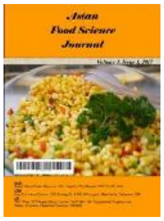

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A Review on Postharvest Storage, Processing and Preservation of Tomatoes (*Lycopersicon esculentum* Mill)

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Tomato (*Lycopersicon esculentum mill.*) is one of the most widely cultivated and consumed horticultural crop globally. The numerous uses of tomatoes can be a contributing factor to its extensive production. It provides an ample and reasonable source of energy, body-building nutrients, and large deposits of vitamins and minerals. The fresh produce are readily available in abundance during the harvest season but due to short postharvest life they are only edible for a very short period of time, except they are quickly and properly stored and preserved. Storage and processing technologies have been employed for centuries to transform perishable fruits and vegetables such as tomato into safe, delicious and stable products. To ensure continuous supply of raw materials for processors, storage is a basic requirement and in addition storage also prolongs the length of the processing season and helps provide continuity of product supply throughout the seasons. The aim of this review paper was to look into the postharvest storage and preservation methods utilized by tomato farmers and processors to ensure nonstop supply of the crop.

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Keyword: Tomato; preservation; season; storage; postharvest; processor and perishable.

1. INTRODUCTION

Tomato (*Lycopersicon esculentum mill*.) is one of the most widely cultivated and consumed horticultural crop worldwide [1]. According to Alam and Goyal [2] tomato is botanically a fruit but classified as vegetable in trade, this is due to the way it is consumed. Naika et al. [3] placed tomato under the solanaceae family, potato, tobacco, peppers and eggplant (aubergine) are among the well-known species under this family. By weight, tomatoes rank number two after potatoes in universal production of all vegetable crops [4].

It is believed that tomatoes originated from some parts of tropical Americas, Ecuador and the wild in Peru, and was introduced into West Africa by Portuguese traders and freed slaves from West Indies. The Spanish in the sixteenth century brought cultivated tomato into Europe and then it was later on Introduced from Europe to Southern and Eastern Asia, Africa and the Middle East [5]. Tomato has fleshy internal segments filled with slippery seeds surrounded by a watery substance. The most common colour of tomato is red but they can be pink, yellow, orange, green, brown or black in colour [5].

Due to the wide variety of nutrients and the many health related benefits, fresh tomato and tomato-based food products provide to the body, They are eaten raw or most times included as an ingredient in a lot of dishes such as salads and sandwiches and as salsa while the processed ones are consumed dried or as pastes, sauces, soups, juices, and drinks [6,7].

Tomato is rich in lycopene, [8] which is helpful in reducing the prevalence of some chronic diseases [9]. It is rich in vitamins [10] minerals, sodium, iron, phosphorus, beta-carotene, potassium and magnesium [11,12], calcium, zinc, vitamins (B1, B2, C, E and K), dietary fiber, carbohydrate, vitamin B6, folate, fatty acid derivatives (including 9-oxo-octadecadienoic acid), vitamin A (beta carotene), and phosphorus. In addition, they are a good source of chromium, pantothenic acid, protein and iron [13]. Presently, tomatoes are utilized at a higher rate in developed countries than in developing countries and hence it may be referred to as a luxury crop [13]. The extensive production of tomato is attributed to its numerous uses [14]. Due to the economic and nutritional importance of this crop, its production has increased in recent years to about 163 million tonnes [15].

Tomato production accounts for about 4.8 million hectares of harvested land area globally with an estimated production of 162 million tonnes. China leads world tomato production with about 50 million tonnes followed by India with 17.5 million tonnes [16]. Other high growers include the USA and Turkey. In Africa, Egypt, Nigeria, Tunisia and Morocco are the leading producers [17]. Due to the increase in tomato production over the years and the nutrients embedded in it, it has become necessary for tomato farmers and processors to adopt good storage methods, processing and preservation techniques that will ensure that the shelf life is extended and the products are available all year round.

2. TOMATO STORAGE

Tomato is a climacteric fruit, which has a short shelf-life under ambient storage conditions [18], they maintain their quality and remain relatively stable so long as they are not harvested and are not damaged by disease or eaten by insects or other animals [19]. The moment the tomatoes are disconnected from their natural nutrient supply, quality reduction sets in and this is due to a natural process that starts as soon as the biological cycle is broken by harvesting [20]. In order to extend the shelf life of tomatoes, it is necessary to retard certain deteriorative processes such as controlling the biosynthesis and action of ethylene [13]. Transpiration, fungal infection, acceleration of the ripening process and senescence are the major limiting factors in the storage of tomato fruit.

