Novelty Journals

ISSN 2394-966X

International Journal of Novel Research in Life Sciences
Vol. 6, Issue 4, pp: (21-28), Month: July - August 2019, Available at: www.noveltyjournals.com

A Review on influence of post harvest treatments on Quality and Shelf Life of Peach Fruits

TajebeMosie*

Horticulture department, Holeta Agricultural Research Center, P.O. Box 31, Ethiopia.

Email: tajebemu@gmail.com

Abstract: **Peach is a 'climacteric' fruit which is a very perishable and deteriorates quickly during storage and that is why it is marketed immediately after harvest. The main causes of this loss can be physiological as well as physical. Therefore the objective of the review is to assess techniques of postharvest storage of peaches. Several techniques were used in extending the storage life by maintaining the quality of peaches so far worldwide. Cold storage reduces the respiration rate of the fruit and hence ripening, senescence and decay development. However, chilling injury (CI) limits the storage life of peaches and nectarines under low temperature. Modified atmosphere packaging during marketing and storage of highly perishable commodities has similar results. The low relative humidity around non-packaged fruits could be the main cause for rapid deterioration of the fruits due to moisture loss, which result in shriveled and brownish fruits. Postharvest application of calcium may delay senescence in fruits with no detrimental effects on consumer acceptance. Exogenously applied calcium able to reduce fruit softening and increases storage life as compared to untreated fruits.1-MCP can also inhibit the ethylene action by blocking the continuously forming receptor sites on the plant cell and would not allow ethylene to bind on to receptor site.1-MCP treatments may differ by the ripeness stage of the fruit, concentration, treatment time and temperature. Therefore integrated use of these techniques can extend the shelf life of peaches tremendously by maintaining physical as well as chemical qualities.**

Keywords: **packaging, peach, postharvest, quality, shelf life, storage.**

1. INTRODUCTION

Peach (*Prunus persica* L.) which belongs to family Rosacea, widely grown in temperate regions of the world (Khattak *et al*., 2002). It is one of the most important horticultural crops in the world because of its attractive taste and nutritive value. Peach is a 'climacteric' fruit which is a very perishable and deteriorates quickly during storage (Nunes, 2008).The postharvest losses of peach fruit were 30 to 40%Zeb and Khan (2008), that's why it is marketed immediately after harvests. Under normal storage conditions the life of fruit does not exceed 5 days (Tonini and Tura, 1998).Peaches have short shelf life mainly under room temperature, partially due to their high respiratory rate and fast ripening process.

The main causes of loss are physiological (wilting, shriveling, chilling injury, decay due to fungi and bacteria) and physical (mechanical) injury. Losses are estimated to be 20-40% in developing countries and 10-15% in developed countries. Loss of firmness and rot development are the main factors that lower the quality of post-harvest fruits. Therefore, these fruits are generally commercialized shortly after being harvested (Kluge *et al*., 1997).The ethylene regulates peaches ripening process. At a certain stage of the ripening process, the ethylene links itself to its action site in the cell, promoting a succession of events that result in ripeness and senescence (Burg & Burg, 1967; Lelièvre *et al*, 1997). Several compounds have shown to block the ethylene's linking site, thus inhibiting its effects (Sisler *et al*., 1990; Sisler, 1991).

Post-harvest decay is the major factor limiting the extension of storage life of fruits. Rapid ripening also shortens the shelf-life of commodities and represents a serious constraint for efficient handling and transportation (Bonghi *et al.* 1999). It happens in high temperature accompanied by low relative humidity during harvesting and marketing. Considering the varying response of different products to post-harvest treatments, development of suitable techniques becomes necessary to achieve optimum quality for any product. The use of physiologically active compounds has attracted food industries and consumers (Alzamora *et al.* 2005).

