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The Application of Active Paper Incorporated with Oleoresin of Cinnamon Leaf (*Cinnamomum burmanii*) Distillation Residues on Maintaining Dragon Fruits (*Hylocereus costaricensis*) Quality during Storage

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Abstract. The purpose of this study was to determine the effect of active paper placement methods on super red dragon fruits quality during storage at ambient temperature. The active papers were incorporated with oleoresin of cinnamon leaf distillation residues. Various active paper placement methods were applied such as wrapping, placed on the cardboard wall, placed cardboard pad, and scrap of paper on the sidelines. Weight loss, peel color, surface and flesh hardness, total titratable acid, soluble solid total, pH flesh fruit, and total plate count (TPC) of super red dragon fruits samples were investigated during 9 days storage. The result shows that active paper placement methods significantly affected the weight loss, surface firmness and color peel change of super red dragon fruits samples. However, active paper placement methods insignificantly affected the titrable acid total, soluble solid total, pH, flesh firmness and microbial spoilage of super red dragon fruits samples. The best method to maintain the super red dragon fruits quality was wrapping method.

1. Introduction

Dragon fruit is a kind of cactus plant originating from Mexico, Central America, and South America. Dragon fruit contains bioactive substances that are beneficial to the health of the body such as antioxidants in the form of ascorbic acid, beta-carotene, anthocyanin and contain fiber in the form of pectin. Dragon fruit flesh also contains vitamin B1, B2, B3, vitamin C and minerals such as calcium, phosphorus, iron, and others [1]. Super red dragon fruit *(Hylocereus costaricensis)* is a type that is often cultivated because it has a sweet taste [2], and has a high economic value. The red color on the dragon fruit shows the presence of beta-carotene compounds, the redder the color of the flesh indicates higher beta-carotene content [3].

Due to the high water content of dragon fruit, the shelf life is short. At a temperature of 20^{o}C dragon fruit can only storage for 1 week [4]. Harvested dragon fruit will undergo taste changes caused by the changes of titrated acids and soluble solid, physical changes of fruit such as color and texture, weight loss, the changes of pH value, or the changes caused by microbial spoilage during storage [5]. Handling is necessary to minimize dragon fruit damage during storage and distribution.

Active packaging is an alternative to maintain the quality of horticultural products. One form of active packaging is the addition of the active compounds to a paper packaging material which is then

known as active paper [6]. In the previous research, the active paper could maintain the quality of plum fruits, peaches and mushrooms *(Agaricus bisporus)* [7] [8].

Oleoresin cinnamon leaves contain linalool as active compounds, which showed antimicrobial activity to inhibit microbial growth [9]. Active paper with the addition of a distillation residues cinnamon leaves oleoresin can provide an inhibitory effect on *Aspergillus niger* and *Pseudomonas fluorescens* [10]. However, the study related to the application of active paper incorporated with oleoresin cinnamon *(Cinnamomum burmanii)* distillation residues on dragon fruit has never been reported. Furthermore, it has the potential to maintain the quality of super red dragon fruit *(Hylocereus costaricensis)* during storage. The purpose of this study was to determine the effect of active paper placement methods on super red dragon fruits quality during storage at ambient temperature.

2. Experimental

2.1. Materials

Cinnamon leaves *(Cinnamomum burmanii)* obtained from Bubakan village, Wonogiri (Indonesia). The active paper materials were Whatman filter paper No.41, chitosan, and tween 80, acetic acid "MERCK", tapioca starch (Rose Brand), and distilled water. The secondary packing materials were cardboard-shaped boxes with length 64 cm, width 18 cm, and height 11 cm which obtained from CV. GIAT, Karanganyar (Indonesia). Cardboard also used as inside partition (8 part for each box) of the box. The super red dragon fruit *(Hylocereus costaricensis)*, harvested after 50 days the flowers bloom, obtained from CV. Purnama Jaya Farm, Sumedang (Indonesia). Testing materials used include distilled water, NaOH "MERCK" 0.1N, phenolphthalein indicator, Plate Count Agar (PCA) "MERCK", sterile normal saline, and alcohol 70%.

