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Studies on postharvest loss assessment of Tomato fruits using Aloe Vera gel as mitigating agent

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Abstract

This work evaluates effect of aloe gel coatings on post-harvest quality management of red ripe tomato fruits. Red ripe tomato fruits were purchased from Mandate market, Ilorin, Kwara State. It was sorted and washed with potable water. The sample was divided into four (4) lots for dip treatment in already prepared different aloe vera solutions and labelled: A0 (control), A1 (1.5% aloe vera), A2 (50% aloe vera) and A3 (100% aloe Vera). The pre-treated lots were stored on a laboratory shelf at ambient for 15 days. Physicochemical and nutritional properties were evaluated using standard procedures. Moisture (97.58%) and ash contents (0.68%) of lot A3 (100% aloe gel) were significantly higher ($p<0.05$) than the other lots. Results showed that lot A1 had the lowest weight loss of 13.1%, while A3 recorded the highest (37.2%). Lot A1 had significantly ($p<0.05$) higher sensory attributes than the other lots. At day 15, TTA was between 0.13 and 0.35 %, with lot A1 recording significantly ($p<0.05$) higher value of 0.35 %. TSS content of the tomato fruits decreased with increase in storage with exception to lot A2 which had the highest value (5.30 ^{o}Brix). There was a decrease in pH value of both the untreated and treated lots. The results also showed that the vitamin C content of the stored tomato fruits increased significantly ($p<0.05$) in all the lots as storage days progressed. The result from the study showed that Lot A1 retarded water loss and delayed fruit softening thereby making them acceptable to consumer.

Keywords: Tomato; Aloe vera; Shelf-life; Coating; Storage

1. Introduction

Postharvest losses in fruits and vegetables occur during harvesting, conveying, storage and market, this accounts for about 20-30% postharvest loss [1];[2]. Tomatoes have been adjudged the 4th most pivotal thriving fruits and vegetable produce worldwide; it is a good source of bioactive chemicals, including vitamin C, carotenoids, and phenolic compounds [3]; [4]; [5]. Physicochemical profile of tomato fruits change significantly over time and with storage temperature [6]. These changes result in loss of quality and restrict its own natural shelf life as well as poor post-harvest management techniques which affects its availability all year round [7]; [4].

In recent time, use of synthetic packaging materials, have been discouraged due to consumers' apprehension on food safety with synthetic chemicals. The awareness is now on the use of chemically free compounds or natural biomaterials/products. Use of edible coating has been implored in promoting storability of fruits and vegetables because its usage has been documented to be cheap, readily accessible and effectual in extending storage time of some fruits and vegetables [8]; [1]; [9]; [10].

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Currently, plant based products have found potential and significance uses as preservatives for fruits and vegetables [11]. Aloe vera is a very short stemmed succulent plant belonging to the family Liliaceae. It is a tropical and subtropical plant, the two major liquid sources of Aloe vera are a yellow latex and a clear gel, which proceeds from the large leaf parenchymatic cells. Aloe vera commonly referred to as a "medicinal plant", is known for its wide range of medicinal (antifungal, antimicrobial and anti-inflammatory) and therapeutic properties [12]; [13]. The oral gel juice is mostly used medically to treat ulcers, gastrointestinal issues, cardiovascular and kidney problems. It also reduces cholesterol and triglyceride levels in blood [14].

Aloe vera gel-based edible coatings have been reported to prevent loss of moisture/minimize shrinkage, maintain colour and firmness, reduced physiological weight loss, oxidative browning, bacterial and fungi count, maintain ascorbic acid and total soluble solid contents. It has also been shown to control shattering, cracking and reduced microorganism proliferation in fruits such as [4]; [11], green grape berries [15] and Ber [16]. The objective of this research work was to study the effect of different concentration of aloe vera gel application on physiologically mature red ripe tomato fruits stored at ambient temperature.

2. Material and methods

2.1. Source of materials

Fresh harvested physiologically mature (Red ripe) tomatoes were procured from Mandate market, Ilorin, Kwara State, Nigeria. They were sorted for wholesomeness and those without bruises, washed with portable water and air dried. Mature leaves of aloe vera plant were collected from Nigerian Stored Products Research Institute, Ilorin. The leaves were washed with portable water and air dried to remove moisture from its surface. Aloe vera gel matrix was removed from the outer portion of the leaves and its colourless gel mashed using a kitchen blender (Philips HR2102). The gel obtained was filtered using a muslin cloth and pasteurized at 70 °C for 45min, to prevent enzymatic degradation.

