International Journal of Food Engineering and Technology
2022; 6(1): 21-27
http://www.sciencepublishinggroup.com/j/ijfet
doi: 10.11648/j.ijfet.20220601.14
ISSN: 2640-1576 (Print); ISSN: 2640-1584 (Online)

Enhancement of Quality and Storability of Avocado (*Persea americana*) Fruit Using a Blend of Aloe Vera Gel and Corn Starch as Surface Coating

Helen Berihu[1, *], Adamu Zegeye[2]

[1]Department of Food Engineering, School of Engineering, Debre Birhan University, Debre Birhan, Ethiopia

[2]Department of Food Engineering, Addis Ababa Institute of Technology, Addis Ababa University, Addis Ababa, Ethiopia

Email address:
helenberihubabye@gmail.com (H. Berihu)

[*]Corresponding author

To cite this article:
Helen Berihu, Adamu Zegeye. Enhancement of Quality and Storability of Avocado (Persea americana) Fruit Using a Blend of Aloe Vera Gel and Corn Starch as Surface Coating. *International Journal of Food Engineering and Technology*. Vol. 6, No. 1, 2022, pp. 21-27.
doi: 10.11648/j.ijfet.20220601.14

Received: February 13, 2022; **Accepted**: May 5, 2022; **Published**: May 12, 2022

Abstract: Avocado has fairly short shelf life so as included in climacteric fruits. The search for biodegradable, safe, healthy and environmental friendly treatments for increasing storage period of fruits has led to use of edible coatings. The study was conducted to check the efficacy of aloe Vera gel, corn starch and composite of the two as an edible coating. The treatment combinations were T0 = control, T1 = corn starch (2.5%) and T2 = Aloe Vera gel (1%) T3=aloe Vera and corn starch (2.5%, 2.5%). Weight loss; pH; colour; firmness and TSS were recorded at the interval of 5 days for 30 days. Aloe Vera coating was very effective in reducing ascorbic acid loss and decay (%). The control fruits started deteriorated before 8 days, whereas, shelf life extended to 26 days for majority of aloe Vera gel alone and with corn starch coated fruits. Finally, T0 showed 21.02% loss in weight, whereas coated avocado fruits as T1 showed 16.89%, T2 and T3 were 9.56% and 9.48% by weight loss, respectively. Both the corn starch and aloe Vera gel edible coating was found good enough to ensure hardness/firmness of the fruits. Consequently it can be concluded that both coating films are a good barriers.

Keywords: Aloe Vera, Avocado, Corn Starch, Edible Coating, Storability, Quality

1. Introduction

Avocado or butter fruit is a tropical ever green climacteric fruit scientifically known as *Perseamericana*, which belongs to the family Lauraceae.

The fruit makes up 65% of the pulp, the seed is 20% and the skin is 15% [1]. Avocados have a high fat content; in between 71 to 88% about 20 times the average for other fruits. From the point of nutritional composition avocado is a fruit with a high nutritive value and an unusual composition. It contains monounsaturated fatty acids, dietary fiber, essential nutrients and phytochemicals [2]. Avocado is one of the most perishable commodities available in the market. It is highly perishable as it contains 65–80% water by weight. It has a very high rate of postharvest respiration, limited shelf life and has special unique characteristics of ripening. If it is left without cuticle, the water quickly begins to evaporate, resulting in poor product shelf life [3].

The external factors include atmospheric composition such as O_2, CO_2, ethylene ratios, water respiration or weight loss, temperature and the stress factors while the internal factors include the species, harvesting time and harvesting technology and its growth stage. The important quality factors of fresh produce contributing to the marketability are texture, colour, appearance, flavour, nutritional value and microbial safety. Edible coatings are thin layers of edible material applied to the product surface in addition to or as a replacement for natural protective waxy coatings and provide a barrier to moisture, oxygen and solute movement for the food [4]. Corn Starch as an edible coating exhibits several advantages, such as its ready availability, low cost and good filmogenic capacity, forming colourless and tasteless films with high oxygen barrier properties and mechanical resistance [5]. Aloe Vera gel has been proven one of the best edible and biologically safe

preservative coatings for different types of foods because of its film-forming properties, antimicrobial actions, and bio-degradability and biochemical properties. This study has focused on surface coating to preserve avocado in postharvest conditions. The different concentration used to determine or improve surface properties of coating materials when applied on fruits, which greatly affect physiological properties and quality of the fruit, have been analysed.

