Journal of Advances and Scholarly Researches in Allied Education
Vol. XV, Issue No. 1, April-2018, ISSN 2230-7540

Review on Study of Postharvest Losses of Fresh Vegetables and Its Preservation Techniques

Dr. Indrajit N. Yadav[1]* Ms. Ambika Pendu[2] Ms. Jai Pednekar[3]

[1,2,3] Department of Chemical Engineering, Bharati Vidyapeeth College of Engineering, Navi Mumbai, (MS) India

Abstract – Vegetables are considered as a commercially important and nutritionally important food commodity due to its major dietary source of vitamins, sugars, organic acids and minerals. The topic of loss reduction in vegetables is the challenge to meet the requirements of future generation. This loss reduction can be expressed as post-harvest losses occurring in vegetables. "Post-harvest loss" is the term used to describe the crops lost to waste, spoilage, and other factors between harvest and consumption by the end user. This article summarizes the literature on various techniques to reduce or prevent post-harvest losses and to increase its shelf life.

Keywords: Post-harvest loss, Vegetables, Preservation Techniques

- X -

INTRODUCTION

All living creatures, including humans, depend on nature for their food. Humans are not only hunters and gatherers, but also farmers. Most of our food consists of agricultural products, which are usually seasonal and spoil quickly. To make food available throughout the year, humans have developed methods to prolong the storage life of products: to preserve them. The rotting process can be postponed by adding preservatives, optimizing storage conditions, or applying modern techniques. Vegetables provide an abundant and inexpensive source of energy, body-building nutrients, vitamins and minerals. Their nutritional value is highest when they are fresh, but it is not always possible to consume them immediately. During the harvest season, fresh produce is available in abundance, but at other times it is scarce. Moreover, most vegetables are only edible for a very short time, unless they are promptly and properly preserved.

Fresh fruits and vegetables are inherently perishable. During the process of distribution and marketing, substantial losses are incurred which range from a slight loss of quality to total spoilage. Postharvest losses may occur at any point in the marketing process, from the initial harvest through assembly and distribution to the final consumer. The causes of losses are many: physical damage during handling and transport, physiological decay, water loss, or sometimes simply because there is a surplus in the marketplace and no buyer can be found.

Losses are high in many Asian countries, because of the inherent difficulty of collecting and transporting small quantities of produce from numerous small farms, and trying to collect these into a large enough quantity for efficient domestic marketing or for export. Even if large shipments can be collected together, the produce is often highly variable in size and quality, so that it is difficult to apply standardized grading and storage procedures. In tropical and subtropical countries, the warm, humid climate adds more stress and accelerates the decay of tropical produce. Postharvest losses of vegetables and fruit in most Asian countries are so high, and the causes of these losses are so diverse, that a great deal of research and training is needed if prevention measures are to be improved. . The need for improvement is shown by the fact that in developing countries where there is still a poor infrastructure and a lack of marketing facilities, postharvest losses of fresh produce range from 20 to 50 %.The term "postharvest loss" - PHL refers to measurable quantitative and qualitative food loss in the postharvest system (de Lucia and Assennato, 1994). This system comprises interconnected activities from the time of harvest through crop processing, marketing and food preparation, to the final decision by the consumer to eat or discard the food. Nowadays, interventions in PHL reduction are seen as an important component of the efforts of many agencies to reduce food insecurity. PHL is increasingly recognized as part of an integrated approach to realizing agricultures full potential to meet the world's increasing food and energy needs. Therefore, reducing PHL along with making more effective uses of today's crops, improving productivity on existing farmland, and sustainably bringing additional acreage into production is critical to facing the challenge of feeding and increased world population.

This technical paper highlights some concepts and problems of postharvest losses in vegetables, and critical factors governing PHL and food waste. It covers losses occurring along the entire food chain, and highlights some strategies and alternatives ways of preventing and reducing these losses.

This paper is a comparative study on various factors causing post-harvest losses in vegetables and methods to reduce them and increase its shelf life are provided below

Manpreet Kaur et al. (2016) studied with a view to know the effect of storage for prediction of the relationship between storage conditions, physical and nutritional quality under low density polythene bag, high density polythene bag and laminated aluminium packaging. The individual quick freezing of the French beans was done. Half of the samples were packed separately and placed in refrigerator at -18oC for two hours. While the other half was stored in deep freezer at -20oC and observations made for 4 months. It was observed that the higher the temperature, the higher the weight loss although the loss was higher in low density polythene bags in all the storage temperatures. There was a slower loss of protein content in samples stored in laminated aluminium polythene bags; however, the samples stored in both temperatures had the greatest loss by fourth month. The results show that packaging in laminated aluminium polythene bags has to be coupled with low temperature storage in order to receive a desirable shelf life.