2.2. Sample preparation

Aloe vera gel solutions were prepared following the method documented by Enab [17] with little modification. Aloe vera gel(1.5%, 50% and 100%) solutions were prepared by dissolving 15 g, 500 g and 1000 g aloe vera gel in 1 L of water and code-named as A1, A2 and A3 respectively.

The already sorted and cleaned tomato fruits were divided into four lots. Each lot was immersed accordingly in the different aloe vera gel solution (0%, 1.5%, 50% and 100%) for 10min and air dried. The immersed treated tomato fruits were then stored on the laboratory shelf for further investigations.

2.3. Sensory evaluation determination

Evaluation of the sensory attributes was carried out using the method reported by [18]. At day 15, the stored tomato fruits were presented to a 20-member semi-trained panelists selected based on their versatility with tomato fruits qualities. The following criteria: appearance, colour, odour, firmness and general acceptability were evaluated by the panelists using a five point hedonic scale.

2.4. Physicochemical properties determination

2.4.1. Weight loss (%)

Weight loss (%) was determined using the method documented by [19]. Tomato sample was weighed using a top-loading digital balance (CAMRY ACS-30-JE11). Its weight at interval of 5 days was measured and its weight loss determined.

2.4.2. Moisture and ash contents

Moisture and ash contents were determined using the method described by AOAC [20].

2.4.3. Determination of total titratable acidity (TTA)

The total titratable acidity, pH and soluble solid was measured as reported by [21]. Ten (10) g of sample was blended and centrifuged at 5000rpm for 20 min, at 4°C. The supernatant was reclaimed for total soluble solids, total titratable acidity and pH determination. Titratable acidity was measured by titrating the supernatant with 0.1 N NaOH till a pH of 8.1 was achieved, giving a rose pink color, and recorded as gram citric acid/100 g fresh weight.

2.4.4. Total soluble solid (TSS) determination

Total soluble solid content was measured using an ABBE MARK II 10481; Cambridge Instrument Inc. NY refractometer at 20°C and reported as °Brix.

2.4.5. pH determination

pH was measured using a SEARCHTECH PHS-3C pH meter.

2.5. Determination of nutritional composition

2.5.1. Carotenoids determination

The samples were mashed using a blender (Philips HR2102). Sixteen (16) ml of acetone-hexane (4:6) solvent was added to a test tube containing 1.0 g of the homogenized tomato sample and mixed to extract the carotenoids. An aliquot was taken from the supernatant and its optical density (OD) measured at 453, 505, 645 and 660 nm using a Searchtech Instrument; UV1902PC, England, UV-VIS spectrophotometer. β-carotene and Lycopene contents were calculated as reported by [22].

2.6. Determination of vitamin C content

The Ascorbic acid content was determined as reported by [23] but with slight modification, using 2, 6-dichlorophenol indophenol titrimetric. Mashed sample (2 g) containing 10 mL of 0.5% oxalic acid (extraction solution) was used, it was turned into 100 mL volumetric flask. Additional extraction solution was used to make up the mark. The solution was thoroughly mixed and filtered using Whatman filter paper (No. 4). 10 mL aliquots of the mixture was titrated against standardized 2, 6-dichlorophenol indophenol solution. An equal amount of the extraction solution was titrated against the standard (2, 6-dichlorophenol indophenol) solution as blank.

2.7. Statistical analysis

Results obtained were subjected to analysis of variance (ANOVA) for significance difference among treated lots by New Duncan's Multiple Range F-Test (DMRT) at ($p<0.05$) using SPSS software package version 20.0.0 (IBM Statistics).

3. Results and discussion

The effect of aloe vera gel coating on the sensory attributes of physiologically mature red ripe tomato fruits during fifteen days (15) storage is as shown in Table 1. The results showed that sample code-named A1 had the highest values in colour (6.85), firmness (6.70), appearance (6.90), odour (7.05) and general acceptability (7.10). The least values in the assessed parameters were shown by the sample code-named A2. Control (A0) was rated higher than sample coded A2, which had the least rated parameters, colour (5.10), firmness (3.60), appearance (3.50), odour (3.75) and general acceptability (3.95).This showed that as concentration of aloe vera gel increased beyond 1.5%, the investigated parameters were negatively affected.

