3
Pineapple all green	9-10	85-90	4-6
Pineapple 25% Yellow	6-7	85-90	1-2

Pomegranate	7-8	85-90	10-12
Sapota mature	20	85-90	2
Strawberry	0	85-90	1
Vegetables			
Beans			
Snap beans	8-10	85-90	3-4
Winged beans	10	85-90	8-10
Beetroot	0-1	90-95	8-10
Brinjal	10	90-95	2
Cabbage(wet season)	0-2	90-95	4-6
Cabbage(dry season)	0-2	90-95	12
Capsicum(green)	7-8	85-90	3-5
Carrot topped	0-2	90-95	20-24
Cauliflower	0-2	90-95	7
Coriander leaves	0-2	90-95	4-5
Chow chow	12-13	90-95	3
Cucumber	10-11	90-95	2
Garlic(bulbs) dry	0	65	28-36
Ginger	8-10	75	16-20
Gourd, bottle	8-9	85-90	4-6
Gourd, snake	18-20	85-90	2
Muskmelon, Honey dew	7-8	85	4-5
Okra	10	90	1.5
Onion, Red	0	65-70	20-24
Onion, white	0	65-70	16-20
Pea, green	0	90-95	2-3
Poato	4	85	30-34
Pumpkin	12-15	70-75	24-36
Radish, topped	0	90-95	3-5
Squash	12-15	70-75	8-24
Sweet Potato	10-12	80-90	13-20
Spinach	0	90-95	10-14
Tomato			
Mature green	12-13	85-90	4-5
Red ripe	5-6	85-90	2
Turnip	0	90-95	8-16
Watermelon	12-15	80-90	2
Yam	16-20	60-70	3-5

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Exercise No. 3

Demonstration of chilling and freezing injury in fruits and vegetables

Chilling injury typically results from "exposure of susceptible produce, especially that of tropical or sub-tropical origin, to temperatures below 10- 15 C".

However, the critical temperature at which chilling injury occurs varies among commodities. Chilling injury is completely different to freezing injury (which results when ice crystals form in plant tissues at temperatures below their freezing point). Both susceptibility and symptoms of chilling injury are product and even cultivar-specific. Moreover, the same commodity grown in different areas may behave differently in response to similar temperature conditions.

Symptoms of Chilling Injury

1. Skin pitting: is a common chilling injury symptom that is due to collapse of cells beneath the surface. The pits are often discoloured. High rates of water loss from damaged areas may occur, which accentuates the extent of pitting.

2. Browning or blackening of flesh tissues: is another common feature of chilling injury (e.g. avocado; Chilling-induced browning in fruit typically appears first around the vascular (transport) strands. Browning can result from the action of the polyphenoloxidase (PPO) enzyme on phenolic compounds released from the vacuole during chilling, but this mechanism has not been proven in all cases.

3. Water-soaking: in leafy vegetables and some fruits (e.g. papaya)

4. De-greening of citrus fruit is slowed by even mild chilling.

5. Fruit that has been picked immature may fail to ripen or ripen unevenly or slowly after chilling (e.g. tomato).

6. Development of off-flavour or odour (low O_2 levels)

7. Rotting: chilling injury causes the release of metabolities (e.g. amino acids, sugars) and mineral salts from cells. Leakage of metabolites and ions, together with degradation of cell membranes, provides substrates for growth of pathogenic organisms, especially fungi. Such pathogens are often present as latent infections or may contaminate produce during harvesting and postharvest operation. Thus, rots is another common symptom of chilling injury, particularly upon removal from low-temperature storage. Symptoms of chilling injury normally occur while the produce is at low temperature. However, they sometimes chilling injury appear when the

produce is removed to a higher temperature and deterioration may then be quite rapid, often within a matter of hours.

Chilling injury symptoms of some fruits

Produce	Lowest safe storage temperature (oC)	Symptoms
Avocado	5-12	Pitting, browning of pulp and vascular strands
Banana	12	Brown streaking on skin
Cucumber	7	Dark-coloured, water-soaked areas
Eggplant	7	Surface scald
Lemon	10	Pitting of flavedo, membrane staining, red blotches
Lime	7	Pitting
Mango	12-13	Dull skin, brown areas
Melon	7-10	Pitting, surface rots
Papaya	7-15	Pitting, water-soaked areas
Pineapple	6-15	Brown or black flesh
Tomato	10-12	Pitting, Alternaria rots

Management of Chilling Injury

i. Maintaining critical temperature - The safest way to manage chilling injury is to determine the critical temperature for its development in a particular produce and then not expose the commodity to temperatures below that critical temperature (Eg. Safe storage temperature for apple is 0-2$_0$C and care should to taken to not to store apple below this critical temperature to avoid chilling injury). However, it has been found that exposure for a short period to chilling temperatures with subsequent storage at higher temperatures may prevent the development of injury. This conditioning process has been effective in managing

- Black heart in pineapple
- Woolliness in peach
- Flesh browning in plum.

ii. MAS - Modified atmosphere storage may also reduce chilling injury in some commodities.

iii. Maintaining high RH - both in storage at low temperature and after storage can minimize expression of chilling injury symptoms, particularly pitting (e.g. film-wrapped cucumbers).

Date

Exercise No. 4

Extraction and preservation of pulps and juices

Preparation of Fruit Juice

Material Required: Kagzi lime fruits, wire basket, muslin cloth. Lemon squeezer, s. s. knife crown corking machine etc.

Procedure :-

1) **Selection of fruit :** Select fully ripe sound fruits.
2) **Preparation of fruits :** wash the fruit thoroughly under a spray of cold water. Put the fruit in wire basket. Dip the wire basket in boiling waste for three minute take out the basket from boiling water and plug them into cold water. Cut the fruit into two half with sharp stainless steel knife.
3) **Extraction of juice :** Extract the juice with lime squeezer strain the juice with course muslin cloth.
4) **Sedimentation :** Keep the juice in deep bottles for sedimentation for a week.
5) **Decantation :** Decant off the supertant juice and fill into sterilized crown caps bottle leaving head space of its 1.5 cm at the top.
6) **Pasteurization :** Keep the bottles on the false bottle of a pan containing boiling water. Pasteurize the product at 170^0 f half an hr.
7) **Sealing –** Allow the bottle to cool wipe them label and store in cool and dry place.

Important Notes :-

1) Juice should be pure and 100%
2) The above method is by heating white the juice can be preserved without heating i.e. by adding chemical preservatives like kms (350 ppm) Benzoic acid (600 ppm)
3) Both acidic fruits can used for bottling of juice or canning of juice
   a. Acidic fruit : Orange, Lemon, Lime, Phalsa
   b. Non Acidic Fruit : Grapes Pamagrant, Mulberry Jamun, Mango.

Preservation of Juices: Fruit juices, RTS and nectars are preserved by pasteurization or by using chemical preservatives. Squashes, crushes, syrups and cordials are preserved by adding chemical preservative like potassium metabisulphite or sodium benzoate.

