The Effect of Variations in Concentration Plasticizer Sorbitol on the Characteristics of Edible Film Made from Tilapia Fish Skin Gelatin (*Oreochromis niloticus*)

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Abstract- Gelatin is a polypeptide produced from the hydrolysis of collagen. Gelatin can be made from fish skin, one of which is tilapia skin (*Oreochromis niloticus*). Gelatin is a hydrocolloid (protein) and is one of the components that can be used as material of edible films. Edible film is defined as a thin layer from edible material and is an alternative packaging that is biodegradable. In the making of edible films made from hydrocolloids, the quality of the film is often fragile, so it requires additional materials that function as plasticizers. A plasticizer is a liquid with a high boiling point that will give it soft and flexible properties when mixed with polymers. One of the plasticizers that can be used is sorbitol. The advantage of sorbitol as a plasticizer is that it can inhibit the absorption of water vapor in edible film, and will improve the physico-chemical characteristics of edible film. The results showed that the optimal concentration of sorbitol plasticizer to produce edible film from tilapia skin gelatin (*Oreochromis niloticus*) with the best characteristics is a concentration of 2.2% sorbitol with physico-chemical characteristics including the tensile strength of 4.78 ± 2.88 Mpa , elongation 127.74±32.50%, thickness 0.096±0.008 mm, water vapor transmission rate 27.78±17.15 g/m²/day and water content of 13.19±0.62% with the highest amino acid content namely Glycine of 154283.75 mg/kg, Proline content of 79273.50 mg/kg while the lowest amino acid was Tyrosine at 3522.67 mg/kg.

Index Terms- gelatin, *edible film*, sorbitol, amino acid

I. Introduction

Fish skin consists of a dermis layer which has a lot of collagen fibers. Skin waste contains collagen and produces gelatin from the hydrolysis of collagen (Ayunin and Suprayitno, 2019). Fish skin that can be used as an option for gelatin is tilapia skin. Use of tilapia skin as gelatin because of its collagen content, processing tilapia into filet products leaves tilapia skin byproducts that have the potential to be used as a good and safe source of collagen (Prastyo *et al*., 2020). Gelatin is a protein obtained from partial hydrolysis of collagen fiber protein which can be used as a multipurpose product, both in the food and non-food industries. Gelatin can be used as a stabilizer, gelling agent, binder, thickener, emulsifier, adhesive, and film former (Afrian and Suprayitno, 2019). Gelatin can be used as a raw material in the making of edible films.

Edible film is an alternative packaging because it is biodegradable and acts as a food carrier and facilitates food handling. The use of edible films for packaging food products can slow down quality degradation, because the edible film has a function as a barrier to the diffusion of oxygen gas, carbon dioxide, and water vapor (Alfian *et al*., 2020). In the making of edible films, it is necessary to add a plasticizer, one of the plasticizers that can be used is sorbitol. Sorbitol is a plasticizer that can reduce brittleness, increase flexibility and film resistance. The use of sorbitol as a plasticizer is known to be more effective, because it produces films with lower water vapor (Hidayati *et al*., 2015). This research is used to provide information about the optimal concentration of sorbitol in edible films so that edible films with the best physico-chemical characteristics can be produced which can later be applied and have a good effect on packaged products.

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II. MATERIALS AND METHODS

2.1 Material

The materials used in this research include materials for making gelatin and edible films. The ingredients used to make gelatin are tilapia skin, aquades, citric acid and water. The ingredients for making edible films are tilapia skin gelatin, aquades and sorbitol plasticizer.

The method used in this research is the experimental method. The research design used in this study was Completely Randomized Design with 3 treatments namely variations of sorbitol concentration 0.2%, 1.2% and 2.2% with 6 replications.