2. Material and Method

Fresh and well matured avocado fruit variety of Hass were collected from Shewarobite farm, Amhara region based on their shape, size, maturity stage in which the uniformity is useful in random selection of the sample. Maximum care was taken to handle the fruit during transportation to reduce weight loss and mechanical injuries. Other raw materials used for coating were corn starch and Aloe Vera. The Aloe Vera gel was collected from Tuludimtu Mountain, Addis Abeba. And corn was collected from Awash Melikasa Research Center, Adam. Collected raw materials were transported to Addis Ababa University, AAiT Food Engineering Laboratory.

Sample was selected based on size, shape and maturity stage. Fruit selected was rated as first grade since coating cannot be successful if there is damage on the surface of the fruit. Fruits selected for the experiment were washed with tap water, and rinsed with distilled water and left it to dry at ambient air condition. Matured leaves of Aloe Vera plant were harvested and washed with a mild (25%) chlorine solution. And Corn was sorted and washed with tap water and rinsed with distilled water.

The equipment used were plastic and carton Bags; commercial juice blender, graduated cylinder, conical flask, digital balance; beakers; oven and furnace; aseptic hood, CIE scale; penetrometer, pH meter; Refracto-meter, spoons, thermometer, magnetic stirrer, aluminium foil and polyethylene bag, Thimbles, grinder: chemicals glycerol, citric acid, sodium hydroxide, silica gel, anhydrous calcium chloride, petroleum ether, potassium sulphate, sulphuric acid and other laboratory grade chemicals and distilled water.

2.1. Processing Method of Coating Material

2.1.1. Preparation of Coating Material from Aloe Vera

Aloe Vera gel preparation was undertaken according to [6]; who advised that Aloe Vera leaves must be processed within 2 hour of harvesting to prevent oxidation of the gel due to exposure to air. Whole leaves were washed with water and the base and tips of the leaves along with its spikes were removed. Next, the skin was carefully separated from parenchyma to obtain Aloe Vera flesh. After separating aloe Vera gel from the outer cortex, the colourless gel like substance which is hydro parenchyma was blended with juice maker. This mixture was filtered to remove unwanted fibers. Then it was pasteurized at a temperature of 70°C for 45 minutes and cooled to ambient temperature. Then Citric acid (4.6g/l) was added to this gel to maintain the pH. The viscosity of the stabilized Aloe Vera gel obtained was improved by using 1% of a commercial gelling agent (glycerol) to improve coating efficiency. Then a solution was prepared in different concentrations 1% and 2.5% by dissolving the aloe Vera gel with distilled water [7].

2.1.2. Preparation of Coating Material from Corn Starch

Corn seed was soaked in 50°C for two hours; to make removal of zein easier. Then it was dried for three days. And the corn seed was milled and corn starch was obtained then it was ready for the next process. According to [8] Corn starch coating solution was prepared by dissolving 1% and 2.5% (w/v) starch in distilled water with agitation for 10 min at 90°C respectively. The pH value was adjusted to 5.6 with 50% (w/v) citric acid (Merck) solution and the solutions were equilibrated for 10 min. Glycerol (Merck) 87% was added as a plasticizer at a concentration of 2mL litter-1 solution.

2.1.3. Preparation of Coating Material from Aloe Vera and Corn Starch

Edible coatings may be composed of polysaccharides, proteins, lipids, and composites [9, 10]. In order to get best result different concentration of mixing ratio was used. Optimization procedures were applied to determine the optimum level of the coating film. The optimization procedures were carried out using Design Expert Software (RSM method). The combination ratio can be summarized in the following table.

Table 1. *Combination ratio of coating film.*

Corn starch	Aloe vera		
	0%	1%	2.5%
0%	T_0	T_1	T_2
1%	T_3	T_4	T_5
2.5%	T_6	T_7	T_8

Where T_0=control, T_1=1% aloe Vera, T_2=2.5% aloe Vera, T_3= 1% corn starch, T_4=1% corn starch and 1% aloe Vera, T_5=1% corn starch and 2.5% aloe Vera, T_6=2.5% corn starch T7=2.5% corn starch and 1% aloe Vera and T_8= 2.5% corn starch and 2.5% aloe Vera.

2.2. Method of Avocado Coating Process

After finding well dispersed solutions of coating material from corn starch and aloe Vera, avocado was dipped into each and mixed solution for 5 minutes then put it into a tray at ambient temperature to dry before storage. Then coated avocado was stored in cartoon bag at temperature of 25°C.