1. Pasteurization: Preservation of fruit juices by application of heat is the most common method. Pasteurization is a process in which juice is heated to 1000C or slightly below for a sufficient time to inactivate/kill the microorganisms, which cause spoilage. Usually the fruit juices are pasteurized between 75 and 880C with times ranging from 30 sec to 30 min depending on the type of heating system, the nature of the juice and the size of the container. Pasteurization can be performed either by heating at low temperature for a long time (LTLT) or heating at high temperature for short time (HTST).

2. Aseptic processing and packaging of fruit juices: Aseptic processing and packaging is defined as the process in which a commercially sterile product is packed into pre-sterilized container in a sterile environment. The system make use of high temperature short time (HTST) sterilization in the temperature range of 90-110oC for acid products (pH<4.6) and ultra high temperature (UHT) sterilization 121oC and above for low acid foods (pH>4.6). The commercial aseptic sterilization process takes place in a continuous, closed system. Aseptic processing mayproduce products with better retention of nutrients and excellent sensory quality. Apple, mango, litchi, pineapple drinks etc. in tetra pack are processed commercially using aseptic processing and packaging system.

3. Preservation with chemical: Fruit juices, pulps, squash, cordial, syrup, RTS drinks etc, are preserved with chemical preservatives. Fruit juice and pulps in bulk are preserved with chemical preservatives. Two chemical preservatives most commonly used in preservation of fruit and vegetable products are

(i) Benzoic acid (benzoates)

(ii) Sulphur dioxide (Sulphites).

i) Benzoic acid: Benzoic acid is the effective agent but sparingly soluble in water, thus its sodium salt, which is water soluble, is generally used. Benzoic acid is more effective against yeast as compared to moulds. However, it does not stop lactic acid and acetic acid fermentation. The quantity of sodium benzoate required depends on the nature of the juice, its acidity and type of microbial infection.

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ii) Sulphur dioxide: Potassium meta-bi-sulphite (K2O2SO2 or K2S2O2) is commonly used as a source of sulphur dioxide. On addition to fruit juice or beverage it reacts with acid of the juice and form potassium salt and sulphur dioxide, which is liberated and form sulphurous acid with the water of the juice. Sulphur dioxide is more effective against mould spores and bacteria than yeast and also inhibits enzymes etc. It acts as antioxidant and bleaching agent thus help in the retention of ascorbic acid, carotene and other oxidisable compounds. It also retards non enzymatic browning or discoloration of the product. Its effectiveness depends on the acidity, pH, temperature and other substances present in the fruit juice.

4. Preservation by sugar: Fruit juice containing 66% sugar generally does not ferment. Fruit syrup or sharbats with high total solids (65% and above) have a very low water activity hence micro-organism do not grow. The sugar acts as a preservative by osmosis and does not support the growth of micro-organism. However, the growth of mould and yeast can occur on the surface of jams or jellies which need to be protected by using airtight packing or covering the product with molten paraffin wax.

5. Preservation by carbonation: Carbonation is a process of mixing carbon dioxide under pressure with water, juice or beverages so that the product when served; gives off gas in fine bubbles and has the characteristics taste. Carbonated beverages are generally bottled with carbon dioxide content ranging from 1 to 8 g/litre.

Assignment:

1) Prepare the flow chart for the extraction of aonla pulp
2) Prepare the flow chart for the extraction of pomegranate juice

Date

Exercise No.5

Preparation of Jam

Definition :

Jam is a product made by boiling fruit pulp with sufficient sugar to a reasonably thick consistency, firm enough to hold the fruit tissue in position.

Jam may be made from a single fruit or form a combination of two or more fruit. Pectin present in the fruit give it a good set, high conc. of sugar facilities preservation Apple, Pear, Apricoat, Loquat, Tomato, Carrot, Grapes, Papaya, Sapota, Karonda, Mango, Strawberry and Muskmelon are used in the preparation of Jam

FPO specification:-

Any Jam prepared should have minimum 68% T.S.S. (w/w) and min 45% prepared fruit in final product (w/w)

Material required: - Fruit or veg stainless steel knife, Steel vessels, spoon, sugar, citric acid, Thermometer, hand refractometer etc.

Procedure:

1. **Selection of fruits: -** Fully ripe fruit having good colour and flavor are selected. If the fruit are firm tough and unripe allow it to stand for a day or two develop characteristics flavor and sweetness.
2. **Preparation of fruits:** The selected fruit are washed thoroughly in fresh water leaves stalk and other undesirable portion is removed peel the fruit and removes any stone and cores.

   The fruit are cut into small pieces. If the fruit is tough and hard, boil it with small quantity of water to soften it.
3. **Addition of sugar and Acid:** The proportion of sugar to fruit depend upon variety of fruit and its ripeness. Generally for sour fruit add equal quantity of sugar by wt of the pulp, while to sweet fruit add only ¾ sugar to the weight at the pulp.

   According to type of fruit add citiric acid @ 1.5 to 3 g 1Kg of fruit (acidity of Jam should be in between 0.5 – 0.6%)

4. **Mixing :** Mix the ingredient thoroughly and allow the mixture to stand for ½ to 1 hr so that sugar dissolved in the juice released from the fruit.
5. **Boiling :** Boiling it desirable in order to cause intimated mixing of the fruit pulp and the sugar and to partially concentrate the product be evaporation of excess moisture.

   Cool the mixture slowly with occasionally stirring and crushing till the temperature reaches 105.5^0c at sea level or till the cooking mass approaches the desire consistency for every 150 m size in the attitude a decrease of 0.6^0c should be allowed in the cooking temperature of 105^0c.
6. **End point :**

   1. Temp test : Boil the mass till it reaches the require temperature at the particular altitude. Once this temp is reaches boiling can be stopped.

   2. **Sheet test :** When mass has been boiling for sometimes and has because sufficiently thick in consistency dip a spoon into it and let the product run off the side of the spoon.

   If on cooling the product fall in the form of a sheet instead of flowing readily in a single stream, It means that the end point has been reached.
7. **Filling and sealing :** Fill the hot Jam into clean dry jar or can, placed on an insulating material like a wooden board or a thick pad of cloth (for preventing the brakeage in the case of glass jar) close the filled container without only delay.
8. **Cooling :** Invert the container for about 5 min to sterilized the lid and allow it to cool.
9. **Labeling and storage:** The filled containers are labeled according to specification like kind of product. Home of manufacture date of manufacture net weight of product.

   The labeled containers are stored in cool and dry place.

Assignment:

Prepare the flow chart for the preparation of papaya jam.

Date

Exercise No.6

Preparation of Jelly

Definition: A jelly is a product prepared by boiling a clear strained solution of pectin containing fruit extract free from pulp by adding sugar and citric acid and concentrating to such consistency that gelatinization takes place on cooling.

FPO specification:-

Any Jelly prepared should have minimum 68% T.S.S. (w/w) and min 45% prepared fruit in final product (w/w)

Material required :- Fruits or vegetables, stainless steel knife, spoon, sugar, citric acid, thermometer, jelmeter, muslin cloth, hand refractometer, menthol etc.

