



IMPACT OF *ALOE VERAGEL* AND CALCIUM CHLORIDE COATING ON THE QUALITY ENHANCEMENT DURING POST-HARVEST LIFE OF FRUITS AND VEGETABLES

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ABSTRACT

Fruits and vegetables being the most important daily diet continue to respire and face numerous issues after harvest that shorten their post-harvest life, reduce post-harvest quality and market value. Amongst them softening of the fruits and deterioration are the major hazard that ends up with loss in the physiological weight, damage of fruit appearance and negative change in organoleptic properties like color, texture and flavor that are generally termed as post-harvest losses. To overcome the post-harvest losses, fruits and vegetables are coated by protective coating material to prolonging its shelf life and enhance fruits quality. *Aloe veragel* and calcium salts (CaCl_2) are the best edible post-harvest coating material that has the ability to retain all the post-harvest quality parameters of fruits and vegetables during storage. In this review results of the recent research articles on the use of *Aloe veragel* and calcium chloride (CaCl_2) salts were organized and discussed. This review will provide a reference for further research studies on the edible coating materials for keeping the post-harvest quality of fruits and vegetables along with the extension in shelf life.

Keywords: Fruits and vegetables, post-harvest quality, edible coating material, *Aloe veragel*, calcium chloride (CaCl_2).

1. INTRODUCTION

Fruits and vegetables are the much more important part of the daily food intake for humans. Due to the challenges and hazards after harvest, fruits and vegetables begins to respire which undergoes some serious problems like loss in the physiological weight, increase in deterioration and negative impact over organoleptic properties like color, texture and flavor. These changes also termed as post-harvest losses in the post-harvest life of fruits and vegetables not only decrease the market value as well as nutritive value but also become a very serious issue during storage. Softening is one factor which eventually reduces its shelf-life because of climacteric characteristic and higher metabolic process (Jilani *et al.*, 2010). Storage life of fresh fruits and post-cut quality it's totally dependent on cultivar, ripeness stage at harvest, processing technologies and storage environment (Toivonen and Deel, 2002). In order to minimize these problems food commodities are coated by protective coating for prolonging its shelf life.

Coating of fruits and vegetables is one of the major control treatments of food industry for reducing the post-harvest losses in various fruits and vegetables. There are various methods and coating materials used for the extension of shelf life and keeping the post-harvest quality of fruits and vegetables. Many researchers used a variety of chemicals as a post-harvest

coating material for fruits and vegetables, however, due to the hazardous nature of inorganic chemicals on human health, a novel method has been introduced in food industry legally known as bio preservation. In the process of bio preservation, instead of inorganic chemicals, the use of some organic matters such plant extracts is used named as edible coating material having no hazardous nature. These coatings retain the post-harvest quality of fruits and vegetables and protect it from softening and decay (Jalal and Ahmad. 2019). Amongst the edible post-harvest coating materials, *Aloe veragel* and calcium salts (CaCl_2) is considered to be the best alternative to chemical storage of fruits and vegetables and has the ability to retain all the post-harvest quality parameters of fruits and vegetables during storage by reducing the rate of respiration, ethylene production and providing protection against fungus and microorganism causing deterioration (Pereira *et al.*, 2009; Dang *et al.*, 2008; Martinez *et al.*, 2006; Bicoet *et al.*, 2009; Miser *et al.* 2014).

Keeping in mind the importance of *Aloe veragel* and calcium salts (CaCl_2) as the best post-harvest edible coating material for keeping the quality and extension of shelf life during storage of fruits and vegetables, various researches on the use of *Aloe veragel* and calcium salts (CaCl_2) on different fruits and vegetables are gathered and discussed briefly to evaluate the importance of these edible coating materials in post-harvest storage of fruits, organize all the researches on these coating materials on one page and provide a reference for further research studies.

2. MATERIALS AND METHODS

2.1. Selection of recent research articles

Recent research article focusing on the post-harvest storage and quality enhancement of fruits and vegetables were downloaded from the scientific data basis of Google scholar and Science direct. Among them, the research articles that only focused on influence of *Aloe veragel* and calcium chloride (CaCl_2) on storage and post-harvest quality of fruits and vegetables were selected for this review and their results were studied thoroughly.

