E-ISSN: 2663-1067
P-ISSN: 2663-1075
IJHFS 2020; 2(2): 48-52
Received: 22-06-2020
Accepted: 28-07-2020

Binod Pokhrel
Faculty of Agriculture, Agriculture and Forestry University, Rampur, Chitwan, Nepal

Corresponding Author:
Binod Pokhrel
Faculty of Agriculture, Agriculture and Forestry University, Rampur, Chitwan, Nepal

Review on post-harvest handling to reduce loss of fruits and vegetables

Binod Pokhrel

Abstract
Fruits and vegetables are the perishable agricultural commodities. Harvesting of pre-matured and over-matured fruits results in shorter storage life and quality deterioration. Thus the fruits should be harvested at proper stage of maturity for good quality with better storage. Vegetables on other hand can be harvested at horticultural maturity. However, poor handling method of produce has resulted to a serious post-harvest loss, loss of time and money spend. Unavailability of suitable handling processes and chemical treatment are triggering huge amount of loss of commodities. Hence, producers are suffering from great economic loss due to lack of proper handling methods, lack of nature and cause of postharvest loss and proper preservation methods. However, loss can be minimized by subejecting produce to proper management and handling procedure such as cleaning, grading and sorting, storage, transportation and marketing. Pre-harvest and postharvest treatment with certain chemicals also extends the shelf life of commodities by preventing from harmful pathogens and from contamination. The data were collected from different relevant sources and has been described in own words. Consequently, this paper suggests the postharvest handling of fruits and vegetables in such a way to reduce post-harvest loss and increase the availability of produce.

Keywords: fruits, vegetables, post-harvest, handling, shelf life, management

Introduction
Horticultural commodities harvested prematurely results in poor quality and such commodities deteriorate much faster than that is harvested at the proper stage of maturity. On the other hand, harvesting beyond optimum maturity results in shorter storage life. Thus the fruits should be harvested at proper stage of maturity for good quality with better storage. The processes carried out immediately following harvesting including cooling, cleaning, sorting, grading, packaging, transportation are postharvest handling processes. At all stages of postharvest handling, there is significant loss in both quality and quantity of perishable commodities. Increase in shelf life, maintenance of quality and minimization of undesirable changes are the main goals of postharvest horticulture. Preservation of original quality of the fruits or vegetables is the best possible outcome achieved in post-harvest handling process. (Toivonen, J, & Terry, 2014) [24].

Harvesting
The physiological maturity of any fruit at harvest has an important effect on post-harvest quality of that fruit (Beckles, 2012) [5]. Postharvest processes like storage, transportation and marketing are influenced by the stage at which the commodities are harvested. Fruits should be harvested at physiological maturity at which they attain maximum dry weight. On other hand, vegetables should be harvested at horticultural maturity or field maturity. Fruits are harvested on the basis of skin colour, taste, size, total soluble solid (TSS) and other desirable characters. Vegetables on other hand are harvested based on consumer's willingness. Maturation, ripening and senescence are the critical stages that predominantly determine the shelf life of fruits and vegetables. The stage of maturity gives an indication of the fruit being ready for harvest (FAO, 2008) [9]. Great care must be taken while harvesting fruits and vegetables to avoid the injuries which will hasten deterioration.

Table 1: Maturity days of some vegetables from days of planting (EI-Ramady, 2015)

Crops	Early variety	Late variety
Tomato	65	100
Radish	22	40
Okra	50	60
Potato	90	120
Peas	58	77
Cabbage	62	110
Cauliflower	55	65
broccoli	70	150
Muskmelon	75	90
Mustard	40	60
Onion	85	120
Pumpkin	110	120
Eggplant	70	85
Carrot	60	85
Beans	56	72

Table 2: Maturity indices of some fruits (EI-Ramady, 2015)

Crops	Maturity indices
Apple	11-12% SSC, red colour of fruit
Banana	Yellowing of peel and disappearance of angle of finger
Litchi	Bright red in colour, total acid ratio of 30-40
Mango	Increase fullness of cheeks or bulge of shoulder, flesh color yellow to yellowish-orange
Papaya	Skin shows yellowing
Peach	Green to yellow colour
Plum	Skin colour changes
Grapes	14-17.5% SSC
Lemon	30% or more juice by volume
Guava	Dark green to light green or yellow
Strawberry	Two third of berry surface showing pink or red color

