

Unit - 4

Post harvest technology

Objectives :

- To learn the importance of fruits, vegetables, cereals, pulses and other food commodities.
- To understand classification, types and perishability of the agriculture commodities.
- To know the composition and nutritional value of fruits and vegetables.
- To study the procedures while cooking and processing of fruits and vegetables.
- To learn the various methods used for extending post harvest shelf life of the agriculture commodities.
- To learn the importance and used of spices and their products in our diet.
- To gain knowledge about sugar processing and its products.

“Post harvest technology can minimize the losses of fresh food commodities and increases the value addition (products) to crops, horticulture, livestock and fisheries sectors etc.”

Post harvest technology plays a vital role in reduction the wastage of perishable agricultural produce, enhancing shelf life of food products, ensuring value addition to agricultural produce, diversification and commercialization of agriculture, generation of employment, enhancing income of farmers and creating surplus for the export of agro and processed foods.

Farmers produce grains, fruits, vegetables and livestock's whereas farm produces are consumed after post harvest treatment. Therefore, post harvest technology is an important intervention in the agriculture value chain. It is very critical intervention as it reduces post - harvest losses at farmer's level and links the agriculture farm to consumer plate. Post harvest techonology add significantly to income of the farmers.

Contents at a glance

- 9.1 Classification and composition
- 9.2 Importance and uses in diet
- 9.3 Colour pigment and flavouring compounds
- 9.4 Changes during ripening and cooking

Fruits

Fruits and vegetables are living entity containing more amount of water, having perishable nature. Fruits are the ripened ovary or ovaries of a plant, together with adjacent tissues. Fruits are important for their attractive colour, pleasing aroma, sweet taste, crispy and crunchy texture and the nutrients that they contribute to the diet.

9.1 A Classifications and composition:

Classification of fruits: Fruits can be classified on the basis of shape, cell structure, type of seed, or natural habitat etc. They may be grouped into soft fruits, segmented fruits, stone fruits, hard fruits, tropical, subtropical, temperate fruits, etc.

Table 9.1 Classification of fruits

S r. No.	Groups	Examples
1.	Berries and soft fruits	Strawberries, grapes and all berries
2.	Citrus fruits or segmented fruits	Orange, sweet lime, pomelos, grapefruits, mandarins and tangerines
3.	Drupes or stone fruits	Peaches, plums, apricots and cherries
4.	Melons	Watermelon and muskmelon
5.	Pomes and hard fruits	Apple and pears
6.	Tropical and subtropical fruits	Banana, guava, papaya, jackfruits, dragon fruits, custard apple, kiwi fruits.



Fig. 9.1 Fruits

Composition of fruits: Fruits are a complex food commodity, composed of number of nutrients such as water, carbohydrates, fibre, vitamins, minerals and pigments, etc. Nutritive value of some fruits is given in table- 9.2

Water: Fruits tend to be juicy because of their high water content which varies from 75 to 90 percent.

Carbohydrate: Fruits contain good amount of carbohydrates including sugar, starch, cellulose, hemicellulose and pectic substances. Sugar namely fructose, glucose and sucrose give sweetness to the fruit. Cellulose contributes to the textural qualities of the fruits. The sugar and starch content of fruits differ with the type of fruit.

Protein and Fat: All the fruits have small amount of protein and traces of fat, which are negligible.

Do You Know ?

The study of fruits is called Pomology.

Table 9.2 Nutritive values of Fruits (per 100 g edible portion)

Fruits	Moisture (g)	Fibre (g)	Vitamins		Minerals			Energy (kcal)
			Vitamin-C (mg)	Beta Carotene (µg)	Calcium (mg)	Phosphorus (mg)	Iron (mg)	
Yellow & Orange fruits								
Mango	81.0	0.7	16	2743	14	16	1.3	74
Orange	87.6	0.3	30	1104	26	20	0.32	48
Papaya	90.8	0.8	57	666	17	13	0.5	32
Vitamin C rich fruits								
Amla	81.8	3.4	600	9	50	20	1.2	58
Guava	81.7	5.2	212	0	10	28	0.27	51
Lemon	85.0	1.7	39	0	70	10	0.26	57
Sweet Lime	88.4	0.5	50	0	40	30	0.7	43
Pineapple	87.8	0.5	39	18	20	9	2.42	46
Other fruits								
Apple	84.6	1.0	1	--	10	14	0.66	59
Banana	70.1	0.4	7	78	17	36	0.36	116
Custard Apple	70.5	3.1	37	0	17	47	4.31	104
Sapota	73.7	2.6	6	97	28	27	1.25	98
Pomegranate	78.0	5.1	16	0	10	70	1.79	65
Water melon	95.8	0.2	1	0	11	12	7.9	16

Source: Nutritive Value of Indian Foods, National Institute of Nutrition, (ICMR), Hyderabad

Vitamins: Fruits are an excellent natural sources of vitamins. The citrus fruits are especially rich in vitamin C and other fruits contain only small amount. Guava (212 mg / 100 g) and amla (600 mg / 100 g) are the excellent and cheap sources of vitamin C. The yellow and orange fruits such as mango, papaya, and orange contain vitamin A in the form of beta-carotene in large amounts.

Fibre : Most of the fruits are rich sources of fibre.

Minerals: Some of the fruits are fairly good source of mineral. Watermelon and custard apple are rich source of iron. Dry fruits such as apricots, dates and figs are rich sources of calcium and iron.

9.2 A Importance and uses in diet:

- Fruits are a good source of different vitamins and minerals, which help to protect the body from infections and diseases. (known as body protectants)
- Fruits are useful in making colourful and attractive dishes like salads, juices, puddings, fresh fruits cake, jam, jelly, smoothies, etc.
- Fruits contain various aromatic components, which give a pleasant flavour for the preparations like milkshakes, fruit cocktail, ice-cream, *shrikhand*, *burfi* and other such sweets.
- Fresh cut fruits or fresh juices are refreshing and provide vitamin, minerals, and energy to the diet.