2.2. Results procurement

Results of the recent research articles in which the use of *Aloe veragel* and calcium chloride (CaCl_2) were studied on the enhancement of post-harvest life of various fruits and vegetables were obtained. Two different tables were formulated indicating the use of *Aloe veragel* and calcium chloride (CaCl_2) alone or with combination of other chemicals or each other, on various fruits and vegetables respectively, and their gained results were briefly discussed in the discussion section of this review.

3. RESULTS

3.1. *Aloe veragel* and Calcium chloride coating on post-harvest life of fruits












Results of the research articles which focused on the post-harvest life of fruits and its quality enhancement during storage studied well. A list of the fruits treated with either *Aloe veragel* or calcium chloride slats (CaCl_2) alone or in combination were formed and their common names, technical names, coating material, visual image and reference of the paper of presented in Table 1 while the results of the given references are discussed briefly in the discussion section.

3.2. *Aloe veragel* and Calcium chloride coating on post-harvest life of vegetables

Results of the research articles focused on the post-harvest quality and storage using either *Aloe veragel* or calcium chloride slats (CaCl_2) were studied and a list of the vegetables were formed and is given in table 2. The results of list given in the table 2 (common names,

technical names, coating material, visual image and reference) is discussed briefly in the discussion section of this review.

Table 1. List of the fruits treated with *Aloe veragel* or calcium chloride slats (CaCl_2) during post-harvest storage.

Fruit Name	Technical Name	Coating Material	Visual Image	Reference
Orange	<i>Citrus sinensis</i>	<i>Aloe veragel</i>		Radiet <i>al.</i> (2017)
Papaya	<i>Carica papaya</i>	<i>Aloe veragel</i> + CaCl_2		Kuwaret <i>al.</i> (2015)
Guava	<i>Psidium guajava</i>	<i>Aloe veragel</i>		Nasutionet <i>al.</i> (2015)
Table Grapes	<i>Vitis vinifera</i>	<i>Aloe veragel</i>		Shahkoomahallyet <i>al.</i> (2014)
Mango	<i>Mangifera indica</i>	<i>Aloe veragel</i>		Ochikiet <i>al.</i> (2014)
Green Grape Berries	<i>Vitis vinifera</i>	<i>Aloe veragel</i>		Chauhan <i>et al.</i> (2014)
Pomegranate	<i>Punica granatum</i>	<i>Aloe veragel</i>		Romeraoet <i>al.</i> (2013)
Fig	<i>Ficus carica</i>	<i>Aloe veragel</i>		Marpudiet <i>al.</i> (2013)
Plums and Peaches	<i>Prunus</i> subg. <i>Prunus</i> and <i>Prunus persica</i>	<i>Aloe veragel</i>		Guillen <i>et al.</i> (2013)
Kiwifruit	<i>Actinidia deliciosa</i>	<i>Aloe veragel</i>		Benitez <i>et al.</i> (2013)
Sweet Cheery	<i>Prunus avium</i>	<i>Aloe veragel</i>		Asghariet <i>al.</i> (2013)















Valencia Orange	<i>Citrus sinensis</i>	<i>Aloe veragel</i>		Aroworaet <i>al.</i> (2013)
Granny Smith and Red Chief Apples	<i>Pyrusmalus</i>	<i>Aloe veragel</i>		Ergun and Satici (2012)
Apple	<i>Pyrusmalus</i>	CaCl ₂		Liu <i>et et al.</i> (2016)
Plum	<i>Prunus</i> <i>Prunus</i>	CaCl ₂		Kirmaniet <i>al.</i> (2013)
Fig	<i>Ficuscarica</i>	CaCl ₂		Irfanet <i>al.</i> (2013)
Mango	<i>Mangiferaindica</i>	CaCl ₂		Dhillonet <i>al.</i> (2013)
Pomegranate	<i>Punicagranatum</i>	CaCl ₂		Nazmyet <i>al.</i> (2012)
Pomegranate	<i>Punicagranatum</i>	CaCl ₂		Abd-elghanyet <i>al.</i> (2012)
Loquat	<i>Eriobotrya japonica</i>	CaCl ₂		Akhtar <i>et al.</i> (2010)
Peach	<i>Prunuspersica</i>	CaCl ₂		Lysiaket <i>al.</i> (2008)

Table 2. List of the vegetables treated with *Aloe veragel* or calcium chloride slats (CaCl_2) during post-harvest storage.

