E-ISSN: 2346-7290

Evaluation of wax preservatives on post-harvest quality and sensory characteristics of cucumber (*Cucumis sativus*)

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ABSTRACT:

Wax coating has been used in preservation and extension of shelf life of fruits and vegetables. Various wax coatings (Aloe vera, Polythene film, and Candle wax) were applied on freshly harvested cucumber to determine the effect on weight loss, moisture content, pH, total solids, total sugar brix, ash content, vitamin C as well as sensory characteristics. The experiment was carried out over a 21day period at ambient temperature. Results obtained indicated that coating Cucumber (*Cucumber sativus*) with Aloe vera gel led to lower weight losses of 7.3% between week 2 and week 3 compared to control with a value of 20.3%. Also, Aloe vera coated Cucumber exhibited significantly higher moisture content 98.01%, total solids 2.40, total sugar (brix) 8.80, pH (5.18), and vitamin C (0.51mg/100ml) after one week of storage at ambient temperature. All treatment samples - Aloe vera wax, Polythene film, Candle wax and Control showed decreased value for the parameters examined over a 21day storage period. Sensory evaluation conducted by a twenty-five (25) member panel revealed that both Aloe vera and Polythene film coated samples had higher consumer preference scores in terms of color, texture and overall acceptability than the Candle wax or Control in week 1, 2, and 3, respectively.

Keywords: Cucumber, Aloe vera, Candle wax, Polyethene film

INTRODUCTION:

Cucumbers, (*Cucumis sativus*) belong to the family Cucurbitaceae. *Cucumis sativus* is native to the Indian subcontinent (Sebastian *et al.,* 2010). Cucumbers are among the most widely grown vegetable crops all over the world. Fruit and vegetables provide an abundant and inexpensive source of energy, body-building nutrients, vitamins and minerals which their nutritional value is highest when they are fresh, but it is not always possible to consume them immediately. Most fruits and vegetables are only edible for a very short time, unless they are promptly and properly preserved.

Spoilage is considered as any changes which renders a product unacceptable for human consumption (Hayes, 1985). Spoilage of fruits and vegetables starts as soon as they are cut off from their natural nutrient supply, their quality begins to diminish, and this is due to a natural process that starts as soon as the biological cycle is broken by harvesting.

Improper storage condition of vegetables (cucumber) both at low temperature (below 10^{o} C) and at ambient temperature rapidly leads to water loss, decay, and yellowish colour in several days that lead to unacceptable quality in the market (Mikal, 2010).Microorganisms that cause spoilage can be introduced to the crop on the seed itself, during crop growth in the field, during harvesting and postharvest handling, or during storage and distribution (Burnett and Beucher, 2001). Soil-borne spoilage microbes that occur on produce are present on harvesting equipment, on handling equipment in the packinghouse, in the storage facility, and on food contact surfaces throughout the distribution chain.

To prevent harvested products from spoiling, they can be preserved by using different methods which are; heating, drying, freezing, use of additives (salt and sugar), and coating (coating agents are usually used to extend the shelf-life of fruits during their storage). Application of these preservatives helps to deal with the decrease of moisture and aroma losses, the delaying of colour changes and gas transfer, and the improvement of the general appearance of the product through storage (Olivas and Barbosa-Canovas, 2005). In addition to the extension of shelf life of fruits and vegetables, antimicrobial agents such as essential oils in edible coatings can extend their shelf life by releasing the essential oils slowly on the surface of the product and maintaining their high concentration during the packaging process (Ouatarra *et al.*, 2000).

The ascorbic acid and caffeic acid contained in cucumber help to reduce skin irritation and swollen (Okonmah, 2011) joints. Cucumber is a dependable laxative food for those who suffer constipation. The juice of cucumber is a valuable medicinal food in the treatment of hyperacidity gastric and duodenal ulcers (Ernestina, 2001).Cucumber fruit is composed mostly of water; more than 96% of edible unpeeled fruit is water. Other constituents of *Cucumis sativus* L, are vitamins, minerals, amino acids, phytosterols, phenolic acids, fatty acids, and cucurbitacins. Furthermore, traces of essential oil, amino acids, pectins, starch, sugars, vitamin C, and curcurbitacin are found in cucumbers (Patri and Silano, 2002). Glycosides, steroids, flavonoids, carbohydrates, terpenoids, and tannins were identified in an aqueous extract of the cucumber fruit (Kumar *et al.*, 2010).

