

## Post Harvest Technology and Value Addition in Fruits

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Dryland Horticulture and Agri-Horticultural systems as an alternate land use system have gained much importance in recent years, as the fruit crops are highly remunerative for replacing subsistence farming and thus alleviate poverty level in rainfed, dryland, hilly and arid ecosystems. These crops have potential for development of wastelands through planned strategies, need comparatively less water than food crops, provide higher employment opportunity and environment-friendly. Fruits are undoubtedly very important for nutrition security with high potential of value addition and foreign exchange earnings.

Tropical fruits are now considered as an important item of commerce as they have gained enormous market potential. Post-harvest losses of fruits and vegetables are more serious in developing countries than those in well-developed countries. The total losses from harvest to the consumer point are as high as 30-40%, which is worth thousands of crores of rupees. About 10-15% of fresh fruits and vegetables shrivel and stale, lowering their market value and consumer acceptability. Minimizing these losses can increase their supply. It will also keep pollution under control. Improper handling and storage cause physical damages due to tissue breakdown. Mechanical losses include bruising, cracking cuts, microbial spoilage by fungi and bacteria, whereas physiological losses include transpiration, pigments, organic acids and flavour. About 30% of fruit decay due to *Penicillium* species.

Tropical fruits, which are at present under-utilized have an important role to play in satisfying the demand for nutritious, delicately flavoured and attractive natural foods of high therapeutic value. They are in general accepted as being rich in vitamins, minerals and dietary fibre and therefore are an essential ingredient of a healthy diet (Table). Apart from nutritive, therapeutic and medicinal values quite a few of these tropical fruits have excellent flavour and very attractive colour. Fruits like jamun and phalsa are highly perishable. Bael fruit is not an easy to eat out of hand item. Many people because of its strong astringent taste do not like fresh Aonla fruit. However, these fruits have unlimited potential in the processed form and consumers all over world can get opportunity to enjoy the fruits in the form of their processed products.

**Table: Composition of some tropical fruits (per 100 g if edible portion)**

Fruits	Edible portion (%)	Moisture (%)	Protein (g)	Fat (g)	Minerals (g)	Fiber (g)	Carbo-hydrates (g)	Carotene (g)	Vitamin (mg)
Aonla	89	81.8	0.5	0.1	0.5	3.4	13.7	9	600
Bael	64	61.5	1.8	0.3	1.7	2.9	31.8	55	8
Custard apple	45	70.5	1.6	0.4	0.9	3.1	23.5	-	37
Jackfruit	30	76.2	1.9	0.1	0.9	1.1	19.8	175	7
Guava	100	81.7	0.9	0.3	0.7	5.2	11.2	0	212
Jamun	75	83.7	0.7	0.3	0.4	0.9	14.0	48	18
Mango	74	81.0	0.6	0.4	0.4	0.7	16.9	2743	16
Phalsa	69	80.8	1.3	0.9	1.1	1.2	14.7	419	22
Pomegranate	68	78.0	1.6	0.1	0.7	5.1	14.5	0	16
Sapota	83	73.7	0.7	1.1	0.5	2.6	21.4	97	6
Tamarind*	-	20.9	3.1	0.1	2.9	5.6	67.4	60	3
Wood apple	53	64.2	7.1	3.7	1.9	5.0	18.1	61	3

Source: Gopalan et al., (1978) \* Tamarind is the richest source of Tartaric acid (8-18%).

**Table 2. Pre-harvest factors influencing post-harvest management of fruits**

Selection of varieties	Higher yield, better keeping quality, slower ripening, longer shelf life under ambient condition and better processing quality.
Cultural operations	Pruning, thinning, irrigation, fertilization.
Pre-harvest treatments	Mango: Three sprays of Topsin-M(0.1%) or Bavistin(0.1%) at 15 days interval before harvest can control anthracnose and stem end rot. Tomato: Three pre-harvest sprays of 0.2% Difolatan at 10 days interval.
Maturity	Peel colour: Mango, pineapple, custard apple and tomato. Pulp colour: Mango and tomato. Shape: Fullness of cheeks in mango, flattening of eyes with slight hallowness in pineapple.
Post harvest factors are:	
Pre-cooling	Aircooling, Hydrocooling Mango: Hydrocooling at 12-15°C with 500 ppm Bavistin increases shelf life.
Washing and drying	
Dis-infestation	Vapour heat treatment, fumigation with EDB et: mango
Waxing	
Control gripping process	Packing, low temperature, ethylene absorbents, skin coating, sulphur guards.
Ripening of fruits	Ethephon / Ethresl, calcium carbide
Packaging	
Pelletization	
Transportation	
Storage	Cool stores, zero energy cool chambers

**Table 3. Recommended temperature, relative humidity and storage life of fruits**

Fruit	Temperature (°C)	Relative humidity (%)	Approx.storage live (weeks)
Custard apple	7-10	85-90	1-2
Guava	5-10	90	2-3
Jackfruit	11-12.8	85-90	3-5
Mango	13	95-90	2-3
Pineapple	7-13	85-90	2-4
Pomegranate	0-5	90-95	2-3 months

Source: T.K.Bose et al., (1999)

### Processing

Processing is the best way of utilizing surplus production of fruits during seasonal gluts.

