

## RESEARCH ARTICLE

## A REVIEW ON POST-HARVEST HANDLING PRACTICES OF TOMATO (*LYCOPERSICUM ESCULENTUM*)

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## ARTICLE DETAILS

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## ABSTRACT

To minimize post-harvest losses, tomato post-harvest handling procedures are crucial. The tomato (*Lycopersicon esculentum*) is one of the vegetables that is grown and consumed the most all over the world. A healthy, balanced diet includes tomatoes as well. Minerals, vitamins, vital amino acids, and antioxidant qualities are abundant in tomatoes. Tomatoes have a short shelf life and are extremely perishable. Post-harvest management procedures are therefore necessary to satisfy the rising population's need for food while minimizing losses. Tomato post-harvest losses are primarily brought on by incorrect sorting and grading, in appropriate packaging, improper packaging without removing field heat, lack of storage facilities, and poor transportation. The quality and shelf life of tomato fruit is greatly impacted by handling procedures such as harvesting, precooling after harvest, washing and disinfecting, sorting and grading, packaging, storage, and transportation. Additionally, there are a variety of creative packaging and storage methods, including refrigeration storage, changed atmosphere packaging, and intelligent packaging. This review article mainly focuses on the different ways to reduce post-harvest losses of tomatoes thereby securing food security.

## KEYWORDS

Tomatoes, postharvest loss, quality degradation, shelf life.

## 1. INTRODUCTION

One of the most well-liked, widely produced, and consumed vegetables worldwide is the tomato (*Lycopersicon esculentum*). The tomato is a member of the Solanaceae family and is native to western South and Central America. The tomato is a crop with a short growing season and a higher yield. Tomatoes, which are abundant in vitamins, minerals, vital amino acids, carbohydrates, and dietary fibers, support a healthy and well-balanced diet. In addition to vitamin C, tomato products are also high in vitamin K, potassium, and folate. Because of their high lycopene and other carotenoid content, tomatoes have strong antioxidant properties (Lenore and Susan, 2000). In the treatment of cancer, chronic illnesses, cardiovascular disorders, etc., tomatoes are quite beneficial medically. Tomatoes are eaten in a variety of cuisines, salads, and processed forms like ketchup, pickles, juices, and sauces. They can be eaten fresh or cooked.

The tomato can be cultivated up to an elevation of 2000 meters above sea level. In temperate climates around the world, a greater variety of tomatoes are produced extensively, and greenhouses enable the cultivation of tomato plants throughout the year. 182,301,395 metric tons were the predicted global tomato output total in 2017, up 1.6% from 179,508,401 tons in 2016 (FAOSTAT, 2019). Tomato is the world's most widely grown and processed vegetable (FAOSTAT, 2017). Tomato production in China, which accounted for roughly 30% of global production, was the highest (FAOSTAT, 2019). After the potato (*Solanum tuberosum*), tomatoes are regarded as the most popular home garden crop and the second most consumed vegetable globally. The tomato is appealing, and the area being cultivated is growing.

The shelf life of tomatoes is very short, and they are highly perishable. To reduce the production losses of tomatoes worldwide, post-harvest

management procedures are crucial. Tomato post-harvest handling procedures are necessary to satisfy a growing population's need for food by reducing losses. The handling, packaging, storage, distribution, transportation, marketing, and other post-harvest operations for fruits and vegetables, including tomatoes, are all included. Reducing post-harvest losses is a goal of post-harvest handling procedures, which also has economic, health, market, better quality, and preservation benefits. fruits and vegetables' quality and shelf life are greatly enhanced by post-harvest management procedures such as harvesting, pre-cooling, cooling, cleaning, and disinfecting, sorting and grading, and transportation (Arah et al., 2016).

Post-harvest losses result from harvesting crops at the wrong stage of maturity, from direct packing and shipment without venting the heat from the fields, from incorrect packaging and insufficient grading and sorting, from poor transportation and handling, and from unsanitary storage conditions (Adhikari and G.C., 2021). Post-harvest losses for fresh produce, including tomatoes, are predicted to range from 5 to 25 percent in developed nations and 20 to 50 percent in underdeveloped nations. According to estimates, between 20 and 50 percent of tomato fruit that is picked for consumption is lost owing to microbial spoilage and other damage sustained during transit as a result of volatile stressors, harsh loading, and unloading. In Nepal, post-harvest losses on tomato output amount to 30 to 33% of the total (Tiwari et al., 2020).

