

POST-HARVEST HANDLING AND PRESERVATION METHODS OF TOMATO (*Solanum lycopersicum* L.) IN NIGERIA: A REVIEW

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Abstract

Tomato production is gaining popularity among horticultural farmers worldwide due to its economic and nutritional importance. This has been achieved through scientific research advances made along the entire production chain. Moreover, scientific researchers paid little attention to tomatoes' post-harvest issues while focusing on improving production. This paper examines post-harvest handling practices and methods to reduce tomato losses, and suggests techniques that farmers can use to remedy the situation. Tomato producers in developing countries have recorded good harvests in recent years. However, the good harvests recorded do not translate into profit due to losses incurred from poor post-harvest handling and preservation. This review revealed that implementing appropriate handling practices, including harvesting, pre-cooling after harvest, cleaning, sorting, grading, packaging, and storage, improved the quality of perishable tomatoes. Different preservation methods, such as refrigeration, heat treatment, drying, tomato pasting, and modified atmosphere packaging, play a vital role in reducing tomato losses. It is concluded that proper handling practices and preservation methods have improved the quality and shelf life of tomatoes, making them available all year round.

Keywords: Tomato, post-harvest handling, preservation, losses.

Introduction

Tomato (*Lycopersicon lycopersicum* L.) is one of the most important vegetable crops cultivated and consumed worldwide (FAO, 2008). The countless benefits of tomatoes can motivate their extensive production (Ochida *et al.*, 2019). According to Arah *et al.* (2016), this increase in production is made possible by the numerous research advances along the entire value chain. Tomatoes are commonly consumed fresh, such as in salads or as an ingredient in many cooked dishes (Adenuga *et al.*, 2013). Tomatoes are a suitable source of nutrients for human nutrition, providing vitamins C, A, and K, as well as potassium and carotenoids such as lycopene and carotene, which act as antioxidants. Tomatoes contain a high amount of lycopene, a type of carotenoid with antioxidant properties, which helps control certain chronic diseases, such as cancer, and many other cardiovascular disorders (Arah *et al.*, 2016). Tomatoes are high in fibre, which aids easy digestion and can assist in weight loss (Arah *et al.*, 2015).

The production of tomatoes accounts for approximately 4.8 million hectares of land worldwide, with an estimated output of 162 million tonnes. China leads the world in tomato production, with approximately 50 million tonnes, followed by India with 17.5 million tonnes (FAOSTAT, 2014). However, scientific researchers have paid more attention to production while focusing less on post-harvest problems. According to Kader (2005), less than 5% of the resource allocation in agricultural research in developing countries is dedicated to post-harvest. It indicated that 95 % of research funds are allocated to production. Research in the production aspect of the entire tomato production value chain has resulted in improved varieties with high yields and resistance to diseases and drought (FAO, 2008). Despite the good yield recorded by farmers, many problems make tomato production unprofitable in developing countries. Post-harvest losses of tomatoes in Nigeria are a significant concern, with the country losing around 45% of its 3.9 million tonnes tomato harvest annually due to

poor storage and supply chain inefficiencies (FAO, 2008). Improper harvesting stages, excessive field heat, unsatisfactory harvesting containers, poor farm sanitation, and inappropriate packaging materials all contribute to on-farm losses. Causes of off-farm losses include a lack of access roads, a poor transportation system, inadequate processing facilities, and a lack of reliable market information (Archana and Jitendra, 2018). This paper aims to examine post-harvest practices and preventive methods for reducing tomato losses.

Post-harvest Handling Practices of Tomato

Appropriate post-harvest handling practices are necessary to maintain the quality and extend the shelf life of harvested tomatoes, thereby reducing losses for farmers in developing countries. Some of the critical handling practices that ensure an increase in quality and extend the shelf life of tomatoes are discussed as follows;

