

The Effect of Glycerol Plasticizer Concentration on Physical-Chemical Characteristics of Edible Film from Catfish Skin Gelatin (*Pangasius* sp.)

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Abstract- Gelatin is a protein derivative compound extracted from animal collagen through hydrolysis and drying process. An edible film can be made from three different types of constituent materials, namely hydrocolloids, lipids, and composites of both. An edible film is an edible thin layer, which is formed to coat food components, and placed on top of or between the food components. One type of colloid that can be used to make the edible film is gelatin. A plasticizer is a substance with low molecular weight, that can enter the protein-polymer matrix, so it increases the flexibility and forming capability of the film. Glycerol is included as a type of plasticizer, which has a low molecular weight, is hydrophilic, adding polarity, and is easily soluble in water. The best edible film made from catfish skin gelatin was obtained at glycerol plasticizer concentration of 1.5% with physical and chemical characteristics including tensile strength of 6.22 MPa, elongation of 54.46%, the thickness of 0.14 mm, water vapor transmission rate of 189.45 g/m²/day, and water content of 10.46%. The analysis results of the amino acid profile showed that the highest amino acid content of the edible film was glycine at 196518.28 mg/kg, and the lowest amino acid content of the edible film was L-Tyrosine at 5370.36 mg/kg.

Index Terms- gelatin, edible film, glycerol, amino acid profile

I. INTRODUCTION

Fish waste is a type of waste that has not been used optimally. Generally, the inedible portion of fish can reach 35%. Whereas, there are skin and bones from fish waste that contain collagen. If it is processed further, it can produce gelatin (Ismail and Suprayitno, 2019). Fish skin that can be used as an alternative for making gelatin is catfish skin. Gelatin is a protein obtained from partial hydrolysis of collagen from skin, white connective tissue, and animal bones (Axiomawan and Suprayitno, 2019). Gelatin is a protein macromolecule that has functional properties and has been widely used in the pharmaceutical, food, and non-food fields. Gelatin has hydrocolloid properties, which can form a thin elastic layer, forming a transparent and strong film, and has high digestibility (Apriyani et al., 2020). Based on these properties, gelatin has the potential as a raw material for making an edible film.

The edible film is an edible thin layer, which is formed to coat food components, and placed on top of or between the food components. In food products, this thin layer serves to inhibit the transmission of water vapor and gas exchange, preventing loss of aroma and transferring fat, improving physical characteristics, as a carrier for additives, and also it is environmentally friendly (Miwada et al., 2015). The edible film, which is formed from a pure polymer, is brittle because of its low tensile strength. So, it is necessary to add plasticizer materials to increase its flexibility. A plasticizer is a substance with low molecular weight, that can enter the protein-polymer matrix, so it increases the flexibility and forming capability of the film (Satriawan and Iling, 2017). The physical characteristics of the edible film are influenced by the types of materials and plasticizer concentration. Glycerol is included as a type of plasticizer, which has a low molecular weight, is hydrophilic, adding polarity, and is easily soluble in water (Prasetyo and Laila, 2018).

II. MATERIALS AND METHODS

2.1 Material

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The research materials used consisted of materials for making gelatin, which were catfish skin obtained from PT. Dimas Reiza Perwira Surabaya, citric acid ($C_6H_8O_7$), aquadest, water, pH paper, aluminum foil, and calico fabric. The materials for making the edible film were catfish skin gelatin, aquadest, glycerol, and aluminum foil.

The method used in this study was the experimental method. The treatments used in this study were variations of glycerol plasticizer concentration. The experimental design used in this study was a Completely Randomized Design with 3 treatments and 6 replications. The glycerol plasticizer concentration used was 0.5%, 1%, and 1.5%.

2.1.1 Making Gelatin

The making of gelatin started with the preparation of the raw material, which was catfish skin. After that, the fish skin was soaked in warm water at 50°C for 30 minutes to remove dirt and remaining meat that was still attached. The clean fish skin was then weighed at 100 g and cut into small pieces of 1×1 cm. Furthermore, the fish skin was soaked using a 1% concentration of citric acid in a ratio of 1:3 (w/v) for 24 hours. When it was finished, the fish skin was rinsed using running water until the pH was neutral. Then, the fish skin was extracted with waterbath at 60-70°C for 6 hours. The ratio of catfish skin with distilled water was 1:3 (w/v). The next step was filtering the gelatin solution using calico fabric. After that, the obtained gelatin solution was poured into a baking pan. Then, a drying process was conducted using a dehydrator at 50-60°C for 8-12 hours to dry. Furthermore, the resulting gelatin sheets were mashed using a blender and stored in a desiccator for further analysis.

