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THE USE OF PINEAPPLE WASTE EXTRACT ON THE EXTRACTION OF GELATIN FROM TUNA SKIN (*Thunnus albacares*)

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A B S T R A K

Hasil samping ikan tuna dalam bentuk kulit masih sangat jarang dimanfaatkan untuk produk dengan nilai ekonomis yang tinggi seperti gelatin. Namun ekstraksi gelatin dengan asam anorganik yang banyak digunakan menimbulkan beberapa masalah terutama tidak ramah terhadap lingkungan. Pemanfaatan asam organik dalam bentuk asam sitrat yang terkandung di dalam limbah nanas dapat menjadi solusi untuk permasalahan tersebut. Penelitian ini bertujuan untuk mengetahui pengaruh lama perendaman kulit ikan tuna dengan ekstrak limbah nanas terhadap sifat fisikokimia gelatin kulit ikan tuna. Rancangan percobaan yang digunakan dalam penelitian ini adalah rancangan acak lengkap (RAL) 5 perlakuan dan 3 ulangan. Perbandingan ekstrak limbah nanas dan kulit ikan tuna yang digunakan adalah 1:1 (b/v) dan lama perendaman : 0, 6, 12, 18 dan 24 jam. Hasil penelitian menunjukkan bahwa lama perendaman kulit ikan tuna dengan ekstrak limbah nanas tidak memberikan pengaruh nyata terhadap kadar air namun berpengaruh sangat nyata terhadap rendemen, kadar abu, viskositas dan nilai pH gelatin yang dihasilkan. Mutu gelatin kulit ikan tuna dengan lama perendaman ekstrak limbah nanas terbaik adalah perlakuan B (6 jam perendaman) dengan nilai sebagai berikut : rendemen 10,06%; kadar abu 6,16%; viskositas 2,31 cP; dan pH 5,21. Gelatin dari perlakuan B sudah memenuhi syarat mutu SNI dan GMIA. Hasil ini dapat menjadi alternatif produk gelatin yang tidak hanya aman untuk dimanfaatkan namun juga dapat mengurangi limbah ikan tuna dan limbah nanas yang selama ini sangat jarang untuk dimanfaatkan.

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A B S T R A C T

The by-product of tuna in the form of skin is still very rarely used for products with high economic value such as gelatin. However, the extraction of gelatin with inorganic acids that are widely used poses several problems, especially not friendly to the environment. Utilization of organic acids in the form of citric acid contained in pineapple waste can be a solution to these problems. This study aims to determine the effect of tuna skin immersion time with pineapple waste extract on the physicochemical properties of tuna skin gelatin. The experimental design used in this study was a completely randomized design (CRD) with 5 treatments and 3 replications. Comparison of pineapple waste extract and tuna skin used was 1:1 (w/v) and immersion times were: 0, 6, 12, 18 and 24 hours. The results showed that the duration of immersion of tuna skin with pineapple waste extract did not have a significant effect on the water content but had a very significant effect on the yield, ash content, viscosity and pH value of the gelatin produced. The quality of tuna skin gelatin with the best duration of immersion of pineapple waste extract was treatment B (6 hours of immersion) with the following values: yield of 10.06%; ash content of 6.16%; viscosity of 2.31 cP; and pH of 5.21. Gelatin from treatment B has met the quality requirements of SNI and GMIA. This result may become an alternative gelatin product which is not only safe to use but also can reduce tuna fish waste and pineapple waste which so far have been very rarely used

INTRODUCTION

Indonesia is one of the maritime countries that has the largest marine resources in the world. Tuna fishing production in West Sumatra has increased. One of the efforts in optimizing this by-product is to use tuna skin in the manufacture of gelatin. Gelatin is a protein derived product obtained from the hydrolysis of animal collagen contained in bones and skin, and is a compound that never occurs naturally (Gómez-Guillén et al., 2011). Fish gelatin is considered a promising alternative to gelatin of animal origin, because it does not have serious consumer problems, and can be produced economically from processing by-products (Chung, 2020).