K.Chitravathi et al. (2016) developed shellac based coating in combination with starch EDTA and sodium alginate. The green chillies were coated with shellac coating, packed in anti-fog film and kept at 8 ± 1 ℃ for storage along with uncoated control. Coated samples showed higher retention of ascorbic acid firmness, chlorophyll content and less weight loss. Phenolic content was higher in uncoated samples. The postharvest treatments studied showed significant extension in the shelf-life of green chillies at low temperatures (8 ± 1 ℃) up to a period of 48 days compared to the control samples (15 days). Application of shellac based surface coating along with modified atmosphere packaging not only reduced the metabolic activities but also maintained the quality attributes of the chillies during storage.

MD. Rayhan Shaheb et al, [2015] conducted experiments both in the field and laboratory with the objective to observe the impact of harvest stage on the seed, quality and storability of French bean. Five harvest stages viz. H1-deep green with light yellow colours of pod, H2-50% green and 50% yellowing of pods, H3-light brown with few yellow colour pods, H4-90% brown colour of pods and H5-100% brown colour and dried pods were considered as treatments for field trial. Harvested seeds were then stored in both cool room and ambient conditions up to 16 months and performed seed quality studies in every 4months. The treatments combination of laboratory studies were T1: H1 seed storage in cool room (SSCR), T2: H1 seed storage in ambient (SSAB), T3: H2SSCR, T4: H2 SSAB; T5: H3 SSCR; T6: H3 SSAB; T7: H4 SSCR; T8: H4 SSAB;T9: H5 SSCR and T10: H5 SSAB. Experiments were laid out in a RCBD and CRD in the field and laboratory, respectively. Results revealed that the highest seed yield and quality of French bean was observed in H3. On the contrary, seed harvested in H4 and stored in cool room (with the mean temperature 18-20℃ and relative humidity around 60-70%) recorded the highest storability compared to ambient condi tion. However, seeds harvested in H3 and H5 were also showed better storability in cool room as well as ambient conditions. To sum up, all theseed quality parameters were satisfactorily well up to 12 months of storage then it declined in quality. Present investigations revealed that the highest seed yield and seed quality in respect to seed vigour and higher seed germination of French bean was obtained inH3 (while pods were shown light brown with few yellow in colour). On the contrary, seeds stored in cool room up to 16 month, H3 (pods appeared 90% of brown in colour) observed the highest storability in terms of higher germination percentage and vigour index. It was also indicated that all the seeds stored in cool room were found better in seed quality compared to ambient condition. However, seeds harvested in H3 and H4 also showed better seed quality and storability in cool room as well as ambient conditions.

Rezzan Kasim's et al. (2015) study was to determine, the effect of different doses of calcium chloride on biochemical and color properties of fresh-cut green bean. Fresh-cut green beans were dipped for 90 seconds in 0.5%, 1%, 2% and 3% solution of calcium chloride at 25°C. The fresh-cut green bean samples were packaged in polystyrene foam dishes, wrapped with stretch film and stored in a cold room at 5±1°C temperature and 85-90% RH. In this study, the effect of calcium chloride treatments on the quality of fresh-cut green bean was investigated. Calcium chloride treatment has been effective on the retention of color of samples for four days. Similarly, the level of fructose and sucrose of samples were high, but that of glucose was low. Polyphenol oxidase activity of samples has been reduced by high level of calcium chloride. Electrolyte leakage was blocked by high calcium chloride treatment, and the visual quality of samples treated with high calcium chloride was high. Hence it is suggested that calcium chloride treatments of fresh-cut green bean are effective to maintain quality for short period of storage.

G S Ubhi et al. (2014) stated on the basis of design of MAP, the low density polyethylene (LDPE) film of 37.5 µm thickness was chosen, and 0, 2 and 4 perforations of 1mm diameter were done in the packages. The french beans (both packed and loose) were stored in the walk-in-cold chamber having dimension 174 X 173 X 216 cm and at a temperature of 5°C ± 0.5°C with a relative humidity of 95%. Both temperature and relative humidity inside the chamber were precisely maintained at desired levels. French beans were put in a single layer in the plastic crates of 50 X 32 X 28 cm and crates were placed on the racks inside the chamber. Approximately 250 g of french beans were packaged in bags of size 10 inch x 8 inch. The effective area of the package was 0.0825 m2, and this effective area of the package was mainly responsible for diffusion of respiratory gases (i.e. O2 and CO2) across the film barrier. As a conclusion it was found that LDPE 37.5µm package with 4 perforations was considered to be the best as regards to maintaining the quality of fresh French beans.

