pISSN: 2338-1345 eISSN 2808-8948– Vol. 9 (2) 38-45 Journal online http://journal.bakrie.ac.id/index.php/APJSAFE

Asia Pacific Journal of Sustainable Agriculture Food and Energy (APJSAFE)

Application of Dipping in $CaCl_2$ Solution as a Postharvest Treatment to Maintain the Quality of Pineapple during Storage

Rafi Renaldy Tamalea[1], Pepita Haryanti[1] and Condro Wibowo[1]*,

[1]*Department of Food Science and Technology, Faculty of Agriculture, Jenderal Soedirman University Indonesia*
*'*Corresponding author's E-mail address: condro.wibowo@unsoed.ac.id*

***Abstract*—** Pineapple is a perishable agricultural product, therefore an appropriate treatment at the postharvest stage Is required to maintain the quality and prolong the shelf life. Recently, several efforts have been conducted to achieve the purposes. Moreover, appropriate treatments are still required for alternative solution for pineapples producers. This study aims to determine the effect of the dipping in $CaCl_2$ solution at various concentrations on physical (mold incidence and mold severity), chemical (pH value), and sensory properties (color, texture, aroma, taste, and overall acceptance) of pineapple during storage. The dipping of the fruits was conducted at 50℃). The samples were MD-2 pineapple with two different classifications of shell color (shell color 0 and shell color 2). The results showed that there was no significant effect of dipping in the $CaCl_2$ solution at 50℃ on the parameters of pH value, mold The mold incidence and mold severity were detected after 16^{th} day of storage on treated samples and control. . After storage for 40^{th} days, the treated sample had better sensory properties compared to untreated ones, particularly on texture, color, and overall acceptance.

***Keywords*—** **Pineapple, $CaCl_2$, shell color, hot water, shelf life.**

Received : 12 August 2021
Accepted : 20 December 2021

INTRODUCTION

Pineapple is one of popular horticultural products in many countries. Over the past nine years, the market in the world has grown on average by 3.3% per year. The consumption of pineapples continues to grow due to the rising income and growing population and to marketing campaigns focused on healthy food consumption. The main exporter of pineapple in the world is Costa Rica (12% of worldwide production), followed by Brazil (10%), and the Philippines (10%). Whereas, Indonesia produces about 5% of pineapple production in the world (Mulderij, 2018).

The consumption of fresh pineapple is high in North America and EU markets (Loeillet et al., 2011). For fresh consumption, the MD-2 pineapple variety becomes the top breed in the pineapple industry. MD-2 pineapple variety has glossy with green golden shell color with a uniform and attractive cylindrical shape. MD-2 pineapple variety is high vitamin C, while the flesh is more yellow, less acid, sweeter, more aromatic, and slightly firmer than other pineapple varieties., Therefore, consumers prefer MD-2 pineapple varieties as compared to other varieties (Syahrin, 2011). In the pineapple plant industry, it is known as shell color, which is divided into six shell colors classification. In general, pineapples are harvested at shell color classification 0 and shell color classification 2. The shell color of pineapple fruit changes from green to yellow (score 1 to 6) during maturation (Joomwong, 2005). The difference in the classification is based on harvesting time and peels' color from green (score 1) to yellow (score 6).

The main problem of fresh fruit distribution is the shelf life. Since pineapple is perishable, it does not last long, so that the quality of the fruit is not good when the exported fruit reaches the consumer. The common treatment used in the industry to store their product is cold storage facilities. This machine conditioned the storage room at low temperatures and high humidity treatments. One of the alternatives that can be done to improve fruit quality is the application of $CaCl_2$.

The application of $CaCl_2$ can maintain fruit quality by inhibiting green pigment degradation and maintaining the fruit texture (Irfan et al., 2013). The application of $CaCl_2$ can cross-link Ca^{2+} with pectic acid and other polysaccharides, thereby limiting fruit softening and respiration enzymes such as polygalacturonase, reducing the rate of respiration and reducing the decrease in ascorbic acid. $CaCl_2$ treatment with postharvest dipping of fruit will not leave residue after the fruit is washed with water (Rahmawati, 2011). The function of $CaCl_2$ is to form a cell wall that is needed in the process of forming new cells; $CaCl_2$ can also change intracellular and extracellular processes that can slow down fruit ripening, maintain cell walls so that it can inhibit fruit softening, and reduce mechanical and microbiological damage (Hasmoro, 2014).

