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Application of Chitosan from Crab Shell Waste (*Portunus pelagicus*) as a Preservative for Muli Bananas (*Musa acuminata* L)

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ABSTRACT

Crab shell is one of the wastes generated from the marine product processing industry. However, the utilization is still very low, especially in Cirebon, it is only used as animal feed and even most of it is waste that also pollutes the environment. One of the alternatives for processing crab shells is used as chitosan because the crab shells are rich in chitin. Chitosan is a chitin derivative compound resulting from the deacetylation process. Chitosan can be called a biopolymer that contains the most nitrogen in nature and also has anti-bacterial, non-toxic, and biodegradable properties because this is why chitosan is in great demand in the industry. Chitosan has a very diverse potential such as in the environmental, pharmaceutical and food fields, one of which has the potential to be a safe preservative in food. This study aims to utilize crab shell waste into chitosan as a preservative for Muli bananas. This research is an experimental study using a completely design with six stages including demineralization, deproteination, deacetylation, manufacture of coating solutions with various concentrations (0%, 1%, 1.5%, 2% and 2.5%), coating process and testing. physical. The parameters measured were the degree of deacetylation, the effect of chitosan concentration and physical tests (discoloration). The results showed that the degree of deacetylation of the chitosan obtained was 95.9825%. From the results of the physical test, it was found that the addition of chitosan with concentrations of 1%, 1.5%, 2% and 2.5% in the coating process resulted in the greater concentration of chitosan being added, the longer the ripening process in bananas and causes bananas peels are not easy to brown.

1. INTRODUCTION

Chitin or chitosan is the second most abundant biopolymer after cellulose that can be found in nature. The main source of chitin or chitosan is the shells of Crustaceae sp, namely shrimp, lobster, crab, shellfish, crab and other shelled animals, mainly from the sea [1]. Chitosan is a chitin derivative compound resulting from the deacetylation process. Chitosan can be called the biopolymer that contains the most nitrogen in nature which has antibacterial, non-toxic, and biodegradable properties. Chitosan has very diverse potential such as in the environmental, pharmaceutical and food sectors, one of which has the potential as a safe preservative in food [1]-[9].

Muli bananas are widely grown on the island of Java. Their skin is thin and susceptible to damage, such as browning. Browning can be caused by enzymes or bruising. This results in a decline in the fruit's quality, both aesthetically and nutritionally, leading to a lower market value, making it less suitable for consumption. To minimize damage to bananas, coating them can be used to preserve and maintain their quality.

2. METHOD

2.1 Raw Materials

Crab shell waste (Portunus pelagicus) from Cirebon, muli banana fruit, 1% acetic acid, distilled water, filter paper, universal indicator, NaOH, and 1 N HCl.

2.2 Preparation of Sample

The crab shells were washed with running water until clean to remove dirt. They were then drained and dried in the sun to remove any remaining water. The dried crab shells were ground using a mortar and blender to form a fine powder, then sieved through a 50-mesh sieve.

2.3 Isolation and Characterization of Chitosan

2.3.1 Deproteinization

Finely ground crab shell powder (200g)was weighed into a beaker, and 2000 ml of 3N NaOH solution was added at a ratio of 1:10 (w/v). The mixture was heated on a hot plate and stirred using a magnetic stirrer for 60 minutes at 90°C. The mixture was then filtered through filter paper and washed with distilled water until the pH reached 7. The solid was then oven-dried at 100°C for 24 hours [1].

2.3.2 Demineralization

The solid product of the deproteinization process was 167.5532 g. 1,172.8724 ml of 1 N HCl was added at a ratio of 1:7 (w/v). It was then heated and stirred at 90°C for 60 minutes. It was then filtered and washed with distilled water until neutral, reaching a pH of 7. The solid was then oven-dried at 100°C for 24 hours.

2.3.3 Deacetylation

The solid product of the demineralization process was weighed at 50 g. 1,000 ml of 50% NaOH was added at a ratio of 1:20 (w/v). The mixture was heated and stirred using a hot plate and magnetic stirrer for 120 minutes at 140°C. It was then filtered and washed with distilled water until neutral, reaching a pH of 7. The solid was then oven-dried at 100°C for 24 hours.

2.3.4 Chitosan Characterization

The chitosan solid formed was weighed at 0.5g. It was then characterized to ensure it was chitosan using a Fourier Transform Infrared (FTIR) instrument.

2.4 Application of Chitosan as a Preservative

2.4.1 Edible Coating Manufacturing

To make edible coatings with chitosan concentrations of 1%, 1.5%, 2%, and 2.5%, the chitosan concentrations were prepared sequentially at 2 g/200 mL of 1% acetic acid, 3 g/200 mL of 1% acetic acid, 4 g/200 mL of 1% acetic acid, and 5 g/200 mL of 1% acetic acid, respectively. Each solution was heated for 60 minutes at 40°C. Then, each solution was filtered to separate the solution and the precipitate. Then, each solution was stirred using a magnetic stirrer for 15 minutes. The solution was then stored at room temperature

2.4.2 The process of coating muli bananas

Chitosan solutions with concentrations of 1%, 1.5%, 2%, and 2.5% were placed in a container. Each muli banana was dipped into the chitosan solution (1%, 1.5%, 2%, and 2.5%) until the entire banana was coated with the chitosan solution. The bananas were then removed and left in the room.