R.Hameed et al. (2013) ,investigated the effect of different storage conditions viz., 0 °C (R.H 80-90 %), 5 °C (R.H. 8090 %), 10 °C (R.H. 80-90 %) and 15 °C (R.H 85-95 %) were observed on green chillies for 3 weeks. After removal from storage, chillies were divided into two lots where one lot was kept at 15 °C (R.H. 85-95 %) and other at ambient conditions (22 °C ± 1 °C) with a R.H 65-70 % for one week shelf study. After the 3 week storage, the fruits subjected to 10 °C exhibited a comparatively less weight loss, decay, softness, ethylene production and respiration rate but more firmness, compared to all other storage conditions. Retention of chlorophyll was higher at the lower temperatures (0 °C), However, chilling injury was observed on the fruit stored at 5 °C and 0 °C, especially when taken out of storage and subjected to shelf life studies, where the fruits were found to be unmarketable after two days. The minimal quality loss occurred at shelf temperature of 15 °C compared to the ambient temperature. It can be concluded that 10 °C storage temperature performed better in slowing down the respiration rate, weight loss and decay, while maintaining the fruit firmness and overall quality. This study clearly pointed out that 10 °C as the best storage temperature for minimizing qualitative losses of green chillies during short-term storage

Mohammad Mizanur Rahman et al.(2012) conducted an experiment to evaluate the effect of packaging material on quality and shelf life of green chilly (Capsicum annum)using passive modification of modified atmosphere packaging system. The modified atmosphere was created by making perforation in the polypropylene packets. Green chillies were pretreated with chlorine water and then packed in polypropylene pockets with (0.1%, 0.2%, 0.3%, and 0.4% perforation) to restrict the respiration of the chilies. After packing, the chilies were stored in ambient temperature. Temperature and humidity were recorded and close observations were made to record the physicochemical parameters like moisture content, rotting/decay, marketability, vitamin C and ß-carotene of the green chili. It was observed that Green chili pre-treated with chlorine water and then packaging in 0.3% perforated polypropylene is the best for quality and shelf life for 10 days of storage at ambient temperature considering its physical appearance, marketable quality and change of physico-chemical parameters. Beyond this storage period, rotting and decay of the spices occurs rapidly, turn into red and shriveled and hence lose marketable quality.

J. N. Kinyuru1 et al. (2010) carried out a preliminary study on mature snap beans with a view to developing a model for short term storage for prediction of the relationship between storage conditions, physical and nutritional quality under low density polythene bags. Half of the samples were packed separately in open polythene bags while the other half was packed in closed polythene bags and stored at 5˚ C, 10˚ C, 15˚ C and 25˚ C and observations made for 9 days. It was observed that the higher the temperature, the higher the weight loss although the loss was higher in open polythene bags in all the storage temperatures. Similar trends were also observed in the loss of chlorophyll in both samples with samples stored at 25˚ C showing 5.5mg/L of chlorophyll content at day 9. There was a higher loss in total soluble solids in the samples stored in open polythene bags at 25℃ with the samples showing 5.3% by day 9.There was a slower loss of vitamin C in samples stored in closed bags; however, the samples stored at 25˚ C for both treatments had the greatest loss by day 9. The results show that packaging in polythene bags has to be coupled with low temperature storage in order to receive a desirable shelf life. In conclusion a combination of low temperature storage and closed polythene packaging has a very good preservation effect on the quality of snap beans.

GD.GChaturanil et.al (2004) investigated the effect of exogenous ethylene application on postharvest ripening and respiratory pattern of chilly (Capsicum annum Var.MI-2) harvested at different stages of maturity was examined chillies harvested at mature green and colour break stages were used for the ripening study. Pods were allowed to ripen at ambient conditions (32± 2℃and 37%RH) with 0, 100, 200, 300, and 400ppm ethylene concentrations. Observations were made on colour development and weight of red ripe pods during storage period. Ethylene treatment had no significant effect on colour development of chilly harvested at both stages of maturity. Fruits harvested at different stages of maturity ranging from light green to full red were usedfor the respiration study at in a closed system. The rate of respiration was low at light green stage and increased with maturity at colour break stage. Respiration rate decreased with fruit ripening and increased with development of full red colour. There was no effect of exogenous application of ethylene on postharvest ripening of chilli that are harvested at either mature green or color break stage. Whether ethylene treated or not, mature green pods failed to ripen while pods at color break stage completed ripening within 8-9 days. Hence, pods harvested above the color break stage can be used for dry chilli production.

