IMPACT OF FUEL TYPE ON PROTEIN CONTENT OF SMOKED STINGRAY AT MS. NOK'S MSME, SURADADI

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ABSTRACT Smoking is a fish preservation method that uses a combination of drying treatment and the application of compounds obtained from burning natural wood fuel in the form of smoke. Fuel in the fish smoking process is an important factor that determines the nutritional quality of the final product. The purpose of this study was to analyze the effect of smoking using coconut shell fuel, coconut fibers and a combination of both on the protein content of stingray and analyze the highest protein content from the use of coconut shell fuel, coconut fibers and a combination of both in stingray smoking. This research was conducted on September 30 - October 10, 2024 at Ms. Nok's MSME Suradadi. The method used in this research is an experimental method with 3 repetitions. Based on the research the highest protein content was obtained in stingray smoking using a type of fuel combination of shell and coconut fiber and coconut fiber fuel, and lower protein levels were obtained from smoking using coconut shell fuel. The results of protein content in stingray smoking using coconut shells obtained an average of 25.70%, stingray smoking using coconut fibers obtained an average of 30.53%, while stingray smoking using a combination of shells and coconut fibers obtained an average of 31.75%. This shows that there is a significant effect between the use of fuel types of coconut shells, coconut fibers and a combination of both on the protein content of stingrays.

Keywords: *Smoking, Fuel Type, Protein Content.*

INTRODUCTION

The diversity of biological resources owned by Indonesia is very diverse, including animal protein sources, especially fish. Indonesia also has a diversity of fishery species including marine fish, freshwater fish and brackish fish. Fish is a balanced and optimal source of nutrition. It contains 18 percent of important amino acid proteins that are maintained despite the cooking process. Fish contains fat ranging from 1 to 20 percent which is easily digested and quickly absorbed by the body. Fish fat is dominated by unsaturated fatty acids which are very important in the growth process and help reduce blood cholesterol (Darianto *et al.,* 2018).

Fish is an economically efficient food source, offering a more affordable option than other animal protein sources such as chicken and beef. In addition, fish has a more efficient protein absorption rate and contains various bioactive compounds that are beneficial to the body. This is largely due to the shorter protein fibers of fish compared to chicken and beef (Kaimudin, 2020). Fish has a relatively highwater content in addition to protein so it is classified as fresh food.

The protein contained in the fish body makes a significant contribution as a source of animal protein, which is 57.2%. Protein has an important role in the body as a building, regulating, and burning material that supports the formation of new tissues, repair of damaged tissues, and the reproductive process. Functionally, fish protein also functions as a regulatory compound that helps synthesize

enzymes and protective hormones that control various metabolic processes of the body. In addition, fish protein is very easily digested by the body and has an amino acid composition that is almost similar in the human body (Wahyudi and Maharani, 2017).

Processing fish can be through the smoking process, smoking is a fish preservation method that combines a combination of drying treatment with the application of compounds produced from burning natural wood fuel in the form of smoke (Ndahwali *et al.*, 2018). The type of fuel used in smoking is one of the important factors that can affect the final quality of the smoked product. The smoking process can be done with various fuel sources, such as firewood or agricultural waste including coconut shells, coconut fibers and rice husks (Asmara *et al.*, 2024). Fish smoking using different fuels can produce different temperatures and smoke compounds so that different smoke fuels can affect the quality of the final result in the smoking process. Based on this, it is very important to know the selection of fuel that is effective on the quality of the final result of smoking, especially the protein content of smoked fish, to determine the quality of smoking results, a study was conducted on the analysis of protein content in stingray smoking using different fuels: coconut shell, coconut fiber and a combination between the two at Ms. Nok's MSME, Suradadi.

Fishery products are one of the products that are relatively quickly damaged (Ernaningsih *et al.*, 2023). The process of quality deterioration will occur immediately during the process of catching fish from the water and dead fish. Handling during fishing activities is part of the initial handling that is the key to the success of fish quality. Fish is a food that is prone to spoilage because it is a place that supports the growth of spoilage microorganisms that can reduce quality. Fish that has undergone the process of spoilage will continue to experience a decrease in quality and cannot return to its best quality after the fish dies. Fish handling is very important to slow down the process of decreasing the quality of fish starting from the capture process until after the fish dies (Handoko and Yuniarti, 2023).