## 2. NUTRITIONAL QUALITY OF TOMATOES

Tomato is botanically some fruit, but it is consumed as a vegetable. Tomatoes are rich in vitamins like vitamin A, vitamin E, vitamin K, biotin, folic acid minerals like sodium, potassium, and calcium, fiber phytonutrient like carotenoids, and many more (Beecher, 1998). The red

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color of the tomato is due to the presence of lycopene. Lycopene not only provides color to tomatoes, it also acts as an antioxidant thereby decreasing the pace of aging. It has been found that lycopene is helpful to protect us from cancer like breast cancer, prostate cancer, cardiovascular diseases, and other chronic diseases (Agarwal and Rao, 2000). The composition of tomato is shown briefly in the following table:

Parameters	Values	Range
Energy (kcal/100 g)	34.67 ± 18.74	18.00–75.00
Ash (%)	8.75 ± 1.69	5.90–10.60
Moisture (g/100 g)	91.18 ± 6.83	68.03–96.17
Total protein (g/100 g)	17.71 ± 5.40	10.50–25.03
Lipid (g/100 g)	4.96 ± 1.19	3.62–5.39
Carbohydrates (g/100 g)	5.96 ± 1.37	3.92–8.00
Total sugar (g/100 g)	50.60 ± 3.69	47.00–56.45
pH	3.83 ± 0.21	3.61–4.08
Acidity (%)	0.48 ± 0.07	0.39–0.55
Reducing sugar (%)	35.84 ± 4.57	30.03–41.21
Fructose (%)	2.88 ± 0.49	1.15–3.42
Glucose (%)	2.45 ± 0.48	1.74–3.18
Sucrose (%)	0.02 ± 0.05	0.01–0.02
Total fiber (g/100 g)	11.44 ± 9.31	1.32–19.36

Source: (Ali et al., 2021)

### 3. RESULT AND DISCUSSION

#### 3.1 Post-Harvest Handling Practices of Tomato

For the majority of harvested fruits and vegetables, post-harvest handling procedures are crucial for post-harvest quality management and shelf life (Arah et al., 2015). To reduce post-harvest losses and maintain the quality of fruits and vegetables, especially tomatoes, both during and after harvest, it is crucial to be aware of the proper post-harvest handling procedures. For example, rough handling of tomato fruits during harvesting and after harvesting can affect the post-harvest quality and shelf life due to mechanical injury and biological injury (Arah et al., 2015). Some post-harvest handling practices of tomatoes are harvesting, precooling after harvest, cleaning/disinfecting, sorting, grading, packaging, storage, and transportation.

#### 3.2 Harvesting

Depending on when the tomato fruit is harvested, the shelf life and quality of the fruits are affected. Fruits and vegetables should be properly picked by paying attention to the right maturity level and quality because lower and higher levels of product maturity reduce storage life and increase spoiling. Tomatoes are ready for harvesting 60 to 70 days after transplanting, depending on the variety. Fruits are picked in the early morning or late at night. The fruit's intended usage determines the harvesting stage. Different stages for harvesting are shown in the following table.

Dark green color	At this point, fruit that will be exported is harvested.
Breaker stage	The dim pink color was observed on the 1\4 part. The best quality fruits are harvested at this stage.
Turning stage	There is light pink color in the blossom end of tomato.
Pink stage	On the fruit's quarter, pink color could be seen.
Reddish pink	Fruits are picked to sell locally.
Fully ripe	Fruits are fully ripened and this is for processing

Source: (Deribe et al., 2019)

Post-harvest physiologists divide the shelf life of fruits and vegetables into three stages: maturation, ripening, and senescence. The maturation stages indicate when something is ready for harvest (FAO, 2008). Depending on how far away the market is, tomato fruit should be gathered at the appropriate time. It is important to take proper care when harvesting tomatoes when they are ripe in order to prevent injuries that will cause them to deteriorate more quickly (Arah et al., 2015).