2.4.3 Physical Testing

The physical testing was carried out by comparing the color changes from day to day in each banana, which had been added with chitosan at concentrations of 1%, 1.5%, 2%, and 2.5%, and those without chitosan, from day 1 to day 7.

3. RESULT AND DISCUSSION

3.1 Isolation and Characterization of Chitosan

A sample of crab shells from Cirebon was cleaned, sun-dried, and ground using a mortar and blender to form a fine powder, then sieved through a 50-mesh sieve. The chitosan isolation process from crab shells involved several stages. The first stage was deproteinization, producing a thick, brownish-yellow solution. Demineralization followed, yielding 167.5532 g of chitin. The final stage was deacetylation, yielding solid chitosan.

The resulting solid chitosan was weighed to 0.5 g. It was then characterized using a Fourier Transform Infrared (FTIR) instrument to confirm its authenticity.

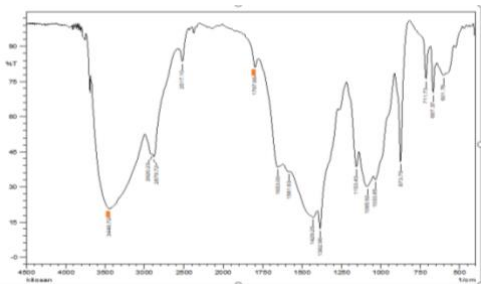


Figure 1 FTIR spectrum of chitosan

The isolated chitosan contained an OH- group, indicated by an absorbance of 3448.72 cm-1. This is useful for releasing the acetyl group from the acetylamide group, producing an amine (NH2) group with binding capacity. The chitosan from this study underwent full deacetylation (90-100%), indicated by the presence of an acetimide group with an absorbance of 1797.66 cm-1. Based on the resulting spectra in the image, several distinctive peaks are visible that indicate the specific characteristics of the chitosan structure. For example, the peak at 1085.92 cm-1 indicates the presence of an ether group, CH3 at a wavenumber of 1429.25 cm-1; the peak at 2920.25 cm-1 indicates a C-H stretch; the peak at 3448.72 cm-1 indicates the presence of an alcohol group overlapping with an N-H stretch; and several other absorption peaks confirm the chitosan structure in the tested samples.

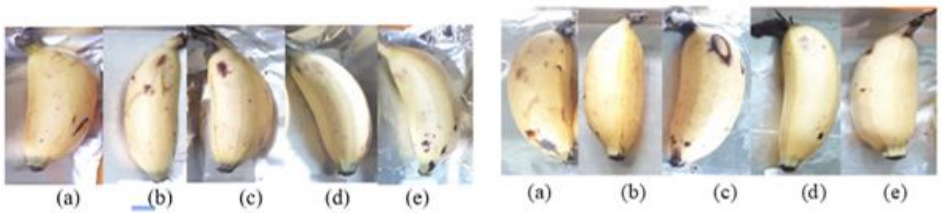
The degree of deacetylation was obtained from the line drawing method and the results of the comparison of wave numbers between amide absorption and hydroxy absorption. The degree of deacetylation of the crab shell sample was obtained at 95.9825%, from the value of the degree of deacetylation obtained that the deacetylation process was running quite well because it produced a high degree of deacetylation value. Because of this, the resulting sample can be said to be chitosan. A sample can be said to be chitosan if it has a degree of deacetylation ≥70%. The degree of deacetylation value of more than 70% can be applied in the food sector. The higher the degree of deacetylation value, the chitosan will affect the application of chitosan because the higher the degree of deacetylation results in more acetyl groups being released and more free amine groups (-NH2) being formed making this polymer polycationic, this will affect the ability of chitosan to form isoelectric interactions with other molecules.

3.2 Application of Chitosan as a Preservative

Fruit coating is a process aimed at preserving the fruit to ensure its longevity. The process of coating muli bananas involves several steps: creating an edible coating, followed by dipping the fruit. Observations from day 1 to day 7 can be seen in Figure 2.

The physical test in this study used a color change test. The physical test analysis was conducted by comparing the color changes from day 1 to 7 of each banana supplemented with chitosan at concentrations of 1%, 1.5%, 2%, and 2.5%, as well as those without chitosan.