2.3. Method of Physiological Analysis

2.3.1. Physiological Weight Loss (%)

This was done as per the standard method of AOAC. Fruits were weighed from both the coated and uncoated groups every 5 days; in order to determine water loss/weight loss of avocado during storage. Water loss was calculated by the following equation:

$$PLW(\%) = \frac{(\mathrm{Wi}-\mathrm{Wf})}{(\mathrm{Wi})} * 100\%$$

Where, PLW psychological weight loss.
W_i is the initial weight of fruits (0 days),
W_f is the final weight of fruits.

2.3.2. Fruit Firmness

Firmness was determined by the required pressure to penetrate the avocado fruit through the peel using penetrometer. The force required for the plunger to press into the fruit was recorded directly from the equipment reading and expressed in kg force.

2.3.3. Fruit Color

Peel colour was measured using a minolte Chroma meter, model CR-300b (Minolta inc., canda). colour measurement were noted using L*, a*and b* scale. L* coordinate is a measurement for clarity (white-black and varies from 0-100). the a* scale varies from negative values for blue to positive value yellow [11]. Before each set of measurements, the Chroma meter was calibrated using the manufacturer standard calibration plate with Y, x and z. y values set at 94.57, 0.31 and 0.32 respectively.

Triplicate measurements were taken of four different positions on each avocado.

2.3.4. Determination of Total Soluble Solid

TSS content of avocado fruit pulp was determined using digital Refractometer, model RFM 960. The percentage of TSS was obtained from direct reading of the instrument which is measured by °Brix.

2.3.5. Determination of pH and Titrable Acidity

The fruits was crushed and made into pulp juice, and used to measure the pH using calibrated digital pH meter. TA will be determined by titration. From the juice 5 ml will be taken and 10 ml of water was added to make the fruit colour light to facilitate clear end point detection. To determine the total TA of the pulp, fresh 0.1 N NaOH was used.

2.4. Statistical Analysis

A Completely Randomized Design (CRD) was used, with 10 avocado fruit replication from each concentration. The data analysis was performed using general factorial design method.

3. Result and Discussion

3.1. Colour

Colour retention of coated avocados was due to delay in ripening of coated avocado. Aloe Vera gel coating material retarded the ethylene production rate, therefore, delaying ripening, chlorophyll degradation, anthocyanin accumulation and carotenoid synthesis thus ultimately delaying colour change of avocado [12]. The use of corn starch has also carried out active compounds such as antimicrobials; on the other hand it has also modify the internal gas composition by creating a modified atmosphere through the regulation of the gas exchange (oxygen, carbon dioxide, volatiles) which has kept the physical change pattern of the avocado. Carrillo et al. [12] Observed that papaya coated with cassava starch and carboxy methyl starch helped to maintain the colour during storage. Generally, the purplish increased with storage time due to ripening of fruits. The composite of the aloe Vera gel and corn starch gives the best result in the colour retention of the fruit which may be due to the composition of the two coating materials.

Table 2. *Effect of coating material on peel colour of avocado fruit.*

Treatment	Color					
	Day 0	**Day 5**	**Day 10**	**Day 15**	**Day 20**	**Day 25**
T_0	L*27.92±0.01^{b}	L*22.72±0.02^{c}	L*20.54±0.02^{a}	L*19.54±0.02^{b}	L*17.83±0.01^{b}	L*15.04±0.02^{d}
	a*2.01±0.01^{c}	a*3.21±0.01^{a}	a*3.94±0.02^{a}	a*4.84±0.05^{a}	a*3.56±0.02^{a}	a*2.23±0.03^{a}
	b*0.78±0.04^{a}	b* 2.44±0.01^{b}	b*5.62±0.09^{a}	b*8.92±002^{a}	b*6.04±0.05^{a}	b*0.35±0.02^{c}
T_1	L*26.04±0.05^{a}	L*24.84±0.06^{d}	L*24.54±0.02^{d}	L*23.5±0.02^{d}	L*22.83±0.01^{e}	L*22.00±0.03^{d}
	a*3.16±0.05^{c}	a*2.95±0.09^{b}	a*2.49±0.06^{d}	a*1.61±0.01^{d}	a*1.64±0.01^{d}	a*1.66±0.03^{b}
	b*1.37±0.09^{c}	b*1.22±0.01^{c}	b*1.1±0.07^{c}	b*1.05±0.05^{c}	b*1.17±0.21^{c}	b*1.12±0.11^{b}
T_2	L*27.94±0.02^{a}	L*27.57±0.02^{a}	L*25.34±0.04^{b}	24.51±0.13^{c}	L*24.06±0.09^{b}	L*23.92±0.02^{b}
	a*3.75±0.07^{b}	a*3.05±0.07^{ab}	a*1.72±0.04^{e}	a*0.59±0.01^{f}	a*0.52±0.02^{f}	a*0.52±0.09^{d}
	b*2.50±0.07^{b}	b*4.13±0.02^{a}	b*1.23±0.05^{c}	b*0.23±0.04^{d}	b*0.015±0.06^{d}	b*0.16±0.01^{d}
T_3	L*27.34±0.02^{a}	L*27.07±0.09^{b}	L*24.81±0.06^{c}	L*23.53±0.11^{d}	L*23.28±0.04^{d}	L*20.23±0.06^{c}
	a*2.54±0.02^{b}	a*2.01±0.01^{c}	a*1.24±0.04^{f}	a*0.88±0.04^{e}	a*1.15±0.06^{e}	a*0.36±0.04^{d}
	b*0.50±0.07^{b}	b*0.22±0.01^{d}	b*0.33±0.04^{d}	b*0.38±0.04^{d}	b*0.05±0.03^{d}	b*0.13±0.02^{cd}