Postharvest strategies have been presumed to extend the shelf life and quality of peaches such as heat (Cao *et al*., 2010), intermittent warming, gamma irradiation and treatment with chemicals such as aminoethoxyvinylglycine, 1-methylcyclopropene (Hayama *et al*., 2008), calcium chloride (Manganaris *et al*., 2007), nitric oxide and salicylic acid (Cao *et al*., 2010).Several approaches like heat treatment, wax coating, vinyl resin plastic coating, fumigation with ethylene bromide, acid dipping and use of fungicides have been tried to control the postharvest losses of fresh fruits (Neo and Saikia, 2010).In order to reduce postharvest losses fresh produce are harvested at green immature stage. However, early harvested fresh produce receives complaints about poor taste, green and hard fruit. Postharvest treatments can help in increasing fruit shelf life and maintaining quality, thus reducing commercial losses for packaging houses. Therefore the objective of the review is for the assessment of techniques in extending shelf life of peach fruits by maintaining its quality.

2. MAJOR POSTHARVEST STRATEGIES APPLIED FOR PEACHES

Peaches are exposed for postharvest diseases mainly by grey mold (*Botrytis cinerea*) and blue mold (*penicillium expansum*) due to lack of effective postharvest treatments and control methods. There are several techniques used in extending the storage life by maintaining the quality of peaches so far worldwide. Some of the strategies are listed above in the introduction. Therefore cold storage, packaging, chemical treatment (calcium chloride and 1-MCP) will be discussed below.

3. COLD STORAGE OF PEACHES

Preservation of stone fruit after harvest, as with other fresh fruit, is mainly dependent on cold storage (Kader, 1992a). Storage at low temperature is important to slow microbial activity and the physiological processes, in order to maintain fruit quality. The ideal peach storage temperature is −1°C to 0°C and the flesh freezing point varies depending on soluble solid contents (Lill *et al*., 1989; Thompson *et al*., 1998). Fruit should be kept at a temperature which confines infection and growth of the prevalent fungi, without causing internal disorders, such as chilling and freezing injury. Cold storage reduces the respiration rate of the fruit and hence ripening, senescence and decay development.

Stone fruit should be cooled without delay after harvest, to minimize exposure to high temperatures, during which infection and decay could manifest. Good temperature management throughout the handling chain is critical to control decay development. Cooling of stone fruit to temperatures higher than -0.5°C may address issues of energy saving and in some cases may assist with management of internal disorders. The low temperature is important in slowing the rate of flesh softening to obtain as long a market life as possible. For most varieties, this low temperature is essential in slowing the development of mealiness and browning during extended storage (Mitchell *et al*., 1974). Temperatures below 0°C may be practical for high maturity, high-soluble-solids fruit of some varieties (Mitchell *et al*., 1974). Danger of fruit freezing may be the only concern in lower temperature storage.

However, chilling injury (CI) limits the storage life of peaches and nectarines under low temperature. It has been widely reported that the expression of CI symptoms, especially flesh browning or internal browning, develops faster and more intensely when susceptible fruit are stored at temperatures between 2.2 and 7.6 ^{o}C (killing temperature zone) than those stored at 0 ^{o}C or below but above their freezing point (Crisosto *et al*., 1999).These symptoms mainly develop during fruit ripening after cold storage, and the problem is not noticed until the fruit reaches customers (Bruhn *et al*., 1991; Crisosto *et al*., 1995). The onset of these symptoms determines the postharvest storage potential because chilling injury development reduces consumer acceptance (Crisosto *et al*., 1997).Therefore, fruit maximum storage life can be achieved near or below 0 °C, depending on the soluble solids content of the fruit. The recommended relative humidity for peach fruit storage is noted to be in the range of 90-95%, respectively (Lill *et al*., 1989; Thompson *et al*., 1998).

