



Research Article

# Effects of Aloe Vera Coatings on Quality Characteristics of Oranges Stored Under Cold Storage

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## ARTICLE INFO

## ABSTRACT

**Article No.:** 110112192

**DOI:** 10.15580/GJAS.2013.1.110112192

**Submitted:** 01/11/2012

**Accepted:** 15/11/2012

**Published:** 20/01/2013

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Three hundred and twenty (320) oranges of Valencia variety were stored under cold conditions in the refrigerator for 8 weeks. The following parameters were carried out during the course of storage: Total soluble solids, titratable acidity, weight loss, firmness, pH, vitamin C and sugar/ acid ratio. The final value for firmness for coated oranges was found to be  $1781.25 \pm 118.30N$ , while that of uncoated oranges was  $1531.25 \pm 185.53N$ . The pH was gradually increasing during the course of storage in the two treatments, whereas vitamin C was found to be decreasing in storage. The total soluble solid for coated oranges was  $9.79 \pm 1.14\%$  while that of uncoated oranges was found to be  $9.34 \pm 0.06\%$  at the end of storage. There was a linear decrease in titratable acidity during the course of storage. It was found that the value obtained for coated oranges was higher than that of uncoated oranges which was obtained to be  $1.14 \pm 0.07$  at the end of storage. Converse to this was obtained for % weight losses in the two treatments. The weight loss for coated oranges was  $29.20 \pm 0.55\%$ , while that of uncoated oranges was  $53.30 \pm 1.17\%$  at the end of storage. A linear increase was observed in sugar/acid ratio in the two treatments during the course of storage with higher value being recorded for uncoated oranges as  $8.90 \pm 0.87$ , while lower value was gotten for coated oranges as  $7.43 \pm 0.34\%$ .

**Keywords:**

Coatings, Aloe vera, quality, oranges, storage

## INTRODUCTION AND LITERATURE REVIEW

The importance of good postharvest practices in minimizing postharvest losses cannot be overemphasized. Appropriate preharvest, harvesting and postharvest chain will result in superior quality produce. The sweet orange (*Citrus cinensis*) is the most commonly grown fruit tree in the whole world (Morton, 1987). It is made up of soft texture, and the edible materials are very important in human diet since they contain essential vitamins.

Edible surface coatings such as waxes are often applied to improve the cosmetic features of fruits and vegetables. These coatings commonly contain ingredients such as polyethylene, carnauba or candelilla, all of which reduce water vapour loss and provide a vehicle for fungicides (Hagenmaier and Baker, 1995; Debeaufort *et al.*, 1998; Alleyne and Hagenmaier, 2000). Several authors including Amarante *et al.* (2001); Jeong *et al.*, (2003) have reported that waxing and coating improves shelf life, slows down ripening, retards water loss, reduces decay and enhances visual quality. It has been estimated that 25% to 80% of harvested fresh fruits are lost due to spoilage (Quezada *et al.*, 2003).

*Aloe vera* is a tropical and subtropical plant that has been used for centuries for its medicinal and therapeutic properties (Eshun *et al.*, 2004). The two major liquid sources of *A. vera* are a yellow latex (exudates) and a clear gel (mucilage), which proceeds from the large leaf parenchymatic cells (Ni *et al.*, 2004). The predominant medical uses of the orally ingested gel juice are against ulcerous, gastrointestinal, kidney and cardiovascular problems and also reduces the cholesterol and triglyceride levels in blood. Moreover, other properties such as anti-inflammatory and antibiotic activities against some diseases (diabetics, cancer, allergy, AIDS) have been reported (Eshun *et al.*, 2004; Reyhlds *et al.*, 1999). Although the main use of *A. vera* gel is in the cosmetic industry, including treatment of burns and scars and in wound healing (Aburjai *et al.*, 2004). There are some reports on the antifungal activity of *A. vera* gel against several pathogenic fungi including *Botrytis cinerea* (Jasso de Rodriguez *et al.*, 2005; saks and Barkai-Golan, 1995).