- Fruits provide fibre and pomace which help in normal digestion and faecal excretion.

9.3A Colour pigments and flavouring Compounds:

Pigments: Fruits contain colour pigments such as chlorophyll (green), carotenoids (orange) and flavonoids and undergo changes during processing and preparation.

a) Chlorophyll: Chlorophyll gives green colour to the fruits. Unripe fruits contain more amounts of chlorophyll e.g. green grapes, raw mango etc.

b) Carotenoids : Carotenoids are present in yellow and orange coloured fruits. It is not much affected by acid and alkali during processing e.g. papaya, mango etc.

c) Flavonoid: It is a group of pigments, commonly found flavonoids in fruits such as anthocyanins and anthoxanthins.

i) Anthocyanins

Anthocyanins pigment gives red, purple or blue colour to the fruits, e.g. black grapes, jamun etc. These pigments are soluble in water. Alkali changes red colour to bluish green, whereas acid enhances red colour of the fruits. Anthocyanins reacts with metals like aluminium, tin, iron to give a blue, greenish blue or greyish blue colour to the fruits. Thereafter fruit juices need to be stored in non-reactive materials like glass, pet bottles etc.

ii) Anthoxanthins

Anthoxanthins pigments imparts white or cream colour to the fruit e.g. banana, custard apple and guava etc.

Do You Know ?

Purple and blue fruits help to enhance memory.

Table 9.3 Colour pigments in fruits

Pigments	Colour	Name of Fruits
1. Chlorophyll	Green	Raw guava, raw mango, green grapes and Indian gooseberry (amla)
2. Carotenoids	Yellow and orange	Ripe mango, orange, papaya, etc.
3. Flavonoids		
a) Anthocyanins	Red, purple or blue	Cherry, jamun, black grapes, mullberry, pomegranates strawberry, plums, kokum, water melon, etc.
b) Anthoxanthins	White or cream	Banana, apple and guava

Flavouring Compounds:

- Fruits have their characteristics flavor due to the presence of many aromatic compounds like organic acids, sugar, esters, essential oils and minerals.
- Orange and lemon contains some essential oils in the outer covering or skin (oil glands), which can be extracted to prepare essence or emulsion.
- Fruits contain various acids, which contribute to their typical flavour. The most common acids present in fruits are malic acid, citric acid, tartaric acid etc. Grapes contain tartaric acid and malic acid.

- Sweet flavour of fruits is due to the presence of sugar.
- Tannins are usually present in immature fruits and give a bitter or astringent flavour.

Ways to retain colour pigments and flavours:

- Fruits may be stored at a particular optimum temperature.
- Storage temperature varies with the type of fruit. Apple can be stored for a longer period in cold storage. Bananas can remain well at room temperature for few days and turn brown in cold storage at ripening stage due to chilling injury.

- Fresh fruits absorb and emit odours when refrigerated.
- Strong flavoured fruits if cut and kept in the refrigerator, must be stored in airtight containers or polyethylene bags to preserve the natural flavour e. g. guava.
- Fruit juices and cut fruits should be stored or served in non-reactive containers like stainless steel, glass or good quality plastic (food grade) to retain its colour, taste and flavor.
- To prevent browning (discolouration) of cut fruits, use sugar syrup, lemon juice or KMS / NaMS solution, e. g. cut apple piece.

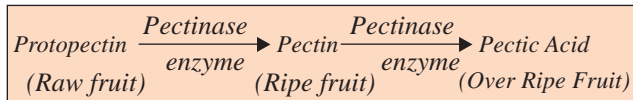
9.4A Changes during ripening and cooking:

Various changes occur in the fruits during ripening and cooking. These include changes in colour, texture, flavour, soluble solids, juiciness, appearance and taste.

A. Changes during ripening:

- **Changes in colour:** Most of the fruits contain both chlorophylls and carotenoids in their peels. In raw stage they appear green in colour because the chlorophylls are predominate pigment at this stage. During ripening, the chlorophyll pigment may be broken down and carotenoid pigment will get synthesized in some fruits. Thus the green pigment tends to disappear and the yellow, orange and red colour of carotenoid pigment becomes more dominant e.g. ripe mango. In some fruits anthocyanins are synthesized during ripening. Anthocyanins pigments give red purple and blue shades to the ripe fruits e.g. jamun, black grapes etc.
- **Changes in texture:** All the fruits contain pectic substances, which are the cementing substances in between the cell walls. The immature or unripe fruits contain

protopectin, which is converted to pectin during ripening by the action of enzyme pectinase. Pectin has gel-forming ability and hence ripe fruits are used for gel / pulp making e.g. ripened guava. In over ripe fruits the pectin gets converted to pectic acid, which does not have same gelling ability. These changes also affect the texture of the fruits as the flesh becomes soft.



- **Development of flavour:** The development of characteristic flavour in ripe fruit involves a decrease in acidity and increase in sugar content. This will also result in production of certain complex mixture of volatile substances and essential oils, which gives the characteristics pleasant sweetness to the fruits. The flavour also indicates the degree of ripeness of the fruits.
- **Changes in soluble solids and taste:** The sweetness of the fruits increases as it ripens because most of the starch is converted to sugar and also the acidity decreases e.g. ripe banana, mango, etc. Tannins, which have astringent properties, become more insoluble. Hence the fruit does not taste astringent anymore and tastes sweets as it ripens.
- B. Changes during cooking:** Cooking results changes in colour, flavour, texture, taste, appearance and nutrients. The following changes are observed during cooking
 - Starch undergoes gelatinization and thickening takes place due to high temp.
 - Cooking results in extraction of pectin from the fruit tissue, which helps in gel formation. This is observed in the preparation of jam or jelly.

