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# Effect Of Chitosan Coating Combined *Aloe Vera* Gel On Cucumber (*Cucumis Sativa* L.) Post-Harvest Quality during Ambient Storage

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**Abstract**
Edible films and coatings are an environmentally-friendly alternative method to extend the postharvest life of fresh and minimally processed fruits and vegetables.Edible coatings based on chitosan (CH),*Aloe vera*gel (AL)and its combination with *Aloe vera*gel (CHAL), were developed and applied to cucumber, in order to improve its quality and shelf life during storage. Weight loss, changes in soluble solids, ascorbic acid content, firmness, pH and the percentage of fungal infection of uncoated and coated samples were determined throughout ambient storage for period of 7 weeks cucumberstored at ambient temperature of 25$^{o}$C, 95-98% RH for seven weeks. The above parameters which are related to post- harvest quality loss were however significantly controlled in the cucumber coated in the following order CHAL>AL> CH>Control. The storability of cucumber fruits was extended by seven weeks. It was concluded that used chitosan mixed with *Aloe vera* gel could be used as a coating for cucumber could serve as an alternative to post-harvest chemical treatments.

**Keywords:** cucumber, edible coating, chitosan,*aloe vera* gel, environmentally-friendly

## INTRODUCTION

Cucumber (*Cucumis sativa* L.) is one of the most important and popular vegetable crops all over the world including Nigeria. The crop is mainly cultivated during the summer season in open fields. It could be grown in two growing seasons, autumn and spring under plastic house conditions. (Abd EL-Kereem, 1998). Edible films and coatings are environment friendly alternative method to extend the postharvest life of fresh and minimally processed fruits and vegetables (Baldwin, 1994; Olivas et al., 2008; Pérez-Gago*et al*.,2005; Vargas *et al*., 2008). They form a semipermeable barrier to gases and water vapor and thereby reduce respiration and weight loss. In addition, edible films and coatings may help maintaining firmness and provide gloss to coated fruit.

Edible films and coatings, also improve mechanical handling properties, carry additives, avoiding loss of volatiles compounds and production of volatiles aroma (Olivas and Barbosa-Ca´ novas, 2005).

Chitosan is a natural polymer obtained by deacetylation of chitin, and when compared with other polysaccharides, chitosan has several advantages such as biocompatibility, biodegradability and no toxicity, while also presenting functional properties as bacteriostatic and fungistatic (Dutta*et al*., 2009; Kumar, 2000). The cationic character of chitosan offers an opportunity to establish electrostatic interactions with other compounds. Due to these characteristics, chitosan has been widely used for the production of edible films (Aider, 2010; Rivero*et al*., 2010; Zani*et al*.,2008). Chitosan films present good barrier properties when compared with other polymers suchas methylcellulose and corn starch (Debeaufort and Voilley, 2009;García*et al*.,2009). Also, mechanical properties of chitosan films can be improved e.g. by the addition of plasticizers (Yoshida *et al*., 2009); however, the presenceof such compounds can affect the structure of chitosan films.

*Aloe vera*based edible coatings have been shown to prevent loss of moisture and firmness, controlrespiration rate and maturation development, delay oxidative browning, and reduce microorganism proliferation infruits such as sweet cherry, table grapes and recterones (Valverde*et al*., 2005; Matinez-Romero *et al*., 2005). In addition to the traditional role of edible coatings as a barrier to water loss and delaying fruitsenescence, the new generation coatings are being designed for incorporation and/or for controlled release ofantioxidants, nutraceuticals, chemical additives and natural antimicrobial agents

(Vargas *et al*., 2008). It has also been reported that the *Aloe vera*extracts possessed antimicrobial activity against bacterial pathogens from grampositive and gram negative (Adetunji, 2008).

The aim of this work was to study the synergetic effect of chitosan and *A. vera* gel, applied as an edible coating, on the change in physicochemical parameters and shelf life in Cucumber, related to fruit quality during ambient storage for a period of seven weeks. This will also ensure food security, sustainable development, poverty reduction and wealth creation in alignment with the objectives of Millennium Development Goals (MDGs).

