EFFECTS OF ALOE VERA BASED EDIBLE COATING ON SHELF LIFE AND QUALITY OF TOMATOES

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Abstract

This study investigated the feasibility of aloe vera based edible coating on the shelf life and quality parameters of unripe tomatoes. It assessed the storability and the microbiological qualities of uncoated and coated tomatoes. The control and coated samples were stored at room temperature 25°C-30°C and relative humidity of 82-84%. The microbial and fungi counts of the uncoated samples were comparably higher than those of the coated samples. For the uncoated samples, the bacterial count ranged between 10 x 10^3cfu/g and 13 x 10^3cfu/g and 4 x 10^3cfu/g and 6 x 10^3 cfu/g for fungal count, while for the coated, it ranged between 6 x 10^3cfu/g and 8 x 10^3cfu/g for bacterial count and 3 x 10^3cfu/g remains for fungal count between the 2nd and the 4th week. For the storability, it was found that the control sample began to deteriorate in quality and begin to show sign of decay from the 2nd week, on getting to the 4th week, the control was totally damaged while for the coated sample, the tomatoes remained fresh and healthy. In terms of the physiological weight loss for the uncoated, there was a percentage weight loss of 45.754% at the end of the 4th week, while for the coated, percentage weight loss was observed and determined to be 13.137% at the end of that same 4th week, finally for the chroma value, there was a significant change in the chroma value of the uncoated sample during the 4th week of storage, as it reads 44.933 which shows that there is a significant color change from the shiny red to faded red, while for the coated sample, the chroma value during the 4th week of storage was 66.581, which showed a much more bright color, as compared to the uncoated sample. Thus, the use of aloe vera based edible coating is highly recommended for storing and extending the shelf life of fresh tomatoes fruit.

Keywords: Bacterial count, edible coating, chroma value, shelf life, tomatoes, aloe vera.

1. Introduction

Tomatoes are one of the most healthy and beneficial foods in daily diets. They are extremely low in calories, rich in vitamin A and vitamin C, beta-carotene, potassium, as well as a great source of fundamental antioxidants, such as lycopene. Tomatoes are considered to be one of the most economically important crops in the world. Economically speaking, tomatoes are worth a tremendous amount of money because they give more yields (Chaudhary *et al.*, 2018).

Nigeria is one of the leading producers of tomatoes that are grown in its diverse agro-ecological zones that range from humid in the southern part of the country to sub-humid in the middle belt part of the country and semi-arid/arid in the northern part, yet the produce is lost at an increasing high and alarming rate of 30% - 50% yearly as a result of poor pre-harvest and post-harvest practices (Aworh, 2010) including storage.

Nigeria is ranked the second largest producer of tomato in Africa and the thirteenth largest in the world, producing about 1.701 million tons of tomato annually at an average of 25-30 tons per hectare (Adebisi-Adelani and Oyesola, 2014). Despite this advantageous situation, Nigeria imports processed tomato paste to the tune of about 65,809 tons valued at ₦11.7 billion ($77.167 million) annually (Ayodele *et al*., 2007) because not less than fifty per cent (50%) of the tomato produced in the country is lost due to lack of preservation facilities. According to World Food Science, about 30-50 per cent of perishable produce are lost after harvest simply as a result of poor storage system and humid weather condition exacerbated by poor marketing distribution and access to markets (Ugonna *et al*., 2015). Thus, the need to condition the tomatoes to prolong their shelf life using an edible coating.

Aloe vera is a well-known plant for its dazzling medicinal attributes. It is a tropical and subtropical plant. There are a few reviews of the antifungal activity of aloe vera gel towards numerous fungi inclusive of *Colletotrichum sp* (Nidiry *et al*., 2011). Lately, there is an accelerated interest in the usage of aloe vera gel-based edible coating for fruits and vegetable due to its anti-fungi properties.