Advantages of processing:

- Helps in converting perishable fruits in to durable form
- Fruits, which are very difficult to eat out of hand can be processed in to a range of highly acceptable fruit product.
- Helps in reducing wastage.
- Value addition.

Methods of processing of fruits into products:

- Preservation by heat treatment.
- Aseptic packaging.
- Preservation of by removal of heat.
- Quick freezing.
- Preservation by removal of moisture.
- Preservation by addition of chemicals.
- Minimal processing.

### **Mango (*Mangifera indica*)**

In general harvest maturity in mango is reached in 12-16 weeks after fruit set, depending on variety. Specific gravity is a good criterion to judge maturity of the fruit. Mangoes are harvested by hand if the pickers can reach them. Fruits on high branches are harvested with a picking pole having a cloth bag and cutting knife at the top. Fruits are to be harvested with little stalk to prevent latex trickling which leads to stem end rot. Mangoes are generally harvested at physiological mature stage and it takes 6-14 days to ripen under ambient conditions. The ripening phenomenon is associated with conversion of starch to sugars and loss of firmness of fruit.

Mango is one such fruit, which can be processed at almost every stage of growth, development, maturity and ripening. Raw mango fruits are utilized for mango powder, pickle, chutney etc. An excellent drink can also be made from green mangoes. Ripe mangoes are utilized for making slab, toffee various beverages such as nectar, squash etc. Drying after exposing to sulphur fumes also preserves ripe mango slices. Methods have also been standardized to produce cryogenically (liquid N) frozen mango slices.

### **Guava (*Psidium guajava*)**

Guava fruits are most commonly harvested by hand. Firm yellow to half-yellow mature fruits are harvested. Over ripe fruits are easily damaged in transport and handling. Fruits that are immature when harvested do not develop into quality ripe fruits. Guava fruits can be kept in ventilated polyethylene bags for 10 days at ambient temperature 18-20°C.

Guava is very popular as a fresh fruit because of its excellent taste, high vitamin content and 100% edibility. This fruit is equally important for the processing industry. A large number of processed products are manufactured from guava. Because of presence of rich amount of pectin, a high quality natural jelly is obtained from guava. Processed guava pulp is an excellent raw material for preparation of various other guava products such as nectars, beverages, jams, toffee, cheese, ice cream topping etc. Guava pulp can be preserved successfully in bulk either by application of heat (aseptic packaging) or addition of chemical preservation (SO<sub>2</sub>). Canned guavas with sugar syrup (40° Brix), Dehydrated guavas, and guava powder are the other important products.

### **Pomegranate (*Punica granatum*)**

Since, pomegranate is highly popular as a fresh fruit, it is not used for processing to a great extent. Pomegranate juice is highly acceptable drink. The steps in making of juice drink include, extraction of juice, clarification in a flash pasturizer, cooling, settling for 24 hours, racking up, filtering and heat preservation. Anardana is made from pomegranate seeds, particularly of the sour type, after drying they are used as acidulant for culinary purpose.

### **Custard apple (*Annona squamosa*)**

Custard apple is harvested in several instalments, but the best harvesting stage is when the firm fruit begins to develop colour. It is generally picked when it becomes creamy yellow between the segments and begins to crack slightly. The fruit has the tendency to burst open if kept on the tree for a long time. Custard apple is highly perishable and can not be stored for long time. It can be stored successfully for 9 weeks at 7-10°C with 85% to 95% RH. Lower storage temperature induces chilling injury. Custard apple can be kept for 9 days after treating with 50 ppm Bavistin and placing in a polythene bag containing  $Kmno_4$  compared to untreated fruits for 5 days. Custard apple is not used for processing purpose to a great extent. On heating the pulp at develops bitterness. To pulp can be frozen successfully for use in the ice cream industry. Ready to serve beverages are made from custard apple. Bitterness of the pulp can be removed by treating with peptic enzyme.

The pulp can be frozen successfully for use in ice-cream industry. At CRIDA, a simple technique has been developed for manual extraction of custard apple pulp by rotatory motion of a round hair comb in the scooped fruit held in stainless steel sieve. This pulp can be supplied to the ice-cream industries.



