Table 4. Average Number of Edible Film Water Vapor Transmission Rate

Sorbitol Treatment (%)	Average Number of Water Vapor Tranmission Rate (%)
0,4	10,41 ± 0,06[a]
0,8	10,89 ± 1,12[a]
1,2	12,28 ± 0,86[ab]
1,6	12,81 ± 1,64[b]
2	13,93 ± 0,49[b]

Explanation: numbers followed by unequal letters mean that they differ significantly at the 5% level.

The rate of water vapor transmission increases with the addition of sorbitol concentrations in edible film formulations. This is because the type of plasticizer used is sorbitol. Sorbitol is a polyhydric alcohol monosaccharide compound which is hydrophilic, increasing the hydrophilic component contained in the film causes the water to penetrate the film easily, thereby increasing the value of the water vapor transmission rate (Putra 2017).

According to Namet et al. (2010) an increase of water vapor transmission rate is thought to be caused by the plasticizer characteristic which is hydrophilic and is able to reduce the voltage between molecules in the edible film matrix which causes the space between molecules to increase so that water vapor can penetrate the edible film.

The water vapor transmission rate value of carrageenan edible film ranges between 10.41 g / mm2 / 24 hours - 13.93 g / mm2 / 24 hours. The highest water vapor transmission rate of edible film was produced in 2% sorbitol concentration treatment, which was 13.93 g / mm2 / 24h, while the lowest water vapor edible film transmission rate was obtained in the 0.4% sorbitol concentration treatment which was 10.41 g / mm2 / 24 hours.

Comparison of water vapor transmission rate with previous research called Putra research (2017) edible film made from breadfruit starch produced a value of water vapor transmission rate of 462.11 g / m2 / 24 hours and Rahmawati (2017) edible film made from carrageenan has a water vapor transmission rate value of 6.83%. According to Japanese Industrial Standard (1975) the maximum value of edible film vapor transmission rate is 10 g / m2 / day. The value of the transmission rate of water vapor edible film in this research ranges from 10.41 - 13.93 g / mm2 / 24 hours does not met the standard because it exceeds the maximum value.

Water Content

The water content of edible films has an important role in the stability of the product to be coated. Edible films with low water vapor content will affect their shelf life so they can last longer. The water content of edible films is related to thickness, the thicker the edible film the higher the water content.

The analysis results of the variance showed that the treatment of sorbitol concentration in carrageenan edible film formulation has a significant effect ($P < 0.05$) on the water content of edible films. The average water content of edible films can be seen in Table 5.

Table 5. Average Number of Edible Film Water Content

Perlakuan Sorbitol (%)	Average Number of Water Content (%)
0,4	4,07 ± 0,51[a]
0,8	7,18 ± 0,28[b]
1,2	6,24 ± 0,69[c]
1,6	9,50 ± 0,26[c]
2	7,66 ± 0,32[d]

Explanation: the number followed by an unequal letter means that it is significantly different at the 5% level.

Water content in foodstuffs affects the shelf life of these foodstuffs. The higher the value of edible film water content, the shorter the shelf life of edible films, and vice versa (Setiani 2013). Water content has an influence on the character of edible films, especially on the physical properties of the edible film. The higher the water content value of edible film causes edible film to become more fragile and soft texture. If the water content in edible film is low, edible film has flexible properties, but if it is too low edible the film will be rigid and have a low stretch (Ilah 2015).

The value of water content in this research fluctuated, while the difference in the high value of water content in this research was suspected due to the surrounding air humidity associated with the storage of materials, the characteristic and type of material and the treatment experienced by the material (Wirakartakusumah 1981). Increased water content due to sorbitol besides functioning as a plasticizer also functions as a sweetener and humectant, which is an additive that is hygroscopic and serves to maintain water content in a material (Bourtoom 2007).

The addition of different sorbitol concentrations has varying water content values. The value of edible film carrageenan water content ranged from 4.07% - 9.50%. The highest water content was produced in the treatment of 1.6% sorbitol concentration, which was 9.50%, while the lowest water content was produced in the treatment of 0.4% sorbitol concentration, which was 4.07%. The increase in the addition of sorbitol concentration can increase the water content value of edible films.

Based on the results of previous research conducted by Riyanto (2017), the edible film made from wheat starch has a water vapor content ranging from 5.7% - 11.46% and Subiyanto (2013) with edible films made from composite semirefined carrageenan and beeswax to produce water vapor content of 44.62% - 51.49%. According to Japanese Industrial Standard (1975) the maximum value of edible film water content is 13%. The water content value of edible film in research with the addition of different sorbitol has met the standard because it does not exceed the maximum value of 4.07% - 9.50%.

Solubility

Solubility in edible films is done to determine the ability of edible film to dissolve in water, so that in ingested process, it can be digested properly. The level of solubility is determining possibility factor of an edible film being applied (Garcia et al. 2000).

The results of the analysis of variance showed that the treatment of sorbitol concentrations in carrageenan edible film formulations has a significant effect ($P < 0.05$) on the solubility of edible films. The average solubility value of edible films can be seen in Table 6.

Table 6. Average Number of Edible Film Solubility

Sorbitol Treatment (%)	Average Number of Solubility (%)
0,4	7,53 ± 0,17^{a}
0,8	8,79 ± 0,26^{b}
1,2	8,47 ± 0,66^{b}
1,6	9,49 ± 0,26^{c}
2	9,56 ± 0,17^{c}

Explanation: the number followed by an unequal letter means that it is significantly different at the 5% level.

The greater the solubility value of edible film, the more edible film dissolved. Bourtoom (2008) states that edible film forming materials that are hydrophilic will dissolve more quickly in water compared to hydrophobic materials such as beeswax, wax and paraffin. Edible films with low solubility values will be difficult to dissolve in water so that they are less suitable to be applied as food product packaging.

The solubility value of carbohydrate edible films ranged from 7.53% - 9.56%. The highest solubility was obtained in the treatment of 2% sorbitol concentration which was 9.56%, while the lowest water content was produced in the treatment of 0.4% sorbitol concentration, which was 7.53%. Along with the addition of sorbitol the solubility of edible films is higher.

Solubility value comparison of edible films with previous research, called Subiyanto's research (2013), edible films made from semirefined composites of carrageenan and beeswax have solubility values ranging from 20.11 - 21.17% and Riyanto (2017) with edible films made from wheat starch producing value solubility ranged from 39.14 to 64.04%.

CONCLUSION

Based on the results of the research that has been done, it can be concluded that the addition of sorbitol concentration has a significant effect on thickness value, tensile strength, elongation percentage, water vapor transmission rate, water content, and solubility of carrageenan edible film.

Edible film with the addition of 2% sorbitol is the best concentration with a thickness value of 0.095 mm, tensile strength of 2.25 Mpa, elongation percentage of 28.89%, water vapor transmission rate of 13.93%, water content of 7.66%, and solubility of 9, 56%. 2% concentration produces edible films that almost met the standards so it is good to be used as food products packaging.

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