R. C. Martin's et al. (2003) research presents a computational evaluation of frozen green beans (Phaseolus vulgaris, L.) quality profile, in terms of ascorbic acid, starch content, chlorophylls a and b, colour (Hunter a and b co-ordinates and total colour difference) and flavour, at storage temperatures of +5, 6, 12 and 18˚C, for respectively, 1, 4, 14, and 60 days. Simulations were set to access the impact of the pre-established after sale dates of the star dating' system. Sensory properties are well retained at low temperatures, but are very sensitive to the higher storage temperatures. Results demonstrate that green beans nutritional and sensory parameters are well retained at the storage temperatures of +5, 6 and 12˚C. At 18˚C, sensory parameters (e.g. colour and flavour) are well retained, but nutritional parameters, such as ascorbic acid and starch, degraded. The study concluded that the star dating' system is a good after sale dating system for frozen green beans for the storage temperatures of +5, 6 and 12˚C. The system fails to maintain a good balance between sensory and nutritional parameters at low storage temperatures.

A K. Sahoo et al. (1999) studied about the freshly harvested French beans obtained from a reliable source were sorted for freedom from defects and then washed under running water to remove all adhering dust and dirt and the hydrocooled by immersion in cold water to reach a temperature of 8 ℃, stored in three conditions,. Open tray, perforated and unperforated polypropylene bags at ambient conditions (30 ± 5℃, RH 70 ± 3 per cent) and at 10 ± 2℃ (RH 88 per cent). In each perforated PP bags there were 16 holes each having 6 mm in diam. At various intervals of time the quality was mentioned in terms of moisture loss, texture change, contents of ascorbic acid, total chlorophyll, caretenoid, peroxidise and lipoxygenase activities. Beans without precooling treatment showed maximum shelf life of 11 days when packed in perforated polypropylene bags and stored in cold room, whereas for precooled samples a maximum shelf life of 32 days was shown under similar conditions of storage. Statistical analysis of data brings out that the storage temperature had significant effect on one of the parameters like ascorbic acid compared to that of the packaging material.

Marisa M. Wall et al. (1995) compared the postharvest quality of green chile fruit after storage in 3 types of packages at 2 temperatures (24℃ and 8℃). Package types were corrugated cardboard boxes, pressed cardboard trays overwrapped with VF- 71 polyethylene, or low-density polyethylene (LDPE) bags. Fruit packaged in boxes or overwrapped trays had 24.8% and 10. 1% weight loss, respectively, after 1 week of storage at 24℃. Fruit packaged in polyethylene bags lost 0.3% weight and remained green. After 1 week at 8℃, the weight losses were 3.8%, 1.8% and 0% for the boxed, overwrapped and bagged treatments, respectively. Postharvest quality was maintained up to 4 weeks when fruit were packaged in LDPE bags and stored at 8℃. In a second study, steady state O_2 and CO_2, levels were determined inside the LDPE packages as fruit weight and temperature were varied. Storage temperatures were 24℃, 16℃ and 8℃. At 8℃, steady state levels O_2 ranged from 12.0 kPa to 0.9 Wa, and CO_2, levels rangedfrom 2.0 kPa to 4.6 kPa as fruit weight was increasedfrom 120 to 480 g. At 24C and 16C, fruit packaged in 480 g units had slower ripening rates than fruit packaged in smaller units; however, fruit stored at 8C remained green the longest, regardless of fruit weight. The main benefit of packaging fresh green chilli peppers in LDPE film was a reduction in fruit water loss. This is in agreement with several other reports for peppers.

A.E. Watada et al. studied senescence of detached fruits of snap beans (Phaseolus vulgaris L.,cv Tendergreen) was studied under different temperature regimes. Shelf life was longest at 5˚C. snap bean fruits were subjected to continuous and transfer temperature treatments to determine their threshold temperature for chilling injury and to determine the maximum duration of exposure at the chilling temperature without injury. Samples were weighed, placed in glass containers at the desired temperature with humidified air metered through the container. It was concluded that tender green beans are severely injured at temperatures below 5°C as indicated both by the sharp increases in respiration and development of visible symptoms. Chilling injury at 5° was not revealed by the deterioration pattern obtained during the continuous holding but the respiration pattern during this experiment and the results of the transfer experiments indicated slight chilling injury. Despite this, 5° appeared to be the most desirable temperature for holding beans since the shelf life was longest at this temperature. Intermediate temperatures between 5° and 10° were not evaluated and might prove most suitable for maximum holding of snap beans.

