Practical Manual

on

Postharvest Management of Horticultural Crops

HPH 316 - 3(2+1)

B.Sc. Hons. Horticulture VI semester

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College of Horticulture and Forestry
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COURSE- Post Harvest Management of Horticultural Crops 3(2+1)

PRACTICAL:

Practice in judging the maturity of various horticultural produce, determination of physiological loss in weight and quality. Grading of horticultural produce, post-harvest treatment of horticultural crops, physical and chemical methods. Packaging studies in fruits, vegetables, plantation crops, spices and cut flowers by using different packaging materials, methods of storage, post-harvest disorders in horticultural produce. Identification of storage pests and diseases in spices. Visit to markets, packing houses and cold storage units.

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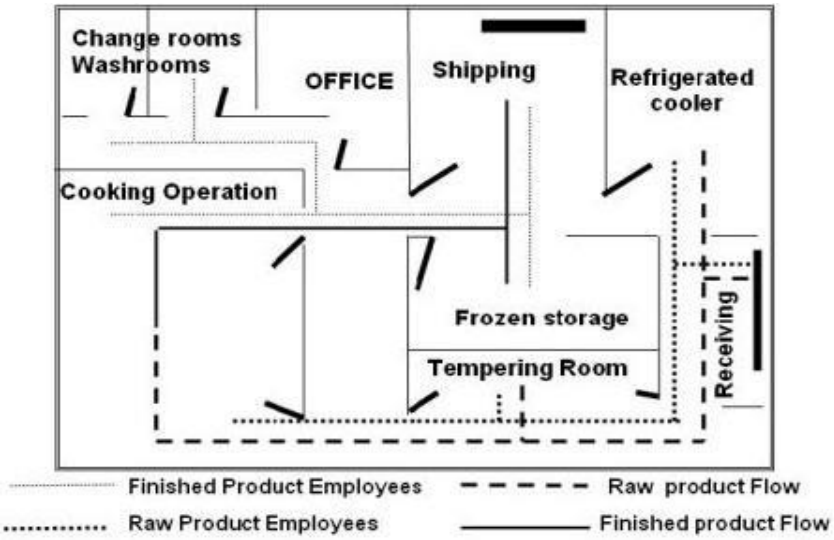
CONTENTS

EXERCISE 1

Objective: To set up processing plant

During every financial year the budget for scale-up of processing under agriculture is decided and accordingly the targets has been set. The products that are being processed vary with the availability of cash crops in and around the locality. The main processed products at cottage level are halved peaches, jam, squash, fruit drinks, chutney and pickles etc. The processing of fruits into different products can be manually handled or through the use of machine. In-spite of huge efforts by the technologist and government, processing is still 2.2 per cent, which is nowhere compared to the developed countries. There are different factors cost and non-cost factors, which are to be considered before planning a processing unit.



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.

Objectives of fruit processing units should be:

1. ……

2. ……

3. ……

Lay out plan of a good unit:

1. ……

2. ……

3. ……

4. ……

5. ……

6. ……

Factors affecting processing unit

1. **Selection of site:** ……
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2. Building for processing plant: ……

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3. Types of plant layout: ……

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4. Water supply: ……

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Categories of processing units

Categories	Annual production (tonnes)	Minimum manufacturing area required (m^2)
1. Home scale		
2. Cottage scale		
3. Small scale		
4. Small scale		
5. Large scale		

5. Product selection: ……

……
……
……

The advantages of good plant layout: ……..

a.

b.

c.

d.

e.

EXERCISE 2

Objective: Machinery and equipment required for processing plant

A. Processing hall: Write Machinery and Equipment required for processing hall

	Machinery and Equipment		Machinery and Equipment
1.		7.	
2.		8.	
3.		9.	
4.		10.	
5.		11.	
6.		12.	

B. Packing and grading rooms: ……..

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C. Store Rooms: ……

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D. Administrative block: ……..

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Draw the diagram for the following:

Refractometer (0-32, 28-62, 56-92^{o}C)		**Fruit grater**

Crown corking machine		**Lug cap sealing machine**
Vegetable cutter		**Fruit pulper**

Homogenizer		Paste filling machine
Can seamer		**Can stacking**

EXERCISE 3

Objective: Practice in judging the maturity of various fruits and vegetables.