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Peaches high respiration rate and susceptibility to injury caused by low temperatures around 0°C and fungal decay allow only brief storage at ambient temperatures; the storage life is less than 7 days at 20°C (Zhou *et al*., 2002). Peaches softened at different rates during the period of the storage regardless of the cultivars and the storage temperatures. At storage regime of 12 ^{o}C, it caused an excessive firmness loss for both cultivars, dropping firmness values below 10 N just after 4 days (Ergun, 2012). Vitamin C content from 'Royalglory' first increased irrespective of the temperatures then decreased in fruits stored at 0 ^{o}C, and continued to increase in fruits at 5 ^{o}C, generating marked differences among treatments (Ergun, 2012). CI symptoms for 'RoyalGlory' fruits at 0 ^{o}C manifested reaching nearly 100% at the end of the storage period while CI symptoms for'Redhaven' fruits at 0 ^{o}C expanded only up to 20% at the end (Ergun, 2012).Cold store extends shelf life by maintaining the quality of peach during post-harvest storage (Tajebe *et al*., 2018).

4. PACKAGING OF PEACHES

Packing of fruits in polymeric films creates modified atmospheric conditions around the produce inside the package allowing lower degree of control of gases and can interplay with physiological processes of commodity resulting in reduced rate of respiration, transpiration and other metabolic processes of fruits (Zagory and Kader, 1988; Erkan and Wang, 2006). Modified atmosphere packaging techniques are accepted now as the technology of the future. Controlled or modified atmospheres (MA) are used as supplementary to fruit cold storage to limit water loss, delay ripening and suppress diseases. MA packaging during marketing of highly perishable commodities has similar results. Different modified atmosphere packaging systems were studied in 'Elegant Lady' and 'O Henry' peach cultivars (Zoffoli *et al*., 1997). Respiration rate and ethylene production decreased as the ripening period progressed in all the storage periods.

Chilling injury limits the storage life of peaches under low temperature for less than two weeks in regular atmosphere. Although the fruits have a good appearance when removed from cold storage, they fail to ripen satisfactorily and become dry and mealy or woolly in texture. Reports have related that the use of MA with elevated CO_2 and reduced O_2 concentrations delay or prevent the onset of these chilling symptoms and the storage life of the fruit can be extended (Lurie and Crisosto, 2005). Repeated attempts have been made to maintain a MA during transport of fresh product either by modification of the atmosphere in the entire transport vehicle or by overwrapping pallet units of product (Harris and Harvey, 1973).

Modified atmosphere packaging has been introduced as a less expensive alternative technology to controlled atmosphere, but different results have been obtained depending on the cultivar and the final CO_2 and O_2 concentration attained at the steady-state (Zoffoli *et al*., 1997). Studies on MAP of peaches and nectarines have showed that MAP slowed down the respiration rate of fruits and retarded the decrease in titratable acidity values, maintained the fruit sugar and soluble solids content, flesh firmness, vitamin C and juice content, and slowed deterioration through decreasing fruit injury and browning development (Deily and Rizvi, 1983; Zoffoli *et al*., 1998).

According to Ben-Yehoshua (1985) sealing individual climacteric fruit in low-density polyethylene bag delayed ripening and softening, and hence improved marketability. The low relative humidity around non-packaged fruits could be the main cause for rapid deterioration of the fruits due to moisture loss, which result in shriveled and brownish fruits. Moreover, the effect of polyethylene could partially be due to the possible difference in air composition around the fruits that might suppress respiration.