It is very difficult to store tomato at ambient temperatures for a long time because they ripen very quickly and become unmarketable in a short period. To ensure uninterrupted supply of raw materials for processors, storage is usually required. The length of the processing season is also extended by storage practices and continuity of product supply throughout the seasons is provided as well [21].

2.1 Low Temperature Storage

The freshness and shelf life of fresh produce is retained and prolonged respectively by this method because it decreases rate of respiration, transpiration and thermal decomposition. Non appearance quality attributes like texture, nutrition, aroma, and flavour in many harvested fruits like tomato can be protected by low quality storage such as Low temperature storage Raison and Lyons [22] Refrigeration storage have been used by tomato handlers, in an attempt to extend shelf life of tomatoes. Tomatoes are sensitive to chilling injury when they are stored below their critical temperature of 100°C. Chilling injury occurs in tomato fruit if they experience temperatures of 10°C for longer than 14 days or temperatures of 5°C for more than 6 to 8 days [23].

2.2 Evaporative Cooling of Tomato

Evaporation of moisture from tomato causes wilting and shriveling which results in weight loss. Evaporative cooling is the process of reducing heat through a change in air pressure caused by volume expansion to obtain low temperature and high humidity, which are necessary for extending the storage life of tomato.

The required optimum temperature of about 10 – 15°C and 85-95% relative humidity [24] can be achieved by using evaporative cooling system which is less expensive [25]. Air temperature can be increased to about 91% in such cooling system, and deterioration of harvested tomatoes due to physiological weight loss can be reduced as a result of this increase in air temperature [26]. Low cost materials like jute sacks, wooden planks, and Basins can be used to locally produce evaporative coolers [26].

2.3 Ethylene Treatment

Uniform accelerated ripening and significant extension of shelf life can be obtained by removing the ethylene produced by fruit with the use of ethylene absorbent either prepared indigenously or by use of ‘purafil’ or potassium permanganate ethylene (commercial form of ethylene absorbent), Ethylene is absorbed and oxidised to water, carbon dioxide, manganese dioxide and potassium by the use of potassium permanganate ($KMnO_4$) which is an ethylene absorber.it is usually applied in the form of sachets or impregnated in plastic containers or in chemical filter. Due to its toxicity it is not applied directly. Impregnation of different packaging material with ethylene absorber can help minimise postharvest losses because aside ethylene, moisture is also being absorbed [27].

It is reported that potassium permanganate ethylene is able to remove the exogenous ethylene from atmosphere, which plays a significant role in tomato fruit ripening by absorbing and oxidising it to carbon dioxide and water, thus increasing concentration of carbon dioxide and blocking the synthesis of endogenous ethylene, which is said to be essential for control of ripening as its synthesis is believed to be vital for many plant developmental processes including ripening [28,29].

In a report, ripe tomatoes were washed and surface moisture removed. They were packed in polypropylene (200 gauge) packets with 0.002% perforation and without perforation. Chalks treated with different concentrations of $KMnO_4$ (1500 ppm-2500 ppm) were kept inside the polypropylene packets, along with the tomatoes. Tomatoes packed in perforated (0.002%) polypropylene (200 gauge) packets with 2500 ppm $KMnO_4$ treated chalks had the shelf life of 28 days in cold storage (04±5°C and 85% RH) and 14 days in room temperature storage (24±5°C and 70% RH). Analysis of the samples were carried out and it was found that $KMnO_4$ (2500 ppm) + perforation showed minimum decay percentage, and slow rate of change in TSS, colour ‘a’ value and lycopene content, while maximum value was recorded for fruit firmness, acidity and ascorbic acid by the treatment [30].

2.4 Modified Atmosphere Packaging (MAP)

Packaging technique of using specialised materials in packaging products in a predetermined composition of gases which are mainly oxygen (O_2) and carbon dioxide (CO_2) is known as modified atmosphere packaging (MAP) [31]. The packaging materials used in MAP allow for diffusion of gases through them until a stable equilibrium is reached between the external gases and those inside the package. The most commonly used MAP materials are polyethylene terephthalate (PET), low density polyethylene (LDP), high density polyethylene (HDP), polyvinyl chloride (PVC), polypropylene, polystyrene and some chemically modified derivatives. The benefit of using MAP is not only in providing a modified atmosphere to control ripening, but also in reducing water loss in stored products, reducing mechanical injuries, and enhancing better hygiene which reduces the spread of food-borne diseases. MAP creates high relative humidity around the fruit which reduces water loss and shrinkage [31].

