Journal of Applied Science and Advanced Technology
Journal Homepage : https://jurnal.umj.ac.id/index.php/JASAT

Performance of Beeswax and Ricebran-Wax Coating on Weight Loss of Local Indonesian Fruits: Kirana Banana, Gedong Mango, and Pontianak Orange

Ratri Ariatmi Nugrahani[1*], Tri Yuni Hendrawati[1], Ummul Habibah Hasyim[1], Rusnia Junita Hakim[2]

[1]*Department of Chemical Engineering, Faculty of Engineering, Universitas Muhammadiyah Jakarta, Jl. Cempaka Putih Tengah 27,Jakarta, 10510, Indonesia*

[2]*Department of Chemical Engineering, Faculty of Engineering, Universitas Pamulang, Jl. Witana Harja No. 18b Pamulang, Tangerang Selatan, Banten, 15417, Indonesia*

ARTICLEINFO

JASAT use only:
Received date : 7 May 2024
Revised date : 18 June 2024
Accepted date : 21 July 2024

Keywords:
Beeswax,
Rice Bran Wax,
Coating,
Banana,
Orange.

ABSTRACT

Bananas, mangoes, and oranges are fruit commodities that are quite potent and have a promising export market share. The shelf life of the fruit is not long and causes physical-chemical damage to the fruit, one way that can be done in post-harvest handling of the fruit is by using the wax method. This study used types of wax, namely beeswax and rice bran wax. The purpose of this study was to determine the effect of beeswax coating on fruit weight loss, to determine the effect of rice bran wax concentration on the characteristics of rice bran wax coating and fruit weight loss, determine the effect of storage time of bananas, mangoes, and oranges on fruit weight loss. The independent variables in this study included rice bran wax concentration (6;9;12;15;18)% and fruit storage time of 3 weeks, while the dependent variables in this study included pH, density (gr/ml), viscosity (seconds), mango fruit weight loss (%). The procedures in this study include the manufacture of beeswax coating, and rice bran coating, analysis of characteristics of beeswax coating and rice bran wax coating, and analysis of weight loss of bananas, mangoes and oranges after coating. The results of the analysis of the characteristics of rice bran wax coating (pH, density, viscosity) on the concentration of rice bran wax (6; 9; 12; 15; 18)% showed that the pH showed a downward trend with a pH value of 9.33; 9.22; 9.21; 9.18 and 8.95, the density showed a tendency to increase with a density value of 1.018; 1.021; 1.022; 1.023; and 1.026 gr/ml, the viscosity showed a tendency to increase with a value of 8.85; 8.2; 8.3; 8.43; 8.56 seconds. Characteristics of Beeswax Coating 12% resulted in a pH of 9.19, a density of 1.019 g/mL, and a viscosity of 8.3 seconds. The smallest weight loss of mangoes and oranges for 3 weeks was fruit coated with 12% beeswax coating, and the smallest weight loss for bananas for 3 weeks was fruit coated with 12% rice bran wax coating.

Introduction

Indonesia is an agribusiness country with a livelihood as a farmer. Fruit crops are one of the most widely cultivated agricultural commodities in Indonesia. Based on BPS data in 2018, the largest production, there are five leading fruit commodities, namely bananas at 7.26 million tons, mangoes at 2.62 million tons, oranges/tangerines at 2.41 million tons, pineapples at 1.81 million tons, and 1.14 million tons of durian. The five leading commodities are produced in almost every province in Indonesia [1-2].

Bananas, mangoes and oranges are fruit commodities that are quite potential and have a promising export market share (Ministry of Agriculture, Directorate General of Horticulture, 2018). Several Indonesian mango varieties that have the opportunity for export marketing are Gedong, Arumanis, Manalagi, and Golek [3].

The Ministry of Agriculture stated that several types of bananas that have the opportunity to be

* Corresponding author.
E-mail address: ratri.ariatmi@ftumj.ac.id

DOI: https://dx.doi.org/10.24853/JASAT.7.1.7-14

developed into export commodities are Mas Kirana bananas, Raja bananas, Ambon bananas, and Raja Bulu bananas [4-5].

The shelf life of bananas, mangoes, and oranges is not long and causes physical-chemical damage to the fruit, which is the main obstacle faced by farmers in the area. This is due to the absence of special post-harvest handling carried out by farmers in the area in maintaining fruit quality. So many fruit crops are damaged before reaching consumers [6].

