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Storage Stability of Cucumber (*Cucumissativus L.*) Using Aloe Vera Gel: A Preliminary Evaluation

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Structured Abstract:

Purpose: Preservation and storage of cucumber has overtime, posed a problem for rural farmers especially in Nigeria due to their limited access and transportation to daily markets, thus resulting in postharvest and economic losses. This paper investigates the storage stability of cucumber using aloe vera gel as a preservative.

Design / methodology / approach: A structured comparative evaluation method was utilized in determining the results of this investigation.

Findings: The highest moisture loss was observed to have occurred in samples having no preservation treatment while the least moisture loss occurred in samples under refrigerated storage. It was also revealed that the untreated samples had the highest degree of ripeness followed by the aloe vera treated. Furthermore, the samples stored under refrigerated condition had the highest degree of shriveling while aloe vera treated samples scored highest in the evaluation for general acceptability.

Originality / Value: This paper shows that aloe vera gel coating is an effective preservative for freshly harvested cucumber; thus can be employed by rural farmers to cut postharvest and economic losses.

Keywords: Aloe Vera Gel, Cucumber, Storage Stability, Bio-preservative.

Paper Type: Research Paper.

Introduction

Consumers around the world demand for food of high-quality, without chemical preservatives, and an extended shelf life. This has led to many storage techniques which have been developed to extend shelf life of food, especially of fruits and vegetables which are generally highly perishable after harvest. Some deteriorating fruits and vegetables are accompanied by the production of poisonous agents, while others inflict loses in the essential nutritive value of the food. The successful application of modern food preservation techniques permits the conservation of inherent desirable food qualities, stabilize food supply and boost food security both locally and globally. Edible films and coatings with the ability to extend shelf life have received much attention in recent years due to their advantages over synthetic films.

Aloe vera, a tropical and subtropical plant is well-known for its numerous medicinal properties. Its gel, alternative to synthetic preservatives such as sulfur dioxide, is colourless, odourless (Jawadul *et al.,* 2014) and nutritionally safe to consume. Aloe vera gel-based edible coatings have been shown to prevent loss of moisture and firmness, control respiratory rate and maturation development, delay oxidative browning and reduce microorganism proliferation in fruits such as table grapes (Castillo *et al*., 2010), sweet cherries (Martinez-Romero *et al*., 2006)and nectarines (Ahmed *et al*., 2009).According to the researchers, this gel operates through a combination of mechanics, forming a protective layer against the oxygen and moisture of the air and inhibiting the action of micro-organisms that cause food borne illnesses through its various antibacterial and antifungal compounds (Serrano *et al*., 2006).

Cucumber (*Cucumissativus L.*) is one of the most important vegetables and one of the most popular members of the *cucurbitaceae* family (Thoa, 1998; Eifediyi & Remison, 2010). The crop is the second most important vergitable after tomato in Western Europe (Phu, 1997) and the forth most important crop after tomato, cabbage and onion in Asia (Tatlioglu, 1997). According to Eifediyi & Remiison (2010), its ranking in tropical Africa is yet to be determined due to its limited use. Cucumber is generally harvested when the fruit is small and immature and can be held in storage for about two weeks at proper temperature and relative humidity. In Nigeria, commercial farming of cucumber is often done by rural farmers with limited access and transportation to daily markets. Preservation and storage of cucumber has overtime, posed a problem for these rural farmers, thus resulting in postharvest and economic losses.

Considering Aloe vera’s success on bio-preservation of table grapes, cherries, mangos and nectarines, and increasing demands for environmentally friendly postharvest handling procedures, we investigated the use of Aloe vera gel as bio-preservative for cucumber (*Cucumissativus L.*) The main reason of choosing this cucumber vegetable in our study is due to their distinctive green vegetable coloration which is frequently used as a quality index (Khanizadeh & Cousineau, 1998). In this study, the storage stability of locally grown cucumber vegetable in Nigeria using aloe vera gel as an effective preservative was investigated.

