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Effect of Edible Coatings from *Aloe vera* gel on *Citrus sinensis* during Ambient storage.

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ABSTRACT

Extension of the shelf life of orange fruits continues to be a challenge in Nigeria. The search for safe, healthy and environmental friendly treatments has led to increased interest in research into edible and biodegradable films and coatings. In this work, the use of Aloe vera gel as a coating to extend the shelf-life of orange fruits was investigated. The oranges were stored at ambient temperature (27+2^{o}C) and at 50-60% relative humidity for five weeks. During ambient storage, uncoated fruits showed 43.11% and 60.63 % increases in total soluble solids and reducing sugar contents respectively. Rapid weight loss and loss of firmness were also observed. The above parameters which are related to post- harvest quality loss were however significantly controlled in the oranges coated with A. vera gel. Percent increase in total soluble solids 56.89% and reducing sugar contents 39.36% were observed. The storability of orange fruits was extended by five weeks. It was concluded that A. vera gel used as a coating for orange could serve as an alternative to post-harvest chemical treatments.

Keywords: Shelf life, Orange Fruits, *Aloe vera*

INTRODUCTION

The sweet orange (*Citrus sinensis* (L.) Osbeck), is the most commonly grown tree fruit in the world (Morton, 1987). Citrus fruits are produced all around the world and world citrus production in selected major producing countries in 2005/2006 is 72.8 million metric tons. Citrus fruits are said to be the first crops in the international trade in terms of values (CIAC, 2002).

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 (Smith *et al.*, 1987; Nisperos-Carriedo *et al.*, 1992; Guilbert *et al.*, 1996; Lerdthanangkul and Krochta, 1996; Avena-Bustillos *et al.*, 1997; McHugh and Senesi, 2000). They are applied directly on the food surface by dipping, spraying or brushing to create a modified atmosphere (Guilbert *et al.*, 1996; Krochta and Mulder-Johnston, 1997; McHugh and Senesi, 2000).

Recently there has been increased interest in using *Aloe vera* gel as an edible coating material for fruits and vegetables driven by its antifungal activities, biodegradability and eco-friendliness. (Saks *et al.,* 1995; Martinez-Romero *et al*., 2003 ; Rodriguez de Jasso *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 nectarines (Valverde *et al.,*2005; Martinez-Romero *et al*.,2006; Ahmed *et al*.,2009) .

MATERIALS AND METHODS

Preparation of *Aloe vera* gel (edible coatings):

Matured leaves of *Aloe vera* plant were harvested and washed with a mild (25%) chlorine solution.. *Aloe vera* gel matrix was then separated from the outer cortex of leave and this colorless *hydroparenchyma* was grounded in a blender .The resulting mixture was filtered to remove the fibers. The liquid obtained constituted fresh *Aloe vera* gel. The gel matrix was pasteurized at 70^oC for 45min. For stabilization, the gel was cooled immediately to an ambient temperature and ascorbic acid (1.9 - 2.0g L^{-1}) was then added. Citric acid (4.5 - 4.6gL^{-1}) was added to maintain the pH at 4. The viscosity of the stabilized *Aloe vera* gel and its coating efficiency was improved by adding 1% commercial gelling agent before use as coating agent. It was later stored in brown Amber bottle to prevent oxidation of the gel (He *et al.,*2005).

Source of oranges: Freshly harvested oranges were procured from a local market in Ilorin, Kwara State, Nigeria. They were selected on the basis of size, color and absence of external injuries. Fresh leaves of *Aloe vera* were obtained from the garden of the Nigeria Stored products Research Institute, Ilorin.

Surface preparation of the oranges: Surface preparation was primarily to remove all contaminants that would hinder proper coating adhesion and to render a sound clean substrate, suitable for firm bonding. Surface sterilization of the oranges was carried out by soaking them in 25% hypochlorite solution for two minutes.

Treatments

T_o (control):- Untreated oranges.

$T_{1:-}$ Oranges coated with *Aloe vera* gel.

The treated and untreated oranges were packed in small plastic baskets and each basket contained 20 orange fruits. The baskets were stored at ambient temperature (27+2^{o}C) and at 50-60% relative humidity .Physiochemical analysis were carried out from 1-5weeks after coating.