Gelatin has distinctive properties, which can change reversibly from sol to gel, expand in cold water, form films, affect the viscosity of a material and protect colloidal systems. The nature of gelatin makes the need for gelatin in the food and non-food industries continues to increase. Gelatin in food products is often used as an emulsifier (Tan et al., 2020), surfactant (Casanova et al., 2020), biodegradable packaging material (Loo & Sarbon, 2020) and micro-encapsulation agent (García-Saldaña et al., 2016). Gelatin in non-food products is used in the pharmaceutical and medical industries, the cosmetic industry (Montero & Acosta, 2020) and the photography industry (Lombu et al., 2015; Sutra et al., 2020). In addition, gelatin is a source of biologically active peptides, some of which exhibit promising antimicrobial, antioxidant, and other functional properties (Gómez-Guillén et al., 2011).

Based on data from the Ministry of Industry, Indonesia is still importing gelatin. The increase in gelatin imports is due to changes in the lifestyle of the Indonesian people where gelatin has an important role both in terms of food and non-food (Nurilmala, Jacoeb, & Dzaky, 2017). However, gelatin imported by foreign countries is mostly made from pork skin, which is certainly a problem for the Indonesian people, whose majority are Muslims

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(Nurilmala et al., 2020). This has led to an increase in demand for gelatin from alternative raw materials (Aksun Tümerkan et al., 2019). Therefore, Indonesia is expected to become a producer of halal gelatin by utilizing fish by-products (waste) so that Indonesia can meet the consumption needs of gelatin in the domestic and foreign markets.

There are two methods used in the gelatin extraction process, namely: acid extraction and alkaline extraction. The difference between the two is in the solvent used and the gelatin product consists of type A gelatin and type B gelatin. Type A gelatin uses soft-based materials, one of which is the skin, while type B gelatin uses hard-based materials where the collagen molecules are older as in bones (Amiruldin, 2007). Several previous studies stated that the use of inorganic acids greatly affects the quality of the gelatin produced. However, the use of inorganic acids has certain problems, especially the cost is expensive and not environmentally friendly.

Several studies that have been conducted regarding the gelatin extraction process explain that the use of inorganic acids in gelatin can be replaced by using organic acids. One type of organic acid that can be used is citric acid. Citric acid is obtained from various types of biological sources, one of which is found in pineapple. Pineapple contains 78% citric acid which can be used as a solution in the extraction of gelatin. All parts of the pineapple can be utilized, both in the form of weevil and skin. The citric acid compounds contained in pineapple can break the collagen bonds in the skin when gelatin extraction is expected to produce good quality gelatin (Abidin, 2016).

This study aims to study the effect of immersion time of tuna skin (*Thunnus albacares*) with pineapple waste extract on the physicochemical properties of gelatin and to determine the duration of immersion of tuna skin with pineapple waste extract which produces the best tuna skin gelatin.

RESEARCH METHODOLOGY

Materials and tools

The raw material used in this study was tuna skin obtained from PT. Dempo Andalas Samudera, Bungus District, Padang City, West Sumatra Province and pineapple waste in the form of weevil and skin obtained from Pasar Raya, Padang City. The chemical used is Aqua DM (Bratachem).

The tools used were analytical scale (Shimadzu ATX224), knife, cutting board, 30 x 30 cm glass mold, waterbath (Memmerth WNB14), gauze, jar, mortar cup, and blender (Philips). The tools for analysis are laboratory oven (Memmert UN110), desiccator (Duran), furnace (Carbolite AAF 1100), Ostwald viscometer (Pyrex) and pH meter (Hanna Instruments).

Research design

This study used a completely randomized design (CRD) consisting of 5 treatments and 3 replications. The data obtained were analyzed using ANOVA and Duncan's New Multiple Range Test (DNMRT) advanced test at a significance level of 1%.

The treatment in this study was the immersion time of tuna skin with pineapple waste extract in the production of gelatin as follows: A = 0 hours; B = 6 hours; C = 12 hours; D = 18 hours and E = 24 hours. The ratio of tuna skin and pineapple waste extract is 1:1 (w/v).

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Research procedure

Making Liquid Extract from Pineapple Waste

Pineapple waste in the form of skin and weevil was cleaned of dirt and then washed and cut into small pieces then it was blended to form pulp and then filtered so that it is separated from the pulp. The pineapple liquid extract that had been obtained was then neatly covered and stored at room temperature (Atma et al., 2018).

Degrading Stage

The tuna skin was cleaned of scales and then washed with running water and then heated using a waterbath at 60 ºC for 1-2 minutes. Fish skin was heated with the aim of expanding the surface. After being heated, the fish skin was cut to a size of 2-5 cm (Yenti et al., 2015).