There is an urgent need to achieve self-sufficiency in food to match all efforts at increasing crop production with equal if not greater efforts of post-harvest technology to save the crops that are produced from deterioration and wastages (Olayemi *et al*., 2010). Thus, the aim of this study is to evaluate the effect of aloe vera gel as an edible coating on the shelf-life of the tomato fruit.

2.Materials and Methods

2.1 *Collection of Tomatoes and Aloe Vera Plant*

The materials used for this study are fresh tomatoes and aloe vera. The fresh tomatoes were gotten from a small garden in Federal University of Technology, Minna, Gidan-Kwano Off-campus, and the aloe vera was gotten in Tunga Market Tunga Minna, Niger State, Nigeria.

2.2 *Sample Preparation*

Fresh aloe vera leaves collected (Figure 1) were cut and soaked in water for about 24 hours for the stains and yellow latex to drop, after that it was cleaned with a clean handkerchief. The bottom, the jagged edges and sharp points as well as one part of the leave were peeled off using the small knife, after which the gel i.e. the colorless parenchyma was extracted by scooping it out using a spoon (Figure 2). After the extraction was done, it was blended using the electric blender. After that it was filtered using a filter cloth to sieve out fibers (Figure 3).

Figure 1: Fresh Aloe Vera leaves
Figure 2: Extracted Aloe Vera Gel

Figure 3: Filtering the Aloe Vera Gel

The filtered sample aloe vera gel was put in a clean pot and heated using a hot plate (electric stove). It was pasteurized at about 100ºC for like 45 minutes in order to deactivate any form of microbial activity that may be taking place in the aloe vera gel, as might affect it preservative power. The gel was left to cool at room temperature. Upon cooling the gel becomes too watery to be used for coating. So, a thickener was needed to improve its adhesiveness so it can be able to stay on the tomato. Although most of the thickeners have one property i.e. they contain starch, so pap (local akamu) was used. The pap was prepared using the aloe vera gel to allow it to have enough thickness to be used as a coating.

After the aloe vera gel was prepared at the laboratory, the tomatoes were selected to obtain homogeneous batches based on color, absence of injuries, and of good health. Tomatoes were divided into two that is control and coated batches. The procured tomatoes were washed thoroughly with running water and surface dried before coating; else the coating would not adhere to the surface while it is still wet. The aloe vera gel was applied to the tomatoes by dipping method, given there are different methods of applying the gel, which could either be by brushing, dripping, dipping.

2.3 *Storage*

The control and coated tomato samples were stored at room or ambient temperature (25°C-30°C) and relative humidity of 82-84% throughout the duration of the study of 4 weeks.

2.4 *Determination of Physiological Weight Loss (PWL)*

Weight loss mainly occurs due to water loss by transpiration and loss of carbon reserves due to respiration (Vogler and Ernst, 1999; Prasad *et al*., 2018). The rate at which water is lost depends on the water pressure gradient between the fruit tissue and the surrounding atmosphere. The physiological weight loss was calculated according to the procedure by Workneh *et al*. (2011). Three tomatoes from each batch were taken and the mass of individual tomatoes was recorded on the day of coating, and at every 5 days interval till it attained red stage. Cumulative mass losses were calculated by using equation 1:

$$\text{Physiological weight loss (\%)} = \frac{Weight\ of\ initial - Weight\ of\ final}{Weight\ of\ initial} \times 100 \qquad 1$$

2.5 *Determination of Color*

Visual assessment is the first impression and a key feature in the choice of fruits. Color is one of the most important visual attributes of fruits. Color of the tomato was determined using Adobe Photoshop

(Photoshop CC 2019). The average value of L*, a*, b* was determined and chroma value (ΔC) was calculated using the equation 2 given below (Weatherall and Coombs, 1992).

$$\Delta C = \sqrt{(L*)^2 + (a*)^2 + (b*)^2} \qquad 2$$

2.6 *Determination of Microbiological Activities (Microbial Analysis)*

Enumeration of bacteria and fungi was carried out by pour plating technique. This was done by inoculating 0.1 ml tenfold serially diluted samples onto nutrient agar (Bacterial), acidified potato Dextrose agar containing Streptomycin (1mg /100 ml) (fungal). The inoculated nutrient agar plates were incubated at 37^{o}C for 24 hours while the potato dextrose Agar plates were incubated at room temperature for 3-5 days. Observed colonies were counted and expressed as colony forming units per gram (cfug^{-1}). Microbiological analysis was carried out on the 2nd week and at the end of storage period which was the 4th week by enumerating the total bacteria and fungi count which is expressed in colony forming units per gram, having a unit of cfu/g.

