Edible Coating Development of Durian Seeds Starch and Glucomannan with The Addition of Essential Oil As An Antimicrobial to Increase Shelf Life of Tomato and Cauliflower

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Abstract. Edible coating can increase shelf life of fruit and vegetable that coated by minimizing water loss. This study aims to determine the effect of the addition of essential oil to edible coating has been made from durian seed starch and glucomannan. The essential oil that is eucalyptus oil and virgin coconut oil (VCO) added with variations up to 2 wt% as antimicrobial to bacteria and fungi on tomatoes and cauliflowers. The results showed that the smallest degree of swelling is obtained on the sample with 2 wt% VCO amount 457.52%. All samples not found fungal growth and bacterial contamination in oil less samples amounted to 3.1 x 10^3 CFU/mL, therefore safe to consume according to BPOM no.16 of 2016. Organoleptic results showed that all samples could be accepted by all panelists except samples of VCO 2%, EO 1% and EO 2% were somewhat disliked. Edible coating application on tomatoes and cauliflower can increase their shelf life until 10 days.

1. Introduction
Vegetable and fruit contain nutrients that support the health of the body. According to data released by the Badan Pusat Statistik (BPS) in January 2017, three out of four Indonesians consume fruit and almost all Indonesians (97.29%) have consumed vegetables [1]. The island of Java is the largest vegetable and fruit producing region in Indonesia and the distribution process of vegetable and fruit from Java to other islands requires various transportation modes such as pickup trucks, refrigerated trucks, and ships with refrigerated containers [2]. However, the transportation modes have a long travel time so that it can affect to the quality of vegetable and fruit that are brought.

Edible coating can extend the shelf life and improve product quality [3]. Starch can be used to form edible coating [4] but it hydrophilic so that bacteria can attack the food products and damage them. To prevent this, an antimicrobial that edible is essential oils [5][6]. Essential oils are secondary metabolites from plants obtained in the flowers, leaves, seeds, bark, fruits, and roots or rhizomes [7]. Based on previous research, the addition of 0.7% cinnamon essential oil, lemongrass 0.7%, lemon 3%, and betel 0.1% were done for each sample of Manalagi fresh-cut apples to inhibit bacterial growth and maintain shelf life [8].

Starch as the raw material for edible coatings can be obtained from durian seeds. The total consumption of durian fruit will certainly produce a lot of durian seed waste. The content of starch in the seeds of durian is high enough so that they can be processed into flour which has a high economic value and becomes a potential product diversification of wheat flour [9]. In this study, an edible coating
was made with the addition of 30% glucomannan and essential oils namely eucalyptus and virgin coconut oil. The edible coating applied to tomatoes and cauliflower.

2. Method

2.1. Material
The material used in this study was durian seed starch, glucomannan, glycerol, aquades, virgin coconut oil (VCO) and eucalyptus oil.

2.2. Edible coating preparation and application
Durian seed starch, glucomannan, glycerol, and aquades were mixed at a ratio of 1: 0.3: 0.3: 20(w/w) for 15 minutes at room temperature. The solution is heated at 70°C for 20 minutes until it thickened then added a variations of VCO and eucalyptus oil amount 0%, 0.1%, 0.5%, 1% and 2%. The method of applying the edible coating was dip coating: tomatoes and cauliflower dipped in edible coating solution for 5 minutes then lifted and air dried for one day.

2.3. Characterization of edible film
The swelling test carried out according to ASTM D-570-098. To find out the size of the edible coating shrinkage itself, an observation was carried out using mica as a substitute for the fruit skin that was coated. Mica size 3 x 3 cm with 3 samples of each variation. Samples are weighed every day to find out the amount of depreciation that occurs over 10 days. The degree of swelling can be found by the following equation:

\[ W(\%) = \frac{m_1 - m_0}{m_0} \times 100\% \] (1)

where W (%) is the degree of swelling, m_1 is the final mass of the sample (g) and m_0 is the initial mass of the sample (g).

Shrinkage testing was done by observing tomatoes and cauliflower (3 samples of each variation) with edible coating application and the tomatoes and cauliflower without coating as a control variable for 10 days with daily monitoring started one day after the sample coated. The data obtained in the form of weight from the sample. From the data obtained, then calculate the value of the weight loss using the following equation

\[ \text{Weight loss (\%)} = \frac{m_0 - m_1}{m_0} \times 100\% \] (2)

Microbiological testing to determine bacterial and fungal contamination in edible coatings is still in accordance with the standard or not. Organoleptic testing to determine the response of panelists' acceptance of fruits and vegetables that are coated based on color, texture, aroma, taste and general acceptance.