2.1.1 Gelatin Production Process

Tilapia skin was washed with running water and soaked in warm water at 50°C for 30 minutes. Furthermore, the skin is drained and weighed as much as 100 grams, then cut into small pieces of ± 1 cm². After that, the fish skin was soaked in a 1% concentration of citric acid for 24 hours with a ratio of skin and a solution of 1:3 (w/v). The fish skin was washed until the pH was neutral. The next step is extraction using a waterbath at 60-70ºC for 6 hours with a ratio of fish skin and aquades was 1:3 (w/v). The filtrate obtained from the extraction process was then filtered using a white cloth. The filtrate was poured into a baking sheet and to be dried using a dehydrator at a temperature of 50-60ºC for 8-12 hours. After drying, it is mashed using a blender to obtain gelatin powder.

2.1.2 Edible Film Production Process

The procedure for making edible films, the first stage was to prepare the tilapia skin gelatin. Then, 5 g of gelatin was weighed and added with 100 mL of aquades, put in a beaker glass. Then stirred and heated using a hotplate at a temperature of 60ºC for 15 minutes. Each homogeneous edible film solution was then added with sorbitol plasticizer with variations concentrations of 0.2%, 1.2% and 2.2%, then stirred and reheated on a hotplate at 60ºC for 15 minutes. Next, the solution is poured on a baking sheet and leveled so that the thickness is the same. The edible film was then dried using an oven at temperature of 65ºC for 18 hours. After drying, the film was cooled to room temperature. When it has cooled, the film is removed from the mold and placed in a desiccator before testing.

III. RESULT AND DISCUSSION

3.1 Tensile Strength

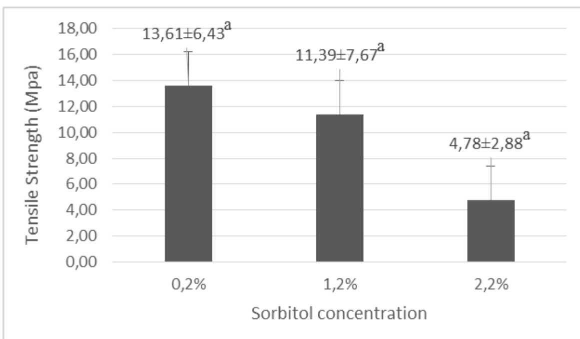

Figure 1. The Result of Tensile Strength

The tensile strength values of edible film ranges from 4.78 Mpa to 13.61 Mpa. The highest tensile strength value was at a concentration of 0.2% sorbitol at 13.61 Mpa, while the lowest tensile strength value was at a concentration of 2.2% sorbitol at 4.78 Mpa. Based on Figure 1, it shows that the higher the concentration of sorbitol added, the lower tensile strength of the edible film. This is in according with Sari *et al*., (2019), that the addition of more sorbitol will reduce the tensile strength value, due to a decrease in intermolecular forces on the polymer.

3.2 Elongation

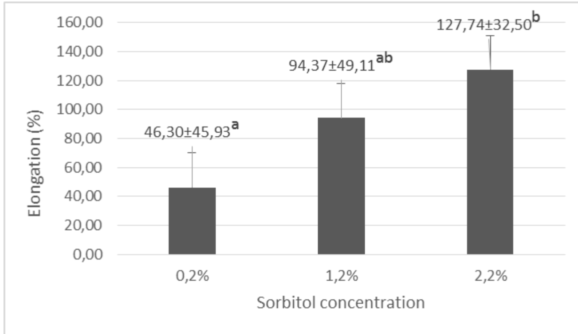

Figure 2. The Result of Elongation

Elongation values of edible film range from 46.30% to 127.74%. The highest elongation value was at 2.2% sorbitol concentration of 127.74%, while the lowest elongation value was at 0.2% sorbitol concentration of 46.30%. Based on Figure 2, it shows that the higher concentration of sorbitol added, the higher elongation value of the edible film. Elongation will increase with the addition of sorbitol, where sorbitol has a function to reduce the hydrogen bonds formed so as to increase the distance between molecules (Oetary *et al*., 2019).