Table 1 Sensory attributes of 15days stored red ripe tomato fruits dip-treated in different concentrations of aloe vera gel solutions

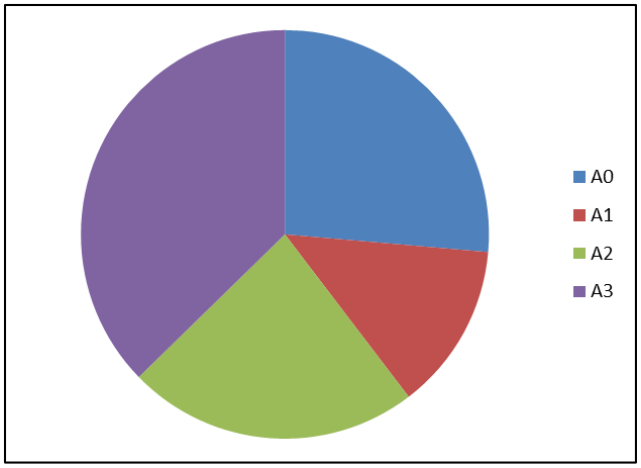
Sample	Colour	Firmness	Appearance	Odour	General acceptability
A0	5.70±1.63^{a}	4.85±1.93^{b}	4.90±1.94^{b}	5.60±1.90^{b}	5.50±1.73^{b}
A1	6.85±1.39^{b}	6.70±1.22^{c}	6.90±1.21^{c}	7.05±1.19^{c}	7.10±1.12^{c}
A2	5.10±1.91^{a}	3.60±1.69^{a}	3.50±1.43^{a}	3.75±1.97^{a}	3.95±1.61^{a}
A3	5.70±1.83^{a}	5.85±2.00^{b}	5.35±2.32^{b}	5.75±1.77^{b}	5.55±1.85^{b}

Results show Mean ±SE of triplicate determination. Key: A0 = control, A1= 1.5% aloe gel, A2 = 50% aloe gel, A3=100% aloe gel

3.1. Physicochemical properties of coated red ripe tomato fruits during storage

3.1.1. Weight loss (%)

After 15days of storage, lot A1 showed the lowest weight loss of 13.1%, followed by lot A2 which was 23.4% while lot A3 recorded the highest weight loss of 37.2% with the control having 26.3% loss.



Key: A0 = control; A1 =1.5% aloe vera; A2 =50% aloe vera; A3 = 100% aloe vera

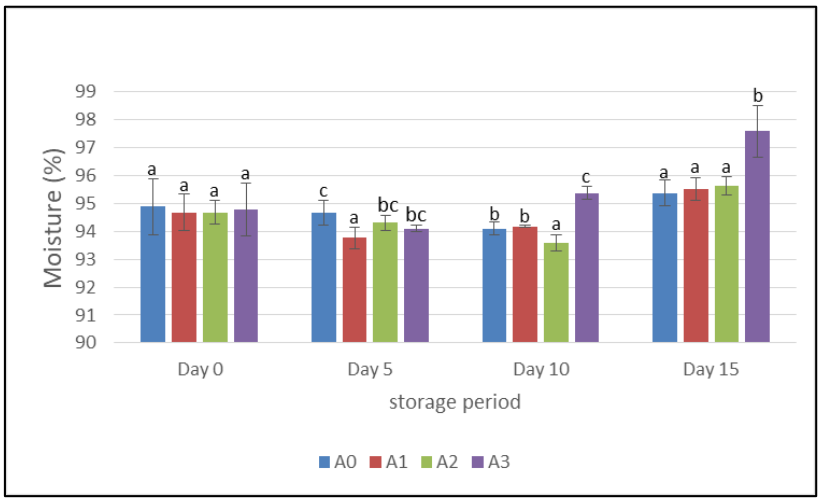
Figure 1 Effect of aloe vera coating on weight loss (%) of red ripe tomato fruits during storage period

3.1.2. Moisture and Ash content

Effect of Aloe vera coatings on Moisture and ash contents of red ripe tomato (*Solanum lycopersicum* L.) is shown in Figure 2 and 3. Generally, values of moisture and ash contents in the study were in the ranges of 93.60–97.58% and 0.20–0.68%, respectively. As would be expected, there was no significant difference ($p=0.05$) in the ash and moisture content at day 0. Whereas following ambient storage for 15 days, differences were noted in the values depending on the treatments. Moisture and ash contents increased compared to day 0, with lot A3 (100% aloe gel) having significantly higher ($p<0.05$) moisture content. Hence, the result affirmed the report published by [24], that aloe gel coating is capable of preventing water loss due to transpiration.

