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APPLICATION OF CORN STARCH AS EDIBLE COATING ON HONEY WATER APPLE FRUIT

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ABSTRACT

Honey water apple is a horticultural commodity with high water content, making it prone to physical, chemical, and microbiological deterioration during storage. Proper postharvest handling is essential to maintain fruit quality and extend shelf life. This study aimed to determine the optimal concentration of corn starch in an edible coating for preserving honey water apple during storage. The experiment used a non-factorial Completely Randomized Design (CRD) with five corn starch concentrations: P1 (1%), P2 (2%), P3 (3%), P4 (4%), and P5 (5%), with three replications, resulting in 15 experimental units. The observed parameters were weight loss, firmness, total soluble solids, and vitamin C content. The results showed that corn starch concentration significantly affected all observed parameters during storage. The 5% corn starch treatment (P5) was the most effective in maintaining fruit quality after 20 days of storage. Fruits coated with 5% corn starch showed a weight loss of 12.89%, firmness of 4.03 kgf, total soluble solids of 9.3 °Brix, and vitamin C content of 45.83 mg/100 g. Thus, a 5% corn starch edible coating effectively maintained the quality and extended the shelf life of honey water apple.

Keywords: corn starch, edible coating, fruit quality, honey water apple, postharvest

INTRODUCTION

Honey water apple requires post-harvest handling to maintain quality during storage. The high-water content of honey guava fruit makes it difficult to store at room temperature, making it susceptible to physical, chemical, and microbiological damage. Honey water apple has a maximum respiration rate of 25 mg CO2/kg for guava stored without packaging, while for packaged guava the maximum respiration rate is 20 mg CO2/kg (Patria, 2013). Respiration in commodities can reduce fruit quality during storage. Post-harvest handling is necessary to prevent damage and slow physiological processes in the fruit. One method that can be used to maintain quality and extend shelf life is by coating Honey water apple fruit with an edible coating.

Edible coating is a thin layer, made from edible materials and can function as a barrier to prevent moisture loss, is permeable to certain gases, and is able to control the migration of water-soluble components that can cause changes in the pigment and nutritional composition of the material (Suprapti et al., 2018). Edible coatings can be made from readily renewable raw materials, such as lipids, polysaccharides, and proteins. These coatings act as a barrier against water vapor, gases, and other dissolved substances. Furthermore, edible coatings can act as carriers for various additional components, such as emulsifiers, antimicrobials, and antioxidants, potentially improving the quality and extending the shelf life of processed fresh fruits and vegetables (Widaningrum et al., 2015).

One agricultural material that can be used as a raw material for edible coating is corn. Corn (*Zea mays*) is a readily available and relatively inexpensive crop. It's abundantly available, found in almost every region in Indonesia. Corn starch contains a high amylose content of around 27%. The high amylose content of corn starch has the potential to produce a stronger and thicker edible coating than other starches

(Kusumawati & Putri, 2013), so that the use of corn in the manufacture of edible coating can provide benefits in protecting, extending shelf life, and improving the quality of food products. Sari & Manik (2018) research showed that the effect of corn starch and glycerol as edible coating on the physicochemical properties of avocados can extend the shelf life for 15 days compared to the control shelf life of only 7 days. The best research results were found in the edible coating treatment with 2.5 ml glycerol, 10 g corn starch, 500 ml aquadest which can provide the smallest weight loss compared to other treatments during storage. The use of corn starch in the study was able to extend the shelf life of the fruit. This study aimed to determine the most optimal concentration of corn starch as an edible coating for honey water apple during storage.

METHODS

Materials and Tools

The materials used in this research were corn starch (Mama Suka) sold in the market, honey water apple, glycerol, phenolphthalein indicator, 1% starch, 0.01 N iodine, and distilled water. The tools in this research are knives, analytical scales, blenders, measuring cups, thermometers, beakers, hot plates, magnetic stirrers, spatulas, label paper, stopwatches, spectrophotometers, Erlenmeyer flasks, penetrometers, distillation flasks, distillation, test tubes, dropper pipettes, measuring cups, burettes, sieves, baking pans, ovens, basins, filter cloths, filter paper, clamps, and stationery.