Total soluble solids (TSS):- Total soluble solids (TSS) were measured by the method described by Dong *et al*. (2001) .Individual orange fruit from each of the treatment were ground in an electric juice extractor for fresh prepare juice. Soluble solids content were measured using T/C hand refractometer in Brix% (Model 10430 porx-reading 0.30 ranges Bausch and Lomb CO. Calif., USA.

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. Oranges were sliced into halves and each half was measured in the central zone.

Water content: - The water content of the orange fruit was determined using the following equation.

$$\text{Water content (\%) } 100 \times \frac{M_1-M_2}{M_1}$$

Where: M_1 = Mass of sample before drying in g.

M_2 = Mass of sample after drying, in g.

Reducing sugar

The reducing sugar of oranges was determined using Fehling's method (Mendham *et al.*, 2000) while the ascorbic acid content was measured using 2, 5-6 dicholorophenol indophenols' method (A.O.A.C 1994).

Statistics

The results of this investigation are means of six measurements. To verify the statistical significance of all parameters the values of means ± S.E. were calculated.

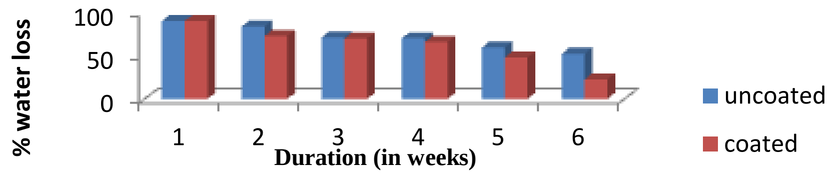

Fig 1: Effect of *Aloe vera gel* on water content of orange fruit…

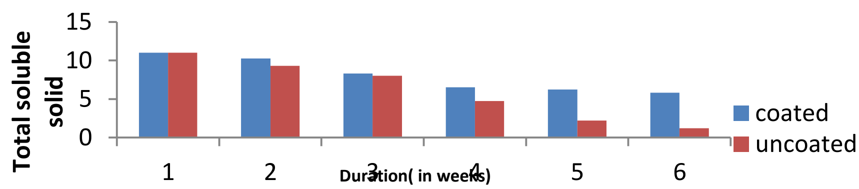

Fig 2: Effect of *Aloe vera gel* on T S S of orange fruits during storage at…

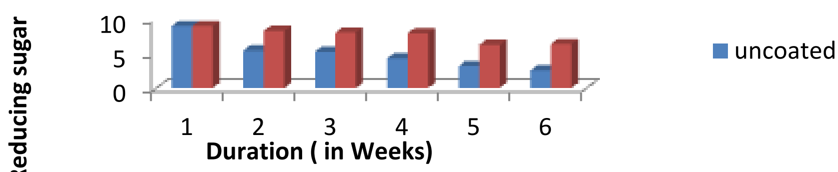

Fig 3:Effect of Aloe vera gel on Reducing sugar of orange fruits during storage at ambient temperature

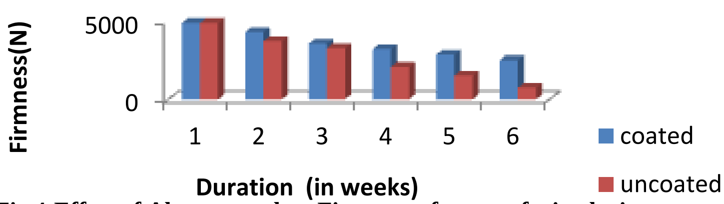

Fig 4:Effect of Aloe vera gel on Firmness of orange fruits during storage at ambient temperature

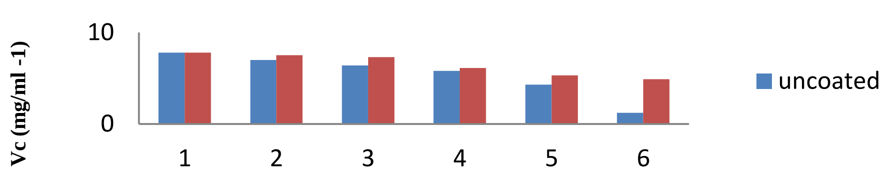

Fig5:Effect of *Aloe vera gel* on Vitamin C of orange fruit during ambient storage

RESULTS AND DISCUSSION

Water content

The mean±SE value for the weight loss of coated oranges was 64.09±7.13 while the mean±SE value for the weight loss of uncoated oranges was 89.65±5.82. These results are in agreement with those of Mahmoud and Savello (1992) and Avena-Bustillos *et al.* (1997) who concluded that coatings and/or films significantly conserved water content.