There has been increasing interest in the use of *A. vera* gel in the food industry as a functional ingredient (Moore *et al.*, 2005). Nevertheless, most of the so-called *aloe vera* products may contain very small amounts of the active compounds, because the processing techniques used to obtain *A. vera* gel affects the product quality and the amount of bioactive compounds in the final product.

It has been found that a procedure of extraction and processing has been developed to ensure the biological integrity, sensorial stability and the quality of the final product for the food industry application (He *et al.*, 2005). *Aloe vera* based edible coatings have been shown to prevent loss of moisture and firmness, control respiration rate and maturation development, delay

oxidative browning, and reduce microorganism proliferation in fruits such as sweet cherry, table grapes and recterones (Valverde *et al.*, 2005; Matinez-Romero *et al.*, 2005; Ahmed *et al.*, 2009). In addition to the traditional role of edible coatings as a barrier to water loss and delaying fruit senescence, the new generation coatings are being designed for incorporation and/or controlled release of antioxidants, 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 gram positive and gram negative (Adetunji, 2008).

In view of the fact that there are no recent report on the utilization of *Aloe vera* in extending the shelf-life of oranges, therefore this study was conducted to fill the gap by evaluating the effects of *Aloe vera* gel coatings on quality and storability of orange fruit.

## MATERIALS AND METHODS

### 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 colourless hydroparenchyma 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°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).

### Procurement of Samples

Freshly harvested valencia oranges were procured from a local market in Ilorin, kwara state, Nigeria. Mature green wholesome oranges were selected for this study. Fresh leaves of *Aloe vera* were obtained from the garden of Nigerian Stored Products Research Institute in Ilorin.

### Surface Preparation of oranges

The primary purpose of surface preparation was to remove all contaminants that would hinder proper coating adhesion and to render a sound, clean substrate, suitable for firm bonding. The surface should be in plant ready condition.

### Treatments

The experiment was a completely randomized design. Three hundred and twenty (320) wholesome oranges were randomly selected into two main groups, one group (160 oranges) was coated with *Aloe vera*, while another group of 160 oranges was not coated i.e. control. Twenty oranges each were arranged in small plastic baskets. The baskets containing the oranges were stored at refrigerated temperature (12°C, 96-98%RH). Physicochemical parameters were carried out weekly in triplicates.

### Physicochemical Analysis

Total soluble solids (TSS) were determined using the method of Dong et al. (2001). Individual orange fruit from each treatment was ground in an electric fruit juice extractor to obtain freshly prepared juice soluble solids. This was measured using portable refractometer in brix %.

The titrable acidity was determined by the standard method of the Association of Official Analytical Chemists (2000), by titrating 10ml of the juice of orange

sample and two drops of phenolphthalein indicator with 0.1N NaOH to the pink end point colouration.

Weight changes /weight losses were determined using analytical weighing balance. Firmness was measured as the maximum penetration force (N) reached during tissue breakeage and determined with a 5mm diameter flat probe. The penetration depth was 5mm and a cross-head speed was 5mm S<sup>-1</sup> using TA-XT2 Texture analyzer (Stable Micro Systems, Godalming, UK).

For pH determination, samples were cut into small pieces and homogenized in a grinder, 10 ml of ground orange juice was suspended in 100ml of distilled water and then filtered. The pH of the sample was determined using a pH meter (pH – 526, WTW measurement systems). Vitamin C content of the samples was measured using 2, 6-dichlorophenol indophenol method as described by (A.O.A.C., 2000). The sugar/acid ratio of the samples was determined by dividing sugar concentration (brix) by the citric acid concentration.