Research Methods

This study was conducted experimentally using a nonfactorial completely randomized design (CRD), with five treatments and three replications, resulting in 15 experimental units. The treatments and formulations in this study were based on those of Sari & Manik (2018), modified with the following variations:

P1 = Corn starch concentration 1%
P2 = Corn starch concentration 2%
P3 = Corn starch concentration 3%
P4 = Corn starch concentration 4%
P5 = Corn starch concentration 5%

Edible Coating Manufacturing

The edible coating solution was prepared based on a modified version of Sari & Manik (2018). The corn starch suspension, specifically cornstarch, was prepared by adding cornstarch at concentrations of 1%, 2%, 3%, 4%, and 5% to a beaker. The mixture was then stirred for 15 minutes. Afterward, the solution was heated to 70°C, 2.5 ml of glycerol was added, and the solution was cooled to room temperature.

Application of Edible Coating on Honey Water Apple

The application of edible coating on honey water apple fruit refers to the research of Sari & Manik (2018). Honey water apple is sorted by separating rotten or damaged honey water apple and selecting honey water apple with a uniform size of around 80-100 g and without defects, then washed and drained, then dried with a cloth or tissue. Honey water apple is dipped in the edible coating solution according to the treatment for 1 minute, then drained with a sieve for 2 minutes. After that, the honey water apple fruit is stored at room temperature for 20 days.

Observation

Observations were made on honey water apple coated with corn starch edible coating, including weight loss, hardness, total soluble solids (TSS), and vitamin C during storage. Observations were made on days 0, 5, 10, 15, and 20.

Weight Loss

Weight loss analysis refers to Sudarmadji et al. (1997). Weight loss is carried out by weighing samples during sampling during a certain storage period. Untreated honey water apple is weighed first as their initial weight, and treated honey water apple based on storage are weighed as their final weight. Weight loss is calculated based on the percentage of weight loss of Honey water apple from the beginning to the end of storage. The tool used is an analytical balance. Weight loss can be calculated using the Equation 1.

$$Wight\ loss\ (\%) = \frac{w_0 - w_t}{w_0} \times 100 \quad (1)$$

where:
W_0 = sample weight on day-0 (g)
W_t = sample weight on day-n (g)

Hardness

The hardness level test refers to Apriyantono et al. (1989), using a penetrometer (Messtorff method). The Messtorff method can also be used in measuring fruit texture using a penetrometer to assess the level of hardness or ripeness of the fruit. The hardness of the stored honey guava is measured by inserting the penetrometer needle into the surface of the honey water apple until the needle stops moving, the measurement is carried out twice. Record the number shown on the pressure scale when the tip of the tool penetrates the fruit flesh.

Total Soluble Solids

Total soluble solids were calculated using a hand refractometer referring to Sudarmadji et al. (1997). The calculation of total soluble solids was done by cutting and taking part of the sample with a knife then taking some of the water about 1-2 ml and dropping it on the refractometer prism, then leaving it for one minute. After seeing the difference between light and dark, then read the refractive index value at the number shown on the scale of numbers read on the refractometer expressed in °Brix units.

Vitamin C

Determination of vitamin C levels refers to Sudarmadji et al. (1997). A 10 g sample of crushed honey water apple was weighed and placed in a volumetric flask. Then, distilled water was added to a volume of 100 ml and homogenized. The mixture was then filtered with filter paper. 10 ml of the filtrate was taken and placed in an Erlenmeyer flask, then 2 ml of 1% starch solution was added and titrated with 0.01 N iodine solution until a constant blue color was formed. The calculation of vitamin C content was carried out using the Equation 2.

$$Vitamin\ C = \frac{\text{ml iodine} \times 0{,}01\ \text{N} \times 0{,}88 \times \text{fp} \times 100}{\text{sample weight}\ (g)} \quad (2)$$

Where:
t= ml titration
N= Normality
df = Dilution factor = 10

Data Analysis

The obtained data were analyzed statistically using analysis of variance (ANOVA). If the calculated F value ≥ F table, the Duncan Multiple Range Test (DMRT) was continued at the 5% level. If the calculated

F value ≤ F table, the DMRT test was not continued. Data analysis used IBM SPSS Statistics 23 for Windows.