Type of Maturity:

***Physiological maturity*:** Attainment of full development of stage just prior to ripening or ripening in non-climacteric fruits *e.g*., fruits and vegetables produced for seed production

Horticultural /Commercial maturity – stage at which growth and development is optimum for specific use (stage acceptable for consumers/market oriented) *e.g*., fresh vegetables for canning/ dehydration/ IQF – Individual Quick Frozen

Horticulture maturity is classified into 3 different groups: 1. Physiological immature; 2. Firm and mature; 3. Harvest ripe

Judging the maturity in fruits crops

I. Computational methods:

1. ……
2. ……
3. ……
4. ……

II. Physical methods:

1. ……
2. ……
3. ……
4. ……
5. ……
6. ……
7. ……
8. ……
9. ……

III. Chemical methods

1. ……
2. ……
3. ……
4. ……
5. ……
6. ……
7. ……
8. ……

9. .....

IV. Physiological methods:

1. .....
2. .....
3. .....
4. .....

Advantage of Estimation of Maturity:

1. .....
2. .....
3. .....
4. .....
5. .....
6. .....
7. .....
8. .....
9. .....
10. .....

Specify the crop against each maturity judging methodology:

1	Calendar date	
2	DFFB	
3	T-Stage	
4	Size	
5	Surface morphology	
6	Specific gravity (Sinker/floater)	
7	Fruit retention strength	
8	Leaf changes	
9	Starch content -Iodine test	
10	Fruit opening	

EXERCISE 4

Objective: Study on maturity signs and harvesting of important fruit crops.

Maturity Signs of Banana:

1. .....
2. .....
3. .....
4. .....
5. .....
6. .....

Maturity Signs of Coconut:

1. .....
2. .....
3. .....
4. .....

Maturity Signs of Mango

1. .....
2. .....
3. .....
4. .....
5. .....
6. .....

Maturity Sings of Sapota

1. .....
2. .....
3. .....
4. .....
5. .....

Maturity Signs of Papaya

1. .....
2. .....
3. .....
4. .....
5. .....

Maturity Signs of Ber

1. .....
2. .....
3. .....
4. .....
5. .....

Maturity Signs of Guava

1. .....
2. .....
3. .....
4. .....

Maturity Signs of Grapes

1. .....
2. .....
3. .....
4. .....
5. .....
6. .....

Maturity Sings of Mandarin and Sweet Orange

1. .....
2. .....
3. .....
4. .....
5. .....

Maturity Sings of Pineapple

1. .....
2. .....
3. .....
4. .....

Maturity Sings of Karonda

1. .....
2. .....
3. .....
4. .....

EXERCISE 5

Objective: Study on maturity signs and harvesting of important vegetable crops.

Maturity Sings of Beans

1. .....
2. .....

Maturity Sings of Beets

1. .....
2. .....
3. .....
4. .....

Maturity Sings of Broccoli

1. .....
2. .....
3. .....
4. .....
5. .....

Maturity Sings of Cabbage

1. .....
2. .....
3. .....
4. .....
5. .....

Maturity Signs of Cauliflower

1. .....
2. .....
3. .....
4. .....

Maturity Signs of Knol-Khol

1. .....
2. .....

Maturity Sings of Carrot

1. .....
2. .....

3. ……

4. ……

5. ……

Maturity Sings of Cucumber

1. ……

2. ……

3. ……

4. ……

5. ……

Eggplant

1. ……

2. ……

3. ……

Maturity Signs of Garlic

1. ……

2. ……

3. ……

Maturity Signs of Onion

1. ……

2. ……

3. ……

4. ……

Maturity Signs of Water Melon

1. ……

2. ……

3. ……

a) Withering of tendril: ……

b) Thumping ……

c) ……

d) ……

Maturity Sings of Potato

1. ……

2. ……

3. ……

4. ……

Maturity Signs of Tomato

1. ……

2. ……

a. Green stage: ……

b. Pink Stage: ……

c. Ripe stage: ……

d. Fully Ripe: ……

Maturity Sings of Chilli

1. ……

2. ……

3. ……

4. ……

Maturity Signs for Leafy Vegetables

1. ……

2. ……

3. ……

4. ……

5. ……

EXERCISE 6

Objective: Study on maturity signs of important flower crops.