Post-harvest handling of fruit is a special treatment factor that needs to be considered so that fruit quality can be maintained until it reaches consumers. One way that can be done in post-harvest handling of fruit is to use the wax method. The Waxing method is an attempt to prevent the occurrence of respiration which affects the quality of the fruit. Wax coating on the surface of the fruit can prevent water evaporation so that it can slow down wilting, andrespiration rates and shine the skin of the fruit so that it adds to the attractiveness for consumers and can extend the shelf life and freshness [7]. This is related to the 2015-2045 national research master plan, which includes a working group on food self-reliance (post-harvest technology) [8].

Beeswax is one of the natural waxes produced and needed by bees as a construction material for their hives, which are generally composed of fatty acid esters and various long- chain alcohol compounds [9-10]. Rice bran wax is a yellowish to brownish hard wax obtained as a by-product of the dewaxing process in refining bran oil, which consists of a mixture of fatty alcohol esters and fatty acids. It exhibits similar characteristics as carnauba wax and can serve as a substitute for coatings on fruits and vegetables. Rice bran wax has a wide range of applications in cosmetics, pharmaceutical purposes, electrical insulation, textiles, and separate waterproofing of food [10-12].

In this study, the manufacture of beeswax coating and rice bran wax coating will affect weight loss and extend the shelf life of mas Kirana bananas, gedong mangoes, and Pontianak oranges.

Methods

The equipment's used in the research include Magnetic Stirrer, Hotplate, Digital Scales, Thermometer, pH meter, Visco cup, and pycnometer. The ingredients used in this study were Soy Lecithin, Aquades, Beeswax, Rice Bran Wax, Stearic Acid, Mango Gedong Gincu, Banana Mas Kirana, Pontianak Orange, Triethanolamine (TEA). This research was started by washing the fruit (bananas, mangoes, oranges), sorting, and soaking the fruit in hot water at 40°C for 2-5 minutes.

Wax Coating Preparation

The coating is made by putting beeswax in pot A and aquades in pan B, both of which are heated until the temperature reaches 90-95°C while continuously stirring. After reaching a temperature of 90-95°C, stearic acid and lecithin were put into pot A while TEA was put into pan B. After mixing, they were cooled to 80°C while continuously stirring. The mixture from pot B is put into pot A, stirring continuously until the mixture reaches room temperature, for 30 minutes. After that, the beeswax emulsion was filtered so that the final results obtained were cleaner [3,5].

Rice Bran Wax Coating Manufacture

Making coatings with rice bran wax concentration (6; 9; 12; 15; 18)% (v/v) was placed in pan A and as many aquades as were placed in pan B, both were heated until the temperature reached 90-95°C while both were continuously stirred. After reaching a temperature of 90-95°C, stearic acid and lecithin were put into pot A while TEA was put into pan B. After mixing, they were cooled to 80°C while continuously stirring. The mixture from pot B is put into pot A, stirring continuously until the mixture reaches room temperature, for 30 minutes. After that, the beeswax emulsion was filtered so that the final results obtained were cleaner [3,7].

Characteristics beeswax dan rice bran wax coating

Analysis of the characteristics of beeswax , rice bran wax coating includes the visual appearance of the edible coating solution (visually the coating produced is homogeneous, lumpy, and smelly), the pH of the Edible Coating Solution (measurement using a pH meter where the pH formula for edible coatings should be close to 8-10), Viscosity Edible Coating solution (measurement using a visco cup, Density is calculated based on the difference between the final pycno weight and the initial pycno weight per pycno volume [7].

The fruit is coated by dipping, and after that it is dried. Analysis of the effect of beeswax coating and rice bran wax coating on weight loss. Weight loss was calculated based on the difference between the initial weight and the weight at the time of

Journal of Applied Science and Advanced Technology 7 (1) pp 7- 14 © 2024

measurement during the fruit storage period of 1,2,3 week.

Results and Discussions

The Effect of Lecithin Concentration on the Characteristics of Ricebran-wax Coating

Figure 1. Formula appearance Rice Bran Wax Coating

Ricebran wax coatings are primarily used in the food industry as a constituent of chocolate coatings, vegetable coatings, and wax emulsions for fruit preservation. The visual appearance of the edible coating formula made from rice bran wax, lecithin, stearic acid, water, TEA gives satisfactory results when stirred vigorously so that the appearance of the formula is more homogeneous. Homogeneity was achieved on all five coatings to form a good emulsion at a temperature of 80-90°C. Based on the results of the visual appearance in **Figure 1** with variations in the concentration of rice bran wax, where the higher the concentration of rice bran wax (6, 9, 12, 15, 18)%, the color of the coating will turn yellow. The color change between the five coatings was not significant.