2.1.2 Making Edible Film

The first thing to do in making the edible film was to prepare the catfish skin gelatin. Catfish skin gelatin was weighed at 5 g and then dissolved using 100 mL of distilled water. The gelatin solution was then heated by a hot plate at 60°C for 15 minutes and stirred using a magnetic stirrer. Then, the variation of glycerol concentration was added according to the treatment, which was 0.5%; 1%; and 1.5%. After all the materials were mixed, it was stirred using a magnetic stirrer and reheated at 60°C for 15 minutes until homogeneous. After that, the mixture was poured into an 18×18 cm baking pan. Then, the drying process was conducted by placing it in an oven at a temperature of 65°C for 18 hours. When it was finished, it was left at room temperature and was conducted the peeling process until the film took off from the baking pan. Furthermore, the film was stored in a desiccator and was ready for the test analysis.

III. RESULT AND DISCUSSION

3.1 Tensile Strength

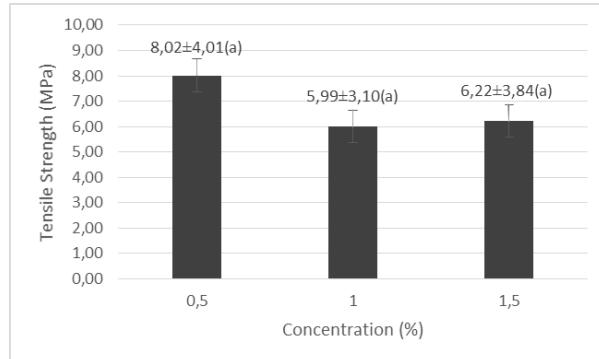


Figure 1. The Result of Tensile Strength

The tensile strength value of edible film with different glycerol plasticizer concentrations produced different tensile strength values. At glycerol plasticizer concentration of 0.5%, it was obtained the tensile strength of 8.02 MPa, a 1% concentration was obtained of 5.99 MPa, and a 1.5% concentration was obtained of 6.22 MPa. The highest tensile strength value of the edible film was obtained at glycerol plasticizer concentration of 0.5% with the tensile strength value of 8.02 MPa, and the lowest tensile strength value was obtained at glycerol plasticizer concentration of 1% with the tensile strength value of 5.99 MPa. Glycerol can reduce the interaction between molecules and weaken the tensile strength of the edible film, so it is obtained the elastic film (Wattimena et al., 2016).

3.2 Elongation

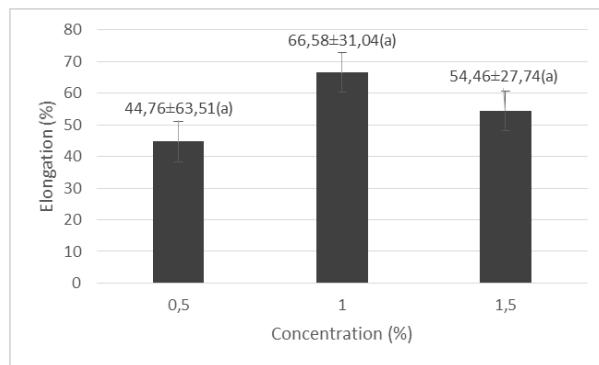


Figure 2. The Result of Elongation

Elongation value of edible film with the addition of glycerol plasticizer concentration of 0.5% was obtained of 44.76%, a 1% concentration was obtained of 66.58%, and a 1.5% concentration was obtained an elongation value of 54.46%. The highest elongation value was obtained at glycerol plasticizer concentration of 1% with an elongation value of 66.58%, and the lowest elongation value was obtained at glycerol plasticizer concentration of 0.5% with an elongation value of 44.76%. According to Harianingsih et al., (2017), glycerol as a plasticizer can reduce internal hydrogen bonds by increasing the free space between molecules, so it reduces stiffness and increases film flexibility.