Materials and Method

Materials

Fresh and healthy Aloe vera leaves were obtained from a horticultural garden in Ilorin, Kwara state, Nigeria. Fresh harvested and uninjured cucumbers were obtained from the fruit and vegetable farm at the Farm Management Unit (FMU) of the National Centre for Agricultural Mechanization, (NCAM), Ilorin, Kwara state, Nigeria. A refrigerator and an electric blender were also used for this experiment.

Sample Preparation

Aloe gel which lies underneath the green outer leaf rind of the plant was obtained by separating the outer cortex of leaves from the gel. The gel was blended with an electric blender for 3 minute at low speed to homogenize, and the resulting gel poured into a plastic bowl for use.

The whole, freshly harvested and uninjured cucumbers were weighed, separated in three parts and labeled as $\mathbf{C_T}$, $\mathbf{AL_T}$ and $\mathbf{U_T}$ respectively; with $\mathbf{C_T}$ representing samples preserved under refrigerated storage, while $\mathbf{AL_T}$ represents samples preserved using aloe vera gel and $\mathbf{U_T}$ represents control sample with no preservation treatment (stored under ambient conditions).

Method

Three replicate samples of $\mathbf{C_T}$ were weighed, placed in a plastic tray and stored in a refrigerator at 4^0C for 30 days. The samples were removed and reweighed and replaced at an interval of 5 days. The average weight of the samples from the commencement of the experiment to the end of the experiment were noted and recorded.

Three replicate samples of $\mathbf{AL_T}$ were also weighed, coated with aloe veral gel and placed in a plastic tray and stored under ambient conditions in a ventilated room at an average temperature of 34^0C.The average weight of the samples from the commencement of the experiment to the end of the experiment were noted and recorded.

Three replicates of the control sample, $\mathbf{U_T}$, were weighed and placed in a plastic tray with no preservative treatment and stored under ambient conditions in a ventilated room at an average temperature of 34^0C.The average weight of the samples from the commencement of the experiment to the end of the experiment were noted and recorded.

Determination of Moisture loss

The degree of moisture loss was determined as a function of weight loss. The initial weight of the samples were taken and recorded prior to the commencement of the experiment while the subsequent weight were taken and recorded at 5 days interval for 30 days.

Moisture loss, (M_L) was determined by subtracting the final weight at the end of the experiment (W_{f30}) from the initial weight (W_i) at the commencement of the experiment.

Determination of Degree of Ripeness, Degree of Shrinkage, Degree of Firmness and General Acceptability

Samples selected for this experiment were examined prior to the commencement of the experiment by a semi-trained 10-member panel. This is to ensure that the selected samples have similar attributes and are free of any form of injuries. At the end of the experiment, the samples were reexamined alongside the pictures of the samples before the commencement of the experiment by the same team of panelists. Attributes such as degree of ripeness, shrinkage, firmness and general acceptability, were evaluated through physical observation, using a comparative evaluation method.

Results and Discussion

Table 1.0 shows the summary of results obtained for moisture loss while Table 2.0 is a summary of the results obtained from the determination of Degree of Shrinkage, Degree of Firmness and General Acceptability.

Moisture Loss

From Table 1.0, it could be observed that there is a gradual increase in moisture loss from all the three samples under study.

The table also revealed that the highest moisture loss occurred with sample having no preservation treatment while the least moisture loss occurred with sample under refrigerated storage.

The less moisture loss from the refrigerated sample (C_T) could be attributed to the low temperature treatment it was subjected to. This could imply that the rate of respiration of the cucumber samples under refrigerated storage was retarded. According to Desrosier & Desrosier (1987), John (2008), cooling reduces the rate of respiration of a freshly harvested commodity. Desrosier & Desrosier (1987) opined that low temperatures near the freezing point of water are effective in reducing the rate at which transpiration occurs, thus, concluding that such temperatures have been found to be valuable in short time preservation of foods.

The higher moisture loss from the untreated samples (U_T) could be attributed to the relatively high rate of respiration. Fruits after separation from parent plant (harvest) continue to respire at the expense of the stored food material, which depending on the rate of metabolism accelerates the process of aging and ripening. This process was described by Biale (1975), and Desrosier & Desrosier (1987). According to the researchers; After harvest, the decline in the rate of oxygen uptake and CO_2 evolution to a low value is followed by a sharp rise to a peak terminating in a post-climacteric stage. This minimum to peak ratio tends to increase with higher storage temperature and low humidity.