The summary of above literature review is given in the table below

Table 3.1 Summary of literature review

Sr. No.	Title	Author	Work	Remark
1	Influence of storage temperatures on the protein content of french beans (Phaseolus vulgaris L.)	Manpreet Kaur, Satish Kumar Gupta, T.C. Mittal and S.R. Sharma,	Quick freezing of the French beans was done. Samples were divided into two and packed (LDPE & laminated aluminium) and stored at particular temperature below Sample 1: refrigerated at -18°C for 2 hrs& Sample 2: deep freezed at -20°C for 4 months.	Packaging in laminated aluminium polythene bags has to becoupled with low temperature storage in order to receive a desirable shelf life.
2	Shelf life extension of green chillies (Capsicum annuum L.) using shellac-based surface coating in combination with modified atmosphere packaging	K. Chitravathi, O. P. Chauhan, P. S. Raju,	The green chillies were coated with shellac coating, packed in anti-fog film and kept at 8 ± 1 ℃ for storage along with uncoated control. Coated samples showed higher retention of ascorbic acid firmness, chlorophyll content and less weight loss. Phenolic content was higher in uncoated samples.	Extension in the shelf-life of green chillies at low temperatures (8 ± 1 ℃) up to a period of 48 days compared to the control samples (15 days).
3	Impact of harvest stage on seed yield quality and Storability of French Bean	MD. Rayhan Shaheb, MD. Nazmullislam, Ashratun Nessa, MD. Altab Hossain and Ayesha Sarke,	The impact of harvest stage on the seed, quality and storability of French bean. Five harvest stages viz. Stored in cool room and ambient for 16 months & tested every 4 months. Treatments combination-T1: H1 seed storage in cool room (SSCR), T2: H1 seed storage in ambient (SSAB), T3: H2SSCR, T4: H2 SSAB; T5: H3 SSCR; T6: H3 SSAB; T7: H4 SSCR; T8: H4 SSAB;T9: H5 SSCR and T10: H5 SSAB	Seeds harvested in H3 and H4 showed better seed quality and storability in coolroom as well as ambient conditions. In addition, it was remarked that all the seedquality parameters were satisfactorily well up to 12 months of storage.
4	Biochemical changes and color properties of fresh-cut green bean (Phaseolus vulgaris L. cv.gina) treated with calcium chloride during storage	Rezzan Kashim, Mehmet Ufuk Kashim.	Fresh-cut green beans were dipped for 90 seconds in 0.5%, 1%, 2% and 3% solution of calcium chloride at 25°C &were packaged in polystyrene foam dishes, wrapped with stretch film and stored in a cold room at 5±1°C temperature and 85-90% RH.	Calcium chloride treatment has been effective on the retention of color of samples for four days. It suggested that calcium chloride treatments are effective to maintain quality for short period of storage
5	Effect of Modified Atmosphere Packaging on French Beans (Phaseolus vulgaris L.) during Cold Storage	G S Ubhi, S R Sharma, J S Grewal and M Javed,	MAP- low density polyethylene (LDPE) film of 37.5 μm thickness was chosen, and 0, 2 and 4 perforations of 1mm diameter were done	It was found that LDPE 37.5μm package with 4 perforations was considered to be the best as regards to maintaining the quality of fresh french beans.

			in the packages. The french beans (both packed and loose) were stored in the walk-in-cold chamber having dimension 174 X 173 X 216 cm and at a temperature of 5°C ± 0.5°C with a relative humidity of 95%.	
6	Evaluating the Effect of Different Storage Conditions on Quality of Green Chillies (Capsicum annuum L.)	R. Hameed, A.U. Malik, A.S.Khan, M. Imran M. Umar and R. Riaz,	Storage conditions 0 °C (R.H 80-90 %) 5 °C (R.H. 80-90 %) 10 °C (R.H. 80-90 %) 15 °C (R.H 85-95 %) For 3 weeks & after that again divided in 2 slots and stored at 15 °C and ambient temperature.	This study clearly pointed out that 10 °C as the best storage temperature for minimizing qualitative losses of green chillies during short-term storage
7	Effect of different packaging systems and chlorination on the quality and shelf life of green chili	Mohammad Mizanur Rahman, MD. Miaruddin MD. Golam Ferdous Chowdhury, MD. Hafizul Haque Khan and M.A. Matin	Greenchillies were pretreated with chlorine water and then packed in polypropylene pockets with (0.1%, 0.2%, 0.3%, and 0.4% perforation) to restrict the respiration of the chilies & were stored in ambient temperature.	It was observed that Green chili pre-treated with chlorine water and then packaging in 0.3% perforated polypropylene is the best for quality and shelf life for 10 days of storage at ambient temperature .
8	Influence of Post-harvest Handling on the Quality of Snap Bean	John N. Kinyuru; Kinyanjui P. Kahenya1; Margaret Muchui; Hellen Mungai,	Half of the samples of French beans were packed separately in open polythene bags while the other half was packed in closed polythene bags and stored at 5˚ C, 10˚ C, 15˚ C and 25˚ C and observations made for 9 days.	In conclusion a combination of low temperature storage and closed polythene packaging has a very good preservation effect on the quality and shelf life of snap beans.
9	Postharvest ripening and respiration of chilli	GD.GChaturanil, S.Wilson, S.Perera, M.P. Hettiarachchi,	Pods were allowed to ripen at ambient conditions (32± 2℃and 37%RH) with 0, 100, 200, 300, and 400ppm ethylene concentrations. Observations were made on colour development and weight of red ripe pods during storage period.	The rate of respiration was low at light green stage and increased with maturity at colour break stage. Respiration rate decreased with fruit ripening and increased with development of full red colour.
10	Green beans (Phaseolus vulgaris, L.) quality loss upon thawing	R.C. Martins, C.L.M. Silva,	Frozen green beans were stored at temperatures of +5, 6, 12 and 18˚ C, for respectively, 1, 4, 14, and 60 days.	Results demonstrate that green beans nutritional and sensory parameters are well retained at the storage temperatures of +5, 6 and 12˚ C. At 18˚ C, sensory parameters (e.g. colour and flavour) are well retained, but nutritional parameters, such as ascorbic acid and starch, degraded.
11	Effect of Temperature and Packaging on the Shelf-life of French Beans	A K Sahoo and P R Kulkarni	French beans were washed under running water to remove all adhering dust and dirt and the hydrocooled by immersion	Beans without precooling treatment showed maximum shelf life of 11 days when packed in perforated polypropylene bags and stored in cold