3.3 Thickness

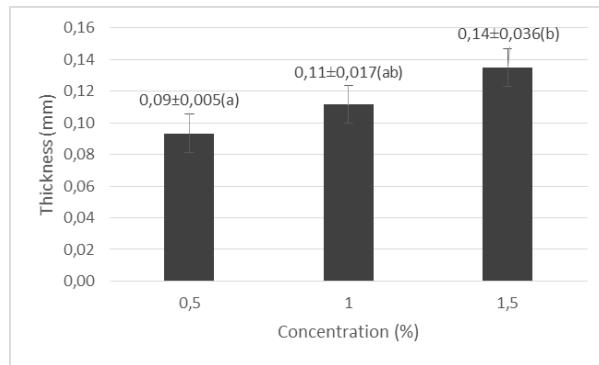


Figure 3. The Result of Thickness

Thickness value with different glycerol plasticizer concentrations produced different thickness values. At glycerol plasticizer concentration of 0.5%, it was obtained the thickness of 0.09 mm, a 1% concentration was obtained of 0.11 mm, and a 1.5% concentration was obtained the thickness of the edible film of 0.14 mm. The highest thickness of the edible film was obtained at glycerol plasticizer concentration of 1.5% with the thickness of 0.14 mm, and the lowest thickness was obtained at glycerol plasticizer concentration of 0.5% with the thickness of 0.09 mm. The thickness value of edible film showed an increase in glycerol plasticizer concentration given.

3.4 Water Vapor Transmission Rate

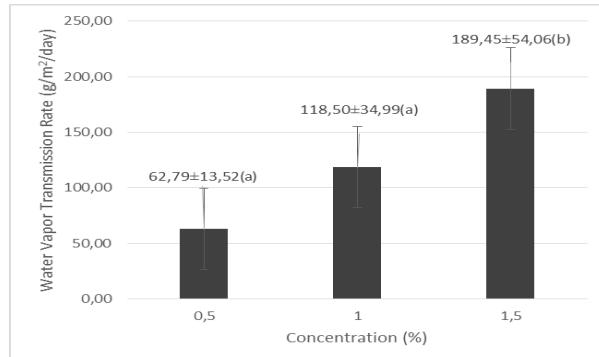


Figure 4. The Result of Water Vapor Transmission Rate

Value of water vapor transmission rate of the edible film with the addition of glycerol plasticizer concentration of 0.5% was obtained of 62.79 g/m²/day, a 1% concentration was obtained of 118.50 g/m²/day, and a 1.5% concentration was obtained of 189.45 g/m²/day. The highest value of water vapor transmission rate of the edible film was obtained at glycerol plasticizer concentration of

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1.5% at 189.45 g/m²/day, and the lowest value of water vapor transmission rate was obtained at glycerol plasticizer concentration of 0.5% at 62.79 g/m²/day. Water vapor permeability is a measure of a material that can be passed by water vapor. The rate of water vapor transmission is influenced by factors, such as temperature, Rate Humidity (RH), the thickness of film, type and concentration of plasticizer, and the properties of basic materials of making the edible film (Utami et al., 2017).

3.5 Water Content

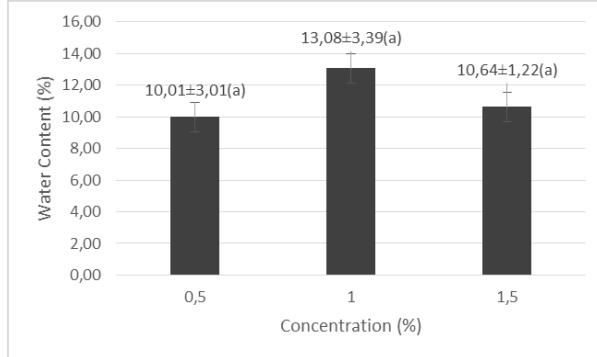


Figure 5. The Result of Water Content

The water content of the edible film with the addition of glycerol plasticizer concentration of 0.5% was obtained of 10.01%, a 1% concentration was obtained of 13.08%, and a 1.5% concentration was obtained the water content of 10.64%. The highest water content value of the edible film was obtained glycerol plasticizer concentration of 1% with the water content of 13.08%, and the lowest water content was obtained at glycerol plasticizer concentration of 0.5% with the water content of 10.01%. According to Winarti et al., (2019), glycerol has the ability as a humectant that can bind water. When drying, the water is difficult to evaporate.