The MA efficiency is related to cultivar, pre harvest factors, temperature, fruit size, marketing period and shipping time (Von Mollendorff, 1987; Crisosto *et al*., 1997; Crisosto *et al*., 1999a). There is a large variation among different selections and/or cultivars of peaches as to their susceptibility to chilling injury when stored either at 0 or 5 oC, indicating that the symptoms have a significant genetic component (Crisosto *et al*., 1999b). Singh *et al*. (2012) reported that packaging of pear fruits in LDPE polythene bags resulted in development of off- flavor and decay during storage. Dhall *et al*. (2012) mentioned that shrink film wrapped cucumber exhibited lower decay incidence and better retention of green color and other physico-chemical attributes during storage as compared to unwrapped cucumber. The CI symptoms include internal and external browning, breakdown and reddish-discoloration of the flesh, decay, and the loss of normal ripening (Jin *et al*., 2009). Many storage techniques, including modified atmosphere packaging (MAP), have been developed over the years to extend the storage life of fruits (Pariasca *et al*., 2000). However, improper gas composition, CO_2 injury, increased ethanol production and flavour problems due to anaerobic respiration have been reported (Zhang *et al*., 2001). Therefore, it is important to study the effect of packaging films on the quality of fruits. High acidity in fruit has been suggested to contribute in part to the flavour retention of ripened fruit (Ulrich, 1970). MAP had significant effects on the organic acids of honey peaches. Malic acid was the principal organic acid in peaches after harvest. During storage at 2°C, TA in control fruit declined rapidly; however, the decrease was slowed by MAP in LDPE packages (Jianshen *et al.*, 2007). An increase in TSS was recorded with advancement of storage period irrespective of the treatments. The increase in total soluble solids with prolongation of storage period may probably be due to increased hydrolysis of polysaccharides and concentration of juice due to dehydration. Towards the end of storage maximum TSS was recorded in control fruit. It may be due to maximum water loss in these fruit. High quality as well as extended storage period in peaches will be exhibited with packagings without perforation and genotypes (Tajebe *et al*., 2018).

5. CHEMICAL TREATMENTS

Chemical treatments are mainly associated with the action of ethylene. Ethylene, a plant growth hormone, plays a central role in initiation and acceleration of ripening process of fresh produce (Theologies, Zarembinski *et al*., 1992). The ethylene receptor sites located on plant cells are involved in ethylene action and trigger the ripening process. Ethylene inhibitors have shown potential benefits for controlling ripening. The most common chemicals used for postharvest treatment of fruits are calcium chloride and 1-MCP.

6. CALCIUM CHLORIDE TREATMENT

Calcium is one of the important elements affecting quality and post-harvest life of many fruits. Postharvest application of calcium may delay senescence in fruits with no detrimental effects on consumer acceptance. Exogenously applied calcium stabilizes the plant cell wall and protects it from cell wall degrading enzymes. It also reduces fruit softening and increases storage life as compared to untreated fruits (White and Broadley, 2003). Calcium deficiency in some fruits causes certain diseases such as bitter pit, cork spot, water core and senescent breakdown. Fruits with calcium deficiency fall earlier than the expected time of ripening and cannot be kept in store longer compared to those with enough calcium (Serrano 2010). Calcium reduction in the cell middle lamella is the major factor of cell wall softening in apple during post-harvest storage (Stow, 1999). Several other roles have been reported for calcium including tissue firmness preservation in apple (Char-donnet *et al.* 2003), peach (Prussia *et al.*,2005), straw-berry (Saftner *et al.*,2003; Verdini *et al.*,2008).

Considerable weight loss occurred during storage due to the inhibition of respiration. Calcium applications are effective in terms of membrane functionality and integrity maintenance which may also be the reason for the lower weight loss found in calcium treated fruits. The lower weight loss in samples treated with $CaCl_2$ dip may also be due to the effect of $CaCl_2$ on the delaying of natural physiological processes like respiration, onset of the climacteric, ripening process and senescence as reported by Hussain *et al*. (2012).All samples demonstrated a gradual loss of weight during storage. Towards the end of the storage period, untreated peach fruits depicted high loss in weight, whereas the weight losses of samples treated with increasing concentration up to 3% calcium chloride dip were decreased with respect (Sohail *et al*., 2015).

Ascorbic acid is an important nutrient and is very sensitive to degradation due to its oxidation compared to other nutrients during food processing and storage (Veltman *et al*., 2000). As a result $CaCl_2$ treatments had a significant effect on retaining ascorbic acid content in peach fruits (Sohail *et al*., 2015). This might be because higher concentrations of $CaCl_2$ delayed the rapid oxidation of ascorbic acid. However the losses in ascorbic acid content may be due to light during storage. The ascorbic acid loss during storage is known to be due to its antioxidant activity especially under postharvest storage conditions (Davey *et al*., 2000).

