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Characteristics of Shredded Fish from *Patin* (*Pangasius* sp.) Meat Treated with Different Cooking Techniques

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A B S T R A C T

Shredded fish, which Indonesian traditional product popular name was "ABON" is the product made from meat through grinding, seasoning, and frying meat. The general population is well aware that shredded beef is one of the foods that keeps well and has low cholesterol and high protein content. Generally, shredded meat was made from beef meat, compared to others source of animal protein. Patin is one of fish with high protein which have potential to be used as a raw material. This study aims to investigate the impact of various cooking techniques on the level of customer preference and quality of shredded Patin, as well as to identify the most effective treatment for producing shredded Patin. This research applied three different cooking methods to the raw materials for making shredded Patin, namely: fresh fish meat, steamed fish meat, and boiled fish meat. The most effective method for creating shredded Patin, according to the research findings, is by utilizing steamed fish meat. The features of shredded Patin include a 9.45% of water content, a 21.75% of protein, a 13.42% of fat, a 4.49% of ash, a 50.84% of carbohydrate and a 0.16% of lysine content. All things considered; the technique used to cook the raw ingredients for shredded Patin affects the final product's quality.

Keywords: boiled, cooking techniques, fish, *Patin*, shredded fish, steamed

1. Introduction

Patin (*Pangasius* sp.) is one type of catfish that has high economic value in Indonesia. This fish is highly favored, especially outside of Java Island, such as in Sumatra and Kalimantan. Its special features include a distinctive taste, low calories, and a chewy yet tender meat texture. The reason people engage in catfish farming is that catfish can be cultivated in limited land and water sources, the methods are easier, and marketing is relatively straightforward. Year after year, the production figures for catfish in Indonesia have consistently increased. According to Putra et al. (2022), the national demand for catfish is quite high, with production in 2017 amounting to 319,966 tons, and in 2018, it rose by 22.25% to 391,151 tons. Furthermore, catfish production in 2019 reached 476,208 tons, an increase of 27.59% from the previous year. Processing is one way to maintain the quality of a food product, especially fish, to prevent it from deteriorating or spoiling. The diversity of food processing is carried out because food ingredients have a limited shelf life. The production of fish floss has become one of the alternatives to anticipate and minimize damage to fish during times of abundant catches in the harvest season. According to Tavares et al. (2021), fish is one of the commodities that is prone to spoilage. This process can be caused by biochemical processes as well as by microbiological activity. The relatively high protein content causes fish to spoil easily if not processed and preserved promptly. According to Alyani et al. (2016), the processing method commonly used by the community is the use of high temperatures. Heat is used to cook food with the aim of making it easier to digest, softer, and easier to chew, producing the desired aroma, and enhancing its nutritional value. However, using excessive heat can reduce the nutritional content of the food.

"ABON" is a food made from shredded meat. Its appearance is usually light brown due to the Maillard reaction. The process of making fish floss involves preparing the meat of the catfish, washing it thoroughly, then steaming it until cooked. After that, the fish meat is shredded into small pieces. All the spices are ground and then mixed into the shredded meat, allowing it to rest for a while so the spices can infuse into the meat. Next, the floss is fried, and once it is cooked, it is lifted out and the oil is drained using a spinner. According to Huthaimah et al. (2017), shredded fish is a processed fishery product made from fish meat or fish preparations that are seasoned. The seasoning is processed through boiling, frying, pressing, or draining oil. The produced product has a soft texture, delicious taste, and a relatively long shelf life. According to Asokapandian (2019), this is caused by the frying process, where a color change occurs due to the reaction between amino acids and reducing sugars, resulting in a yellow-brown color during frying.

The processing fresh fish into shredded fish generally affected its nutritional content, where high temperatures caused proteins to denature, reduction of protein, and impacted their functional properties. According to Kim et al. (2023), fish can be processed using various cooking techniques including frying, boiling, and baking. The cooking process can cause changes in the components of fish meat both in terms of texture or its chemical content. The purpose of this study is to ascertain how various cooking techniques affect the properties and sensory attributes of shredded fish and to pinpoint the most effective technique for producing shredded fish with a satisfactory quality and sensory profile.

2. Material and Methods

2.1 Material

The primary raw material used for the present study is *Patin* fish, which weights approximately 400 and 450 grams and has a length of about 40 cm. The fish and additional ingredients for the shredded fish are purchased from traditional fish market and minimarket in Sleman, Special Region of Yogyakarta, Indonesia. All chemicals in this article that don't have a description were bought from SmartLab in Indonesia.