#### 3.3 Precooling After Harvest

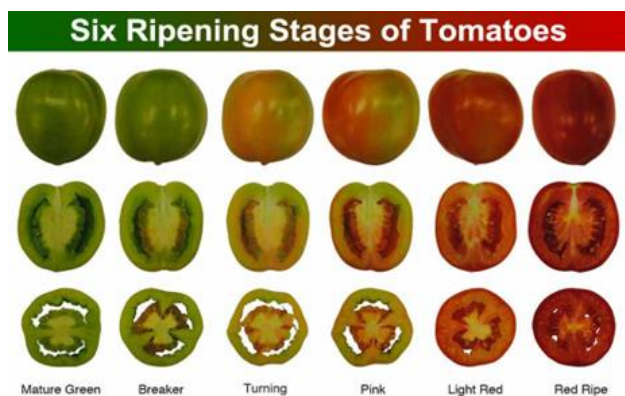
Prior to any post-harvest handling activity, precooling is required to quickly remove the field heat (Bachmann and Earles, 2000). Precooling reduces the impact of microbiological, metabolic, respiration, and ethylene production (Shahi et al., 2012). Additionally, by lessening ripening, water loss, and decomposition, it increases the shelf life of horticultural products (Ferreira, 1994). Harvested fruit tomatoes are pre-cooled by submerging them in ice water that has been disinfected with sodium hypochlorite (Adhikari and G.C., 2021). The best time to handle tomatoes is either in the morning or late at night when the temperature ranges from 13-20°C (Ferreira, 1994). Tomato is a climacteric fruit thus after harvesting tomato fruit its respiration continuous and becomes more prone to microbial spoilage, water loss, and decay due to field heat. So immediate precooling of fruits after harvesting removes the field heat and significantly extends shelf life. After harvest, quick pre-cooling of tomatoes extends shelf life and lowers the rate of quality loss. There are various precooling techniques, including forced air cooling, natural air cooling, hydro cooling, ice cooling, and vacuum cooling (Shahi et al., 2012). For quality and long-term storage, tomatoes must be pre-cooled.

#### 3.4 Cleaning or Disinfectant

Cleaning or disinfectant is necessary to remove the dirt, pesticide residue, germs, and other waste product attached to the fruit and also to reduce the incidence of foodborne illness that can be transferred to the consumer. Cleaning or disinfectant is important to minimize post-harvest losses and for proper storage and packaging for a long duration. Fruits and vegetables can be protected from post-harvest and foodborne diseases through the use of various disinfectants during washing (Arah et al., 2015). Before and after harvest, sodium hypochlorite, and thiabendazole have also been used to sterilize tomato fruits to reduce the incidence of fungal infection (Batu and Thompson, 1998). By removing the microbial fruit burdens, one can maintain optimal tomato output while storing them. (Getinet et al., 2011). According to a study Based on his findings, In Kathmandu, Nepal, 25% of the total respondent cleaned tomatoes with clean water, however, the majority didn't clean the tomato due to ignorance of correct cleaning techniques and the right use of cleaning agents (Tiwari et al., 2020). To simultaneously reduce excessive heat and microbiological diseases, disinfection and hydro chilling are options (Arah et al., 2015).

#### 3.5 Sorting and Grading

The sorting and grading of fruits and vegetables are also important steps in post-harvest handling practices and in packaging and marketing. A process of separating healthy and clean fruits from those that are rotten, damaged, or diseased is known as sorting (Arah et al., 2015). In addition to producing ethylene, damaged or diseased fruits can also release ethylene into the environment, affecting healthy fruits in the process (Saltveit, 1999). Grading is the process of classifying fruits and vegetables according to their color, size, stage of development, maturity, or level of ripeness (Arah et al., 2015). Grading can be carried out manually or with a machine. There are various grading schemes based on factors like size, color, weight, etc. Tomatoes are typically categorized as small, medium, and giant. Grading according to fruit maturity or color stage can help to get rid of overripe fruits that easily create ethylene to speed up the ripening process in the state of the complete fruit. sorting and grading play a vital role in maintaining the post-harvest shelf life and quality of harvested tomatoes (Arah et al., 2015). Sorting prevents the spread of pathogens from diseased tomatoes to healthy one.



Source: (Michael, 2020)



Source: (Deulkar and Barve, 2018)

### 3.6 Packaging

To reduce post-harvest losses, the packaging is a crucial post-harvest handling procedure. Food products are enclosed in packaging to safeguard them against biological and mechanical harm. When it comes to tomato packing, post-harvest management is crucial for dividing the product into manageable sections (Idah et al., 2007). Most frequently used in developing nations are wooden boxes, cardboard, paper, weaved plastic baskets, plastic crates, nylon, sacks, and polythene bags (Idah et al., 2007). Tomato fruits are packaged in a variety of ways, including polythene, grease-free paper, and fresh paper.

