Edible film characteristics at different casein concentrations

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Abstract. The edible film is a coating material in the form of a sheet that is used as packaging to wrap a food product. The concentration of casein given as a base material can affect the characteristics of the edible film produced. The research objective was to determine the characteristics of the yield value, thickness and tensile strength of the edible film made using different casein concentrations. The study used 3 treatments of casein concentration, i.e., 7.5%; 8.5%, and 9.5%, respectively, and 3 replications each. The results showed that higher casein concentrations had significantly increased the edible file yield from 10.59% to 13.38. This measure was followed by the increase of thickness value of edible film produced ranging from 0.0534 to 0.0611 mm. Moreover, the high-level concentrations of casein used as material for the edible film produced a higher tensile strength value, reach 22.51 N at 9.5% casein. In conclusion, the use of casein as a material up t0 9.5% can increase the yield, thickness, and tensile strength of the edible film produced.

1. Introduction

The edible film is a coating material in the form of sheets used as packaging to wrap a food product and can be eaten at the same time [1,2]. The advantages of edible films are to improve food quality, extend shelf life, increase economic efficiency, and inhibit water vapor transfer. Moreover, the edible film acts as a protection against mechanical damage, inhibits gas exchange, prevents loss of aroma, prevents fat transfer, and as a carrier for additives [3]. The edible film has many advantages when compared to other packaging materials. One of them is that edible film can degrade quickly, thereby reducing environmental pollution due to the use of synthetic packaging. Edible films are also able to reduce the weight loss of food products during storage and increase the resistance to color, acidity, sugar, and flavor of packaged materials [4]. Edible films can be manufacture from various materials, for example, the hydrocolloid, lipid, and composite groups of both materials [5]. Hydrocolloid, a water-soluble polymer, can form colloids or form a gel from the solution. The hydrocolloid group dwells of proteins and polysaccharides [6]. Edible films made of protein are better at inhibiting water vapor, gas, or solutes and are also more biodegradable thereby reducing environmental problems [7]. One of the proteins that can be used in making edible films is casein. Casein is the main milk protein that mostly contains glutamine amino acid produced a special characteristic i.e. difficult to break down in high temperatures. Referring to these features, casein is commonly used as the main material for

edible film manufacturing that can produce certain characteristics. The characteristics of the edible film are influenced by the base material used [8]. The concentration of casein given as the main material is assumed can affect the characteristics of the edible film produced. Therefore, the objective of the research was to elucidate the effect of the casein concentration on the yield, thickness, and tensile strength of the edible film.

2. Methods

2.1. Research procedure

The casein (7.5; 8.5 and 9.5%) was mixed with distilled water in Erlenmeyer covered with aluminum foil. The mixture of these ingredients is then dissolved at a temperature of 95±2°C for 30 min with a magnetic stirrer. About 25 minutes after reaching a temperature of 95°C, glycerol was added and stored for 1 hour at room temperature (22°C).

The edible solution is then flattened until the same thickness is obtained. The next stage was to put the solution in the oven for 5 hours at a temperature of 50°C. The dry edible films were aerated for about 1 hour before being carefully removed. Edible films were stored in food wrapping paper for 2 days at 27°C before measurement [9].

2.2. The edible film characteristics measurement

There were three characteristics of the edible film measured in this research i.e., the yield, thickness, and tensile strength of the edible film. The is calculated as the percentage of edible film weight to edible film solution weight [10]. The thickness of the edible film was measured using a micrometer (accuracy 0.01 mm) at five different areas of the edible film [11]. The tensile strength (N) was obtained using digital gauge HF 500 (sample dimension was 8x3 cm^3) [12].

2.3. Statistic analysis

All data collected were subjected to one way ANOVA procedure of SPSS (SPSS version 21), followed by a Duncan's-multiple-area test to separate differences among means [13].