Procedure :

1. **Selection of fruit: - The** fruit should be sufficiently ripe but not over ripe and they should have good flavor slightly under ripe fruit yield more pectin than over ripe fruit does because as the fruit ripen the pectin present in it decomposed into pectin acid which does not form a jelly with acid and sugar in practice mixture of under ripe and ripe fruit is used.
2. **Preparation of fruits:** Fruits are washed thoroughly with water remove any adhering dirt. Peeling is done if necessary and then fruit are cut into thin slices so that the acid and pectin in them can be extracted easily.
3. **Extraction of pectin: - Sufficient** quantity of water is added into the fruit slices. The mixture is boiled for half an hour with occasional stirring to avoid charring in the bottom. According to type of fruit citric acid is added at the rate of 1-3 gm per litre of juice. After extraction of pectin, extract should be filtered through the four fold muslin cloth.
4. **Test of pectin :**

   1. Alcohol test: One tea spoon full strained extract is taken in beaker and cooled and 3 teaspoon full of methyl spirit which are poured gently down the side of beaker which is rotated for mixing and allowed to stand for few minute.

a) If extract rich in pectin a single transparent lump or clot well form an equal amount of sugar be in to be added to the extract for reparation of jelly.

b) The extract contain moderate amount of pectin the clot will be less firm and fragment three fourth amount of sugar is to be added.

c) If extract is poor in pectin, numerous small granular cloths will be seen one half the amount of sugar is added.

2. Jelmeter test : The Jelmeter works on the principle of viscosity. First the bottom of the jelmeter tube is closed with little finger. The soloution must be strained through a muslin cloth to get rid of all solid particles and to avoid choking of Jelmeter. The strained extract is poured into jelmeter, till it is filled to the brim. Then the finger is removed from the bottom end and extract is allowed to flow or driple for extractly one minute at the end of which the finger is replaced. The reading of the level of extract in the jelmeter indicate how many parts of sugar are to be added to one part of juice. If the extract completely fall down within a minute, it indicates poor pectin content and such extract needs further boiling until required pectin strength is attained in the extract. To get accurate results, the temperature of the solution should be in the range of 21^0 to 38^0C.

5. **Addition of sugar:** The quantity of sugar to be added depend on the pectin strength of the extract according to alcohol or jelmeter test the requisite quantity of sugar is added into the extract.
6. **Cooking and mixture :** The mixture is boiled till 105.5^0c (at M.S.L.) temperature is reaches. The temp to which the jelly is to be cooked decrease by and 0.6^0c for every 150 m rise in sea level and mixture is looked at corresponding temp at the place during cooking care is taken to prevent charring of the mixture in the bottom by regular stirring of the mixture.
7. **Determining the end point :**

1. Temperature test: When the mixture is boiled at the specified temperature for particular the cooking is stopped.

2. Sheet test: When the jelly is ready it fall down in the form of sheet when tickled down from a spoon. If it falls down in the form of drop, cooking is further continued. Once the end point is reaches boiling should be immediately stopped.

8. **Filling and sealing:** The jelly is allowed to stand for a while and then scum is removed.

   The clear jelly is filled into sterilized jelly bottle leaving 1/3 inch and sealed air tight. If this provision is not available, paraffin wax sealing is done. The wax is melted and poured over the cooled jelly forming a layer of 0.1 cm. This prevents the microbial growth on the surface of jelly.

9. **Labeling and storage :** The sealed bottles are labeled giving the specification as required.

   The labeled bottle as stored in cool and dry places.

IMPORTANT HINTS

1. Final product should contain minimum of 45% fruit
2. Total soluble solids should not be less than 65%.
3. Addartificial pectin if fruits are poor in pectin.
4. Add citric acid in fruits of low acidity.
5. Permitted colours and preservatives can be added if necessary.
6. Good jelly should be gelatinous, clear, sparkling, transparent and of an attractive colour.
7. Jelly should not be sticky, syrupy, or gummy.
8. Good jelly should retain original flavor and aroma.
9. When cut it should retain its shape and show clean cut surface.

<u>Common difficulties arise in jelly making,</u>

1. Failure of jelly to set - it is due to,

a) Lack of acid and pectin b) Addition of to much sugar c) Cooking below and beyond end point d) Slow cooking for long time.

2. Cloudy or foggy jelly -due to, a) Improper clarification of extract. b) Use of immature fruits. c) Overcooking. d) Overcooling. e) Faulty pouring into container. f) Non removal scum
3. Formation of crystals is due to addition of excess sugar
4. Synerisis or weeping jelly- it is sudden erudition of fluid from jelly it is due to
   a) Excess of acid. b) Too low concentration of sugar. c) Insufficient pectin
5. Fermentation - due to bacteria and mould etc.

Assignment:

Prepare the flow chart for the preparation of wood apple/guava jelly.

Date

Exercise No.7

Preparation of RTS and Nectar

Ready to serve (RTS):

This is a type of fruit beverage which contains at least 10% fruit juice (for lime drink 5% juice) and not less than 10% total soluble solids. The acidity in these drinks shall not exceed 3.5% as citric acid. RTS beverages are preserved by using preservatives not exceeding 70 ppm SO2 or 120 ppm benzoic acid. It is not diluted before serving hence it is known as ready to serve drink for example mango drink, guava drink, pineapple drink etc.

Papaya RTS

Ripe fruits → Washing → Peeling → Cutting into halves → Seed removal → Passing through pulper → Pulp → Mixing with strained syrup solution (Sugar + Water acid, heated just to dissolve) Homogenisation → Bottling → crown corking → Crown corking → Pasteurization (about 90^{o}C for 25 min) – Cooling → Storage.

Sr. No.	Fruit	Juice/Pulp	Quantity of water required
1	Bael;	10	Quantity of finished products – Quantity of juice (litre) + sugar (kg) + acid (kg) used.
2	Lemon/Lime	10	
3	Guava	10	
4	Aonla (blend)	Aonla pulp 10 Lime juice 2 Ginger juice 1	
5	Mango	10	
6	Ginger	2.5	

Nectar:

This type of fruit beverage contains at least 20% fruit juice or pulp and 15% total soluble solids and is preserved by heat processing. The acidity in fruit nectars shall not exceed 1.5% as citric acid. No class II preservative like SO2 or benzoic acid is permitted in fruit nectar as per Indian Food Laws. It is not diluted before serving.

Assignment:

Prepare the flow chart for the preparation of RTS.

Date

Exercise No.8

Preparation of Squash and Syrup

Preparation of Orange Squash

Squash : This is a strained juice containing moderate quantities of fruit pulp to which cane sugar is added for sweetening. it containing at least 25 per cent fruit juice or pulp and and 40 to 50 per cent TSS, 1 per cent acidity and 350 ppm SO_2.

Material: fruits or Juice, sugar, water, bottles, crown corking machine.

