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Postharvest Factors Affecting Shelf Life and Quality of Harvested Tomatoes; a Comprehensive Review

Muhammad Qasim[1*], Samman Liaqat[2], Atta Ullah[1], Hassan Khan[3], Hammad Nasir[4], Malik Saud Awan[5], Kashif Akbar[6]

[1]Department of Agriculture, The University of Swabi, Pakistan
[2]Department of food Science and Technology, The Islamia University of Bahawalpur, Pakistan
[3]Department of Soil and environmental Sciences, The University of Agriculture, Peshawar, Pakistan
[4]Department of Soil Science, The University of Swabi, Pakistan
[5]Department of Food Science and Technology, The University of Swabi, Pakistan
[6]Department of Food Science and Technology, The Agriculture, Peshawar, Pakistan

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***Corresponding author:** Muhammad Qasim
Department of Agriculture, The University of Swabi, Pakistan

Abstract **Review Article**

Tomatoes are a member of the Solanaceae family and are one of the most widely grown and consumed vegetable crops on the planet. In most developing nations, tomato farming can provide a source of income for most rural and periurban growers. However, in these regions of the world, postharvest losses make production unprofitable. Tomatoes can lose up to 42% of their value after harvesting. The quality of tomatoes after harvest was influenced by several preharvest methods used during cultivation. Fertilizer treatment, trimming, maturity stage, cultivar selection, and irrigation are some of these aspects. Maintaining the quality after harvest required the use of optimum postharvest handling methods or parameters such as temperature, relative humidity and physical handling protocols. The major goal of this review of literature was to look at how pre-harvest and post-harvest variables impact the quality and shelf life of tomatoes. The current review of literature concluded that postharvest quality losses in tomatoes may be reduced by proper informations and regulating both preharvest and postharvest variables.

Keywords: Tomato, Soft fruits, vegetables, Pre harvest, Postharvest factors, Shelf life, Physical handling.

INTRODUCTION

Origin and importance of tomato

Functional foods and nutraceuticals have gotten a lot of press in recent years, especially when it comes to dietary protection. Consumption of high amounts of vegetables and fruits has been shown in several epidemiological studies to lessen the risk of many contagious human diseases such as cancer and cardiovascular disorders (Rao and Agarwal 2000; Levy and Sharoni 2004). It has been reported that antioxidant activity of fruit and vegetable varies with variety and agronomic circumstances (Luthria *et al*., 2006). Tomatoes are the most abundant source of antioxidants among vegetables, and in addition to carotenoids (lycopene, -carotene, and lutein), flavonoids have been identified as a category of polyphenols significant in providing antioxidant effects (Mikulic Petkovsek *et al*., 2007; Usenik *et al*., 2008).

Tomato (*Solanum lycopersicum* L.) is a vegetable crop belongs to family Solanaceae that is thought to have originated in South America's Andean area; its popularity in the last half-century has resulted in large-scale production. Tomatoes are a valuable crop, with a global yield of 177.04 million tonnes from 4.78 million hectares worth $95.62 billion. China tops the world in tomato production, with 56.42 million tonnes produced yearly, followed by India with 18.40 million tonnes. These may be eaten in a variety of ways. Fresh fruits are used in salads and sandwiches, as well as salsa, whereas processed fruits are used in pastes, preserves, sauces, soups, juices, and beverages.

Tomato farming may be a source of income for most rural and periurban farmers in the world's poorer countries. Despite the multiple advantages of the crop, postharvest losses make its cultivation unprofitable in most regions of the world. Tomato postharvest losses can range from 25 to 42 percent worldwide (Rehman *et al*., 2007). Growers, processors, and merchants, as well as the entire country, suffer as a result of these losses in terms of foreign exchange revenues (FAOSTAT, 2012;

Arah *et al*., 2015). It is also critical to understand the preharvest elements that might promote exceptional characteristics in fruits during harvest, as well as how to preserve quality after harvest utilizing suitable postharvest handling and treatment procedures. The goal of this study is to look at several preharvest and postharvest variables and see how they impact the postharvest quality and shelf life of harvested tomatoes.

Preharvest Factors

Fertilizers application

Consumers have been increasingly worried about the quality of the food products they consume in recent decades. As a result, scientists looked at the effect of plant nutrition on the quality of the fruits produced. Increasing the quality of tomatoes, such as beta carotene and lycopene, can aid farmers and the tomato processing sector by increasing the value of the product. Fertilizers are one method of increasing lycopene and -carotene levels. A study was conducted in Indonesia to check the effect of phosphorus fertilizer on quality of two tomato varieties (Mawar and Karina) (Rahayu *et al*., 2018). Findings showed the usage of phosphorus fertilizer has positive effect on tomato quality. They suggested that quality and quantity of tomato was influence and increased by the application of phosphorous fertilizer. The high nutrients concentration (beta and lycopene carotene) in tomato fruit was also recorded. Viskelis (2008) had reported that lycopene contents in tomatoes highly influenced by variety and the maturation process. It has been reported that some varieties of tomato have low lycopene and beta carotene while some have high (Temitope, 2009).