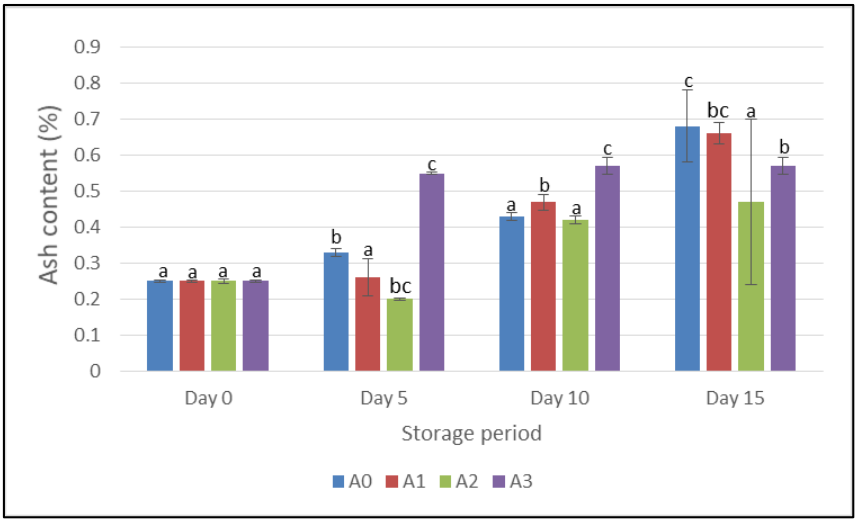
3.1.3. TSS, TTA and pH determination

TSS and TTA determine the flavor and nutritional status of fruits. In this study, a notable decrease was recorded in total soluble solid and total acidity (figure 4 and table 2 respectively), except for treatment lot A2 (50% aloe gel). Also, there were decreases in the pH (table 2) of treated and control samples. Reduction in soluble solid content might have occurred due to slower rate of hydrolysis of carbohydrates [25]. The same phenomena have been published by many scientific reports, like that of [21] who recorded higher soluble solid while in storage using wood by-product to extend shelf life of tomato. Typically, the pH of fresh tomato ranged from 4.1–4.8 depending on cultivar [26]. The reduction in pH value during storage would limit the range of microbial spoilage; this further recommends the use of aloe gel coating.



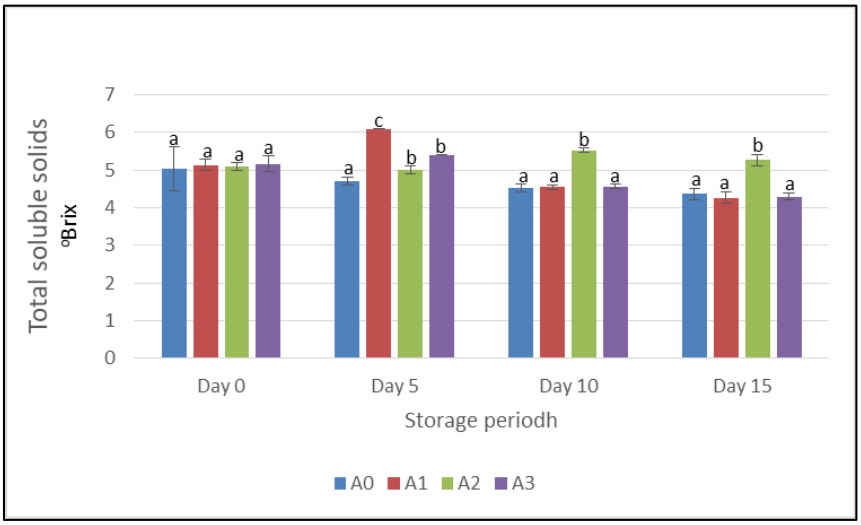
Key: A0= Control; A1= 1.5% Aloe vera gel; A2=50% Aloe vera gel; A3=100% Aloe vera gel.

Figure 2 Effect of aloe vera coatings on moisture content of red ripe tomato fruits during storage period



A0= Control; A1= 1.5% Aloe vera gel; A2=50% Aloe vera gel; A3=100% Aloe vera gel.