3. Results and discussion
Edible coating solution from durian seeds with a variety of brownish-colored essential oils for variation of 0% and VCO and whitish color for eucalyptus oil variations. Before being applied to tomatoes, an edible coating solution is printed on the film to be tested for the degree of swelling and shrinkage.

3.1. Degree of Swelling and Shrinkage of Edible Coatings
Edible coating samples with the addition of eucalyptus oil cannot be measured the degree of distortion because the sample is destroyed after being immersed in water. Degree of swelling of the samples with VCO addition (Figure 1) showed that the addition of VCO reduced the degree of swelling.
Figure 1. Effect of VCO composition on the degree of swelling

Results of the shrinkage test seen in Figure 2 for edible coating shrinkage with the addition of VCO and eucalyptus oil. Based on Figure 2 edible coating has decreased from the first day to the third day because the coating still wet and not yet dry completely. Meanwhile, after the third day the weight loss of coatings not too large and tend to be stable or no longer shrink.

Figure 2. Weight loss of edible coatings on mica

3.2. Effect of Edible Coating on Tomatoes and Cauliflower Shelf Life
The weight loss observed in tomatoes and cauliflower coated edible coating with the addition of VCO and eucalyptus oil for ten days are showed in Figure 3 and Figure 4. Figure 3 showed that the lowest weight loss was in tomato sample with the addition of 1% VCO and sample with the addition of 2% eucalyptus oil, while the largest in tomato without coating. From Figure 4 seems that the lowest weight loss in the cauliflower sample with the addition of 2% VCO and sample with the addition of 0.5% eucalyptus oil, while the largest in the cauliflower sample without the addition of coating.
3.3. Microbiology and Organoleptic Tests

Microbiological testing has been carried out by the TPC (total plate count) method to count the number of bacterial and fungal colonies in the samples. The test sample for bacterial TPC was selected 0% sample assuming the sample with the addition of oil has a smaller number of colonies than the 0% sample. While for fungal TPC, 3 samples were selected: 0%, VCO 2% and EO 2%.

Results of the test obtained that the number of colonies formed in the TPC of bacteria is $3.1 \times 10^3$ which meet the regulation of the Head of the Indonesian Drug and Food Control Agency No. 16 of 2016 concerning "Microbiological Criteria in Processed Food". It means the 0% edible coating samples are safe for consumption because the allowable bacterial colony limit is a minimum of $10^3$ CFU/mL and a maximum of $10^4$ CFU/mL. While for fungal TPC, the results are as shown that during the incubation period of 7 days there was no growth of fungal colonies.

Organoleptic testing is only done on tomatoes by coating the tomatoes with an edible coating of each variation. For each variation used 1 tomato, after dipped tomatoes sliced in half and stored for 1 day so that the edible coating layer can be formed perfectly. After the edible coating is formed, the tomatoes can be sliced back into 13 parts and will be tested by 13 panelists who have been selected to test in terms of color, texture, flavor and taste of each variation.
Figure 5. Organoleptic test results

From the results obtained it can be said that the color and texture of all the samples can be said to be liked by all panelists only for the aroma and taste there is a difference especially in the eucalyptus oil sample which is not very preferred due to the strong aroma of eucalyptus oil making it difficult for panelists to feel the sample because the taste of the sample is mixed with the flavor. Based on Figure 5 that on VCO 2% the average panelists stated rather dislike the taste while for EO 1% and 2% both the aroma and taste of the average panelist stated rather dislike. With this result it can be concluded that based on the color and texture of all the samples passed the organoleptic test while for the aroma of the sample 1% and 2% EO did not pass the organoleptic test while in terms of taste the sample VCO 2%, 1% EO and 2% did not pass the organoleptic test.

4. Conclusion
From the results and discussion on the current study, the increasing VCO composition decreasing the degree of swelling edible coating. The results of bacterial contamination in samples without oil amounted to $3.1 \times 10^3$ CFU/mL while fungal contamination in all samples found no fungus growth so it safe to consume according to BPOM No. 16 of 2016. Addition of VCO and eucalyptus oil are proven to be able to prevent microbial growth, especially in fungi. Organoleptic results showed that all samples were acceptable to all panelists except for the 2% VCO sample, 1% EO and 2% EO rather unpopular. Application of edible coatings on tomatoes and cauliflower can reduce weight loss and increase shelf life.

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