Curing Stage

At this stage, the fish skin was soaked according to the treatment, the ratio of fish skin and pineapple waste extract was 1:1 (w/v) with immersion time of 0, 6, 12, 18 and 24 hours. The fish skin that had been soaked according to treatment, was rinsed with running water until it reached a pH of 4-5 (Yenti et al., 2015).

Gelatin Extraction Stage

At this stage, the fish skin was heated in a waterbath for ±3 hours at a temperature of 60 ºC. Then the liquid gelatin was filtered and placed in a 30 x 30 cm glass mold. After that, the gelatin was dried in an oven at a temperature of 60 ºC for ±48 hours and then obtained gelatin in the form of sheets. Then the gelatin was mashed with a blender so that it becomes powdered gelatin (Sutrisno et al., 2021; Tkaczewska et al., 2018; Yenti et al., 2015). The gelatin product extracted with pineapple waste can be seen in Figure 1.

Figure 1. Gelatin from tuna fish skin

Sample Analysis

Moisture Content with the Oven Method (Andarwulan et al., 2011)

Water content analysis is a way to measure the water content contained in a food ingredient. The weight loss is measured due to the evaporation of water in the material which was dried in an oven at 105°C for 20 minutes. This method is used for all foodstuffs, unless the product is decomposed at 105°C for 5 hours.

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The porcelain dish was dried at 105°C for 1 hour. Then cooled and weighed. The sample was weighed as much as 5 g. The dish containing the sample was placed in an oven at 105°C until the weight was constant.

Ash Content with Dry Ashing Method (Andarwulan et al., 2011)

Ash is an inorganic residue obtained by ashing or the process of destruction of organic components with strong acids. This inorganic residue consists of various minerals whose composition and amount depend on the type of food material.

The sample that had been evaporated was put into a furnace at 600°C, previously the weight of the dry cup and the weight of the sample haad been known. The evaporation process was carried out until all the ingredients change color to gray, then the sample was weighed.

Viscosity Measurement with Ostwald Viscometer (Gelatine Manufacturers of Europe (GME), 2017)

Viscosity is measured by comparing the flow time of the solvent and polymer solution at various concentrations or concentrations. The viscometer has the advantage that in order to achieve a wide range of concentrations, the polymer solution can be diluted in the viscometer by adding a measured amount of solvent.

The sample was heated on a hotplate and then homogenized with a magnetic stirrer, after that the sample was put into an Ostwald viscometer with water as a fluid comparison. Then record the time the sample stream flows. It was repeated 3 times until it was accurate.

Measurement of pH Value with a pH Meter (Gelatine Manufacturers of Europe (GME), 2017)

The degree of acidity is used to express the level of acidity or alkalinity possessed by a solution. pH is defined as the activity of hydrogen ions (H^+). The hydrogen ion activity coefficient cannot be measured experimentally so its value is based on theoretical calculations.

A total of 0.2 g of sample was dissolved in 20 ml of distilled water. Then homogenized with a magnetic stirrer at a temperature of 70°C. Then measured the degree of acidity (pH) at room temperature with a pH meter.

Organoleptic Test (Restuning, 2012)

Organoleptic testing is a test based on the sensing process. Sensing is defined as a physio-psychological process, namely awareness or recognition of the sensory organs of the properties of objects due to the stimuli received by the senses.

RESULTS AND DISCUSSION

Gelatin yield

Yield is a economic key parameter in the gelatin industry and its applications (Ningrum et al., 2020). The results of the analysis of diversity showed that the duration of immersing fish skin with pineapple waste extract had a very significant effect on gelatin yield. The average yield of gelatin is presented in Table 1.

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Table 1. Average of gelatin yield

Fish skin immersing time with pineapple waste extract	Yield (%)
A = 0 hours	7.17 a ± 0.55
B = 6 hours	10.06 b ± 0.09
C = 12 hours	10.33 b ± 0.04
D = 18 hours	10.40 b ± 0.04
E = 24 hours	10.60 b ± 0.07
Diversity Coefficient = 2.60 %	

The numbers in the same column followed by letters are not the same, indicating a very significant difference according to the DNMRT follow-up test at the 1% level.