2.2 Production of Shredded Fish

The production of shredded fish in this study refers to the research conducted by Argo et al. (2018), with modifications in the initial cooking process of the raw materials. Ingredients for the manufacturing of shredded fish were consist of fresh meat of *Patin* fish (65%), sugar (19.7%), salt (1.3%), garlic (2.6%), onion (3.9%), coriander (0.6%), galangal (1.3%), ginger (0.6%), lemon grass (0.6%), bay leaf (0.16), kaffir lime leaf (0.16), tamarind (0.2%), and coconut milk (2.7%). In brief, fresh *Patin* fish is cleaned, cut, and then divided into three cooking techniques for the raw material, namely the ground fresh *Patin* fish (A), shredded *Patin* fish that has been steamed at 70 ℃ for 10 minutes (B), and *Patin* fish that has been boiled at 90 ℃ for 10 minutes (C). In treatments B and C, the fish is then shredded to obtain small-sized pieces. The fish meat for each treatment is then mixed with spices in the preparation of shredded fish, including sugar, shallots, garlic, ginger, galangal, salt, coriander, lemongrass, coconut milk, bay leaves, kaffir lime leaves, tamarind, and coconut milk, with measurements as presented in the shredded fish formulation. (Tabel 2). All the spices except for the bay leaves, kaffir lime leaves, and lemongrass are blended until smooth. Once all the spices are finely ground, they are poured into the fish ingredients. The fish meat mixed with the seasoning is stirred evenly and left to sit for 15 minutes. The next step is to fry the seasoned fish mixture in hot oil at a temperature of 160 degrees for 30 minutes, using a ratio of seasoned fish mixture to cooking oil of 3:1. The frying is accompanied by continuous stirring until a shredded fish product with a golden-brown color is achieved. At this stage, it can be said that the shredded fish is ready to be consumed. However, to further optimize its quality, the shredded fish is then placed in a spinner to separate the meat from the leftover cooking oil resulting from the frying process. The yield of shredded fish obtained from the three treatments mentioned above ranges from 30-37%.

2.3 Chemical Characteristics of Shredded Fish

2.3.1 Proximate contents

2.3.1.1 Water content

The determination of the water content (AOAC, 2005) of shredded fish are as follows: blank aluminum cup is dried in the oven for 15 minutes, cooled in a desiccator for 30 minutes, and weighed. Sample 2 grams (a), placed in a cup, and heated in the oven for 4 hours at a temperature of 105 oC to 110 oC or until a constant weight is achieved. The cup is cooled deeply in the in the desiccator and weighed again (b). The percentage of water content (wet weight) can be calculated by the following formula: (a–b)/a x 100.

2.3.1.2 Protein content

There are 3 stages in protein testing, namely destruction, distillation, and titration (AOAC, 2005). Protein content measurements were carried out using the micro Kjeldahl method. Determination of protein content in shredded fish is as follows: the sample is weighed as much as possible (0.5 g), then put into a 100-ml Kjeldahl flask, then weigh it with 0.5 g of selenium and 3 ml of concentrated H_2SO_4. Samples were digested at 410 ℃ for less than 1 hour until the solution was clear and then cooled. After it cools, enter 50 ml of distilled water and 20 ml of 40% NaOH into the Kjeldahl flask, then carry out the distillation process with a distillator temperature of 100 oC. The distillation results are stored in a 125-ml erlenmeyer flask containing a mixture of 10 ml of boric acid (H_3BO_3) 2% and 2 drops of pink methyl red indicator. After volume, the desilate reaches 40 ml and is bluish green in color, then the distillation process, then desolate with 0.1N HCL until the color changes to pink and titration volume can be recorded. Protein content can be calculated using the following formula:

N (%) = (ml HCL sample−ml HCL blank) x N HCL 14,007/mg sample x 100

Information:

Protein content: N content x conversion factor

Conversion factor: 6.25

2.3.1.3 Fat content

The determination of fat content is referred to AOAC (2005). A total of 5 g of sample (y) was wrapped in filter paper and put into a Soxhlet flask (the flask is previously dried in the oven, put in a desiccator, and then weighed (x). Into the flask, hexane solvent is added and then carried out reflux for 6 hours. Then the flask containing the reflux results is heated in the oven to 105 ℃. After that, it was cooled in a desiccator and weighed (z). Fat content is determined by the formula:

Fat content (%) (wb) = (z−x)/y x 100

Fat content (%) (db) = Fat content based on wet weight/ (100−Water content) x 100

2.3.1.4 Ash content

The determination of ash content is referred to AOAC (2005). In brief, the cup to be used is weighed first (x). Furthermore, the sample was weighed at 3 g (y), then put into a furnace at a temperature of 600 oC. The evaporation process is carried out until all the ingredients change color gray (until complete ash), then the cup containing the sample ash is weighed. Ash content is calculated based on the following equation:

Ash rate (%) (wet basis) = (z−x)/y x 100

Ash rate (%) (dry basis) = Ash rate based on wet basis/ (100−water content) x 100%

2.3.1.5 Carbohydrate content

Carbohydrate levels are done by difference method, namely the result of reduction from 100% with water content, ash content, protein content, and fat content, so carbohydrate levels depend on the reduction factor. Carbohydrate levels can be calculated using the formula: Carbohydrate content (%) = 100% - (%water + %ash + %fat + %protein)

2.3.2 Lysine contents

Lysine testing in processed fish products is important because of Lysine is an essential amino acid that is said to be directly related to growth and can activate the growth hormone HGH (Human Growth Hormone). This growth hormone is responsible for increasing muscle development, burning fat, and regulating the immune system (Fernandez, 2014). In this research, lysine testing refers to the method (Kakade and Ellinger 1989) of as much as 1 g of ground sample suspended in 100 ml of distilled water in an Erlenmeyer tube. After that, 4% (w/v) sodium bicarbonate was added, then heated at 40 ℃ for 10 minutes using a water bath. Next, add 0.1% solution. (v/v) ninhydrin and heating continued at the same temperature for 110 minutes, then add 3 ml of hydrochloric acid solution and heat in an autoclave at 120 ℃ for 60 minutes. After the sample cooled, 5 ml was added to distilled water and filtered with Whatman No. 1 filter paper. The resulting extract collected was extracted with 10 ml of ether. The ether fraction was discarded while the water fraction was heated in a water bath to remove residues from the ether fraction still left behind. The absorbance of the water fraction was read at a wavelength of 336 nm using a spectrophotometer. Lysine content was calculated using a calibration curve (standard). Lysine calculation uses the formula:

Lysine Amino Acid Content % = [X x DF / Sample (mg)] x 100

X = y−a/b

Information:

X: Absorbance results

DF: Dilution factor

y: Sample absorbance results

a and b: Linear regression values

2.4 Sensory Evaluation of Shredded Fish

Sensory evaluations are based on the Indonesian National Standardization of sensory assessment sheet No. 2346:2015 concerning guidelines for sensory testing of fishery products (National Standardization Institution, 2015). Assessment specifications include appearance, smell, taste, and texture. The panelists consisted of the 30 mothers who agreed to contribute to this research by signing the consent form. The next panelist is given samples of catfish floss with codes A, B, and C. Panelists can give a score from 1-9, with a scale of 9 indicating very, very like it, scale 8 states really like it, scale 7 states like it, scale 6 states somewhat like it, scale 5 states neutral, scale 4 states somewhat dislike, scale 3 states said they didn't like it, scale 2 said they really didn't like it, and scale 1 said they didn't like it expressed that he really, really didn't like it. Next, the results of the sensory test are carried out with a with a calculation of the standard deviation and confidence interval to determine whether the catfish shredded product is suitable for consumption or not. Then the data obtained from the assessment sheet is tabulated, and the quality value is determined by looking for the average results for each panelist at a 95% confidence level.

2.5 Data Analysis

Data was analyzed statistically using SPSS version 16. The parametric test data obtained is tested for normality and values its homogeneity. If the data is obtained with a normal distribution and is homogeneous, then continue with Analysis of Variance (ANOVA). The variance test, or ANOVA, is carried out for decision-making that this treatment has an effect on the test material (F value) and continued with a further test, namely the Honestly Significant Difference Test (Tukey), which is carried out if the p value <5%. Non-parametric test data in the hedonic test were analyzed using the Kruskal-Wallis test. The Kruskal-Wallis test aims to determine whether treatment differences influence (p<5%) or not (p>5%). If there is a difference in treatment that gives a real effect, then proceed with the Mann-Whitney test.