An experiment was conducted to study the effect of chlorine, packaging and storage conditions on quality and shelf life of tomato. Tomato treated with chlorine; packed in perforated (0.25%)

polyethylene bag and kept at ambient (Temperature 20-25°C and relative humidity 70-90%) condition resulted in substantial reduction in losses caused by decay and weight loss. This treatment combination also considerably delayed compositional changes in TSS, total sugar, reducing sugar, vitamin-C, B-carotene, etc. Under this condition, shelf life of tomato was extended up to 17 days as compared to non-treated and kept in ambient condition without packaging or packed in gunny bag for 7 days only [31].

2.5 1-Methylcyclopropene (1-MCP)

Ethylene plays an important role in the ripening of climacteric fruits such as tomatoes by activating several ripening-related physiological changes [32]. The negative effects of ethylene accumulation in fruits and vegetables can be prevented by the use of ethylene inhibitor.

Many compounds have shown the ability to block the ethylene binding site, by causing either the suppression or the inhibition of ethylene effects. The ability to control both ripening and softening of apples have been shown by diazocyclopentadiene and 2,5 norbonadiene. However, due to toxicity and manufacturing concerns none of these compounds is commercially acceptable. Other compounds with prospective use are aminooxyacetic acid (AOA), aminoethoxyvinylglycine (AVG), and silver thiosulfate (STS). If external sources of ethylene such as climacteric fruits, fungi, propane, and cigarette smokes are available, the efficacy of AOA and AVG are reduced. Only STS has commercial applications in many countries amongst the inhibitors mentioned above. Though, its continued use is being questioned as silver is a strong pollutant, and many countries have proposed to ban its use [33].

The action of ethylene in many fruits and vegetables has been shown to be suppressed by the use of 1-methylcyclopropene (1-MCP).This cyclic olefin, 1-methylcyclopropene (1-MCP) is a well-established and effective tool and is thought to bind irreversibly to the ethylene receptor sites, thereby preventing or delaying ethylene responses [33]. The rate of ethylene production in harvested climacteric fruit like tomato is indicative of the metabolic activities within the fruit. The higher the metabolic activities within the harvested fruit, the shorter its shelf life. However, the aim of every postharvest technology is to slow down the metabolism in the harvested produce thereby prolonging shelf life. The use of 1-MCP by tomato handlers is essential in extending the shelf life of harvested tomatoes. This has also shown to slow down many of the metabolic activities associated with the ripening process such as colour change, cell wall breakdown, and respiration rates making it a useful technique in extending the storage life of fruits [31].

Moretti et al. [33] Investigated the ability of 1-methylcyclopropene (1-MCP) to slow down tomato fruit ripening. Fruit without external blemishes were graded for size (diameter = 80±5 mm) and mass (m = 130±10 g), were placed inside hermetically sealed boxes, and 1-MCP was applied for 12 hours (T = 22±1°C; RH = 80-85%) at four different concentrations: 0 (control), 250, 500 and 1000 $mL.L^{-1}$. Fruits were held at ambient conditions (T = 23±°C; RH 80-85%) for 2 days and then stored inside a cold room (T = 20±1°C; RH = 85-95%). Every 3 days, during a 15-day period, fruits were analysed for firmness, total soluble solids, titratable acidity, external color, and total carotenoids. The firmness of fruit treated with 1000 $mL.L^{-1}$ was about 88% higher than control fruits after 17 days. The a*/b* ratio, an indicator of skin color, for fruit treated with 1000 $mL.L^{-1}$ of 1-MCP was 38% lower than control fruits at the end of the storage period. Treatments with higher concentrations of 1-MCP delayed total carotenoids synthesis and color development. Control fruits stored for 17 days had about 190% more total carotenoids than fruits treated with 1000 $mL.L^{-1}$ of 1-MCP. Postharvest application of 1-MCP was an efficient method to delay tomato fruit ripening. As 1-MCP concentration increased, ripening was further delayed. Tomatoes treated with 250, 500, and 1000 $mL.L^{-1}$ of 1-MCP were delayed by 8 to 11, 11 to 13 and 15 to 17 days, respectively.