## RESULTS AND DISCUSSION

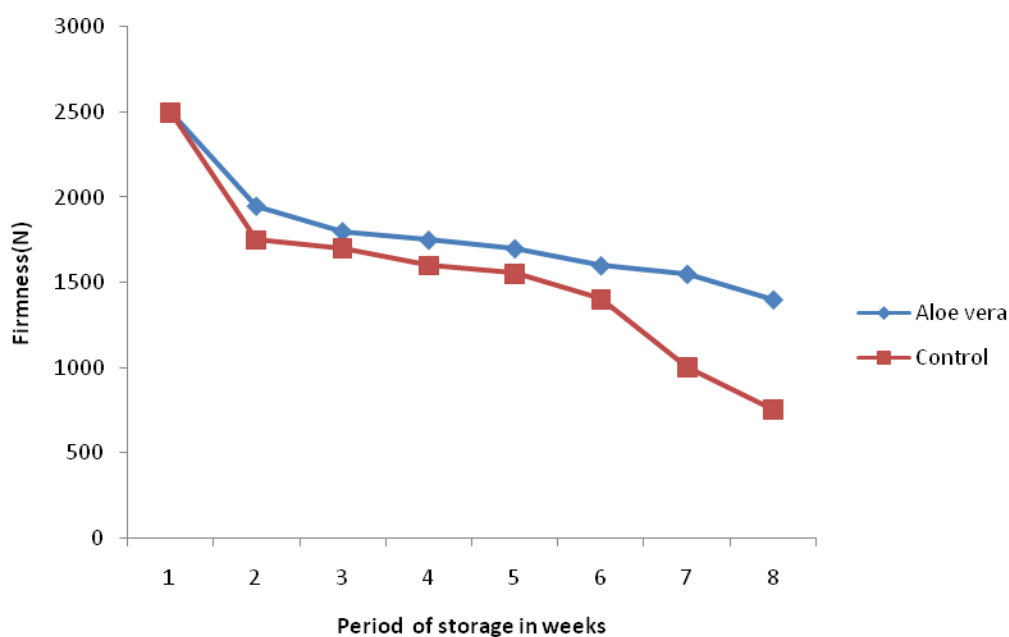


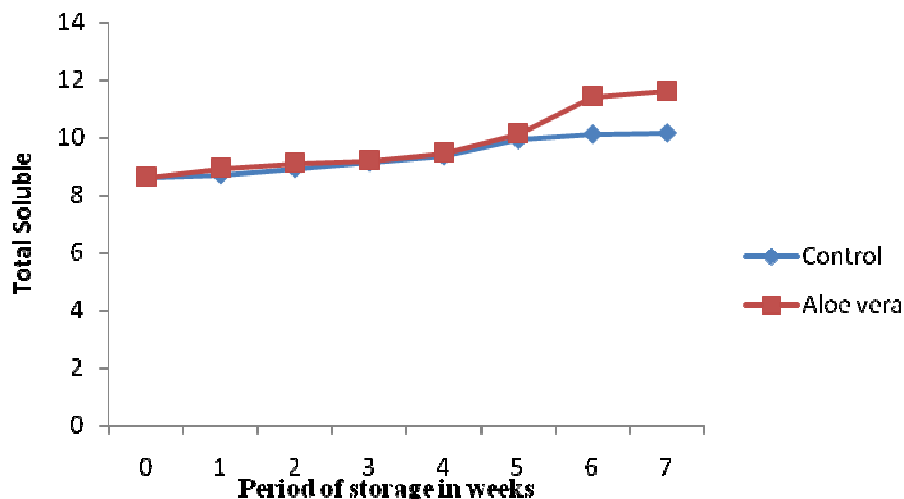
Fig1:Aloe vera coating effects on Firmness (N)(mean±SE) of orange at cold temp

Figure 1 shows the effects of coating on firmness. There was a decreasing trend in firmness in both coated and uncoated oranges during the course of storage. However, the control (untreated fruits) exhibited higher loss in firmness than the coated samples; this was due to the effects of waxing which delayed softening in coated samples. This is in agreement with the observation by Hagenmaier and Baker (1995) who

found that coating with wax reduces shriveling of oranges than the control. The retention of firmness in coated fruits was due to reduction in degradation of insoluble protopectins to more soluble pectic acid and pectin. It was found that during fruit ripening, depolymerization or shortening of chain length of pectin substances occurs with an increase in pectinesterase and polygalacturonase activities (Yaman and Bayoindirli,

2002). Hence low oxygen and high carbon-dioxide concentrations reduce the activities of these enzymes and allows retention of the firmness during storage (Salunkhe *et al.*, 1991) . It was found that the mean value for the firmness of coated oranges was  $1781.25 \pm 118.30N$  while that of the uncoated oranges was  $1531.25 \pm 185N$ . Hence, our results are in agreement