Precooling

Harvesting stage is usually characterized by high heat content of many fruits and vegetables and should be minimize with dispatch before carrying out of any postharvest handling activity (Bachmann, 2000) [4]. Precooling is done for rapid cooling of a commodity to the required transit or storage temperature and to slow down the physiological processes. It is the first step in temperature management. Immediate cooling after harvest is most important operation as increased field heat gives rise to undesirable changes in some metabolism and triggers quality deterioration. (Akbudak, 2012) [2]. Precooling minimises the effect of microbial activity, metabolic activity, respiration rate, and ethylene production (Shahi, 2012) [22], whilst reducing the ripening rate, water loss, and decay, thereby preserving quality and extending shelf life of harvested tomatoes (M.D. Ferreira, 1994) [16]. Precooling can be done with various processes like room cooling, forced air cooling, hydro-cooling, vacuum cooling and ice cooling. However, rate of cooling depends on cooling medium, thermal properties of produce, contact between medium and produce stacking pattern.

Cleaning

Proper cleaning and sanitation of the produce is the subject of major concern to all the farmers, intermediaries and consumers, not only to control of post-harvest diseases, but also for prevention of food-borne illness to consumers (Arah I. K., 2016) [12]. Fruits and vegetables should be cleaned with related methods and materials. Sodium hypochlorite solution, thiabendazole, chlorinated water are frequently used for cleaning or disinfection. The PH of wash solution is found to be more effective in between 6.5 to 7.5.

Sorting and Grading

One of the most important processes in packaging and marketing of fruits and vegetables is sorting and grading (O. Arjenaki, 2013) [20]. Sorting is the process of removing of damaged, diseased, rotten fruits from healthy and clean ones which are unsuitable for marketing and storage. Secondary contamination can be minimized by removing diseased and damaged commodities. Only sensory quality parameters are taken into consideration during sorting. Sorting is the most important marketing strategy which needs to be considered during handling. Therefore, fruits and vegetables are sorted into different grades which fetch higher price in the market (Alao, 2000) [3]. The process of categorising fruits and vegetables based on their shape, size, colour and internal characteristics is called as grading. Grade can be A, B, C or 1, 2, 3 or fine, course or large, medium, small etc. Some timers the term sizing and grading are used synonymously in which grading is based on size. Differentiation of fruits and vegetables in a common factor or parameter helps handlers in storing in favourable containers, transportation and easy handling. Grading on the basis of different maturity stages and other morphological appearance like colour helps to remove overripe and unripe fruits. Overripe fruits produce ripening hormone ethylene which hastens the ripening of fruits of whole mass (Arah I. K., 2016) [12].

Packaging

Packaging is the process of enclosing produce to protect from external contamination (physical, chemical and biological) and mechanical injuries (Kochhar, 2014) [15]. For mandarin and apple, corrugated cardboard boxes and for tomatoes, specific sizes of plastic trays or cartoons are suitable to local conditions are standardized and locally available wrapping/cushion materials are recommended (Bhattarai, 2018) [6]. Nylon sacks, plastic or wooden crates, woven palm baskets, cardboard boxes and polythene bags are the common packaging materials that are used in most of the developing countries (Idah & Yisa, 2007) [11]. Most of these packaging materials do not provide all protection needed by the commodity. Some structures made up of nylon sacks do not allow the circulation of cool air due to non-aeration which increases inner temperature causing a build-up of heat due to respiration and containers with rough surfaces and edges cause mechanical injuries to the produce (Arah I. K., 2016) [12]. Package must have sufficient mechanical strength, must be free from chemical substances, should allow rapid cooling of the contents and packaging should meet the handling and marketing requirements.