The highest yield of gelatin was obtained at the time of immersion for 24 hours of 10.60%. As the yield of gelatin increases, it shows that there is an interaction between the duration of immersion of fish skin and pineapple extract caused by the presence of bromelain enzymes in pineapple which can break peptide bonds. This causes the yield to be higher as the immersion time increases. This is in accordance with the statement which states that the concentrated acid content in pineapple can help the gelatin extraction process (Santosa & Prayitno, 2018). In another study, it was stated that at the curing stage with a high acid concentration, the yield increased due to the large amount of collagen that was converted and transformed into gelatin (Said & Triatmojo, 2011). The reaction of breaking the covalent bond in the tropocollagen structure will be easier to carry out in an acidic environment and with greater ionic strength (Hermanto et al., 2014).

The yield of gelatin from skin can be increased by using more intense extraction conditions, such as higher temperatures, more extreme acid-base treatments, and/or enzymes (Aykın-Dinçer et al., 2017). However, too large an acid concentration will result in a gelatin structure with a relatively lower molecular mass and lower viscosity. Overall, the resulting yield in this study is around 7.17-10.60%.

Water Content

The results of the diversity analysis showed that the duration of immersion of fish skin with pineapple waste extract did not have a very significant effect on the water content of gelatin. The average of gelatin water content is presented in Table 2.

Table 2. Average of gelatin water content

Fish skin immersing time with pineapple waste extract	Water content (%)
A = 0 hours	7.59 ± 0.23
B = 6 hours	6.16 ± 0.15
C = 12 hours	5.76 ± 0.20
D = 18 hours	5.28 ± 0.15
E = 24 hours	4.95 ± 0.07
Diversity Coefficient = 17.23 %	

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The highest water content in treatment A (0 hours) was 7.59% and the lowest in treatment E (24 hours) was 4.95%. The decrease in water content of gelatin was caused by the duration of immersion of fish skin with pineapple waste extract. The decrease in water content is directly proportional to the duration of immersion of fish skin with pineapple waste extract. This is due to the longer the immersion, the more bromelain enzymes hydrolyze so that the fish skin swells and the water loss during the test is also higher. Swelling of the skin is the proof of collagen bonds quickly breaking and when heating or drying gelatin, the water content evaporates more quickly, so that the water holding capacity weakens and evaporates easily (Santosa & Prayitno, 2018). The water content of gelatin in this study was not much different from the previous study, which was 1.75% (Moranda et al., 2018). The water content of gelatin produced for all treatments met the quality requirements of SNI gelatin, which is a maximum of 16% (Badan Standardisasi Nasional, 1995).

Ash Content

The results of diversity analysis showed that the duration of immersing of fish skin with pineapple waste extract had a very significant effect on the ash content of gelatin. The average ash content is shown in Table 3.

Table 3. Average of gelatin ash content

Fish skin immersing time with pineapple waste extract	Ash content (%)
A = 0 hours	3.43 a ± 0.24
B = 6 hours	2.44 b ± 0.20
C = 12 hours	2.11 b ± 0.06
D = 18 hours	1.81 c ± 0.02
E = 24 hours	1.44 d ± 0.04
Diversity Coefficient = 6.34%	

The numbers in the same column followed by letters are not the same, indicating a very significant difference according to the DNMRT follow-up test at the 1% level.

The decrease in ash content is directly proportional to the duration of immersion with pineapple waste extract due to demineralization which causes minerals in fish skin to dissolve in the immersion process. The longer the immersion time causes the demineralization process to last longer which has an impact on decreasing the ash content of gelatin. In treatment A (0 hours), the demineralization process had already occurred even though the immersion process had not occurred for too long. This is in line with the statement that the gelatin extraction process using the acid method produces a low ash content because during immersion the mineral components in fish skin can dissolve (Moranda et al., 2018). The ash content will be high if the washing process is not perfect so that the minerals stay at the time of ashing. The lower value of ash content indicates that the extracted gelatin has a high quality. However, to obtain lower ash content, proper demineralization of fish skin can be carried out prior to gelatin extraction (Vala et al., 2017). Based on Table 3, the ash content for treatments B, C, D

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and E met the quality standard of SNI 063735-1995, which is a maximum of 3.25% (Badan Standardisasi Nasional, 1995).

Viscosity

The results of the analysis of diversity showed that the duration of immersing fish skin with pineapple waste extract had a very significant effect on gelatin viscosity. In Table 4, it can be seen the average viscosity of the gelatin.