Vegetable Name	Technical Name	Coating Material	Visual Image	Reference
Bell Pepper	<i>Capsicum annuum</i> Group	<i>Aloe veragel</i>		Ullahet <i>al.</i> (2017)
Tomato	<i>Lycopersicon Esculentum</i>	<i>Aloe veragel</i>		Chrysargyriset <i>al.</i> (2016)
Cucumber	<i>Cucumissativus</i>	<i>Aloe veragel</i>		Adetunjiet <i>al.</i> (2014)
Tomato	<i>Lycopersicon Esculentum</i>	CaCl_2		Arthur <i>et al.</i> , (2015)

4. DISCUSSION

4.1. Coating on Fruits

Results of the references given in Table 1 focusing on the use of *Aloe veragel* and calcium chloride slats (CaCl_2) for the post-harvest quality of fruits are discussed here.

- * Radiet *al.* (2017) applied gelatin coating in combination with *Aloe veragel* (50, 100 %) along with black and green tea extracts (5, 10 %) on fresh cut oranges to improve its quality and extend its post-harvest life. They stored treated fresh cut oranges at temperature of 4°C for 17 days. It was observed that coated samples especially with 100% *Aloe veragel* preserved physicochemical and sensory attributes. By the application of *Aloevera* gel, gelatin and also tea extracts reduces weight loss, microbial attack and hence improved the post-harvest shelf life of fresh cut oranges during storage.
- * Kuwaret *al.* (2015) applied *Aloe veragel* and 10% honey individually and also in combination with chemical dipping containing 2% CaCl_2 and 1% ascorbic acid on fresh-cut papaya and stored for 12 days at 4°C in order to study its quality extension. On the basis of quality parameters studied it was concluded that 10% honey and *Aloe veragel* coating along with chemical application retain the freshness of fresh-cut papaya. Loss of weight percentage, Total soluble solids, and pH were reduced and also browning was delayed by the application of coating. Moreover, ascorbic acid and percent acidity were preserved. Thus, *Aloe veracoating* with 10% honey might be used as a safe and natural polysaccharide based edible coating to retain and prolong shelf life of fresh-cut papaya.
- * Nasutionet *al.* (2015) studied the effect of *Aloe veragel* with additives by preserving the guava fresh cuts at 5 °C temperature with 80% R.H. 2 fruits of guava fresh cuts were chosen, one coated by gel of *Aloe verawhereas* other represented as uncoated, 1.5% ascorbic acid, 0.2% potassium sorbate and 2% Calcium Chloride were used as a additives These additives has the quality to proceed the shelf life of the treated samples providing the maximum effects of inhibition. *Aloe-vera* combined withcalcium chloride coated guava presented the leastweight loss.Minimum lightness

in color was observed in treated fruits as related to untreated fruits. Fresh cuts were studied for sensory attributes. *Aloe vera* + Ascorbic Acid + Potassium Sorbate coated Guava have the maximum Ascorbic Acid content was the most acceptable sample. Coated guava fresh cuts with gel of *Aloe vera* and additives have longer shelf life and retain the quality of fresh cuts for longer time.