*Note: All values are a mean ± standard deviation with two duplicates

i $^{a-e}$ Values followed by different superscript letters are significantly different ($p<0.05$)

Where T_0 is control

T_1 is 2.5% corn starch

T_2 is 2.5% aloe Vera, 2.5% corn starch

T_3 is 1% aloe Vera.

Table 2 illustrates that colour change in avocado coated edible tends to be stable in colour. In contrast to avocado samples without edible undergo significant colour changes. This suggests that avocado fruit with edible coatings can retain colour of fruit surface. The higher L value, the brighter fruit colour that indicates avocado is getting mature.

Rapid colour changes in avocado without edible coating were observed due to degradation of chlorophyll pigments so that its colour changes from green to purplish. As well L^* value, showed that a value on avocado coated edible has a colour that tends to be stable when compared to the samples of avocado control (without edible).

b* value of avocado sample has a positive value (+). It indicates that sample has a yellowish degree [13]. Value of b^* on

avocado coated edible has relatively a stable value. However, avocado control sample (without edible coating) has an increase in value b*. It shows that application of edible coating on avocado has an effect on inhibition of colour of avocado surface. Whereas, b* value of control avocado increased.

3.2. Weight Loss of Avocado

Weight loss is one phenomenon that occurs in avocado fruits; Shrinkage of edible parts can be caused by fungal, bacterial as well as impact of persistence of respiration process. Associated with characteristics and phenomena that occur, weight loss of avocado fruit continues process of respiration after harvest. Application of edible coating on avocado aims at decreasing weight loss. The greater the weight loss of avocado the shorter shelf life of avocado will be. Measurement of weight loss on avocado in this study was conducted to identify the best edible coating treatment to reduce weight loss of avocado.

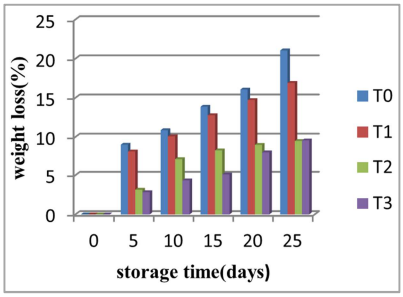

Figure 1. *Effect of coating on weight loss of avocado.*

As shown in figure 1, all samples demonstrated a gradual loss of weight during storage. Weight loss mainly occurs due to water loss by transpiration and loss of carbon dioxide reserves due to respiration.

The rate at which water lost depends on the water pressure gradient between the fruit tissue and the surrounding atmosphere.

Aloe Vera gel based edible coating composed with corn starch act as barrier, thereby restricting water transfer and protecting fruit from mechanical injuries.