Procedure:

1. Select the fully ripe sound fruits, free form blemishes.
2. Wash them thoroughly in cold water.
3. Trim or peel out the fruits and cut them into pieces
4. Extract the juice as per procedure and strain through a coarse muslin cloth.
5. Measure the juice and sugar according to following recipe.
6. Prepare the syrup by mixing sugar water and acid and heat it just to dissolve.
8. Strain the syrup and then mix it with juice
9. Add the preservative mentioned in the recipe
10. Pour the squash into previously sterilized bottles leaving head space of nearly 1.5 cm. and cap the bottles with crown cork bottles
11. Pasteurize product at 85°C for half an hour. Label, store in cool and dry place.

Squashes can be prepared according to following recipe

Sr. No.	Fruit	Ingredient for one litre pulp/juice			
		Sugar (Kg)	Water (lit.)	Citric acid (g)	Preservative (g)
1	Orange*	1.75	1.0	20	2.5 KMS
2	Mango	1.75	1.0	20	2.5 KMS
3	Lime, Lemon	2.00	1.0	--	2.5 KMS
4	Bael	1.80	1.0	25	2.5 KMS
5	Pineapple	1.75	1.0	20	1.9 KMS
6	Guava	1.80	1.0	20	2.0 KMS
7	Papaya	1.80	1.0	25	2.5 KMS
8	Karonda	1.80	1.0	5	4.0 SB
9	Jamun	1.80	1.0	15	3.0 SB
10	Water melon	0.50	.25	10	1.5 SB

KMS= Potassium metabisulphite SB= Sodium benzoate

F.P.O Specifications: a) T.S.S – 40% b) Juice – 25% c) Acidity – 1.0%

Preparation of syrup

Definition : It is a type of fruit beverage which contain at least 25%. Fruit juice or pulp and in 65% total soluble solids. It also contain 1.3 to 1.5 % acid is diluted before serving.

FPO Specifications :

The prepared syrup should have min 65% TSS (w/w) and min 25% (w/w) fruit juice.

Material required :- Ripe lemon fruit, steel vessel, muslin cloth, sugar, citric acid, salt, potassium metabisuphite, basket press, hand refractometer.

Receipe :-

Clear Juice	:	1 kg	Citric Acid	:	24 gms
sugar	:	2 kg	Water	:	0.50 lit
Pottasium metabisulphite	:	2 gms			

Procedure :

1. Select fruits, which are fully developed and free from blemishes.

2. Wash the material thoroughly.

3. Extract the juice.

4. Strain the juice.

5. For one kilogram of juice prepare 3 kg sugar syrup of 70 ° Brix by dissolving 2 kg sugar in 900 gram of water. Strain it and add 50 gram of citric acid.

6. Mix the juice to hot syrup

7. Fill the product in previously sterilized bottles.

8. Keep the bottles in the boiling water for half an hour and seal them when hot.

9. Allow the bottles to cool and label them.

10. Store the bottle in cool and dry place.

Assignment:

1) Prepare the flow chart for the preparation of orange squash.
2) Prepare the flow chart for the preparation of aonla syrup.

Date

Exercise No.9

Preparation of osmotically dried products

Osmotic drying is based on removal of moisture from a fruit pieces by placing them in contact with granular sugar or a concentrated sugar solution.

The fruit which are highly acidic and have sensitive aroma can be dried by using osmotic dehydration. In this method the fruits after preliminary treatment are placed in hypertonic solution of 70^0B sugar syrup and kept for 4 hrs to overnight. During this period, the water oozes out in syrup due to osmosis. About 50% of moisture from the fruit is removed in can process. The fruits are then drained from the syrup, rinsed and further dried in hot air drier to desired moisture content. During osmotic drying, acid from the fruit oozes out in the syrup while some sugar enters in the fruit thus the final product attains the required sugar acid balance. Apricots, grapes, apple etc. can be dried by using osmotic drying.

Drying of Fruits and Vegetables:

1.Raisin: - Rasins are the second most important product prepared from grape berries, wine being the first. The quality of raisin depends on the size of berries, the uniformity and brilliance of the berry colour, the condition of the berry surface, the texture of the skin, pulp in the berry, moisture content, chemical composition and presence of decay, mould, yeast and foreign matter. Based on the method of preparation and variety of grape used for raisin making, they are called natural, sultana, golden bleached, sulphur bleached, black corianth and valencians.

a) Predrying treatment :

Grapes are immersed in an alkaline solution prior to drying. Dipping the berries facilitates drying by farming cracks in skin. A sodium hydroxide (0.5% NaOH) is used at a temperature usually ranging from 93 to 100^0c. In Australia and India, cold dip solutions such as potassium carbonate (24%) are used. These dip accelerate moisture loss by causing wax platelets on the grapes skin to dissociate thus facilitating water diffusion. Raisin produced by cold dip process

are light in colour. Other researchers have used acid dip (Ascorbic acid & malic acid) instead of sulphuring as a method of obtaining light coloured raisins. However this product would undoubtedly have to be held at reduced temperature to prevent darkening during storage.

B. Sulfuring:

The use of sulphurdioxide (SO_2) is common in food industry. Grape berries are exposed to SO_2 before drying. These can be sulfured by placing them in compartment containing burning sulphur. Recently bolted gas of SO_2 is injected into chamber containing the fruits. The bolted gas systems offers numerous advantage such as better ability to control the quantity of SO_2 absorbed by the fruit, less air pollution and it is cost effective. Duration of sulfuring and concentration of SO_2 depends on size, condition of maturity and cultivar of produce being sulfured. The permissible level of SO_2 in raisins in India is 750 ppm.

Date

Exercise No.10

Preparation of fruit bar and candy

Preparation of Ber candy

Definition : A fruit when impregnated with sugar free from syrup drained and dried is called as candied fruit.

Procedure:

Selection of fruits:-

For the selection of fruit following criteria are applied.

i) Fruit should be riped

ii) Should be free from diseases and blemishes

iii) Remove wrinkled, old fruits which are not fit for consumption

Prelimary preparation:-

i) Wash the fruits carefully in fresh cold water.

ii) With the help of needles make holes on the ber surface.

iii) With the help of cork borer remove the seed from fruit

iv) Keep the ber fruit in boiling water for 2-3 minutes.

Sulphur treatment :-

The prepared fruit are then treated with sulphur fumes for 2 hrs (2 gm sulphur/kg of ber

fruits)

Dipping the fruit in sugar syrup :-

The fruit treated with sulphur are then dipped in 40% sugar syrup (1% citric acid for 4 hrs.)

i) For next 24 hrs. fruit are dipped in sugar syrup of 60% Conc. (1% citric acid

ii) For next 24 hrs. fruit are dipped in sugar syrup of 75% Conc. for 7-8 days.

Washing drying and storage:- The fruit are removed from the syrup and are washed with clean water. The candy thus prepared is dried in sunlight for about 2-3 days. The dried candy is stored in plastic bags carefully. Plastic bags are the stored in cool dry place.

Fruit toffee/bar:

Pulpy fruits like mango, guava, papaya etc can be used for making toffee. It is prepared by using 1 kg fruit pulp, 700 g sugar, 100 g glucose, 150 g skimmed milk powder and appropriate amounts of butter or ghee, essence and colour.