3. Results and discussion

3.1. Edible film yield

The yield is the ratio between the weight of the edible film and the weight of the edible film solution. The average yield of edible films with different casein concentration treatments was between 10.59–13.38% (figure 1). Using a higher level of up to 9.5% of casein was significantly increased the yield of edible film produced. The yield of the edible film is influenced by the amount of water, the type and composition of the raw materials used. In research of Hakim (2015) using whey Dangke as a base ingredient and added sorbitol (35%), produce an average edible film yield of 6.27–10.44% [14]. While Fatma et al (2015) reported that using a combination of whey and variations of the glycerol concentration obtained an average yield of 7.26 to 7.87% [10].

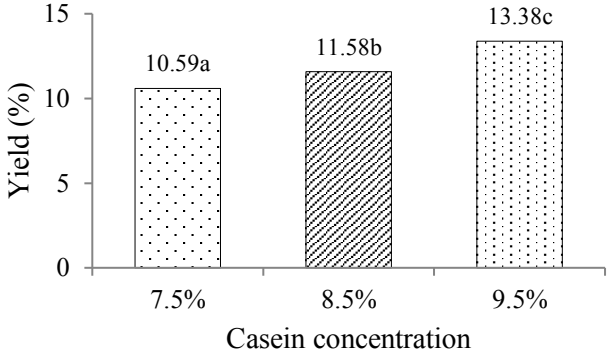

Figure 1. The yield (%) of edible film.

Casein is divided into two parts, hydrophobic and hydrophilic. The hydrophilic part of casein can bind with water to form an edible film. The higher the casein concentration, the higher water content trapped during the gelatinization process, thus increased the yield of edible film produced [15].

The yield value was altered by the water content in the edible film solution. The more casein used, the lower the amount of unbound water that would experience evaporation during the drying process [16]. Water is one of the factors that determine the value of the yield. The more free water, the lower the yield value.

3.2. Thickness

Thickness is a physical characteristic of the edible film whose value is influenced by the concentration of hydrocolloid forming the edible film and the size of the glass plate. The results of the study on the effect of casein concentration and volume of different edible solutions on the thickness of the edible film are presented in figure 2.

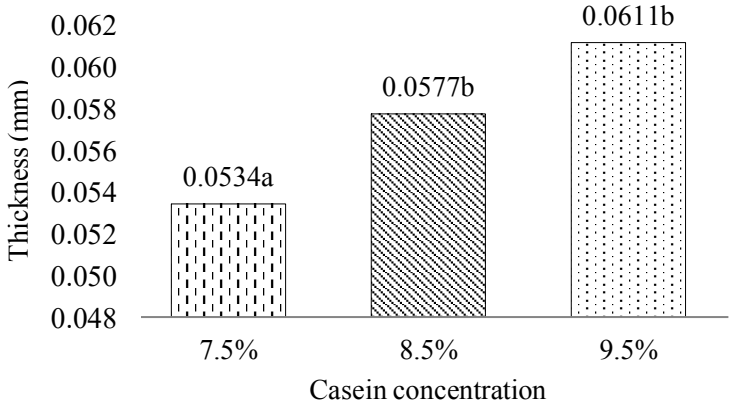

Figure 2. Thickness (mm) of edible film produced from different casein concentrations.

The average thickness of the edible film produced with different casein concentration treatments was between 0.0534–0.0611 mm. The thickness of the edible film is influenced by the type and composition of the material used. Several studies have shown almost a similar value as this study [17]. The raw material for Kimpul starch, which was incorporated with potassium sorbate, showed that the thickness of the edible film produced ranged from 0.065–0.081 mm. Sara (2015) using whey and agar using the addition of sorbitol as a plasticizer has a thickness of 0.029–0.042 mm [18].

The results of the analysis of variance showed that the concentration of casein had a significant effect ($P<0.05$) on the thickness of the edible film. The thickness of the edible film using a casein

concentration of 7.5% was significantly lower than the casein concentration of 8.5%. However, there were no differences between concentrations of 8.5 and 9.5%. Fatma et al (2015) reported that the thickness of the edible film is highly dependent on the composition, properties, and content of the constituent polymers [10]. Sara (2015) also confirmed the thickness is influenced by the properties and composition of the materials used in making edible films [18].