Carnation

1. .....
2. .....
3. .....
4. .....

Gerbera

1. .....
2. .....
3. .....
4. .....

Rose

1. .....
2. .....
3. .....
4. .....

Gladiolus

1. .....
2. .....
3. .....
4. .....

Chrysanthemum

1. .....
2. .....
3. .....
4. .....

Tuberose

1. .....
2. .....

Sweet William

1. .....
2. .....

EXERCISE 7

Objective: To study about grading and different types of grader

Grading of size and quality is an essential for the marketing of fruits and vegetables. Sizing machines may be grouped broadly into two based on diameter and based on weight. Machines, which grade by diameter, vary in design and size. It gives higher output than the machine grade by weight. Roller feed conveyor is used for quality sorting of fruits/vegetables. A good weight grader has many advantages. It can be used for any shape, easily adjustable and can be used for crops that are easily blemished. Grading by weight can be more accurate than grading by diameter. Mostly, grading involves simultaneous evaluation of multiple properties which makes complexity in mechanical grading and hence manual grading is preferred. The separation may be based on size, shape, colour of the food product, which is done to make different qualities.

Grading method: …….

Manual grading: ……..

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Machine grading: ……

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Grading machines for fruits and vegetables: There are four types of grading machines for fruits and vegetables. They are screens, roller grader, and diverging belt grader and weight grader.

Screens: …….

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Roller grader: ……

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Weight grader: ……

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Expanding pitch rubber spool potato sizer …….

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Root crop combines: ……

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EXERCISE 8

Objective: Effect of Postharvest Factors on Postharvest Quality of Horticultural Produce

1) Curing: ……

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2) Degreening

Degreening is the process of decomposing green pigments in fruits usually by applying ethylene or other similar metabolic inducers to give a fruit its characteristic colour as preferred by consumers. It is applicable to banana, mango, citrus, and tomato.

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3) Pre-cooling ……

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4) Washing and Drying ……

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5) Sorting and Grading ……

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6) Disinfestations ……

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7) Post-Harvest Chemicals Treatment ……

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8) Waxing ……

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9) Ripening of Fruits ……

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10) Pre-packaging in Plastic Film ……

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EXERCISE 9

Objective: Preparation and importance of zero energy cool chambers for on farm storage.

Introduction: In India quality deterioration of horticultural produce takes place immediately after harvest due to lack of on-farm storage. Maintenance of low temperature is a great problem in our country. Refrigeration is energy intensive, expensive, not so easy to install and run in remote areas and also not always environment friendly. Due to lack of cold/cool storage space a substantial amount of fruits and vegetables are lost after production. Considering acute energy crisis and lack of cool storage facility development of low cost/low energy cool chambers is best option and Zero Energy Cool Chambers is best example of this.

Concept of Zero Energy Cool Chambers (ZECC)- ……..……

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The main advantages of this on-farm low cost cooling technology are:

1. It does not require any electricity or power to operate
2. Materials required like bricks, sand, bamboo etc. available easily and cheaply.

Principle of ZECC (EVAPORATIVE COOLING) ……

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Construction: …… ….

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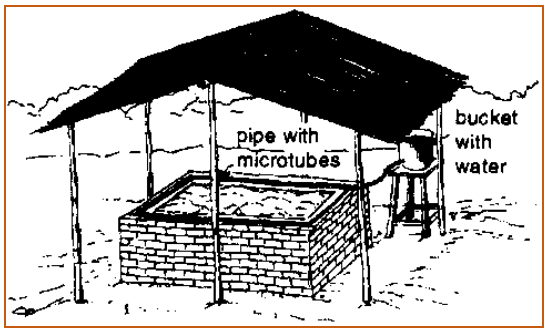

Zero Energy Cool Chamber

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COST OF COOL CHAMBER (100 Kg Capacity Chamber)

Material	Approx. Cost (Rs.)
Brick (400 Nos)	1000.00
Sand	100.00
Bamboo, Khas Khas, etc. for top cover	300.00
Thatched Shed	500.00
Water tank, pipes, tubes poly sheet etc.	600.00
Plastic Crates (6 Nos)	1200.00
Labour	300.00
Total	**4000.00**

Operation: ……

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Effect of ZECC on shelf life of fruits and vegetables: ……..