## MATERIALS AND METHODS

### Preparation of Chitosan

Mature edible dark yellow crabs (*Cancer pagurus*) were collected from the brackish waters of Warri/Sapele Delta state. They were killed after which the visera and muscles was carefully removed. The exoskeleton particularly the carapace was washed with warm tap water in order to remove foreign materials and remaining muscle particles. The shells were dried at 60$^{o}$C overnight, ground with a centrifugal grinding mill (Retsch/Brinkmann ZM-1,Westbury, NY), and shell particles between a mesh size of 20 (0.841 mm) and 40 (0.420 mm) were used as starting material. The methods established to extract chitin from crab fish shell waste by No and Meyers (1995) and further processing of chitin into chitosan through autoclaving (No *et al*., 2000) was used to prepare different chitosan samples forthis study. Dried crab shell particles were treated with 1 N NaOH at 65$^{o}$C for 1 hour at a solid: solvent ratio of 1:10, w/v for deproteinization (DP). Following a washing step, deproteinized shell particles was treated with 1 N HCl at room temperature for 30 minutes at a solid: solvent ratio of 1:1.5, w/v for demineralization (DM). Particles was treated with acetone at 1: 10 w/v concentration, washed, and bleached with 0.315% NaOCl at a 1:10 w/v ratio for5 minutes for decoloration (DC). Resultant chitin was treated with 50% NaOH at a 1:10 w/v ratio at 121$^{o}$C/15 psi for 30 minutes for deacetylation (DA). Subsequent washing and drying steps yielded chitosan.

### Preparation of Edible Coatings of *Aloe Vera*

Matured leaves of *Aloe vera*plants were harvested and washed with a mild 25 % chlorine solution. *Aloe vera*matrix was then separated from the outer cortex of leaves and this colourlesshydroparenchyma was ground in a blender.

The resulting mixture was filtered to remove the fibres. The liquid obtained constituted fresh *Aloe vera*gel. The gel matrix was pasteurized at 70$^{o}$C for 45 minutes and allowed to cool immediately to an ambient temperature. Ascorbic acid (2.0g\l) and then citric acid (4.5g\l) were added to maintain its pH at 4. The viscosity of *Aloe vera*and its coating efficiency was improved by using 1% commercial gelling agent which was used as coating agent. This was later stored in brown amber bottle to prevent oxidation of gel using the method (He *et al*., 2005).

### Source of fruits

Cucumber fruits, were purchased from Ipata market in Ilorin on the day after harvest and were immediately placed in ambient storage(27$^{o}$C±3).Uniform sized, defect-free fruits were selected.

### Treatments

$T_o$ (control):- $T_o$ was selected as the control (untreated cucumber); $T_1$Cucumber was coated with1.5% w/vchitosan and 1.5% v/v *Aloe vera* gel; $T_2$Cucumber was coated with 1.5% v/v *Aloe vera* gel;$T_3$Cucumber was coated with 1.5% w/vChitosan. The treated and untreated was packed in small plastic basket and each basket contains 20 cucumber fruits. The basket was stored at ambient temperature (25$^{o}$C, 95-98%RH), Physiochemical analysis was carried out from week 1-7 of after coating.

**Weight loss:** To evaluate weight loss, separate samples in 3 replicates of each treatment were used. The same samples were evaluated for weight loss each time at weekly intervals until the end of experiment. Weight loss was determined by the following formula:

Weight loss (%) = [(A−B)/A] x 100

Where A indicates the fruit weight at the time of harvest and B indicates the fruit weight after storage intervals. (A.O.A.C., 1994)

**Firmness**:- Firmness was measured as the maximum penetration force (N) reached during tissue breakage, and determined with a 5 mm diameter flat probe. The penetration depth was 5 mm and the cross-head speed was 5 mm $s^{-1}$ using a TA-XT2 Texture Analyzer (Stable Micro Systems, Godalming, UK), MA. Cucumber was sliced into halves and each half was measured in the central zone.