Fish processing plays an important role in inhibiting the activity of microorganisms that cause spoilage. Preservation through methods such as salting, drying and smoking is required in the processing process to maintain fish quality. Factors that determine the quality of smoked fish include the stage of cleaning fish before smoking, adding flavorings, smoking techniques and selecting the type of fuel used in the smoking process (Sirait and Saputra, 2020). Based on the formulation of the problem, it is necessary to process fish to inhibit spoilage microorganisms. The smoking method is one of the efficient ways to maintain fish quality. One of the factors that can determine the quality of smoked fish is the selection of fuel used in the smoking process. The fuel used in the smoking process is an important factor because it can affect the taste, aroma, and color of smoked fish, besides the type of fuel used has an important role in controlling the temperature and time of smoking which has an impact on the nutritional quality of the final product. The purpose of the study was to analyze: (1) The effect of smoking using coconut shell fuel, coconut fibers and a combination of both on the protein content of stingray (2) the highest protein content from the use of coconut shell fuel, coconut fiber and a combination of both in stingray smoking. Based on the formulation of the problem, the hypothesis put

forward in the study is as follows: H0: There is no significant effect on differences in smoke raw materials on stingray protein content, H1: There is a significant effect on differences in smoke raw materials on stingray protein levels.

METHOD

This research took place at Ms Nok's Fish Smoking Processing, Suradadi with protein content testing carried out at the Semarang Fishery Product Quality Testing Center (BPMHP) Laboratory. The material used in this research is smoked stingray fish that has gone through the smoking process at Ms. Nok's MSME, Suradadi. Equipment for the protein content test included a measuring cup, kjeldahl distillation, kjeldahl flask, burette (pyrex), pipette, and erlenmeyer.

The method applied in this research is the experimental method. According to Sugiyono (2019), the experimental method is an approach that is carried out experimentally and is in quantitative research with the aim of identifying the effect of independent variables (treatment) on dependent variables (results) under controlled conditions. Independent variables (X) refer to variables that are considered to have an influence or to be a factor causing changes in other variables. The independent variables (X) in this study include the type of fuel used in the smoking process including coconut shell, coconut fiber, and a combination of coconut shell and coconut fiber. Meanwhile, the dependent variable (Y) refers to the variable that is affected or caused by the influence of the independent variable. The dependent variable (Y) in this study is the protein content of smoked stingray.

The data collection technique used in this study uses the observation method. According to Sugiyono (2017) observation is a data collection method that has distinctive characteristics when compared through other techniques. Observation data is collected by observing ongoing activities. The phenomenon studied in this research is the analysis of protein content in stingray smoking using different fuels, namely coconut shell, coconut fiber and a combination of both at Ms. Nok's MSME, Suradadi.

The data used in this study include primary data and secondary data. Sugiyono (2013) states that primary data is information generated directly through the object of research by data collectors. Primary data from this study was obtained through observations of ongoing activities at Ms. Nok's Fish Smoking MSME, Suradadi and Secondary data refers to information that is not obtained directly through the object of research, but is obtained from other sources, such as documents or relevant agencies. Secondary data in the study was obtained through information obtained through relevant agencies or institutions. The fuel treatments carried out on stingray smoking are as follows:

A1= using Coconut Shell

A2= using Coconut Fiber

A1.A2= using a combination of Coconut Shell and Coconut Fiber

Based on the experimental design matrix, the number of repetitions was arranged 3 times with 3 kinds of treatments, namely stingray smoked using coconut shell (A1), coconut fiber (A2) and a combination of shell and coconut fiber (A1.A2), so that the number of experimental units 3x3 = 9 research units. The amount of fuel used in this study was 1 kg each in each smoking treatment consisting

of coconut shell fuel, coconut fiber and a combination of coconut shell and coconut fiber to measure the protein content of stingray.

Tests on smoked stingray were conducted to determine protein levels using the Kjeldahl method in accordance with the standard (SNI No. 01-2354.4-2006). This process includes three main stages: deconstruction, distillation and titration. Samples are heated with concentrated sulfuric acid H2SO4 in the deconstruction process to decompose the elements, this process is accelerated by the addition of catalysts such as Na2SO4, CuSO4, and selenium. The deconstruction process is considered complete when the solution is clear in color. Next, the distillation process where ammonium sulfate is decomposed into ammonia which is then converted into an alkaline solution by adding NaOH and then heating it. The ammonia formed is then collected in a concentrated boric acid solution (H3BO3) which has been given a BCG indicator and methyl red. The titration process is carried out by adding 0.02 M HCL solution to the ammonia that has been collected and the titration is considered complete when there is a change in the color of the solution from dark blue to pink. The blank process is also carried out to measure the nitrogen content that comes from the reagents in the test.

The research stages for the protein content test began with weighing a 2 g sample of smoked stingray using weighing paper, then the paper was folded and put into the deconstruction flask. Next, the addition of two catalyst tablets along with some boiling stones. Then, 15 mL of concentrated sulfuric acid (H2SO4) and 3 mL of hydrogen peroxide (H2O2) were added, then left for 10 minutes under acidic conditions. The deconstruction process is carried out at 410 0C for approximately 2 hours (until the solution becomes clear), then let the solution cool to room temperature and add 50-75 mL of distilled water. Then, prepare a 250 mL erlenmeyer containing 25 mL of 4% H3BO3 containing an indicator. The flask containing the deconstruction results is then installed in a steam distillation device and add 50-75 mL of sodium hydroxide-thiosulfate solution. The distillation process was continued until the solution volume was at least 150 mL (green solution). Then, the distilled sample was titrated using 0.2 N HCl solution until the color of the solution changed from green to neutral gray and the titration volume was recorded to calculate the protein content.