3.6 Amino Acid Profile

No.	Parameter	Unit	Result
1	L-Serine	mg/kg	35052.55
2	L-Glutamic Acid	mg/kg	75943.99
3	L-Phenylalanine	mg/kg	21015.26
4	L-Isoleucine	mg/kg	13970.43
5	L-Valin	mg/kg	22852.90
6	L-Alanine	mg/kg	81016.25
7	L-Arginine	mg/kg	84398.88
8	Glycine	mg/kg	230957.45
9	L-Lysine	mg/kg	35174.41
10	L-Aspartic Acid	mg/kg	37443.68
11	L-Leucine	mg/kg	28407.84
12	L-Tyrosine	mg/kg	5829.55
13	L-Proline	mg/kg	117204.43
14	L-Threonine	mg/kg	27911.79
15	L-Histidine	mg/kg	7746.23

The amino acid profile can be detected in catfish skin gelatin. There were 15 types of amino acids. The highest amino acid content in catfish skin gelatin was glycine at 230957.45 mg/kg, followed by L-Proline at 117204.43 mg/kg, and the lowest amino acid was L-Tyrosine at 5829.55 mg/kg. Catfish skin gelatin was then used as the main material in making the edible film. The amino acid profile of edible film is as follows.

No.	Parameter	Unit	Result
1	L-Serine	mg/kg	30609.12
2	L-Glutamic Acid	mg/kg	69359.60
3	L-Phenylalanine	mg/kg	22135.10
4	L-Isoleucine	mg/kg	11515.19
5	L-Valin	mg/kg	18879.13
6	L-Alanine	mg/kg	70518.85
7	L-Arginine	mg/kg	76167.41
8	Glycine	mg/kg	196518.28
9	L-Lysine	mg/kg	22169.76
10	L-Aspartic Acid	mg/kg	37575.90

11	L-Leucine	mg/kg	22990.44
12	L-Tyrosine	mg/kg	5370.36
13	L-Proline	mg/kg	93533.25
14	L-Threonine	mg/kg	24186.08
15	L-Histidine	mg/kg	7556.31

Based on the best treatment, the amino acid profile can be detected on edible film from catfish skin gelatin. There were 15 types of amino acids ranging from 5370.36 mg/kg to 196518.28 mg/kg. The highest amino acid content of the edible film from catfish skin gelatin was glycine at 196518.28 mg/kg and followed by L-Proline at 93533.25 mg/kg while the lowest amino acid of the edible film was L-Tyrosine at 5370.36 mg/kg. The structure of edible film is dominated by amino acids which include 14% hydroxyproline, 16% proline and 26% glycine, this depends on the composition of gelatin contained in the raw material. Gelatin has a range strength, the special structure of gelatin contains hydroxylisin and hydroxyproline, which are amino acids that are not found in other proteins (Suprayitno, 2019).

Physical characteristics which was tensile strength of edible film influenced by the constituent components of the amino acids produced, especially the glycine and proline amino acids. This is in accordance with the statement of Hazirah et al., (2018), that glycine and proline amino acids play an important role in gel strength. Gelatin containing high amounts of glycine and proline amino acids has been shown to have high gel strength compared to gelatin with low glycine and proline amino acids. The higher of gelatin gel strength value used as raw material, the higher was the tensile strength value of the edible film.

IV CONCLUSION

The best edible film made from catfish skin gelatin was obtained at glycerol plasticizer concentration of 1.5% with physical and chemical characteristics including tensile strength of 6.22 MPa, elongation of 54.46%, the thickness of 0.14 mm, water vapor transmission rate of 189.45 g/m²/day, and water content of 10.46%. The highest amino acid content of the edible film was glycine at 196518.28 mg/kg, and the lowest amino acid was L-Tyrosine at 5370.36 mg/kg.

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