**pH**:- After firmness analysis, cucumber was cut into small pieces and homogenized in a grinder, and 10 g of ground cucumber was suspended in 100 ml of distilled water and then filtered. The pH of the samples were assessed using a pH meter (pH-526; WTW Measurement Systems, Wissenschaftlich, TechnischeWerksta¨tten GmbH, Wellhelm, Germany)

**Total soluble solids (TSS):-** Total soluble solids (TSS) were measured by the method described by Dong *et al*., (2001) .Individual cucumber fruit from each of the treatment will be ground in an electric juice extractor for freshly prepared juice. Soluble solids content was measured using T/C hand

refractometer in Brix% (Model 10430 porx-reading 0-30 range Bausch and Lomb Co. Califonia., USA.
**Ascorbic acid**: - Ascorbic acid content was measured using 2,5-6 dicholorophenol indophenols' method described by A.O.A.C 1994.

**Fungal decay**
Fungal decay was visually inspected weekly during thestorage period. Cucumber fruits showing surface mycelia development was considered decayed. Results wereexpressed as the percentage of fruits infected.

**Statistics**
All results are means ± S.E., SPSS software (version 12.0, SPSS Inc., US) was used for all statistical analysis for Analysis of variance. The significance level used was 0.05.

## RESULT AND DISCUSSION

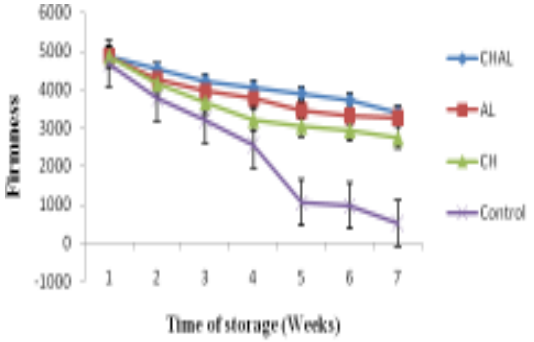


**Figure1:Effect of edible coatings from chitosan and *Aloe vera* on the firmness of cucumber.**

**Firmness**
The result obtained in Figure 1. showed that edible coatings from CHAL, AL, CH had a firmness 4098 ± 185.52 , 3832.86 ±218.29,3519.57±286.10, respectively while the uncoated had a firmness of 2398.86±599.78.

Texture is a critical quality attribute in the consumer acceptabilityof fresh fruit and vegetables.

Fruit firmness is a major attribute that dictates the postharvest lifeand quality of fruit. Chitosan coatings significantly reducedthe loss in firmness of fruits during storage. Fruit firmnessincreased as chitosan concentration increased. Cucumber is a softfruit that suffers a rapid loss of firmness during ripeningwhich contributes greatly to its short postharvest life and susceptibilityto fungal contamination. The beneficial effect of the elevated chitosanconcentration on firmness has also been reported for tomato(El Ghaouth*et al.*, 1992), peach, Japanese pear, kiwifruit (Du*et al.*, 1997), 'Murcott' tangor (Chien*et al.*, 2007), papaya(Ali *et al.*, 2011) and guava (Keqian Hong *et al.*, 2012). The retentionof firmness with chitosan coating is in agreement with theresults of Bautista-Banos*et al.* (2003), where solo papayastreated with 1.5% chitosan coating were firmer than the controlduring 14 days storage, at ambient temperature.