RESULTS AND DISCUSSION

Weight Loss

The analysis of variance (ANOVA) results showed that the corn starch concentration in the edible coating significantly affected ($p<0.05$) the weight loss of Honey water apple from day 5 to day 20 of storage. The weight loss values were recorded from day 5 to day 20 of storage. The average weight loss of honey water apple fruit during storage is presented in Table 1. The results showed that weight loss increased with increasing storage duration in all treatments. However, the increase in weight loss varied among the corn starch concentrations. At the end of the storage period (20 days), the highest weight loss was observed in P1 (1% corn starch), at 22.31%, while the lowest weight loss was observed in P5 (5% corn starch), at 12.89%. This indicates that a higher concentration of corn starch in the edible coating was associated with lower weight loss during storage. Statistical analysis showed that the corn starch concentration significantly affected the weight loss of honey water apple fruit ($p<0.05$).

Based on the results of the study, the weight loss value obtained with a corn starch concentration of 1.5% was 17.52 and with a corn starch concentration of 3% was 16.02. The higher the corn starch concentration used, the thicker the edible coating layer produced and the more the pores of the fruit are closed so that weight loss can be maintained. In addition to the inhibitory mechanism, the corn starch concentration also has a significant effect on the effectiveness of the coating. Recent research on green grapes shows that increasing the corn starch concentration from 1%, 3%, 5%, to 7% consistently reduces the percentage of weight loss (Nurkhori et al., 2024). This occurs because the edible coating layer formed at a higher concentration is thicker and denser, making it more effective in inhibiting water evaporation than the layer formed at a lower concentration (Ifmalinda et al., 2024; Nurkhori et al., 2024).

Table 1. Average weight loss of honey water apple fruit (%)

Treatment	Storage Duration (Days)				
	0	5	10	15	20
P1 = 1% corn starch concentration	0.00	4.66^{a}	8.37^{a}	15.91^{a}	22.31^{a}
P2 = 2% corn starch concentration	0.00	4.57^{ab}	7.74^{a}	14.59^{b}	18.97^{b}
P3 = 3% corn starch concentration	0.00	4.43^{ab}	6.85^{bc}	13.61^{cb}	16.01^{c}
P4 = 4% corn starch concentration	0.00	4.14^{bc}	6.48^{c}	12.49^{d}	14.80^{cd}
P5 = 5% corn starch concentration	0.00	3.96^{c}	5.68^{c}	10.52^{e}	12.89^{d}

Note: Values followed by different lowercase superscript letters within the same column indicate significant differences ($p<0.05$).

The same pattern was also shown on the 10 to 20 day of storage. Honey water apple fruit coated with edible coating with a higher concentration of corn starch gave lower weight loss during storage. High corn starch concentration can inhibit the loss of water vapor during transpiration. This is supported by the statement of Alsuhendra et al. (2011), the higher the starch concentration, the lower the fruit weight loss because coating using edible coating on weight loss prevents water loss in the fruit. Research conducted by Sutrisno (2019) showed that a starch-based edible coating was able to cover the pores of honey water apple fruit, thereby inhibiting the transpiration process and reducing weight loss.

Hardness

The results of the analysis of variance showed that the concentration of corn starch in the edible coating had a significant effect ($p < 0.05$) on the hardness of honey water apple fruit during storage. The

average hardness values of honey water apple fruit at different storage durations are presented in Table 2.

Table 2. Average hardness of honey water apple fruit (kgf)

Treatment	Storage Duration (Days)				
	0	5	10	15	20
P1 = 1% corn starch concentration	5.30	4.70	4.07^{a}	3.63^{a}	3.13^{a}
P2 = 2% corn starch concentration	5.23	4.77	4.40^{ab}	3.93^{b}	3.50^{b}
P3 = 3% corn starch concentration	5.17	4.83	4.53^{bc}	4.10^{bc}	3.70^{bc}
P4 = 4% corn starch concentration	5.20	4.90	4.70^{bc}	4.37^{cd}	3.90^{cd}
P5 = 5% corn starch concentration	5.20	5.00	4.83^{c}	4.60^{d}	4.03^{d}

Note: Values followed by different lowercase superscript letters within the same column indicate significant differences ($p < 0.05$).

On day 0 and day 5 of storage, the hardness of honey water apple fruit did not differ significantly among treatments. On day 10, the highest hardness value was observed in P5 (4.83 kgf), which did not differ significantly from P3 and P4 but was significantly higher than P1 and P2. The results indicate that increasing the concentration of corn starch in the edible coating helped maintain the hardness of the fruit during storage. This may be attributed to the formation of a thicker and denser polysaccharide film on the fruit surface as the corn starch concentration increased. The edible coating acts as a physical barrier that reduces water transfer through transpiration and gas exchange during respiration, thereby reducing water loss and maintaining cell turgor in the fruit tissue.