Another study was also carried out to find out the efficacy of 1-MCP, an ethylene inhibitor on the shelf life and quality of freshly harvested tomato fruits. The application of 1-MCP (Cel fresh) at the rate of 1 tablet (0.18%)/1 m^3 and 1 tablet/2 m^3 on the storage life of tomato fruits stored up to 12 days under room condition revealed the delayed red color development and ripening, retained higher fruit firmness, reduced the acidity loss of tomato (US-516 hybrid) fruits harvested at breaker stage of maturity and extended the storage life up to 12 days at room temperature (24-27°C and 30-43% RH) compared to untreated control fruits. The sensory evaluation of tomato fruits revealed better appearance, texture, taste and overall acceptability of Cel fresh treated fruits than untreated control fruits. The treatment of fruits at higher concentration of 1-MCP (1 tablet/1 m^3) exposure for 12 h was more efficient and better in delaying the ripening and retaining higher fruit firmness resulting in better quality and higher overall acceptability as revealed by sensory evaluation of room temperature stored tomato fruits. Cultivar, developmental stage, time from harvest to treatment and multiple application are main factors to be concerned prior to use of 1-MCP. [34].

3. PREPARATION OF TOMATO FOR STORAGE, PROCESSING AND PRESERVATION

The preparation of tomato for preservation should be as soon as harvest is carried out, this is because the chances of deterioration increase rapidly as time passes. Preparation can be done using the processes outlined below.

3.1 Cleaning and Washing

The tomatoes have to be thoroughly cleaned to get rid of any dirt or insecticide residues after harvesting and this can be done by the use of sodium hypochlorite or chlorine. The process of cleaning the tomato usually entails washing it in a pail with clean water that is frequently refreshed [35].

3.2 Peeling

Peeling of tomato before preservation is necessary and this can be done without difficulty with a stainless steel knife. In order to prevent the discolouration of the plant tissues, it is really important that the knife be made of stainless steel. It is best to first dip them in boiling water for 1 ½ to 3 minutes in order to soften the skin, then the softened peel can now be removed without too much effort [31]. Cheryl et al. [35] wrote a review paper on the Conventional and Alternative Methods for Tomato Peeling. The review highlighted the conventional methods used in tomato peeling, their efficacy and the potential applications of infrared, ohmic heating and power ultrasonic as a novel technology for tomato peeling. He stated that Steam/hot water and lye peeling have been the most commercialised methods, but compared to steam peeling, lye peeling is more preferred and has gained widespread application among processors due to its association with higher product yields and better product quality [35].

3.3 Cutting

Cutting is most times employed before some preservation methods are carried out because approximately uniform pieces are usually required. Tomatoes are usually cut into cubes, thin slices, rings or shreds for the heating, drying and packing stages. To prevent microbial contamination, the cutting utensils have to be sharp and clean. The quality of the products decreases from the moment they are cut, due to the release of enzymes and nutrients for micro-organisms. The damage done to the plant tissues also leads to a decrease in quality. For this reason, the interval between peeling/cutting and preserving has to be as short as possible [31].

3.4 Blanching

Blanching or pre-cooking is done by immersing tomatoes in water at a temperature of 90-95°C. The result is that the tomatoes become somewhat soft and the enzymes are inactivated. In order to prevent unwanted colour and odour changes and an excessive loss of vitamins blanching is done before a product is dried [31]. A study was carried out to determine the effect of blanching methods on drying kinetics of bell pepper and it was observed that the blanched samples generally had higher drying rates than the untreated samples [36].

4. TOMATO PROCESSING AND PRESERVATION

The process of drying, freezing or treating foods with substances to prevent the upsurge in the number of microorganisms such as bacteria and fungi in order to stop decomposition is known as preservation. The primary aim of preservation is to prolong the shelf life of the produce [37].

Processing and preservation is a set of physical, chemical and biological processes that are performed to prolong the shelf life of food and at the same time retain their colour, texture, flavour and especially nutritional value. Food preservation is achieved by destroying enzymes and microorganisms using heat (blanching, pasteurisation), or preventing their action by removal of water, increasing acidity or using low temperatures. During tomato season, large portions of tomatoes are processed into concentrated tomato paste, which are reconstituted into other products such as tomato sauce, ketchup and other value-added products [38]. Drying is also another way of extending the postharvest shelf life of tomato. Dried tomato products are used as important ingredients for pizza, various vegetables, and spicy dishes [39].