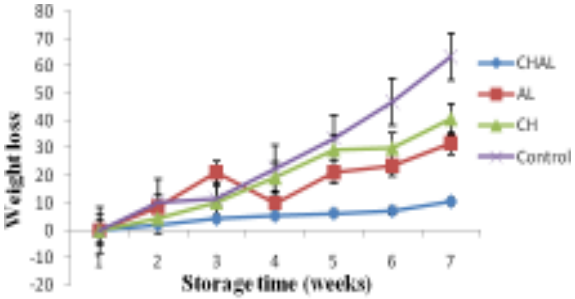


**Figure2:Effect of edible coatings from chitosan and *Aloe vera* gel on the weight loss of cucumber**

**Weight Loss**
The result obtained in Figure 2. showed that CHAL, AL, CH had a weight loss 5.17± 1.30 , 16.71 ±4.11, 19.22±5.65, respectively while the uncoated had a weight loss of 26.91±8.48. Fruit weight loss is mainly associated with respirationand moisture evaporation through the skin. Chitosan coatings have been shown to be effective atcontrolling water loss from other commodities, includingcucumber and pepper (El Ghaouth*et al.*, 1991), papaya (Ali*et al.*, 2011) and longan fruit (Jiang and Li, 2001). Chitosan has been reportedto be more effective at delaying weight loss in banana andmango (Kittur*et al.*, 2001) and strawberries (Ribeiro*et al.*,2007) than are starch and cellulose derivatives. The weightloss appeared to be the major determinant of storage life andquality of fruits. Chitosan coatings significantly reduced theweight loss of the fruits during storage compared to the control.The minimum weight loss was observed in the chitosantreatments of 1.5% and 2.0%. The slower rate of moistureloss from the chitosan coated fruits may be attributed to theadditional barrier against diffusion through stomata (Paulland Chen, 1989).

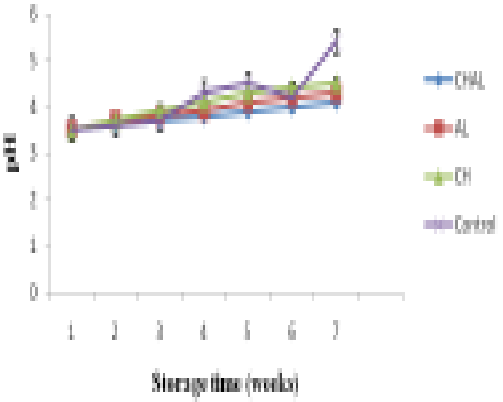


Figure3: Effects of edible coatings from chitosan and *Aloe vera* gel on the pH of cucumber

The result obtained in Figure 3. showed that edible coatings from CHAL, AL, CH had a pH 3.8± 0.08 , 3.9 ±0.11, 4.05±0.14, respectively while the uncoated had a pH of 4.17±0.23.

The pH increasedsignificantly at ($p<0.05$) along with increasedstorage time in both coated and uncoated fruits(Figure. 3). These results agreed with those reportedby El-Ghaouth*et al*. (1991) and Garcia *et al*.(1998) that the decrease of acidity during storagedemonstrated fruit senescence. It was determinedas a small change in pH represents a large changein hydrogen ion concentration (Ball, 1997).The change in pH is associated with number of reasons;it might be due to the effect of treatment onthe biochemical condition of the fruit and slowerrate of respiration and metabolic activity (Jitareerat*et al*., 2007). Coatings slowed the changes on pHand titratable acidity, effectively delaying fruit senescence.

This was probably because the semipermeablechitosan film formed on the surface ofthe fruit might have modified the internal atmospherei.e., the endogenous $CO_2$ and $O_2$ concentration of the fruit, thus retarding ripening (Lowings&Cutts, 1982; Bai*et al*., 1988). The increase in Ph may be due to the breakup of acids with respirationduring storage (Pesis*et al*., 1999).

**Total soluble solid**

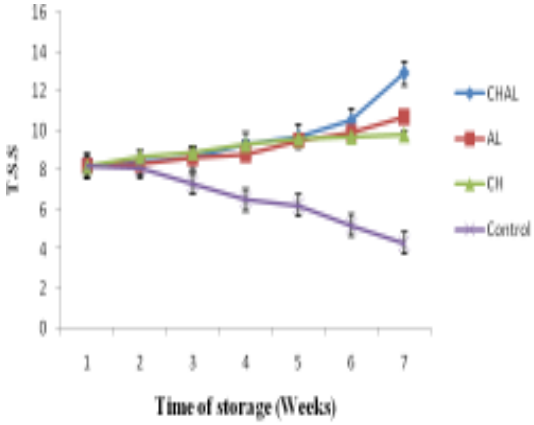


Figure 4:Effect of edible coatings from chitosan and *Aloe vera* gel on the total soluble solid of cucumber

The result obtained in Figure 4. showed that edible coatings from CHAL, AL, CH had a T.S.S 9.66±0.62, 9.14 ±0.35, 9.17±0.22, respectively while the uncoated had a T.S.S of 6.54±0.55.

