Indonesian Journal of Chemical Science and Technology (IJCST)

State University of Medan, https://jurnal.unimed.ac.id/2012/index.php/aromatika

IJCST-UNIMED 2026, Vol. 09, No. 2, Page; 228 – 233

Received : Nov 6th, 2025 Accepted : Jul 9th, 2026 Web Published : Jul 31st, 2026

The Effect of Edible Coating Made from Vanname Shrimp (Litopenaeus vannamei) Shells with the Addition of Cinnamon as an Edible Film for Fruit Preservation

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ABSTRACT

This study aimed to determine the effect of an edible coating made from vanname shrimp (Litopenaeus vannamei) shells with the addition of cinnamon (Cinnamomum sp.) extract as an edible film for fruit preservation. Shrimp shells, which are fishery by-products rich in chitin and chitosan, are utilized as the main material for making edible coatings because they are biodegradable, safe, and possess antimicrobial properties. The addition of cinnamon extract was expected to enhance the effectiveness of the edible film in inhibiting microbial growth and oxidation, while also improving the physical characteristics and shelf life of fruits. The study was conducted with various concentrations of cinnamon extract addition and was tested for parameters such as weight loss, color, firmness, and microbiological resistance of fruits during storage. The results showed that the application of the vanname shrimp shell–based edible coating with added cinnamon was able to slow down the deterioration of fruit quality, reduce weight loss, maintain color and firmness, and inhibit the growth of spoilage microorganisms. Therefore, the use of this edible coating has the potential to serve as a natural and environmentally friendly alternative for extending the shelf life of fruits.

Keywords: edible coating, vanname shrimp shell, cinnamon, edible film, fruit preservation

1. INTRODUCTION

Indonesia is a tropical country rich in fruit production. According to the Central Bureau of Statistics (BPS) in 2021, fruit production in Indonesia reached 25.9 million tons[1]. Meanwhile, data from the Food and Agriculture Organization (FAO) in 2014 showed that Indonesia ranked among the world's top 20 fruit-producing countries. However, fruits produced from Indonesian agriculture are generally perishable and have a relatively short shelf life. This is because these fruits continue to undergo physiological changes that affect their properties and quality. Such physiological processes include photosynthesis, respiration, transpiration,

e-ISSN : 2622-4968, p-ISSN : 2622-1349

and fruit ripening after harvest. These processes lead to several changes in the fruit, as indicated by alterations in color, texture, aroma, and taste[2].

Physiological processes such as respiration in fruits can affect postharvest quality by reducing nutritional content due to degradation reactions. Therefore, proper measures are needed to prevent postharvest damage and to extend the shelf life of agricultural products[3]. Appropriate postharvest technology is essential to minimize deterioration, maintain quality, and prolong fruit freshness. One potential method is the application of edible coating on the surface of fruits or other horticultural products. Edible coatings function as gas barriers, especially to oxygen (O_2), thereby slowing down respiration[4].

An edible coating is a layer made of edible materials that is directly applied to the surface of products through spraying, dipping, or dripping methods depending on the requirements[5]. The coating acts as a barrier to oxygen, moisture, and solute migration. According to Tapia and Blacido in[6], materials used for edible coatings are those capable of forming films, such as carrageenan, starch, chitin, chitosan, alginate, and pectin[7]. Edible films can also serve as barriers to water vapor and humidity. They are made from natural polymers such as polysaccharides, lipids, proteins, or their combinations. The use of natural raw materials offers advantages such as biodegradability, biocompatibility, edibility, and broad application potential[8]. This technology not only extends the shelf life of fruits but also maintains their safety against biological and microbiological hazards that can cause spoilage[9]. Therefore, this study was conducted to develop an edible coating based on vanname shrimp (Litopenaeus vannamei) shells with the addition of cinnamon extract as an edible film for fruit preservation.

