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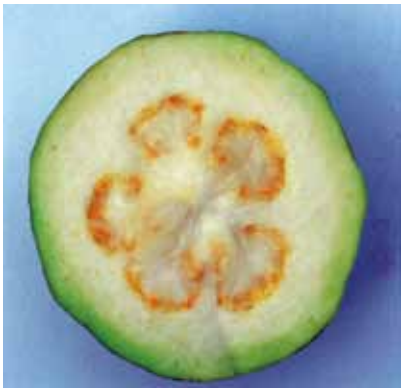
Post-harvest management for longer shelf-life of guava

Guava is known as 'Apple of Tropics' and is an important fruit crop owing to its high nutritive and antioxidant properties. Despite, high nutraceutical properties and health advantages, there are many problems which limit its distribution and marketability. Being a climacteric fruit, it leads to higher ethylene evolution and respiration rate which enhance the softening, susceptibility to chilling and diseases and reduce the shelf life of fruits. To minimize the risk, farmer sell their orchards to the middleman which is a major drawback in this line and get very low price of their orchards. Therefore, there is urgent need to explore proper supply management chain along with effective technologies to the farmers at ground level, so that they can sell their own produce and get desired price. Some recent innovative technologies, like use of harvesting tools, ecofriendly coating materials, packaging material, postharvest treatments against diseases and fruit flies, safe storage techniques etc. could be a milestone in increasing quality and shelf-life from a week to two weeks or more than that.

GUAVA (*Psidium guajava* L.) is a popular super fruit of India and is being cultivated worldwide. It is believed that guava fruits contains four times higher ascorbic acid to that of orange and varies from 200 to 600 mg in nearly ripe fruits. Guava is consumed along with its seeds which are rich in omega fatty acids and fibre. Ripe guava fruit has both carotenoids and flavonoids in their pulp. Thus pink orange colour pulp is attributed to more antioxidant properties. A number of processed products from guava have great demand in the market. Now-a-day's guava is used to prepare good quality jelly, fresh fruit juice, nectar, RTS and powder. In India, guava is mainly cultivated in Uttar Pradesh, Maharashtra, Madhy Pradesh, Karnataka and Rajasthan. Guava from Allahabad region of Uttar Pradesh and Sawai Madhopur region of Rajasthan is considered to be best in terms of quality. ICAR institute CISH, Lucknow is working on guava. Farmers in the Rajasthan are also moving towards guava cultivation seeing the good response of 'Gola Barfkhana' variety which is having very good TSS and acid blend ratio. Major lacuna in guava is high perishability and higher postharvest losses which limits its supply to the market. Guava is climacteric in nature, thus faster ripening and softening occurs which is a problem to the farmers because farmer cannot adopt such promising technologies to reduce these losses. A major common tradition among farmers is that they sell their orchards to the third party to avoid risks of postharvest losses, handling and transportation problems. They sell guava fruits at the rate of ₹ 8-15 per kg during market glut and the third party contractor (commonly known as *Adatiya's*) take advantages of this opportunity by selling farmers produce at higher rate after completion of glut. So, farmers are unaware of technical knowhow and lack awareness to those technologies by which they can sell their produce after this glut, at higher prices. Improper post-harvest management of guava fetches less prices in the market and posses very poor shelf-life. Higher softening, chilling injury, pathogenic diseases, mechanical damage and injuries, improper harvesting methods, unavailability of packaging materials and storage facilities, bruising injuries etc. are major challenges in the export line and supply chain of guava. Post-harvest diseases like anthracnose and stem end rot are more common during storage. Hence,



White fleshed guava

Pink fleshed guava

there is urgent need to adopt such innovative technologies at farmer's level, so that they can easily reduce such a huge loss and can eliminate this role of middleman. On-farm processing should be done in order to maintain quality and super marketability of guava fruit.

A number of technologies were developed in this direction. Development of harvest indices, precooling methods, grading designations, waxing and coatings, postharvest chemical treatments, safe and ideal packaging materials, and modern storage techniques could play a crucial role in minimizing loss and maximizing quality. We need to adopt them from field to market, then only we shall be able to maintain quality.