Assignments:

1) Prepare the flow chart for the preparation of ber candy.
2) Prepare the flow chart for the preparation of fruit bar.

Date

Exercise No.11
Preparation of tomato products

The different products prepared from tomato are

1) Tomato juice
2) Tomato puree and paste
3) Tomato sauce/ketchup
4) Tomato chutney
5) Tomato soup
6) Tomato pickle
7) Canned tomatoes

Tomato ketchup :

Tomato ketchup is made by concentrating tomato juice or pulp without seed and piece of skin.

Spices, salt, sugar, vinegar, onion, garlic etc. are added to the extent that the ketchup contain not less than 12% tomato solids and 28% total solids.

FPO specification:

T.S.S. : 25%
Acidity : 1.0%

Receipe :

Tomato pulp	-	1 Kg
Sugar	-	75 g
Salt	-	10 g
Onion (chopped)	-	50 g
Ginger	-	10 g
Garlic	-	5 g
Red chilli powder	-	5 g
Cinnamon, Cardamom (large), Cumin, Black Pepper (powdered)	-	10 g each
Clove (headless)		5 nos.
Vinegar	-	25 ml
Sodium benzoate	-	0.25 g per Kg final product

Procedure:

1. **Selection of fruit: - Select** fully ripe, red tomatoes free from insect and disease, fully ripe tomatoes have characteristics flavor and sweetness.
2. **Preparation of the fruit:** Wash the fruit thoroughly in fresh water.
3. **Extraction of juice:** Cut the stalk end portion with the help of stainless steel knife then cut fruits into small pieces and cook them in steel vessels while cooking press the fruit pieces with wooden mallet and strain through 1 mm mesh stainless steel sieves. Press the pulp thoroughly so as to get the maximum juice.
4. **Addition of spices, sugar, salt and vinegar:** Add 1/3 amount of sugar to the tomato juice. Take all the spices as per recipe and then tie in muslin cloth after making into fine powder and small pieces (onion, garlic clove, cardamom, black pepper, cumin, mace, cinnamon and red chilli powder) keep the bag immersing in the boiling pulp.
5. **Cooking :** Cook the pulp to thick consistency by till it reduces to $1/3^{rd}$ of its original volume remove the muslin bag and squeeze it to remove extract of spice. Add vinegar, salt and remaining quantity of sugar. Heat the mass for few minute to dissolve the ingredient and the final volume of the product is reduced to $1/3^{rd}$ of its original volume.
6. **Determining the end point :**
    1. **Volume test :** The end product must be 1/3 the original pulp
    2. **T.S.S.:** T.S.S. the final product should have minimum of 28% T.S.S.
    3. **Blotting paper test:** Put a drop of mass over a blotting paper. If all the free water in the mass has evaporated and only a red mark remain on the blotting paper stop further boiling.
7. **Addition of chemical preservatives :** To the small quantity of finished product add the chemical preservatives sodium benzoate at the rate of 750 mg/kg of the finished product and mix thoroughly.

8. **Filling and sealing :** Pour the finished product into medium sized pre-sterilized bottle leaving ½'' head space and then air tight with crown cap.
9. **Pasteurization :** The sealed bottles are pasteurized in boiling water for 30 min. Keeping them on a false bottom to avoid bumping while pasteurization.
10. **Labeling and storage :** Label and store at cool and dry place.

PREPARATION OF PUREE AND PASTE

Tomato pulp without skin or seeds, with or without added salt, and containing not less than 9.0% of salt free tomato solids, is known as medium tomato puree'. It can be concentrated further to heavy tomato puree which contains not less than 12.0% solids. If this is further concentrated so that it contains not less than 25% tomato solids, it is known as tomato paste, on further concentration to 33% or more of solids it is called concentrated tomato paste.

Tomato pulp is prepared from ripe tomatoes in the same manner as tomato juice. Cooking for concentration of the pulp can be done either in an open cooker or a vacuum pan. In the former most of the vitamins are destroyed and the product become brown. On the other hand, use of vacuum pans, which are extensive, help to preserve the nutrients, and also reduce the browning to a great extent. In vacuum pans the juice is boiled at about 71^{o}C only. While cooking in an open cooker, a little butter or edible oil is added to prevent foaming, burning and sticking.

After cooking, the total solids content of the juice is higher than required, more juice is added to lower it, if it is lower, cooking is continued till the desired concentration is reached. Theendpoint of cooking puree and paste can be determined either with a hand refractometer or by measuring the volume.

Process

Tomato juice (strained) → Cooking to desired consistency (open cooker / vacuum pan) → Judging of endpoint for puree (or) paste → Filling hot into bottles or cans (82-88^{o}C) → Sterilization in boiling water for 20 min. →Cooling → Storage at ambient temperature.

Assignments:

1) Prepare the flow chart for the preparation of tomato ketchup.

Date

Exercise No.12

Preparation of canned products

Canning:

The process of sealing foodstuffs hermetically in containers and sterilization them by heat for long storage is called as canning.

Principle:

Destruction of spoilage organisms within the sealed container by means of heat.

Steps involved in canning of fruits and vegetables

Preparation of fruit and vegetables: Preparation of food commodity for canning consists of washing, sorting, grading, peeling, halving, blanching etc.

1) Washing: Fruit and vegetables are generally washed with water to remove dust, dirt and adhering surface micro-flora. Fruits like peach, apricot etc are lye peeled so not washed before peeling. On the other hand, washing after peeling removes vitamins and minerals and should be discouraged. Different methods of washing include soaking or agitating in water, washing with cold or hot water sprays etc.

2)Sorting and grading: Sorting and grading ensures the removal of inferior or damaged commodity. For sorting, inspection belt can be used, in addition to trained personnel who detect poor quality produce unsuitable for canning.

3)Peeling, coring and pitting: These are the primary unit operations for preparing fruit and vegetables for canning. Depending upon the type of commodity, peeling and coring methods are selected such as (1) by hand or knife (2) by machine (3) by heat treatment (4) by using lye solution. Cores and pits in fruits like apple, peach, apricot etc are removed by hand or by machine (de-corer).

4) Lye peeling: Lye is an boiling aqueous solution of caustic soda (Sodium hydroxide) or Potassium hydroxide (1-2%) used in conjunction with ample water supply and heat

source for peeling. Fruit and vegetables like peaches, nectarines, apricot, sweet orange segments, carrots and sweet potatoes are peeled by dipping them in boiling caustic soda (1-2%) for 1-2 minutes (depending upon the strength of lye, temperature/maturity and nature of fruit or vegetable) followed by dipping in cold water. The hot lye loosens the skin from the flesh underneath which is removed by gentle rubbing of fruit by hand. The fruit can also be dipped in a dilute solution of hydrochloric acid or citric acid for few seconds to neutralize the alkali. The method is very quick and efficient to reduce wastage and peeling cost. The effectiveness of lye peeling depends upon lye concentration and temperature, product holding time and agitation.