3. Results and Discussion

Tomatoes both from control and aloe vera coated showed mass loss throughout the storage period (Table 1). The physiological loss in weight of the control is higher than that of the coated. The physiological weight loss of control and coated during the 1st week is 8.104% and 1.125%, which shows a difference of about 6.979% between that of the control and the coated. The physiological weight loss during the 2nd week was 22.500% for the control and 7.884% for the coated, while for the 3rd week is 34.094% for the control and 10.125% for the coated while during the 4th week; the physiological weight loss for the control is 45.754% while that of the coated was 13.137%.

Table 1. Effect of Aloe Vera Based Edible Coating on the Physiological Loss in Weight (%) during storage period.

	CONTROL		COATED	
TIME	Original Weight (g)	Percentage Loss (%)	Original Weight (g)	Percentage Loss (%)
0th Week	30.196	0.000	29.413	0.000
1st Week	27.749	8.104	29.082	1.125
2nd Week	23.402	22.500	27.094	7.884
3rd Week	19.901	34.094	26.435	10.125
4th Week	16.380	45.754	25.549	13.137

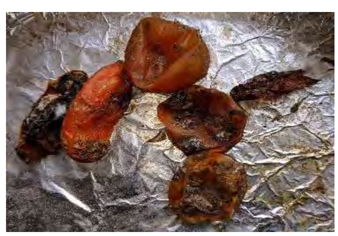
Table 2. Effect of Aloe Vera Based Edible Coating on the Chroma of the Tomatoes during storage period.

	CONTROL				COATED			
TIME	L*	a*	b*	ΔC	L*	a*	b*	ΔC
0th Week	42	-7	44	61.229	45	-7	33	55.444

1st Week	38	28	34	58.172	43	3	37	56.807
2nd Week	36	32	42	63.906	43	21	46	66.378
3rd Week	31	35	37	59.624	42	34	47	71.617
4th Week	23	23	31	44.933	38	35	42	66.581

Tomatoes, both control and coated, registered some changes in L*, a* and b* values during the storage period. Table 2 shows the effect of coating on L*, a*, b* and ΔC values of tomatoes. L* means lightness (from white to black). L*values did not experience much significant change until the turning stage, indicating that there was no significant change in lightness when the green color was still predominant. The initial L* values for the control and coated tomatoes were 42 and 41 (slight difference in the initial L* value is due to coating). When red color pigments started to synthesize, there was a decline in L* value; a similar result was also reported by Carreño *et al*. (1995). Though there was a decrease in L* value in both coated and control tomatoes, coating showed a significant difference in L* value when compared to control during the 2nd Week of storage. L* value of control during its red stage in the 2nd Week was 36, whereas for the coated fruit, in the same week was 43. L* value of coated fruit decreased during its ripening. L* value of coated fruit during its red stage in the 4th week was 38. a* values change from negative (green color) to positive (red color) (Weatherall and Coombs, 1992). a* value of control during its red stage in the 2nd week was 36, whereas for the coated fruit on the same day it was 21. The increase in a* value was, however, slower for the tomatoes treated with aloe vera gel compared to control. a* value of tomato increased during its ripening, and for the coated fruit during its red stage in the 4th week, it was 35. The initial b* (blue to yellow) values for control and coated tomatoes were 44 and 33, afterwards the values gradually decreased to 42 for control tomatoes and to 46 for coated tomatoes in the 2nd week. b* value of coated tomato during its red stage in the 4th week was 42. The chroma value (ΔC) depends on a* and b* values. The chroma value indicates the colour intensity (saturation) of the sample. There was a slight increase in the chroma value from the initial value. But there were significant differences in chroma value of coated tomatoes when compared to control tomatoes. ΔC of the control was 63.906 during its ripening in the 2nd week, whereas for the coated fruit it was 66.378 on the same day. ΔC value increased during ripening of tomato. ΔC value of coated fruit during the 4th week was 66.581 and that of the control was 44.933.