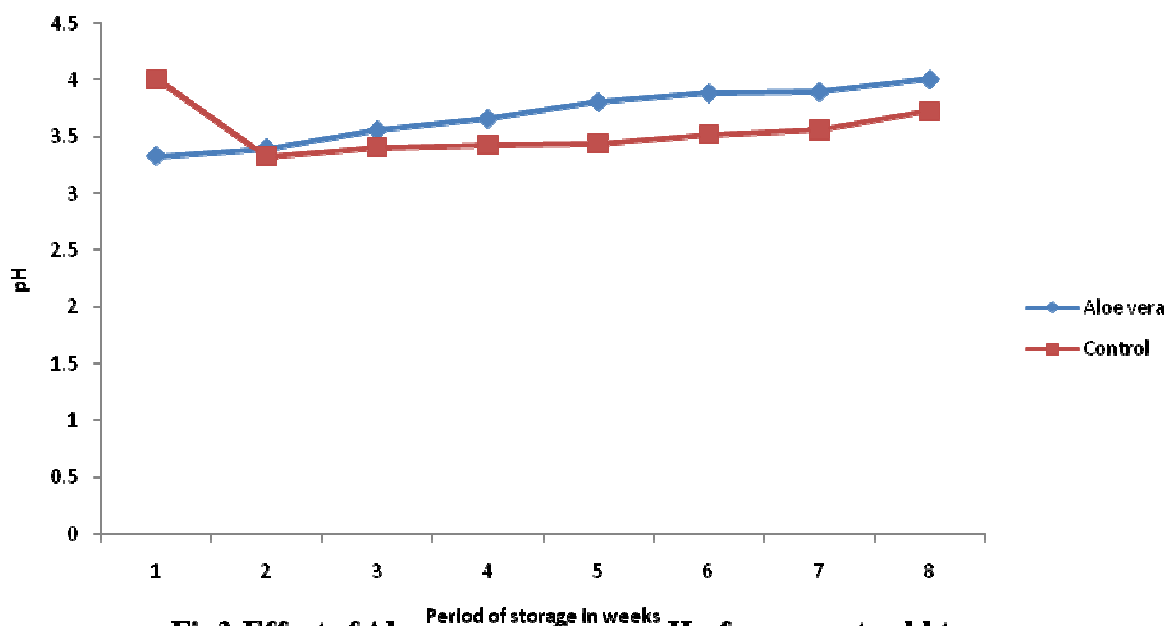
with the findings by Yaman and Bayoindirli (2002), who worked on cherries coated with semperfresh. Also, the results of this work is in line with that of Patricia *et al.*,(2005) who reported that refrigerated strawberry coated with wheat gluten-based films had better firmness retention than control fruit.



**Fig2: Aloe vera coating effect on TSS of orange at cold temp**

Figure 2 shows that the mean value for TSS of coated oranges was  $9.79 \pm 0.40\%$ , while that of uncoated oranges was  $9.34 \pm 0.02\%$ . There was no significant difference ( $P > 0.05$ ) in these values. These results were in accord with that of Kittur *et al.* (2001) who

worked on banana and mango coated with polysaccharide-based coatings and that of Patricia *et al.* (2005) who worked on strawberry coated with wheat gluten-based films.



**Fig3: Effect of Aloe vera coating on pH of orange at cold temp**

The pH of the orange juice was found to be gradually increasing during the course of storage as shown in Figure 3. The final value of pH for uncoated oranges was  $3.53 \pm 0.17$ , while that of coated oranges was  $3.69 \pm 0.2$ . There was no significant difference ( $P > 0.05$ ) between the two treatments. It was found that coated oranges

had higher value at the end of storage period, this was due to the semi-permeability created by aloe vera coatings on the surface of the fruit, which might have modified the internal atmosphere i.e. endogenous  $O_2$  and  $CO_2$  concentrations in the fruit, thus retarding ripening (Lowings and cuts, 1982; Bai *et al.*, 1988).