2. EXPERIMENTAL

2.1. Chemicals, Equipment and Instrumentation

The equipment used in this study included a blender, pan and stove, thermometer, weighing balance, bowls or containers, spoon or spatula, drying rack, measuring cylinder, hot plate, stirring rod, and knife, all of which were utilized to support the preparation, processing, and characterization of the edible coating. The materials used consisted of strawberries as the coated fruit, vanname shrimp (Litopenaeus vannamei) shells as the source of chitosan, and cinnamon bark extract (Cinnamomum sp.) as an active additive in the edible film. Additional supporting materials included gelatin as a film-forming agent, glycerol as a plasticizer, and distilled water as the main solvent. Several chemical reagents—vinegar, sodium hydroxide (NaOH), potassium iodide (KI), iodine (I_2), phenolphthalein indicator, and starch (amylose)—were also employed in the extraction and characterization processes of the edible coating.

2.2. Research Procedure

The research procedure consisted of several stages, including the collection and preparation of vanname shrimp shells, the preparation of the edible coating solution, film casting, and the application of the coating to fruits.

In the first stage, clean shrimp shells were collected and soaked in vinegar solution to remove the inner membrane. The shells were then dried under sunlight, ground into a fine powder, and sieved to obtain a uniform particle size.

e-ISSN : 2622-4968, p-ISSN : 2622-1349

The edible coating solution was prepared following a modified method of Septiana (2009). The shrimp shell powder was mixed with a binding agent such as starch or gelatin in a 1:10 ratio. The mixture was heated using a hot plate at approximately 55 °C for 20 minutes while being stirred continuously. Glycerol was then added according to the treatment variation (10%, 30%, and 50%), and the temperature was increased to 70 °C. Subsequently, 1% cinnamon leaf extract was gradually added into the solution while stirring until a homogeneous mixture was obtained. The edible coating solution was then cooled to room temperature.

For the casting process, the prepared solution was poured onto a flat mold or plastic sheet lightly coated with oil to prevent sticking. The surface was leveled using a spatula to obtain a uniform thickness (approximately 0.25 mm, using 10% w/w shrimp shell powder). The coated layer was then air-dried in an open area. Once dried, the edible film was carefully peeled off and stored in a clean, dry container at room temperature.

In the application stage, strawberries with uniform ripeness were washed under running water and air-dried at room temperature. After drying, the strawberries were immersed in the edible coating solution (maintained at 40 °C) for 2 minutes, lifted, and air-dried for 45 minutes at 27 °C. The coated fruits were stored for up to 10 days, while uncoated strawberries served as the control for comparison during analysis.

3. RESULTS AND DISCUSSION

3.1. Weight Loss

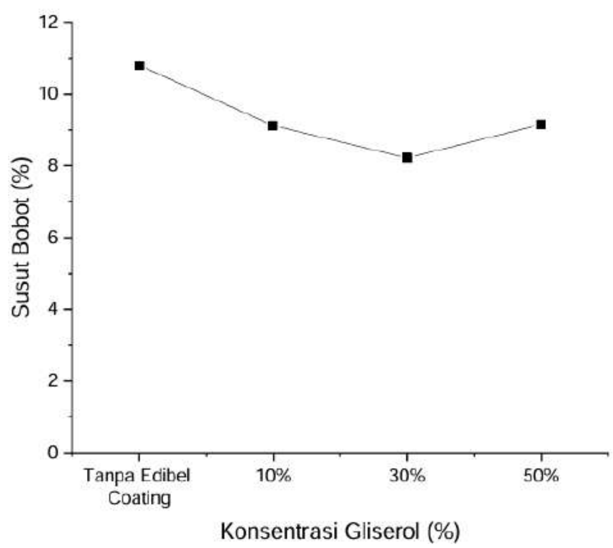

Figure 1. The Effect of Edible Coating on the Weight Loss of Strawberries on Day 10

