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# Post harvest management of vegetable crops: Introduction

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**Abstract**
Horticulture is backbone of our country and greater population about 60-65% is directly or indirectly dependent on it. Horticulure produce also earns good in export earnings for the country. Unfortunately about 25-30% of horticulture produce gets wasted due to lack of post-harvest management of vegetables which resulted in huge loss of crores of rupees. A complex series of metabolic adjustments occur in vegetables after harvest which are influenced by dislocation of supply of nutrients, water and growth regulators from the parent plant to the harvested vegetables. The overall process leads to postharvest deterioration of the produce. However, the losses can be reduced with adoption of postharvest management and use of processing technology of vegetable crops.

**Keywords:** Post-harvest techniques in vegetables. Post-harvest management, processing of vegetables

## Introduction
India is a rich horticural country producing wide variety of fruits, vegetables, spices, ornamental and medicinal plants. India is second largest producer of vegetables in the world. Unfortunately, having such a huge production a considerable postharvest loss to the tune of 10-25% of vegetables (Selvakumar 2014) [1] occur annually mainly due to inefficient postharvest management practices. To achieve the target of feeding the growing population and meeting the requirements of processing industry and export trade, increasing production and productivity will not be sufficient. Reduction in post-harvest losses is therefore need of the hour to feed growing population of country.

The term postharvest losses are defined as "losses that occur after harvest till the produce reaches consumers. It can quantity as well as qualitatively losses. Post-harvest losses are more painful and costlier than pre-harvest in terms of money and labour. Vegetables are highly perishable having moisture content of (80-90%). They are live commodities and continue their life processes like respiration and transpiration even after harvest. When the fruit is attached to the parent plant, water and photosynthates are supplied to it. But losses are not replaced during postharvest stage and hence the produce depends on its own food reserve and moisture content with the result they perish fast. Water is lost from the product due to transpiration and food reserve depleted by respiration.

**Table 1:** post-harvest losses in vegetables (Selvakumar 2014)

| Name of vegetable | Post-harvest losses as percentage of production |
|---|---|
| Beans & peas | 7-12 |
| Brinjal | 10-13 |
| Cabbage | 7-15 |
| Cauliflower | 10-15 |
| Garlic | 1-3 |
| Onion | 15-30 |
| Potato | 15-20 |
| Tomato | 10-20 |

## Reasons for Postharvest losses
Factors which are responsible for post-harvest losses vary widely from place to place and become more and more complex. The following reasons for postharvest losses are as under:-

1. Moisture loss causing wilting / shrinkage
2. Loss of photosynthates like carbohyderates, proteins occur
3. Physical damage through pest and diseases attack

4. Physiological loss causing decline in quality
5. Fibre development
6. Greening (Potato)
7. Microbial causes insects and rodents
8. Activity of enzymes of the plant or food
9. Chemical reaction not catalysed by enzymes of the tissue
10. Physical changes such as freezing, brusing, drying & pressure et.

**Minimisation of post-harvest losses by various technological adoptions**

There are two approaches for reducing postharvest losses of vegetables. The first approach for loss reduction is to follow scientific postharvest management of vegetables. Another approach for loss reduction in processing into value added products. Postharvest technology of vegetable crops envisages development of appropriate techniques to reduce postharvest losses to prevent spoilage and help to utilise maximum crops in a nutritious and safe manner.

**(i) Post-harvest management practices**

Post-harvest losses can be reduced by adopting breeding technologies for longer shelf life, improvement of pre-harvest factors and haevesting techniques, proper methods of handling, marketing, packaging, transportation and storage, development of appropriate processing technology

**1. Selection of varieties:** Varieties with better keeping and processing quality and lesser handling susceptibility should be bred and selected for different vegetables. A few examples of varieties with long shelf life are Arka Vishal, Pusa Gaurav (Tomato), Arka Nidhi and Arka Neelakandh (Brinjal).

**2. Harvesting:** Harvesting should be done at proper stage where there is minimum damage and loss, as rapidly as possible and at minimum cost. Harvesting should be done at early morning or late evening hours. A temperature of above 27 $^0$C during harvesting should be avoided. The products that are to be send to distant markets are harvested in the evening and transported in the cool hours of night where as commodities for local markets are harvested early morning. Harvesting should not be done immediately after rain or irrigation. Harvesting at optihmum stage of maturity ensures maximum quality and yield. Care must be taken to avoid mechanical injury to product.

**3. Sorting/Grading:** Sorting of harvested vegetable produce is done to remove diseased, damaged, misshapen,over mature, insect attacked and rotten vegetable. Disease/insect attacked should also be discarded to avoid any spread of infection to normal and healthy vegetable/fruit produce.

**4. Washing:** The Produce is cleaned/washed to remove adhering dirt, dust, insects, mould and spray residues and to improve appearance. Onion, garlic, okra anf mushrooms are not washed after harvest. Chemically mild detergent (soap solution), glacial acetic acid or Nacl (1%) can be used for surface decontamination. Chlorinated water (100 pp cholorine) is also effective in surface decontamination. Fruits and vegetables are to be rinsed again with clean wastes and excess water allowed to dry before packing.