2.2. Oleoresin extraction

The extraction of cinnamon leaf distillation residue was conducted by using ethanol 70% (1:6) for 5 hours at 780C. The extract was filtered to separate the pulp and the filtrate. The separation between the solvent and oleoresin by using a vacuum rotary evaporator (IKA RV10) with a pressure of 500-700 mmHg (64 0C/120 rpm) until the solvent evaporated entirely [10].

2.3. Active paper manufacturing

The filter paper was cut to 2x2 mm. 15 g of filter paper immersed in 250 ml of distilled water for 24 h. Immersion filter paper and 250 ml of distilled water were blended for 5 minutes. The 4.5 g of tapioca in 50 ml of distilled water was mixed into the paper pulp and blended for 5 minutes. Furthermore, 0.45 g chitosan in 100 ml of 1% acetic acid was mixed in a blender with pulp for 5 min. 4% (w/w) of oleoresin was put into 50 ml of distilled water and stirred with a magnetic stirrer. During stirring, Tween 80 was added until an emulsion was formed. The emulsion was slowly added to the pulp and blended for 5 minutes. Paper moulding was done by using a 30 x 20 cm mould. Pulp poured evenly into the mould, and on the top covered with a fabric for pressing until flat. Wet paper sheets were dried for 48 hours at room temperature and reversing every 24 hours [10] [11] [12].

2.4. Fruits packaging

The fruits were packed using cardboard-shaped boxes. A total of 7 dragon fruits were placed into cardboard and given a bulk head for each fruit. The applied active paper placement methods were wrapping (Wrap), the placement of paper on the cardboard wall (Wall), the paper on the cardboard pad (Pad) and scrap of paper on the sidelines of the cardboard (Sidelines). The active paper was used for each treatment weighing at 16 g. Dragon fruits that have been packed subsequently analyzed on days 0, 3, 6, and 9 after storage at room temperature (28^{o}C, RH 83% during the day and 31^{o}C, RH 68% in the evening). The data were collected such as weight loss [13], peel color [14] using RGB Color Analyzer -1002 Lutron , surface and flesh hardness [13] using Fruit Hardness Tester FR-5105 Lutron ,

titrable acid total [15], soluble solid total [15] using Hand refractometer ATAGO, pH flesh fruit using pH meter ,and total plate count (TPC) [16].

2.5. Data analysis

The data were statistically analyzed by using *One Way Analyzes of Variance* (ANOVA) at a significance level $\alpha = 0.05$. If the result shows the difference between the variable then followed by *Duncan's Multiple Range Test* (DMRT) at a significance level $\alpha = 0.05$.

3. Result and Discussion

3.1. Weight loss

The test result showed that the use of active paper can reduce the weight loss rate. Weight loss caused by reduced water content in the fruits. Postharvest fruit no longer receives water intake from plants. Otherwise, damage to epidermal and periderm tissue causes acceleration of water out of the tissue. In previous research using peaches, plums [7] and mushroom [8] also showed the ability of active paper to inhibiting weight loss. The active paper incorporated with oleoresin of cinnamon distillation leaf residues is known to have antimicrobial compounds that can inhibit the growth of destructive microbes in the fruit that caused the demage to cell tissue [10].

3.2. fruits hardness

The data showed different results between the effect of active paper on the hardness level of fruit surface (fruit peel) (table 2) and fruit flesh (table 3). The level of hardness decline on the fruit surface was higher than the flesh fruit. Although it seems that the active paper was able to slow the hardness decline of the fruit surface. There is no significant decrease in the level of fresh fruits hardness and application of active paper does not show an effect on the hardness level. One of the factors that accelerate the decline in the hardness level is the extracellular enzyme-producing microbes that degrade polysaccharide, hemicellulose, and pectin [17] layers in the skin layer of the fruit. Active paper with the addition of essential oils is known to have the ability to inhibit microbial growth [8]. The active paper will release the compound to headspace. Inhibition effect possible because of the compound released into the headspace has antimicrobial effect.