Figure 2. Appearance Rice Bran Wax Coating and Beeswax Coating

Based on the results of the visual appearance in **Figure 2** with the same concentration of rice bran wax and beeswax 12%, where the color of beeswax coating is yellower than rice bran wax coating because the basic ingredient of beeswax has a yellower color. The rice bran wax coating is milky white, and the beeswax coating is yellowish cream.

Characteristics of Rice Bran Wax Coating (pH)

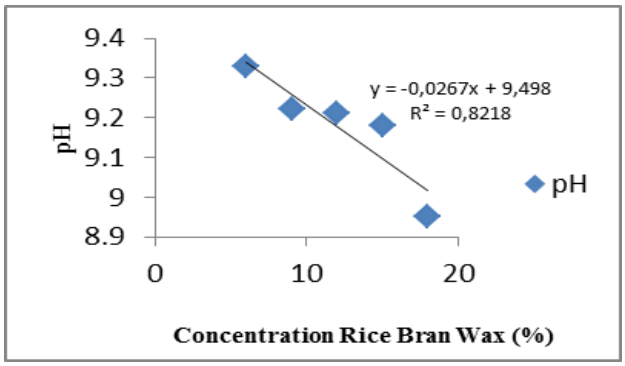

Figure 3. Effect of Lecithin Concentration on pH

Based on **Figure 3**, the concentration of rice bran wax has an effect on pH following the linear regression equation y = -0.026x + 9.498, where the value of y is pH and x is the concentration of rice bran wax. The R2 value is 0.821, this shows a close correlation between y and x, where the greater the concentration of rice bran wax, the lower the pH of the coating. The pH of the rice bran wax coating obtained is 8.95-9.33, because the pH of rice bran wax is 4-6.5, which is acidic, so the more the wax concentration, the lower the coating pH, and the pH value of rice bran wax.

The coating is in accordance with previous edible coating research, namely the research of Hassan et al., 2014 with the use of beeswax coating having a pH of around 8-10. According to research by Lam et al 2009 wax coating has a pH of about 8.5-10. The pH of the coating is maintained so that the conditions are alkaline because if the conditions are acidic it will cause a lot of bacteria & fungi to live in the coating, so the coating is more easily damaged. The pH value of Beeswax Coating with a concentration of 12% was 9.19. These results are in accordance with the pH value of the wax coating in previous studies.

Characteristics of Rice Bran Wax Coating (Density)

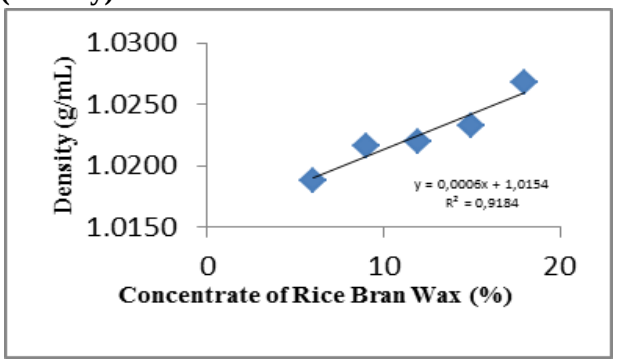

Figure 4. Effect of Rice Bran Wax Concentration on Density

Based on **Figure 4**, the concentration of rice bran wax has an effect on density following the linear regression equation y=0.0000x+1.015, with the value of y being the density and x being the concentration of rice bran wax. The R2 value is 0.918, this shows a close correlation between y and x, where the greater the concentration of rice bran wax, the greater the density. The results of the density of rice bran wax coating obtained are 1.018-1.026 g/ml, the specific gravity value of rice bran wax is 0.932-0.945. Based on research by Lam et al 2009 wax coating has a density of 0.98-1.02 g/ml. The density of the coating is determined by the constituent components in the coating. The smaller the density of a solution, the better the solution can be applied as a coating [8]. The density value of Beeswax Coating with a concentration of 12% was obtained at 1,019. These results are in accordance with the value of the density of the wax coating in the study [10].