The same pattern was observed on days 15 and 20 of storage. On day 20, P5 showed the highest hardness value (4.03 kgf), followed by P4 (3.90 kgf), P3 (3.70 kgf), P2 (3.50 kgf), and P1 (3.13 kgf). These results indicate that the 5% corn starch edible coating was more effective in maintaining fruit hardness during storage. The findings are consistent with those reported by Ifmalinda et al. (2024), who investigated the application of corn starch edible coatings to maintain the quality of avocado fruit using corn starch concentrations of 1.2–3.6% during 10 days of storage. Their results showed that the hardness values were 44.017 at a corn starch concentration of 1.2% and 52.376 at 3.6%. The higher corn starch concentration resulted in better maintenance of fruit hardness, which was attributed to the ability of the coating to reduce respiration and water loss, thereby slowing fruit deterioration.

Total Soluble Solids

The results of the analysis of variance showed that the concentration of corn starch in the edible coating had a significant effect ($p < 0.05$) on the total soluble solids (TSS) of honey water apple fruit on days 15 and 20 of storage. The average total soluble solids values of honey water apple fruit at different storage durations are presented in Table 3.

On days 0 to 10 of storage, the total soluble solids values at different corn starch concentrations did not differ significantly among treatments. This indicates that the initial quality of the fruit was relatively homogeneous and that the treatments had not yet produced a significant effect on total soluble solids. On day 15, the TSS value of P5 (5% corn starch), which was 9.1 °Brix, did not differ significantly from those of P2, P3, and P4 but differed significantly from P1. A similar pattern was observed on day 20 of storage. The TSS values tended to increase with increasing storage duration, although the magnitude of the increase differed among treatments. Treatment P1 (1% corn starch) showed the highest TSS values on days 15 and 20, reaching 10.9 and 11.2 °Brix, respectively. In contrast, P5 (5% corn starch) maintained the lowest TSS values, at 9.1 and 9.3 °Brix, respectively. These results indicate that a higher concentration of corn starch in the edible coating was more effective in suppressing the increase in TSS during storage.

The edible coating forms a barrier on the fruit surface that can reduce water loss and modify gas exchange, thereby slowing physiological processes associated with fruit ripening.

Table 3. Average total soluble solids of honey water apple fruit (°Brix)

Treatment	Storage Duration (Days)				
	0	5	10	15	20
P1 = 1% corn starch concentration	8.9	9.1	9.6	10.9[a]	11.2[a]
P2 = 2% corn starch concentration	9.0	9.0	9.6	10.2[ab]	10.4[ab]
P3 = 3% corn starch concentration	8.8	8.7	8.9	9.4[ab]	9.7[ab]
P4 = 4% corn starch concentration	8.0	8.3	8.5	9.1[b]	9.5[b]
P5 = 5% corn starch concentration	8.0	8.2	8.7	9.1[b]	9.3[b]

Note: Values followed by different lowercase superscript letters within the same column indicate significant differences ($p < 0.05$).

The increase in TSS during storage is associated with the ripening process. Novita et al. (2016) stated that the increase in TSS in fruit is related to the breakdown of carbohydrate polymers, particularly starch, into simpler soluble sugars such as sucrose, glucose, and fructose during ripening. Therefore, the lower increase in TSS observed in the fruit coated with 5% corn starch indicates that the coating may have slowed the ripening process. The results are consistent with research conducted by Sutrisno (2019), which showed that the addition of starch to an edible coating could inhibit the ripening of water apple fruit during storage, thereby slowing the increase in total soluble solids. Similarly, Ifmalinda et al. (2024) reported that the application of corn starch edible coatings at concentrations of 1.2–3.8% to avocado fruit during 10 days of storage resulted in TSS values of 9.2 °Brix at 1.2% corn starch and 8.7 °Brix at 3.8%. The higher corn starch concentration resulted in a lower TSS value, which was attributed to the formation of a thicker coating layer that reduced gas exchange and delayed ripening.

In addition to the concentration of corn starch, the characteristics of starch components, particularly amylose and amylopectin, may influence the properties of the edible coating. Amylose tends to form a denser and more homogeneous film structure, which can improve the barrier properties of the coating against water vapor and gases. In contrast, amylopectin has a branched structure that generally produces a more flexible and relatively permeable film. Wang et al. (2021) reported that edible coatings with higher amylose content could more effectively suppress changes in TSS because the polymer network formed by amylose can reduce the diffusion of water and oxygen. This mechanism may contribute to the lower TSS values observed at higher corn starch concentrations in the present study.