The results showed that muli bananas without chitosan solution ripened more quickly than those coated with the solution. The color change on the muli banana skin shifted from yellow to brownish-yellow, with brown spots appearing. This color change occurred more quickly in the uncoated muli bananas. This was evident on days 1 and 2, when the preservative-coated muli bananas were pale yellow with a slight greenish tinge, indicating they were not yet ripe. On day 3, the muli bananas began to turn completely yellow, indicating they were beginning to ripen. From days 4 to 7, the color of the bananas deepened, indicating their ripeness. During this time period, there was a significant color change at each chitosan concentration. The higher the chitosan concentration, the longer the banana ripening process, resulting in a longer browning process.



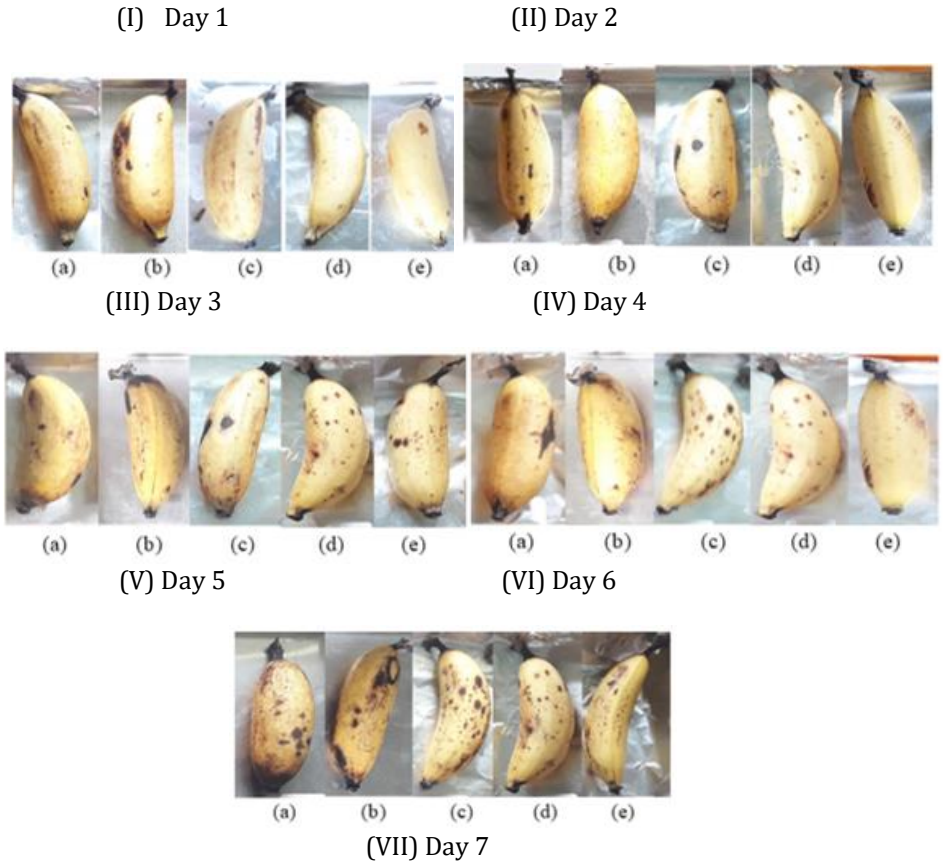


Figure 3. The results of physical tests of banana samples coated with chitosan on the first day (I), second day (II), third day (III), fourth day (IV), fifth day (V), sixth day (VI) and seventh day (VII), with different treatments: control (a), 1% chitosan (b), 1.5% chitosan (c), 2% chitosan (d) and 2.5% chitosan e)

Color is an easily observable determinant of food quality. Color can be an indication of food quality. Food ingredients that have an unsightly color or give the impression of poor quality will affect consumer perception. Color parameters can be assessed by visual observation. Color changes can occur enzymatically and non-enzymatically [17].

The browning process is generally divided into two: enzymatic and non-enzymatic browning. The color change that occurs in bananas is caused by the browning process. Enzymatic browning is caused by the activity of the enzymes phenolase and polyphenolase. The formation of brown color is due to the oxidation of phenol and polyphenol compounds by phenolase and polyphenolase enzymes to form quinones, which then polymerize to form melanin (a brown pigment). Enzymatic browning requires four components: phenolase and polyphenolase (enzymes), phenol and polyphenol compounds (substrates), oxygen, and copper ions, which are the active sites of the enzymes. To prevent enzymatic browning, one or more of these components can be eliminated [18].

The optimum concentration of chitosan for preservation is 2.5% because muli bananas coated with a chitosan solution last longer than other bananas. Therefore, the higher the concentration of chitosan added, the more it will inhibit the ripening and browning process in muli bananas and increase their shelf life.

4. CONCLUSION

The results showed that chitosan can be isolated from crab shell waste, with a high degree of deacetylation of 95.9825%. Increasing the concentration of chitosan in preserving muli bananas significantly impacts the results of physical tests, such as color changes on the fruit skin, with the optimal concentration being 2.5%.

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