One of the causes of postharvest damage to pineapple is mold. This mold can attack whole pineapples both in the

plantation and during storage. This mold infects the pineapple fruit through wounds that form at the peduncle of the pineapple when the pineapple is harvested or during storage (Reny, 2017). This condition will influence the consumer preference of the fruits.

Sensory properties of the fruit evaluation influences consumers' acceptance of fruits, the characteristics that impart distinctive quality may be described by four different attributes: color and appearance, taste, texture, and nutritional value. The appearance of the product usually determines whether a product is accepted or rejected (Diane, 2010)

Previous research reported that the dipping treatment of smooth cayenne pineapple fruit into a $CaCl_2$ solution with a concentration of 2% at 38℃ and 40℃ for 10 and 20 minutes could reduce the internal browning index, reduce the activity of polyphenol oxidase, peroxidase, and phenylalanine ammonium lyase enzymes (Goncalves et al., 2000). However, the study still has a limitation: the storage period and observations were only carried out for 15 days. The fruit varieties used were only smooth cayenne and the storage temperature was at 9℃. Moreover, the appropriate concentration of $CaCl_2$ and the right dipping temperature were needed to obtain good quality fruit to extend the shelf life of pineapples. This research aimed to study the effect of dipping in the $CaCl_2$ solution with various concentrations applied at 50℃ on pineapples' quality during storage for 40 days.

MATERIALS AND METHODS

A. Materials

The material used is pineapple variety MD-2 which was harvested from pineapple plantations in Lampung. The samples were fruit with a classification of shell color 0 and the other groups were pineapples with a classification of shell color 2. Characteristics of pineapple fruit with shell color 0 is a fruit that has a dark green color, while pineapple fruit with shell color 2 is a fruit that has a green color with a slightly yellowish color. Each fruit weighed 1.46 kg – 1.7 kg. In addition to $CaCl_2$, coating Wax OE 6012 (Nanjing Tianshi, China), and Pochloraz were also prepared for the application of treatments.

B. Dipping in $CaCl_2$ solution at 50℃

Before the dipping process, the water (70 l) was heated in the drum by using a heater until the temperature reaches 50℃. Afterward, the pineapple is dipped into the solution for 5 minutes with concentrations of $CaCl_2$ 0%, 2%, 4%, and 6% w/v from a capacity of 70 l of water per treatment. After that, the fruit is dried and cooled until the room temperature (36-37℃) by placing it on a board with open air for approximately 10 minutes. In addition, the fruit was dipped in the fungicide pochloraz with a concentration of 2 cc/l and OE 6012 wax with 100 ml/l by manually dipping each for 10 seconds. Then the fruits were put into a box per treatment and stored in cold storage at a temperature of 7℃. Observations and analyses were carried out every eight days with a total of 40 days of storage.

C. Experimental Design

The treatment studied in this research was the concentration of the $CaCl_2$ as dipping solution. The fruits were dipped in the $CaCl_2$ solution with concentration of 0% (K2), 2% (K3), 4% (K4) and 6% (K5). The dipping process was conducted at 50ºC. Moreover, control was also prepared. These treatments were applied to two different classification of shell color (shell color 0 and 2).

D. Variables

The pH was determined using a digital pH meter (pHs-2F, Harris, England) (AOAC, 2012). Fifty (50ml) of the juice was transferred into a beaker and the pH was determined after the meter was calibrated using standard buffer solutions of pH 4.0 and 7.0. Sufficient time was allowed for equilibration before readings were taken.

Determining the mold incidence and severity on the pineapple, observations of mold incidence were carried out by observing the peduncle of the pineapple whether there is mold or not, and the mold severity was carried out by observing the peduncle of the pineapple by divided into four parts cross-section. The following is the percentage of pineapple parts that have mold incidence: 0 parts = 0%; 1 parts = 25%; 2 parts = 50%; 3 parts = 75%; 4 parts = 100%

Sensory tests were conducted to determine the level of acceptance of color, texture, aroma, taste, and overall acceptance/liking. This sensory test uses the scoring test method (Kaneko et al., 2006). The number of panelists was 20 people of a wide range of ages and both sexes. Panelists were asked to assess the pineapple samples presented and fill in the data on the sensory test questionnaire. For this purpose, they used a structured 5 points scoring scale, using ranges varying from "1" to "5". The high score was expected because it represented better quality on each parameter.