- Cooking makes the commodity soft, palatable and digestible. Cellulose present between the cell walls softens hence the fruit becomes soft e.g. cooked apple, guava, mango pieces.
- Loss of water and air results in shriveling of the fruits.
- While cooking, there is loss of vitamin C, therefore, fruits should be preferably eaten without cooking.
- Colour pigments of the fruits usually get oxidised, darkens and becomes dull due to cooking temp. Anthocyanins leaching in water which gives a bluish purple colour to the preparation due to oxidation e.g. addition of black grapes to apple jam, orange, marmalade, etc.
- Flavour of fruits enhances due to cooking but overcooking may result in loss of Flavour, therefore optimum cooking should be done.



Why raw fruits are green?

Vegetables

Vegetables are called protective foods as they are rich in vitamins and minerals.



Fig. 9.2 Vegetables

Definition: Vegetables are those plants or parts of plants that are served either raw or cooked as part of main course of meal.

9.1 B Classification and composition:

Classification of vegetables:

Vegetables are classified according to the part of the plants consumed

1. Green Leafy Vegetables (GLV) :

- Green Leafy Vegetables have a high water content.
- They are fresh and crispy.
- They are low in calories and proteins.

Examples : Spinach, fenugreek leaves, colocasia leaves, amaranth leaves, radish leaves, cabbage, celery, coriander, dill leaves (shepu), etc.

2. Roots, tuber and bulbs:

- These vegetables are rich in carbohydrates.
- They provide good amount of calories due to presence of carbohydrates (starch).
- They can be preserved for a longer time due to low moisture content.

Examples : Beetroot, carrot, colocasia, turnip, potato, sweet potato, yam, tapioca, onion, garlic.

3. Fruit vegetables:

- These vegetables have high amount of moisture and hence are highly perishable and tender.
- They are rich in fibre.

Examples : Cucumber, tomato, gourds, ladies finger, brinjal, pumpkin, capsicum, green chilli, raw jackfruit, drumstick, etc.

4. Seeds:

- Tender seeds of leguminous family are used as vegetables.
- The mature dry legumes are rich in protein as compared to the fresh seeds.

Examples : Peas, beans, tender legumes.

5. Flowers, stem and shoots:

- These vegetables add variety in the diet.
- These also provide a variety of vitamins and minerals especially when used in the raw forms as salads, *koshimbir or raitas*.

Examples : Flowers - cauliflower, broccoli, drumstick flower, banana flower, stems and shoots – lotus stem, colocasia stem, etc.

Table 9.4 : Classification of vegetabes

Sr. No.	Parts of Plant	Examples
1.	Leaves	Spinach, fenugreek, colocasia, amaranth, radish, cabbage, celery, coriander, shepu
2.	Roots, tubers and bulbs	Beetroot, carrot, colocasia, turnip, potatoes, sweet potato, yam, tapioca, onion and garlic
3.	Fruits	Cucumber, tomato, gourds, ladies finger, brinjal, pumpkin, capsicum, green chilli, raw jackfruits, drumstick.
4.	Seeds	Peas, beans, tender legumes
5.	Flowers, stem and shoots	Flowers - cauliflower, broccoli, drumstick flower, banana flower, stem and shoot- lotus stem, colocasia stem, etc.

Composition : Composition of vegetables are as follows and nutritive values are given in table 9.5.

1. **Water:** Most of the vegetables have a high water content. Vegetables remain fresh and crispy due to the presence of water, mostly greater than 75 %.

Do You Know ?

Broccoli is a very good source of protein.

2. **Protein:** Vegetables provide less protein. Seeds of leguminous family (peas and beans) are important source of protein in vegetarian diet.
3. **Carbohydrates:** Carbohydrates provided by vegetables are starch, pectin, fibre (cellulose) and sugar in variable amounts. Roots and tubers contain a high amount of starch and as they mature, starch get converted into sugar. Vegetables fibres and pectin helps in digestion of food.
4. **Fats:** Vegetables have negligible amount of fat.
5. **Vitamins:** In green leafy vegetables vitamin A and vitamin C are abundant. Green leafy vegetables, yellow and orange coloured vegetables provide vitamin A in the form of beta-carotene. Vitamin C and beta-carotene content depends upon freshness of leaves.
6. **Minerals:** Vegetables provide good amount of minerals. Green leafy vegetables provide calcium and iron in sufficient quantity.

9.2B Importance and uses in diet:

- One of the best reasons for including vegetables in the diet is to ensure a natural ample source of vitamins, fibre and minerals.
- Vegetables are important protective foods and are highly beneficial for the maintenance of health and prevention of diseases.
- They contain valuable nutrients, which can be utilized for bodybuilding and repair.
- They add variety to the diet, increase palatability and prevent constipation due to their high fibre content.
- While cooking vegetables, their nutritive value should be preserved to the maximum level.

Table 9.5 Nutritive value of vegetables (Per 100 g edible portion)