Cutting/halving/ slicing: After peeling, the fruits are halved or cored either manually or mechanically. However, peeled fruit should always be kept submerged in either water, containing 1-2 % salt solution or acid to avoid enzymatic browning. Peaches, apricot, pears, tomatoes etc are peeled before canning. However, the fruits which are canned retain better nutrients as compared to peeled fruits.

5) **Blanching:** Treatment of fruit and vegetables with boiling water or steam for short periods followed by immediate cooling prior to canning is called blanching. The basic objectives of blanching are as under:

- To inactivate enzymes
- To clean the product initially to decrease the microbial load and to preheat the product before processing
- To soften the tissue to facilitate compact packing in the can
- To expel intracellular gases in the raw fruit to prevent excessive pressure built up in the container.
- To allow improved heat transfer during heat processing
- To ensure development of vacuum in the can and to reduce internal can corrosion.

Blanching is carried out either by hot water or using live steam. Water blanching is generally of the immersion type or spray type as the product moves on a conveyer.

Only soft water should be used for blanching as hard water toughens the tissue and destroys the natural texture.

Prevention of browning: Some fruits which cannot be blanched due to their delicate tissue structure are treated with some chemicals to prevent oxidative browning, occurring due to exposure to oxygen during peeling and slicing. Oxidative browning is caused by action of oxidase enzyme with catechol and tannins and is common in peach, apple, potato, mushroom, cherry, apricot, grapes and persimmon. Pineapple, tomato and melons are however not prone to browning.

6) Syruping: A solution of sugar in water is called a syrup. Normally sucose syrup is used in canning. Syrup is added to improve the flavor and to serve as a heat transfer medium for facilitating processing. Syruping is done only for fruits. The syrup should be filled at about 79 to 82^0C, leaving a head space of 0.3 to 0.5 cm.

7) Brining: A solution of salt in water is called brine. Only vegetables are brined. Common salt of good quality free from iron should be used. Hot brine of 1 to 3 per cent concentration is used for covering vegetables and is filled at 79 to 82^0C, leaving a head space of 0.3 to 0.5 cm.

8) Filling in cans: Tin cans are washed in hot water or in steam jet to remove any adhering dust or foreign matter. The cans are then sterilized by dipping in hot water tank or the cans are passed through a steam sterilizing tunnel before use. Generally plain cans are used however, for coloured fruits like plums, black grapes; strawberries etc lacquered cans are employed. The fruit and vegetable either slices, halves or whole are filled into the cans keeping in view the declared drain weight.

9) Exhausting: The process of removal of air from cans is called exhausting.

10) Heat processing: The cans after sealing are immediately transferred to the heating retorts to achieve sterilization of contents. Heat processing consists of heating cans to a predetermined time and temperature of heating to eliminate all possibilities of microbial spoilage. Over cooking should be avoided as it spoils the texture, flavour and appearance of the product. Generally all fruits and acid vegetables can be processed satisfactorily in boiling water (100^oC) as the presence of acid retards the growth of bacteria and their spores.

11) Cooling and storage: After processing, the cans are cooled rapidly to about 39^0C to stop the cooking process and to prevent stack-burning. Cooling is done by dipping the cans in cold water.

After labelling, the cans, they are packed in strong wooden cases or CFB cartons and stored in a cool and dry place.

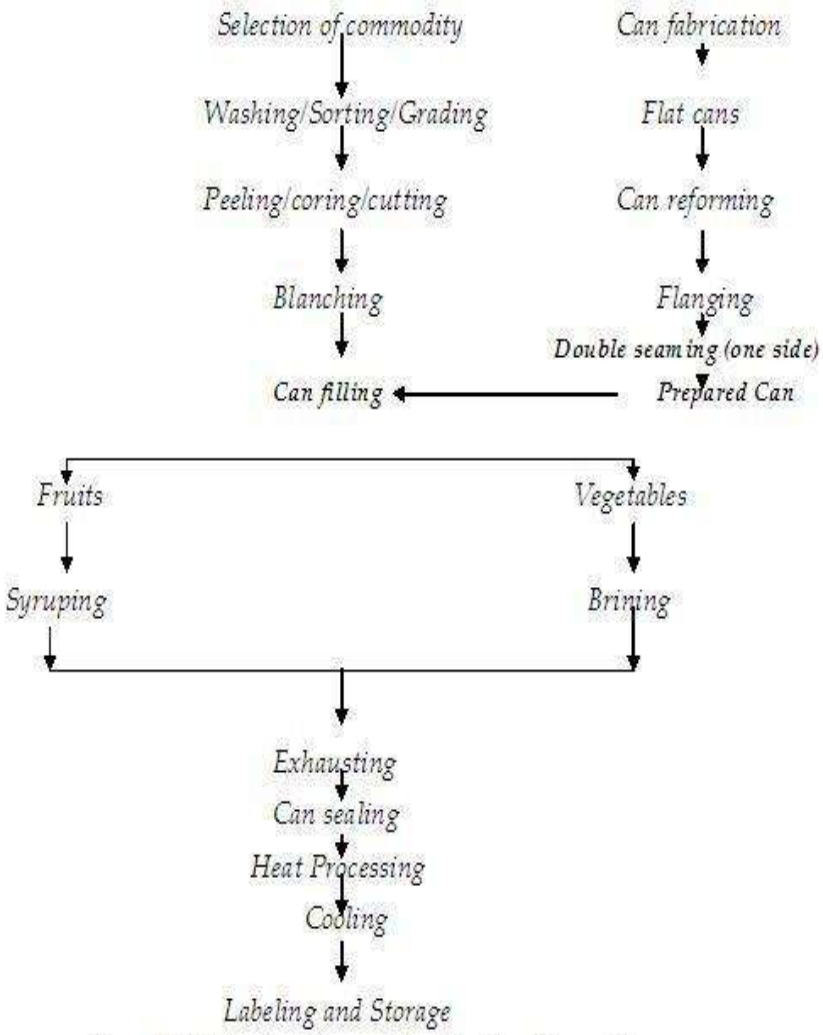


Figure 7.1: Flow sheet for canning of fruits and vegetables

Date

Exercise No.13

Layout and planning of pack house

Need of packhouse

After harvest, fruits and vegetables need to be prepared for sale. This can be undertaken on the farm or at the level of retail, wholesale or supermarket chain. Regardless of the destination, preparation for the fresh market comprises four basic key operations:

1. Removal of unmarketable material,
2. Sorting by maturity and/or size,
3. Grading,
4. Packaging.

Any working arrangement that reduces handling will lead to lower costs and will assist in reducing quality losses. Market preparation is therefore preferably carried out in the field. However, this is only really possible with tender or perishable products or small volumes for nearby markets. Products need to be transported to a packinghouse or packing shed in the following cases: for large operations, distant or demanding markets or products requiring special operations like washing, brushing, waxing, controlled ripening, refrigeration, storage or any specific type of treatment or packaging.

These two systems (field vs. packinghouse preparation) are not mutually exclusive. In many cases part field preparation is completed later in the packing shed. Because it is a waste of time and money to handle unmarketable units, primary selection of fruits and vegetables is always carried out in the field. In this way products with severe defects, injuries or diseases are removed.