Throughout storage, Coated avocado fruit have significant ($P<0.05$) effect on the weight loss than that of uncoated avocado. At the end of the 25th day, uncoated avocado stored at room temperature showed 21.02% loss, whereas the weight losses of coated avocado with 1% Aloe Vera gel was 9.56%; while avocado coated with 2.5% corn starch was 16.89% and avocado coated with the composite of 2.5% aloe Vera and 2.5% corn starch coated fruit samples shows 9.48%. This positive effect in terms of reduction of moisture loss may be due to the hygroscopic properties of Aloe gel and that allow the formation of water barrier between the fruit and the surrounding environment. Additionally, Aloe Vera gel mostly composed of polysaccharide which is highly effective as a barrier against moisture loss without incorporation of lipid. In fact, coatings containing Aloe Vera gel were reported to increase the shelf-life of different fruits, such as papaya [14], Ananas (*Comosus*) [15]. Similar reductions in weight loss have been reported in Aloe Vera coated sweet cherry and table grapes [16]. The results indicate that the moisture content was gradually decreased during the storage period. The reduction in moisture content during storage was also reported by Sharmin, M. R et al [17].

In the case of corn starch the reduction in weight loss was probably due to the effects of this coating as a semi permeable barrier against oxygen, carbon dioxide, moisture and solute movement, thereby reducing respiration, water loss and oxidation reaction rate [18]. Oluwaseun, A. C. et al [19] Observed that corn starch coated cucumber showed a significant delay in weight loss compared to uncoated one.

Consequently the best result was obtained at the composite coating material. This may be due to the optimization of internal modified atmosphere of the avocado fruit with the activity of both aloe Vera gel and corn starch.

Table 3. *Effect of coating on pH value of avocado.*

Treatment	pH					
	Day 0	Day 5	Day 10	Day 15	Day 20	Day 25
T_0	6.83±0.02^{a}	6.87±0.01^{ab}	6.90±0.01^{b}	7.03±0.01^{ab}	7.16±0.03^{a}	7.23±0.01^{ab}
T_1	6.65±0.07^{b}	6.88±0.01^{bc}	6.95±0.03^{ac}	7.05±0.02^{a}	7.11±0.01^{b}	7.15±0.01^{b}
T_2	6.78±0.02^{c}	6.85±0.01^{c}	6.88±0.01^{d}	6.94±0.01^{b}	6.99±0.02^{c}	7.03±0.01^{c}
T_3	6.80±0.05^{e}	6.88±0.01^{d}	6.94±0.01^{a}	6.96±0.01^{d}	7.04±0.01^{a}	7.14±0.01^{c}

*Note: All values are a mean ± standard deviation with two duplicates
i $^{a-e}$ Values followed by different superscript letters are significantly different ($p<0.05$)
Where T_0 is control
T_1 is 2.5% corn starch
T_2 is 2.5% aloe Vera, 2.5% corn starch
T_3 is 1% aloe Vera

3.3. Determination of pH

pH increase significantly ($p<0.05$) during storage, there was an increment of the pH values throughout the storage time (Table 3). pH value of control at the time of storage on the 25th day was 7.23, whereas 2.5% aloe Vera was 7.03. while pH value of 1% corn starch coated fruit was 7.15 and the composite 2.5% aloe Vera and 2.5% corn starch coated fruit was increased to 7.03. The increase in pH value may be due to break-up of acids with respiration during storage.

3.4. Titratable Acidity (TA) of Avocado

As Table 4 Shows the titratable acidity of the fruits gradually falls during the storage. The fall in titratable acidity is highest in case of control which is 11.89 at 0 day to 2.82 at 25th day of storage. However the reduction in acid content was lowest in case of coated fruit samples. Aloe vera gel treatment (T_3) showed minimum fall in the titratable acidity (11.12 to 6.02) followed by T_2 (11.41 to 4.60).

Table 4. *Effect of titrable acidity of avocado.*

treatment	TA					
	Day 0	Day 5	Day 10	Day 15	Day 20	Day 25
T_0	11.89±0.03^a	8.47±0.03^d	6.54±0.16^c	4.84±0.08^c	3.11±0.15^b	2.82±0.09
T_1	11.4±0.04^b	8.23±0.01^b	6.38±0.08^c	5.76±0.02^b	4.93±0.06^b	3.27±0.22
T_2	11.41±0.07^b	9.64±0.01^a	8.43±0.03^b	6.84±0.05^a	5.22±0.14^a	4.60±0.08
T_3	11.12±0.17^b	10.56±0.01^c	9.33±0.04^a	8.09±0.02^d	7.38±0.11^c	6.02±0.38

*Note: All values are a mean ± standard deviation with two duplicates
i $^{a-c}$ Values followed by different superscript letters are significantly different ($p<0.05$)
Where T_0 is control
T_1 is 2.5% corn starch
T_2 is 2.5% aloe Vera, 2.5% corn starch
T_3 is 1% aloe Vera.