E. Statistical Analysis

Data of pH value were analyzed by ANOVA (Analysis of Variance) test at the level of 5% and the DMRT (Duncan's Multiple Range Test). Mold incidence and severity variable data were analyzed by descriptive analysis. Sensory evaluation data variables were analyzed by Friedman's Comparative Test.

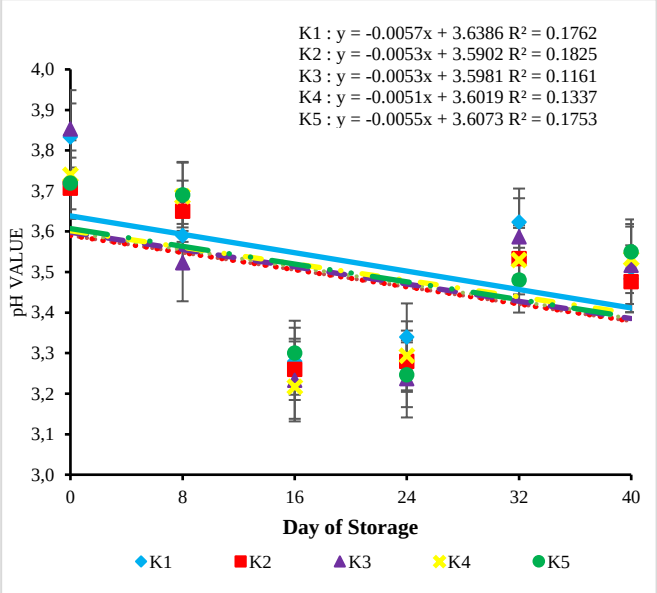
RESULTS AND DISCUSSIONS

pH Value

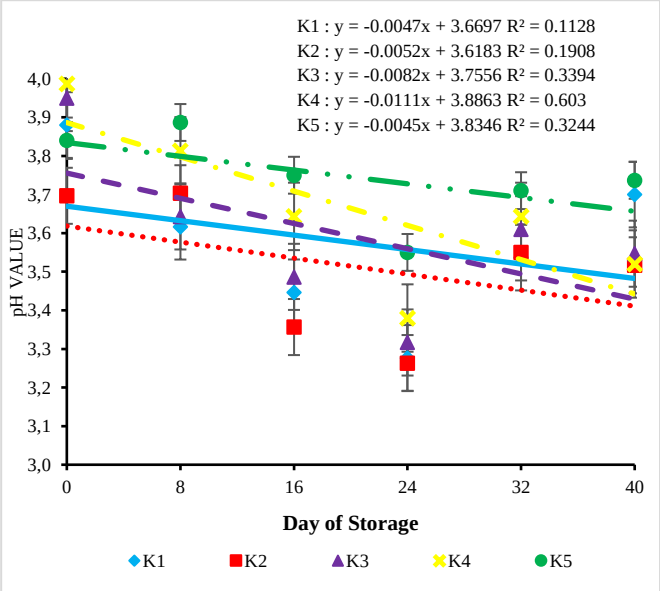
In general, pineapples have a pH value between 3.4 to 4.2 depending on the variety of fruit and the level of maturity of the pineapple. Another study conducted by (Samreen et al., 2020) showed the pH value of fresh pineapple juice was 3.69. The MD2 variety of pineapple has a pH value between 3.63 to 3.82 (Syazwani et al., 2013).

The results of the analysis showed that the dipping in the $CaCl_2$ solutions at various concentrations at 50℃ on two different types of pineapple shell color classification during 40 days of storage did not affect the pH value. The value of the regression equation and the average pH value based on

2 types of pineapple shell color classification are presented in Figure 1.



(a)



(b)

Fig.1 The average value and the value of the regression equation of the pH value of pineapple during 40 days of storage on fruit shell color classification 0 (a) and shell color classification 2 (b).

Previous research by Elham et al. (2011) reported that the application of soaking apples in a $CaCl_2$ solution was not significantly different on total dissolved solids, total titrated acid, pH, and vitamin C of fruit compared to control. The level of $CaCl_2$ 2 penetration into the fruit probably causes this result. Three independent processes may cause slow penetration: (1) access to aqueous pores in cuticles is not optimal; (2) solutions cannot penetrate all fissures in cuticles and pores in lenticels; and (3) large aggregates may be formed between calcium ions and components of the fungicide formulation (Schlegel, 2004).