3.3. Color (red) intensity on fruit surface

Table 4 showed that the use of active paper inhibits the color change that occurs on the surface of the fruit surface. Discoloration in non-climatic fruits indicates the presence of fruit shaking and the process leading to decay [18]. The color change is probably caused by the destruction of the cell and causes the cytosol content out to spur enzyme activation that causes browning [5]. In previous research using active paper with the addition of cinnamon oleoresin was able to inhibit the enzymatic oxidation effect in mushroom. It is possible that the active paper incorporated with oleoresin of distilled cinnamon leaves residue also gives a similar effect.

3.4. pH, total titrable acid, and total soluble solid

Data showed that the use of active paper has no significant effect on pH, total titrable acids, and total soluble solid of fruits flesh compared to controls (table 5, table 6, and table 7). This is thought to be due to the properties of the active paper used. active paper incorporated with essence oil known has antimicrobial activity [8] so that the effect of active paper was only shown in the damage caused by microbes, such as cell damage that causes weight loss, decreased hardness and color. Another possibility is related to the ability of active paper to transmit its compound on the headspace [8] so that the effect does not get into the flesh. in the another study showed that applies edible coating chitosan on cantaloupe did not show any effect on the chemical properties of the fruits during storage [19].

Table 1 Weight Loss during Storage

Treatment	Weight Loss (%)			
	Day 0	Day 3	Day 6	Day 9
Control	0.00^{Aa}±0,00	1.56^{Ab}±0,07	11.78^{Ec}±0,21	24.80^{Ed}±0,00
Wrap	0.00^{Aa}±0,00	1.60^{Bb}±0,00	3.66^{Ac}±0,01	6.08^{Ad}±0,07
Wall	0.00^{Aa}±0,00	6.66^{Eb}±0,07	9.07^{Dc}±0,07	13.62^{Cd}±0,07
Pad	0.00^{Aa}±0,00	1.69^{Cb}±0,00	6.39^{Cc}±0,00	16.16^{Dd}±0,07
Sidelines	0.00^{Aa}±0,00	1.92^{Db}±0,07	4.66^{Bc}±0,00	13.02^{Bd}±0,00

Table 2 Surface Fruits Hardness

Treatment	Hardness Level (Pa)			
	Day 0	Day 3	Day 6	Day 9
Control	14668Ab±465	14408Ab±923	1113Aa±60	1044Aa±17
Wrap	15924Bd±48	14475Ac±352	9259Cb±124	1386Ba±30
Wall	14371Ac±235	13841Ac±125	10107Db±329	1812Ca±52
Pad	14652Ac±490	13922Ac±380	7420Bb±480	1288Ba±116
Sidelines	14954Ac±98	14626Ac±415	7265Bb±195	1394Ba±22

Table 3 Flesh Hardness

Treatment	Hardness Level (Pa)			
	Day 0	Day 3	Day 6	Day 9
Control	947.4ABa±60	926.3Aa±30	841.4Aa±50	898.0Aa±30
Wrap	926.2Aa±30	1060.6Bb±60	947.5Bab±00	961.6ABab±60
Wall	1039.4ABa±50	997.0ABa±70	1110.1CDa±10	1046.5Ba±60
Pad	1050.0Ba±55	1028.8ABa±25	1046.5Ca±40	1000.5ABa±5
Sidelines	1032.3ABa±20	1025.2ABa±10	1166.7Db±10	1025.2Ba±29

Table 4 Color Intensity

Treatment	Intensity Red Color Fruit			
	Day 0	Day 3	Day 6	Day 9
Control	340.88ABd±19.62	278.88Bc±7.60	148.50Ab±4.60	79.25Aa±5.30
Wrap	395.50Bc±8.48	345.75Ec±6.01	296.00Eb±1.77	174.38Da±7.60
Wall	334.09ABd±3.42	319.62Dc±3.71	266.38Db±7.60	112.50Ba±2.12
Pad	322.66Ad±3.77	277.38Bc±4.77	195.92Cb±7.90	136.67Ca±4.72
Sidelines	322.50Ad±2.12	261.00Ac±8.02	165.83Bb±3.06	109.62Ba±6.89