**5. Trimming:** Trimming is done in crops like cabbage and lettuce etc. To remove unwanted, discoloured, rotten and damaged parts. Trimming enhances visual quality, reduces deterioration of produce, facilitates handling packaging and transport.

**6. Curing:** Curing is a process of strengthening and wound periderm (skin) of root and tuber crops for a specified period under well-defined conditions of temperature and relative humidity which enhances shelf life of these crops by forming corky layer which protects against water loss and infections by decaying organisms. In bulb crops (onion &garlic).Curing is a drying process for toughening of outer skin and tightening of necks. Potato curing is most effective at about 20$^0$c and 80% relative humidity.

**7. Waxing:** Waxing is done mainly to minimize water loss and reduce shrivelling and wilting to enhance therefore storage life. Wax seals off the stem near the petiole and the pores on the surface of fruits which are the main routes of transpiration. Waxing on the surface of fruit or vegetable product which are the main routes of transpiration. Waxing also improves appearance of produce. Paraffin wax, Carnuba wax and various resins are common types of wax used for preparation of wax emulsion. Waxes are generally applied by foaming, spraying and brushing of which foaming is the best, since it leaves a very thin coating. Some of the common coating materials are semperfresh, prolong and waxol. Vegetables like tomato, brinjal, sweet pepper, cucumber, muskmelon, carrot are often waxed

**8. Precooling:** Pre-cooling is the process of removing field heat from the harvested commodity, particularly when harvested during hot weather.Pre-cooling helps in decreasing rate of transpiration and respiration delayed ripening and easing the load on the cooling system of transport or storage chambers. There are several methods of pre-cooling process as

a) Room cooling
b) Hydro-cooling
c) Contact icing
d) Vaccum cooling

**9. Post- Harvest Disease Control:** Vegetables suffer significantly due to invasion of fungi and bacteria causing disease and resulting in huge postharvest losses. Succulence of vegetables makes them prone to infection by micro-organisms Mechanical injuries, contamination by diseases vegetables, heat and other environmental agencies pre-dispose products to diseases. Post-harvest diseases can be controlled by use fungicides as sprays or dips, incorporated in wax or impregnated in packaging materials.

**10. Sprout inhibition:** Tuber and bulb crops (onion & potato) enter a dormant stage at maturity, sprouting starts at the end of dormancy or rest period. Sprouting is a growth resumption process. Sprouting causes huge loss due to respiratory utlisation of substrates. Maleic hydrazide (MH-40), 3-Cholorisopropyly-N-Phynle Carbamate (CIPC), Methyl naphthalene acetic acid (MENA) and 2,3,4,6 tetra nitro benzene (TCNB) are commonly used as sprout inhibitors. Gamma irradiation at 0.02- 0.15 KGY is widely accepted by many countries for successful sprout inhibition of onion and potato with out affecting other quality attributes.

**11. Packaging:** Packaging is a fundamental and necessary for management of highly perishable products. The main role of packaging is to assemble the produce into convenient units for

handling and safeguard the produce during distribution, storage and marketing. Packaging materials are selected according to plant characteristics. It improves storage life of produce and provides greater attraction to the produce. An efficient package practices protects product from any physical, physiological and pathological deterioration throughout storage, transport and marketing packaging material should provide cushioning to fresh produce as several types like bamboos baskets, sacks (mode of plastic or jute),wooden crates, corrugated fibre board (CFB) cartons are used. Vegetables mostly bamboo baskets, gunny bags, plastic crates are used for packaging purposes.

**12. Transport:** Transport is an important linkage in postharvest handling, storage and distribution. Transport of horticultural produce from field to the distribution markets is done by rail, truck, airplane and ship. Serious losses take place due to improper handling, careless loading and unloading and use of improper containers. Transport of produce during cool hours of night, use of ventailated, insulated evaporative cooled or regrigerated vehicles ensures preservation of quality. Pallets are used in many developed countries for trading of horticultural produce. It is also important to introduce mechanical loading and unloading particulary with the use of fork lift trucks. In advanced countries refrigerated containers known as reefer containers produce. In India use of containers working on evaporative cooling techniques should be encouraged.

**13. Waxing:** Vegetables such as tomato, brinjal, sweet pepper, cucumber, muslmelon, carrot etc. are often waxed with a water emulsion by dipping or spraying to retard the moisture loss from the product and at the same time to improve their lustre. This practice of keeping the product sound and lustrous is generally not in vogue in our country.