A gradual decrease in titratable acidity occurred in avocado fruit throughout the storage period. The probable reason for decline in the acidity may be the utilization of organic acids in the respiration and metabolic processes of the fruit.[20], also suggested that the decrease in acidity has been attributed towards the conversion of organic acids into sugars and their further utilization in the metabolic process of the fruit. According to Pinal B. et al [21] the titratable acidity values in both coated and uncoated fruit had decreased with the passage of storage time. However, the results of the present study suggest that the acidity values in the control fruits were significantly (*P<0.05*) lower as compared to that of starch and aloe Vera gel coated fruits. The results from this study are in agreement with those of Debeaufort F. J. et al [22] who used edible coating to preserve strawberry and found that the edible coating could reduce the transpiration rate due to declining of availability of organic acids for enzymatic reaction of respiration. It is also considered that coatings reduce the rate of respiration and may therefore delay the utilization of organic acids [23].

3.5. Firmness of Avocado

Surface coatings were found to cause higher retention of tissue firmness and the positive effect was attributed to the restriction in metabolic activities associated with cell wall degrading enzymes. The aloe Vera coating with or without corn starch showed significant retention in firmness of avocado fruits as compared to the uncoated ones.

Adetunji C. O et al [15] Described the preventive effect of aloe Vera based coatings on the texture retention of tomato during marketing at room temperature and attributed it to permeability properties of the coatings. However, the texture retention profile did not vary significantly (*p>0.05*) between the composite and aloe Vera alone coatings. The fruits coated with aloe Vera alone showed more loss of firmness during storage which may be attributed to less preventive effect of aloe Vera alone on ripening of avocado fruits as compared to other coating.

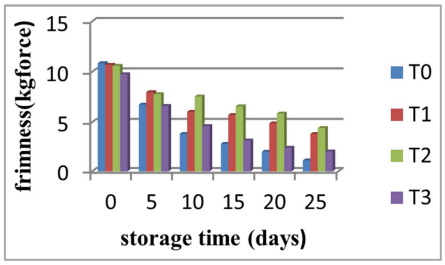

Figure 2. *Effect of coating on firmness.*

Table 5. *Effect of coating of TSS of avocado fruit.*

treatment	TSS					
	Day 0	Day 5	Day 10	Day 15	Day 20	Day 25
T_0	8.24±0.02^a	5.86±0.07^b	5.58±0.09^a	4.74±0.02^a	3.74±0.03^c	1.47±0.04^b
T_1	8.24±0.01^a	6.92±0.03^a	5.58±0.09^a	4.74±0.01^a	3.74±0.02^a	3.6±0.09^a
T_2	8.18±0.01^b	6.79±0.32^a	6.02±0.08^a	4.93±0.01^b	4.42±0.02^b	4.06±0.04^a
T_3	8.17±0.01^b	6.69±0.02^a	6.35±0.01^a	5.45±0.01^b	4.21±0.02^c	1.47±0.04^c

*Note: All values are a mean ± standard deviation with two duplicates
i $^{a-c}$ Values followed by different superscript letters are significantly different ($p<0.05$)
Where T_0 is control
T_1 is 2.5% corn starch
T_2 is 2.5% aloe Vera, 2.5 corn starch
T_3 is 1% aloe Vera.

3.6. Effect of Coating on Total Soluble Solid

As shown in Table 5 Significant ($p<0.05$) decrease in TSS content was observed in uncoated avocado than coated avocado during storage. Loss of TSS could be due to utilization of sugar in respiration and other metabolic activities. The uncoated avocado showed rapid loss in TSS which could be due to higher respiratory and metabolic activity of the fruit naturally, whereas minimum TSS was observed in uncoated avocado. In coated sample, maximum TSS was detected in T_2 (2.5% aloe Vera 2.5% aloe Vera). Coated avocado retain higher TSS due to the composite of aloe Vera and corn starch which could have provided effective gas barrier. Corn starch shows lesser decline in TSS as compared to that of the aloe Vera. Maximum TSS in aloe Vera coated compared to uncoated could be attributed to higher concentration of aloe Vera forming a thin layer on the fruit surface which retards deterioration as observed by Mani, A. et al [24].

Aloe vera gel treated fruits showed a lower increase in TSS (Total Soluble Solid), which indicated that control fruits presented a more pronounced maturation development than coated avocado during storage periods. In case of Aloe vera with corn starch coated fruits, decrease TSS content of fruits during storage periods. This is due to the value of ascorbic acid content for coated avocado fruits were found to be higher than that of uncoated fruits. Similarly, Brishtia, F. H. et al [25] found that ascorbic acid content was higher in Aloe coated papaya fruits than the control fruits during the storage period at temperatures 25°C-29°C and 82-84% RH. Corn starch coated mango retarded TSS development because aloe gel decreases the respiration and eventually metabolism of sugars.