**Manual extraction of Custard apple pulp**

### **Jackfruit (*Artocarpus heterophyllus*)**

The fruit is used both in the unripe and ripe stage. Raw jackfruit is popularly used as a vegetable. Fully mature but unripe fruits are harvested and appearance and a dull sound upon tapping judge fruit maturity. Ripe jackfruit is consumed as a dessert fruit. Jackfruit chips are prepared by frying ripe or semi-ripe fruits. Jackfruit leather is also prepared from the ripe or semi-ripe fruit. A palatable beverage concentrate can be made from jackfruit pulp by adding sugar, citric acid and water. In addition high class canned, frozen and dried products such as nectar, preserves confections etc can be prepared from the ripe fruits. The green jackfruit utilized for making pickle, canned and curried vegetables. The wastes (skins, peels and cores), which constitute about 45% of the total fruit weight, have been found to be a fairly good source of pectin.

### **Bael fruit (*Aegle marmelos*)**

The bael fruit is known for its medicinal properties. The bael fruit is one of the most nutritious fruits. It contains 61.5 g of water, 1.8 g of protein, 1.7 g of minerals, 31.8 g of carbohydrates and 1.19 mg of riboflavin/100 g edible portion. It may be noted that no other fruits has such a high content of riboflavin. Bael fruit has been used from time immemorial for processing in the mature green form to prepare preserves. The difficulty in the extraction of ripe bael fruit pulp is overcome by addition of water equal in weight to the pulp, adjusting the pH to 4.3 with citric acid and heating at 80°C for one minute, before passing through the extractor/pulper. Addition of water dilutes the mucilage and the

application of heat rot only inactivates the enzymes but also helps in dissolving the mucilage uniformly throughout the pulp. The fruit pulp thus obtained has almost the same consistency and colour as mango pulp. Ripe Bael fruit pulp, if extracted properly can be used for the preparation of various fruit products viz., nectar squash/leather/slab, powder etc., which can be commercially exploited.

### **Aonla (*Phyllanthus emblica*)**

The fruit is highly nutritious and is a rich source of pectin and polyphenols apart from ascorbic acid. Aonla fruits are well known for their medicinal properties. The fruits are used for curing chronic dysentery, bronchitis, and diabetes. The storage of Aonla depends on maturity at harvest. The fruit keeps well in cool chamber for 17-18 days compared to 8-9 days at ambient temperature.

Aonla fruit is seldom consumed fresh but the fruit is valued highly in the Ayurvedic system of medicine. In Ayurvedic preparation like 'Chyavanprash' and triphala, Aonla is one of the main ingredients. Fruit products like pickle, preserve, candy, jam, syrup and dried shreds are made from Aonla. Aonla preserve is very important article of commerce and is in great demand. Streaming or blanching the fruit prior to processing can minimize ascorbic acid loss in the products. It is also used in tanning and dyeing industries.

A technique has been developed at CRIDA for separation of segments of aonla and do away with nut by steaming. These segments were used for preparation of different products. In a study on the suitability of different varieties for processing into candy, murabba and pickle, the candy of variety Chakkiya ranked first in respect of ratings for color, flavor, texture and total score and overall ranking. The variety Banarasi ranked first for texture and variety, Francis ranked first for color. After a storage period of 4 months at room temperature, the variety Chakkiya again ranked first in all attribute except flavor. The candy of Banarasi ranked second over all. In case of murabba the variety Krishna ranked first in all attribute followed by Chakkiya, which ranked second in all attribute except texture, where it ranked first.



Squash was prepared by blending Aonla juice with other juices viz., ginger, roselle, pineapple and lime. Organoleptic evaluation of squash revealed that score for color, flavour and consistency increased with addition of ginger and Roselle. The blend of aonla, ginger, roselle (80:15:5) ranked first in all attributes including over all ranking, this was followed by blend of aonla, lime, ginger (75:20:5). Roselle helps in improving the color and ginger helps in improving the flavor of squash.



**Aonla squash blended with other juices**

### **Ber (*Zizyphus mauritiana*)**

Ber fruit are consumed as such or can be processed into different fruit products. Juicy varieties are better suited for pulp and juice extraction. The fully ripe, well-developed fruits are washed de-stoned and juicer extracts juice. Ber juice can be used for the preparation of ready to serve beverage. Carbonated beverage of ber is highly acceptable and has excellent keeping quality. Dehydrated for is prepared by treating ber fruits with sulphur dioxide at 3.5-10 g/kg for 3 hours followed by sun drying, or carbinet drying below 15% moisture. Ber can be utilized for candy and ber pulp can be processed into wine. The steps include diluting the pulp, adding pectinase enzymes adjusting proper Brix with sugar, addition of yeast, fermentation, stabilization and clarification.