3. Results and Discussions

3.1 Proximate Contents of Shredded Patin

Shredded *Patin* resulted from this study was initially assessed for quality considering its proximate composition, as shown in Table 1.

Table 1 – The proximate contents of shredded *patin*

Shredded *Patin*	Water (%)	Fat (%)	Ash (%)	Protein (%)	Carbohydrate (%)
A	8.17 ± 0.06^{a}	13.37 ± 0.06^{b}	5.52 ± 0.41^{b}	25.92 ± 0.74^{c}	46.97 ± 0.09^{a}
B	9.47 ± 0.20^{b}	13.41 ± 0.17^{b}	4.53 ± 0.14^{a}	21.75 ± 0.37^{b}	50.83 ± 0.84^{b}
C	11.21 ± 0.19^{c}	12.66 ± 0.27^{a}	4.58 ± 0.31^{a}	18.80 ± 0.07^{a}	52.67 ± 0.60^{c}

Data represent mean ± each parameter of three replications. Different superscript lower letter showed the significant differences between samples (p<0.05)

The results showed that the difference in cooking methods of raw materials affected the water, protein and carbohydrate content of shredded *Patin* (p<0.05). Likewise, in determining the amount of fat, it was seen that shredded *Patin* with raw material of *Patin* fish meat cooked by boiling was significantly different from shredded *Patin* with raw material of steamed fish meat and in the form of fresh fish meat. For ash content, it was seen that there was no significant difference between shredded *Patin* with raw material of steamed fish meat and raw material of boiled fish meat (Table 1). Processing temperature affects the increase in water content where in this study, shredded *Patin* increased its water content along with the increase in the temperature of the raw materials which was adjusted to the cooking technique, including: without cooking (fresh fish meat) temperature ranging from 10-15℃, steaming (temperature 70-80℃), and boiling (temperature 90-100 ℃). Based on the Indonesian National Standard number 3707-2013 (National Standardization Institution [NSI], 2013) the maximum water content in shredded fish is 7% so that if referring to the standard, none of them meet it. However, the protein content of shredded Patin from this study showed a significant increase in protein content, where all three treatments produced shredded Patin with a protein content exceeding 15% (NSI, 2013). All shredded *Patin* in recent study have complied with the standard for shredded fish, which specifies a maximum fat content of 30%, a maximum carbohydrate content of 30%, and a maximum ash content of 7%. Raw material properties have an impact on the finished product; for For instance, the shredded patin's water content was higher than recommended. The texture of beef, which is typically utilized as shredded meat raw material, differs from that of fish meat. Additionally, fish meat has a 5–10% greater water content than fresh beef, with fish meat having a water content of up to 84% and beef having a water content of 73–76% (Bezbaruah and Deka, 2021; Afifah et al., 2021). The water content of shredded patin matches with a study by Yuliana et al. (2021) that used Rinuak fish (*Psilopsis* sp.) as the raw material and found that the water content of fish floss was 8.65%. The characteristics of shredded fish products, which are dried products with a relatively high fat content, can be explained by the water content of the shredded Patin used in this study (Table 1). The water content range of this shredded patin product is rather low, which is a crucial factor for food stability. According to Tsironi et al. (2020), shredded fish products have a water activity (Aw) of about 0.6, which indicates a slight chance of bacterial overgrowth. With a range of 18.8 to 25.92%, the protein content of shredded Patin in this study was relatively high. The introduction of additional protein-rich components, like coconut milk, is one of the factors that affect the increase in protein content of patin fish after it is processed into shredded fish products. According to Fatimah and Gugule (2017), coconut milk can also contribute to the composition of fat content. Its fat content is 24.54%, with saturated fatty acids—specifically, lauric fatty acid (52.92%) and myristic fatty acid (13.22%)—dominating the fat content. Additionally, there is a negligible difference in the amount of ash in shredded patin between boiling and steamed raw materials. The by-difference approach is used to determine the carbohydrate content of shredded patin. The results show that the breakdown of sugar added during the manufacturing process of shredded patin is influenced by the treatment of raw materials with varying cooking temperatures.

3.2 Lysine Contents of Shredded Patin

One of the essential amino acids, lysine, additionally acts as a gauge for how much cooking (variations in raw material cooking techniques) impacts the quality of shredded patin. Figure 2 in this study displays the amount of lysine in the shredded patin.

