

Handling operations

to reduce post-harvest losses in mango

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Mango fruit is largely like by peoples and it contains a good amount of vitamins, minerals and antioxidants. India is the largest producer and an important, exporter of mango in the world. It is observed that around 25–45% of post-harvest losses occurs in mango, that can be successfully reduced by following proper post-harvest handling operations, which includes; trimming, desapping, sanitization, grading, hot water treatment, waxing etc. Mango is usually harvested when fully matured, but in the unripe stage; as it is highly perishable in nature it can be artificially ripened at the destination market before sale. Plastic crate, wooden boxes and corrugated fiberboard can be used for packaging of mangoes that can be transported in refrigerated vehicles to decrease the post-harvest losses.

Keywords: Mango, Post harvest loss, Post harvest handling

MANGO (*Mangifera indica*) also known as the king of fruits, is mainly grown in tropical and sub-tropical regions in India from sea level to an altitude of 1500 meters. According to latest FAOSTAT data, India is the world's largest producer of mango with production quantity of 24 million tonnes (MT) in 2020. Nearly 1000 varieties of mango are found in India but, only few are grown commercially. Majorly, mango growing states are Uttar Pradesh, Andhra Pradesh, Karnataka, Bihar, Gujarat and Tamil Nadu. India is also a largest exporter of fresh mango to the world and major export destinations are United Arab Emirates, UK, Oman, Qatar and Kuwait. According to the Agricultural and processed food products, export development authority (APEDA), India has exported around 21,033.58 MT of fresh mangoes to the world for the worth of ₹271.84 crores during the year 2020–21. Huge demand of Indian mangoes has been noticed in the US, but due to Covid-19 pandemic its export to US is restricted since 2020. In 2019–2020, around 1,095

MT worth ₹29 crores was exported to the US and it is anticipated that this figure will exceed by 2022. Generally, around 25–45% of post-harvest losses occur in mango. It is very important to follow proper post-harvest operations in mango to maintain the desirable quality that helps in ease of exportation in the national and international market.

Trimming and desapping

Cutting the stem that remains after harvesting of fruit is known as trimming. It is crucial to cut these stems before packaging, as it can break off during handling which results in oozing out of sap/latex and staining on the mango skin. Furthermore, if this latex dried than it becomes difficult to remove it from mango surface. Mango quality matters a lot when it comes for exportation. For mango producers and exporters, sap-burn (also called latex burn) is the major concern, as it decreases the cosmetic quality of fruit which ultimately results in lesser economic return especially in International markets. This latex/sap is highly acidic (pH 4.3) in

nature, that causes a brownish-black to black streaks or blotches when comes in contact with mango skin and also results in allergic reactions in human skin. Sap on mango gives invitation to the microorganism and soil particles, as it is gluey as well as sugary in nature that leads to fast decaying and reduction in the storage life of fruit. Basically, this sap contain two components, i.e oil (yellow-brown) and protein polysaccharide (aqueous milky and viscous). Only an oil fraction (especially terpinolene) is known to cause damage to mango skin, which exudates first when de-stemming is done, whereas protein polysaccharide that released after the oil fraction is responsible for clear glaze on mango skin. De-sapping can be done physically by keeping mango fruit in an inverted position on trays/conveyor belts, as well as chemically by using sodium carboxymethyl cellulose, calcium hydroxide solutions, lauryl sulphate sodium, sodium hydroxide and alum. Fruits with adhered pedicels are usually dipped in a chemical solution and then the pedicle is



Freshly plucked mango with pedicle



Cutting of pedicle with scissor



Fruit sap



Desapping in mangos by inverting over tray/wire mesh

used as an aqueous sanitizer in food industry. The recommended dose of chlorine ranges between 50–200 ppm, pH 6.0–7.5, with a contact time of 2–5 min. High doses of chlorine can cause tainting and sodium residues remaining on products can damage the tissues of mango. Furthermore, chlorine can react with organic matter to form carcinogenic products. Hence, it is important to use chlorine within the recommended range. Generally, these sanitizer's works in both ways—firstly, use of chlorine ensure that all the spoilage causing microorganism present in water is killed and cannot further contaminate the fruits and secondly, chlorine helps in reducing the load of microorganism from the fruit surface. Chlorine sanitizers are found very effective in reducing the population of *Salmonella* therefore, preventing cross-contamination and creates hindrance in the internalization of pathogen in mangoes.

manually broken with mango, and dipped into the solution for approximately 2 min followed by cleaning with chlorinated water and drying. This technique helps in lowering the incidence of sap-burn in mango.