Figure 3 Effect of aloe vera coatings on ash content of red ripe tomato fruits during storage period



Key: A0= Control; A1= 1.5% Aloe gel; A2=50% Aloe gel; A3=100% Aloe gel

Figure 4 Effect of aloe vera coating treatment on Total soluble solids of red ripe tomato fruits during storage period

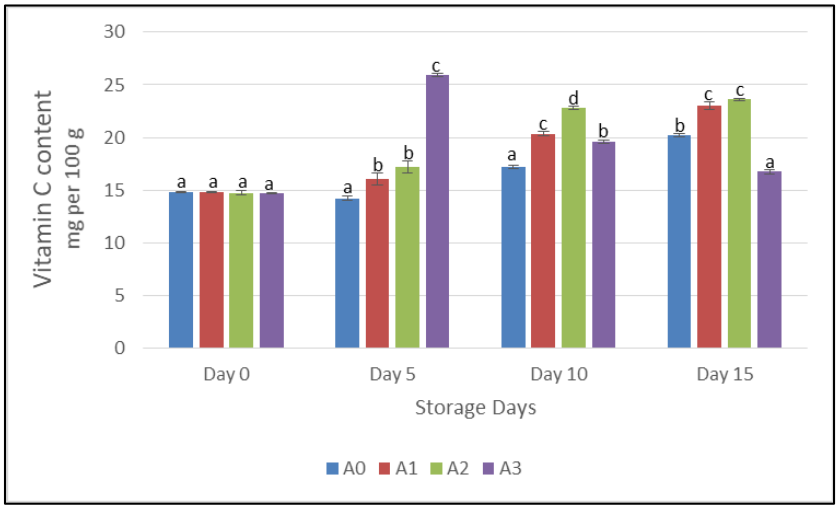
Table 2 Effect of aloe vera coating treatment on TTA and pH of red ripe tomato fruits (*Solanum lycopersicum L.*) during storage

Sample	TTA (%)				pH			
	Day 0	Day 5	Day 10	Day 15	Day 0	Day 5	Day 10	Day 15
A0	0.31±0.006^{a}	0.27±0.001^{a}	0.27±0.001^{c}	0.25±0.001^{b}	4.56±0.006^{a}	4.47±0.006^{b}	4.20±0.00^{a}	4.04±0.006^{a}
A1	0.31±0.003^{a}	0.28±0.001^{b}	0.29±0.001^{c}	0.35±0.001^{c}	4.57±0.15^{a}	4.46±0.000^{a}	4.30±0.001^{d}	4.22±0.006^{c}
A2	0.31±0.006^{a}	0.29±0.001^{c}	0.19±0.000^{a}	0.13±0.001^{a}	4.56±0.03^{a}	4.46±0.000^{a}	5.51±0.006^{b}	4.14±0.000^{b}
A3	0.31±0.004^{a}	0.27±0.001^{a}	0.24±0.001^{b}	0.20±0.002^{b}	4.58±0.005^{a}	4.77±0.006^{c}	4.49±0.006^{c}	4.39±0.000^{d}

Results show Mean ±SE of triplicate determination. Key: A0=control, A1=1.5% aloe gel, A2=50% aloe gel, A3=100% aloe gel

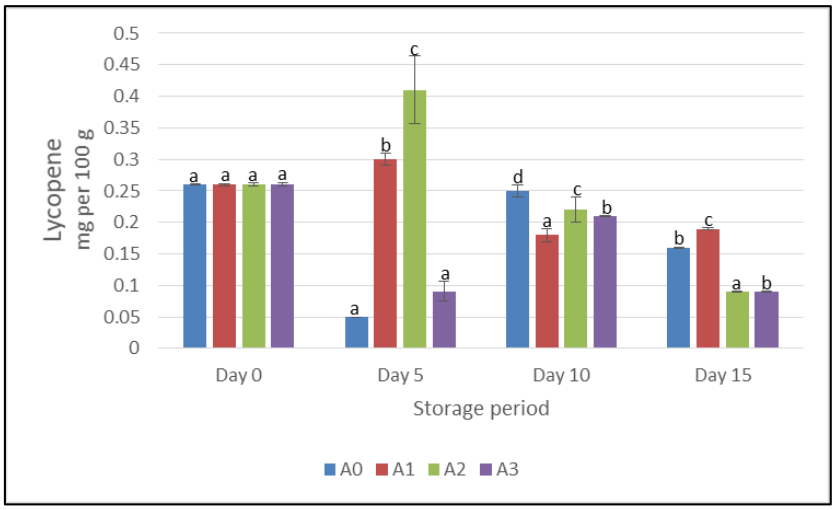
3.2. Nutritional properties of coated tomato during storage