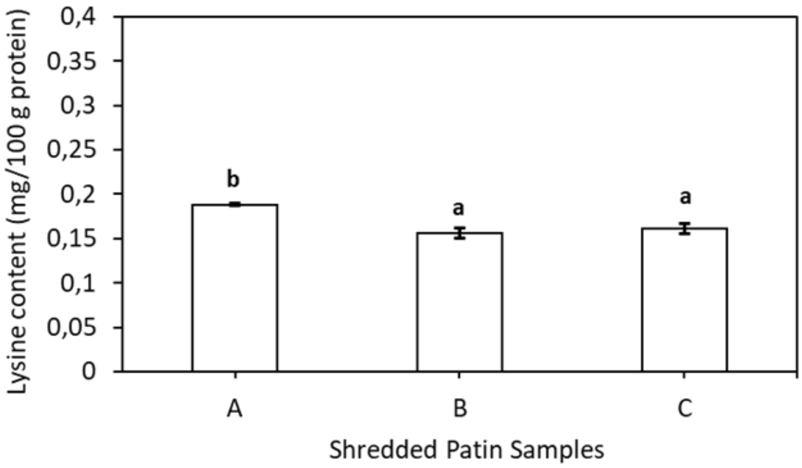

Fig. 1. The amount of lysine in shredded patin, A: shredded patin with ground fresh Patin fish (A), B: shredded Patin fish that has been steamed at 70 ℃ for 10 minutes, and C: shredded Patin which fish meat had boiledat 70 ℃ for 10 minutes (C). Values are reported as the mean of four replicate groups and error bars indicate standard deviation. Different lowercase letters on the bar charts indicate statistically significant differences at each sample were assessed by the Tukey at $p < 0.05$

Figure 1 shows that differences in cooking techniques for raw materials have a significant effect on the lysine content of shredded Patin ($p<0.05$). Previous research by Kartikaningsih et al. (2021) stated that the lysine content of shredded tuna was 0.32 mg/100 g protein. World Health Organization (2007) required the Recommended Dietary Allowance of lysine for children and adult humans is 0.03 mg/100 g protein. This implies that food products made from this study (shredded Patin) could serve as a source of vital nutrients for good health. Significant changes were found in the raw material cooking technique in this investigation, particularly in shredded Patin code A, which had the highest lysine content (0.19 mg/100 g), followed by shredded Patin codes C and B (none of which showed any significant differences). Heating affects the breakdown of proteins and creates important amino acid components (Li et al., 2022).

3.3 Preference of Panelist on Shredded Patin

Three varieties of shredded patin developed during the current study are depicted in Figure 2. The surface textures and colors of the shredded patin were affected by different cooking techniques. Based on the figure, it can be seen that the use of fresh fish meat as the raw material, resulted shredded Patin with a darker color compared to shredded Patin which raw material is previously steamed and boiled.

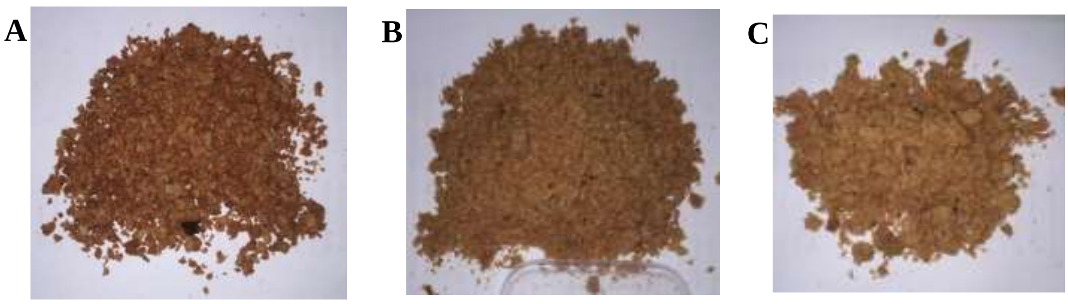

Fig. 2. Three types of shredded Patin produced in the present study. A: shredded patin with ground fresh Patin fish (A), B: shredded Patin fish that has been steamed at 70 ℃ for 10 minutes, and C: shredded Patin which fish meat had boiledat 70 ℃ for 10 minutes (C)