Vegetables	Fibre (g)	Moisture (g)	Protein (g)	Fat (g)	Energy (KCal)	Calcium (mg)	Iron (mg)	Beta Carotene (µg)	Vitamin C (mg)
Leafy Vegetables									
Amaranth	1.0	85.7	4.0	0.5	45	397	3.49	5520	99
Coriander	1.2	86.3	3.3	0.6	44	184	1.42	6918	135
Colocasia	2.9	82.7	3.9	1.5	56	227	10.0	10278	12
Fenugreek	1.1	86.1	4.4	0.9	49	395	1.93	2340	52
Drumstick	0.9	75.9	6.7	1.7	92	440	0.85	6780	220
Lettuce	0.5	93.4	2.1	0.3	21	50	2.4	990	10
Radish	1.0	90.8	3.8	0.4	28	265	0.09	5295	81
Shephu	1.1	88.0	3.0	0.5	37	190	17.4	7182	--
Cabbage	0.6	91.9	1.8	0.1	27	39	0.80	120	124
Spinach	0.6	92.1	2.0	0.7	26	73	1.14	5580	28
Roots and Tubers									
Beetroot	0.9	87.7	1.7	0.1	43	18.3	1.19	--	10
Carrots	1.2	86.0	0.9	0.2	48	80	1.03	1890	3
Potato	0.4	74.7	1.6	0.1	97	10	0.48	24	17
Onion	0.4	86.6	1.2	0.1	50	46.9	0.60	--	11
Radish	0.8	94.4	0.7	0.1	17	35	0.4	3	15
Sweet Potato	0.8	68.5	1.2	0.3	120	46	0.21	6	24
Other Vegetables									
Brinjal	1.3	92.7	1.4	0.3	24	18	0.38	74	12
Cauliflower	1.2	90.8	2.6	0.4	30	33	1.23	30	56
Cluster beans	3.2	81.0	3.2	0.4	16	130	1.08	198	49
French Beans	1.8	91.4	1.7	0.1	26	50	0.61	132	24
Cucumber	0.4	96.3	0.4	0.1	13	10	0.60	--	07
Tomato	0.8	94.0	0.9	0.2	20	48	0.64	351	27
Pumpkin	0.7	92.6	1.4	0.1	25	10	0.44	50	02
Capsicum	1.0	92.4	1.3	0.3	24	10	0.57	427	137
Fresh Peas	4.0	72.9	7.2	0.1	93	20	1.5	83	09
Bottle Gourd	0.6	96.1	0.2	0.1	72	20	0.46	--	--
Bitter Gourd	0.8	92.4	1.6	0.2	25	20	0.61	126	88
Tinda	1.0	93.5	1.4	0.2	21	25	0.90	13	18
Ladies Finger	1.2	89.6	1.9	0.2	35	66	0.35	52	13

Source : Nutritive Value of Indian Foods, National Institute of Nutrition, (ICMR), Hyderabad.

Do You Know?

Eating foods with carotenoid can lower the risk of cancer.

9.3B Colour pigments and flavouring compounds :

Classification of Pigments :

Vegetables, apart from their nutritive value are important for their bright colours. The colours results from the various pigments present in their tissues. These pigments are classified as following on the basis of colour and solubility

a) On the basis of colour :

Pigments are classified into three categories.

Chlorophyll - Green colour

Carotenoids - Yellow / orange colour.

Flavonoids i) Anthocyanin - Red purple

ii) Anthoxanthin - Yellow white

Do You Know?

Colour is also used as a guide in quality control and harvesting maturity index.

b) On the basis of solubility :

The plant pigments are classified into two groups.

1) Fat soluble pigments – Chlorophyll and Carotenoid

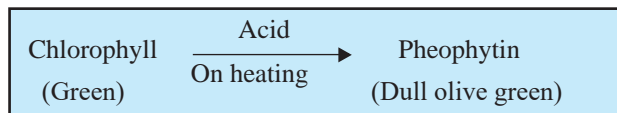
2) Water soluble pigments – Flavonoids

Pigments in detail:

1) **Chlorophyll:** Chlorophyll is the green pigment present in plants. It enables the plants to synthesize carbohydrates by photosynthesis in the presence of sunlight and oxygen. Chlorophyll is mostly concentrated in green leaves, which give a green colour to leaves. Chlorophyll is insoluble in water and soluble in fat.

Effect of acid, alkali and heat on Chlorophyll:

Effect of acid: When vegetables are cooked in acidic medium like lemon or tomato, the green colour changes to the Olive green. Due to the action of acid, Chlorophyll changes to Pheophytin.



Effect of alkali: While cooking the green vegetables, if cooking soda (sodium bi carbonate) is used, green colour changes to bright green colour due to formation of Chlorophyllin and if excess soda is added the vegetables tends to be mushy in texture.

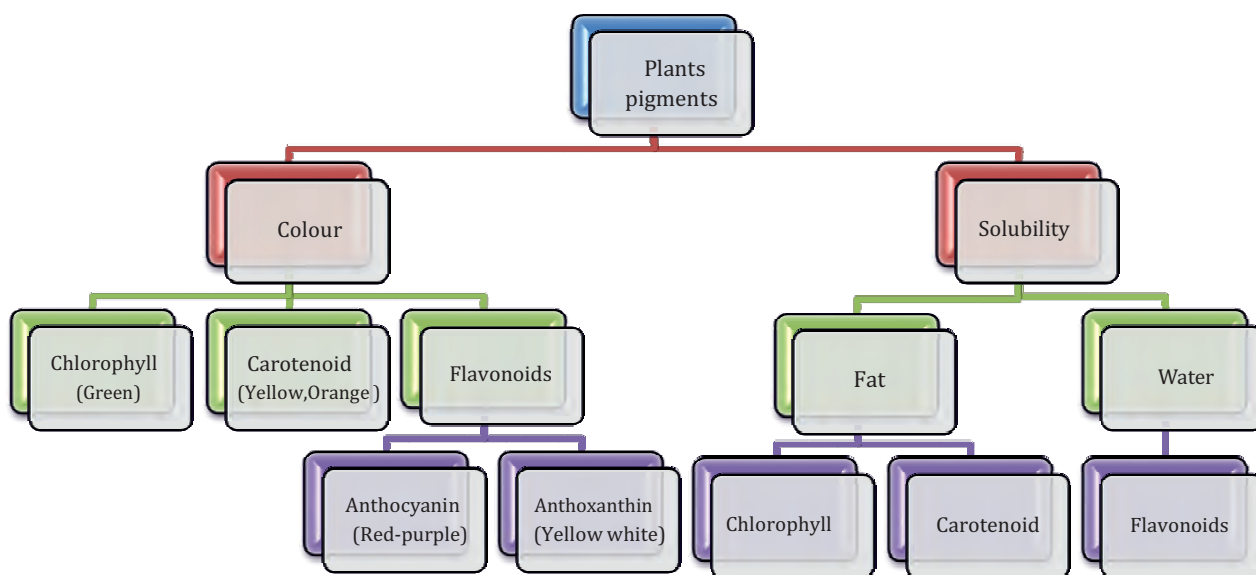
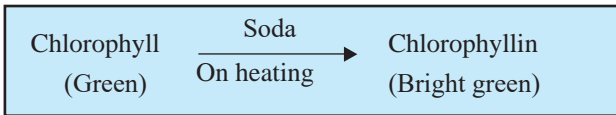
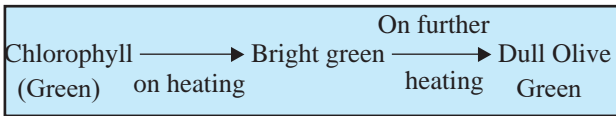