Sanitization with chlorine

Freshly harvested mango carries a heavy load of microorganism with them that further can cause diseases. Washing with water is not enough to lower the load of microorganism. Therefore, it is very important to use sanitizer that helps to eliminate

or reduce pathogenic and spoilage microorganism which is also cost-effective, eco-friendly and non-hazardous in nature. Mango is highly susceptible to diseases, caused by pathogenic microorganisms because they are rich in water and nutrients that provide an ideal substrate for the development of pathogenic microorganisms. This leads to a reduction in the quality of mango, especially during the post-harvest period, and cause economic losses. Chlorine gas, sodium hypochlorite solutions and calcium hypochlorite are commercially

Grading

Mangoes are graded on the basis of their colour, weight, size and maturity. It can be done manually or by using a grading machine. Larger fruits take 2–4 days longer to ripen than smaller ones, therefore, it is best to avoid packaging of smaller fruits with larger ones in order to achieve uniform ripening. Fruits that are immature, overripe, harmed, or sick should be thrown away. On the basis of weight, AGMARK classified mango in 4 grades, i.e. A (100–200 g), B (201–350 g), C (351–550 g) and D (551–800 g).



Dipping in sodium hypochlorite solution (100 ppm) for 2–3 min



Pre-ripening, mango fruit sanitization with chlorine



After sanitization, draining excess water

Hot water treatment (HWT)

HWT is the technique in which green mature fruits are dipped in hot water (52–55°C) for 5–10 min so that egg and larvae present on mango surface get killed. Anthracnose and stem end rot are the major post-harvest disease of mango. But these diseases can not be identified in the green stage of mango and can only be seen when fruit is ripened. HWT can be successfully employed to reduce the incidence of these post-harvest diseases. Additionally, it has several benefits such as it cleans mango surface carrying plant exudates, easy to use for



Rotting in mango fruit

horticultural industries, and short time treatment. It is important to monitor the temperature of water, if the temperature drops below 52°C then the effectiveness of HWT decreases, whereas, temperature more than 55°C cause the scalding of mango peel. After heat treatment, it is important to cool the mango under clean tap water, as HWT speed up the further ripening of mango, followed by drying in front of blowers.

Waxing

After sanitizing and hot water treatment, the natural wax/bloom on mango surface gets removed, which results in high water evaporation and drying of the mango fruit surface. Additionally, it also removes glossiness of the fruit surface. Waxing technology (coating of fruit with a thin layer of wax) helps in covering of the small pore on the skin surface and thus reduces the transpiration as well as respiration in fruit, which results in increasing the shelf-life of the fruit along with providing shininess to the fruit. It also helps in delaying the ripening, when there is less or no demand of mango in the market. Food safety and standard authority

of India (FSSAI) approved the natural waxes like; Candelilla wax, beeswax and carnauba wax that can be applied to a fruit surface by using roller brushes, wax applicator or by hand. Sometimes, wax is applied along with fungicide.