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Storage of fruits in cool chamber

Crop	Cool chamber		Room temperature	
	Shelf life (days)	PLW (%)	Shelf life (days)	PLW (%)
Aonla	18	1.72	9	8.70
Banana	20	2.50	14	4.80
Grape fruit	70	10.20	27	4.94
Guava	15	4.00	10	13.63
Kinnow	60	15.3	14	16.10
Lime	25	6.00	11	25.00
Mango	9	5.04	6	14.99
Sapota	14	9.46	10	20.87
Amaranth	3	10.98	<1	49.82
Okra	6	5.00	1	14.00
Parwal	5	3.89	2	32.86
Carrot	12	9.00	5	29.00
Potato	97	7.67	46	19.00
Mint	3	18.6	1	58.5
Turnip	10	3.4	5	16.0
Peas	10	9.2	5	29.8
Cauliflower	12	3.4	7	16.9

EXERCISE 10

Objective: Study on pre-cooling methodology for fruits and vegetables.

Pre-cooling: **Pre-cooling is the rapid removal of field heat from freshly harvested product before shipment, storage, or processing, and is essential for many perishable horticultural crops.*

Conduction: Conduction is the transfer of heat energy between adjacent molecules in an object or between molecules in adjacent objects; it is not dependent on gross movement of the object. The rate of heat transfer through a uniform material is directly proportional to the cross sectional area of the path and temperature drop and inversely proportional to the thickness. Conduction can occur between molecules in a solid, liquid or gas.

Convection: Convection is the transfer of heat energy by transport of a heated fluid material. The fluid can be air or a liquid. The transport (movement) may be a) natural or free convection, caused by difference in buoyancy, or b) forced convection, accomplished with pumps, blowers, or fans. The principal resistance to heat transfer is found in a relatively stagnant laminar layer and an adjacent turbulent zone of fluid at the solid-fluid interface. Heat must pass through the laminar layer to the moving layer by conduction in the fluid.

Radiation: Radiation is the transfer of heat energy by emission of energy, without need of a conducting or convecting medium, from the surfaces of opaque bodies and from within semi-transparent objects. Heat from the sun or a hot stove is received through open space by radiation.

1. **Room cooling:** ……..

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2. **Forced-air Cooling:** ……

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3. **Hydro-cooling:** ……

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4. **Package Icing:** ……

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5. Vacuum-cooling: ……

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6. Evaporative cooling: ……

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Pre-cooling methodology used commonly for vegetables and fruits

Vegetables	
Crop	**Precooking method**
Asparagus	Hydro-cooling, Package icing
Beans, snap	Room cooling. Forced-air cooling. Hydro-cooling
Beets	Room cooling
Broccoli	Package icing. Forced-air cooling. Hydro-cooling
Brussel Sprouts	Hydro-cooling, Vacuum, Package icing
Cabbage	Room cooling. Forced-air cooling
Carrots	Package icing. Room cooling
Cauliflower	Hydro-cooling, Vacuum cooling
Chinese Cabbage	Hydro-cooling, Room cooling. Forced-air cooling
Com, sweet	Hydro-cooling, Package icing. Vacuum
Cucumber	Forced-air cooling. Hydro-cooling
Eggplant	Room cooling, Forced-air cooling
Fruits	
Apples	Room cooling, Forced-air cooling. Hydro-cooling
Apricots	Room cooling, Hydro-cooling
Berries	Room cooling, Forced-air cooling
Cherries	Hydro-cooling, Forced-air cooling
Grapes	Forced-air cooling
Nectarines	Forced-air cooling, Hydro-cooling
Peaches	Forced-air cooling, Hydro-cooling
Pears	Forced-air cooling, Room cooling, Hydro-cooling
Plums	Forced-air cooling, Hydro-cooling

EXERCISE 11

Objective: Execution of degreening in citrus fruits.

Degreening: ……..

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EXERCISE 12

Objective: Effect of Fruit Wax Coating on Postharvest Quality

Waxes: *Esters of higher fatty acid with monohydric alcohols and hydrocarbons and some free fatty acids.*

Advantages of wax application are: ……...