3.3 Thickness

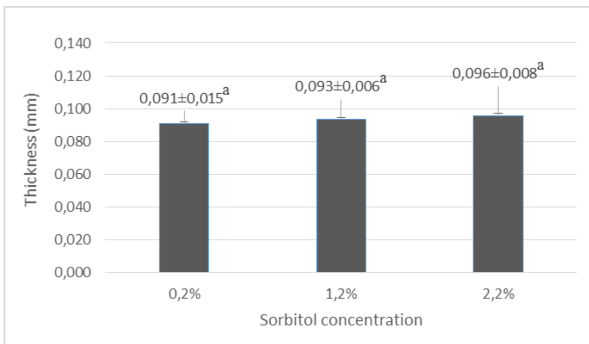

Figure 3. The Result of Thickness

Thickness of edible film ranges from 0.091 mm to 0.096 mm. The highest thickness value was at 2.2% sorbitol concentration of 0.096 mm, while the lowest thickness was 0.2% sorbitol concentration of 0.091 mm. Based on Figure 3, it shows that the higher concentration of sorbitol added, the thicker edible film produced. The more amount of sorbitol added, the thicker edible film produced because the final total volume increased due to the increase in total solids in the solution (Sari *et al*., 2019). The thickness of the edible film is influenced by the addition of the plasticizer sorbitol, the total solids contained in the suspension, the volume of the solution, and the area of the mold used.

3.4 Water Vapor Transimission Rate

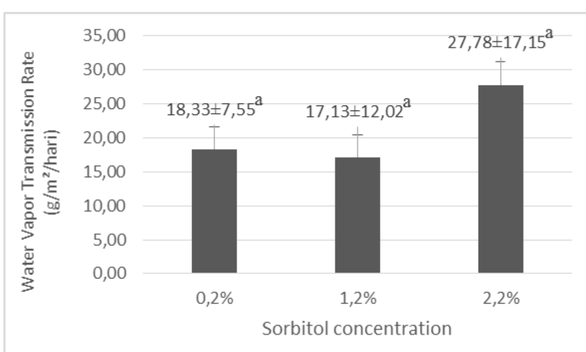

Figure 4. The Result of Water Vapor Transmission Rate

The value of the water vapor transmission rate ranged from 17.13 g/m²/day to 27.78 g/m²/day. The highest water vapor transmission rate was at a concentration of 2.2% sorbitol at 27.78 g/m²/day, while the lowest water vapor transmission rate was at a

1.2% sorbitol concentration at 17.13 g/m²/day. Sorbitol has hydrophilic properties so that water molecules easily pass through the film. The more plasticizer content in a film, the polymer structure will be more open and water molecules will more easily pass through the pores of the film. The value of the water vapor transmission rate of edible films is influenced by the properties of the polymer used, the more hydrophilic and cationic a polymer, the higher value of the water vapor transmission rate of the film (Darni *et al*., 2017).

3.5 Water Content

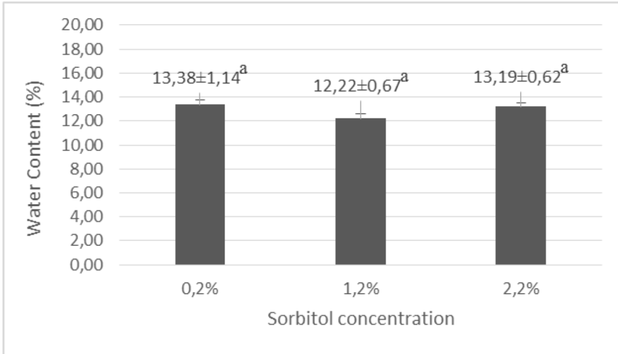

Figure 5. The Result of Water Content

The water content of edible film ranges from 12.22% to 13.38%. The highest water content value was at a sorbitol concentration 0.2% of 13.38% while the lowest water content was at a sorbitol concentration 1.2% of 12.22%. The high water content of edible films is due to the addition of sorbitol because sorbitol functions as a plasticizer as well as a humectant and hygroscopic additive so that it can maintain the water content in a material (Tanjung *et al*., 2020).