Table 3. Effect of Aloe Vera Based Edible Coating on the External appearance and glossiness of The Tomatoes during storage period.

TIME	CONTROL	COATED
0th Week		
1st Week		
2nd Week		
3rd Week		
4th Week		

From table 3 above, during the 0th week of storage, there was no much difference in the appearance of the control to that of the coated, except for the glossiness and shiny surface shown by the coated tomatoes' surface due to the coating that was applied to it. During the 1st week, the control is already turning to pink/light red (30%-60% of the surface is not green), while the coated was still at the turning stage (10% to 30% of the surface is not green). In the 2nd week, the control is already at the light red/red maturity stage

(60% - 90% of the surface not green/ more than 90% of the surface is not green). In the 3rd week, the control has ripened and started shrinking and decaying, looking unhealthy, while the coated was showing a maturity stage of light red (60%-90% of the surface is not green). Finally, during the 4th week, the control sample was showing total decay, spoiled and smelling, while for the coated, although showing sign of shrinkage was still looking fresh, healthy, edible and odorless.

Table 4: Total Bacteria and Fungi count (cfu/g)

TIME	CONTROL (cfu/g)		COATED (cfu/g)	
	otal Bacterial Count	otal Fungi Count	otal Bacterial Count	otal Fungi Count
ıd Week	10×10^3	4×10^3	6×10^3	3×10^3
h Week	13×10^3	6×10^3	8×10^3	3×10^3

From Table 4, showing the Total Bacterial and Fungi count, during the 2nd week, the Total bacterial count was $10 \times 10^3 cfu/g$ for the control and $6 \times 10^3 cfu/g$ for the coated samples respectively, while during the 4th week, the total bacterial count was $13 \times 10^3 cfu/g$ for the control and $8 \times 10^3 cfu/g$ for the coated, thus showing a significant increase in the number of bacteria count of $3 \times 10^3 cfu/g$ from the 2nd week to the 4th week for the control and the bacteria count of $2 \times 10^3 cfu/g$ for the coated, therefore the bacteria count is much at the 4th week for the control than the coated. While for the fungi count, it increases by $2 \times 10^3 cfu/g$ from the 2nd week to the 4th week, while for the coated, the fungi count remained unchanged even after the 2nd week to the 4th week.

Aloe gel based edible coating act as barrier, thereby restricting water transfer and protecting fruit skin from mechanical injuries. This positive effect in terms of reduction of moisture loss may be due to the hygroscopic properties of aloe gel that allow the formation of water barrier between the fruit and the surrounding environment, thus, preventing its external transferences (Morillon, *et al*., 2002). Interestingly, aloe vera gel mostly composed of polysaccharide (Ni *et al*., 2004) which is highly effective as a barrier against moisture loss without incorporation of lipid.
According to Ergun and Satici, (2012) aloe vera gel treatment delayed the green color loss on the fruit skin of apples stored at 2°C for 6 months.. Skin color of table grapes showed lower increases in aloe treated than in control (untreated) fruits. Table grapes are rich in anthocyanin compounds, which account for their red color. The ripening process of table grapes has been correlated to the anthocyanin content (Cantos *et al*., 2002). At the end of cold storage (1°C, 95% RH), control fruits exhibited a redder and darker color than Aloe-treated table grapes, showing the aspect of overripe fruit, which is considered to be detrimental to color quality (Tripathi and Dubey, 2004). The modified atmosphere created by the aloe vera gel coating material retarded the ethylene production rate, therefore, delaying ripening, chlorophyll degradation, anthocyanin accumulation and carotenoid synthesis thus ultimately delaying color change of fruits (Carrillo-Lopez, 2000). Color also retain in aloe gel (100%) treated papaya fruit (Brishti, 2013). Moreover, the aloe vera coating imparted an attractive natural-looking sheen to table grapes (Tripathi and Dubey, 2004), papaya (Brishti, 2013) which was correlated to lower changes in both skin color and dehydration.

