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Increase In Total Dissolved Solids (TPT) and Vitamin C In Tomato using Edible Coating Aloe Vera and Vacuum Packaging

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A R T I C L E I N F O

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A B S T R A C T

Edible coating is a technique to increase the shelf life of tomatoes. The purpose of this study was to determine the best concentration for using aloe vera as a coating material and to analyze the effect of the combined use of aloe vera edible coatings packed in vacuum on the shelf life of tomatoes. The study used an experimental method consisting of 4 levels, namely without coating (K0V), 30% aloe vera coating (K30V), 50% aloe vera coating (K50V),and 70% aloe vera coating (K70V). The results showed that the coating treatment of aloe vera had an effect on the total dissolved solids (TPT) and vitamin C in storage of tomatoes, although based on statistical results it did not show significant results. The best concentration to maintaince the shelf life of tomatos is aloe vera coating 30% (K30V) treatment was the best concentration

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INTRODUCTION

Tomato is a horticultural product whose production continues to increase from 2015 to 2021, reaching 1.1 million tons in 2021 (BPS-RI, 2023), that one of the most commercialized fruits due to their high nutritional value and health-promoting compounds (Duguma, 2022). Tomato is one of the most consumed fresh vegetables in the world; however, its highly perishable nature limits its postharvest life (Davila-Avina, 2011). The wrong process of handling and storing tomatoes will cause damage, both physically, chemically, and microbiologically to the tomatoes (Yuniastri et al., 2020).

One of the postharvest treatments to extend the shelf life of tomatoes is by applying edible coatings (Handojo et al., 2022; Wisudawaty et al., 2020). Edible coating is a thin and continuous layer made of edible ingredients, formed to coat food components (coating) or placed in food components (film) that functions as a barrier against mass transfer (for example moisture, oxygen, lipids, light, solutes) (Prasetyo et al., 2018). Application with an edible coating on tomatoes can maintain hardness, vitamin C, total acid and lycopene better than without coating (Tetelepta et al., 2019). Coatings significantly reduce weight loss of harvested fruit and maintain their general and therefore acceptable appearance during storage periods(Vignesh & Nair, 2019). The application of edible coating serves to replace the natural wax layer that is lost due to post-harvest handling (Kohar et al., 2018).

The application of coating with a vacuum enhances all the positive effects, due to which the transmission of the water vapor resistance of the sample is significantly increased, and obtains better sample color retention and mechanical response during cold storage (Vargas et al., 2009). The combination of vacuum packaging and edible coating containing 2% turmeric extract increased the shelf life of chicken breast, keeping total mesophilic aerobic bacteria and total aerobic psychotrophic bacteria below the microbiological limit recommended for distribution. and consumption (Dalvandi et al., 2020).

One of the ingredients that can be used as an edible coating is aloe vera. The polysaccharide content in Aloe vera gel is able to inhibit the transfer of CO2 and O2 in postharvest products (Fauziah et al., 2020). Application of Aloe vera as an edible coating for eggplant can reduce weight loss by 13.16% (Hartass et al., 2020). Another study showed that the use of aloe vera extract as the best edible coating material at 100% concentration and 45 minutes of soaking time showed that the shelf life of tomatoes affected the vitamin C and organoleptic content. Organoleptic results for tomatoes affected color and texture parameters up to 16 days of storage(Sartika et al., 2015), the best treatment on tomatoes with 30% aloe vera gel concentration at 10^{o}C low temperature storage was still accepted by consumers until the 21st day (Marwina et al., 2016).

In this study, the application of edible coatings will also be combined with vacuum packaging techniques. The use of vacuum packaging is expected to increase the shelf life of tomato products. Research (Mulyawanti et al., 2018) shows that the use of vacuum packaging shows a lower TPT content and fruit cracking rate compared to MAP (Modified Atmosphere Packaging) packaging. In addition, research (Nurrahmah et al., 2017) showed that storing bananas in

vacuum plastic had an effect on the physical, physiological, and expression of ripening genes. This study aims to determine the optimal concentration of using edible coatings made from aloe vera on vacuum packed tomatoes for weight loss, degree of acidity (pH), and organoleptic (color and texture), so that it is expected to be able to extend the shelf life of tomatoes during storage.

LITERATURE REVIEW

Tomatoes are a climacteric fruit with a high nutritional content. However, tomatoes are easily perishable after harvest and do not last long for storage, because after harvest tomatoes continue to experience changes due to physiological, mechanical, enzymatic and microbiological influences (Wisudawaty et al., 2020). The highest component of tomatoes is water, which is 90.55% (Diatara & Nurpilihan, 2019). High water content causes tomatoes to deteriorate very quickly.