### **Jamun (*Syzygium cumini*)**

It is reported that jamun fruits are used for making products such as jam, jelly beverages, wine and vinegar. It has been found that maximum yield of jamun juice with a high level of anthocyanins and other soluble constituents can be obtained by grating the fruit, heating to 70°C, and passing through basket press. The jamun juice thus obtained is again heated to 85°C and then cooled to room temperature. Sodium benzoate (500 pm) is added to the juice before it is stored. Pure jamun juice can also be stored by heat pasteurization. The juice being highly acidic is not consumed as such. A ready to serve beverage (nectar) is prepared with 25% juice, 18° Brix and 0.6% acidity. Jamun seeds are also known for their properties which help to cure diabetes, diarrhea and dysentery.

### **Phalsa (*Grewia subinaequalis*)**

Being highly perishable, the fruit must be utilized within 24 hours after picking. The popularity of phalsa fruit is due to its attractive colour ranging from crimson red to dark purple and its pleasing taste. The juice when extracted gives a deep crimson red to dark purple colour and is very popular. It is rated very high in indigenous system of medicine. The juice is extremely refreshing and is considered to have a cooling effect especially in hot summer. Heating the crushed phalsa fruit to 50°C gives the highest recovery of the juice with an appropriate quantity of anthocyanin and other soluble and insoluble materials. Studies have shown that addition of cane sugar to the juice has a protective effect on colour stability.

### **Tamarind (*Tamarindus indica*)**

The fruit of tamarind a pod 5 to 15 cm long, 3 to 10 seeds surrounded with edible pulp which is principal souring agent for sauces, chutney, in beverages and in general cooking. Pulp is carminative, laxative, given as infusion in biliousness and febrile conditions. It is also used in dying and tanning and for polishing and cleaning metal ware. The tartaric acid is extracted from unripe fruits. The polysaccharide (jellose) is extracted from seeds, which is used as a sizing material in the cotton and jute industries. Besides, polyose obtained from the seed is good substitute for fruit pectin in the preparation of jam, jelly or marmalade. The bark and leaves are used for tanning. Tamarind balls are prepared after taking out seeds from the fruit. Tamarind paste and tamarind juice concentrate are the other commercial products.

### **Roselle**

The calyces of Roselle (*Hibiscus sabdarifa* L) which grows well even when sown in September under rainfed conditions in Alfisols can be utilized for processing into different products. It can be a very good source for coloring fruit products that don't have attractive color. With the ban on coal tar food dyes, it is easy to arouse interest in Roselle as a coloring source. Today, Roselle is attracting the attention of food and beverage manufactures and pharmaceutical concerns who feel it may have exploitable possibilities as a natural food product and as a colorant to replace some synthetic dyes.

- Chopped and added to fruit salads.
- Stewing as sauce.
- Roselle syrup.
- No need to add pectin to jelly. In fact the calyces posses 3.19% pectin and in Pakistan Roselle has been recommended as a source of pectin for the fruit preservation industry.
- Juice made by cooking a quantity of calyces with ¼ water in ratio to amount of calyces is used for cold drinks and may be frozen or bottled if not for immediate needs. In West Indies and America (tropical) Roselle is prized primarily for the cooling lemonade like beverage made from calyces.

#### Roselle sauce

- After extraction of color, acids and pectin for jelly making, the calyces mass could be further processed to a sauce which was organoleptically highly acceptable.

### **Guava**

#### Jellies with Guava – Roselle blends

Calyces of roselle can be used as a source of colorant for guava jelly, since there is a problem of browning in guava jelly during storage. Organoleptic evaluation of jellies prepared from different proportions of guava – roselle (calyces) revealed the preference of tasters for blending at 85:15 proportion to get jelly with attractive color. Roselle calyces can be used with guava for jelly making without significant change in guava flavor (Table 4)



**Jellies with guava – Roselle blends**

**Table 4. Organoleptic evaluation of jellies prepared from Guava – Roselle blends**

Treatment	Organoleptic score				
	Color (10)	Flavor (10)	Taste (10)	Consistency (10)	Total (40)
Guava jelly	8.1	8.1	7.8	7.6	31.6
Guava – Roselle (85-15)	8.6	7.9	8.0	8.1	32.6
Guava – Roselle (80-20)	8.3	7.6	7.0	8.4	31.3
Roselle	7.3	7.2	7.4	7.7	29.6
CD 0.05	0.72	0.63	NS	NS	1.91
SE	0.25	0.22	0.32	0.29	0.66