Characteristics of Rice Bran Wax Coating (Viskosity)

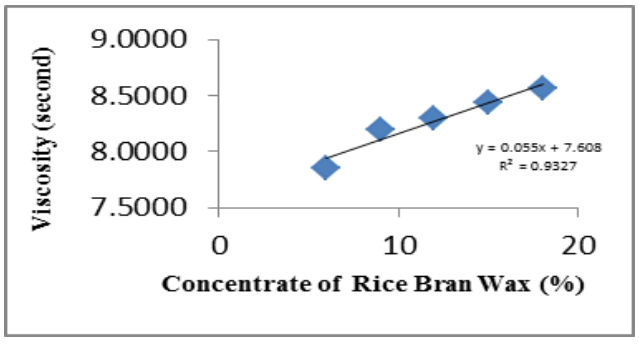

Figure 5. Effect of Rice Bran Wax Concentration on Viscosity

Based on **Figure 5** the concentration of rice bran wax has an effect on viscosity following the linear regression equation y=0.55 x + 7.608 with the value of y being the viscosity and x being the concentration of rice bran wax. The R^2 value is 0.932, this shows a close correlation between y and x, where the greater the concentration of rice bran wax, the greater the viscosity. The viscosity of rice bran wax coating obtained is 7.85-8.56 seconds. Coating can be applied easily if it has a good viscosity. The viscosity value of Beeswax Coating with a concentration of 12% was obtained at 8.3 seconds.

Effect of Rice Bran Wax Concentration and Storage Time of Bananas, Mangoes and Oranges on Weight Loss

In the postharvest handling of mangoes, wax coating or waxing can suppress respiration rate so that this treatment is an alternative to extend the shelf life of fruits. Wax will inhibit the process of respiration so that the chemical changes that occur in the fruit are relatively inhibited. With inhibition of respiration will delay fruit ripeness [2,8].

Weight loss is one of the quality parameters that reflects the level of fruit freshness, the occurrence of weight loss is caused by the loss of water and decomposition glucose in fruit by respiration which converts sugar into CO2 and H2O. In addition, weight loss is also associated with a decrease in hardness, so that the bond between cells in the fruit becomes weaker and the distance stretches so that water is free contained in the fruit becomes easily evaporated [11].

Based on the research data, the weight loss of bananas, mangoes and oranges was observed for 3 weeks as shown in **Figure 6** with variations in the concentration of rice bran wax where the fruit weight loss increased every week, where the smallest weight loss for 3 weeks was bananas coated with rice bran. wax coating with a concentration of 12% is 65.91%, mangoes are coated with rice bran wax coating with a concentration of 15% at 8.30% and oranges are coated with rice bran wax coating with a concentration of 18% is 12.59%. Mangoes and oranges coated with beeswax coating obtained a lower weight loss value than fruit coated with rice bran wax coating, namely 6.59% and 10.11%, as shown in **Figure 6**.