Edible coating is a packaging technology as a coating which provides significant benefits by enabling the integration of different active ingredients into the coating matrix, meaning that these substances are associated with and possibly eaten with the fruit. This will help improve the organoleptic and nutritional qualities of the fruit and shelf life (Pham et al., 2023). The use of aloe vera as an edible coating is safer for health because it is natural. Aloe vera gel contains various bioactive ingredients that are useful for health so that when used as a coating it can add to the properties of the fruit given the coating. Aloe vera contains polysaccharides that can withstand fluid loss and inhibit the transfer of gases (O2 and CO2) from the surface of the fruit skin while reducing the rate of senescence and maintaining fruit freshness (Arifin et al., 2016).

Vacuum packaging is packaging that can be used to store Fruits and can maintain the quality of fruit (moisture content, capsaicin content, ascorbic acid, carbohydrates, protein and mineral elements like Fe, P, Na and K) compared to those without a vacuum (Deepa et al., 2013). Vacuum packaging has a positive effect on postharvest quality and extends the shelf life of fresh fruit (Moradinezhad & Dorostkar, 2021)

METHODOLOGY

The research method used in this study was 2 (two) factors, namely the concentration of aloe vera coating treatment and storage time. The first factor consisted of 4 levels, namely without aloe vera coating (K0V), 30% aloe vera coating (K30V), 50% aloe vera coating (K50V), and 70% aloe vera coating (K70V). The second factor was storage time on days 0, 3, 6, 9, and 12. The quality analysis carried out in this study included weight loss, degree of acidity (pH), and organoleptic tests on tomatoes. In this research there were 4 steps, namely:

a. Tomato Fruit Preparation

   The tomatoes used were taken from the Induk Cikema market, Cibinong, West Java. Tomatoes are sorted first. The sorting process is a selection process based on the size and color of fruit with the same degree of ripeness (stage 4 (pink) is pink or red more than 30% but not more than 90%) so that good fruit quality and uniform size are obtained. After the sorting stage, grading is

carried out. Tomatoes that have been sorted are cleaned with running water to remove any remaining dirt attached to the skin of the tomatoes, then dried.

b. Making Edible Coating Solution from Aloe Vera

At this stage, aloe vera as an edible coating material was subjected to a sorting process first. The aloe vera used was taken from plantations in the Sawangan, Depok, West Java. The selected aloe vera was seen from the color of the leaves which were green, had a wide leaf size and there were no diseases and physical damage such as broken or injured leaves. After sorting, the aloe vera is washed with boiled water until clean. Then the aloe vera was soaked using a 10% citric acid solution for 30 minutes, its function is to reduce microbial contamination on the leaves so that it is hoped that later there will be no contamination on the aloe vera gel. After that, the aloe vera was rinsed with boiled water so that the remaining acid is gone. Then peeled to take the gel. The aloe vera gel obtained was rinsed again using boiled water to remove the yellow sap, then pulverized using a blender for 2 minutes. To get a good and clear solution/extract, the crushed aloe vera extract must be filtered (Hartass et al., 2020). If the aloe vera extract has been obtained, the next step is to make the extract into 3 concentrations namely, 30%, 50% and 70%. Aloe vera extract was diluted with the addition of distilled water.

c. Immersion Tomatoes in Aloe Vera Edible Coating

Tomatoes that were already clean are subjected to the dipping process in the aloe vera edible coating solution. The best duration of immersion in the aloe vera solution was 45 minutes with the same concentration of 30%, 50% and 70% for each sample. Furthermore, the tomatoes are air-dried for 20 minutes.

d. Storage of Coated Tomatoes

Tomatoes that had been coated with an edible coating of aloe vera are drained and dried for 20 minutes, packed using vacuum plastic filled with 3 tomatoes. Once packaged, then stored in the refrigerator with a temperature of $\pm$ 5^{o}C for 12 days to determine the quality changes that occur. Quality tests carried out were Total Dissolved Solids (TPT) and Vitamin C.

RESEARCH RESULT

Table 1. Test Results for Total Dissolved Solids (TPT)

Day	Total Dissolved Solids (TPT) (^{o}Brix)			
	K0V (Control)	**K30V**	**K50V**	**K70V**
0	3,9	4,5	4	4,2
3	4,3	4,2	4,3	4,4
6	3,6	3,9	3,4	4,1
9	4,5	4,4	4,4	4,4
12	4,4	4,5	4	4,25

Table 2. Test Results for Vitamin C

Day	VITAMIN C (mg/100 g)			
	K0V (Control)	**K30V**	**K50V**	**K70V**
0	18,92	18,48	18,04	18,92
3	33,44	39,6	34,32	34,76
6	35,2	28,6	30,36	22,44
9	26,4	22,44	23,32	23,32
12	17,16	25,52	19,8	16,28

DISCUSSION

1. Total Dissolved Solids (TPT)

The TPT value is used to identify the maturity level of the fruit. The higher the maturity level of the fruit, the more TPT content in the fruit. The moresour the fruit, the less TPT content. The greater the pH value, the greater the TPT value. During the ripening process, the TPT content increases indicating that the fruit has a lot of sugar content. The increase in the TPT value in fruit is due to the hydrolysis of carbohydrates into glucose and fructose compounds.