The thickness of the edible film is also affected by viscosity. Giving different casein concentrations will affect the thickness of the edible film. In the treatment of casein concentrations of 8.5 and 9.5%, the solution was thicker when compared to the casein concentration of 7.5%. The higher the presence of complex compounds in casein, it will play a role in increasing the viscosity of the edible solution. High viscosity causes more hydrogen bonds to occur so that more gel is formed. The gel is formed from water which binds to the casein. Hydrogen bonds can occur between water molecules with amino groups and carboxylic acids in proteins, due to the attractive forces between parts of the protein chain and water, proteins are easily dispersed in the colloid form [16]. One of the factors that can affect the thickness of the edible is the viscosity of the edible solution [19]. Viscosity is positively correlated with the number of solids in the solution. The higher the number of solids, the viscosity will increase.

3.3. Tensile strength

To be noted in particular is the tensile strength is the maximum tension that can be achieved until the edible film is torn before tearing. The results of the study on the effect of different casein concentrations and edible solution volumes on the tensile strength of edible films are presented in figure 3.

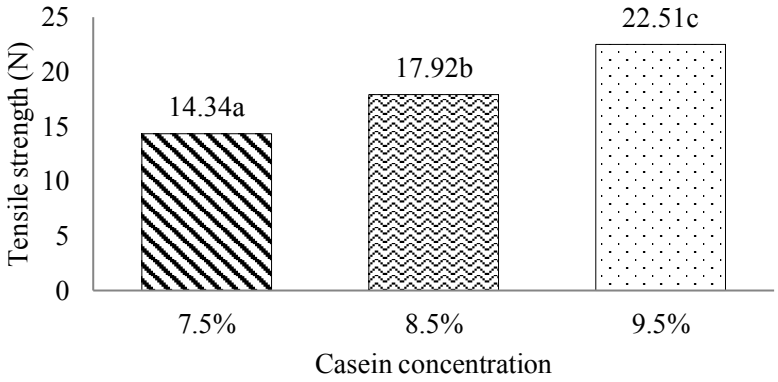

Figure 3. Tensile Strength (N) edible film

Figure 3 clearly showed that the average tensile strength of edible films produced with different casein concentrations was between 14.34–22.51 N. This can be caused by the raw materials used in making edible films. According to Sara (2015) using whey and with a concentration of 10, 20, 30, 40 and 50% sorbitol, having an average tensile strength of 10.30–12.30 N [18]. Fatma et al (2015) sing a combination of whey and agar with the addition of variations in the concentration of glycerol obtained an average tensile strength of 4.47–12.98 N [10].

The analysis of variance showed that the concentration of casein had a significant effect on the tensile strength of the edible film. The results of the further test of casein concentration treatment showed that each casein concentration treatment experienced a difference in tensile strength between one another. The increase in the concentration of casein used in making edible films causes the tensile strength of the edible films to increase. This is due to the increase in compounds that bind to the edible film. According to Guilbert and Biquet (1990) the number of bonds formed on the edible film will increase the tensile strength so that the ability to break apart is even greater and it is resistant to fracture [20].

The tensile strength of the edible film is also altered by the thickness of the edible film. The increase in casein concentration and volume of the edible solution caused the thickness of the edible film to increase. This increase is related to the increase in molecular weight in the edible film. The increase in molecular weight occurs due to the increase in the number of casein molecules that bind to the edible film. According to Santoso et al (2012) the thickness of the edible film has a positive correlation with tensile strength [21]. The thicker the edible film, the higher the tensile strength because the thickness is associated with increasing molecular weight. The tensile strength of the edible film is influenced by the formulation of the material used [22].

4. Conclusion

All these studies increasing the concentration of casein can increase the yield value, thickness, and tensile strength of the edible film.