1. ……

2. ……

3. ……

4. ……

5. ……

6. ……

7. ……

Disadvantage: ……..

1. ……

2. ……

Type of Waxes Used

A. Natural waxing: ……..

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B. Artificial waxing: ……

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1. Solvent waxes: ……

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2. Water waxes: ……

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3. Paste or oil waxes: ……

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Categories of Wax according to their Use

1. Storage wax: ……..

2. Pack-out wax: ……

3. High-shine-wax: ……

Fruits suitable for waxing

Immature fruit vegetables	cucumbers and summer squash
Mature fruit vegetables	eggplant, peppers and tomato, potato, pumpkin, carrot, snake gourd, coccinia and capsicum
Fruits	apple, avocado, banana, citrus (orange, mandarin, lemon, grapefruit), guava, mangoes, melons, papaya, peaches, pine apple etc.

Methods of wax application

Performance of a wax depends on method of application and its uniformity on the surface of fruits or vegetables.

1. Spray waxing: ……..……..

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2. Dipping: ……

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3. Foam waxing: ……..

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4. Flooding: ……...

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List of Waxes Commercially Used

1. Paraffin wax.
2. Carnauba wax.
3. Bee wax.
4. Micro crystalline waxes (complexes of 5-hydrocarbon having branched chain).
5. Shellac.
6. Wood resins.
7. Polyethylene (Oxidized polyethylene wax or hydrocarbon wax).

EXERCISE 13

Objective: Determination of physiological loss in weight (PLW) and total soluble solids (TSS) in fruits and vegetables.

Physiological loss of weight (PLW):

Procedure: ……

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Calculation:

$$\% \text{ PLW} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

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Estimation of total soluble solids (TSS): ……

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Conversion of the reading of the refrectometer with scale indicating Sucrose for a temperature different from 20±0.5^{0}C

Temperature^{0}C	**Scale reading for soluble solids content (%)**									
	5	**10**	**15**	**20**	**25**	**30**	**40**	**50**	**60**	**70**
	Corrections to be subtracted									
15	0.29	0.31	0.33	0.34	0.34	0.35	0.37	0.38	0.39	0.40
16	0.24	0.25	0.26	0.27	0.28	0.28	0.30	0.30	0.31	0.32
17	0.18	0.19	0.20	0.21	0.21	0.21	0.22	0.23	0.23	0.24
18	0.13	0.13	0.14	0.14	0.14	0.14	0.15	0.15	0.16	0.16
19	0.06	0.06	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08
	Corrections to be added									
21	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08
22	0.13	0.14	0.14	0.15	0.15	0.15	0.15	0.16	0.16	0.16
23	0.20	0.21	0.22	0.22	0.23	0.23	0.23	0.24	0.24	0.24
24	0.27	0.28	0.29	0.30	0.30	0.31	0.31	0.31	0.32	0.32
25	0.35	0.36	0.37	0.38	0.38	0.39	0.40	0.40	0.40	0.40

EXERCISE 14

Objective: Determination of acidity and ascorbic content in fruits and vegetables.

Write down the procedure for Titratable acidity estimation

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Calculation:

$$\text{Titratable acidity (\%)} = \frac{\text{Titre} \times \text{Normality of alkali} \times \text{volume made up} \times \text{equivalent weight of acid}}{\text{Volume of sample taken} \times \text{volume of aliquot taken} \times 1000} \times 100$$

Milli equivalent weight of acid:

Malic acid - 0.0067g Oxalic acid - 0.0045g Citric acid monohydrate - 0.0070g Tartaric acid - 0.0075g
Lactic acid – 0.0090g Acetic acid – 0.0060g Oleic acid – 0.00282g

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Write down the procedure for Ascorbic acid estimation

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Calculation:

$$\text{Ascorbic acid (mg/100 g)} = \frac{\text{Titre} \times \text{Dye factor} \times \text{volume made up}}{\text{Aliquot of extract taken} \times \text{Weight of sample taken}} \times 100$$

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EXERCISE 15

Objective: Determination of reducing and total sugars content in fruits and vegetables.

Reducing sugars estimation procedure: ……..