Storage

Storage is the art of keeping the quality of agricultural materials and preventing them from deterioration for specific period of time, beyond their normal shelf life (Kiaya, 2014) [14, 25]. Some commodities are stored short-term and some are stored for long term according to their nature of deterioration and their demands in the market and also by their relative prices in the market. Most of the enzymes work best up to temperature of 30°C and are inactivated above 400C. Continuous exposure of some climacteric fruits to a temperature of about 300C or above causes the flesh to ripen, but the fruits fail to develop

colours. Lycopene accumulation in tomato is inhibited at high temperature, thus tomato ripened at higher temperature do not develop red color. Ripe tomatoes can be stored at temperatures of 10-15°C and 85-95% relative humidity for long term storage (Castro, 2005) [7].

Table 3: Storage loss of fruits and vegetables in Nepal

Crop	Loss (%)	Storage type
Tomato	14-25	Zero energy
Apple	10	Cool storage
Apple	15-30	Underground pit
Carrot	6-14	Zero energy
Orange	22-23	Cellar storage

Table 4: Storage temperature and relative humidity of some fruits (SM Yahaya, 2019) [23]

S. N.	Name of the fruit	Storage temp. (°C)	Relative humidity (%)
1	Pineapple	8-10	85-90
2	Pomegranate	0-1.66	85-90
3	Guava	8.30-10.00	80-85
4	Mango	7.20-8.80	85-90
5	Grapes	0-1.66	80-85
6	Jackfruit	11.10-12.70	85-90
7	Banana		
	(a) For ripening	15.50-21.00	80-85
	(b) Ripened fruit	11.10-12.70	85-90
8	Grapefruits	7.20-8.80	85-90
9	Pear	0-1	85-90
10	Papaya	8.30-10.00	80-85
11	Lime	8.30-10.00	85-90
12	Litchi	0-1.66	85-90
13	Lemon	7.20-8.80	85-90
14	Strawberry	0-1.66	85-90
15	Apple	0-1.66	85-90
16	Plum	0-1.66	85-90
17	Peach	0-1.66	85-90

Table 5: Storage temperature and relative humidity of some vegetables (SM Yahaya, 2019) [23]

Sl. No.	Name of vegetable	Temperature (°C)	Relative humidity (%)
1	Asparagus	0-0	95
2	Brinjal	10.0-11.10	92
3	Bitter gourd	0.6-1.7	85-90
4	Cabbage (early)	0.0-1.7	92-95
5	Cabbage (late)	0.0-1.7	92-95
6	Cauliflower	0.0-1.7	85-95
7	Coriander	0.0-1.7	90
8	Cucumber	10-11.7	92
9	Garlic	0.0	65
10	Ginger	7.2-10.0	75
11	Okra	8.9	90
12	Onion (leaf)	0.0	90-95
13	Onion (bulbs)	0.0	70-75
14	Pea (green)	0.0	88-92
15	Pepper (ripe)	5.6-7.2	90-95
16	Potato (Irish)	3.0-4.4	85
17	Pumpkin	1.7-11.6	70-75
18	Sweet potato	10-12.8	80-90
19	Tomato (unripe)	8.9-10.0	85-90
20	Tomato (ripe)	7.2	90
21	Watermelon	7.2-15.6	80-90

Transportation

In most of the developing countries like Nepal, marketing centers are located far from the point of production and also inaccessible by road. Harvested commodities are brought to the local market from point of production by trolleys, bus, motorcycles or manually. Long distance transportation (different parts of country to Kathamndu) is carried out by bus, trucks and other vehicles. On the other hand, developed countries have good road conditions with refrigeration facilities. Worst condition of road has led to improper transportation of harvested commodities which has become the big challenge on both production and consumption level (Abimbola, 2014) [1]. Transporting of horticultural commodities in refrigerated containers is not only convenient but also reduces the loss. However, in developing countries the initial investment for refrigeration and other operation costs are very high which may be beyond the access of people. Quick transportation of fruits and vegetables should be carried out for successful marketing and quality maintenance. Most of the losses which occur during transportation occur due to physical and mechanical injury and uncontrolled conditions, mainly temperature and humidity (Opadokun, 1987) [21]. During transportation of commodities, losses up to 20% can occur. To reduce such losses of the produce, long distance facilities should be provided and produce should be properly packed and stacked in well ventilated containers (Yahaya & Mardiyya, 2019) [23]. Good and efficient transport system not only reduce the post-harvest loss of horticultural produce but also will assist in stabilizing the price fluctuations of various commodities available in different markets of the country.