General considerations about design

A packinghouse needs to be located close to the production area and within easy access to main roads or highways. It also needs to have one entrance to facilitate and control supply and delivery. Moreover, it needs to be large enough for future expansion or additional new facilities. Sufficient space outside is also required to avoid congestion of vehicles entering and leaving. Buildings should be designed to ensure sufficient shade

during most of the day in the loading and unloading areas. They also need good ventilation in summer and protection in winter.

Packinghouses are usually built with cheap materials. However, it is important to create a comfortable environment both for produce and workers. This is because product exposed to unfavorable conditions can lead to rapid deterioration in quality. Also, uncomfortable working conditions for staff can lead to unnecessary rough handling.

A packinghouse should have adequate room for easy circulation with ramps to facilitate loading and unloading. Doors and spaces should be sufficiently large to allow the use of forklifts.The reception area should be large enough to hold product equivalent to one working day. The main reason for this is to keep the packinghouse in operation in the event of an interruption in the flow of product from the field (rain, machine breakdown, etc).

Electricity is critical for equipment, refrigeration and particularly lighting. Because packhouses usually work extended hours or even continuously during harvest time, lighting (both, intensity and quality) is critical in identifying defects on inspection tables. Lights should be below eye level to prevent glare and eyestrain (Figure 25). Light intensity should be around 2 000-2 500 lx for light coloured products but 4 000-5 000 for darker ones. The working area together with the whole building should have lighting. This is in order to avoid the contrasts caused by shaded areas, resulting in temporary blindness when the eyes are raised. Dull colours and non-glossy surfaces are a requirement for equipment, conveyor belts and outfits. In this way, defects are not masked because of the reflection of light. It also helps to reduce eye fatigue.

A good supply of water is important for washing product, trucks, bins and equipment, as well as for dumping. In some cases it may also be necessary for hydro cooling. Provision of an adequate waste water disposal system is as important as a good source.

Administration offices should be located on clean and quiet areas and if possible elevated. This is so that the entire operation is visible. Packinghouses should have facilities or laboratories for quality analysis.

General considerations about operations

- Reception
- Removal of rejects
- Sizing
- Grading
- Waxing
- Degreening
- Controlled ripening
- Pest and disease control
- Temperature treatment.

Date

Exercise No.14

Layout and planning of processing unit

For setting up fruit processing plant following cost and non cost factors affecting location of the plant are taken into consideration.

• Cost factors include raw material cost, transportations cost, cost of land, building and machinery, utilities cost, taxes and insurance costs.

• Non-cost factors consists of wages, salaries and incentives, market potential, community attitude, cost regulation, quality of life (school, living, recreation for workers etc) and environmental impact.

Objective:

The main objective for selection of site for processing unit is to minimize the sum of all costs. To minimize the cost, one should think not only the today's costs, but of long term costs as well.

Plant layout :

The advantages of good plant layout are:-

1. Saving in floor space
2. Increased output
3. Fewer production delays
4. Reduced material handling
5. Greater utilization of machine and man power
6. Easier and better supervision
7. Less congestion and confusion
8. Better appearance and more sanitary condition of work areas
9. Reduced risk to health and safety of employees

1) Selection of Site for fruit processing unit

The location of unit is a dominant factor in viability (success or failure) of any processing industry. The following factors are considered in the selection of site for processing unit.

- Easy availability of raw material: Fruit and vegetables should be available in adequate quantity in the locality as they are highly perishable and deteriorate in long distance transportation. Other raw material like fuel, sugar, salt, chemicals etc and miscellaneous hand tools such as nuts, bolts, minor machinery parts etc should also be easily available in the locality.
- The site should be well connected with road.
- Proper transport facilities for movement of raw material and finished products.
- Area should have adequate supply of potable water and electricity (preferably three phase connection).
- Environment should be clean and free from debris, dirt, dust etc.
- The processing industry should preferably be well away from other industries to avoid soot, smoke and disagreeable odour.
- Provision for disposal of processing waste.
- Adequate availability of labour.
- The selected site should have scope for future expansion.

2. Building for processing plant:

Following points should be kept in mind for establishment of building for the processing plant.

- It may be single storied or multi storied building. Single storeyed building is sufficient for small unit working for short periods during the year. However, for larger processing plants running throughout the year, multistoried construction is desired. It facilities the movement of raw material and finished products.
- Firm flooring to withstand constant use of water and movement of heavy machinery.
- Slope in flooring (2cm per meter) for proper drainage.
- All doors, windows and ventilators should be provided with fine wire gauge to prevent entry of flies, wasps and other insects.
- The roof of the building should be high and well ventilated to provide outlet for vapours and steam.
- The windows should have large glass panels for sky light and artificial lighting.

- Provision for dressing and toilet rooms separately for male and female workers.

3. Types of plant layout

The layout of a processing plant can be selected on the basis of either product layout or process layout (Fig 1). Product layout deals with either single fruit or single product such as apple processing in to juice or jam processing line in which only apple product can be handled.

• In product layout, all types of jam, pickle, juice or ketchup can be handled irrespective of fruit.

• In process layout, the machinery dealing with different unit operation is placed separately. For example for extraction of juice, the fruit is washed in washing line, grate in grating machine, pressed in hydraulic press and then juice is filled in filling line and processed in processing line.

Depending upon the size of the unit, the layout can be selected.