The purpose of packing tomatoes in polythene bags was to improve quality and give them a 28-day shelf life over other packaging. Numerous research on tomatoes have revealed that wrapped tomatoes considerably reduced weight loss and had firmer fruits than unwrapped tomatoes. A thorough investigation of packaging technologies was necessary to reduce losses of packaged fruits and vegetables since adequate packaging reduced losses during handling and transportation (Idah et al., 2007). Consumer packaging and transportation packaging both come in a variety of forms. The transport packaging consists of wooden boxes, corrugated fiberboard boxes, plastic corrugated boxes, plastic crates, sacks, palletization, unitization, and other goods (Adhikari and G.C., 2021).

Also, Active packaging, intelligent packaging, and changed atmosphere packaging are some of the different packaging techniques. Active packaging is a type of packaging that uses additives in or on the package material to extend shelf life, increase safety, improve sensory qualities, and preserve product quality. The term "intelligent packaging," often known as "smart packaging," refers to a system of packaging that serves as a monitoring system for certain food attributes and can alert the producer, retailer, and consumer to changes in those properties (Robertson, 2016). MAP modifies the oxygen and carbon dioxide levels in the package atmosphere by sealing actively respiring produce in polymeric film packages (Adhikari and G.C., 2021). The use of MAP extends the shelf life of produce by improving moisture retention and, if not sterilizing, at least reducing exposure to diseases and pollutants (Mangaraj and Goswami, 2009).

### 3.7 Storage

Due to their high perishability, tomatoes require adequate storage to increase their shelf life and reduce post-harvest losses. To minimize deterioration until it is used, storage is meant to offer an environment. Optimum temperature and humidity control are very powerful tools for maintaining the goods in the ideal conditions during storage. The tomato fruit can be kept at ambient temperatures for a week's worth of short-term storage (Zindarcic and Pozrl, 2006). Ripe tomatoes can be kept for a long time at a temperature of around 10-15°C and a relative humidity of 85% to 95% (Castro et al., 2005). There are fewer storage facilities available, and the locals are not fully knowledgeable about how to store agricultural products for later use (Tiwari et al., 2020).

The quantity and shelf life of many tropical fruits, such as tomatoes, are negatively impacted by very low storage temperatures. For instance, chilling a tomato fruit would lessen its flavor, which is mostly governed by the fruit's Total Soluble Solid (TSS) and pH levels (Moretti et al., 1998). One of the best ways to maintain the quality of fruits and vegetables for several days is to store them in the refrigerator (Battu and Keith, 1998;

Rodriguez et al., 2001). Fruits and vegetables are stored using a variety of methods, including ground storage, ambient storage, refrigerated storage, air-cooled storage, modified atmospheric storage, hypobaric storage, and controlled atmospheric storage (Adhikari and G.C., 2021).

### 3.8 Transportation

One of the most crucial factors in reducing post-harvest losses is transportation. Many tomato farmers in impoverished nations like Nepal have production facilities located far from market hubs, and the country's road infrastructure is poor (Arah et al., 2015). Post-harvest handling is improved during transportation when an appropriate cooling and refrigeration system is in place. Transportation delays can cause producers to lose up to 20% of their sales (Babatola, 2000). Human labor, donkeys, public transit, rental trucks, buses, lorries, gasoline tanks, articulator trucks, and pick-up vans are some of the modes of transportation available (Idah et al., 2007). Because of the poor state of road networks in underdeveloped nations, transportation is challenging, leading to post-harvest losses. Therefore, efficient transportation facilities are necessary for proper post-harvest management methods. The quality of fruits is effectively and conveniently preserved when tomatoes are transported in refrigerated trucks (Arah et al., 2015).

## 4. CONCLUSIONS

After harvest, certain post-harvest handling procedures must be followed in order to maintain the post-harvest quality and shelf life of tomato fruits. The major goal of post-harvest handling procedures is to reduce post-harvest losses. Because tomatoes are highly perishable, they naturally have a short shelf life. As a result, several post-harvest handling procedures are used to decrease post-harvest losses and increase the shelf life of tomato fruits. Simple post-harvest handling procedures have been proven to be effective in poor nations like Nepal where there are few post-harvest technologies to manage post-harvest losses in tomatoes. The quality and shelf life of tomato fruits after harvest can be maintained and extended by post-harvest management procedures including harvesting, precooling after harvest, cleaning or disinfecting, sorting and grading, packaging, storage, and transportation. In comparison to other factors, there are significant losses of tomato fruits occurring during various post-harvest handling procedures, particularly in storage and transportation. If post-harvest technology does not advance, post-harvest quality losses in tomatoes will become a significant issue in developing nations.

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