			in cold water to reach a temperature of 8 ℃, stored in three conditions- Open tray, perforated and unperforated polypropylene bags at ambient conditions (30 ± 5℃, RH 70 ± 3 per cent) and at 10 ± 2℃ (RH 88 per cent). In each perforated PP bags there were 16 holes each having 6 mm in diam.	room, whereas for precooled samples a maximum shelf life of 32 days was shown under similar conditions of storage
12	Prolonging the shelf-life of fresh green chile peppers through modified atmosphere packaging and low temperature storage	Marisa M. Wall and Robert D. Berghage,	Green chilly was stored in 3 types ofpackages at 2 temperatures (24°C and 8°C). Package types were corrugated cardboard boxes, pressed cardboard trays overwrapped with VF-71 polyethylene, or low-density polyethylene (LDPE) bags.	Packaging fresh green chilly in LDPE film causes a reduction in water loss.
13	Effect of Chilling and Non-chilling Temperatures on Snap Bean Fruits, Watada and Morris: Chilling of snap beans	A. E. Watada and L. L. Morris,	Senescence of beans was studied under different temperature regimes Samples were weighed, placed in glass containersat the desired temperature with humidified air metered throughthe container.	It was concluded that tendergreen beans are severely injured attemperatures below 5°C as indicated both by the sharp increases inrespiration and development of visible symptoms.

CRITICAL FACTORS CONTRIBUTING TO POSTHARVEST LOSSES

Postharvest losses vary greatly among commodities and production areas and seasons. As a product moves in the postharvest chain, PHLs may occur from a number of causes, such as improper handling or bio deterioration by microorganisms, insects, rodents or birds.

There are internal and external factors contributing to postharvest loss.

1. Internal Factors

The following sections describe PHL occurring at all stages in the food supply chain from the moment of harvesting, to handling, storage, processing and marketing.

a) Harvesting: The time of harvesting is determined by degree of crop maturity and weather conditions.

Primary causes of losses at the harvest stage include:

- Absence of an established maturity index for some commodities, and/or lack of maturity index for local export markets.
- Low adoption of established indices, as price and distance to market influence adoption.
- Poor weather at harvesting time which affects the operations and functionality of harvesting machines or human labor and usually increases the moisture content of the harvested products.

Loss is also caused by employment of improper harvesting methods such as:

Rough handling; untimely harvesting; lack of appropriate and/or poorly-designed harvesting tools, equipment, and harvesting containers.

b) Pre-cooling Loss: At this stage is primarily due to the high cost and lack of availability of pre-cooling facilities, inadequate training on pre-cooling technology at the commercial scale, and lack of information on cost benefits of pre-cooling technology.

c) **Transportation:** Primary challenges in the transportation stage of the supply chain include poor infrastructure (roads, bridges, etc.), lack of appropriate transport systems, and a lack of refrigerated transport. In most developing countries, roads are not adequate for proper transport of horticultural crops. Also, transport vehicles and other modes of transport, especially those suitable for perishable crops, are not widely available. This is true both for local marketing and export to other countries. Most producers have small holdings and cannot afford to purchase their transport vehicles. In a few cases, marketing organizations and cooperatives have been able to acquire transport vehicles but cannot alleviate poor road conditions (Kaur, et. al., 2016).

d) **Storage:** Facilities, hygiene, and monitoring must all be adequate for effective, long-term storage. In closed structures (granaries, warehouses, hermetic bins, silos), control of cleanliness, temperature, and humidity is particularly important. It also very important to manage pests and diseases since damage caused by pests (insects, rodents) and molds can lead to deterioration of facilities (e.g. mites in wooden posts) and result in losses in quality and food value as well as quantity.