Fig. 9.3 Classification of plants Pigments



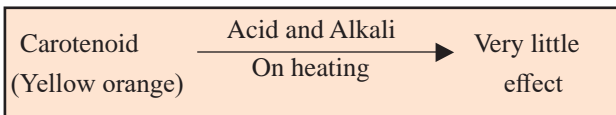
Effect of heat: Chlorophyll pigment is affected by heat. On heating, green colour becomes bright green. On further heating, acids are liberated and the colour changes to dull olive green.



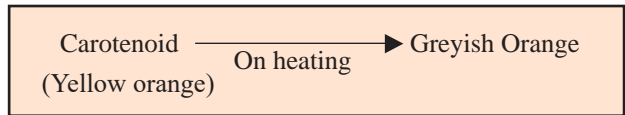
2) **Carotenoid:** Carotenoids include yellow, orange, and red orange pigments. They are fat-soluble pigments. The name carotenoid is derived from the pigment carotene, which is present in carrots. The red pigment in tomato called lycopene is included in carotenoids.

Effect of acid, alkali and heat on carotenoids :

Effect of acid and alkali The presence of acid and alkali have very little effect on the colour of carotenoid pigments.



Effect of Heat: On excess heating, yellow orange colour changes to greyish orange.

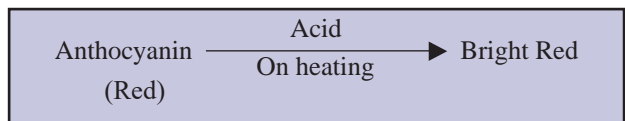


3) **Flavonoids:** Flavonoids are water soluble pigments which include Anthocyanins and Anthoxanthins.

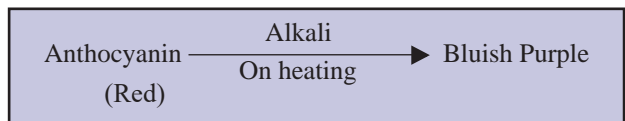
a) **Anthocyanins :**

Anthocyanins are red colour pigments, which are easily soluble in water. They are present in beetroot in the form of Betanin. It is highly water soluble so the colour is leached in the water. Therefore the vegetable should be cooked in the whole form with the skin.

Effect of acid, alkali and heat on Anthocyanin: In acidic medium colour changes to bright red.



Effect of Alkali: In alkaline medium colour changes to bluish purple.



Effect of Heat: Heating has very little effect on Anthocyanin.

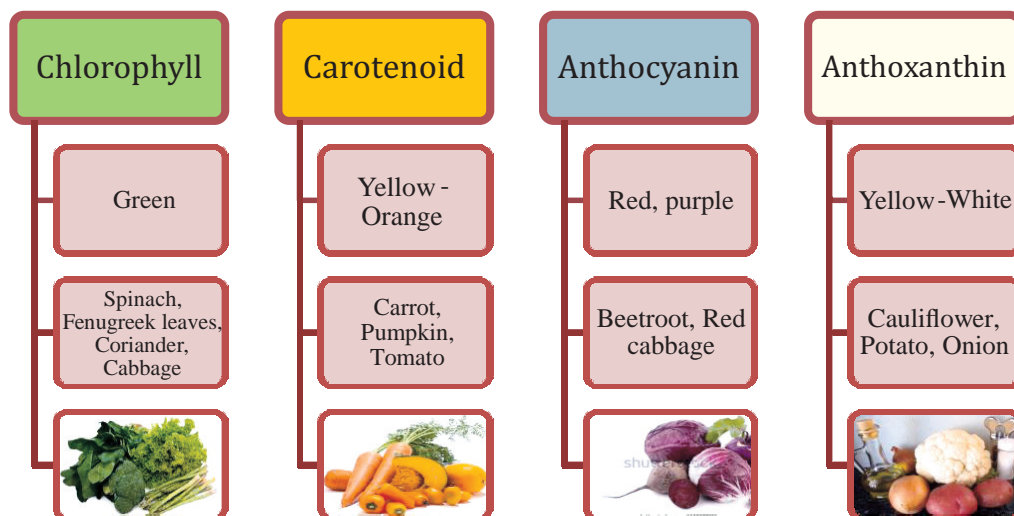


Fig. 9.4 Classification of pigments according to colour

Table 9.6 : Effect of Acid, Alkali and Prolonged heat on the colour pigments

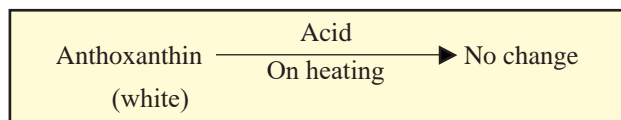
Sr. No.	Name of the pigment	Solubility	Acid	Alkali	Prolonged heating
1.	Chlorophyll	Fat	Olive Green	Intense Green	Olive Green
2.	Carotenoid	Fat	Little Effect	Little Effect	Little Effect, may darken if excess
3.	Flavonoids				
a.	Anthocyanins	Water	Bright red	Purple or Blue	Little Effect
b.	Anthoxanthins	Water	White	Yellow	Darkens if excess

b) Anthoxanthins:

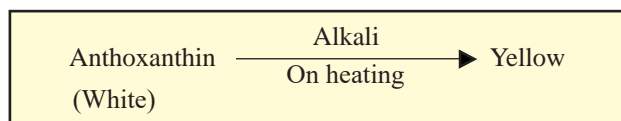
Anthoxanthins are water soluble and colourless pigments. They include two pigments i.e Flavones and Flavonols. These pigments are present in potatoes, onion, cauliflower and others.