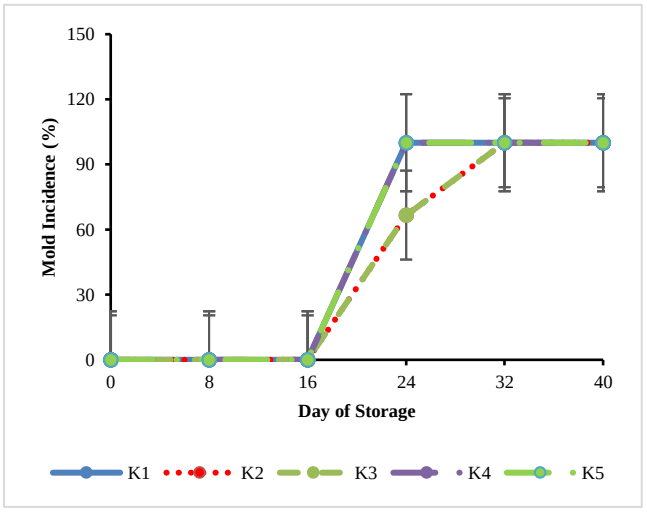
Based on Figure 1, the pH value for pineapple fruit during 40 days of storage can be categorized as acidic because the pH value of all treatments is in the range of 3 to 4. The trend of the regression equation tends to decrease the pH value. This may be due to pineapples, including non-climacteric fruits (Sari, 2020).

So that during storage, organic acids do not decrease quickly, in contrast to climacteric fruit which during storage of organic acids decreases quickly in fruit because it is used as a substrate for energy sources in the respiration process (Verawati et al., 2020).

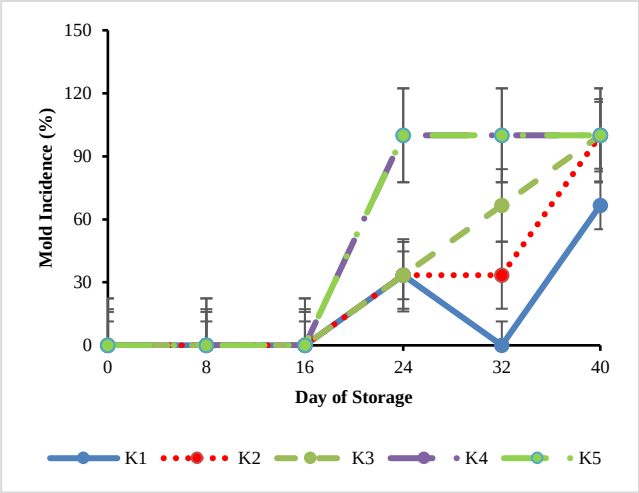
Mold Incidence and severity

This mold can attack whole pineapples in the field or during storage and cause black rot. Mold infects fruit through wounds that form at the base of the fruit when the fruit is harvested. The infection starts from the base of the fruit with the shape of a small circle, wet and soft spots. Next, the spots enlarge and expand in all parts of the fruit. Finally, the inner tissue of the fruit becomes soft, black, watery, and emits an odor (Reny, 2017).

The results of observing the severity of mold and the incidence of mold attack in the dipping in the $CaCl_2$ concentration with hot water dipping on 2 types of pineapple shell color classification during 40 days of storage are presented in Figure 2 and Figure 3, respectively.

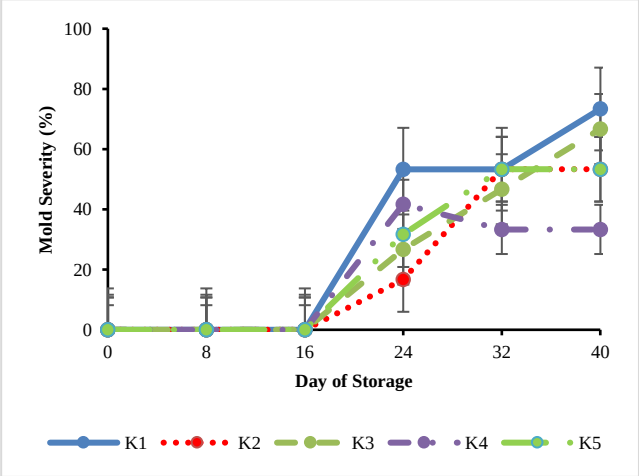


(a)