3. Conclusion

This work shows that aloe vera has potent preservative capacity. Its harmless nature to both humans and the environment makes it far more advantageous than the average chemical preservative which often has dangerous side effects on health. Aloe vera gel applied as an edible coating on tomatoes has a positive effect in retarding the ripening process and microbial action on it. This method is effective as a physical barrier and thus reduces the weight loss, maintaining the firmness and enhancing the shelf life of tomatoes by preventing microbial/microbiological actions. In addition, aloe vera gel delays softening. Thus, aloe vera gel can be used as an edible coating to reduce post-harvest loss of tomatoes and increase its shelf life. It is an effective method that can be adopted in our daily life as well as our food industries.

Greater attention should be taken on edible coating, most especially the one that is based on aloe vera gel, since it has anti-microbiological properties, that is it contains certain substance that inhibits the growth of bacteria and fungi. Aloe vera based edible coating is also harmless when it comes to the health of the one consuming it, instead it contains other food vitamins and minerals which gives the human body additional nutrients. Aloe vera gel therefore can be used in preserving tomatoes thereby extending their shelf life.

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DEVELOPMENT OF MORINGA (*Moringa oleifera L.*) SEED OIL EXPELLING MACHINE

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Abstract

A Moringa (Moringa oleifera L.) seed oil expelling machine was developed after physico-mechanical properties of the seeds were determined at 6.75% moisture content. The average seed length, width and thickness were found to be 8.94, 7.84 and 6.96mm, respectively. The arithmetic mean diameter, geometric mean diameter, mean surface area, sphericity and aspect ratio were found to be 7.92 mm, 7.70 mm, 46.85 mm^2, 86.46% and 88.24, respectively. The true density, bulk density and porosity were 0.95 kg/m^3, 0.52 kg/m^3 and 45.02%, respectively. Mean angle of repose was 17.82^o, coefficients of friction on mild steel surface was 0.45. Energy required to crush the seeds was found to be 147 Nm at Brinell Hardness Number below 325.32. These properties were used as input for the design of the Moringa seeds oil expelling machine using mild steel of 0.73m x 0.16m x 0.86m frame, a hopper of 0.003m^3 and an electric motor. The machine was designed, fabricated and tested to evaluate its performance in relation to manual and motorised processes. Power requirement of the machine and shaft rotational speed was 1.08 hp and 500 rpm, respectively. The machine was powered by 1.5 hp electric motor to accommodate power losses. The test was carried out in a two-step process of crushing the seeds into paste and pressing the oil out of the paste. Results obtained were mean extraction rate of 2.30 g/min (1.60 ml/min), mean throughput and yield were 1.66 kg/hr, and 35.5 ml/kg, respectively. Mean actual efficiency, weight of residual cake and unrecovered oil were 14.66%, 332.50g and 29.87%, respectively. Performance of the developed machine was compared with other machines and it was higher than that of the manual traditional process. Based on the results obtained after the test running of the machine, it was recommended that a hull removing unit, cake grater and any other additional necessary components should be added to the machine to make it multipurpose.

Keywords: Moringa, oil extraction, oil seeds.

1. Introduction

Moringa (*Moringa oleifera L.*) is a natural as well as cultivated variety of the genus *Moringa* belonging to family *Moringaceae.* It is a small size tree with approximately 5 to 10 m height and is cultivated all over the world due to its multiple utilities. It is a highly valued plant, distributed in many countries of the tropics and subtropics (Warra, 2014). It is popularly known as the “miracle tree” or “tree of life” and identified by various names, such as Drumstick tree or Horseradish plant in English and Zogale in Hausa.