The Effect of CMC, Agar, and Konjac on the Characteristics of Durian Seed Starch Edible Film

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Abstract. Edible film as synthetic plastic food wrap alternatives continuously developed. Durian seed starch is one of the materials used on edible film fabrication. This research studied on durian seed starch-based edible film with the addition of carboxymethyl cellulose (CMC), agar, and konjac with a mass fraction of 10%, 20%, 30%. The observed characteristics were swelling degree and tensile strength of the fabricated film. The edible film solution was made using ratio of flour and additives, water, and glycerol of 1:20:0.3 (w/w), stirred for 20 minutes at 70°C. The results showed that agar addition on edible film made the film could not be fabricated, konjac addition increases the swelling degree and the tensile strength, while CMC addition increases the swelling degree and decreases the tensile strength. Agar and CMC are not compatible to be the additive on the durian seed starch edible film. The most optimal results were with the addition of 30% of konjac with the tensile strength of 9.4 MPa and swelling degree of 1073.81%.

1. Introduction

The research of edible film as synthetic plastic substitute on food packaging has been extensively studied. Starch has been widely used as edible film because it produces an odorless, tasteless, transparent film with good mechanical properties [1].

Durian is a fruit that is famous in Southeast Asia. In Indonesia, durian production continues to increase every year [2]. However, only its flesh that mainly used and the seed is thrown away. A study shows that durian seed has high starch content and predicted to have greater mechanical properties than mung bean based edible film, which its properties is comparable to HDPE, LDPE, PP, and PS [1][3].

The research of starch based edible film focussed on increasing its mechanical strength while decrease its susceptibility to water. Some study has been conducted to increase the performance of durian seed starch edible film. A study shows that water vapor transmissibility decrease with the addition of CMC on durian seed starch edible film but its tensile strength and elongation also decreasing [4]. Other studies by Ginting (2016), added chitosan as the additives on durian seed edible film and shows that its addition increase the tensile strength of the edible film but reduce its elongation [5]. Addition of agar and konjac has not been done on durian seed edible film. However, the addition of agar on cassava starch edible film increase its elongation [6]. In this study, the addition of CMC, agar, and konjac will be evaluated.

2. Method

2.1. Material

The material in this study is durian seed, aquades, glycerol, CMC, agar, and konjac.
2.2. **Durian seed starch preparation**
Durian seed flour was made by drying the durian seeds by peeling the outside parts of the seeds first. Seeds that have been thinly sliced are then dried at a temperature of 45 °C for 24 hours. Dried seeds were weighed and mixed with water as much as 5 times the weight of seeds and then mashed using a blender for 5 minutes until they become porridge. The pulp is then filtered and the filtrate is taken. The filtrate is allowed to settle and washed with water, carried out until the water is washed clear. The slurry is dried in an oven at 45 °C for 24 hours, then mashed and sieved with a 200 mesh sieve.

2.3. **Edible film preparation**
Durian seed flour, water, and glycerol were mixed at a ratio of 1: 20: 0.3 (w/w) by stirring for 15 minutes at room temperature. The solution is heated at 70°C for 20 minutes until it thickens. The solution is poured into an acrylic mold with a depth of 3 mm with the size of the mold following the size of the standards of the tests to be performed.

2.4. **Characterization of edible film**
Edible film then characterized by swelling test and tensile test. The swelling test was carried out according to ASTM D570 and the tensile test was carried out according to ASTM D882.

3. **Results and Discussion**
Figure 1 shows the surface of each film formed. The addition of agar on durian seed starch makes the film could not be formed properly. The crack occurs because the film shrinks during the drying process and becomes brittle [7]. No defect found on the other samples.

![Figure 1](image)

**Figure 1.** The surfaces of the samples after dried and peeled off (a) without addition, (b) agar addition, (c) konjac addition, (d) CMC addition.

3.1. **Swelling test**
The addition of CMC and konjac increases the swelling degree of the film. In Figure 6, it appears that the sample with the addition of CMC has a greater effect on increasing the degree of swelling, ranged from 700.98% to 1842.97%. The addition of konjac in the film increase the swelling ranged from 420.25% to 1073.81%. Compared to the film without any addition, the swelling degree of film with CMC addition should lessen the interaction of the film with water but it was increased instead [4].
the previous study, at high concentration, the CMC might congregate, hence it could not be fully dispersed in the solution thus creates a path for water to interact with the film and increase the film swelling degree [8].

Figure 2. Swelling degree of durian seed starch film.

3.2. Tensile test
The tensile strength of the film without addition was greater than the one that has been reported by Pimpa (2012). This was because the difference between gelatinization which higher temperature would decrease the tensile strength. The tensile strength with konjac addition ranged from 9.4 MPa to 13 MPa, while CMC addition 5.8 MPa to 7.2 MPa. This test indicates that the highest tensile strength was with the addition of 30% konjac of 13 MPa.

The results of the CMC addition on the film decrease the tensile strength. There was declination in both strength and elongation in the addition of 30% CMC. On the lower addition, the result was similar to the previous study, which concludes that the decrease could possibly indicates that the CMC addition was already past its limits, therefore the solution could not distribute evenly and tends to congregate on itself [4].

Figure 3. Tensile test results (a) tensile strength, (b) elastic modulus.
4. Conclusion
Based on the current study, the agar is not a compatible addition on durian seed edible film because it cracks the fabricated film. Furthermore, the addition of CMC worsens the film performance. Konjac addition not only shows an increase in its mechanical properties but also increase its swelling degree of the film. The best mechanical property of konjac addition is 30%.

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