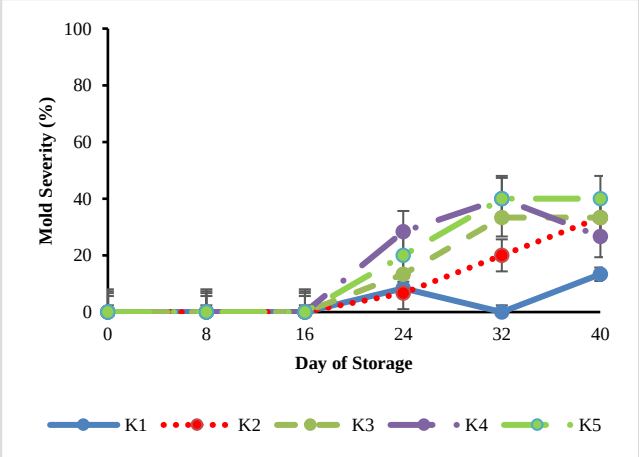


(b)

Fig.2 The average percentage of mold incidence in pineapples during 40 days of storage for shell color classification is 0 (a) and shell color classification is 2 (b).



(a)



(b)

Fig.3 The average percentage of mold severity on pineapple fruit during storage for 40 days with shell color classification 0 (a) and shell color classification 2 (b).

Based on Figures 2 and 3, mold attack on pineapple fruit with all treatments and control treatments began to appear after the 16th day of storage. Research conducted by Reny (2017) on pineapple fruit of the MD-2 variety, mold attacks began to appear on day 21 after storage with 0% and 25% fruit maturity levels. The result is that fruit that has a higher maturity level of 25% allows for faster mold attack and a higher percentage than lower fruit ripeness levels. During the fruit ripening process, carbohydrates will be converted into sugar so that the sugar content will increase along with the increase in fruit ripeness. If the sugar content is higher, microorganisms such as mold can quickly develop on the fruit (Reny, 2017).

Sensory Evaluation

Sensory evaluation analysis was carried out with five parameters: texture, color, aroma, taste, and acceptance.

Texture.

The results of the analysis in Table 1 showed that the dipping in the $CaCl_2$ solution at 50°C on 2 different types of pineapple shell color classifications during storage for 40 days in shell color classification 0 did not affect the texture, whereas in shell color classification 2 there was the effect. This shows that the higher the Ca content of the fruit, the harder the fruit texture. The fruit texture on the shell color classification of 2 storage days 40 showed that the $CaCl_2$ application treatment had a better texture than the control or without $CaCl_2$ application. Another study on apples, pears, and avocados showed that $CaCl_2$ treatment could delay the decrease in hardness levels and reduce respiration during low-temperature storage (Irfan et al., 2013).

The application of $CaCl_2$ is known to maintain the texture of the fruit because the $CaCl_2$ solution enters the pores of the fruit and will work on the cell wall in bridging the galacturonic acid in pectin. In one part of the fruit cell wall, the middle lamella is an area that contains a lot of pectins which when interacting with Ca^{2+} will form Ca pectate, which plays a role in increasing the attachment between cells so that it can maintain the rigidity of the fruit texture (Nungki et al., 2013).

Color

The results of the analysis in Table 2 showed that the dipping in the $CaCl_2$ solution at 50°C on 2 different types of pineapple shell color classification during storage for 40 days on shell color classification 0 did not affect the intensity of color, while in shell color classification 2 storage days 40 there was a significant effect.

On day 0 there was a significant effect due to the possibility of freshly harvested fruit having quite different colors. Meanwhile, on day 40, the fruits that had a greener and fresher color were those with $CaCl_2$ application treatment than the control. This result could be because the application of $CaCl_2$ can delay fruit maturity so that the fruit still looks fresh and has a longer shelf life than the control treatment (Lv et al., 2020).

Aroma

The results of the analysis in Table 3 showed that dipping in $CaCl_2$ solution at 50℃ did not affect the aroma except in day 24 and 32. A previous study conducted by Wei et al., (2017), explained that the application of Ca could increase fruit aroma through fatty acid metabolism. Ca treatment increases the volatile aromatics content because Ca promotes the decomposition of bound substances into free forms and the synthesis of volatile aromatic substances in pears (Wei et al., 2017).