e) **Grading:** Proper packing and packaging technologies are critical in order to minimize mechanical injury during the transit of produce from rural to urban areas. Causes of PHL in the grading stages are: lack of national standards and poor enforcement of standards, lack of skill, awareness, and financial resources.

f) **Packaging and labeling:** After harvest, fresh fruits and vegetables are generally transported from the farm to either a packing house or distribution centre. Farmers sell their produce in fresh markets or in wholesale markets. At the retail level, fresh produce is sold in an unpackaged form or is tied in bundles. This type of market handling of fresh produce greatly reduces its shelf life if it is not sold quickly.

g) **Secondary processing:** Causes of post-harvest loss in this stage include limited availability of suitable varieties for processing, lack of appropriate processing technologies, inadequate commercialization of new technologies and lack of basic infrastructure, inadequate facilities and infrastructure, and insufficient promotion of processed products.

h) **Biological:** Biological causes of deterioration include respiration rate, ethylene production and action, rates of compositional changes (associated with color, texture, flavour, and nutritive value), mechanical injuries, water stress, sprouting and rooting, physiological disorders, and pathological breakdown. The rate of biological deterioration depends on several environmental factors, including temperature, relative humidity, air velocity, and atmospheric composition (concentration of oxygen, carbon dioxide, and ethylene), and sanitation procedures (Kaur, et. al., 2016), (Chitravathi, et. al., 2016), (Shaheb, et. al., 2015).

i) **Microbiological:** Micro-organisms cause damage to stored foods (e.g., fungi and bacteria). Usually, microorganisms affect directly small amount of the food but they damage the food to the point that it becomes unacceptable. Toxic substances elaborated by molds (known as mycotoxins) cause loss in food quality and nutritional value.

j) **Chemical:** Many of the chemical constituents naturally present in stored foods spontaneously react causing loses of colour, flavour, texture and nutritional value. One such reaction is the "maillard relation' that causes browning and decolouration in dried fruits and other product. There can also be harmful chemicals such as pesticides or obnoxious chemical such as lubricating oil (Kashim & Ufuk Kashim, 2015).

2. External Factors

Factors outside of the food supply chain can cause significant postharvest loss. These factors can be grouped into two primary categories: environmental factors ic and socio-economic patterns and trends.

a) **Environmental factors:** Climatic conditions, including wind, humidity, rainfall, and temperature influence both the quantity and quality of a harvest.

b) **Temperature:** In general, the higher the temperature the shorter the storage life of horticultural products and the greater the amount of loss within a given time, as most factors that destroy the produce or lower its quality occur at a faster rate as the temperature increases (Kashim & Ufuk Kashim, 2015).

c) **Humidity:** There is movement of water vapour between stored food and its surrounding atmosphere until equilibrium of water activity in the food and the atmosphere. A moist food will give up moisture to the air while a dry food will absorb moisture from the air. Fresh horticultural products have high moisture content and need to be stored under conditions of high relative moisture loss and wilting (except for onions and garlic). Dried or dehydrated products need to be stored under conditions of low relative humidity in order to avoid adsorbing moisture to the point where mold growth occurs (Kashim & Ufuk Kashim, 2015).

d) **Altitude:** within given latitude the prevailing temperature is dependent upon the elevation when other factors are equal. There is on the average a drop in temperature of 6.5°C (Kashim & Ufuk Kashim, 2015) for each kilometre increase in elevation above sea level. Storing food at high altitudes will therefore tend to increase the storage life and decrease the losses in food provided it is kept out of direct rays of the sun.

e) **Time:** The longer the time the food is stored the greater is the deterioration in quality and the greater is the chance of damage and loss. Hence, storage time is a critical factor in loss of foods especially for those that have a short natural shelf life.

Post harvest treatments

The post-harvest treatments play an important role in extending the storage and marketable life of horticultural perishables.

The most important postharvest treatments include:

a) **Washing with chlorine solution:** Chlorine treatment (100–150 ppm available chlorine) can be used in wash water to help control inoculums build up during packing operations. Maintain pH of wash water between 6.5 and 7.5 for best results.

b) **Calcium application:** The post-harvest application of CaCl2 or play an important role in enhancing the storage and marketable life of vegetables by maintaining their firmness and quality. Calcium application delays aging or ripening, reduces postharvest decay, controls the development of many physiological disorders and increases the calcium content, thus improving their nutritional value. The post-harvest application of CaCl2 (2–4 %) or Ca(NO3)2 for 5–10 min dip extend the storage life of pear up to 2 months, plum up to 4 weeks and apple up to 6 months at 0–2 ºC with excellent color and quality. Calcium infiltration reduces chilling injury and increase disease resistance in stored vegetables.