Based on **Figure 1**, the application of edible coatings with various glycerol concentrations affected the weight loss of strawberries during 10 days of storage. Strawberries without an edible coating showed the highest weight loss, approximately 10.8%, indicating the absence of a protective layer capable of slowing down transpiration and respiration rates. In the treatment with 10% glycerol coating, the weight loss decreased to around 9.1%, suggesting that the coating layer began to reduce moisture loss. A more significant reduction

e-ISSN : 2622-4968, p-ISSN : 2622-1349

was observed at a glycerol concentration of 30%, which exhibited the lowest weight loss of about 8.2%. This result indicates that the concentration represents an optimal point, where the coating layer was sufficiently compact and elastic to effectively inhibit water evaporation and maintain surface moisture of the fruit. However, at a concentration of 50%, the weight loss increased again to approximately 9.1%. This condition is presumed to result from excessive glycerol content, which makes the coating layer overly plasticized and sticky, thereby reducing its effectiveness as a water vapor diffusion barrier. Moreover, an overly soft layer may develop cracks or uneven thickness, leading to a decrease in its protective function.

3.2. Color

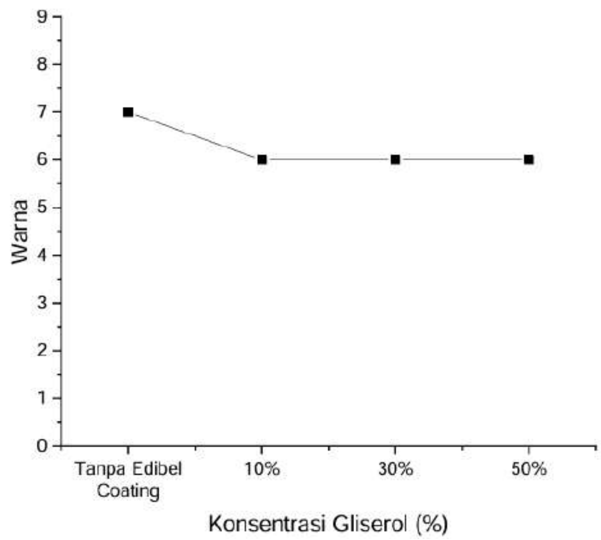

Figure 2. The Effect of Edible Coating on the Color of Strawberries on Day 10

Based on **Figure 2**, the application of edible coatings with varying glycerol concentrations affected the color of strawberries on 10 day of storage. Uncoated strawberries exhibited the highest color score, approximately 6.8, indicating that the fruit tended to undergo color changes more rapidly due to the absence of a protective layer. These color changes are generally associated with increased activity of polyphenol oxidase (PPO) and the degradation of anthocyanin pigments during respiration and oxidation processes. In the treatments with edible coatings containing 10% glycerol, the color score decreased to 6.0 and remained relatively stable up to glycerol concentrations of 30% and 50%, with similar values. This indicates that the edible coating effectively slowed down the color changes of strawberries, as the coating layer acted as a gas barrier (O_2 and CO_2), thereby reducing respiration rate and the activity of pigment-degrading enzymes. Consequently, anthocyanin degradation was minimized, resulting in more stable fruit color. The lack of significant differences in color among glycerol concentrations from 10% to 50% can be attributed to the primary role of glycerol as a plasticizer, providing elasticity to the coating layer. Meanwhile, the effect on color is largely determined by the overall ability of the coating to limit oxygen diffusion rather than the variation in glycerol content. Therefore, once the minimum effective concentration (around 10%) is reached, increasing glycerol concentration does not provide additional benefits to color stability.