Samples treated with aloe vera gel (AL_T) as an edible coating showed a higher level of moisture loss than samples under refrigerated storage but had lesser moisture loss than untreated samples. This occurrence could be attributed to the effect of aloe vera coating on the samples. Aloe vera gel which operates through a combination of mechanics (Serrano *et al*., (2006), partially clogs thestomatal pores of the samples, forming a protective layer against the surrounding oxygen while limiting CO_2 evolution in the samples under consideration. This is in line with the findings of Castillo *et al*., (2010). The surface tension created by the coating may have also been helpful in limiting the interaction of the atmospheric moisture with the sample under study. According to Castillo *et al*., (2010); John (2008), application of edible coatings and waxes on fresh fruits and vegetables has been found to be helpful in reducing their postharvest moisture and weight loss.

Degree of Ripeness, Degree of Shriveling, Degree of Firmness and General Acceptability

The summary of results for comparative physical evaluation is presented in Table 2.0.

Degree of Ripeness

From Table 2.0, it could be observed that 6 evaluators indicated that the untreated sample had the highest degree of ripeness while 4 evaluators indicated same for samples treated with aloe veragel. This is further demonstrated in Figure 1.0. According to the evaluators, samples under refrigerated storage had the least degree of ripeness.

The high degree of ripeness observed in the untreated samples could be attributed to the breakdown of chlorophyllas a result of the action of ethylene gas under ambient conditions without any preservative treatment. Ethylene gas is a ripening hormone which is responsible for the breaking down of the green chlorophil pigments in the exterior part of the peels of fruits and vegitables, allowing carotinoid pigments to be expressed. According to John (2008), oxygen is also needed for the breakdown of chlorophyll. The rapid breakdown of chlorophyll in the untreated samples could therefore be as a result of inherent biochemical process which resulted in the emission of ethylene gass, relatively high level of respiration in the sample, giving rise to higher loss of green pigments. Hoa *et al*., (2002) and Carillo-Lopez *et al*., (2000) obtained similar results while experimenting on mango.

The lower degree of ripeness observed in samples treated with aloe vera gel could be attributed to the respiratory inhibition effect of aloe vera gel. This respiratory inhibition may have interfared with the production of ethylene gas, giving rise to small amount of ethylene being produced. The protective action of aloe vera gel against atmospheric oxygen on the sample under study may have also assisted in the delayed breakdown of the green pigments. This resulted in the samples retaining its green pigments for a longer time when compared to the untreated samples. The partial clogs of the stomatal pores of the samples may have also contributed to the slow buildup of CO_2 in the samples under study, further delaying oxidative action involved in the chlorophyll breakdown. This is similar to the result obtained by Ergun & Satici (2012), Dang *et al*., (2008), Hoa *et al*., (2002) and Carillo-Lopez *et al*., (2000). According to the researchers, this may be attributed to modified atmospheric conditions created by Aloe vera gel coating, in return, delaying chlorophyll degradation and carotenoid synthesis.

The least degree of ripeness observed with refrigerated samples could be attributed to the slow level of chlorophyll breakdown as a result of the cold temperature treatment. The metabolism of living tissues is a function of the temperature of the environment; Lower temperatures greatly retard metabolism. (Desrosier & Desrosier, 1987). This suggests that the low level of metabolism in the samples under study may have been responsible for the slow rate of chlorophyll breakdown, resulting in delayed ripening.

Degree of Shriveling

Shriveling or Chilling is a major problem in postharvest handling of fruits and vegetables. This is because many tropical and subtropical fruits and vegetables are sensitive to low temperature storage below 10^0C and develop symptoms of chilling injury, making the commodity unfit for marketing (John, 2008).

From Figure 1.0, it could be observed that the highest degree of Shriveling occurred for samples under refrigerated storage while the other samples had no shriveling. This shriveling occurrence may be attributed to changes in membrane permeability, changes in cell wall structure, abnormal respiratory activity and impairment of enzyme activity of the chilled sample at 4^0C, since the samples were not enclosed in the thin low density polyethylene (LDPE) bags as described by John, (2008). According to the researcher, Banana, Papaya and mango when enclosed in sealed polyethylene bags, develop modified atmosphere and humidity inside the bags and helps alleviate chilling injury symptoms. It could therefore be inferred that direct chilling of cucumber at 4^0C results in shriveling of the samples.