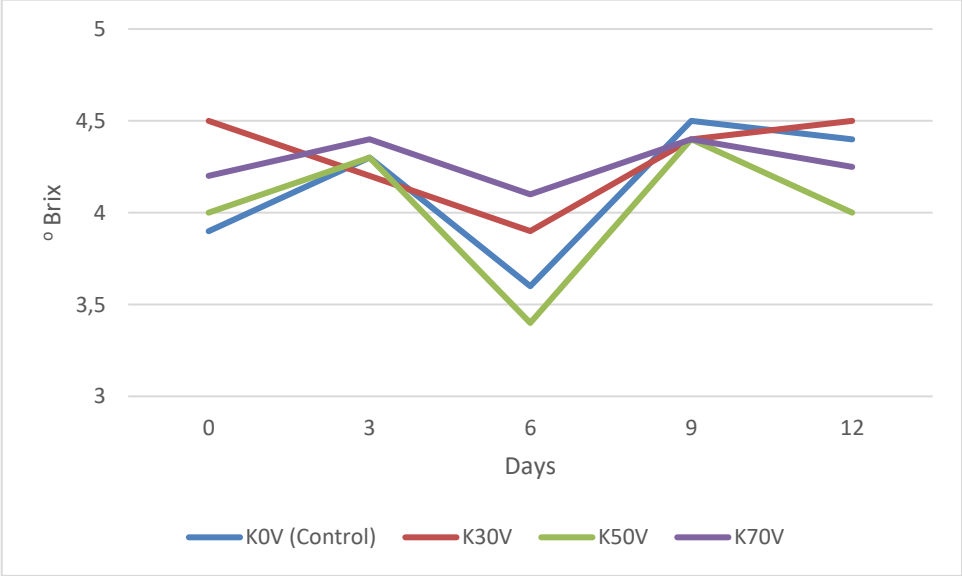

Figure 1. Testing Total Dissolved Solids of Tomatoes in Each Treatment

Based on Figure 1, it can be seen that the TPT content values in tomatoes during storage ranged from 3.40-4.50 °Brix. The average value of the TPT content of tomatoes increased at the beginning of storage until the 3rd day of storage, except for the K30V treatment which decreased. At 6 HSP, a decrease in the value of TPT content occurred in all treatments and increased again on the 9th day of storage. The highest increase in TPT content occurred on the 9th day of storage in the K50V treatment of 1.0 °Brix while the lowest increase in TPT content occurred on the 3rd day of storage in the K70V treatment of 0.20 °Brix. However, at the end of storage, namely the 12th day, the TPT content of tomatoes in the K30V treatment increased again by

0.1 °Brix, in contrast to the other treatments, namely K0V, K50V, and K70V which decreased sequentially, namely 0.1, 0.4, and 0.15 °Brix. This can happen because the tomatoes in the K30V sample experienced a longer peak of maturity than other tomatoes. In addition, the use of different samples of tomatoes can also cause TPT values during storage to fluctuate in each treatment.

At the end of storage, the TPT content of tomatoes was 4.40 °Brix in the K0V treatment, 4.50 °Brix in the K30V treatment, 4.00 °Brix in the K50V treatment, and in the K70V treatment it was 4.25 oBrix. This shows that the K30V treatment has a greater value so that it can maintain the TPT content of tomatoes. Judging from the average TPT content of tomatoes during 12 days of storage, the K30V treatment had the largest average value of 4.30 °Brix, so the K30V treatment was the best treatment compared to other treatments.

The results of the test of variance (ANOVA) with a level of 5% showed that the K30V, K50V, and K70V treatments had no significant effect on the Total Dissolved Solids (TPT) of tomatoes, so they could not proceed to Duncan's test. However, storage time has a significant effect on Total Dissolved Solids (TPT) of tomatoes. The duration of storage of 0 HSP, 3 HSP, 9 HSP and 12 HSP had the same effect on TPT, but was significantly different from storage of 6 HSP. However, at storage of 9 HSP there is the highest TPT value of tomatoes so that storage of 9 HSP is the most optimum storage in maintaining the TPT value of tomatoes during storage.

2. Levels of Vitamin C

Vitamin C is a water-soluble vitamin and is easily oxidized when exposed to air. It is found in almost all vegetables and fruits, one of which is tomatoes. Based on Figure 2, it can be seen that the value of vitamin C content in tomatoes during storage ranged from 16.28-39.60 mg/100 g.