4. Conclusion and Recommendation

4.1. Conclusion

This study was conducted to improve the storability of avocado using edible coating specifically Aloe Vera, corn starch and Composite of corn starch and aloe Vera used as a coating film for avocado fruit. The storage time and the thickness of the film applied to the surface of the fruit were criteria to select the optimum point of the formulation ratio of the coating material.

From the result Avocado applied edible coating and stored at room temperatures had lower weight loss than avocado without edible coating; these treatments were effective as a physical barrier and thus reduced the weight loss during postharvest storage. In addition, Aloe Vera gel delayed softening, total soluble solid, and maintained the quality of avocado fruit. The composite of the two coating material has also retard ripening of the fruit which keeps the fruit longer storage time than the control. Overall, storage life was extended by coating treatments due to delayed ripening and softening, reduced decay and weight loss.

However significant ($p<0.05$) differences were observed among these coatings: composite of aloe Vera gel and corn starch was superior during storage maintaining avocado fruit in higher quality levels relative to other coating.

From this we can conclude that edible film with the presence of aloe Vera has reduced the value of water vapour permeability significantly *($p<0.05$)* which is suitable condition in reducing the respiration rate of the fruit.

The quality maintenance and the storage life extension of avocado reveal that composite of aloe Vera gel and corn starch coating can be considered for commercial application during storage of the fruit.

4.2. Recommandation

The study was conducted in the application of edible coating for further presevation of avocado. in which tangible result was obsereved in terms of increasing storage time and keeping quality. the technology is reduction of post havesting loss caused in horticultural fruit including avocado. The method focused in the reduction of posthavesting was the technology of surface coating from edible coating materials.

1. It is recommended that further study need to be conducted on the application of edible film coating used in food stuffs.
2. In this study avocado was the ultimate fruit, however other fruit and vegetables can be coated within the coating materials.
3. It is recommended that further studies would be interesting to carry out further experiment on the study of Postharvest quality management of horticultural produce through eco-friendly treatments is an emerging field. One of such promising and emerging postharvest treatment for extending the market life of lively respiring horticultural produce is ‘Edible coating’. Edible coatings when applied on harvested horticultural commodities such as fruits, vegetables. It positively affects physical (moisture retention, glossiness, appearance, firmness), physiological (respiration rate, ethylene evolution rate), and biochemical attributes (cell wall degrading enzymes) attributes of horticultural commodities.

References

[1] Ozolua, R. I., Anaka, O. N., Okpo, S. O., & Idogun, S. E. (2009). Acute and sub-acute toxicological assessment of the aqueous seed extract of persea americana mill (lauraceae) in rats reseach paper, 6 (4), 573-578.

[2] Fulgoni, V. L., Dreher, M., & Davenport, A. J. (2013). Avocado consumption is associated with better diet quality and nutrient intake, and lower metabolic syndrome risk in US adults: results from the National Health and Nutrition Examination Survey (NHANES) 2001– 2008. Nutrition Journal, 12 (1), 1-6.

[3] Forero., M. P. (2007). Storage life enhancement of avocado fruits. McGill University.

[4] Avena-bustillos, R. D., John m. Krochta, Mikal E. Saltveit (1997). Water Vapor Resistance of Red Delicious Apples and Celery Sticks Coated with Edible Caseinate-Acetylated Monoglyceride Films. journal of food science, 62 (2).

[5] Sapper, M., & Chiralt, A. (2018). Starch-Based Coatings for Preservation of Fruits and Vegetables. 152 (8), 1-19.

[6] Ramachandra, C. T., & Rao, P. S. (2008). Processing of Aloe Vera Leaf Gel: A Review. American Journal of Agricultural and Biological Sciences, 3 (2), 502-510.

[7] He, Q., Changhong, L., Kojo, E., & Tian, Z. (2005). Quality and safety assurance in the processing of aloe vera gel juice. Journal of Food Control, 16, 95-104.

[8] Ghosh, A., Dey, k., & Bhowmick, N. (2015). Effect of corn starch coating on storage life and quality of Assam lemon (Citrus limon Burn.). journal of crop and weed, 11 (1), 101-107.