These results were in accord withthat of Kitture*t al*. (2001) who worked on banana and mango coated with polysaccharide-based coatings and that ofPatricia *et al*. (2005) who worked on strawberry coated with wheat gluten-based films.

**Ascorbic acid content**

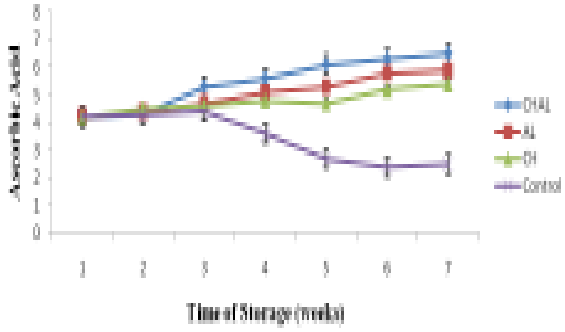


Figure5: Effect of edible coatings from chitosan and *Aloe vera* gel on the Ascorbic acid content of cucumber

The result obtained in Figure 1. showed that edible coatings from CHAL, AL, CH had an ascorbic acid content 5.47± 0.35 , 5.05 ±0.25, 4.77±0.16, respectively while the uncoated had an ascorbic acid content of 3.44±0.34. The reason for high vitaminC content in coated fruit can be attributed toslow ripening rate of chitosan treated fruit. Oxidationof ascorbic acid may be caused by several factorsincluding exposure to oxygen, metals, light,heat and alkaline pH (Sritananan*et al*., 2005). Coatingsserved as a protective layer and control thepermeability of $O_2$ and $CO_2$ (Srinivasa*et al*., 2002).The ascorbic acid contents in chitosan coated fruitswere higher than uncoated fruits at the end of

storage.The effect of chitosan was reported with thebreak of glycosides link to produce different lowermolecular weight fragments, which help in protectingthe outer and inner surface of fruits (Park *et al*.,1993). The results congregates with the findings ofJiang *et al*. (2004) who narrated that ascorbic acidcontent decreased when longan fruit was coatedwith chitosan at low temperature 2°C.

**Percentage of fungal infection**

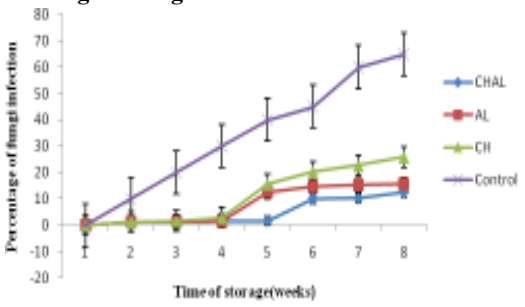


**Figure 6: Effect of edible coatings from chitosan and *Aloe vera* gel on the percentage of fungi infection of cucumber**

The result obtained in Figure 6. showed that edible coatings from CHAL, AL, CH were able to reduced the fungal infection to the following percentage of 4.81± 1.82% , 7.8 ± 2.57%, 11.33 ±3.85%, respectively while the uncoated had a fungal infection with a percentage of 33.75±8.17%.Serious market losses of horticultural produce resultfrom postharvest disease development. Numerous reportsindicate that chitosan effectively controls postharvestrots during storage, delays the onset of infectionand slows down the infection process. In this study it was observed that thereduction of rots increases with increasing chitosanconcentration. Some other researchers have also observed that chitosan-treated fruits such as apples,kiwifruit, pears and cucumbers has caused a reduction ofstorage rots(Bautista-Ban˜ os*et al*.,2004; Du *et al*., 1997).

## CONCLUSION

Applications of Chitosan and *Aloe vera*gel coatings to cucumber were shown to be beneficial in keeping the quality of the fruits in storage. Finally, the overall result showed that the coatings from Chitosan and *Aloe vera* gel is effective in extending theshelf-life of cucumber fruits when compared to untreated cucumber in the following order:CHAL>AL> CH> Control.

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