**14. Marketing System:** Vegetable market is often suffering from several constraints due to their high perishable nature, season market and bulky nature. Assembling and subsequent marketing of the produce is further blocked due to lack of proper storage facilities and quick transport systems. Very often the products are formed to dispose of their produce at a very nominal price where there arises seasonal gluts due to these bottle necks. Another major defect in vegetable marketing is the in volovement of several intermediaries which dominate the trade and get huge profit. Consequently producers margin in the consumer price becomes very low. It is therefore essential that organized effort for establishing co-operative system of marketing should be enforced at village and districxt levels to control activity of intermediaries and to regulate the vegetable marketing smoothly and in a streamlined system. Moreover, close co-ordination among Agricultural Marketing Board, National Horticulture Board and state department of agriculture/Horticulture should be ensured to formulate an action plan for regulating marketing of vegetables in a smooth and streamlined way.

**15. Storage:** Storage of vegetable produce an important for improving shelf life avoiding market glut and to ensure supply throught the year and increase profit to the producers. The principle aim of storage is to reduce and control transpiration, respiration and disease infection at the same time maintaining life processes at the required level. Different methods of storage of vegetable produce are as:-

a) **Refrigerated storage**: Highly perishable vegetable produce requires refrigerated vegetable storage since it retards the rate of metabolic change, moisture loss, respiratory heat products and spoilage caused by heat production and spoilage caused by micro-organisms and thereby enhances retaining life of vegetable produce.
b) **Controlled/Modified atmosphere:** The main purpose of controlled atmosphere (CA) or modified atmosphere is to adjust the atmosphere composition of gases surrounding the commodity by removal or addition of gases. Thus resulting in an atmospheric composition different from that of normal air. Modified atmosphere does not differ in principle from the controlled atmosphere storage except that the control of gas concentris less precise.
c) **Hyobaric storage:** Hyobaric storage is similar to controlled atmosphere storage in which produce is stored in partial vacumm. The vacumm is created by vacumm pump to a particular desired low pressure. The process of ripening and sencence is greatly reduced by decreasing rate of respiration and removal of ethylene.
d) **Zero-energy cool chamber:** In tropical areas like india, tremendous amount of quality deterioration take place immediately after harvest of produce due to lack of on farm storage facilties to overcome this problem, low cost environmental friendly zero energy cool chambers are developed by IARI New Delhi these chambers work on principle of evaporative cooling using locally available materials like brick sand and bamboos. The temperatures in these chambers are less than surrounding atmosphere. These chambers can be used for short term storage of products at the farmers field itself.

Postharvest loss is more serious as compared to production loss. Reduction of postharvest losses significantly increase availability of vegetables without bringing additional land into production and without using additional inputs. Although losses cannot be reduced completely, but can be minimised by adoption of modern cultural practices, harvesting, handling, marketing and processing techniques.

**Processing in vegetables**

Processing industry of horticulture crops including vegetable crops is a very backbone of horticulture industry taking care of gluts and wastes. Processing can fetch an additional income to the grower, s and helps in stabilising the prices with economic returns. The best indicator of the economic contribution of food processing to the food system is the value addition. Value addition is the indicator of the industry, s contribution to GDP.

**Case studies**

A study was conducted on the effects of postharvest handling and storage temperature on the quality and shelf of tomato during 2011 by Abubakari Mutari and Rees Debbie which revealed that rough handling of tomatoes can result in the destruction of the fruit cell wall leading to softening and reduced marketability of the produce. Also, high storage tempera-ture can result in increased respiration (3.8 mlCO2/kg-h) and ethylene production (7.85 µl/kg/h) significantly as well as accelerate ripening (16.80) and weight loss (97.08%). Therefore these conditions (rough handling and high temperature) accelerate the metabolic rate of tomatoes and there by reduce the shelf life of the produce.

Nasrin *et al* 2008 [3] conducted a study on shelf life and quality of tomato and confirmed that tomato treated with

chlorine; packed in perforated (0.25%) polyethylene bag and kept at ambient temperature (20-25 °C) & relative humidity 70-90%) condition resulted in substantial reduction in decay and weight losses. The same treatment combination also considerably delayed compositional changes in TSS, total sugar, reducing sugar, vitamin-C, B-carotene, etc. Under this condition, shelf life of tomato extended upto 17days as compared to non-treated and kept inambient condition with out packaging or packed in gunny bag for 7 days only.

Serrano *et al*. (2006) [4] packaged broccoli (Brassica ole-racea L.) heads using 3 types of polypropylene filmsmacro-perforated, micro perforated and non-perforated, and then stored at 1°C for 28 days and observed that, especially for micro perforated and non-perforated films, all changes related with loss of quality were significantly reduced and delayed with time. Both high CO2 (5-20%) and low O2 (down to 1%) concentrations retard respi-ration and senescence of broccoli heads (Serrano *et al* 2006) [4]. Increasing CO2 seems to be more effective than decreasing O2 Broccoli maintains its quality longer in both perforated and sealed polyethylene packages than did non-packaged controls (Granado-Lorencio *et al* 2008) [5]. MAP does not affect significantly the *in vivo* bio-availability of carotenoids and tocopherols from broccoli, supporting its convenience for use by the food industry and consumers (Granado-Lorencio *et al* 2008) [5].

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