Journal of Applied Science and Advanced Technology 7 (1) pp 7- 14 © 2024

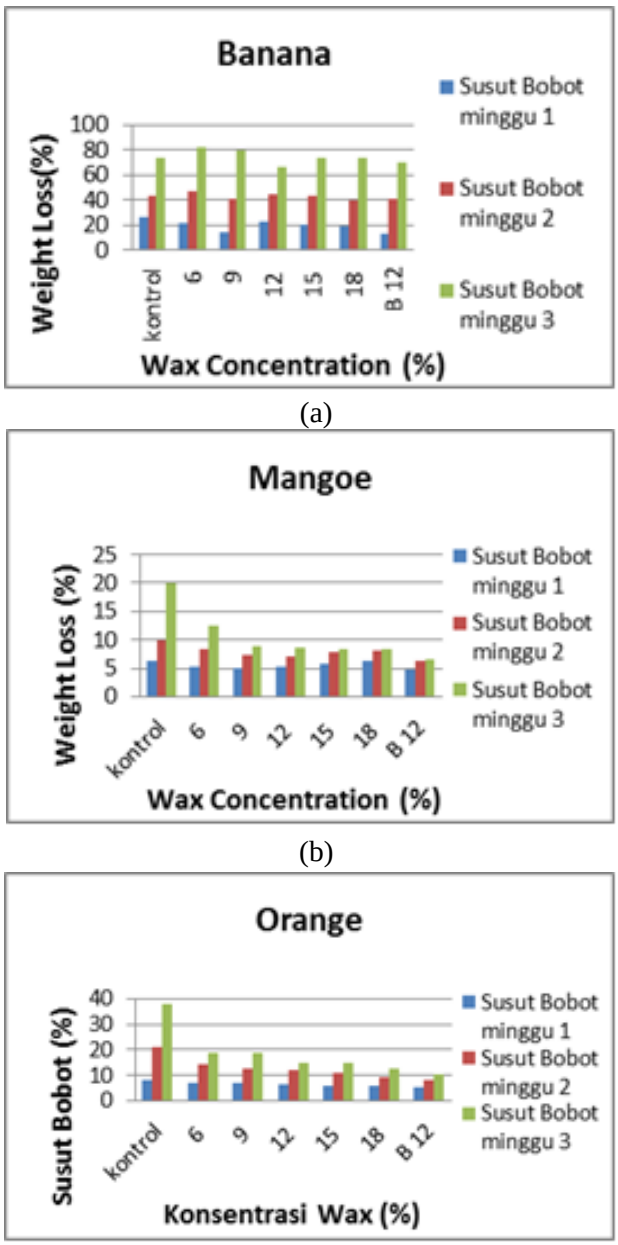

Figure 6. Effect of Wax Concentration and Storage Time on Fruit Weight Loss for (a): Banana, (b): Mango, (c): Orange

Based on the research data, the weight loss of bananas, mangoes and oranges was observed for 3 weeks as shown in **Figure 6** with variations in the concentration of rice bran wax where the fruit weight loss increased every week, where the smallest weight loss for 3 weeks was bananas coated with rice bran. wax coating with a concentration of 12% is 65.91%, mangoes are coated with rice bran wax coating with a concentration of 15% at 8.30% and oranges are coated with rice bran wax coating with a concentration of 18% is 12.59%. Mangoes and oranges coated with beeswax coating obtained a lower weight loss value than fruit coated with rice bran wax coating, namely 6.59% and 10.11%, as shown in **Figure 6**. In addition to weight loss observations, the physical fruit is one of the parameters observed where bananas coated with coating and control last only one week, most likely because bananas cannot be broken into several pieces in 1 bunch. Then the mango fruit, where the rice bran wax coating with a concentration of 6%, 9%, 12% survived without any rot for 2 weeks, and those coated with rice bran wax coating with a concentration of 15%, 18% and 12% beeswax survived without any rot for 3 weeks.

It can be seen from **Figure 7** that the mango flesh is ripe within 3 weeks. Mango flesh coated with 15% rice bran wax coating is yellow and not fully ripe and has a sweet-sour taste, this is appropriate where mangoes coated with 15% rice bran wax coating have the smallest weight loss due to the process of water loss and decomposition. The glucose in the fruit is retained by the coating.

Figure 7. Physical Appearance of Mango Fruit with Rice Bran Wax Coating (6, 9, 12, 15, 18)%

In contrast to mangoes that are coated with rice bran wax coating, the physical appearance of mangoes coated with 12% beeswax coating is still hard, the flesh is yellow and tastes sour. This indicates that the beeswax coating is better at holding the respiration and transpiration rates in mangoes. The following is a picture of 8 mangoes coated with a 12% beeswax coating.

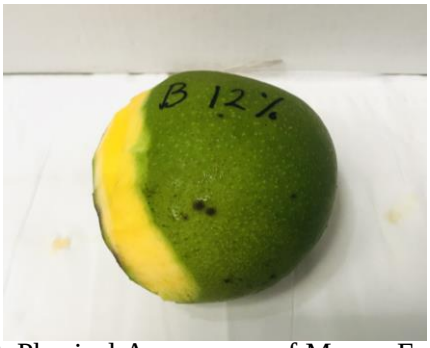

Figure 8. Physical Appearance of Mango Fruit with 12% Beeswax Coating

Then on citrus fruits, those coated with rice bran wax coating with a concentration of 9%, 15%, 18% and 12% beeswax survived without any rot for 2 weeks, and those coated with rice bran wax coating with a concentration of 6%, 12% survived without any rot for 3 weeks. It can be seen from **Figure 9** where the ripe orange flesh within 3 weeks, the orange flesh coated with rice bran wax coating with a concentration of 12% has the best physical and sweet taste compared to other citrus fruits.