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 vapor loss and provide a vehicle for fungicides (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.

Aloe Vera is a tropical and subtropical plant that has been used for centuries for its medicinal and therapeutic properties (Eshun and He 2004). Aloe Vera commonly referred to as a medicinal plant is known for its wide range of therapeutic properties. Major liquid components of Aloe Vera are yellow latex (exudate) and clear gel (mucilage), which proceeds from the large leaf parenchymatic cells (Ni *et al*., 2004).Aloe Vera gel is used in the cosmetic industry including treatment of burns and scars and wound healing (Aburjai *et al*., 2004). There are some reports on the antifungal activity of Aloe vera gel against several pathogenic fungi including Botrytis cinerea (Jasso *et al.*, 2005).

Wax coatings are an attractive alternative for the extension of shelf life and post- harvest storage of fruits. They constitute a covering on the material that acts as a barrier to transmission of gases, improving appearance, moisture content, oxygen and carbon dioxide diffusion and in this manner prolong shelf life and improve quality (De Leon-Zapata *et.al*, 2017). Sathivel (2005) reported that wax coating can be applied directly on the fruit or vegetable surface in liquid form by immersion, aspersion or brushing.

Fruit and vegetables have a short shelf life spanning only a few days after harvest. Most of the harvested vegetables are lost as a result of poor storage methods arising from lack of infrastructures or poor storage facilities. In Nigeria more than 30% of harvested vegetables are lost due to spoilage and they do not reach the final consumer, this translates into huge financial losses and food insecurity. The objective of this research is to determine the effect of various wax preservatives on the nutrient content, shelf life and sensory characteristics of cucumber stored at ambient temperature.

MATERIALS AND METHODS:

The Experiment was carried out in the Department of Crop and Soil Science laboratory, University of Port Harcourt, Nigeria.

Preparation of Samples

The cucumbers were washed under flowing water to remove dirt, and wiped dry with fine linen.

Preparation of Aloe Vera Gel

Matured leaves of aloe vera were harvested and washed with a mild 25% chlorine solution. Aloe vera matrix was separated from the outer cortex of the leaves and the colorless hydroperenchyma was homogenized in a blender and the mixture was filtered to remove the fibers. The gel matrix (Aloe vera) was pasteurized in a water bath at 70^{o} C for 15mins and allowed to cool immediately to ambient temperature.

Ascorbic acid (2.0g/l) and citric acid (4.5g/l) were then added to maintain its pH at 4. The coating efficiency and viscosity of Aloe vera gel was improved by the addition of 1% commercial gelling agent (methyl cellulose). The prepared treatment was then stored in a brown amber bottle to prevent oxidation of gel using the method described by He *et al.*, (2005).

Preparation and Application of Candle Wax

Solidified candle wax was placed in a stainless bowl and placed over a Bunsen burner where it was allowed to melt. After melting while it is still on the burner, the prepared cucumbers were manually rubbed with the wax using a fine bristle brush.

2.5 Determination of Weight loss

This was taken weekly using analytical balance (model Rs 6000) to determine fruit weight loss. The difference between the initial and final weight of the cucumbers were calculated. The formula used to calculate % weight loss was

$$\text{Wt loss (\%)} = \frac{\text{Initial wt} - \text{wt of sample}}{\text{Initial wt}} \times 100$$

Determination of Ascorbic Acid

Ascorbic acid content of the samples was determined by titration using the standard indophenol solution. The standard solution was prepared by dissolving 0.05g of 2,6 dichlorophenolindophenol in water and diluting to 100ml mark. Then, 0.05g of ascorbic acid is dissolved in 60ml of 20% metaphosphoric acid and diluted with 250ml of distilled water. Sample determination was carried using 50ml of unconcentrated juice

pipetted into 100ml volumetric flask and 25ml of 20% metaphosphoric acid added and made up with distilled water. Thereafter, 10ml was pipetted int a small flask. A known volume (2.5ml) acetone, was added to the small flask and titrated against the indophenol solution until a faint pink color persists for 15secs. The vitamin C content calculated as mg/100ml of sample.