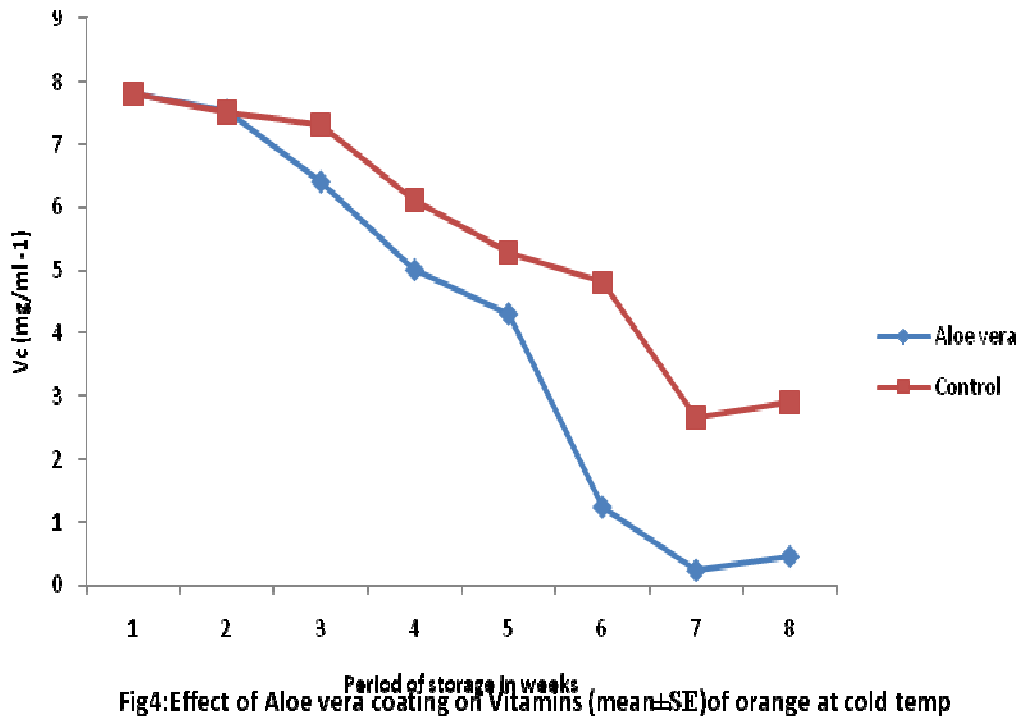


Figure 4 shows the effect of coating on vitamin C. Ascorbic acid is an important nutrient quality parameter and is very sensitive to degradation due to its oxidation (Veltman *et. al.*, 2000) compared to other nutrient during food processing and storage. The value of vitamin C for coated oranges was found to be higher than that of uncoated i.e. control. The results of this study were in line with the findings of Kumar *et. al.* (2000) who found

that ascorbic acid content decreased with increasing period of storage in fruits of kinnow. Our findings were also in agreement with the work carried out by Bhattacharya (2004), who found that ascorbic acid of fresh fruit was maximum just before ripening and then decrease due to the action of enzyme called ascorbic acid oxidase.