Table 4. Average of gelatin viscosity

Fish skin immersing time with pineapple waste extract	Viskocity (cP)
A = 0 hours	2.68 a ± 0.25
B = 6 hours	2.31 b ± 0.02
C = 12 hours	1.86 c ± 0.11
D = 18 hours	1.10 d ± 0.08
E = 24 hours	0.86 d ± 0.05
Diversity Coefficient = 7.39%	

The numbers in the same column followed by letters are not the same, indicating a very significant difference according to the DNMRT follow-up test at the 1% level.

The highest viscosity was 2.68 cP and the lowest was 0.86 cP. Treatment D (18 hours) and treatment E (24 hours) showed low viscosity values. This is because the high acid concentration of pineapple causes the molecular mass to be low, resulting in a low viscosity value. The high concentration of acid causes the structure of the amino acid chain to be more open so that more amino chains are cut. This causes the formation of shorter amino chains, resulting in lower gelatin viscosity (Nurilmala, Jacoeb, & Suryamarevita, 2017). One of the main challenges in the production of fish-based gelatin is to obtain a product with a sufficiently high viscosity. These challenges can be achieved through manipulation of conditions during the extraction process (Sousa et al., 2017).

Acid greatly affects the viscosity of gelatin, where the longer the immersion, the lower the viscosity of the gelatin produced and this will affect the viscosity of the gelatin. The high acid concentration in pineapple and soaking time caused a decrease in the viscosity of the gelatin produced in this study. The gelatin viscosity values produced in treatments A, B and C met the standard, namely in the range of 1.5-7.5 cP (Gelatin Manufacturers Institute of America (GMIA), 2019). Viscosity is strongly influenced by differences in measurement procedures and conditions, characteristics of raw materials, and gelatin extraction methods.

pH value

The results of the analysis of diversity showed that the duration of immersion fish skin with pineapple waste extract had a very significant effect on the pH value of gelatin. The average of gelatin pH value was shown in Table 5.

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Table 5. Average of gelatin pH

Fish skin immersing time with pineapple waste extract	pH value
A = 0 hours	6.11 a ± 0.02
B = 6 hours	5.21 b ± 0.02
C = 12 hours	5.12 b ± 0.02
D = 18 hours	5.03 c ± 0.07
E = 24 hours	4.85 d ± 0.03
Diversity Coefficient = 0.71%	

The numbers in the same column followed by letters are not the same, indicating a very significant difference according to the DNMRT follow-up test at the 1% level.

Table 5 showed the pH value of gelatin ranging from 4.85-6.11. The highest pH value was in treatment A (0 hours) of 6.11 and the lowest pH value was found in treatment E (24 hours) of 4.85. The duration of immersion of fish skin with pineapple waste extract produced gelatin with a high acidity level. Some of the influencing factors are the citric acid contained in the pineapple and the incomplete rinsing of the fish skin which resulted in the remnants of the pineapple waste extract remaining on the fish skin. The washing process at the extraction stage greatly affects the results so that the washing process is an important step to remove the acids attached to the fish skin (Abidin, 2016). The decrease in pH which is directly proportional to the immersion time is also caused by the reasons stated above. From Table 5, the best gelatin pH was produced in treatments B, C, D and E because it met the standard, which was in the range of 3.80-6.00 (Gelatin Manufacturers Institute of America (GMIA), 2019).

Organoleptic

Organoleptic testing is a test based on sensing using 20 untrained panelists. The organoleptic testing of gelatin in this study included: odor, texture and color (Restuning, 2012).

Odor

Odor is an aroma caused by the stimulation of chemical compounds that are smelled by the olfactory nerves in the nasal cavity when food enters the mouth (Winarno, 2008). Like taste, odor is also a factor that determines panelists' acceptance of a product (Setyaningsih et al., 2014). Testing on the gelatin odor is an important aspect because gelatin is the basic ingredient for food product mixing so that it will affect the judgment of consumers. Research data on the odor of gelatin is presented in Table 6.