Determination of pH

The pH of the cucumber extract was determined directly using a digital pH meter (Model PHS-2F). The pH meter was first calibrated using Buffer solutions of pH 4 and 7.

Determination of Total Sugar (Brix)

The hand held sugar refractometer was used. The prism of the refractometer was cleaned and a drop of the cucumber extract was placed on the prism and closed. The total soluble solids (Brix %) was read off the scale of the refractometer.

Determination of Total Solids

Total solid contents of cucumber were determined using the A.O.A.C. (2005). A dish with cover was cleaned and dried at 105^{o}C for 15 minutes and cooled in a desiccator for 10 minutes and weighed (W_1). Five grams of the sample was then weighed into the dish (W_2) and the dish and the content dried at 105^{o}C for 4hours in an air oven (Shang Hang) until a constant weight was obtained. The dish and its content were then removed from the oven, cooled in a desiccator and weighed again (W_3). The weight of the solid was then calculated using the formula

% Total solid = 100 – % Moisture content

$$\% \text{ Moisture content} = \frac{W_3 - W_2}{W_2 - W_1} \times \frac{100}{1}$$

Determination of Ash content.

AOAC (1990) method was used in the determination of ash content of the samples. One gram (1g) of sample was weighed into a previously ignited and cooled porcelain crucible with lid. The crucible and sample were heated on a heating mantle in a fume cupboard until smoking ceased. The crucible and the content were then transferred to a muffle furnace and allowed to ash for three hours at 500^{o}C. The crucible with its content were removed from the furnace and cooled in a desiccator, and weighed again. The percentage ash content of the sample was then calculated as follows;

$$\text{Ash (\%)} = \frac{Weight\ of\ ash}{Weight\ of\ sample}\ x\ 100$$

Sensory Evaluation.

Sensory evaluation was carried out in accordance with the method described by Iwe (2010). A sensory panel twenty- five (25) members were used in determining the degree of acceptability, using a nine -point hedonic ranking scale. Sensory characteristics of colour, texture, flavor and overall acceptability were evaluated in accordance with the method described by Iwe (2005). Samples were evaluated by panelist for acceptability scores, Liked extremely = 9, Liked very much = 8, Liked moderately =7, Liked slightly = 6, Liked or Disliked = 5, Disliked slightly = 4, Disliked moderately = 3, Disliked very much = 2, Disliked extremely = 1

Statistical Analysis.

Data was collected in triplicate samples and analyzed using analysis of variance and least significant difference.

RESULTS

Results (Table 1) showed reduction in weight from 11.9% to 7.3% for Aloe vera coated cucumber between week 1 and week 3 of the storage duration, while Polyethene coating and the control samples had higher margins of weight loss of 16.1% from week 1 to week 2 and 20.9% between week 2 and week 3. Also, the control samples showed that the weight loss between week 1 and week 2 was 4.6%, with an increase of 20.9% occurring in week 2 and week 3.

Table 1: Effect of treatments and storage time/duration on Weight Loss

Treatment	Week 1	Weight loss (%)	Week 2	Weight loss (%)	Week 3
Aloe vera	232.46[b]	11.9%	204.70[b]	7.3%	189.74[a]
Candle wax	288.73[a]	73.1%	77.70[c]	0.00	0.00[c]
Polythene film	223.30[b]	16.1%	187.47[b]	20.9%	148.21[b]
Control	278.19[a]	4.6%	265.41[a]	20.9%	209.73[a]
LSD	12.60		27.01		26.86

Means of the same letter in a column are not significantly different

Aloe vera coated samples (Table 2) showed higher moisture content (98.01) than all other samples. The results also showed higher vitamin C content 0.51mg/100ml after one week of storage period, with no significant differences existing in total solids samples between the aloe vera coated samples and polyethene coated samples. Also, there was no significant difference between Aloe vera coated samples and polyethene coated samples for total sugar brix indicating that the treatment had no effect on total sugar with the first 7 days of storage.

The effect of various waxing preservatives on the chemical parameters of cucumber are shown in Tables 2, 3 and 4 for week one, two and three respectively. Results showed significantly higher moisture content for Aloe vera coated cucumber for the weeks under the study than all other sample with values ranging from 98.01 to 97.42% at the end of 3 weeks of storage under ambient conditions.