- 1. Harvesting:** The most suitable period for harvesting any fruit is at physiological maturity, which strongly affects the fruit's post-harvest quality and shelf life (Arah *et al.*, 2016). Tomatoes can be harvested at different physiological maturity stages; they can be harvested when they're mature green, partially ripe, or fully ripe (FAO, 2008). Tomato, a climacteric fruit, can be suitably harvested at the mature green stage to allow ripening and senescence during the post-harvest period (Beckles, 2012). Harvesting tomatoes at the mature green stage will give producers ample time to prepare the fruit for the market and prevent mechanical injuries during harvesting (Arah *et al.*, 2016). Harvesting tomatoes at a fully ripened stage makes them susceptible to mechanical damage, resulting in shorter shelf life (Arah *et al.*, 2015). Therefore, when harvesting tomatoes at this stage, care must be taken to avoid injuries that can accelerate deterioration.
- 2. Pre-cooling after Harvest:** Pre-cooling reduces the effects of microbial activity, metabolic activity, respiration rate, and ethylene production, thereby slowing the rate of ripening and decay, and preserving the quality and extending the shelf life of harvested tomatoes (Ferreira *et al.*, 1994). The temperature suitable for pre-cooling tomatoes after harvest ranges between 13 °C and 20°C, which can be obtained in the early hours of the morning or late in the evening (Archana and Jitendra, 2018). Harvested fruit should be pre-cooled to remove excessive field heat if harvested outside the recommended periods. A cost-effective pre-cooling method for harvested tomatoes involves dipping the fruit in cold water or mixing it with disinfectants, such as sodium hypochlorite (Anthon *et al.*, 2008). Arah *et al.* (2015) recommended that using a simple on-farm structure, like a small hut made of thatch, can be beneficial in pre-cooling harvested tomatoes.
- 3. Cleaning and Washing:** The harvested tomatoes must be thoroughly cleaned to remove any dirt or chemical residues, which can be done by using sodium hypochlorite or chlorine. Cleaning the tomato usually involves washing it in a bucket with clean water that is frequently refreshed (Cheryl *et al.*, 2012).
- 4. Sorting and Grading:** Sorting involves removing damaged or diseased fruits from healthy ones. Damaged or diseased fruits produce ethylene in substantial quantities, which affects the surrounding fruits (Anthon *et al.*, 2008). Grading categorises fruits and vegetables based on colour, size, stage of maturity, or degree of ripening (Idah *et al.*, 2007). The two processes are essential in maintaining the quality and shelf life. Sorting minimises the spread of pathogens from unhealthy fruits to healthy fruits during post-harvest handling (Arah *et al.*, 2015). Grading also helps handlers to categorise fruits and vegetables under familiar characters, which enables easy handling.

5. **Packaging:** Packaging is one of the crucial practices used in addressing post-harvest losses of fruits and vegetables. It involved enclosing produce or product to protect it from mechanical injuries and contamination from other sources (Idah *et al.*, 2007). As a post-harvest handling practice in tomato production, packaging involves putting produce into sizeable portions for easy handling. Moreover, unsuitable packaging materials can damage fruit (Anthon *et al.*, 2008). Some common packaging materials used in most developing countries include wooden crates, cardboard boxes, baskets, plastic crates, nylon sacks, jute sacks, and polythene bags (Idah *et al.*, 2007).
6. **Storage:** Tomatoes are highly perishable due to their high moisture content and are therefore very difficult to store at ambient temperatures for an extended period (Arah *et al.*, 2016). The storage of tomatoes is required to ensure a continuous supply of raw materials for processors. Tomato fruits can be stored in ambient conditions for a short time if there is sufficient ventilation to reduce heat generated by respiration (Moneruzzaman *et al.*, 2009). For long-term storage, ripe tomatoes can be stored at 10–15°C and 85–95% relative humidity (Ochida *et al.*, 2019). At 10 – 15°C, ripening and chilling injuries are reduced to low levels. These conditions are challenging to obtain in most tropical countries, resulting in significant losses of harvested tomatoes (Nasrin *et al.*, 2008). These confirm the claim that tomato quality is compromised when exposed to high temperatures and high relative humidity (Anthon *et al.*, 2008). Low-temperature storage is detrimental to the shelf life and quality of tomatoes. Using an appropriate temperature during tomato storage is crucial for extending the fruit's shelf life and maintaining its quality. Tomato handlers in tropical countries can store tomatoes for a short to relatively intermediate time using an evaporative cooling system made from woven jute sacks (Kader, 2005).

Preservation Methods of Tomato

To maintain the quality and extend tomatoes' shelf life, reducing post-harvest losses, specific preventive methods must be followed to achieve this goal. The following are some preventive measures for reducing tomato losses that can be employed.