[9] Donhowe, G., & Fennema. (1993). The effects of plasticizers on crystallinity, permeability, and mechanical properties of methylcellulose films. Journal of Food Processing and Preservation, 17 (4), 247-257.

[10] Guilbert, S. e., Gontard, N., & Gorris, L. G. M. (1996). Prolongation of the Shelf-life of Perishable Food Products using Biodegradable Films and Coatings. Journal Food Science and Technology, 29 (1-2), 10-17.

[11] McGuire, R. G. 1992. Reporting of objective color measurements *HortScience* 27 (12): 1254-1260.

[12] Carrillo-lope, A., ramirez-bustamant, f., valdez-torre, j. b., & rojas-villegas, r. (2000). Ripening and quality changes in mango fruit as affected by coating with an edible film Journal of Food Quality, 23 (5), 479-486.

[13] Nofrida, R., Warsiki, E., & Yuliasih, d. I. (2013). The effect of storage temperature on the erpa leaf (aerva sanguinolenta) color indicator smart label. Journal teknologi industri pertanian, 23, 232-241.

[14] Marpudi, s. L., & Abirami, L. S. S. (2011). Enhancement of storage life and quality maintenance of papaya fruits using Aloe vera based antimicrobial coating. indian journal of biothecnology, 10, 83-86.

[15] Adetunji C. O, Fawole O. B, Arowora K. A, Nwaubani S. I, Ajayi E. S, Oloke J. K, Majolagbe O. M, Ogundele B. A, Aina J. A, Adetunji J. B (2012). Effects of Edible Coatings from Aloe Vera Gel on Quality and Postharvest Physiology of Ananas Comosus (L.) Fruit During Ambient Storage *Global Journal of Science Frontier Research Bio-Tech & Genetics, 12* (5).

[16] Mart´ınez-Romero, D., Alburquerque, N., Valverde, J. M., Guillen, F., Castillo, S., Valero, D.,(2006). Postharvest sweet cherry quality and safety maintenance by Aloe vera treatment: A new edible coating. Postharvest Biology and Technology, 39, 93-100.

[17] Sharmin, M. R., Islam, M. N., & Alim, M. A. (2015). Shelf-life enhancement of papaya with aloe vera gel coating at ambient temperature. Department of Food Technology and Rural Industries, Bangladesh Agricultural University, 13 (1), 131-136.

[18] Baldwin, E. A., Burns, J. K., Kazokas, W., Brecht, J. K., Hagenmaier, R. D., Bender, R. J. (1999). Effect of two edible coatings with different permeability characteristics on mango (Mangifera indica L.) ripening during storage. Postharvest Biology and Technology, 17, 215-226.

[19] Oluwaseun, A. C., Kayode, A., Bolajoko, F. O., Adetunji, Bunmi, J., & AR, O. (2013). Effect of edible coatings of carboxy methyl cellulose and corn starch on cucumber stored at ambient temperature Asian Journal of Agricultural Biotechnology, 1 (3), 133-140.

[20] Srinivasa, P. C., Baskaran, R., Ramesh, M. N., Prashanth, Harish Prashanth K. V., & Tharanathan, R. N. (2002). Storage studies of mango packed using biodegradable chitosan film. European Food Research and Technology, 205, 504–508.

[21] Pinal B. Vyas a, Neeta B. Gol a & T. V. Ramana Rao (2014). Postharvest Quality Maintenance of Papaya Fruit Using Polysaccharide-Based Edible Coatings. *International Journal of Fruit Science, 14: 81–94, 2014, 14*, 81-94.

[22] (Debeaufort F. J., A. Quezada-Gallo and A. Voilley, 1998. Edible films and coatings: tomorrow's packaging: a review. *Crit Rev Food Sci Nutr.,* 38: 299–313).

[23] (Yamanand O. and L. Bayoindirli, 2002. Effects of an edible coating and cold storage on shelf-life and quality of cherries. *Lebnsm. Wiss. Und. Technol*. 35: 46-150.).

[24] Mani, A., Jain, N., Singh, A. K., & Sinha, M. (2017). Effects of Aloevera Edible Coating on Quality and Postharvest Physiology of Ber (Zizyphus mauritiana Lamk.) under Ambient Storage Conditions. international journal of pure applied bioscience, 6 (5), 43-53.

[25] Brishtia, F. H., Misira, J., A, A. S., & J., A. (2013). Effect of Biopreservatives on storage life of papaya (Carica papaya L.). *International Journal of Food Studies, 3*, 126-136.