Taste

The results of the analysis in Table 4 showed that the dipping in the $CaCl_2$ solution at 50℃ on 2 different types of pineapple shell color classification did not affect the taste of the fruits. An effect was found during the storage at day 16 for the fruits with shell color classification 0However, other treatments did not show the effects. This could be because the $CaCl_2$ treatment and the $CaCl_2$ content in the fruit can improve the fruit's sensory quality, including aroma, taste, and appearance. In addition, the results of research conducted by Oz and Zeynep (2013) on mulberries showed that the application of $CaCl_2$ can increase shelf life and fruit quality by reducing the respiration process which is the cause of sensory decay (aroma, taste, and appearance).

Acceptance

The results of the analysis in Table 5 show that dipping in the $CaCl_2$ solution at 50℃ on 2 different types of pineapple shell color classifications during 40 days of storage in shell color classification 0 did not affect acceptance, whereas in shell color classification 2 storage days 40 showed a difference. The panelists preferred the treatment with the $CaCl_2$ application compared to the control because the quality of the fruit with the $CaCl_2$ application treatment overall had a color, aroma, taste, and texture that were more acceptable to the panelists than the control. Another study conducted by Shiri et al., (2014) that the application of $CaCl_2$ on kiwi fruit can improve sensory qualities such as fruit pulp and flesh color, aroma, and fruit texture.

CONCLUSIONS

The dipping in the $CaCl_2$ solution at 50℃ on 2 classifications of pineapple shell color did not affect the pH value of the pineapple. The mold incidence and severity appeared after the 16^{th} day of storage. After storage for 40^{th} days, the treated sample had better sensory properties, particularly on texture, color, and overall acceptance compared to untreated ones.

ACKNOWLEDGEMENT

The authors acknowledge the facilities provided and financially supported by the PT. Great Giant Pineapple.

Table 1. Texture

Data	Texture (day 0)		Texture (day 8)		Texture (day 16)		Texture (day 24)		Texture (day 32)		Texture (day 40)	
Shell color	0	2	0	2	0	2	0	2	0	2	0	2
Treatment												
K1	4.15	3.80	3.90	3.45	3.30	3.40	3.40	3.10	3.45	2.95	2.90	1.20 c
K2	4.20	3.75	3.90	3.10	3.50	3.35	3.40	3.05	3.30	3.00	3.00	1.75 bc
K3	4.10	3.10	3.85	3.70	3.45	3.15	3.40	3.05	3.20	2.95	2.90	2.55 ab
K4	4.00	3.25	3.75	3.25	3.40	3.10	3.30	2.85	3.15	2.75	2.80	2.55 a
K5	4.15	3.30	3.70	3.35	3.55	3.20	3.35	3.00	3.10	2.75	2.85	2.15 ab

Numbers followed by the same letter are not significantly different in Friedman's Comparative Test

Table 2. Color

Data	Color (day 0)		Color (day 8)		Color (day 16)		Color (day 24)		Color (day 32)		Color (day 40)	
Shell color	0	2	0	2	0	2	0	2	0	2	0	2
Treatment												
K1	4.20	2.55 ab	3.65	3.25	3.30	3.20	3.45	2.85	3.10	2.85	2.80	1.40 b
K2	4.25	3.05 a	3.85	3.30	3.60	3.30	3.30	2.80	2.70	2.80	2.70	1.95 ab
K3	4.35	2.25 b	3.85	3.35	3.80	3.00	3.35	2.80	2.75	2.70	2.80	2.30 a
K4	3.95	2.20 b	3.60	3.10	3.50	3.30	3.30	2.85	3.00	2.80	2.70	2.45 a
K5	4.15	3.00 ab	3.85	3.10	3.35	3.25	3.15	2.75	3.00	2.80	2.50	2.45 a

Numbers followed by the same letter are not significantly different in Friedman's Comparative Test