1. **Refrigeration:** Refrigeration is a crucial method for preserving the quality and extending the shelf life of fruits and vegetables for several days. Low-temperature storage can prevent the decrease in quality characteristics such as nutrition, texture, flavour, and aroma in harvested tomatoes (Anthon *et al.*, 2008). Tomato handlers employed refrigeration storage methods to extend the shelf life and quality of tomatoes (Lee *et al.*, 2008). Tomatoes are prone to chilling injury when stored below their critical temperature of 10°C. Lee *et al.* (2008) reported this disadvantage of refrigeration, where low temperatures from refrigerated storage caused chilling injuries, leading to pitting, uneven ripening, and fungal infestation of stored fruits. This suggests that refrigerated storage may not be an effective method for storing tomatoes over an extended period (Moneruzzaman *et al.*, 2009).
2. **Drying is one of the oldest methods of preserving tomatoes.** Drying preserves tomatoes by removing moisture from the fruit, thereby preventing deterioration (Ochida *et al.* 2019). The drying tomato procedure involves removing moisture from the fruit to a point where deterioration is less likely to occur (Beckles, 2012). This can be done using the sun's heat, an oven, and a dehydrator. The produce after drying should be stored in a dry, airtight container. Opega *et al.* (2017) reported that oven-dried tomatoes have a higher taste, flavour, colour, and acceptability compared to the sun-dried product. The drawback of the drying method for preserving fruits and vegetables is that it results in the loss of some nutrients due to nutritional changes that occur during the process (Moneruzzaman *et al.*, 2009). Some dietary

changes during drying include calorie content, fibre, vitamins, and minerals (Ochida *et al.*, 2019). For optimal retention of nutrients in dried foods, store them in a cool, dark, and dry place, and use them within a year (Lee *et al.*, 2008).

- 3. Heat Treatment of tomato:** Post-harvest heat treatment of fruits and vegetables is becoming popular among handlers to prevent chilling injuries in fruits sensitive to temperature (Arah *et al.*, 2016). This technique can be used to control or reduce chilling injuries in stored fruits (Lurie and Klein, 1992). Heat treatments using hot air and heated water can reduce chilling injuries in fruits such as tomatoes, oranges, and mangoes (Rodriguez *et al.*, 2001). Heat-treating tomato fruit at approximately 37–42°C before cold storage can slow down ripening and increase disease resistance during storage (Lurie and Klein, 1992). Before storage, heat treatment had no effect or enhanced some quality traits of stored tomatoes (Rodriguez *et al.*, 2001). Post-harvest heat treatment can be combined with refrigeration storage to increase the shelf life and quality of harvested tomato (Arah *et al.*, 2016).
- 4. Tomato Paste:** Tomato paste or pulp is concentrated to 14–15% soluble solids in open pans, followed by concentration in vacuum pans, and then packed in pre-sterilised bottles while still hot (Anthon *et al.*, 2008). Large-scale processing units manufactured tomato paste using vacuum evaporators and packed it in a tin can or bulk packages. The tomato paste is used to make various products, such as soup, sauce, ketchup, and others (Archana and Jitendra, 2018). There are two types of tomato paste: hot break and cold break. These are used to produce various end products. After being chopped and heated, fresh tomatoes are immediately placed in a high-temperature range of 85 to 100°C to make a hot break paste. Cold break paste involves chopping fresh tomatoes and heating them at a lower temperature range of 65 to 75°C (Ochida *et al.*, 2019).
- 5. Modified Atmosphere Packaging (MAP):** Modified atmosphere packaging utilises specialised materials to package products in a predetermined composition of gases, primarily oxygen and carbon dioxide (Nasrin *et al.*, 2008). The packaging materials used in modified atmosphere packaging must allow the diffusion of gases until a stable equilibrium is achieved between the external gases and the gases inside the package. The most widely used modified atmosphere packaging materials include low-density polyethylene, high-density polyethylene, polyvinyl chloride, polypropylene, and some chemically modified derivatives (Archana and Jitendra, 2018). The advantage of using modified atmosphere packaging is that it provides a controlled atmosphere to slow down ripening and reduce water loss in stored products, minimise mechanical injuries, and enhance hygiene, thereby reducing the spread of foodborne diseases. Modified atmosphere packaging creates a high relative humidity surrounding the fruit, which reduces water loss (Nasrin *et al.*, 2008).

Conclusion

Tomatoes are perishable and begin to deteriorate a few days after harvesting. It is concluded from this review that appropriate post-harvest handling practices and preventive methods for reducing tomato losses should be strictly adhered to to extend the shelf life and maintain the quality of harvested tomatoes. Failure to comply with the appropriate post-harvest handling practices and preventive methods could lead to tomato losses.

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