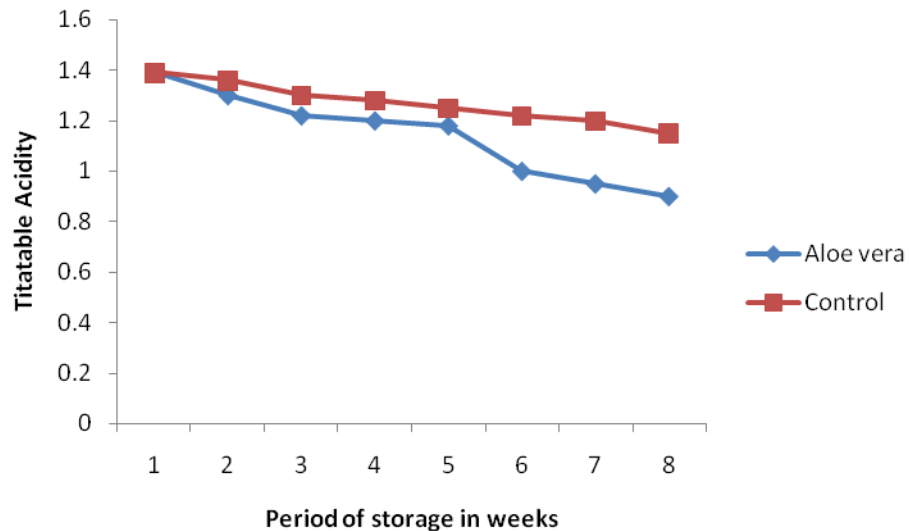


Fig 5: Effect of Aloe vera coating on TA (mean $\pm$ SE) of orange at cold temp

Figure 5 shows the effects of Aloe vera coatings on titratable acidity (TTA) during the course of cold storage. (TTA) is directly related to the concentration of organic acids present in the fruits. No significant difference ( $p>0.05$ ) was found in titratable acidity of coated and uncoated oranges. The final value of TTA of uncoated oranges at the end of storage was found to be  $1.14\pm 0.06\%$ , while that of coated oranges was  $1.27\pm 0.03\%$ . The decreasing acidity at the end of storage might be due to the metabolic changes in fruits resulting from the use of organic acids in respiratory process; this observation was in agreement with the findings of Echeverria and Valich (1989). Weight loss is an

important index of Postharvest activities. It is mainly attributed to the loss of water during metabolic processes like respiration and transpiration. Moisture loss and gaseous exchange from the fruits are usually controlled by the epidermal provided by guard cells and stomata. The coating helps to reduce this further because it forms a film on the top of the skin acting as an additional barrier to moisture loss. This barrier also reduce oxygen uptake by the fruit which in turn slowed down rate of respiration and associated weight loss from the fruit surface. The mean value for the weight loss of coated oranges was  $29.20\pm 0.55\%$  while that of uncoated oranges was  $53.30\pm 1.17\%$ .

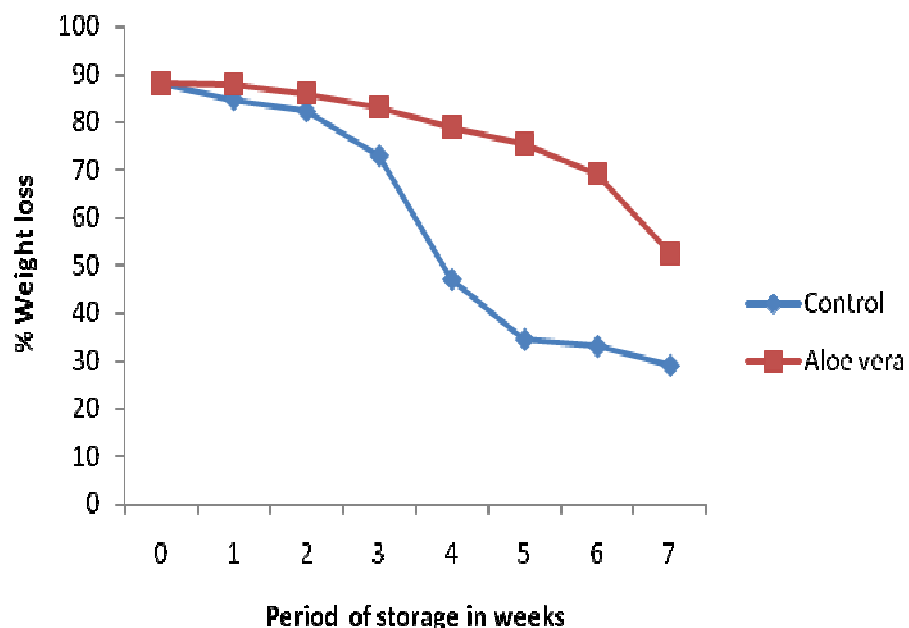


Fig6: Effect of Aloe vera coating on % weight loss

Figure 6 shows the effects of coatings on weight loss of oranges during the course of storage. The reduction in weight loss for coated oranges was probably due to the effects of these coatings as a semi-permeable barrier against oxygen, carbon-dioxide, moisture and solute movement, thereby reducing respiration, water loss and oxidation reaction rates (Baldwin *et al.*, 1999; Park, 1999). The results obtained in this study are in agreement with the findings of Garc Aia *et al.*, (1998 a,b) for strawberries coated with starch- based coatings and those of Joyce *et al.*(1995) who reported that waxing extended the storage life of avocado both through reduction in water loss and modification of the internal