e-ISSN : 2622-4968, p-ISSN : 2622-1349

3.3. Firmness

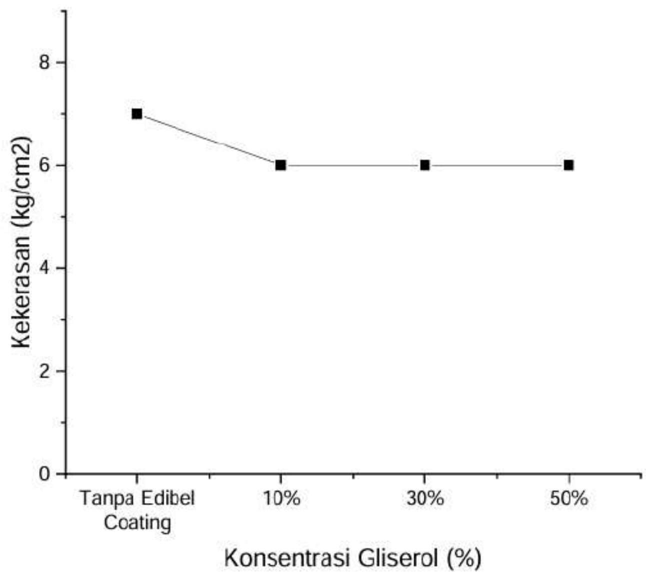

Figure 3. The Effect of Edible Coating on the Firmness of Strawberries on Day 10

Based on **Figure 3**, the application of edible coatings with varying glycerol concentrations affected the firmness of strawberries on 10 day of storage. Uncoated strawberries exhibited the highest firmness, approximately 7.0 kg/cm², whereas coated fruits showed a decrease in firmness to around 6.0 kg/cm² for all glycerol concentrations (10%, 30%, and 50%). These values remained relatively stable across the three treatments. The reduction in fruit firmness during storage is a natural phenomenon caused by respiration and the activity of hydrolytic enzymes, such as polygalacturonase, cellulase, and pectin methylesterase, which degrade cell walls and soften the fruit texture. However, the presence of edible coatings can slow down this softening process by limiting gas exchange (O_2 and CO_2), thereby reducing respiration rate and enzymatic activity. The lack of significant differences among the 10%, 30%, and 50% glycerol treatments indicates that the primary function of the edible coating in maintaining fruit firmness is determined by the presence of the protective layer rather than the glycerol content. Glycerol acts as a plasticizer, influencing the elasticity and flexibility of the coating layer, but it has little effect on controlling fruit firmness. Therefore, once the minimum effective concentration is reached, higher glycerol levels do not significantly affect the firmness of strawberries.

4. CONCLUSION

Based on the results of this study on the effect of edible coatings with various glycerol concentrations on the quality of strawberries during 10 days of storage, it can be concluded that the edible coating significantly influenced the weight loss, color, and firmness of the fruits. Uncoated strawberries exhibited the highest weight loss (approximately 10.8%), indicating a high rate of water loss due to the absence of a protective layer. The application of edible coating with 30% glycerol resulted in the lowest weight loss (around 8.2%),

e-ISSN : 2622-4968, p-ISSN : 2622-1349

demonstrating optimal effectiveness in reducing transpiration and maintaining surface moisture. Regarding color, the edible coating slowed down color changes in strawberries by stabilizing anthocyanin pigments through the inhibition of oxygen diffusion and polyphenol oxidase (PPO) activity. In terms of firmness, all edible coating treatments (10–50% glycerol) were able to slow down fruit softening caused by respiration and the activity of hydrolytic enzymes. Overall, the edible coating with 30% glycerol was the most effective treatment for maintaining the physical quality of strawberries during storage.

ACKNOWLEDGEMENT

The authors would like to extend their heartfelt appreciation to the Institute for Research and Community Service (LPPM) at the State University of Medan (UNIMED) for providing the financial support that made this research possible. Special thanks are also conveyed to the staff of the Chemistry Department Laboratory, Faculty of Mathematics and Natural Sciences, for their dedicated assistance, guidance, and cooperation throughout the experimental work. Their support was invaluable in ensuring the smooth progress and successful completion of the study.

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e-ISSN : 2622-4968, p-ISSN : 2622-1349