The effect of aloe vera gel treatment on the nutritional composition of fresh ripe tomato is as shown in Figs. 5, 6 and 7. The general overview of the results showed that the ranges of vitamin C, lycopene and beta-carotene were 13.82–30.19mg/100g, 0.05–0.41 mg/100 mL and 0.03–0.24 mg/100 mL respectively. There was no significant difference ($p=0.05$) in the nutritional composition of tomato in all the treatments and control at day 0. As storage progressed to day 15, significant differences ($p<0.05$) were recorded in the nutritional composition of stored tomatoes depending on the treatments. The vitamin C content of control A0 and treated lots A1 and A2 showed an increase but were all significantly different ($p<0.05$). Lot A3 showed a much lower value on day 15 of storage. A decrease in lycopene content was recorded for all the lots at day 15 of storage. Similar result was reported by [18] where green tomato was stored using wood ash as a medium, the untreated control had high vitamin C. Conversely, a general decrease was recorded in lycopene and beta-carotene on day 15 of the storage, showing a negative correlation. The beta carotene of all the samples showed a huge decrease at the end of storage, this could be attributed to degradation reactions of isomers, apocarotenals, epoxides, apocarotenones, and short chain cleavage products of beta carotene during storage [27].



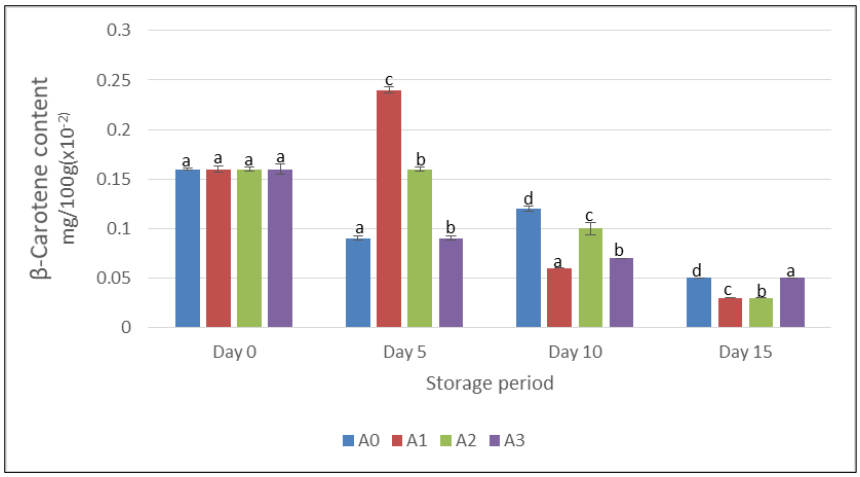
Key: A0= Control; A1= 1.5% Aloe gel; A2=50% Aloe gel; A3=100% Aloe gel.

Figure 5 Effect of aloe vera gel coating treatment on Vitamin C content of red ripe tomato fruits during storage period



A0= Control; A1= 1.5% Aloe vera gel; A2=50% Aloe vera gel; A3=100% Aloe vera gel.

Figure 6 Effect of aloe vera coating treatment on Lycopene content of red ripe tomato fruits during storage period.



Key: A0= Control; A1= 1.5% Aloe vera gel; A2=50% Aloe vera gel; A3=100% Aloe vera gel.

Figure 7 Effect of aloe vera coating treatment on β-Carotene content of red ripe tomato fruits during storage period

4. Conclusion

Documented results on the development and use of natural edible biodegradable coatings over synthetic polymers have been so promising especially due to their ecofriendly nature and consumer acceptability. In this study, the shelf life of physiologically mature red ripe tomato fruits were shown to be extended by the application of Aloe vera gel at 1.5% concentration, as they retarded water loss due to transpiration by acting as a physical barrier, delayed fruit softening and maintained the fruit quality thereby making them maintain consumer acceptability.

Compliance with ethical standards

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Disclosure of conflict of interest

The Authors declare no conflict of interest.

Authors Contributions

- **Onyegbula, A.F.:** Conceptualization, Methodology, investigation and writing (Original draft)
- **Fashanu, T. A.:** Methodology, investigation and visualization.
- **Yusuf, K A.:** Resources and investigation.
- **Babatunde, O.:** Formal analyses and data curation
- **Adole, E. B**.: Methodology, writing (review and editing)

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