

Post-Harvest Management of Fruits for Shelf Life Extension

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INTRODUCTION

The process of managing fruit crops after they have been harvested represents an essential part of the horticultural value chain, which seeks to achieve three goals: loss reduction, quality preservation, and extension of product shelf life. Fruits exhibit this characteristic because their high moisture content together with their active metabolic processes and their vulnerability to physical damage and microbial contamination make them extremely perishable goods. Indian markets experience post-harvest losses of 20 to 30 percent for fruits because farmers use incorrect techniques to harvest fruits and the country lacks sufficient storage capacity and its transportation network fails to provide adequate service and farmers do not understand scientific methods to handle their harvests. Effective management of post-harvest activities enables the distribution and sale of fruits to increase, while their profitability will rise.



Causes of Post-Harvest Losses

The post-harvest losses that affect fruits occur because three types of factors combine to create losses that involve physical damage and biological spoilage and physiological processes. The combination of mechanical injuries that occur during harvesting and handling and transportation results in bruising and cuts that lead to fruit spoilage. Fruits experience accelerated aging because

physiological processes enable them to breathe and lose water and produce ethylene. Microbial spoilage leads to fruit quality decline because fungi and bacteria attack the fruit, and environmental conditions because they include high temperatures and humidity levels that exceed normal limits and storage practices that do not follow proper procedures lead to fruit deterioration.



Principles of Shelf Life Extension

Post-harvest management aims to achieve its main goal through methods that decrease metabolic processes while protecting food from spoilage through methods which reduce respiration rates and control water evaporation

and prevent microbial growth and slow down fruit ripening through temperature and humidity control and suitable packaging and safe handling methods which preserve fruit quality and freshness during extended storage periods.



Harvesting Management

The correct harvesting time depends on fruit maturity to achieve both maximum product quality and extended storage life. The best time to conduct harvesting work occurs when temperatures are cooler between the early morning and evening times because this timing helps decrease both field heat and respiration rate. The use of appropriate harvesting tools and gentle handling techniques helps minimize mechanical damage and preserves fruit integrity.

Pre-Cooling Techniques

Pre-cooling denotes the quick process which removes field heat from harvested crops because this method decreases respiration rates and microbial activity and thus extends the product's shelf life. The common pre-cooling methods include room cooling for small-scale operations and forced-air cooling which provides faster and uniform cooling and hydro-cooling which uses chilled water for rapid heat removal and vacuum cooling which works best for leafy produce. These techniques help preserve freshness from the moment of storage until the time of transportation.

Sorting and Grading

Sorting and grading operate as vital post-harvest procedures which guarantee consistent product quality while increasing its market worth because the process eliminates damaged goods from the inventory. The process of grading products according to their size and color and maturity enables better customer acceptance which improves marketing efforts and brings higher profits to farmers.

Packaging Techniques

The process of proper packaging functions as a vital system which protects fruits from three types of damage during handling and transportation. The combination of corrugated fiberboard boxes and plastic crates with cushioning materials functions as a secure method for product delivery. The advanced packaging methods of Modified Atmosphere Packaging and Controlled Atmosphere Packaging enable packaging systems to control oxygen and carbon dioxide levels which results in reduced respiration rates and extended product shelf life.



Temperature and Storage Management

The most critical element that determines how long fruits will remain fresh is their temperature because low temperatures create metabolic and microbial activity halts which requires specific temperature conditions to store each fruit type with apples needing 0–1°C and mangoes needing 12–13°C and bananas needing 13–14°C and citrus fruits needing 4–7°C storage temperatures and humidity levels between 85 and 95 percent must be maintained to stop moisture loss and shriveling while maintaining fruit quality throughout storage.

Use of Chemicals and Growth Regulators

The application of chemical substances together with growth regulators during post-harvest procedures enables the preservation of fruit quality which extends shelf life and protects against diseases through the use of wax coatings which decrease moisture loss and enhance visual appeal while calcium chloride applications strengthen fruit texture and product durability and fungicides protect against spoilage and 1-Methylcyclopropene (1-MCP) ethylene inhibitors stop fruits from maturing yet consumers need to follow product application requirements for safe usage.

Role of Ethylene Management

Ethylene acts as a natural plant hormone which governs the ripening process of mangoes and bananas and apples through its climacteric fruit function while proper spacing between storage areas and the implementation of potassium permanganate ethylene absorbers and inhibitor products can effectively control ethylene gas emissions which results in prolonged shelf life and improved product storage and transportation efficiency.

Advanced Technology

Post-harvest management benefits from advanced technologies because controlled atmosphere storage systems create storage conditions which preserve products through its oxygen and carbon dioxide control and temperature control to extend product life. The refrigerated transport systems or cold chains

operate at fixed low temperatures throughout their journey from farm to market which results in reduced product quality loss during shipping. Irradiation technology achieves two functions by decreasing microbial content and postponing ripening while maintaining nutritional value. Natural materials such as chitosan aloe vera gel and starch create edible coatings which establish protective barriers that decrease respiration and water loss. Smart packaging systems use sensors and indicators to provide continuous updates about temperature and humidity levels and fruit freshness status during storage and shipping processes.

Value Addition and Processing

The strategy of processing fruits through value addition offers two benefits because it decreases post-harvest waste while increasing product shelf life. Farmers and entrepreneurs gain extra income by processing fruits into products which include juices and jams and dried fruits because these products extend shelf life and create new market opportunities.

Challenges in Post-Harvest Management

The technological progress achieved in India has not solved the existing difficulties which stop post-harvest operations from functioning properly because cold storage facilities remain insufficient and transportation networks stay underdeveloped and farmers lack proper knowledge about scientific handling methods and advanced technologies remain too expensive and market connections remain weak.

Future Prospects

The future of post-harvest management in India shows positive developments through three factors which include cold chain infrastructure expansion and modern technology adoption and farmer training capacity-building programs. The digital tool integration which includes Internet of Things and artificial intelligence and blockchain technology will enhance traceability and quality control and supply chain efficiency. Farmer-producer organizations will benefit from better market access which will help

them achieve their post-harvest systems work more effectively and sustain their systems.

CONCLUSION

Post-harvest management serves as an essential component in horticulture because it determines how long fruits remain usable and their quality and market worth. The market value of fruits will increase when scientific harvesting methods and handling techniques and storage methods and packaging methods receive adoption. India can achieve post-harvest loss reduction through proper infrastructure development and technological interventions and awareness programs. The country will attain sustainable horticultural growth while increasing farmer income.

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