Vitamin C

The results of the analysis of variance showed that the concentration of corn starch in the edible coating had a significant effect ($p < 0.05$) on the vitamin C content of honey water apple fruit from day 10 to day 20 of storage. The average vitamin C content of honey water apple fruit at different storage durations is presented in Table 4.

The results showed a decrease in vitamin C content during 20 days of storage in all corn starch concentration treatments. On days 0 and 5, the vitamin C content did not differ significantly among treatments. As storage duration increased, the vitamin C content decreased, although the magnitude of the decrease varied among treatments. On day 10, treatment P5 showed a vitamin C content of 49.59 mg/100 g, which did not differ significantly from P3 and P4 but differed significantly from P1 and P2. A similar pattern was observed on days 15 and 20 of storage. The decrease in vitamin C content during storage is associated with physiological and biochemical processes that occur after harvest. Vitamin C, particularly ascorbic acid, is susceptible to oxidation during storage. The edible coating can act as a

barrier that reduces water loss and modifies gas exchange at the fruit surface, which may slow the physiological processes associated with quality deterioration and help retain vitamin C content.

Table 4. Average vitamin C content of honey water apple fruit (mg/100 g)

Treatment	Storage Duration (Days)				
	0	5	10	15	20
P1 = 1% corn starch concentration	51.76	47.24	43.47^{a}	39.53^{a}	34.22^{a}
P2 = 2% corn starch concentration	51.48	47.84	44.54^{a}	40.47^{ab}	36.58^{a}
P3 = 3% corn starch concentration	53.03	48.39	46.43^{ab}	44.62^{bc}	40.27^{b}
P4 = 4% corn starch concentration	52.26	49.38	47.31^{ab}	45.51^{c}	42.93^{bc}
P5 = 5% corn starch concentration	53.44	49.83	49.59^{b}	47.97^{c}	45.83^{c}

Note: Values followed by different lowercase superscript letters within the same column indicate significant differences ($p < 0.05$).

The results showed that the application of a corn starch-based edible coating affected the retention of vitamin C in honey water apple fruit during storage. All treatments experienced a decrease in vitamin C content as storage duration increased, but the rate of decrease differed among treatments. The 1% corn starch treatment (P1) showed a greater decrease in vitamin C content, whereas the 5% corn starch treatment (P5) maintained a higher vitamin C content until the end of storage. This suggests that increasing the corn starch concentration improved the barrier properties of the edible coating, thereby reducing water loss and gas exchange and helping to preserve vitamin C during storage. The higher corn starch concentration may produce a thicker coating layer on the fruit surface, providing a more effective barrier against moisture loss and gas exchange. Water loss during transpiration can contribute to changes in the concentration and stability of soluble components in fruit tissue, while oxygen exposure can promote the oxidation of ascorbic acid. Therefore, the reduction in vitamin C content during storage may be related to both oxidative degradation of ascorbic acid and changes associated with water loss.

These results are consistent with the study conducted by Zakia (2025) on the application of corn starch edible coatings to red cayenne pepper using corn starch concentrations of 1–4% during 20 days of storage. The study reported vitamin C contents of 19.79 mg/100 g at a corn starch concentration of 1% and 22.04 mg/100 g at 4%. The higher corn starch concentration resulted in better retention of vitamin C during storage, which was associated with the formation of a thicker coating layer that provided greater protection against quality deterioration. Devianti and Wardhani (2018) stated that vitamin C degradation during storage is associated with oxidation of ascorbic acid. Ascorbic acid can be oxidized to dehydroascorbic acid, which may subsequently undergo further degradation. Thus, the ability of the edible coating to reduce exposure to oxygen and moisture loss may contribute to better retention of vitamin C during storage.

CONCLUSION

Variations in corn starch concentration in edible coating significantly affected weight loss, hardness, total soluble solids, and vitamin C levels in honey water apple. Edible coating with a corn starch concentration of 5% (P5) was the selected treatment in maintaining the quality of honey water apple after being stored for 20 days. Honey water apple coated with corn starch edible coating with a concentration of 5% (P5) had a weight loss value of 12.89%, hardness of 4.03 kgf, total soluble solids of 9.3°Brix, and vitamin C content of 45.83 mg/100 g.

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