Harvesting

Harvesting stage plays an important role and determines the overall quality of fruits. As per the need and distance of market, a farmer should harvest the produce. Guava fruits harvested at fully mature stage produce ethylene which helps in ripening of the fruits after detaching from mother plants. Fruit takes around 120-140 days for maturation from flowering. One should determine the maturity on the basis of colour. Onset of light yellow colour or dark green to light green on the maturity may give an idea. Hand picking is more popular in India because there is no large acreage and suitable to avoid mechanical damage. Hand picking with the help of clipper is more appropriate method to reduce mechanical damage. Specific gravity may be a reliable index and at the time of harvesting it should be 0.95 to 1.00. Total soluble solids range from 9.0-12.5 per cent. After harvesting, fruits are procured to package house for washing and precooling. Precooling is done at a temperature range 9-10°C for 24 hours. During the harvesting, field box along with cushioning materials must be used at every step.

Farmer doing on-farm packaging in Sawai Madhopur district (Rajasthan)

Grading

This is a very important operation which ensures the final price and marketability. Grading helps to secure extra return as graded produce fetches higher price than the ungraded. Uniform size, colour, shape attracts the consumers who are ready to pay desired price by seeing the conditions of fruits. In the international market, fruits are graded according to destination country. Weight and diameter are two important factors for grading of guava. Guava fruits vary in the size from round to pear shaped. The skin has colour from green to pale yellow whereas flesh is having white, yellow and pink colour. Grading can be done by manually or semi/fully automated machines for round shapes. Now a days, roller graders are used to grade them on the basis of size. Some grade designations were determined by the Codex Alimentarius Commission and divided into extra class, class 1 and class 2. Provision size concerning guava as per International markets is given below.

Table 1. Concerning size chart of guava for International market

Size code	Weight (g)	Diameter (mm)
1	>450	>100
2	351-450	96-100
3	251-350	86-95
4	201-250	76-85
5	151-200	66-75
6	101-150	54-65
7	61-100	43-53
8	35-60	30-42
9	<35	<30

Coating and multilayer coating

Covering of a layer with the glossy semi-liquid material (either natural or synthesized) is known as coating which can reduce its evapotranspirational loss and decrease the respiration rate which is attributed to delay in ripening and longer shelf life. People are getting aware towards harms of postharvest chemicals. Thus, it is required to develop more safe and natural coating materials which should be free from any chemical residue. There are several plant based gums, leaf extracts which have been found to retard the physiological and metabolic processes during storage and also retain the quality and fresh appearance. Recently, a lot of research work has been carried out to investigate the effect of different edible coatings like chitosan, sodium alginate, aloe vera gel, guar gum, lasoda gel along with some other plant based formulations. Formulations of 1-2% gums solely or in combination with others are enough to extend the storage life of fruits upto one week. Similarly, a recent trend has

Process flow chart of coating of guava fruits

come into existence that coating into multiple layers could be more effective than simple coating. Though, significant research achievements were obtained. This involves two steps of coating procedures. In one step, fruits are coated with one coating material and then dried for sometime and again coated with another material. This creates a strong layer that slower downs the respiration rate and water loss. Coating also imparts glossiness over the fruit surface which fetches higher price in the markets and malls.

Packaging

Guava fruits are packed in the locally available packaging materials. At domestic level, fruits are packed in the plastic crates, bamboo baskets by using cushioning material like newspaper, husk and tissue paper. However, for export purpose, well ventilated corrugated fibre board (CFB) boxes are suitable. These boxes should be lined with suitable cushioning materials like guava leaves, paddy straw, newspaper cuttings and foam sheets to avoid injury during transit. However, in majority of area, newspaper cuttings are more popular due to cheaper and easier availability. ICAR institute Central Institute for Subtropical Horticulture (CISH) has developed CFB boxes having capacity of 2.0 and 4.0 kg with 0.5% ventilation for packaging of guava for export. Packing of fruits in multilayers is not recommended due to compression injury during transit.

Delay of ripening and senescence

Delaying of ethylene and senescence is a crucial step in the export line of guava and need to be emphasized. Many attempts were made in this regards and got a spectacular results. In this direction, use of 1-Methyl cyclopropene (1-MCP) an ethylene inhibitor which delays ripening, fruit softening, retards the growth of pathogens, alleviate chilling injury, delays change in skin colour and extend the shelf life of fruits, shows better

On-farm handling operations of guava

results in many countries. Its dose varies from 300 nL to 600 nL depending upon cultivar and storage conditions. Recently, an aqueous formulation of 1-MCP is available in the market which is cost effective as there is no need to construct a chamber as in case of gaseous formulation and has more potential to delay the ripening and softening. Therefore, application of this solution may be included in the line of supply for extended storage life.