Overall, the appearance of the shredded fish from this study has a golden-brown final result. This is due to the interaction between the processing process (heating) during the manufacture of shredded fish with protein-rich raw materials (Patin fish) and sugar components, where this phenomenon is called the Maillard reaction. Furthermore, the continuous heating process, starting from the raw materials followed by the frying stage, causes the formation of amino acids that play a role in the formation of the golden-brown color, namely glycine and lysine. According to Bhat et al. (2021), the presence of the amino acid lysine exhibits strong reactivity in the Maillard reaction. The heating process affects the taste of shredded fish, especially related to the content of amino acids that trigger the umami taste. However, in this study, the concentration of amino acids that trigger umami, namely glutamate amino acid, was not measured. Based on the hedonic evaluation, the panelists preferred shredded Patin with raw materials that went through a boiling process (C), followed by shredded Patin with codes B and A, with an average taste preference value of 8.1, 8 and 6.36, respectively (Fig. 3). Measurement of the amino acid lysine content in this study was correlated with the emergence of a slightly bitter aftertaste in shredded Patin with code A, considering that the highest lysine content was found in shredded Patin with code A. This is in accordance with the opinion of Kong et al. (2018), who stated that leucine (Leu), isoleucine (Ile), try, phenylalanine (Phe), lysine (Lys), valine (Val), histidine (His), and arginine (Arg) are the bitter amino acids. Similar to taste, the aroma of shredded Patin is also influenced by the presence of free amino acids resulting from protein degradation due to heating. Li et al. (2022) stated that fish aroma is significantly influenced by the composition of nucleotides and free amino acids (FAAs).

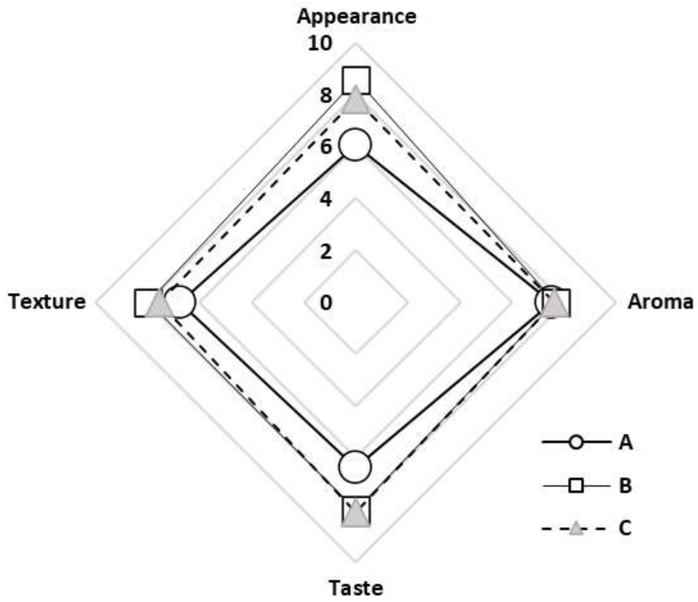

Fig. 3. Panelists preferences on f shredded Patin produced in the present study.

A: shredded patin with ground fresh Patin fish (A), B: shredded Patin fish that has been steamed at 70 ℃ for 10 minutes, and C: shredded Patin which fish meat had boiledat 70 ℃ for 10 minutes (C)

Figure 3 shows that the aroma of shredded Patin does not show any significant difference considering that shredded Patin resulted from this study uses raw materials with the same composition. The presence of spices, including garlic, coriander, salt, and sugar, produces a positive aroma, so this product is preferred. The results of the preference test for shredded Patin also show that shredded Patin with code B is the sample most preferred by panellists, followed by samples A and C. The texture parameter clearly shows this, where frying process in the final step of shredded Patin's manufacturing resulted fibrous texture as well as the texture of shredded meat-based beef meat. The shredded Patin B is the most shredded Patin preferred by panellist, whereas shredded Patin C is the product with the lowest preferences, since the boiling process increases the water content, thereby reducing the level of panellist acceptance of the final result of shredded Patin C. The panellist's assessment of the texture parameter on shredded Patin C is in line with the water content of shredded Patin, which has the highest value of 11.21% compared to other samples.

4. Conclusions

Different cooking techniques of raw material impacted characteristics of shredded fish which consist of water, protein, and carbohydrate (p<0.05). In other hand, there were no significant different of ash and lysine content of shredded *Patin* using steamed and boiled meat as raw material. In this study, the steaming of fish meat is important pre-stage technique to create nutritious shredded Patin, which concentrated essential amino acids such as lysine and can be applied by food industries.