Results on Table 2 show that Aloe vera coated cucumber had significantly higher values of moisture 98.01%, pH 5.18, Total ash 0.33 and vitamin C 0.51mg/100ml when compared with other treatments as the control.

Table 2: Effect of Treatments on Physico-chemical parameters at week 1

Treatment	Moisture content %	Total Solid %	Total Sugar (Brix)	pH	Ash (%)	Vit. C (mg/100ml)
Aloe vera	98.01[a]	1.99[a]	8.80[a]	5.18[a]	0.33[a]	0.51[a]
Polythene	97.51[b]	2.49[b]	8.80[a]	4.97[b]	0.27[c]	0.40c
Control	97.24[c]	2.76[a]	8.00[b]	4.49[c]	0.32[b]	0.48[b]
LSD	0.30	0.15	0.00	0.00	0.00	0.03

Means of the same letter in a column are not significant different

Table 3 shows the effect of treatment on physico-chemical parameters. Results indicated that the moisture content of Aloe vera gel coated samples (97.93) were higher than polyethene 97.42 and control 97.03. Aloe vera coated samples value for total solids were 2.47 and total brix sugar 8.60 were significantly higher than other treatments. There was no significant difference in ash content and vitamin C content after 14 days (2weeks) of storage. The pH values showed aloe vera 6.86, polyethene 5.09 and control 4.88 respectively.

The effect of various wax treatment on chemical parameters after 3 weeks of storage duration are shown in Table 4. Vitamin C content values which ranged from 0.15 – 0.16mg/100ml across treatment samples did not show any significant difference. However, the ash content and pH values of aloe-vera coated samples were higher than the polyethene coated samples and control with values of 0.36 and 6.71.

Total solid content of the samples ranged from 1.99 – 2.58% for Aloe vera coated samples, 2.49 – 2.87% for polythene coated samples and 2.76 – 3.12% for control between week 1 and week 3 respectively. These results indicate a significant increase in the total solid content on a week by week basis. The increase in total solid content can be attributed to the loss of moisture from the samples.

The results after 3 weeks of storage also indicated that the polyethene coated samples had higher values of total solids 1.88 and total brix sugar 8.10. However, there were decreasing values for moisture, total brix, ash and vitamin C evaluated with the progression of time. The results also showed that all candle wax coated samples deteriorated to unacceptable levels after 1 week of storage.

Table 3: The effect of treatments on Physico-chemical parameters at week 2

Treatment	Moisture content %	Total Solid %	Total Sugar (Brix)	pH	Ash (%)	Vit. C (mg/100ml)
Aloe vera	97.93^{a}	2.07^{c}	8.10^{b}	6.86^{a}	0.36^{a}	0.20^{a}
Polythene	97.42^{b}	2.58^{b}	8.60^{a}	5.09^{b}	0.16^{a}	0.16^{a}
Control	97.03^{b}	2.97^{a}	8.10^{b}	4.88^{c}	0.37^{a}	0.16^{a}
LSD	0.11	0.79	0.00	0.00	0.25	0.10

Means of the same letter in a column are not significant different

Table 4: The effect of treatments on Physico-chemical parameters at week 3

Treatment	Moisture content %	Total Solid %	Total Sugar (Brix)	pH	Ash (%)	Vit. C mg/100g)
Aloe vera	97.42^{a}	2.58^{c}	7.70^{c}	6.71^{a}	0.36^{a}	0.16^{a}
Polythene	97.13^{b}	2.87^{b}	8.10^{a}	6.03^{b}	0.13^{c}	0.15^{a}
Control	96.88c	3.12^{a}	7.80^{b}	5.08^{c}	0.28^{b}	0.16^{a}
LSD (P<0.05)	0.14	0.08	0.00	0.00	0.01	0.03

Means of the same letter in a column are not significant different

The results of Sensory evaluation are shown in Tables 5, 6, and 7 for the period of study. The sensory preference scores indicated that Aloe vera and Polythene coated cucumber had significantly higher scores in terms of color, texture and overall acceptability than Candle wax or Control during the first, second and third week of study. All samples evaluated showed decreasing color acceptability with time progression. However, the use of coating considerably improved color acceptability. The results of the textural sensory characteristics of the Cucumber decreased with time. Results of Table 5 showed that Aloe vera and polythene film coated cucumber were significantly higher than the control with values 8.15 and 7.90 respectively.