According to findings of Ripening diseases can also be caused by a lack of potassium in soil less tomato production (Passam *et al*., 2007). In contrast to potassium, an increase in nitrogen input to greenhouse-grown tomatoes over a particular threshold level might diminish fruit quality by lowering sugar content. The needed quality attributes or the purpose for which the crop is grown will aid in the selection of not only the type of fertilizer but also the amount utilized throughout production. In tomato cultivation, for example, an appropriate supply of potassium fertilizer increases fruit colour and minimizes the occurrence of yellow shoulder, while also increasing the fruit's titratable acidity (Passam *et al*., 2007).

Some critical quality features of fruits, such as total soluble solids (Senevirathna and Daundasekera, 2010), glucose, fructose, and pH (Parisi *et al*., 2006), can be harmed by a high nitrogen input of roughly 250 kg/ha. Improved fruit flavours can be achieved by supplying decreased forms of nitrogen, such as ammonium (Heeb *et al*., 2005). However, variations in phosphorus availability in soils used to grow tomato crops had little effect on quality parameters such total soluble solids (Oke *et al*., 2005), pH, acidity of tomato juice, or fruit colour features (Adams, 2002). When it comes to trace elements, the quantity of boron utilized has the greatest impact on tomato fruit quality, with other micronutrients having an impact only when the plants display severe deficient signs. Fruit firmness is reduced when boron levels are low, which is a key problem during storage.

As a result, several studies have indicated that calcium supplementation has a good impact on many quality measures. Cause in blueberry cultivation, for example, was recently examined and found to be effective in delaying post-harvest softening and reducing weight loss in blueberry fruits (Wojcik and Lewandowski, 2011). Foliar calcium use in strawberry cultivation has been shown to reduce post-harvest rots (Angeletti, 2010) and improve fruit firmness (Singh *et al*., 2007).

Effect of pruning on quality of tomato

By reducing the quantity of flowers, fruit, or fruit trusses, inter-fruit competition is effectively reduced, and more assimilate is channelled to fewer sinks. This results in larger fruits (Luengwilai *et al*., 2010b and Prudent *et al*., 2009) and, in certain situations, higher sugars and TSS levels (Luengwilai *et al*., 2010b and Prudent *et al*., 2009). The effects of pruning on TSS, on the other hand, are dependent on a number of factors, including the fruit-to-leaf ratio (or fruit load), truss position, sink developmental stage, and genetic background (Gautier *et al*., 2001; Bertin *et al*., 2001, Davis and Estes, 1993, Fanasca *et al*., 2007, Franco *et al*., 2009, Gautier *et al*., 2005, Heuvelink, 1997). Pruning may improve fruit size in most cultivars under the correct conditions, making it a potential method for increasing the marketability of high TSS fruits that tend to be smaller; bigger fruit (within a given range).

Climatic factors/conditions

The nutritional content of tomato fruits is highly influenced by climatic conditions, particularly temperature and light intensity. As a result, the amount of ascorbic acid, carotene, riboflavin, thiamine, and flavonoid in plants depends on where they are grown and what season they are grown in. The ascorbic acid concentration in plant tissues decreases as light intensity decreases. Because transpiration rates rise with rising temperature, temperature has an impact on plant mineral nutrient intake and metabolism. Rainfall has an impact on the plant's water supply, which can affect the composition of the harvesting plant component as well as its susceptibility to mechanical damage and decay during later harvesting and handling procedures, resulting in a short shelf life and poor quality (Ismail *et al*., 2007).

Maturity stages

Many quality parameters are influenced by the maturity stage of tomato fruit during harvest (Beckles, 2012). Because tomatoes are climacteric fruits, they can

be harvested at various stages of maturity, such as mature green, half-ripe, or red ripe, depending on the market and producing location. Each stage of harvest has a distinct postharvest characteristic that the fruit will display. According to Moneruzzaman *et al*., (2009), all tomato cultivars under evaluation have the longest shelf life when harvested at the green maturity stage. When fruits are harvested green, their nutritional content and look may be affected.

At harvest, the maturity stage of soft fruits is undoubtedly one of the most important factors affecting numerous quality attributes and shelf life. Soft fruits, as non-climacteric fruits, must be picked until they are completely red and have a °Brix value of 7-8% to ensure fruit quality (Figure 1). As a result, it may be possible to increase its shelf life at the expense of flavour and nutritional content. Because of fruit softening and greater vulnerability to physical damage, harvesting strawberries at the completely ripe stage is preferable to maximize nutritional content while limiting shelf life (Mart´ınez-Romero *et al.*, 2007). When ripe, unripe fruits are more prone to shrivelling and physical damage, as well as having a low flavour quality. Fruits collected too early or too late in the season are more prone to post-harvest physiological issues than fruits harvested at the optimum maturation stage (Yamazaki *et al*., 2000). Fully ripe fruits had a greater decay rate than three-quarter ripe fruits.