References

[1] Robertson L G 1992 *Food Packaging Principles and Practice* (New York: Marcell Dekker. Inc)
[2] Maruddin F, Malaka R, Baba S, Amqam H, Taufik M and Sabil S *IOP Conf. Ser.: Earth Environ. Sci.* **492** 012043
[3] Kumalasari K 2005 *Pembuatan dan Karakterisasi Edible Film dari Pati Bonggol Pisang dengan Penambahan Plasticizer Gliserol dan Propilen Glikol* (Bogor: Institut Pertanian Bogor)
[4] Sothornvit R and Krochta M J 2000 Water vapor permeability and solubility of films from hydrolyzed whey protein *J. Food Sci.* **65** 700–3
[5] Prasetyaningrum A, Rokhati N, Kinasih D N and Wardhani F D N 2010 Karakterisasi bioactive edible film dari komposit alginat dan lilin lebah sebagai bahan pengemas makanan biodegradable *Seminar Rekayasa Kimia dan Proses* **2** 1411–4216
[6] Renata C, Reis D, Devilla I A, Oliveira G H H, Corrêa P C, Ascheri D P R, Souzay A B M and Servulo A C O 2014 Mechanical properties, permeability and solubility of films composed of yam starch and glycerol *Interciencia* **39** 410–5
[7] Yoshida M P and Antunes A J 2004 Characterization of whey protein emulsion films *Brazilian J. Chem. Eng.* **21** 247–52
[8] Damat 2008 Efek jenis dan konsentrasi plasticizer terhadap karakteristik edible film dari pati garut butirat *J. Agritek.* **16** 333–9
[9] Anugrahati N A 2003 Sifat-sifat komposit edible film dari pektin albedo semangka (Citrullus vulgaris Schard) dan tapioka *J. Ilmu dan Teknol. Pangan* **1** 1–15
[10] Fatma, Malaka R and Taufik M 2015 Karakteristik edible film berbahan whey dangke dan agar dengan menggunakan gliserol dengan persentase berbeda *JITP* **4** 63–9
[11] Setiani W, Sudiarti T and Rahmidar L 2013 Preparasi dan karakterisasi edible film dari poliblend pati sukun-kitosan *J. Teknosains Pangan* **3** 100–9
[12] Bourtoom T 2008 Plasticizer effect on the properties of biodegradable blend film from rice starch-chitosan *J. Sci. Technol.* **30** 149–65
[13] Gaspersz V 1994 *Metode Perancangan Percobaan* (Bandung: Armico)
[14] Hakim M Q 2015 *Karakteristik Edible Film dari Whey Dangke yang Ditambahkan Level Agar yang Berbeda* Skripsi (Makassar: Universitas Hasanuddin)
[15] Kusumaningtyas E 2013 Peran peptida susu sebagai antimikroba untuk meningkatkan kesehatan *Wartazoa* **23** 63–75
[16] Gaman P M and Sherrington 1994 *Pengantar Ilmu Pangan Nutrisi dan Mikrobiologi* (Yogyakarta: Gajah Mada University Press)
[17] Warkoyo, Rahardjo B, Marsono D W and Karyadi J N W 2014 Sifat fisik, mekanik dan barrier edible film berbasis pati umbi kimpul (*Xanthosoma sagittifolium*) yang diinkorporasi dengan kalium sorbet *Agritech*. **34** 72–81
[18] Sara N E M 2015 *Karakteristik Edible Film Berbahan Dasar Whey Dangke dan Agar dengan Penambahan Konsentrasi Sorbitol* Skripsi (Makassar: Universitas Hasanuddin)

[19] Rachmawati E and Suryani L 2011 Optimasi Proporsi Campuran Gluten dan Gum Arab Serta Penambahan Asam Stearat dalam Pembuatan Edible Film dan Aplikasinya untuk Pelapisan Kacang Bawang Rendah Lemak *Prosiding Seminar Nasional* (Surakarta: Universitas Slamet Riyadi) pp 98–106
[20] Guilbert S and Biquet B 1990 *Edible Film and Coating in Food Packaging Technology* (New York: VCH Publishers Inc.)
[21] Santoso B, Herpandi V, Ariani and Pambayun R 2012 Karakteristik edible film dari kacang ekstrak kacang kedelai dengan tambahan tepung tapioka dan gliserol sebagai bahan pengemas makanan. *J. Tek. Kim. USU* **2** 198–201
[22] Suryaningrum D T H, Basmal J and Nurochmawati 2005 Studi pembuatan edible film dari karaginan *Jurnal Penelitian Perikanan Indonesia* **11** 1–13