

POST HARVEST PHYSIOLOGY

FRUIT RIPENING

32.1 Definition: Ripening may be defined as those nonreversible, diverse, physical, chemical and qualitative changes that render the fruit attractive for consumption at the transition phase following maturation.

32.2 Metabolic changes during fruit ripening :

During the post harvest handling and storage period, an attempt is generally made to maximize control over textural changes to prevent, synchronize or accelerate the process.

32.2.1 Seed maturation

Quality attributes

32.2.2 Changes in pigmentation

- a) Degradation of chlorophyll
- b) Unmasking of existing pigments
- c) Synthesis of carotenoids
- d) Synthesis of anthocyanins

Color

fruit ripening is usually associated with changes in the color of the fruit which is due to changes in the pigment composition of chlorophyll, carotenoids and anthocyanins. In the ripening fruit, there is a fast disappearance of chlorophyll accompanied by accumulation of red and yellow carotenoid pigments in the chloroplast. As the tomato fruit matures, the predominant carotenoid that is synthesized is **carotene**. Some fruits like grapes, pomegranate produce anthocyanins when mature. In tomato another pigment accumulates during ripening is **Lycopene**.

32.2.3 Softening

- a) Changes in pectin composition
- b) Possible alterations in other cell wall components
- c) Hydrolysis of storage materials

Texture

Softening may be a detrimental quality in some fruits like cucumber, squashes which are consumed in unripe state. In others, it is an essential component in the development of optimum quality. With the progress of ripening the fruit softens. The softening is due to enzymatic hydrolysis of polysaccharides. The cell wall is made up of cellulose, hemicellulose, calcium pectate, polyuronides, and glycol protein. The important cell wall hydrolyzing enzymes like pectin methyl esterase (PME), polygalacturonase (PG) and cellulase increase during ripening and the dissolution of middle lamella is observed. This is accompanied by an increase in the enzyme PME.

Another enzyme poly galacturonase (PG) which is not present in green tomato appears during ripening. This enzyme hydrolyses oligo galacturonoids.

32.2.4 Change in carbohydrate composition.

- a) Starch conversion to sugar
- b) Sugar inter conversions

32.2.5 Production of aromatic volatiles

32.2.6 Changes in organic acids

Flavor

During ripening, starch hydrolysis occurs, and sugar accumulates. For example starch content of banana decreases from the initial 21% to about 1% in ripened fruit. This is accompanied by accumulation of sugars mainly sucrose to the extent of up to 20% by fresh weight. The taste of the fruit depends upon the sugar-acid ratio and also on the absolute level of sugar and acid contents. The PH of all the fruits is in the acidic range.

32.2.7. Fruit abscission occurs.

32.2.8 Changes in respiration rate (respiration rate increases).

32.2.9 Increased permeability of tissue.

32.2.10. Quantitative and qualitative changes in protein occur.

32.2.11 Development of surface waxes occurs.

32.3 FACTORS INFLUENCING FRUIT RIPENING

A) Temperature affects the rate of synthesis of specific pigments and their final concentration in the fruit. The optimum and maximum temperature for synthesis of a specific pigment varies between species. For eg. Lycopene synthesis in tomato is inhibited above 30°C whereas in watermelon synthesis is not prevented until the fruit temperature rises above 37°C.

B) Oxygen is essential for carotenoid synthesis and increasing the oxygen concentration enhances the synthesis of this pigments.

32.4 Climacteric and non- climacteric Fruits: Fruits of different species vary in their ability to ripe, when detached from the parent plant. Many fruits must be harvested only when fully ripe eg. **Grape, cherry, lemon** etc. they are not capable of ripening after detachment and are called **non climacteric fruits**. Other fruits **like apple, banana, tomato** can be harvested unripe but after fully mature stage. They can undergo normal ripening even though detached from the parent plant and are called **climacteric fruits**. These fruits often, undergo hydrolytic conversions in storage materials and synthesize the pigments and flavors associated with a ripe fruit.

32.5 HORMONAL REGULATION OF RIPENING

32.5.1 Ripening Induction

Application of ethephon promotes degreening and early ripening in grape, tomato, coffee, peach, pear, plum and citrus. Smoking is commercially employed to hasten degreening and ripening of banana and mango. Calcium carbide release acetylene, on hydrolysis of which hasten ripening process. ABA (1 ppm) Thiourea (20%), CCC (4000ppm) (2 chloro ethyl – trimethyl ammonium chloride), Etherel (200-300 ppm) sprays one week before harvest hastens ripening.

32.5.2 Delay of Ripening

The self life of fruits like apple, banana and other can be improved by storing the fruit in low oxygen tension (2-3%) or by absorbing ethylene with a suitable absorbent like alumina or silica gel impregnated with potassium permanganate. Another commercial practice is to preserve the fruits in cold storage. Maleic Hydrazide, GA(10^{-6} M), IAA (10^{-6} M), Kinetin (10^{-5} M), sprays one to two weeks before harvesting and post harvest dip of cycocel, Alar, GA (150 ppm), vit K₃ (menadione Sodium bisulfite), KMnO₄, CaCl₂, waxol delays ripening.

32.5.3 Sugarcane Ripening

Glyphosine, glyphosate and ethephon hasten ripening of sugarcane. Other compounds like chlormequat, mefluidide, Polaris and ripenthol also used for sugarcane ripening.

32.5.4 USE OF HORMONES TO IMPROVE SHELF LIFE OF CUT FLOWERS

The use of preservative solutions to promote the quality and longevity of cut flowers is known for many years. Flower preservatives are composed mainly of sugars and germicides and some times include mineral solutes, organic acids, salts, antioxidants and ethylene inhibitors. Use of hormones in preservation solution is relatively limited. However cytokinins are widely used.

Sl. No.	Type of compound	Crop plants	Optimum conc. And purpose	Nature of action
1	Cytokinins (kinetin, BA, IPA, PBA)	Carnations, rose, iris, tulip, gerbera, anthurium	<ul style="list-style-type: none"> • 100 ppm for pulsing • 10-100 ppm for bud opening & holding solution 	<ul style="list-style-type: none"> • Ethylene production is reduced. • Burst in ethylene production is delayed. • Improved water uptake and maintained turgidity.

2	Auxin (2-4D)	Carnation	<ul style="list-style-type: none"> • 500 ppm for holding solution 	<ul style="list-style-type: none"> • Inhibits ethylene production • Retards petal senescence
3	GA3	Carnation gladiolus	<ul style="list-style-type: none"> • 200 ppm holding solution, • 20-35 ppm for bud opening 	<ul style="list-style-type: none"> • Delays senescence
4	ABA		<ul style="list-style-type: none"> • 1 ppm in continuous holding solution • 10 ppm for 1 day 	<ul style="list-style-type: none"> • Delays wilting by stomatal closure
5	Growth retardants B-Nine	Snap dragon carnation roses	<ul style="list-style-type: none"> • Snapdragon 10-50 ppm • Carnation & roses – 500 ppm for pulsing & 125 ppm for holding solu 	<ul style="list-style-type: none"> • Delays senescence
	Chlormequat	Gladiolus, tulip & carnation	<ul style="list-style-type: none"> • 20-50 ppm for bud opening • 10 ppm for holding solution 	<ul style="list-style-type: none"> • Delays senescence
6	Inhibitors Eg. MH	Snap dragon, lupine	<ul style="list-style-type: none"> • 0.5-1% for 30 min for pulsing • 250-500 ppm for holding solution 	<ul style="list-style-type: none"> • Reduces respiration of flowers • Slows down metabolism, ageing & development