Table 5: Effect of Treatment on sensory qualities of cucumber stored at week 1

Treatment	Colour	Texture	Overall acceptability
Aloe vera	7.80^{a}	8.15^{a}	8.00^{ab}
Candle wax	4.80^{b}	3.15^{c}	4.20^{c}
Polythene film	8.15^{a}	7.90^{a}	8.25^{a}
Control	7.80^{a}	7.65^{b}	7.40^{b}
LSD (P<0.05)	0.65	0.60	0.62

Means of the same letter in a column are not significant different

Table 6: Effect of Treatment on sensory qualities of cucumber stored at week 2

Treatment	Colour	Texture	Overall acceptability
Aloe vera	7.35^{ab}	7.80^{a}	7.45^{a}
Polythene film	7.50^{a}	7.60^{a}	7.60^{a}
Control	6.65^{b}	7.15^{a}	6.65^{b}
LSD (P<0.05)	0.79	0.72	0.76

Means of the same letter in a column are not significant different

Table 7: Effect of Treatment on sensory qualities of cucumber stored at week 3

Treatment	Colour	Texture	Overall acceptability
Aloe vera	5.75^{ab}	5.45^{a}	5.65^{a}
Polythene film	6.05^{a}	5.15^{a}	6.20^{a}
Control	5.30^{b}	4.75^{b}	4.45^{b}
LSD (P<0.05)	0.58	0.65	0.55

Means of the same letter in a column are not significant different

DISCUSSION:

Weight loss which occurs in cucumber fruits after harvest is due to transpiration associated with loss of water vapor to the surrounding atmosphere. However, Aloe vera coated cucumber had the least moisture loss compared to other treatments and this is due to the gel that sealed the surface of the fruit thereby reducing the amount of respiration and transpiration within and outside of the fruit leading to a reduced amount of water loss. This result is in agreement with the findings of Martinez-Romero *et al.,* (2006) who reported that Aloe vera gel coating has been effective in controlling water loss from other commodities such as sweet cherry.

Further, the findings of Morillon *et al.*, (2002) who reported the positive effect of Aloe vera coating in terms of reduction in moisture loss agrees with result obtained in this research. The hygroscopic properties of Aloe vera gel allowed the formation of water barriers between the fruit and surrounding environment,, thus preventing its external transferences may be responsible for reduction in weight loss.

The results indicate lower moisture loss from the Aloe vera coated samples. The result obtained is in agreement with the findings of Ahmed *et.al*, (2009) who reported that coating of Cherry fruits with Aloe vera gel resulted in reduced moisture loss and transpiration rate. Also, the vitamin C content and total brix of all the samples reduced over a 3week period.

The results at the end of week 2 (Table 3) indicated a reduction in values of vitamin C from 0.51mg/100ml to 0.20mg/100ml. The decrease in value of vitamin C could be attributed to the activity of ascorbic acid oxidase, an enzyme responsible for the breakdown of vitamin C during storage of fruits and vegetables. Similar results have also been reported by Arowora *et.al,* (2013) that ascorbic acid content of fruits was highest prior to ripening and then decrease due to the activity of Ascorbic acid oxidase. The results also showed an increase in the pH values of the coated cucumbers showing that some of the total solids and the organic acids have been broken to other components

Tables 6 and 7 showed decreasing values of texture profile scores with Aloe vera coated Cucumber samples being significantly higher than the control during the second and third week of storage. Overall acceptability sensory profile showed that both the Aloe vera coating and polythene film were not significantly different during the duration of study between week 1 and week 3. Similar improvement has been reported on sensory evaluation scores for wax coated pea stored over a four-week period (Molina *et.al*, 2015). Jena et.al, (2019) reported similar improvements in organoleptic properties, shelf life and fruit quality of pomegranates coated with Aloe vera gel. The aloe vera coated samples displayed lower weight losses, shinny appearance, minimum loss in ascorbic acid content

CONCLUSION

The application of wax coating as preservatives resulted in shelf life extension of the harvested cucumbers compared to the control. The results indicated that coating cucumbers with Aloe vera gel led to improved textural characteristics of the product. Physico-chemical analysis revealed that there was improved moisture retention in the cucumber fruits over a 21day storage period. Coating cucumber with Aloe vera gel or polythene film also led to a reduction in the loss of vitamin C.

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