1. **Thermal treatments :**

Thermal treatments included

a) **Hot water treatment:** Vegetables may be dipped in hot water before marketing or storage to control various post-harvest diseases and improving peel color of the vegetables.

b) **Coating:** Coating of vegetables is a common post-harvest practice. Food grade waxes are used to replace some of the natural waxes removed during harvesting and sorting operations and can help reduce water loss during handling and marketing. It also helps in sealing tiny injuries and scratches on surface of vegetables. It improves cosmetic appearance and prolongs the storage life of vegetables. The coating must be allowed to dry thoroughly before packing.

c) **Packaging:**

Packaging plays a very important role in protecting fresh produce:

- It provides protection from dust
- It reduces microbial contamination from the surrounding environment and from consumer contact;
- It helps to maintain the freshness of produce;
- It extends the postharvest shelf life;
- It increases the sale of fresh produce.

CONCLUSION

The use of various preservation techniques for fresh and minimally processed French beans and Green chillies receives increasing interest because it improves on product shelf-life, may add to the texture and sensory characteristics and is environmentally friendly. This review paper shows the different preservation techniques to reduce or prevent the post-harvest losses.

REFERENCES

A. K. Sahoo and P. R. Kulkarni (1999). Effect of Temperature and Packaging on the Shelf-life of French Beans, Journal of Scientific & Industrial Research; Vol 58, pp. 533-537.

Dhatt A.S., Mahajan B.V.C. (2007). Horticulture post-harvest technology harvesting, handling and storage of horticultural crops. Punjab Horticultural Postharvest Technology Centre, Punjab Agricultural University Campus, Ludhiana.

G. S. Ubhi, S. R. Sharma, J. S. Grewal and M. Javed (2014). Effect of Modified Atmosphere Packaging on French Beans (Phaseolus vulgaris L.) during Cold Storage, International Journal of Engineering Science Invention ISSN (Online): 2319 – 6734 Volume 3 Issue 5 May, 2014

G.D. G. Chaturanil, S. Wilson, S. Perera, M.P. Hettiarachchi (2004). Postharvest ripening and respiration of chilli (Capsicum annum Var. MI-2),Postharvest technology.

John N. Kinyuru; Kinyanjui P. Kahenya; Margaret Muchui; Hellen Mungai (2010). Influence of Post-harvest Handling on the Quality of Snap Bean(Phaseolus vulgaris L.),Journal of Agriculture and Food Technology, J. Agric. Food. Tech 1(5) 43-46.

K. Chitravathi, O. P. Chauhan, P. S. Raju (2016). Shelf life extension of green chillies (Capsicum annuum L.) using shellac-based surface coating in combination with modified atmosphere packaging, Journal of Food Science and Technologists.

Manpreet Kaur, Satish Kumar Gupta, T.C. Mittal and S.R. Sharma (2016). Influence of storage temperatures on the protein contentof french beans (Phaseolus vulgaris L.), Journal of Dairy & Food Res., vol. 2, pg.no. 164-167.

Marisa M. Wall and Robert D. Berghage (1995). Prolonging the shelf-life of fresh green chile peppers through modified atmosphere packaging and low temperature storage,Journal of Food Quality 19. pp. 467-477.

MD. Rayhan Shaheb, MD. Nazmul Iislam, Ashratun Nessa, MD. Altab Hossain and Ayesha Sarke (2015). Impact of harvest stage on seed yield quality and Storability of French Bean, ISSN 0258-7122Bangladesh J. Agril. Res. 40(4): pp. 641-656.

Mohammad Mizanur Rahman, MD. Miaruddin MD., Golam Ferdous Chowdhury, MD. Hafizul Haque Khan and M.A. Matin (2012). Effect of different packaging systems and chlorination on the quality and shelf life of green chili, Bangladesh J. Agril. Res. 37(4): pp. 729-736.

R. Hameed, A.U. Malik, A. S. Khan, M. Imran M. Umar and R. Riaz (2013). Evaluating the Effect of Different Storage Conditions on Quality of Green Chillies (Capsicum annuum L.) Tropical Agricultural Research Vol. 24 (4): pp. 391 – 399.

R.C. Martins, C.L.M. Silva (2003). Green beans (Phaseolus vulgaris, L.) quality loss upon thawing, Rua Dr. Antonio Bernardino de Almeida, 4200-072 Porto.

Rezzan Kashim, Mehmet Ufuk Kashim (2015). Biochemical changes and color properties of fresh-cut green bean (Phaseolus vulgaris L. cv.gina) treated with calcium chloride during storage, Food Science and Technology, ISSN 0101-2061, Food Science and Technology 10.1590/1678-457X.6523, Campinas, 35(2): 266-272, Abr, Jun. 2015

Corresponding Author

Dr. Indrajit N. Yadav*

Department of Chemical Engineering, Bharati Vidyapeeth College of Engineering, Navi Mumbai, (MS) India

E-Mail – indrajityadavpatil@gmail.com