Ripening

The process by which fruit attains their desirable flavour, quality, colour, palatable nature and other textural properties is known as ripening. Mango possesses the hard texture, high acidity, low soluble solids and poor eating quality when it is in a mature green harvest stage. As ripening starts, various changes in the composition start to begin such as hydrolysis of starch into sugar (detected by starch-iodine test), increase in total soluble solids, decrease in acidity, degradation

of chlorophyll and synthesis of carotenoids and softening of texture that ultimately results in increases of its consumer acceptability. In starch-iodine test, as the ripening starts, starch content of fruit gets converted into sugar and dark iodine staining (code-1) changes towards lighter staining (code-6). The best temperature for ripening is 19–23°C and humidity above 90%. There are various methods for the post-harvest ripening of mango such as use of calcium carbide, ethylene gas and by giving ethephon (2-Chloroethyl phosphonic acid) treatment. Use of calcium carbide (also known as masala) is banned in India as the traces of phosphorus and arsenic were known to cause harmful effect on human health. Additionally, it gives poor flavour and fruit quality. Ethylene gas is widely acceptable



Totally unripe (100% starch)



Ripe-Retail quality (70% starch)



Ripe- Eating quality (50% starch)



Overripe (30% starch)



Senescent (10% starch)



About to rot (0% starch)

Starch iodine test rating

method, however, high cost of gas and lack of infrastructural facilities limited its use. FSSAI approved the use of ethephon as a source of ethylene gas and ethephon in powder form (in a sachet) should not come in direct contact with fruit.

Packaging and transportation

Proper packaging is important for the protection of produce from external contamination (physical, chemical and biological) as well as from mechanical injuries. However, plastic crates are highly recommended as they provide protection from compression damage, have a smooth inside finished, easily cleanable, stackable and reusable (for 5–6 years). Corrugated fiber board should be equipped with vertical divider in the middle and ventilation holes in the sides to avoid heat build-up inside the carton. Fruits are frequently packaged with cushioning material to protect them from damage and spoilage during storage and transportation. Individual fruit packaging in the honey-comb nets and tissue paper promotes optimal ripening while minimizing the spoilage. Mango should be transported quickly for effective marketing and quality preservation.

In developing countries, non-refrigerated trucks are generally used for transportation, that can reduce the shelf-life of fruit. However, it is possible to transport the fruit at night under non-refrigerated conditions if it has been pre-cooled. The fruit must be cooled before transportation, because refrigerated vehicles are not designed to lower the fruit temperature. Commodity losses might reach 20% when being transported. Produce should be carefully packaged and stored in well-ventilated containers in order to avoid such losses.

Way forward

Farmers can decrease the post-harvest losses of mango by adopting the proper post-harvest handling steps, which can be easily carried out in their orchard or field. In a country like India, where the farmers and small traders do not have an easy access to proper artificial ripening facilities for fruits under controlled conditions, especially in rural areas, they are trapped and bound to use harmful methods, i.e. carbide or masala etc. for in-box ripening of fruits. With the increasing health challenges faced by people of our country, it becomes imperative to develop safe and feasible

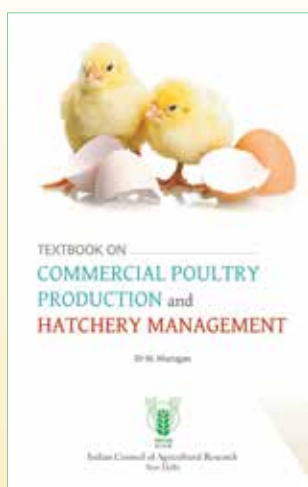
solutions for artificial ripening of fruits. Keeping this in view, FSSAI permitted the use of ethylene gas and various industries should come up with excellent, safer and effective mango ripening solution, by in-box method or during in-transit stages.

SUMMARY

Mango is highly perishable in nature and its losses (25–45%) starts from the harvesting time to the packaging, storage, transportation, retailing and consumption. The losses in these stages can be reduced by following proper post-harvest handling. Trimming and desapping are performed to decrease the incidence of sap burn, whereas, sanitization successfully reduces the load of harmful microorganism present on mango surface. Hot water treatment helps in lowering the occurrence of post-harvest diseases such as stem end rot and anthracnose. Ethephon can be used for artificial ripening of mango, as it is recommended by FSSAI. Proper packaging and ideal transportation conditions can significantly reduce the post-harvest losses in mango.

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