According to Goldberg [40] the following reasons amongst others are some of the advantages why tomato is processed and preserved:

i. Protection against spoilage
ii. Long shelf life
iii. Add value
iv. Availability
v. Easy transportation
vi. Profitability
vii. Lower cost
viii. Easy to store
ix. Convenience
x. Safety

5. METHODS OF PRESERVING TOMATO

5.1 Drying

One of the ancient ways of preserving tomato is drying. The basic procedure involves removal of moisture from the fruit to a point where decay is not likely. This can be achieved by using an oven, a dehydrator or the warm heat of the sun. Once finished, the produce should be stored in a dry place in air tight containers [41].

Opega et al. [42] worked on the Effect of Drying Methods and Storage Conditions on Nutritional Value and Sensory Properties of Dehydrated Tomato Powder (*Lycopersicon esculentum mill*) the effects of two drying methods, (oven drying and sun drying) of tomatoes and storage conditions of the products were studied to assess their effects on chemical, nutritional quality and sensory properties. Sensory evaluation which included four parameters, i.e. revealed taste, flavour, consistency, colour beside overall acceptability was significantly superior in the oven dried tomato product over the sun dried.

5.2 Preservatives (Chemical)

They prevent the growth of microorganisms and help preserve the tomato. There are many types of chemical preservatives that are used in food processing some of which include, sodium benzoate, sodium metabisulphite, sulphur dioxide, Sodium chloride (common salt) and citric acid. For example The efficacy of sulphur dioxide is more against moulds or bacteria than yeasts and has the additional advantage of slowing down browning or darkening of some products [40].

Shampa et al. [43] also carried out a research on the Effect of Chemical Preservatives and Storage Conditions on the Nutritional Quality of Tomato Pulp .The results revealed that higher concentration of sodium benzoate and storage at -10°C might be a better way for long term preservation of tomato pulp.

5.3 Boiling

An effective way of preserving food is by using heat. The reason is because majority of harmful pathogens are killed at temperatures close to the boiling point of water. Therefore, heating food is a form of food preservation comparable to that of freezing but much superior to it in its effectiveness. A preliminary step in many other forms of food preservation, especially forms that make use of packaging, is to heat the foods to temperatures sufficiently high to destroy pathogens [44].

5.4 Pasteurisation

This is also known as post-heat treatment. Tomato paste can be pasteurised in their bottles using hot water. It is imperative to note that the product and the water should maintain the same temperature at all times, otherwise the bottles will burst. The filled bottles with their lids closed are placed in a larger pan of water with water heated to boiling point. This could be done for at least 45 minutes [45]. Nenad et al. [46] looked into the impact of different thermal processing of tomato to its antioxidant activity, vitamin E, dry matter and sugar content with the aim to establish the nutritive profile and distinguish superior genotypes in order to obtain high-quality final product with more benefit to human health.it was observed that Thermal processing by drying at 60°C and pasteurization of tomato changed the level of total sugar and dry matter content. Total antioxidant activity decreased by drying, compared to fresh fruit while the level of vitamin E decreased in juice pasteurized at high temperature (100°C).

5.5 Freezing

Tomatoes may be frozen whole, sliced, chopped or puree. Tomatoes can be frozen raw or cooked. Firm, ripe tomato should be sorted for freezing and should not be blanched. The pathogens responsible for food decay are killed or do not grow very quickly at reduced temperatures during freezing [47].

5.6 Curing

It has been well acknowledged for centuries that adding salt to foods as preservative is of great value. Salt acts as a dehydrating agent in foods by binding with water molecules. The effect sugar has as a preservative is similar to those of salt in preventing spoilage of food. The use of either compound or certain other natural materials is known as curing.

i. Sugar: If the concentration of sugar in the preserved material is increased about 66 %, the water content is decreased to such an extent that the multiplication of microorganisms is checked and the present ones die in due course [48].

ii. Salt: Strong salt solution never allows the microorganism to grow in the preserved products. It acts both by osmosis and as a poison and it is more effective than sugar. A brine solution of 10 to 15% is sufficient for permanent preservation of most of the products. The pleasant flavor each compound adds to the final product is one of the desirable side effects of using salt or sugar as preservative [49].

