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Maturity indices of fruit crops

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In postharvest physiology we consider "mature" as "that stage at which a commodity has reached a sufficient stage of development that after harvesting and postharvest handling to be done, its quality will be at least the minimum acceptable to the ultimate consumer". Maturation is the stage of development leading to the physiological maturity (when a plant or plant parts will continue ontogeny even if detached) or horticultural maturity (when a plant or plant parts possesses the pre-requisites for utilization by the consumer for a particular purpose). Maturity indices help in deciding that when a given commodity should be harvested to provide some marketing and to ensure the attainment of acceptable eating quality to the consumer. Fruits are picked at wrong stage of maturity may develop physiological disorders in storage and may exhibit poor dessert quality. For selecting the harvest maturity of fruits or vegetables it should be kept in mind that harvested commodity should have its peak acceptable quality (nontoxic, size, appearance and flavour with adequate shelf life). Quality indices consist of a combination of visual appearance, texture & flavour. The principles dictating at which stage of maturity a fruit should be harvested are crucial to its subsequent storage and marketable life and quality. Post-harvest physiologists distinguish three stages in the life span of fruits and vegetables: **maturation, ripening, and senescence.** Maturation is indicative of the fruit being ready for harvest. At this point, the edible part of the fruit is fully developed in size, although it may not be ready for immediate consumption. Ripening follows or overlaps maturation, rendering the produce edible, as indicated by taste. Senescence is the last stage, characterized by natural degradation of the fruit, as in loss of texture, flavour etc. Some typical maturity indexes are described in following sections. The maturity has been divided into four categories:

1. **Physiological maturity:** It is the stage when a fruit is capable of further development or ripening when it is harvested i.e. ready for eating or processing.

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2. **Horticultural maturity:** It refers to the stage of development when plant and plant part possesses the pre-requisites for use by consumers for a particular purpose i.e. ready for harvest.
3. **Commercial maturity**

   It is the state of plant organ required by a market. It commonly bears little relation to physiological maturity and may occur at any stage during development stage.
4. **Harvest Maturity: It** may be defined in terms of Physiological maturity and horticultural maturity, it is a stage, which allows fruits at its peak condition when it reaches to the consumers and develop acceptable flavour or appearance and having adequate shelf life.

Principle of harvest maturity:

a) Harvested commodity should have its peak acceptable quality when it reaches the consumer.

b) Produce should develop an acceptable flavour or appearance.

c) Produce should have optimum size and shape required by the market.

d) It should not be toxic or unacceptable.

e) Harvest maturity should have adequate shelf life.

Maturity indices of different fruit crops

S.No	Fruits	Maturity Indices
1.	Mango	a) Tapka stage b) Specific gravity (1.0-1.02 for Alphonso & less than 1.0 for dashehari). c) White powdery like appearance on skin of mature mango. d) Change in fruit shape (fullness of the cheeks) e) Days to fruit set (110-125 days for Alphonso and Totapuri). f) Change in skin color from dark-green to light-green to yellow (in some cultivars). g) TSS 12-15 % (Measured by hand refractometer) h) Change in flesh color from greenish-yellow to yellow to orange.
2.	Banana	a) Degree of fullness of the fingers i.e., disappearance of angularity in a

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		cross section. b) Skin and pulp ratio (1.20:1.40 for Dwarf Cavendish). c) Drying of plant parts. d) Acid content 0.25% e) Days to fruit set (90 days for Dwarf Cavendish). f) Bananas are harvested mature-green and ripened upon arrival at destination markets.
3.	Citrus	a) All citrus are non-climacteric fruits, they ripe gradually over weeks or months and are slow to abscise from the tree. b) External color changes during ripening, but is a function of climate more than ripeness and a poor indicator of maturity. c) TSS 12-14% for mandarin and for sweet orange 10-12% d) By acidity (mandarin 0.4%, sweet orange 0.3%) e) The best indices of maturity for citrus are internal: ^{o}Brix (sugar), acid content and the ^{o}Brix/acid ratio (mandarin 12-14 ^{o}Brix, sweet orange 12 ^{o}Brix).
4.	Papaya	a) Change of skin color from dark-green to light-green with some yellow at the blossom end (color break). b) TSS 7-11% c) A minimum soluble solids of 11.5% is required d) Uniformity of size and color, firmness, freedom from defects such as sunburn, skin abrasions, pitting, insect injury and blotchy coloration, freedom from decay.
5.	Guava	a) Guava fruits are picked at the mature-green stage (color change from dark- to light-green), TSS 12-14 % b) Color is a good indicator of ripeness stage c) Size and shape may be important in some markets d) Freedom from defects, insects and decay e) Firmness and extent of gritty texture due to the presence of stone cells (sclereids) f) Flesh color depends on cultivar, it can be white, yellow, pink, or red

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6.	Sapota	a) Skin color change from light-brown with a tinge of green to light-brown to dark-brown. b) Weight of fruit 65-70 gms c) Flesh yellow streak when scratched with finger nail d) **Appearance:** Size, shape (oval), color, freedom from defects and freedom from decay. e) Firmness (firm-ripe sapotes are preferred). f) Flavour is related to soluble solids content (13-26%) and acidity (0.2-0.3%).
7.	Jackfruit	a) Jackfruits can reach very large size (as much as 90 cm long, 50 cm wide, and 25 kg in weight), depending on the cultivar, production area, and the fruit load on the tree. b) Color change from green to yellow to brown is used as an indication of maturity and ripeness stages. c) Optimum harvest for long-distance transport is when the fruit changes color from green to yellowish-green. d) Freedom from defects (sunburn, cracks, bruises) and decay e) Jackfruits contain 25-30% carbohydrates (fresh weight basis) including about 15-20% starch in unripe fruits that is converted to sugars (sucrose + glucose + fructose) in ripe fruits. f) The unripe fruit is used as a starchy vegetable, either boiled or roasted, and when ripe it is used as a dessert fruit. Average acidity is 0.25% citric acid. g) Jackfruit fruit lets are commonly sold in producing countries as a fresh-cut product.
8.	Aonla	a) There are number of factors affect the maturity of fruits such as location, variety, climate, season, nutrition, soil type and moisture etc. b) The maturity indices of aonla fruits are change of seed color from creamy white to brown black.
9.	Pomegranate	a) External red color (depending on cultivar) b) Red color of juice

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		c) Acidity of juice below 1.85%
10.	Ber	a) Ber mature 150-1 75 days after flowering. b) Green to golden yellow color c) Seed/stone ratio: 12 to 18 d) TSS 15-18%
11.	Apple	a) T-Shape b) Color c) Size d) Firmness as measured by pressure tester e) Days after full bloom (DAFB) f) Percent soluble solids (or sugar levels)

Conclusion:

It is important to deliver high quality fruits to the consumers and reducing post-harvest losses and thus it can be achieved by picking them at optimum maturity along with other measures. Much information is available about growth, maturity and respiration; however, more research is needed to develop indices based on them which are economic, easy to learn and apply at the field.