According to Moneruzzaman *et al*., (2009), tomato fruits can be harvested at a mature green stage to provide growers adequate time for long-distance sale, while picking at the completely ripe stage to optimise nutritional content is preferable for local marketing.

Irrigation

Because tomato is not a drought-resistant crop, yields are reduced significantly following brief periods of water scarcity during cultivation. In tomato cultivation, proper irrigation scheduling is consequently critical to the crop's development. However, because water is a precious resource in most producing locations, producers have had to design a more effective water management strategy in recent years that preserves crop output while reducing moisture stress on their crops to a manageable level. Deficit irrigation reduces fruit water accumulation and fresh fruit output while increasing total soluble solids levels; moreover, irrigating with salt water has little effect on total fruit yield but modestly reduces fruit moisture content (Mitchell *et al*., 2007).

Cultivar Type

The cultivar type determines the potential quality of the fruit. Different quality factors distinguish different cultivars, making some more valuable to producers and consumers than others. A producer's choice of a high-yielding tomato cultivar with desirable fruit attributes and a longer shelf life is therefore critical (Hanna, 2009). Failure to choose the right cultivar might result in poorer yields, inferior quality fruits, or lower market acceptance. Varying cultivars have different sizes, colours, textures, and flavours, as well as different storage potential. Getinet *et al*., (2008) investigate the effect of tomato cultivar on postharvest quality of tomatoes preserved under various settings. They discovered that tomato cultivar Roma VF had a larger sugar content than cultivar Marglobe while losing less weight. Tomato cultivar selection is so crucial for postharvest storage life and eating quality.

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Postharvest factors

Temperature

Postharvest quality, according to Peppelenbos (2007), includes market quality, edible quality, transportation quality, table quality, nutritional quality, internal quality, and appearance quality. Quality refers to a set of features, attributes, and properties that provide humans with meaning and pleasure. Color, flavour, and nutrition are all factors that consumers evaluate while evaluating product quality. The last manifestation of the inter-relationship between the commodity and its environment is the quality of the output.

The most efficient technique to retain quality has been discovered to be proper temperature regulation between harvest and consumption. Keeping harvested fruits cold, about 20 degrees Celsius, will slow down several metabolic actions that contribute to ripening, giving you more time to complete all postharvest tasks. A one-hour delay between harvesting and chilling a crop results in a one-day decrease of shelf life (Paull, 1999; De Wild *et al*., 2003). The temperature of the ambient environment has a direct impact on the respiration and metabolic activities of harvested climacteric fruits like tomatoes. High temperatures can increase the rate of respiration (CO2 generation) in fruits and vegetables that have been picked or stored (Pranamornkith *et al*., 2012).

Relative Humidity

Tomatoes have a high-water content and are prone to shrinking after harvest. Fruit shrivel can occur even if only a tiny amount of moisture is lost. The ideal relative humidity for mature green tomatoes is between 85 and 95 percent (v/v), but between 90 and 95 percent (v/v) for firmer ripe fruits. Evapotranspiration increases below the recommended level, resulting in shriveled fruits. Tomato fruit that is stored at a lower relative humidity will shrink (Suslow and Cantwell, 2009).

Physical Handling

The consequences of mechanical trauma on fruit, according to Miller (2003), are cumulative. Injuries that are equal to or greater than the bio-yield point cause a complete breakdown of the structure of the affected cells, as well as unfavorable metabolic activities such as increased ethylene production, accelerated respiration rates, and ripening, all of which result in reduced shelf life or poor quality. To prevent mechanical damage and avoid losses, it is critical to treat tomato fruit with care throughout harvest and postharvest operations.

CONCLUSION AND RECOMMENDATION

Tomatoes (*Solanum lycopersicum* L.) are a fruit crop in the Solanaceae family. It is said to have originated in the Andean area of South America, and its popularity has led to a large-scale spread of its cultivation during the last 50 years. Tomatoes are commonly ingested in a variety of forms and contain a considerable number of secondary metabolites that have free radical scavenging properties. Tomato quality control begins in the field and continues until the product reaches the ultimate customer. The fruits' postharvest quality is influenced in part by several preharvest procedures used during cultivation. After harvest, no postharvest treatment procedure or handling methods can increase the quality of any fruit; it can only be maintained. To produce high-quality fruits at harvest, it's critical to understand and manage the numerous roles that preharvest elements including fertilizer treatment, pruning, maturity stage, cultivar selection, and irrigation might play. This study concludes that the quality and storage life of tomatoes after harvest is influenced not only by postharvest factors but also by some preharvest factors during production. Plant breeders will need to do research to discover those organoleptically relevant volatiles and their genetic regulatory mechanisms so that they may design techniques for keeping the desired volatiles while reducing the unwanted ones in breeding lines.

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