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References

Afifah, N., Ratnawati, L., Indrianti, N., and Sarifudin, A. 2021. The effect of pre-drying treatments on the quality of dehydrated ground beef IOP Conf. Ser.: Earth Environ. Sci. 924 012006.

Asokapandian, S., Swamy, G. J., & Hajjul, H. (2019). Deep fat frying of foods: A critical review on process and product parameters. Critical Reviews in Food Science and Nutrition, 60(20), 3400–3413. https://doi.org/10.1080/10408398.2019.1688761

Bezbaruah, G. and Deka, D. D. 2021. Variation of moisture and protein content inthe muscle of three catfishes: A comparative study. International Journal of Fisheries and Aquatic Studies 9(1): 223-226

Fachinger, J., den Exter, M., Grambow, B., Holgerson, S., Landesmann, C., Titov, M., et al. (2004). Behavior of spent HTR fuel elements in aquatic phases of repository host rock formations, 2nd International Topical Meeting on High Temperature Reactor Technology. Beijing, China, paper #B08.

Fachinger, J. (2006). Behavior of HTR fuel elements in aquatic phases of repository host rock formations.*Nuclear Engineering & Design*,*236*, 54.

Fatimah, F and Gugule, S. 2017. Characteristic of coconut milk powder made by variation of coconut-water ratio, concentration of tween and guar gum J. Appl. Sci. Res. 13 6 34-44.

Fernandez. I, 2014. Essential Amino Acids for Children's Growth and Development. Food for Kids Indonesia.

Kartikaningsih, H., Yahya, Hartita, Y. T., Jaziri, A. A., Zzaman, W., Kobun, R., and Huda, N. 2021. The nutritional value, bacterial count, and sensory attributes of little tuna (*Euthynnus affinis*) floss incorporated with the banana blossom. *Slovak Journal of Food Sciences* (15), p. 846–857. https://doi.org/10.5219/1657.

Kim, D., Caputo, V., and Kilders, V. 2023. Consumer preferences and demand for conventional seafood and seafood alternatives: Do ingredient information and processing stage matter?. Food Quality and Preference 108, 104872. https://doi.org/10.1016/j.foodqual.2023.104872

Kong, Y., Zhang, L.-L., Zhang, Y.-Y., Sun, B.-G., Sun, Y., Zhao, J., Chen, H.-T., 2018. Evaluation of non-volatile taste components in commercial soy sauces. Int. J. Food Prop. 21 (1), 1854–1866. https://doi.org/10.1080/10942912.2018.1497061.

Li, R., Sun, Z., Zhao, Y., Li, L., Yang, X., Chen, X., Wei, Y., Li, C., and Wang, Y. 2022. Effect of different thermal processing methods on water-soluble taste substances of tilapia fillets. *Journal of Food Composition and Analysis* 106, 104298. https://doi.org/10.1016/j.jfca.2021.104298.

Mettam, G. R., & Adams, L. B. (1999). How to prepare an electronic version of your article. In B. S. Jones & R. Z. Smith (Eds.), *Introduction to the electronic age* (pp. 281–304). New York: E-Publishing Inc.

National Standardization Institution [NSI] (2013). *In Bahasa:* Standard National of Indonesia number 3707-2013 (shredded fish ‘s quality).

National Standardization Institution [NSI] (2015). *In Bahasa:* Standard National of Indonesia number 2346:2015 (sensory testing of fisheries products).

Strunk, W., Jr., & White, E. B. (1979). *The elements of style* (3rd ed.). New York: MacMillan.

Tavares, J., Ana Ma. Liliana G., Fidalgo, Vasco, L., Renata A. A., Carlos A. P., Ana M. S., and Jorge A. S. 2021. "Fresh Fish Degradation and Advances in Preservation Using Physical Emerging Technologies" Foods 10, no. 4: 780. https://doi.org/10.3390/foods10040780.

Tsironi T, Houhoula, D and Taoukis, P. 2020. Hurdle technology for fish preservation. Aquaculture and Fisheries 5 65–71.

Van der Geer, J., Hanraads, J. A. J., & Lupton, R. A. (2000). The art of writing a scientific article. *Journal of Science Communication, 163*, 51–59.

World Health Organization – WHO. 2007. Protein and aminoacid requirements in human nutrition: report of a joint WHO/FAO/ UNU expert consultation (Technical Report Series, No. 935). Geneva: WHO.