4. Water supply and drainage

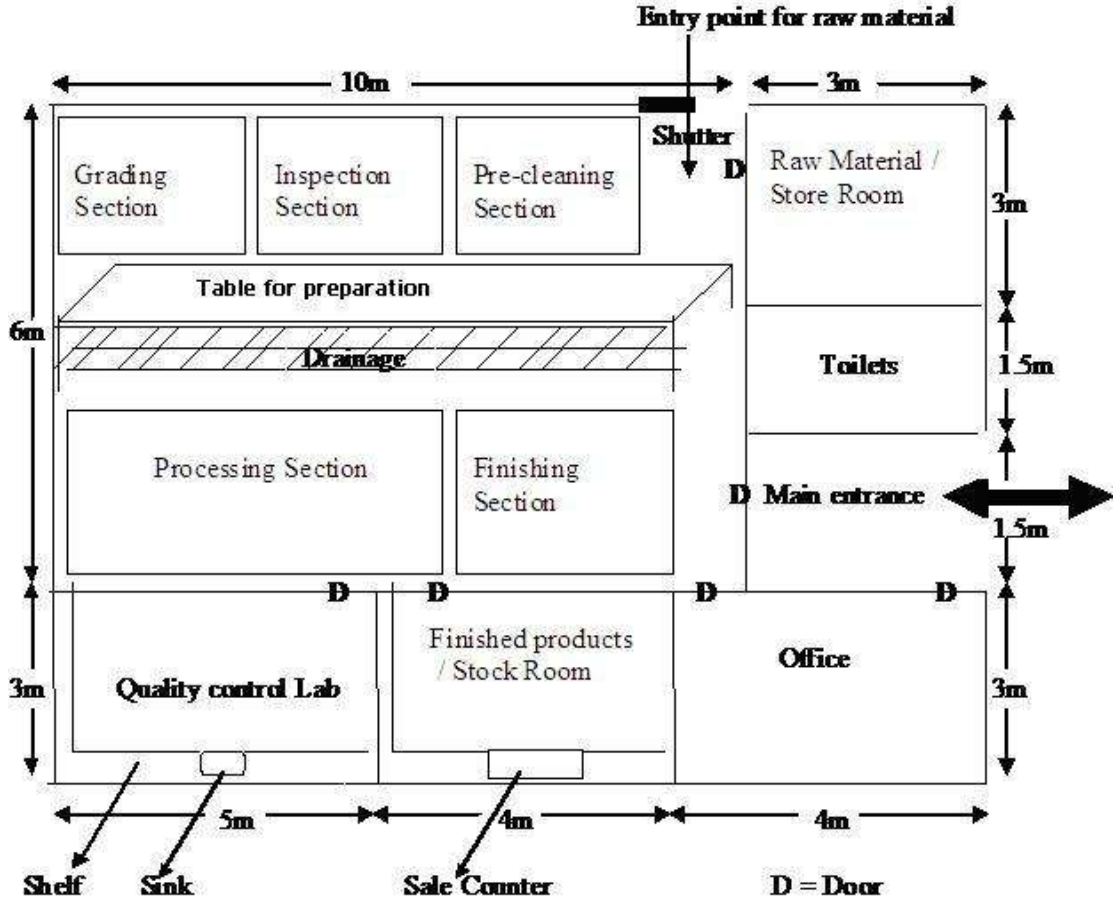
Water of potable nature should be abundant in supply. If water is not of desired quality there is a need for installing water softening plant.

- A large quantity of water is needed for cleaning of fruits and vegetables, making syrup and brine, washing floors and machinery etc.
- Water system should work at sufficiently high pressure so that supplies can be made to different places without any break.
- The water should not be alkaline or very hard, should be free of organic matter.
- Presence of iron and sulphur make the water unsuitable for making syrups and brines.
- Saline water affects the taste of the products and should be avoided.

5. Categories of fruit processing units

According to Fruit Products Order (1955) of the Govt. of India, the fruit processing units are categorized as under depending upon the installed capacity and requirement of minimum area for processing (Small scale, home scale, cottage scale, large scale etc.).

Sr.No	Category	Annual Production, tonnes	Minimum manufacturing area required, m^2
1.	Home scale(B)	25	25
2	Cottage scale	10-50	60
3.	Small Scale(A)	50-100	100
4.	Small Scale(B)	100-250	150
5.	Large Scale	250	300



Layout of a processing plant

Date

Exercise No.15

Quality evaluation of products- physico-chemical and sensory

Quality is a measure of the degree of excellence or degree of acceptability by the consumer. It is also defined as the combination of attributes or characteristics of the products that has significance in determining the degree of acceptability of the product to a user. Industry defines quality as the measure of purity, strength, flavour, colour, size, maturity, workmanship or any other distinctive attribute or characteristics of the product. The quality standards of fresh and processed fruit or vegetable products vary with their intended use. For marketing purposes; size, attractiveness, maturity, organoleptic quality and freedom from defects are to be kept in mind. While for processing, physico-chemical attributes of raw material such as presence of soluble solids, development of uniform colour, flavour, juiciness, uniform maturity, tenderness in some vegetables etc are taken into consideration. During processing of fruit or vegetables into value added products; colour, flavour and texture etc also become important.

Methods of quality evaluation

1) Physical methods: These are the quicker methods and require least training for the evaluator. They include visual appearance, colour, texture, consistency, size, shape or some process variables like head space, fill, vacuum, drain weight etc. The colour of the food products can be measured using calorimeter, tintometer or Hunter colour difference meter. While texture can be determined by using texture analyser or firmness of fruit is estimated by penetrometer. On the basis of texture profile, the product can be classified as chewy, grainy, crispy, mealy etc. These methods are called as instrumental methods.

2) Chemical methods: These are the standard analytical methods and are used for quantitative chemical evaluation of nutritive value and quality levels. However, such

analytical methods are lengthy, tedious and expensive. For routine analyses quick tests are developed like pH, acidity, TSS, jellification etc.

Attribute	Method /equipment to be used
1. Physical test	Vernier calliper
Size	Weighing balance
Weight	Water displacement method
Volume	Specific gravity bottle, pycnometer
Specific gravity	Net weight + Tare weight
Gross weight	Weight of container
Tare weight	Gross weight – Tare weight
Colour	Visual colour chart
Texture	Texture Analyser
Firmness	Penetrometer, Pressure tester
Consistency	Ostwald viscometer
Viscosity	Brookfield viscometer
Head space	Head space gauge
Vaccum/ pressure	Vaccum/ pressure gauge
Can testing	Can tester
2. Chemical test	
TSS	Hand Refractometer
Brine strength	Salometer
Moisture	Oven drying method, infra-red moisture meter
pH	pH meter
Titratable acidity	Alkali titration method
Sugars (Reducing)	2,6 dichloro-phenol- indophenol dye titration method
Sugars(Non-reducing)	Silver nitrate titration using Mohr's method
3. Sensary evaluation	
Colour	Hedonic rating test
Flavour	Numerical scoring test
Body	Ranking test
Overall acceptability	Paired comparison test; Single sample test; Multiple sample test

Sensory evaluation:

After physical, chemical and microbiological examinations have been performed on a finished products with a satisfactory result, the product is considered ready for distribution, but only after its palatability or sensory quality has been assessed. Sensory quality is a combination of different senses of perception which come into play in choosing and eating a food. The principle sensory properties which affect the palatability of food are as follows.

i) Appearance
ii) Texture
iii) Flavour

Although the physical and chemical tests are not adequate to give the required information, human judges, therefore, have to be used. Measurement of the relative palatability of a food is attempted in two ways

i) By obtaining the judgement of experts,
ii) By testing the preferences of a sample of the public for whom the products is intended and is known as market testing.

Date

Exercise No.16

Visit to processing unit

INDEX

CERTIFICATE

This is to certify that Shri./Ku._____

Enrolment No. _____has completed practical of Course No. **Hort-366 (Post-harvest Management and Value Addition of Fruits and Vegetables)** as per the syllabus of B.Sc. (Hons.) Agriculture Third year Sixth Semester in the laboratory of College as prescribed by M.C.A.E.R., Pune.

Date: **Course Teacher**

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

Section of Horticulture

College of Agriculture, Akola

Practical Manual

Post-harvest Management and Value addition of Fruits and Vegetables

Compiled by

Dr. A.D. Warade

Assistant Professor (Hort.)

Dr. S.R. Dalal

Professor (CAS) & Head of Section

Dr. P.M. Chandan

Assistant Professor (Hort.)

Course No. : HORT-366 (New) **Credit : 2 (1+1)**

Name of Student : _____

Enroll. No.: _____**Batch :** _____

Session : _____ **Semester:** _____