6. TOMATO PRODUCTS

There are different types of tomato products and usually there is some confusion about the differences between them, thus here are some definitions that were reported by Thakur et al. [49].

6.1 Tomato Juice

Tomato juice is a juice from whole crushed tomatoes with no skin or seeds, which has been subjected to fine screening, and is intended for consumption without dilution or concentration. It is smooth and in a liquid form available in cans or bottles. In recipes where a subtle tomato flavour and smooth texture are required, tomato juice can be included in small quantities [48,49].

6.1.1 Tomato juice production

Fully ripe well developed colour tomatoes are washed, trimmed, steamed, crushed in a crusher or cut into pieces with knives. The crushed pieces are heated in the steam jacketed kettle till they become quite soften. The heated tomatoes are passed through the pulping machine using a fine mesh sieve to separate juice from seeds and the skin. The sugar and salt at 1% is added and heated to 85-90ºC. The hot juice is then filled in bottles, sealed immediately and pasteurized in boiling water for about 30 minutes and cooled [49].

6.2 Tomato Paste

Product obtained after concentration of tomato pulp, removing skin and seeds and containing more than 24% natural tomato soluble solids (NTSS) [49].

6.2.1 Tomato paste production

Tomato pulp or juice is concentrated to 14-15% soluble solids in open pans followed by concentration in vacuum pans and packing in pre-sterilized bottles while still hot. In large scale processing units, the tomato paste is manufactured by using vacuum evaporators and packed either in tin can or in bulk aseptic packages. The tomato paste is utilized for manufacture of different products like ketchup, soup, sauce etc [50].

Hot Break and Cold Break are the two types of tomato paste and they are used in making different end products. The fresh tomatoes after chopping must be heated immediately to a very high temperature (ranging from 85 to 100°C) in order to make Hot Break (HB) paste while Cold Break (CB) paste requires the fresh, chopped tomatoes to be heated at a lower temperature (ranging from 65 to 75°C). Hot Break paste is usually used for ketchup and different types of tomato sauce requiring a 28-30° Brix, while Cold Break paste is mainly used for triple concentrate paste at 36-38° Brix which are then packaged for domestic use [51].

6.3 Tomato Puree

Tomato paste with low concentration of NTSS (8-24%). In USA it is also called tomato pulp or concentrated juice, it corresponds to the commercial tomato paste found in the market [49].

6.3.1 Tomato puree production

The pulp is concentrated under vacuum to about 9% to 12% total solids so as to get tomato puree.

The sufficiently scalded product is mashed to puree by passing through a sieve, which retains the skins, the seeds, as well as the fibrous substances. It is necessary to evaporate the liquid contained in pulp by heating the product until the desired consistency is reach. The product is filled in bottles, crown corked and processed in boiling water for 30 min. and cooled [50,52,and 53].

6.4 Tomato Powder

Product obtained after drying using sun, oven or dehydrator and pulverised into powder [49].

6.4.1 Tomato powder production

The process of removing moisture from food to inhibit the growth of mold and bacteria is known as dehydration and this process extends the shelf life of tomato. This process forms the basis for tomato powder [54].

The fresh ripe tomatoes are sorted according to size and shape, the sorted tomato are cleaned by soaking for 1-2 minutes in 1% sodium hypochlorite solution and then rinsed with clean portable tap water and allowed to drain. The tomato will then be sliced into slices of about 5-10 mm and the seeds removed. The sliced tomato will be blanched for one minute at 90°C and allowed to drain. It will then be placed inside the drying chamber of the oven and the oven temperature set at 60°C for oven drying or dehydrator and under the sun for sun drying method. Afterwards it will then be cooled, milled and packaged appropriately [55].

7. CONCLUSION

Tomato is a perishable food product that starts deteriorating 2-3 days after harvesting. However some postharvest handling practices and treatments carried out after harvest determines the postharvest quality of the tomato. In developing countries, failure to adhere to these best practices has resulted in high amount of loss. From this review it was concluded that if the appropriate postharvest storage, processing and preservation methods are adhered to, the quality of the harvested tomato fruit can be maintained and shelf life extended else, postharvest losses in tomatoes will continue to be a major challenge for tomato handlers most especially of developing countries.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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