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Calculation:

$$\text{Reducing sugars (\%)} = \frac{\text{Factor} \times \text{Dilution}}{\text{Titre value} \times \text{Weight of sample taken}} \times 100$$

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Total sugars estimation procedure:

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$$\text{Total sugars as invert sugars (\%)} = \frac{\text{Factor} \times \text{Dilution}}{\text{Titre} \times \text{Weight of sample taken}} \times 100$$

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% Sucrose = (% total invert sugars - % reducing sugars) x 0.95

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% Total sugars = (% reducing sugars + % sucrose)

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EXERCISE 16

Objective: Packing methods and types of packing and importance of ventilation.

Packaging of Fruits and Vegetables

"Wrapping or placement of object in paper or other packaging materials, keeping in box etc. is known as - packing"

"Packaging is an industrial and marketing technique for containing, protecting, identifying and facilitating the sale and distribution of agricultural, industrial and consumer products is known as - packaging"

Function of the packaging

1. ……
2. ……
3. ……
4. ……

Common Packaging Materials

1. ……
2. ……
3. ……
4. ……
5. ……

Packaging materials and its use

Natural materials:

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Natural and synthetic fibres:

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Wooden boxes:

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Wire-Bound Crates:

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Corrugated Fibre Board:

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Importance of ventilation:

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Exercise 17

Objective: To study about pre-packaging (consumer size packing) and palletization

Pre-packaging is generally defined as packaging the produce in consumer size units either at producing centre before transport or at terminal markets. Packaging of fresh produce in consumer unit packs protects the produce against the damage and excess moisture loss.

The packaging material used should have the following properties

1. Sufficient permeability to oxygen, carbon dioxide and water vapour

2. Good tensile strength, transparency, heat sealability and printability

3. Desired protective physical properties

Considering above characteristics LDPE film is most widely used for consumer pack. It has got wider temperature range (50-70ºC) and cheapest. The permeability requirement depends upon rate of respiration of the produce, the package bulk density and storage temperature. Pre-packing of banana fruits is done in 100 gauge polythene bags under room temperature and cold storage.

The gas permeability of package can be controlled by

1. Varying either the **density** of the film
2. Varying **thickness** of the film
3. Providing **perforation/ventilation** to the film

Advantages of pre-packaging of produce

1. ……

2. ……

3. ……

4. ……

5. ……

6. ……

Disadvantage

1. ……

2. ……

Palletization:

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Cushioning materials:

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For the cushioning material to be useful

1. ……

2. ……

3. ……

4. ……

EXERCISE 18

Objective: To study identification of different types of disorders

Crop	Disorder	Symptoms
	Chilling Injury	.....
		.....
		.....
		.....
		.....
	Freezing Injury	.....
		.....
		.....
		.....
		.....
	Blossom end rot	.....
		.....
		.....
		.....
	Cat face	.....
	Cracking	.....
		.....
		.....
Capsicum	Blossom-end rot	.....
		.....
		.....
Onion	Freezing Injury	.....
		.....
	Translucent Scales	.....
		.....
Garlic	Sprouting of bulbs	.....
		.....
	Splitting	.....
		.....

Lady's finger	Chilling injury	.....
		.....
	Freezing injury	.....
		.....
Cucumber	Freezing injury	.....
		.....
Peas	Freezing injury	.....
		.....
	Greening	.....
		.....
	Black heart	.....
		.....
	Chilling injury	.....
		.....
	Freezing injury	.....
		.....
Potato	Black spot	.....
		.....
	Internal Brown Spot	.....
		.....
		.....
		.....
	Hollow Heart	.....
		.....
Brinjal	Chilling Injury	.....
		.....
	Freezing Injury	.....
		.....
Cabbage	Yellowing	.....
		.....
		.....
		.....

	Black Leaf Speck	.....
		.....
		.....
		.....
	Physical Injury	.....
		.....
	Chilling injury	.....
		.....
Cauliflower	Freezing Injury	.....
		.....
	Physical Injury	.....
		.....
Broccoli	Browning	.....
		.....
	Bitterness	.....
	Splitting/ Cracking	.....
		.....
	Cavity spot	.....
		.....
	Freezing injury	.....
		.....
Radish	Freezing Injury	.....
		.....
Beet root	Internal black spot/brown heart/heart rot	.....
		.....
Turnip	Whip tail	.....
		.....
		.....
		.....
Lettuce	Tip burn	.....
		.....