- * Shahkoomahally *et al.* (2014) applied *Aloe vera* gel on table grapes in order to study its impact on fruit. *Aloe vera* coating was used with 2% CaCl₂ and 1% citric acid on table grapes at 4°C and 85± 5% relative humidity for about 60 days and stored in refrigerator. According to their results loss of weight and Total Soluble Solids of table grapes were diminished by the usage of *Aloe vera* gel coating. Whereas Vitamin C and percent acidity were preserved. By gel of *aloe vera* coating browning and dehydration was delayed.
- * Ochikiet *et al.* (2014) did research after examining the perishable nature and post-harvest losses of mango. They used gel of *Aloe vera* (0, 25, 50 and 75) % on mango fruit along with (1%) chitosan with a storage life of twenty days at 13°C. The outcomes indicated that at 50 and 75 percent of gel of *Aloe vera* prolong the shelf life of mangoes by decreasing weight loss percentage. Total soluble solids, pH and fruits firmness were also retained by coating. Therefore results suggested that with 50 percent gel of *Aloe vera* minimized the post-harvest losses and also retained the mango fruit quality.
- * Chauhan *et al.* (2014) applied gel of *Aloe vera* coating on berries to study the effect on storage life of grape berries after harvesting. Green grape berries coated with gel of *Aloe vera* with 0, 1, 5, and 10 percent w/v and stored in an air free jar for 40 days at a temperature of 15°C. It was observed that by coating with 5 and 10 percent *Aloe vera* levels the berries revealed lesser weight loss, cracking, browning, fungal decay and injury. Total Soluble Solids and titratable acidity was increased. It was also examined that gel of *Aloe vera* is edible, biologically safe, vigorous and very healthy coating in retaining the fruits quality.
- * Romerao *et al.* (2013) precluded that by coating pomegranate fruits with *Aloe vera* either individual or combined (0.5% or 1%) ascorbic acid and citric acid results in extending the shelf life when stored for 12 days at a temperature of 3°C. All the quality attributes such as firmness of fruit, phenol compounds, and anthocyanin content were maintained during storage interval. Moreover, no off flavor was perceived during organoleptic analysis and maximum score of sensory acceptance were observed because of gel of *Aloe vera* coating.
- * Marpudiet *et al.* (2013) studied the application of gel of *Aloe vera* as economic and environmental friendly in light of controlling losses after harvest such as quality characteristics and prolonging shelf life of fig. Two fruits sets were chosen, one coated with gel of *Aloe vera* while other left as control and stored ambient temperature (29±30°C). Every second day data were collected and conclusion drawn was that weight losses showed diminishing trend in those coated with *Aloe vera* gel with minute changes detected in physiochemical characteristics like pH, titratable acidity, TSS. It also reduced the decay, shriveling and browning of fruits.
- * Guillen *et al.* (2013) coated plums and peaches with *Aloe vera* gel and *Aloe arborescens* gel and kept it at 20°C for 6 days. Ethylene production and quality parameters like color, reduction of acidity and enhancement in ripening index (total soluble solids/total acidity ratio) all delayed. Effects of *Aloe arborescens* were more promising than *Aloe vera* gel in decreasing weight loss.
- * Benitez *et al.* (2013) applied *Aloe vera* gel on fresh kiwifruit in 4 distinct proportions (0, 1, 5, 15) % (v/v) keeping the freshness of sliced kiwifruits. After *Aloe vera* gel

application slices were packaged and stored under the temperature of $4\pm 1^{\circ}\text{C}$. Quality attributes such as color and texture, total soluble solids, titratable acidity, microbial load were assessed during storage. With the application of *Aloe vera* Gel, the degree of respiration and spoilage caused by microbial activities were greatly reduced in slices of kiwi fruit. They perceived that 1 logarithmic unit mesophilic load for 15% and 5% treated slices was reduced after 7 days of storage. It was also concluded that during storage the texture of untreated samples were declined more rapidly than the treated slices. Also due to microbial load the superiority of uncoated trials were reduced after six days of storing. Their outcomes showed that *Aloe vera* gel application enhanced the quality of stored kiwifruit slices and also 5% coating indicate healthy alternative coating for fresh sliced kiwifruit.