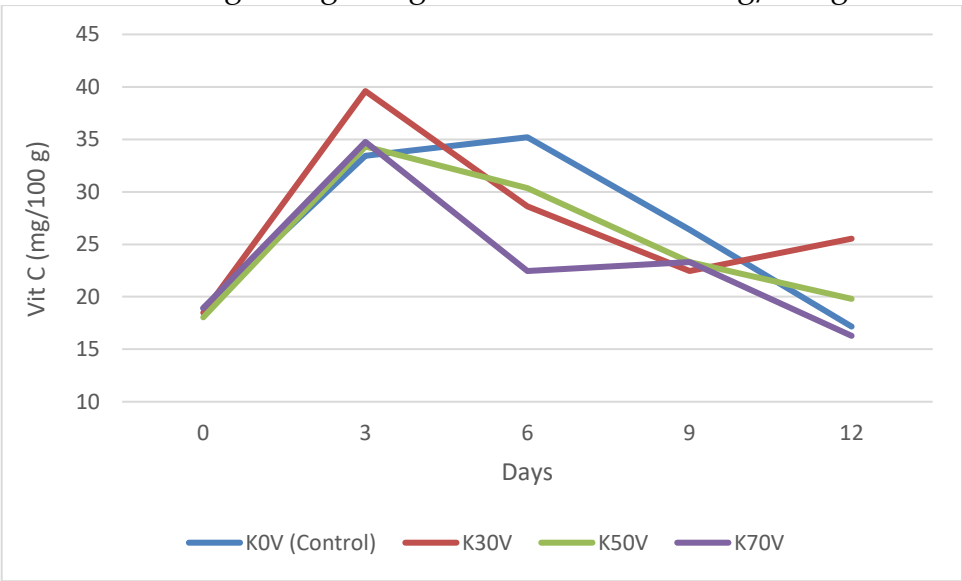

Figure 2. The Results of Testing the Levels of Vitamin C In Tomatoes in Each Treatment

Figure 2 shows that the initial storage levels of vitamin C in tomatoes in all treatments increased until the 3rd day of storage. At 6 HSP there was a decrease in tomato vitamin C levels in the three aloe vera coating treatments, namely a decrease of 11.00 mg/100 g in the K30V treatment, 3.92 mg/100 g in the K50V treatment, and 12.32 mg/100 g in the K70V treatment. In contrast to the K0V treatment (control) which increased by 1.76 mg/100 g on the 6th day of storage. This happens because the levels of vitamin C will continue to increase during storage because the respiration process continues to occur where simple sugars will form which act as precursors in the formation of vitamin C, but if the substrate for the formation of vitamin C is no longer available then the levels of vitamin C will decrease.

The highest increase in vitamin C levels in tomatoes occurred on the 3rd day of storage in the K30V treatment of 21.12 mg/100 g, while the lowest decrease in vitamin C levels occurred on the 12th day of storage in the K50V treatment of 3.52 mg/100 g. Looking at the 12th day of storage and the average vitamin C content of tomatoes during storage, the K30V treatment was the best treatment compared to the other treatments in maintaining vitamin C levels. The K30V treatment was able to maintain tomato vitamin C levels of 25.52 mg/100 g on the 12th day and had the highest average value of vitamin C, namely 26.93 mg/100 g during storage. This proves that aloe vera as an edible coating functions to inhibit the rate of transpiration and respiration so that it can maintain levels of vitamin C in tomatoes.

The results of the test of variance (ANOVA) with a level of 5% showed that the aloe vera coating treatment (K30V, K50V, and K70V) had no significant effect on the vitamin C content of tomatoes, so it could not be continued with the Duncan test. However, storage time has a significant effect on the vitamin C content of tomatoes. There was a significant difference between the 3 HSP and the vitamin C content of tomatoes stored at low temperatures.

CONCLUSIONS AND RECOMMENDATIONS

The combination of using aloe vera as an edible coating which is vacuum packed had an effect on the storage of tomatoes, although based on statistical results it did not show significant results. The best concentration for using aloe vera as an edible coating is the 30% aloe vera coating treatment. Treatment of aloe vera coating 30% (K30V) is the best treatment compared to treatment without aloe vera coating (K0V), aloe vera coating 50% (K50V), and aloe vera coating 70% (K70V) because it is able to maintain the average value of weight loss 0.172%, the average pH value was 4.42, the TPT average value was 4.30 ^{o}Brix, the average vitamin C content was 26.93 mg/100 g, the average color organoleptic value was 3.58, the texture organoleptic value was 3.82, and the aroma organoleptic value of 3.85 was still acceptable to the panelists until the 12th day.

ADVANCED RESEARCH

Make more varied combinations other than aloe vera coating which is vacuum packed with aloe vera coating which is packed with other packaging techniques as a comparison.

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