Table 6. Average of gelatin odor test

Fish skin immersing time with pineapple waste extract	Value
A = 0 hours	3.40

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B = 6 hours	2.05
C = 12 hours	2.20
D = 18 hours	1.95
E = 24 hours	1.52

Odor value includes: 5 = worse, 4 = bad, 3 = the same, 2 = somewhat good, 1 = good

Table 6 showed the highest odor value of gelatin, namely treatment E (24 hours) with a value of 1.52. While the lowest odor assessment was in treatment A (0 hours) which was 3.40. The odor test was carried out by comparing the gelatin produced from this study with commercial gelatin. The decrease in value indicates the fishy smell coming from the fish skin was decreasing or it can be concluded that the quality of the gelatin was getting better in terms of odor.

The fishy smell that disappears was caused by the distinctive smell of the bromelain enzymes contained in pineapple which seeps into the gelatin, creating a distinctive taste and even aroma (Yuanisa, 2017). During the extraction process, the bromelain enzymes can remove the fishy smell on the fish skin. This is supported by a statement that states that gelatin produced by an acid process produces gelatin that does not have a sharp smell (Suhardiyanto et al., 2015).

Texture

Texture is a pressure sensation that can be felt with the mouth (when bitten, chewed and swallowed) or palpated with the fingers (Kartika, 1998). Gelatin texture testing is the most important test in producing gelatin. Testing the gelatin texture profile includes: hardness, cohesiveness, elasticity, gumminess and chewiness (Atma et al., 2018). Research data on gelatin texture was shown in Table 7.

Table 7. Average of gelatin texture test

Fish skin immersing time with pineapple waste extract	Value
A = 0 hours	2.35
B = 6 hours	2.25
C = 12 hours	2.00
D = 18 hours	2.05
E = 24 hours	2.05

Texture value includes: 5 = worse, 4 = bad, 3 = the same, 2 = somewhat good, 1 = good

Table 7 showed the highest texture rating in treatment C (18 hours) and the lowest in treatment A (0 hours). From the results obtained, the panelists assessed that the texture of gelatin in this study was acceptable or almost the same as the texture of commercial gelatin. Based on the GMIA standard, the gelatin texture that meets the requirements is a dry fine granular texture or in the form of a powder (Gelatin Manufacturers Institute of America (GMIA), 2019).

The acid process produced gelatin with a slightly coarse grained texture due to the influence of temperature and drying time. At high temperatures, high acid concentrations will

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cause further hydrolysis so that some of the gelatin is also degraded during the process of collagen changing into gelatin (Yenti et al., 2015).

Color

Color assessment has been done by direct visual observation of the product with the sense of sight of each panelist. The determination of the product quality depends on many factors, but before other factors are tested and analyzed, the color factor visually appears first in determining the panelists' acceptance of the product (Salihat & Putra, 2021; Winarno, 2004). Research data on the color test was shown in Table 8.

Table 8. Average of gelatin color test

Fish skin immersing time with pineapple waste extract	Value
A = 0 hours	4.15
B = 6 hours	2.60
C = 12 hours	3.05
D = 18 hours	3.10
E = 24 hours	3.90

Color value includes: 5 = worse, 4 = bad, 3 = the same, 2 = somewhat good, 1 = good

Table 8 showed the results of color testing of gelatin using sensory directly. The panelists gave the lowest gelatin color test assessment in treatment A (0 hours) which was 4.15 and the highest in treatment B (6 hours) was 2.60. The color of gelatin is increasingly changing due to the influence of sugar heating and the reaction with amino acids called the Maillard reaction. The effect of immersion time, heating temperature, and drying of gelatin in the oven becomes an indicator at the time of gelatin extraction where there is a decrease in the color of gelatin which becomes more brownish than commercial gelatin (Santosa & Prayitno, 2018).

CONCLUSION

The duration of immersion of tuna skin with extract from pineapple waste has a very significant effect on the yield, ash content, viscosity, and pH value, but did not significantly affect the water content of gelatin.

Based on organoleptic testing by comparing the gelatin product with commercial gelatin, it concludes that gelatin with the best duration of immersion of pineapple waste extract in treatments B and C, but when observed from physicochemical tests that meet SNI 063735-1995 and GMIA, the best is treatment B (immersion time: 6 hours) where the yield is 10.06%, water content is 6.16%, ash content is 2.44%, viscosity is 2.31 cP, and pH is 5.21.

Suggestions that can be conveyed in this study are testing other parameters such as antimicrobials and heavy metals to obtain gelatin that can be produced on a larger scale and can be applied in the food, cosmetics and medicine industries.

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