Post harvest weight changes in fruits and vegetables are usually due to the loss of water through transpiration. This loss of water can lead to wilting and shriveling which both reduce a commodity's marketability. Edible films and coatings can also offer a possibility to extend the shelf life of fresh-cut produce by providing a semi-permeable barrier to gases and water vapor and therefore, they can reduce respiration, enzymatic browning and water loss (Guilbert, 1986; Baldwin & Nisperos-CarriedoBaker, 1995).

Total soluble solids (TSS)

The mean ± SE value for the TSS of coated orange was 8.025±0.9 while the the mean ± SE value for the TSS of uncoated oranges was 6.08±1.63. These results are in agreement with those of Smith and Stow (1984) who concluded that coatings and/or films significantly affected TSS.

Soluble solids content of coated and uncoated oranges stored under cold condition was decreased at the end of the storage period. The loss of soluble solids during storage period is as natural as sugars which are the primary constituent of the soluble solids content of a product consumed by respiration and used for the metabolic activities of the fruits (Özden & Bayindirli, 2002).

The mean±SE value for the reducing sugar of coated oranges was 7.61±0.45 while the mean±SE value for the reducing sugar of uncoated oranges was 4.94±0.92.These results are in agreement with those of Ahmad and Khan (1987), El Ghaouth *et al.* (1991) and Li and Yu (2000) and McHugh and Senesi (2000) who concluded that coatings and/or films significantly affected reducing sugar content of produce.

The mean±SE value for the firmness of the coated was 3554.33±368.22 while the mean±SE value for the uncoated was 2708.67±626.19. Lerdthanangkul and Krochta (1996) also made similar observations and concluded that coatings and/or films significantly affected firmness of fruits in storage. The softening process in orange has been reported to be dependent on the increase in polygalacturonase, ßgalactosidase and pectinmethylesterase activities

(Batisse *et al*., 1996; Gerardi *et al*., 2001; Rem´on *et al*., 2003), being responsible for fruit quality loss. *A. vera* treatment significantly reduced the firmness losses (more than 50%) during ambient storage compared with the control fruits. In addition, *A. vera* gel probably had some effects on the reduction of cell wall degrading-enzymes responsible for orange softening. These results show beneficial effects of the *Aloe vera* coating on increasing the orange shelf life, since it has been postulated that fruit softening and texture changes during the orange storage determine fruit storability and shelf life as well as reduced incidence of decay and less susceptibility to mechanical damage (Batisse *et al*., 1996; Vidrih *et al*., 1998).

The mean±SE value for the coated orange for Vitamin C was 6.48±0.50 while the mean±SE value for the uncoated was 5.41±0.51. Ascorbic acid is lost due to the activities of phenoloxidase and ascorbic acid oxidase enzymes during storage past workers (Salunkhe *et al*., 1991 Weichmann *et al*. 1985), while studying green bean, spinach and broccoli, postulated that the lower the oxygen content of the storage atmosphere, the smaller is the loss of ascorbic acid. The claim was that the oxidation of Vitamin C was mainly regulated by ascorbic acid oxidase and other oxidases, most of which had a low affinity for oxygen. Ascorbic acid content decreased for cherries stored at both ambient temperature and cold temperatures. *Aloe vera* gel coatings were effective in reducing the ascorbic acid loss for both storage conditions (Fig. 5). At the ambient temperature, the ascorbic acid contents of *Aloe vera gel* coated orange were significantly different from the control orange. The reduction of ascorbic acid loss in coated orange was due to the low oxygen permeability of *Aloe vera gel* coating which lowered the activity of the enzymes and prevented oxidation of ascorbic acid.

The effect of low temperature significantly reduced the ascorbic acid loss. This shows the effect of temperature on the activities of the related enzymes.

CONCLUSION

Aloe vera gel, applied as edible coating in orange fruit, has beneficial effects in retarding the ripening process. This treatment was effective as a physical barrier and thus reduced the weight loss during postharvest storage. In addition, *A. vera* gel delayed softening, ascorbic acid and TSS losses and maintained the quality of the orange fruits.

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