Degree of Firmness

Texture is an important attribute demanded by consumers and most of the time is responsible for fruit acceptability.

It could be observed from Figure1.0 that the highest degree of firmness occurred for samples treated with aloe vera. This could be attributed to the reduced rate in the breakdown of its cell wall components as a result of the slow rate of ripening and respiratory activities caused by the aloe vera gel. Inhibition of bacterial activities may also have contributed to the slow rate of cell wall breakdown. This is in line with the findings of Castillo *et al*., (2010), Ahmed *et al*., (2009) and Martinez-Romero *et al*., (2006). According to the researchers, aloe vera gel-based edible coatings have been shown to prevent loss of firmness and reduce the activities of microorganisms in fruits such as table grapes, sweet cherries and nectarines. The rate and extension of firmness loss during storage are the main factors determining fruit quality and postharvest shelf life (Padmaja & Bosco, 2014).

The control samples however, showed a higher loss of firmness according to Table 2.0. This could be due to the higher rate of respiration and ripening. Hongmei *et al*., (2009) during her work on Indian jujube (*Zizyphusmaurtiana*), discovered that the firmness level of jujube fruits coated with aloe vera gel was significantly higher than the control samples which were not treated with aloe vera. The researchers thus concluded that the firmness loss in the control samples was mainly due to fruit softening/ ripening which was due to the degradation of cell wall components, mainly pectins, by the action of specific enzymes, such as polygalacturonase.

The samples under refrigerated storage, according to Table 2.0, appeared to have the least level of firmness. This judgment may be attributed to the high level of chilling injury experienced in the samples. This chilling injury which may have resulted due to the changes in membrane permeability, changes in cell wall structure and abnormal respiratory activity may have influenced the judgment of the evaluators.

General Acceptability

Table 2.0 showed that samples preserved with aloe vera were generally more accepted that the other samples. This may be attributed to the physical characteristics of the sample at the end of the experiment. Sample treated with aloe vera showed lesser degree of ripeness, least degree of Shriveling and the highest degree of firmness during the comparative evaluation. These are the main characteristics often evaluated by consumers before purchasing cucumber from an open market.

Conclusion

From this study, the storage stability of cucumber (*Cucumissativus L.*) was revealed. The study revealed that Aloe vera gel coating is effective in suppressing weight loss, delaying ripening, maintaining firmness and preserving its freshness. The study further showed that cucumber preserved with aloe vera gel for a period of 30 days is generally more acceptable than ones preserved under low temperature at 4^0C or unpreserved. It could therefore be concluded that the shelf life and consumer acceptability of cucumber is increased if preserved using aloe vera gel as an edible coating.

Recommendation

This is a preliminary study. It is therefore recommended that a more comprehensive study on the effect of aloe vera on the storage stability of cucumber using a non-destructive firmness tester and an Instrumental colour tester be carried out. It is also recommended that the effect of aloe vera gel on the sensory attributes of cucumber be investigated.

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Table 1.0

Summary of results for moisture loss

Sample	W_i (g)	W_{f5} (g)	W_{f10} (g)	W_{f15} (g)	W_{f20} (g)	W_{f25} (g)	W_{f30} (g)	Moisture Loss (g)
C_T	628.2	592.8	543.5	508.1	486.8	476.1	470.8	157.4
AL_T	681.5	624.9	577.1	544.0	531.9	522.4	516.7	164.8
U_T	737.4	674.4	617.9	587.7	576.6	568.9	560.9	176.5

Table 2.0

Summary of results for comparative physical evaluation

Sample	**Degree of Ripeness**	**Degree of Shriveling**	**Degree of Firmness**	**General Acceptability**
C_T	0	10	0	0
AL_T	4	0	7	7
U_T	6	0	3	3

Figure 1.0

Chart for the summary of results for comparative physical evaluation