Table 5 pH Value

Treatment	pH Value			
	Day 0	Day 3	Day 6	Day 9
Control	5.29Aa±0.14	5.10Ca±0.03	5.54Aa±0.36	5.34Ba±0.06
Wrap	5.30Aab±0.03	5.07Ca±0.06	5.89Ad±0.01	5.39Bc±0.16
Wall	5.31Ab±0.04	5.02CBa±0.01	5.72Ac±0.04	4.98Aa±0.11
Pad	5.24Aab±0.20	4.94BAa±0.01	5.99Ac±0.19	5.34Bb±0.01
Sidelines	5.16Ab±0.10	4.86Aa±0.02	567Ad±0.22	5.24Bc±0.04

Table 6 Total Titratable Acid

Treatment	Total Titratable Acid (%)			
	Day 0	Day 3	Day 6	Day 9
Control	10.20ABc±0.28	8.45Ab±0.21	9.30Abc±0.71	6.15ABa±0.63
Wrap	10.07BCb±0.42	10.20Cb±0.56	10.80ABb±0.28	4.70Aa±1.27
Wall	9.15Ab±0.07	8.90ABb±0.34	10.00ABb±0.85	5.32Aa±0.17
Pad	11.42Cb±0.60	9.74BCb±0.08	10.95ABb±1.20	5.60Aa±0.00
Sidelines	10.50BCb±0.56	8.65Ab±0.49	11.35Bb±0.21	7.75Ba±0.07

Table 7 Total Soluble Solid

Treatment	Total Soluble Solid (oBrix)			
	Day 0	Day 3	Day 6	Day 9
Control	10.07Aa±0.39	11.16Ba±0.62	10.38Aa±0.25	11.05Aa±0.35
Wrap	9.83Aa±0.24	11.38Bb±0.53	10.12Aab±0.53	11.20Aab±0.56
Wall	9.25Aa±0.35	9.95ABa±0.28	9.50Aa±0.71	11.60Ab±0.28
Pad	9.10Aa±0.85	10.20ABab±0.71	9.50Aa±0.71	11.70Ab±0.14
Sidelines	9.17Aa±0.04	9.40Aa±0.71	9.22Aa±0.32	11.80Ab±0.00

Table 8 Total Plate Count

Treatment	Total Plate Count (CFU/ml)			
	Day 0	Day 3	Day 6	Day 9
Control	3.12Aa±0.39	5.02BCb±0.52	5.54Ab±0.74	7.31ABc±0.37
Wrap	2.97Aa±0.16	3.64Aa±0.24	4.60Ab±0.51	7.08ABc±0.04
Wall	3.16Aa±0.04	4.06Ab±0.18	5.27Ac±0.16	7.36Bd±0.41
Pad	3.01Aa±0.01	4.32ABb±0.24	5.44Ac±0.06	6.34Ad±0.05
Sidelines	3.30Aa±0.02	5.20Cb±0.34	5.51Ab±0.12	7.05ABc±0.60

The number followed by superscript (A, B, C, D, E) in the same column show no significant difference at 5% significant level.
The number followed by superscript (a, b, c, d, e) in the same line show no significant difference at 5% significant level.

3.5. Total plate count

Most of the damage caused to fruit products is caused by decaying microorganism. Test results showed that the use of active paper by wrapping methods and placement on the wall able to withstand the growth rate of microorganisms although other treatments did not show a significant effect. microorganisms found in the fruit of the post-harvest dragon include Xanthomonas campestri, Dithiorella spp, Fusarium lateritium, Aspergillus niger and Aspergillus flavus [20]. Active paper with the addition of tested oleoresin is able to inhibit the growth of niger aspergillus and pseudomonas fluorescence and is known to have linalool compounds capable of inhibiting the growth of microbes [10]. The active compounds contained in the paper will be transferred to the headspace [8]. Treatment with the wrapping method gives a better effect than other treatments is possible because it has a larger surface of the fruit. A larger contact area will provide better protection on packed product

4. Conclusion

The active paper placement methods significantly affected the weight loss, surface firmness and color peel change of super red dragon fruits samples. However, active paper placement methods insignificantly affected the titrable acid total, soluble solid total, pH, flesh firmness and microbial spoilage of super red dragon fruits samples. The best method to maintain the super red dragon fruits quality was wrapping method.

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