Effect of acid, alkali and heat on Anthoxanthins :

Effect of acid: There is no change in colour in acidic medium and remains white in this medium.



Effect of alkali: In alkaline medium, colourless vegetables change to yellow colour.

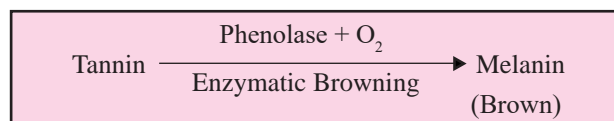


Effect of heat: There is no effect of heat on this pigment. If heating is excessive it darkens.

Tannins :

Some of the vegetables may become dark or brown when cut or exposed to air due to the presence of colourless phenolic substance called Tannin e.g. potato, brinjal, raw banana.

Vegetables when exposed to air, convert tannin (colourless) to melanin (brown) with the help of enzyme phenolase in the presence of oxygen.



This change in colour is known as enzymatic Browning.

To prevent enzymatic browning:

- Vegetables like potatoes should be cooked in the whole form with the skin.
- Vegetables should be chopped and immediately dipped in water.
- Chopped vegetables should be cooked immediately.



Fig. 9.5 Browning Reaction

Flavouring Compounds

Vegetables have different characteristic flavours, which would add to the palatability of the food. Some of them have mild flavour and others have strong distinctive flavours. Carrots give sweet taste and flavour because of their

high sugar content. Spinach has a slightly bitter flavour. Similarly certain vegetables such as onion, cabbage, cauliflower and mustard leaves have strong flavours. The natural flavour of these vegetables may be due to the presence of many compounds such as sulphur compounds, volatile oils, aldehydes, alcohols, ketones, and organic acids. Each vegetable has its unique individual flavour as a result of mixture of many of these compounds in varying combinations and amounts.

Mild flavoured vegetables: The vegetables such as carrots, peas and potatoes are mild in flavour and will become strong with prolonged cooking. Even slight overcooking of mild vegetables may cause loss of flavour and nutrients. Cooking should bring out or enhance the flavour of vegetables. Improper methods or overcooking may result in loss of flavour or may develop an undesirable flavour.

Vegetables having strong flavour in the raw state: Vegetables like onions and garlic have strong flavour and tend to lose the strong flavour when they are cooked in water. When onions are peeled or cut, they produce certain volatile compounds, which irritate the eyes and cause their watering. This is due to the conversion of sulphur compounds to volatile sulphur compounds due to enzyme action in tissues. These vegetables may be cooked in such a way so as to retain desirable amount of flavour after cooking. If mild flavour is required, then the onions should be cooked in plenty of water, without covering the pan. If strong flavour is desired, then onions should be cooked in minimum amount of water in a covered pan.



Why do our eyes water while cutting onions?

Vegetables having mild flavour in the raw state: The vegetables like cabbage and radish have a mild flavour in the raw state and

may develop a strong flavour when overcooked or improperly cooked. On cooking volatile sulphur compounds are formed which should escape in order to maintain the flavour. Hence, these vegetables should be cooked without a cover and must not be pressure cooked.



Why Cauliflower should not be pressure cooked or cooked without cover?

9.4 B Changes during cooking:

(a) Changes in nutrients, flavour and colour pigments:

Vegetables are cooked to soften the cellulose and to increase the digestibility of starch. Cooking may change the flavour of vegetables and make them more palatable.

➤ Changes in nutrients :

i) Changes in carbohydrates:

- Cellulose absorbs water and becomes soft on cooking.
- Presence of acidic medium toughens cellulose whereas cooking soda softens it.
- On application of moist heat, starch present in vegetables undergoes partial or complete gelatinization.
- On application of dry heat or frying, dextrinisation takes place as seen in potatoes, which are deep fried.

ii) Changes in Proteins:

- Though vegetables are not rich source of proteins, whatever little protein is present it undergoes coagulation.

iii) Changes in vitamins: Loss of vitamins may take place due to the following reasons.

- **Exposure to heat:** Many vitamins such as Vitamin C and thiamine are susceptible to heat so cooking destroy these vitamins to some extent.
- **Oxidation:** Vitamin C rich vegetables

when cut and exposed to air undergoes oxidation, hence these vegetables should not be cut and kept for a longer period.

- **Due to solubility in water:** Vegetables, rich in water soluble vitamins are cooked in water, may lose vitamin significantly.
- **Use of cooking soda:** Results in loss of B complex vitamins.

iv) Changes in water content:


- If moist heat method of cooking is used, water is absorbed by the vegetables.
- Dry heat methods like baking result in dryness due to loss of water to some extent.
- In high moisture vegetables like tomatoes, leafy vegetables, water is released from the cells due to cell breakdown.

➤ **Changes in flavour:** Change in flavour of vegetables may occur during cooking depending on the types of vegetables used.

➤ **Changes in colour pigments:** Table 9.6 shows effect of various factors on the colour pigments during cooking.

Why vegetables are important?