Table 3. Aroma

Data	Aroma (day 0)		Aroma (day 8)		Aroma (day 16)		Aroma (day 24)		Aroma (day 32)		Aroma (day 40)	
Shell color	0	2	0	2	0	2	0	2	0	2	0	2
Treatment												
K1	2.75	3.20	2.65	2.95	3.50	3.25	2.65	3.35 a	3.30 a	2.95	2.82	2.36
K2	2.70	2.45	2.95	2.60	3.20	3.35	2.65	3.10 ab	2.70 a	3.10	2.09	2.73
K3	2.55	2.80	2.60	2.70	3.20	3.20	2.70	2.75 ab	2.90 a	2.60	2.82	3.00
K4	2.60	2.95	2.90	2.75	3.30	3.15	2.60	2.65 b	2.45 b	3.00	2.73	2.91
K5	3.00	2.90	2.65	2.95	2.90	3.35	2.40	2.90 ab	2.55 a	3.10	2.36	2.45

Numbers followed by the same letter are not significantly different in Friedman's Comparative Test

Table 4. Taste

Data	Taste (day 0)		Taste (day 8)		Taste (day 16)		Taste (day 24)		Taste (day 32)		Taste (day 40)	
Shell color	0	2	0	2	0	2	0	2	0	2	0	2
Treatment												
K1	2.35	2.90	2.70	3.05	3.60 a	3.15	2.75	3.10	3.00	2.65	2.82	3.45
K2	2.55	2.65	2.85	2.90	3.25 ab	3.60	2.35	3.15	2.65	3.15	2.64	3.36
K3	2.80	2.60	2.90	2.80	3.50 ab	3.30	2.60	2.70	2.85	2.70	3.18	3.18
K4	2.60	2.90	3.05	2.90	3.20 ab	3.30	2.65	2.65	2.50	2.80	2.82	3.36
K5	2.85	2.95	2.70	2.85	2.70 b	3.45	2.50	2.90	2.80	3.15	3.27	3.73

Numbers followed by the same letter are not significantly different in Friedman's Comparative Test

Table 5. Acceptance

Data	Acceptance (day 0)		Acceptance (day 8)		Acceptance (day 16)		Acceptance (day 24)		Acceptance (day 32)		Acceptance (day 40)	
Shell color	0	2	0	2	0	2	0	2	0	2	0	2
Treatment												
K1	2.25	2.80	2.55	3.00	2.55	2.90	2.50	3.00	3.05	2.65	2.60	1.40 b
K2	2.15	2.55	2.40	2.55	2.70	3.20	2.45	3.10	2.70	2.90	2.40	2.00 ab
K3	2.35	2.55	2.75	2.75	2.55	2.70	2.45	2.90	2.90	3.00	2.40	2.05 a
K4	2.45	2.80	2.85	2.70	2.40	2.90	2.70	2.60	2.55	2.90	2.40	2.05 a
K5	2.85	2.85	2.70	2.80	2.30	2.90	2.45	2.85	2.55	3.10	2.35	1.70 ab

REFERENCES

AOAC, 2012. Official Methods of Analysis of the Association of Official Analytical Chemists, 20th ed.

Diane M. Barrett, John C. Beaulieu & Rob Shewfelt. (2010) Color, Flavor, Texture, and Nutritional Quality of Fresh-Cut Fruits and Vegetables: Desirable Levels, Instrumental and Sensory Measurement, and the Effects of Processing, Critical Reviews in Food Science and Nutrition, 50:5, 369-389, DOI: 10.1080/10408391003626322.

Elham, S., Vali, R., and Yavar, S. 2011. Effect Of Calcium Chloride ($CaCl_2$) On Postharvest Quality Of Apple Fruits. *African Journal of Agricultural Research*, Vol. 6(22), pp. 5139-5143.

Gonçalves, N.B., Vânia, D.D.C., Jorge, R.D.A.G. 2000. Effect Of Calcium Chloride And Hydrothermical Treatment On Enzymatic Activity And Phenol Content Of Pineapple. Esq. agropec. bras., Brasília, v.35, n.10, p.2075-2081.

Hasmoro, H.B.S., Trisnowati, R. Rogomulyo. 2014. Pengaruh Kadar CaCl2 terhadap Pematangan dan Umur Simpan Buah Sawo (Manilkara zapota L.) van Royen). *Jurnal Vegetalika*, 3(4): 52-62.

Irfan, P. K., Vanjakshi, V., Prakash, M. N. K., Ravi, R., & Kudachikar, V. B. (2013). Calcium chloride extends the keeping quality of fig fruit (Ficus carica L.) during storage and shelf-life. Postharvest Biology and Technology,82, 70–75. https://doi.org/10.1016/j.postharvbio.2013.02.008.