3.6 Amino Acid Profile

No	Parameter	Unit	Result
1	L-Glutamic acid	mg/kg	39287.64
2	L-Phenylalanine	mg/kg	82511.30
3	L-Isoleucine	mg/kg	31960.01
4	L-Valin	mg/kg	10183.91
5	L-Serin	mg/kg	19101.37
6	L-Alanin	mg/kg	86118.80
7	L-Arginine	mg/kg	102554.59
8	Glycine	mg/kg	254093.35
9	L-Lysine	mg/kg	30150.28
10	L-Aspartic Acid	mg/kg	43226.61
11	L-Leucine	mg/kg	26847.11
12	L-Tyrosine	mg/kg	8391.89
13	L-Prolin	mg/kg	119864.38
14	L-Threonin	mg/kg	32003.59
15	L-Histidine	mg/kg	11460.92

The highest amino acid content in tilapia skin gelatin was Glycine at 254093.35 mg/kg and the lowest was L-Tyrosine at 8391.89 mg/kg. While the amino acid content of L-Proline is 119864.38 mg/kg. The amino acid gelatin has a Gly-X-Y rearrangement unit, where X is proline and Y is hydroxyproline. The amino acid composition of gelatin always contains high levels of glycine and proline (Firdayanti and Suprayitno, 2019). Tilapia skin gelatin is then used as a raw material in producing edible films. The results of the amino acid profile of edible films are presented as follows:

No	Parameter	Unit	Result
1	L-Glutamic acid	mg/kg	24083.63
2	L-Phenylalanine	mg/kg	57691.41
3	L-Isoleucine	mg/kg	14117.89
4	L-Valin	mg/kg	6977.05
5	L-Serin	mg/kg	12839.87
6	L-Alanin	mg/kg	61469.07
7	L-Arginine	mg/kg	55671.61
8	Glycine	mg/kg	154283.75
9	L-Lysine	mg/kg	19159.36
10	L-Aspartic Acid	mg/kg	31923.68

11	L-Leucine	mg/kg	17814.75
12	L-Tyrosine	mg/kg	3522.67
13	L-Prolin	mg/kg	79273.50
14	L-Threonin	mg/kg	19190.62
15	L-Histidine	mg/kg	5615.91

The highest amino acid in edible film is Glycine at 154283.75 mg/kg and the lowest amino acid is L-Tyrosine at 3522.67 mg/kg. The amino acid content of L-Proline in the edible film was 79273.50 mg/kg. The high amino acid Glycine and Proline in edible film is due to the basic material used is gelatin, where gelatin itself has high amino acid content of glycine and proline.

The content of amino acids in the raw material, namely gelatin, will affect the tensile strength of the edible film. The influential amino acids are glycine and proline, the higher the glycine and proline content, the higher gel strength of edible film. This is in accordance with Utomo and Suprayitno (2019), gelatin with high glycine and proline content as amino acids will have a higher gel strength. The higher gel strength value in gelatin, the higher tensile strength value will be. This statement is in accordance with Wijayani *et al*., (2021), where the higher of the gelatin gel strength used as raw material, so higher the tensile strength value of the edible film. The high gel strength of the raw material indicates that the gelatin has strong intermolecular forces between polymer chains.

IV. CONCLUSION

Sorbitol concentration of 2.2% is the optimal concentration to produce edible film from tilapia skin gelatin (*Oreochromis niloticus*) with the best characteristics with physico-chemical characteristics including tensile strength values of 4.78±2.88 Mpa, elongation 127, 74±32.50%, thickness 0.096±0.008 mm, water vapor transmission rate 27.78±17.15 g/m²/day and water content of 13.19±0.62% with the highest amino acid content, namely Glycine 154283.75 mg/kg, Proline content is 79273.50 mg/kg while the lowest amino acid is Tyrosine at 3522.67 mg/kg.

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