Vegetables are good sources of



- Carbohydrates
- Protein
- Vitamins
- Minerals
- Fat (little amount)
- Water

Fig. 9.6 Importance of Vegetables

(b) Ways to minimise quantitative and qualitative losses during cooking of vegetables:

While cooking vegetables the main objective is to minimise losses of natural

flavours, colours and nutrients so that their quality as well as the nutritive value can be maintained. Following are the ways to minimise losses while cooking vegetables:

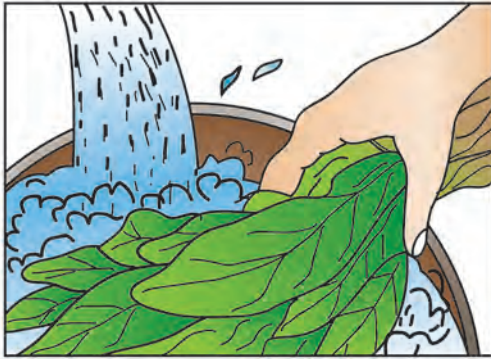
1. Wash the vegetables thoroughly before peeling and cutting.
2. Peel the vegetables as thinly as possible to preserve the nutrients present under the skin.
3. In order to avoid nutrient losses, do not finely chop the vegetables.
4. Raw vegetables can be used in the form of salads, *raitas* to add colour, texture to the meal and also to prevent the loss of nutrient during cooking.
5. Salads should be prepared just before serving.
6. Acid foods such as lime juice, tomato, vinegar and curd can be used as salad dressings to prevent browning and prevent loss of vitamin C from the vegetables.
7. Vegetables should be cooked in just enough liquid.
8. Cut vegetables should be added to the boiling water to reduce the cooking time.
9. All vegetables except strong flavoured vegetables should be cooked in a closed pan to minimise the nutrient losses.
10. Development of strong flavour of sulphur containing vegetables and discolouration of green leafy vegetables can be prevented if they are left uncovered for few minutes of cooking.
11. Vegetables should be cooked until just done and should not be overcooked.
12. Avoid contact with acid foods like lime juice, tomatoes for green leafy vegetables and alkaline substances such as soda for red vegetables to preserve the natural colour of the vegetables.

13. Do not use soda to retain the green colour of leafy vegetables as it results in loss of vitamin C and B complex vitamins and makes the vegetables mushy.
14. Cook roots and tubers like potato, sweet potato and beetroot with the skin to retain

the colour, flavour and nutrients.

15. Do not discard the cooking water if vegetables are properly washed as it can be used for soups or gravies.

Do



Wash vegetables before cutting.

Don't



Cutting the vegetables before washing results in loss of vitamins.



Use a sharp knife.



Use of blunt knife results in loss of vitamins.

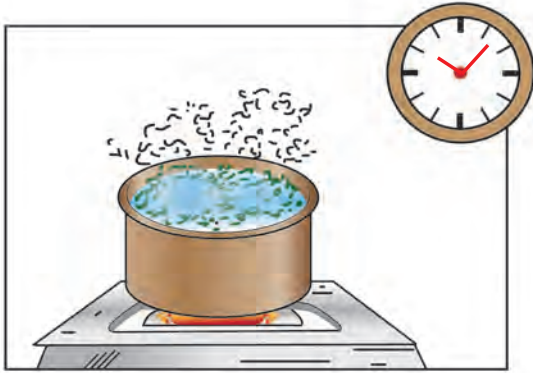


Use hot water.



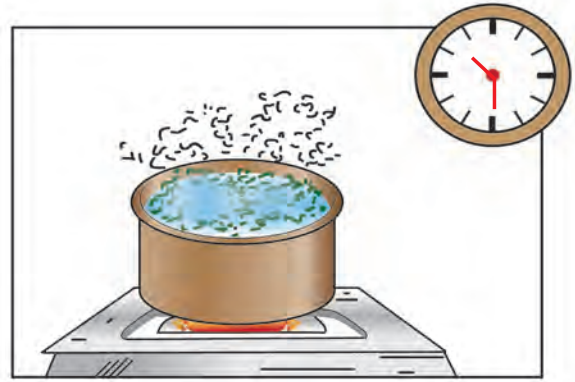
Use of cold water increases cooking time.

Do

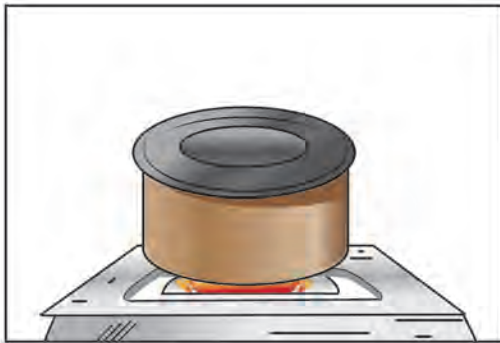


Use correct temperature and time for cooking.

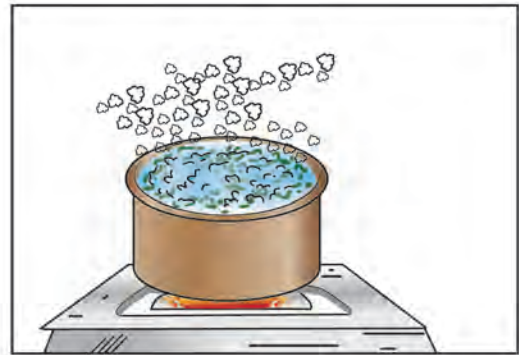
Don't



Over cooking.



Cover and cook.



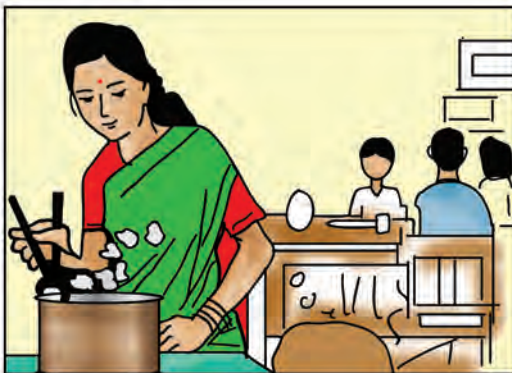
Uncovered cooking.