Joomwong, A and Sornsrivichai, J. 2005. Impact of Cropping Season in Northern Thailand on the Quality of Smooth Cayenne Pineapple I. Influence on Morphological Attributes. *Int. J. Agri. Biol*., Vol. 7, No. 3.

Kaneko, S., K. Kumazawa, H. Masuda, A. Henze, T. Hofmann. 2006. Molecular and Sensory Studies on the Umami Taste of Japanese Green Tea. J Agric Food Chem. 54(7):2688-2694.

Loeillet, D., Dawson, C. and Paqui, 2011. Fresh pineapple market: from the banal to the vulgar. Acta Horticulturae 902: 587-594.

Lv J, Han X, Bai L. 2020. Effects of calcium chloride treatment on softening in red raspberry fruit during low-temperature storage. J Food Biochem. 00:e13419.https://doi.org/10.1111/jfbc.13419.

Mulderij, R. 2018. An Overview Global Pineapple Market. Accessedfromwww.freshplaza.com/article/2194086/overview-global-pineapple-market on 25 July 2021.

Nungki, K.A., M. Dawam, M., and Roedy, S. 2013. Application And Ethephon Of Calcium Chloride For Improving The Fruit Quality Of Pineapple. *JKTI*, Vol. 15, No.1, June 2013: 41-48.

Oz, T. A., Zeynep, U. 2013. The Effects Of Calcium Chloride And 1-Methylcyclopropene (1-Mcp) On The Shelf Life Of Mulberries (Morus Alba L.). Journal of Food Processing and Preservation 38 (2014) 1279–1288.

Rahmawati. 2011. Pengaruh Perlakuan Konsentrasi Kalsium Klorida ($CaCl_2$) dan Lama Penyimpanan terhadap Kadar Asam Askorbat Buah Tomat. *Buletin Anatomi dan Fisiologi*. Vol. XIX, No. 1.

Reny. 2017. Pengaruh Klorin Dan Pelapis Buah Pada Tingkat Kemasakan Yang Berbeda Terhadap Pekembangan Stadium Dan Mutu Nanas Kultivar MD2. *Tesis*. Fakultas Pertanian. Universitas Lampung.

Sari, M., Juliana, S. 2020. Prediksi Laju Respirasi Terong Dengan Persamaan Arrhenius. *Jurnal Agroteknosains*. Vol. 4, No. 2.

Samreen, Ch V.V. Satyanarayana, L. Edukondalu, Vimala Beera, and V. Srinivasa Rao. 2020. Physicochemical Characteristics of Pomegranate and Pineapple Juice. *Indian Journal of Ecology (2020) 47 Special Issue*. (11): 60-63.

Schlegel, T. K., & Schönherr, J. 2004. Mixing calcium chloride with commercial fungicide formulations results in very slow penetration of calcium into apple fruits. *Journal of Plant Nutrition and Soil Science*, 167(3), 357–362.

Shiri, M.A., Ghasemnezhad, M., Moghaddam, J.V., Ebrahimi, R. 2014. Fruit Growth and Sensory Evaluation of 'Hayward' Kiwifruit in Response to Preharvest Calcium Chloride Application and Orchard Location. Agriculture Conspectus Scientific cus. Vol. 79 (2014) No. 3 (183-189).

Syahrin, S. 2011. Consumer preferences towards pineapple cultivars in Malaysia. Acta Horticulturae 902: 595-600.

Syazwani, S., Nurliya, I., and Ding, P. (2013). Storage Quality Of 'MD2' Pineapple (Ananas Comosus L.) Fruits. *Acta Horticulturae*, (1012), 897-901.

Verawati, N., Nur, A., Khairul, M. 2020. Pemanfaatan Chitosan Dari Limbah Udang Galah Sebagai Edible Coating Buah Tomat Dengan Variasi Waktu Penyimpanan. *Jurnal Pangan dan Agroindustri*. Vol.8 No.3: 134-144.

Wei, S., Qin, G., et al. 2017. Calcium treatments promote the aroma volatiles emission of pear (Pyrus ussuriensis ‘Nanguoli’) fruit during the postharvest ripening process. Scientia Horticulturae 215 (2017) 102–111.