Figure 9. Physical Appearance of Citrus Fruits with Rice Bran Wax Coating (6, 9, 12, 15, 18)%

Figure 10. Physical Appearance of Banana with Rice Bran Wax Coating

Conclusions

The results of the characteristics of rice bran wax coating (density, pH, viscosity) on the concentration of rice bran wax (6; 9; 12; 15; 18)% , where the value of density, viscosity showed a tendency to increase with increasing concentration of rice bran wax, and the pH value showed tendency to decrease with increasing concentration of rice bran wax. The smallest weight loss for 3 weeks was bananas coated with rice bran wax coating with a concentration of 12% of 65.91%, mangoes coated with rice bran wax coating with a concentration of 15% at 8.30% and oranges coated with rice bran wax coating with a concentration of 8.30%. 18% by 12.59%. Mangoes and oranges coated with beeswax coating obtained a lower weight loss value than fruit coated with rice bran wax coating, namely 6.59% and 10.11%, respectively.

Acknowledgment

Thank you to the Chemical Engineering Master's Degree Study Program and LPPM Muhammadiyah University of Jakarta who have provided support for this research.

Author Contributions

The authors' contributions to the paper are as follows: study conception, design, analysis, and interpretation of results: RAN, TYH; data collection: UHH, RJH; draft manuscript preparation: RJH. All authors have reviewed the results and approved the final version of the manuscript.

Conflicts of Interest

All authors declare that they have no conflicts of interest.

References

[1] Abhirami, P., & Venkatachalapathy, N. (2019). Characterization of Refined Rice Bran Wax: An Alternative Edible Coating. International Journal of Current Microbiology and Applied Sciences, 91-97. https://doi.org/10.20546/ijcmas.2019.805.012

[2] Dewandari, K. T., Mulyawanti, I., & Setyabudi, D. A. (2009). Konsep Sop Untuk Penanganan Pascapanen Mangga Cv. Gedong Untuk Tujuan Ekspor.

[3] Dhyan, C., Sumarlan, S. H., & Susilo, B. (2014). Pengaruh Pelapis Lilin Lebah dan Suhu Penyimpanan Terhadap Kualitas Buah Jambu Biji. Jurnal Bioproses Komoditas Tropis , Vol 2 No 1.

[4] Harahap, I. S. (2018). Kajian Analisis Pelilinan Terhadap Sifat Fisik-Kimia Jeruk Keprok Di Kabupaten Tapanuli Selatan. Eksakta Jurnal Penelitian dan Pembelajaran MIPA , Volume 3 Nomor 1 .

[5] Ismail, E. (2019). Kementan Sarankan Teknologi untuk Ekspor Mangga. Jakarta: Republika.co.id.

[6] Lam, N. D., Thang, P. C. (2015). The Formulating Of An Fruit Coating For Use In Banana Preservation. Work Shop On Agrl&Biosystems..

[7] Masruroh, H., Fauzi, A. F., Anggryani, D., & Paramita, V.(2013). Pengaruh Penambahan Xhantan Gum Dalam Aplikasi

Journal of Applied Science and Advanced Technology 7 (1) pp 7- 14 © 2024

Teknologi Edible Coating Aloe Vera Untuk Mempertahankan Mutu Tomat (Solanum Lycopersicum) Menggunakan Metode Spray. Prosiding SNST ke-4.

[8] Pranoto, H. C. (2016). Pemberian $KMnO_4$ Dan Gel Lidah Buaya Untuk Menunda Pemasakan Dan Mencegah Penyakit Antraknosa Pada Buah Pisang Mas Kirana. Malang: Universitas Muhammadiyah Malang.

[9] Ristekdikti. (2016). Rencana Induk Riset Nasional 2015-2045. Jakarta: Kementerian Riset, Teknologi, Dan Pendidikan Tinggi.

[10] Subdirektorat Statistik Hortikultura. (2018). Statistik Tanaman Buah-Buahan Dan Sayuran Tahunan Indonesia 2017. Jakarta: Badan Pusat Statistik/Bps-Statistics Indonesia.

[11] Taqiyyah, A. (2015). Pengaruh Penambahan Fungisida Pada Bahan Pencuci Serta Suhu Penyimpanan Terhadap Peningkatan Kualitas Mangga (Mangifera Indica L.) Cv. Gedong. Bogor: Institut Pertanian Bogor

[12] Utama, I. G., Utama, I. M., & Pudja, I. A.(2016). Pengaruh Konsentrasi Emulsi Lilin Lebah Sebagai Pelapis Buah Mangga Arumanis Terhadap Mutu Selama Penyimpanan Pada Suhu Kamar. Jurnal Biosistem Dan Teknik Pertanian, Vol 4 No 2.