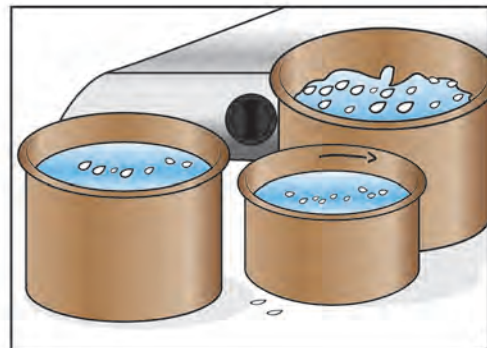
Use just enough water.



Discarding the left over water.



Cook food just before serving.



Bulk cooking.

Points to remember

For Fruits

- Fruits can be classified on the basis of shape, cell structure, type of seed, or natural habitat.
- Fruits are good source of water, carbohydrates, fibre vitamins and minerals
- They contain colour pigments such as chlorophylls, carotenoids and flavonoids.
- Fruits contain flavor compounds such as organic acids, sugars, tannins, minerals salts and essential oils.
- During ripening, fruits undergo changes in colour, texture, flavour and taste.
- Some fruits turn brown when cut and exposed to air. This can be prevented by addition of acid, sugar or cream to the fruits.
- Cooking results in changes in colour, flavor, appearance and nutrients present in fruits.

For Vegetables:

- Vegetables are different parts of the plants that are used as food either in raw or cooked form.
- Vegetables are classified on the basis of

the part of the plant used.

- The dark green leafy vegetables have high water content and are rich sources of beta carotene, vitamin C, iron, calcium and fibre.
- The roots and tuber vegetables mainly provide calories due to their starch content and have a small amounts of vitamins and minerals except carrots, which are an excellent source of beta carotene
- Other vegetables have small amount of vitamins, minerals and fibre.
- The colour of vegetables is due to the presence of various colour pigments namely chlorophyll, carotenoids and flavonoids
- Vegetables such as potato turn brown when cut and exposed to air due to enzymatic browning
- Selection of cooking method is important to retain the colour, flavour and nutrients of vegetables.
- Consumption of raw vegetables in the form of salads is advisable to minimize the loss of nutrients.

Exercise

Q.1 (a) Select the most appropriate option:

- Overripe fruits contain pectic substances in the form of _____
(Pectic acid, Protopectin, Pectin)
- Loss of water and air results in _____ of fruits.
(Expansion, shriveling, remain same)

- Citrus fruits contain vitamin _____
(A, C, D)
- Black grapes contain _____ Pigment.
(Chlorophyll, Carotenoids, Anthocyanin)

- v. Chlorophyll is _____ pigment present in plant.
(Green, Red, Brown)
- vi. _____ are fat soluble pigments.
(Anthocyanins, Carotenoids, Anthoxanthins)
- vii. The green leafy vegetable are a good source of_____
(Vitamin A, Vitamin E , Vitamin K)
- viii. _____ enzyme causes browning of vegetables
(Phenolase, Melanin and Rennin)
- ix. Roots and tubers are rich in _____
(Starch, Vitamins, Iron)
- x. Anthoxanthins are water soluble and _____ pigments.
(Colourless, Odourless, Tasteless)

(b) Match the following:

A	B
i. Chlorophyll	a. Indian Gooseberry (Amla)
ii. Fruit Juices	b. Raw mango
iii. Vitamin C	c. Ripe Jamun
iv. Anthocyanin	d. Ripe Mango
v. Carotenoid	e. Non Reactive Containers
vi. Flavouring Compound	f. Anthoxanthin
	g. Essential oil

ii. Match the following:

A	B
i. Red Cabbage	a. Anthoxanthin
ii. Spinach	b. Vitamin C
iii. Lemon	c. Strong flavoured
iv. Radish	d. Vitamin A
v. Garlic	e. Anthocyanin
vi. Carrots	f. Carotenoid
	g. Onion

(c) State whether the following statements are true or false:

- Banana is an excellent source of Vitamin C.
- Dry fruits are rich sources of minerals.
- Fruit juices should be stored in aluminium container.
- Orange and Papaya contains Vitamin A.
- Chop the vegetables before washing.
- Salads should be prepared just before serving.
- Addition of soda to vegetables while cooking increases vitamin B content.
- Cooking water should be discarded.
- Cook vegetables in just enough water.

Q.2 Name the following :

- Pigment present in black grapes
- Flavour compound in fruits
- Pigment present in carrot
- Pigment present in green leafy vegetables
- A flavouring compound in vegetable
- Compound formed when green leafy vegetable are cooked with acid
- The pigment present in cauliflower.
- Browning reaction in fruits and vegetables

Q.3 Short answer questions

(a) Write short notes on the following

- i. Chlorophyll in fruits
- ii. Ways to retain colour pigment and flavor in fruits
- iii. Importance of fruits in diet
- iv. Changes during cooking of fruits
- v. Carotenoids
- vi. Flavonoids
- vii. Changes during cooking of vegetables
- viii. Tannins

(b) Give reasons

- i. Fruits become soft on ripening
- ii. Raw Amla (Indian Gooseberry) is astringent
- iii. Fruits when cut turn brown
- iv. Sweetness increases on ripening of fruits
- v. Cauliflower should not be pressure cooked
- vi. Sweet potatoes should be cooked with skin
- vii. When onions are cut the eyes start watering
- viii. Soda should not be used while cooking green vegetables

Q.4 Long answer questions

- i. Explain in detail the changes taking place during ripening of fruits.
- ii. Name the colour pigments present in fruits and explain the effect of acid or alkali on the pigments.
- iii. Explain in details the precautions to be taken to avoid quantitative and qualitative losses during and before cooking the vegetables.
- iv. Name the colour pigments present in vegetables and write the changes during cooking.

❖ Project:

- i. Select five recipes using fresh fruits and five recipes of preserved fruit products and prepare an attractive booklet.
- ii. Select three recipes for each colour pigment. Prepare an attractive booklet of these recipes.