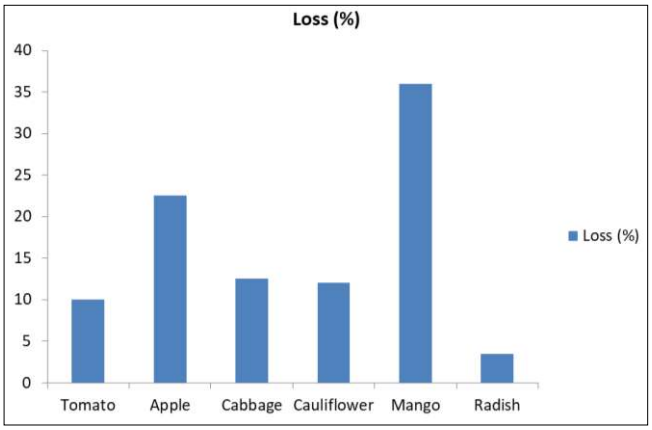

Fig 1: Transportation loss of fruits and vegetables

Marketing

Marketing is the process by which horticultural commodities are moved from point of production to the point of consumption. Marketing is the ultimate and end process in the post-harvest system. However, marketing and transportation are the similar processes which is an essential link in the system (Victor Kiaya, 2014) [14, 25]. Marketing of fresh perishables presents more problems compared to other durable agricultural products (Yahaya, M, & S, 2015) [27]. Marketing of horticultural crops is quite difficult as compared to cereal crops due to perishable nature, bulkiness, seasonal produce, great care and immediate disposal. As a result, the supply of horticultural commodities is subjected to various problems including wide fluctuating in prices. The spectrum of prices from producer to consumer, which is an outcome of various intermediaries at different levels in the marketing system, is

also unique for fruits and vegetables (Neeraj, 2017) [19]. Loss of the produce may occur at different intermediaries. Pre-harvest contract is the common marketing practice followed due to perennial nature and uncontrolled volume production. Contractors purchase the orchard in lump sum basis few months prior to production season.

(D. Dhakal, 2005) [8] found following four types of marketing channels in the market survey of acid lime and hill lemon in Nepal.

Channel 1: Producers-Retailers- Consumers

Channel 2: Producers-Wholesalers-Retailers-Consumers

Channel 3: Producers-Commission agent-Wholesaler-Retailers-Consumers

Channel 4: Producers-Collectors-wholesalers-Retailers-Consumers

In Nepal, the interest of producers and consumers are rarely fulfilled. Hence, farmers get less return of the money invested while consumers pay more than what is necessary. More loss is experienced when fruits and vegetables are in excess in the market. This discourages farmers to produce fruits and vegetables. Therefore, efforts should be made to avoid glutting and the loss should be reduced to bearest minimum (Mardiyya SY, 2019) [17, 18].

Conclusion

Postharvest shelf life and quality of fruits and vegetables greatly depend upon postharvest handling practices, treatments and harvesting method too. Due to perishable nature of produce, fruits and vegetables should be used with dispatch. Postharvest handling methods significantly cannot improve the quality but can maintain the condition when if handling is done with great care. Failure to adopt these postharvest handling methods has resulted in high amount of loss especially in developing countries like Nepal. Postharvest loss can be considerably minimized and shelf life can be extended by careful manipulation of postharvest handling methods. Loss can be minimized by careful harvesting, careful handling, implementing important cultural methods, storage, packaging and transportation. Controlled atmosphere storage and low temperature treatment has been found to be effective for fruits and vegetables. Until the simple postharvest practices are followed, postharvest losses in fruits and vegetables will continue to be a major challenge for handlers of developing countries.