- * Asghari *et al.* (2013) dipped sweet cheery (cv. Napoleon) in Nitric Oxide 0, 1, 5 and 10 $\mu\text{mol/L}$ with 25 and 33 percent concentration of gel of *Aloe vera* to observe its impact at storage duration for 30 days at $1\pm 0.5^{\circ}\text{C}$. It was indicated that with this action of treatment the market value of fruit, phenolic contents, Vitamin C, catalase enzyme activity, percent decay and weight loss was better retained and the post-harvest life was enhanced by coating.
- * Arowora *et al.* (2013) reported that he stored orange fruits (Var. Valencia) for two months in refrigerator of which partial treated with gel of *Aloe vera* and other left as untreated. It was indicated that fruits with *Aloe* gel on them had better effects on shelf life in comparison to non-treated control positive effect was found when *Aloe vera* gel were applied which in turn conserved percentage of weight loss, Vitamin C and titratable acidity was declined during storage interval. Whereas direct rise in sugar acid ratio, pH and Total Soluble Solid of orange were seen and retained because of *Aloe vera* coating.
- * Ergun and Satici (2012) supervised an experiment to control post-harvest degradation of quality in fruits by applying *Aloe vera* gel as bio preservative and designated two dissimilar varieties of apple i.e. “Granny Smith” (having green color) and “Red Chief” (red in color). Whereas, coated these with 0, 1, 5 and 10% w/v gel of *Aloe vera* and stored at 2°C for 6 months. Soluble content and percent titratable acidity were concluded higher for “Granny Smith” apples conserved with 5% and 10% of *Aloe vera* gel in every part of storage loss of weight, just as green color was retained in “Granny Smith” apples whereas “Red Chief” apples indicated no variations. “Granny Smith” pH value increased contrast to “Red Chief” apples.
- * Liu *et al.* (2016) examined that the utilization of fresh apple slices tend to understanding different enzymatic browning that discourage the citizen to taste. Three treatments were used Chitosan, ascorbic acid and Calcium chloride coating applied on fresh apple slice in this work to observe their preservation effects. Calcium chloride has better preservation effect than chitosan and ascorbic acid coating when they were applied on fresh apple slice. Chitosan and calcium chloride coating showed less weight loss and high ascorbic acid content of apple slices than chitosan and ascorbic acid coating. Chitosan and Calcium chloride coating also better at anti browning in apple slices.
- * Sohail *et al.* (2015) performed a study on storability of peach fruit by calcium treatment and used various levels (1, 2 and 3%) of calcium chloride for five minutes and stored in soft board cartons. A decrease in firmness and Vitamin C content was spotted and rise in percent weight loss, TSS and percent decay was observed. Significant impact of storage intervals and calcium applicability has been observed on quality of peach while indicating that by 1 and 2 percent calcium application give slight retention as compared to 3 percent calcium chloride.

- * Kirmaniet *al.* (2013) conducted the effect of calcium chloride and the function gibberellic acid on the quality of plum after post-harvest. Results concluded that fruit size, weight and firmness were retained by treatment of CaCl₂ throughout storage interval. Moreover, storage stability of treated fruits were deeply enhanced with CaCl₂ in combination with gibberellic acid.
- * Irfanet *al.* (2013) determined the influence of calcium on quality extension of fig fruit. The study indicated that ascorbic acid and fruit color were affected positively. CaCl₂ restricted the growth of yeast, mold and mesospheric aerobic-bacteria. Moreover, the fig fruit treated with calcium chloride slow down ripening and hence extended the shelf- life.
- * Dhillonet *al.* (2013) conducted the result of calcium chloride on the storage life of mango. The fully mature mango fruit were harvested and treated with different concentration of calcium chloride (0%, 2%, 4%, 6% and 8%) and stored for about 12 days at room temperature 6% CaCl₂ treatment after harvest was effective in increasing storage life of mangoes up to 12 days at ambient conditions.
- * Nazmyet *al.* (2012) studied to find the impact of calcium treatment and film wrapped on pomegranate quality after postharvest. Three distinct concentrations were used to dip fruits in CaCl₂ that is (0, 1 or 3%) each individually or in along with film wrapped for four minutes. Non-film wrapped fruits had high respiration rates and weight loss upon its comparison with wrapped filmed fruits. While film enfolded fruit immersed with CaCl₂ (2%) had supreme firmness, peel-thickness, and vitamin C content and sensory quality. There was no statistical difference was observed between the treatments due to variations in total anthocyanin content and total soluble solids values.
- * Abd-elghanyet *al.* (2012) did an experiment by wrapping pomegranates fruits with polyolefin film along with CaCl₂ application. For this purpose fruits were dipped in three different levels of CaCl₂ (1, 2 and 3)% for 4 minutes either individually or in combination with polyolefin film and stored for two months with relative humidity of 85±5. Wrapped fruits showed significant (p<0.05) level of delay in changes of water loss, firmness, TSS and percent decay as compared to un wrapped fruits. Also 2% CaCl₂ along with wrapped film preserved physiochemical and sensory attributes.
- * Akhtar *et al.* (2010) picked loquat fruit to execute its analysis and choose contrasting concentrations of CaCl₂ that is (1, 2 and 3%) to dip fruit for 2 min while safekeeping them in board boxes at 4°C in cold storage environment for four to five weeks. After the prescribed timing, it was indicated that reduction in browning index, weight loss detected when immersed with 2% and 3% concentrate of CaCl₂ and also retained TSS, firmness and Vitamin C content for four to five weeks.
- * Lysiaket *al.* (2008) evaluated peach fruit by immersing in 2% CaCl₂ solution for 30 minutes at 20°C temperature to retain its storage stability with storage duration of two weeks at 4°C in packed and un-packed polyethylene bags. Storage stability was deeply enhanced with CaCl₂ and polyethylene bags, moreover enhancement in firmness, decline in Total soluble solid/ Titratable acidity ratio and Total Soluble Solids were retained by the application of calcium chloride.