The total soluble solids of peach fruits were showed an increasing trend irrespective of treatments when storage period increased. However after 24 days of storage, increase in TSS was significantly ($P \leq 0.05$) higher in control sample compared to $CaCl_2$ treated fruits (Sohail *et al*., 2015). The increase in TSS was probably due to the hydrolysis of polysaccharides and concentrated juice content as a result of dehydration with the passage of storage time (Akhtar *et al*., 2010).The slow increase of TSS in 3% $CaCl_2$ might be due to the fact that more concentration of calcium chloride (3%) formed a thin layer on the surface of fruit which delayed degradation process (Sohail *et al*., 2015). The increase in TSS is attributed to the enzymatic conversion of higher polysaccharides such as starches and pectin into simple sugars during ripening (Hussain *et al*., 2008). Therefore, the $CaCl_2$ dip resulted in delaying the increase in TSS in samples subjected to higher concentration of $CaCl_2$ even after 24 days of cold storage (Sohail *et al*., 2015).

1-Mcp Treatment of Peach Fruits

Recently the synthetic gaseous compound 1-methylcyclopropene (1-MCP), found to be a good ethylene antagonist compound, can be used to extend the shelf life of fresh produce by controlling over-ripening and ripening related changes such as dramatic changes in color, texture, flavor, pH and aroma of the fruit flesh. It also provides insight into ethylene action and response in research programs. 1-MCP can inhibit the ethylene action by blocking the continuously forming receptor sites on the plant cell and would not allow ethylene to bind on to receptor site. 1-MCP has ten times greater affinity for the ethylene receptor sites than ethylene (Blankenship and Dole, 2003).The efficacy of 1-MCP on the physiology of fruits and vegetables are proven such as less ethylene production, lower respiration rate and reduced color change. 1-MCP treatments may differ by the ripeness stage of the fruit, concentration, treatment time and temperature. The concentration can vary among different cultivars and exposure period. To avoid ethylene production and action, 1-MCP is applied before the initiation of ripening (Serek *et al*., 1995).The current treatment process involves continuous exposure of 1-MCP concentration in a controlled room environment for several hours, allowing the 1-MCP to bind to the ethylene receptors on the plant cell, which results in inhibiting ethylene action and delayed ripening (Serek *et al*., 1995; Hotchkiss, Watkins *et al*. 2007). This treatment however is effective in delaying the ripening only for a few days since the formation of receptor sites is a continuous process which triggers ripening. Hence there is a need for a system which provides continuous replenishment of 1-MCP to bind with the existing and continuously forming receptor sites to further delay the ripening.

The mature green fruits treated with 1-MCP presented better firmness than the non-treated fruits. Firmness was 40 to 60% greater than the one observed in non-treated fruits (Sohail *et al*., 2015). Ripe fruits treated with 1-MCP showed a similar behavior in relation to the mature green fruits, however, due to the linear regression significance, it may be inferred that concentrations above 900 nL L-1 promote the maintenance of greater firmness (Sohail *et al*., 2015).

7. CONCLUSION

The postharvest loss of peach fruits under room temperature storage condition is high due to its fast respiratory and ripening processes. These losses can be physiological as well as mechanical. Therefore Postharvest loss prevention strategies have been presumed to extend the shelf life and quality of peaches. Storage at low temperature is important to slow microbial activity and the physiological processes, in order to maintain fruit quality and extending its shelf life. Controlled or modified atmospheres (MA) can be used as supplementary to fruit cold storage to limit water loss, delay ripening and suppress diseases intern which can interplay with gas concentration. Now a day’s chemical treatment of peach fruits can prolong storage life of peaches by maintaining its quality. Exogenously applied calcium stabilizes the plant cell wall and protects it from cell wall degrading enzymes. Also 1-MCP can inhibit the ethylene action by blocking the continuously forming receptor sites on the plant cell and would not allow ethylene to bind on to receptor site.

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