References

1. Abimbola O. Post-harvest losses and welfare of tomato farmers in Ogbomosho, Osun state, Nigeria. Journal of Stored Products and Post-harvest Research 2014;5(2):8-13.
2. Akbudak BA. Effects of pre-harvest harpin and modified atmosphere packaging on quality of cherry tomato cultivars 'Alona' and 'Cluster'. British Food Journal 2012;114(2):180-196.
3. Alao SL. The importance of post-harvest loss prevention. Graduation ceremony of School of food storage technology. Nigeria: Nigerian Stored Products Research Institute, Kano 2000, P1-10.
4. Bachmann JE. Post-harvest Handling of Fruits and Vegetables, Appropriate Technology Transfer for Rural Areas, USA 2000.
5. Beckles D. Factors affecting the post-harvest soluble solids and sugar content of tomato (*Solanum lycopersicum*) fruit. Postharvest Biology and Technology 2012;63(1):120-140.
6. Bhattarai DR. Postharvest Horticulture in Nepal. Horticulture International Journal 2018;2(6):458-460.
7. Castro LV. Effect of cooling delay and cold-chain breakage on 'santa Clara' tomato. Journal of Food, Agriculture and Environment 2005;3(1):49-54.
8. Dhakal D, KT. Marketing survey of acid lime and hill lemon in Nepal. Journal of Institute of Agriculture and Animal Science 2005, 107-116.
9. FAO. Basic Harvest and Postharvest Handling consideration for Fresh Fruits and Vegetables Handling and Preservation. Rome, Italy: FAO 2008.
10. Hurst W. Harvest, handling and sanitation. In W. Hurst, Commercial Tomato production Handbook B 1312. Georgia: CAES publication, University of Georgia 2010.
11. Idah P, Yisa EA. Fruits and vegetables handling and transportation in Nigeria. AU Journal of Technology 2007;10(3):175-183.
12. Isaac Kojo Arah *et al*. Postharvest Handling Practices and Treatment Methods for Tomato Handlers in developing countries: A Mini Review. (P. Parolin, Ed.) Advances in Agriculture 2016, 1-8.
13. Kader AA. A Perspective on Postharvest Horticulture (1978-2003). Horticulture Science 2003;38(5):1004-1008.
14. Kiaya V. Postharvest losses and strategies to reduce them. ACF International 2014.
15. Kochhar PP. Active packaging in food industry; a review. Environmental Science, Toxicology and Food Technology 2014;8(5):1-7.
16. Ferreira MD, JB. Physiological responses of strawberry to film wrapping and precooling methods. Proceedings of the Florida State Horticultural Society 1994;107(3):265-269.
17. Mardiyya SY, SY. Review of post-harvest losses of fruits and Vegetables. Biomedical Journal of Scientific Research and Technology 2019, 10192-10200.
18. Mardiyya SY. Review of Postharvest Losses of Fruits and Vegetables. Biomedical Journal of Scientific and Technical Research 2019, 10192-10200.
19. Neeraj AC. Marketing and production of fruits and vegetables in India. International Journal of Current Microbiology and Applied Sciences 2017;6(9):2896-2907.
20. Arjenaki O, OM. Online tomato sorting based on shape, maturity, size and surface defects using machine version. Turkish Journal of Agriculture and Forestry 2013;37(1):62-68.
21. Opadokun J. Reduction of post-harvest losses in fruits and vegetables. Zaria: IAR 1987.
22. Shahi NC. Effects of precooling treatments on shelf life of tomato in ambient condition. International Journal of Food, Agriculture and Veterinary Science 2012;114:50-56.
23. Yahaya SM, AM. Review of Post-harvest Losses of Fruits and Vegetables. Biomedical Journal of Scientific and Technical Research 2019, 10192-10200.
24. Toivonen PM, JE, Terry MA. Post-harvest Care and the Treatment of Fruits and Vegetables. Springer Science + Business Media 2014, 465-483.
25. Victor Kiaya. Postharvest Losses and Strategies to Reduce Them. Scientific and Technical Department.

ACF International 2014.
26. Wikipedia. (N.D.). https://en.wikipedia.org/wiki/Postharvest#:~:text=In%20agriculture%2C%20postharvest%20handling%20is,plant%2C%20it%20begins%20to%20deteriorate.
27. Yahaya LF, ML, SM. Isolation and Identification of Pathogenic Fungi Causing Deterioration of Lettuce Plant (*Lactuca sativa*). Journal of Plant Science and Research 2015.