4.2. Coating on Vegetables

Results of the references given in Table 2 focusing on the use of *Aloe veragel* and calcium chloride slats (CaCl₂) for the post-harvest quality of vegetables are discussed here.

- * Ullahet *al.* (2017) did an experiment after examining the perishability and post-harvest losses of bell pepper fruits. Different coating material were applied on bell pepper by immersing in gum arabic at a level of (6, 9 and 12%) with a combination of

Aloe veragel (4, 5, 6 %) and cinnamon oil (0.5, 0.75, 1 %) and stored at 8°C for 24 days with relative humidity. The obtained results indicated that 12% gum arabic along with 6% *Aloe veragel* enhanced the storage quality and physico chemical attributes by reducing weight loss percent, and disease incidence in coated fruits as compared to uncoated. Through this treatment pH, total soluble solids, ascorbic acids, titratable acidity, firmness and color were also retained during storage.

- * Chrysargyris *et al.* (2016) applied different level of aloe gel (0%,5%,10%,15% and 20%) on tomato fruits and kept at 11°C with 90% R.H for 14 days in order to determine the post-harvest quality of fruit. It was concluded that with the usage of 10 and 15% Aloe gel production of ethylene, TSS and Percent acidity was minimized in fruits coated with 10% *Aloe veragel* in storage duration, whereas there was rise in Vitamin C content thus preserving the quality of the tomato. In 20% Aloe treated fruits Lycopene and β Carotene were decreased whereas total phenolic compound and antioxidant activity were rised during storage. Decay index, softness, loss of weight, respiration rate and fruit color were kept same among treatments. Hence 10% *Aloe veracoated* treatment helped to extend the storage life of tomato and keep the quality during storage.
- * Adetunjiet *al.* (2014) coated cucumber with gel of *Aloe vera* along with chitosan and stored at 25°C for seven weeks to prolong its post-harvest life and improve its quality. The postharvest quality characteristics i.e. total soluble solids, fruit firmness, Vitamin C content, titratable acidity and loss of weight were retained with gel of *Aloe veracoating* as compared to the control.
- * Arthur *et al.* (2015) determined the effect of different CaCl₂ concentration on the post-harvest quality of tomato fruits in different dipping time period. Tomatoes are immersed in 3 distinct level of CaCl₂(0%, 2% and 6%) for different dipping time (10, 20, and 30 min). 6% calcium chloride for 30 minutes gave the best result in maintaining the Vitamin C, titratable acidity, weight and firmness. The fruits treated with calcium chloride showed significant (P<0.05) level of delay in the changes of water loss, firmness, titratable acidity, TSS, Vitamin C and decay.

CONCLUSION

It is concluded from the results of the studied research articles in this review that both *Aloe veragel* and calcium chloride slats (CaCl₂) are for the proven and promising post-harvest reagents that enhances the post-harvest quality of fruits and vegetables during storage.

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