atmosphere. Similar results were obtained by Bai *et al.* (2003) who studied Galla apple coated with 10% zein (natural corn protein). The sugar-acid ratio contributes to the unique flavor of citrus. At the beginning of the ripening process, the sugar- acid ratio is low because of low sugar content and high fruit acid content, this makes the fruit taste sour. During the ripening process the fruit acids are degraded, the sugar content increases, and the sugar- acid ratio achieves a higher value. The increase in sugar-acid ratio level could be attributed mainly to breakdown of starch into water, soluble sugars, sucrose and glucose during ripening.

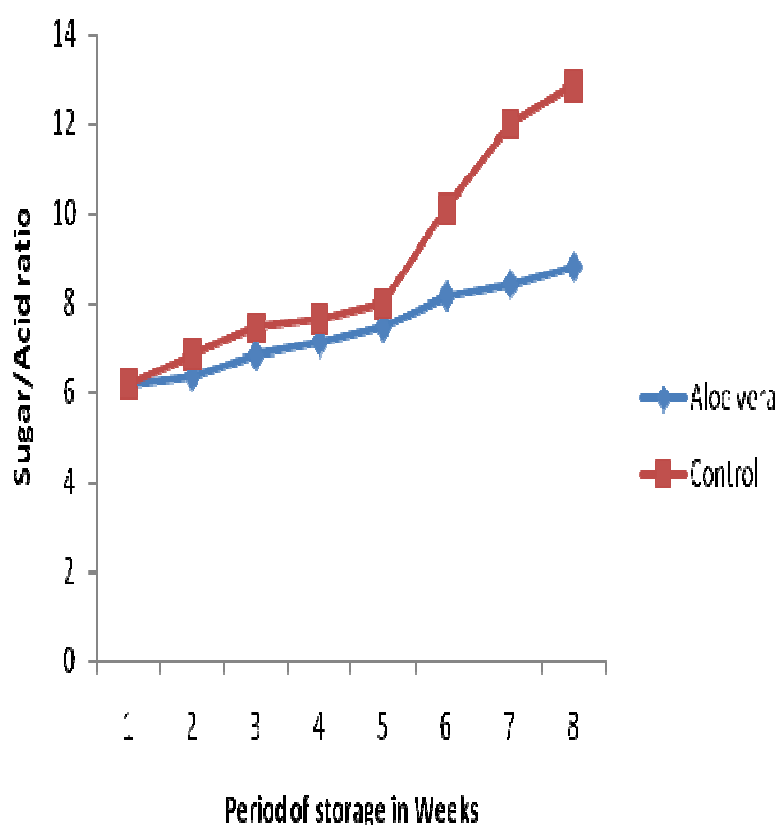


Fig7:Effect of Aloe vera coating on Sugar/Acid ratio of orange at cold temp

The final value for the sugar-acid ratio for coated orange was  $7.43 \pm 0.34\%$ , while that of the uncoated oranges was  $8.90 \pm 0.87\%$  as shown in figure 7. Significant differences ( $P < 0.05$ ) was observed in sugar- acid between oranges coated and the control during the course of storage. The finding in this study was similar to the work carried out by Manzano *et al.* (1997 a,b) who had similar decreasing trend in Hadden mango treated with wax coatings and stored at different temperatures.

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**Cite this Article:** Arowora, KA, Williams JO, Adetunji CO, Fawole OB, Afolayan SS, Olaleye OO, Adetunji JB, Ogundele BA (2013). Effects of Aloe Vera Coatings on Quality Characteristics of Oranges Stored Under Cold Storage. *Greener Journal of Agricultural Sciences*, 3(1): 039-047, <http://doi.org/10.15580/GJAS.2013.1.110112192>.