Storage

Storage of the fruits at a low temperature is recommended during transport and shipping. Low temperature also helps in delaying of ripening. Safe storage temperature for guava is 8-10°C with 90% relative humidity. This will extend shelf life upto 2 weeks. However, sometimes long term storage at this temperature may cause chilling injury. So, adoption of Controlled atmosphere storage (CA) is more promising to extend the shelf life and alleviation of chilling injury in guava. The compositions of gases are more important in this method. CA technique has been standardized by several researchers and proved to be a milestone in guava supply chain. Exposure of guava to CA containing 5% O_2 and 2.5% CO_2 and fruits ripen at 20°C exhibit best sensory and nutritional quality and could be stored upto one month.

Major post-harvest diseases and insect-pests

Fruit fly is major serious pest of guava countrywide. These lay their eggs inside the fruit skin and maggots feed on the flesh. This problem leads to rotting in fruits. The larvae of fly causes oviposition punctures on the fruit and damage to the fruit and become more devasting during

Faulty packaging of guava


Ripe guava fruits

S. No.	Description	Cost Norms
1.	Cold storage unit type 1-basic mezzanine structure with large chamber (>250 MT) type with single temperature Zone.	• @₹ 8000/MT for capacity upto 5000 MT • @₹ 7600/MT for capacity between 5001 to 6500 MT. • @₹ 7200/MT for capacity between 6501 to 8000 MT. • @₹ 6800/MT for the capacity between 8001 to 10000 MT.
2.	Cold storage unit type-2, Pre engineering Building, Type for multiple temperature and product use, more than 6 chambers of <250 MT capacity and basic material handling equipment.	• @₹ 10000/MT for capacity upto 5000 MT • @₹ 9500/MT for capacity between 5001 to 6500 MT. • @₹ 9000/MT for capacity between 6501 to 8000 MT. • @₹ 8500/MT for the capacity between 8001 to 10000 MT.
3.	Cold storage unit type-2 with add-on technology for controlled atmosphere.	Additional ₹ 10000/MT for add on components of CA as per component wise cost.

Source: National Horticulture Board
*For calculation of capacity, 3.4 cubic meter (120 cubic feet) of chamber volume shall be considered equivalent to 1 MT storage.

What farmers can do?

It is very difficult to adopt all these tasks by a single farmer. By creating small self-help groups farmers can do combined postharvest operations and take advantages of various schemes, subsidies and trainings'. Farmers association can do more effective work and solve the problems of farmers. Such type of association may create facilities like establishment of Cold storage, CA storage, ripening facilities etc. for export purpose for fruits. Because a single farmer cannot afford the costs. By joint ventures farmers can start supply management chains at small or local regions. This type of facilitation may help in capacity building of the farmers and they can sell own produce by a small effort and by adopting proper horticultural practices. Small scale processing is also a better option to modify the commodity and to add variety to the market. This processing and value addition may change the scenario of the farmers.

maturation of fruits. For this control, pheromone trap are used in which chemical methyl eugenol captures male flies. Anthracnose and fruit rot are reported to be most serious. Hot water treatment is considered good for disinfestations against fruit fly and pathogens. A temperature range 46 to 50°C for 10-20 min was reported to be effective against fruit fly disinfection by several workers. Preharvest management strategies should be properly implemented.

Economics and subsidy on cold storage

A ripening chamber establishment as per norms of National Horticulture Board having capacity of 1 MT incurred cost of ₹ 1 lakh/MT. Size of chamber is 11 CuM. Cold room having capacity of 30 MT may be incurred on an average cost around ₹ 15 Lakh. The establishment of cold storage may be done by the help of NABARD or any other financial tie-up either with the govt. or private sector companies.

Capital investment subsidy schemes for construction of cold storages under project scheme of National Horticulture Board for horticulture produces are discussed here.

SUMMARY

Availability of rich phytochemicals and high nutraceutical value has increased demand of this fruit in past few years. Improper handling may reduce the market value, economic life and overall quality of the produce. Commercial success of the fruit has favoured the development of new innovative postharvest techniques. A large number of improved technologies are adopted in developing countries and still some best technologies remain unused. Therefore, there is needed to provide such improved methodologies to the famers, growers and stakeholders. Farmer can apply these technologies from field to market and get higher price. These applied methodologies could be implemented and integrated in the supply management chain at commercial scale.

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