The data analysis process in this study uses SPSS software version 25. The tests used include the classical assumption test which includes the data normality test and the homogeneity of variance test. After the classical assumption test is fulfilled, then to test whether there is a significant effect between the use of smoked fuel on the protein content of stingray using the anova test, if the results of the anova test show a significant effect, the tuckey test is carried out to identify which group shows a significant difference.

RESULTS AND DISCUSSION

General condition of Ms. Nok's MSME, Suradadi

Fish smoking in Suradadi Village is a business that has basically developed and become one of the livelihoods. Fish smoking activities, especially in Ms. Nok's MSME, are businesses that still use

traditional smoking techniques, namely hot smoking. The smoking process carried out at Ms. Nok's MSME uses coconut shell fuel and coconut fibers which can give a distinctive taste to the smoking product. The equipment used for smoking fish also still uses traditional equipment, not yet using a chimney due to the high cost of manufacturing.

At Ms. Nok's MSME, smoked fish ranging from stingray, tuna, manyung fish, pihi fish, and snapper fish are produced every day. Smoked fish products are sold to enthusiasts or baskets and taken for sale at the Suradadi traditional market. Smoked fish processors in Ms. Nok's MSME experience obstacles in achieving national standards, especially in applying for the Indonesian National Standard (SNI) Certification. Although they have applied for SNI certificates several times, the complicated process and strict requirements are often an obstacle.

The processing process carried out at Ms. Nok's MSME in Suradadi involves several important steps, starting from the receipt of raw materials to the smoking process. Smoked fish is processed through the following steps:

Raw Material Receipt

The freshness of raw materials has a very important role in determining the final quality of the product. According to Swastawati (2018) the main factor that must be considered is that the raw materials used must be fresh or still have good quality. The raw material for making smoked fish is fresh fish or fish that has gone through the freezing process. For the production of smoked fish, fresh fish or fish that has gone through the freezing process is the main raw material. The fish available at Ms Nok's MSME include various types of fish, including manyung, pihi, snapper, tuna, and stingray.

These fish are obtained fresh, to ensure that they meet the high quality standards required for producing smoked fish products. Among these species, stingray is considered the main raw material, as stingray is favored for its great texture and taste after being processed into smoked fish. The fish used in Ms. Nok's production is purchased directly from local fishermen or fish traders operating at the Perikanan Nusantara Port in Tegalsari. This direct purchase ensures that the fish used is of the highest quality and handled well from the moment it is caught. By purchasing fresh fish directly from the port, Ms. Nok's MSME are able to maintain a high standard of freshness, which is very important to their customers.

Fish Weeding and Cutting Process

A very important initial step in smoked fish processing is the weeding process. The purpose of this weeding process is to remove unnecessary parts of the fish including scales, gills, internal organs, and other impurities (Askar *et al.,* 2024). When processing stingray, the gutting process begins with careful removal of any waste from the stomach contents. This step is critical because the fish's internal organs, particularly the intestines, can contain harmful putrefying bacteria that can cause an unpleasant odor and rapid deterioration of the fish. By removing these contaminants early in the process, the risk of bacterial growth can be minimized, resulting in a cleaner and safer product.

Once the gutting process is complete, the next important step is to cut the fish into pieces. This is done to ensure that the smoke can penetrate evenly into the fish during the smoking process. Cutting the fish allows the smoke to reach all parts of the meat, resulting in a more consistent flavor, texture, and curing quality. Even exposure to the smoke ensures that the fish is properly smoked, enhancing its flavor and extending its shelf life.

Fish Washing Stage

After the weeding and cutting processes are completed, the next important step in preparing the fish for smoking is the washing process. The purpose of washing is to ensure that all remaining dirt, fish blood, and other impurities are thoroughly removed from the fish meat. This step is essential for maintaining the fish's cleanliness, improving its taste, and ensuring the final product is of high quality. The fish washing process is carried out by dipping the fish into a fiber box filled with fresh water. While submerged, the fish is carefully rubbed to remove any remaining mucus, blood, or other substances that may still be attached to the flesh. The washing process is not a one-time step; it can be repeated several times to ensure that all dirt and residues are fully removed. By doing so, the fish meat is cleansed and prepared for the next stage of processing, which is the smoking process. According to Nofreeana (2017), fish washing aims to remove dirt on stingrays such as blood and mucus.

Fish Draining Stage

At Ms. Nok's MSME, after the fish has been thoroughly washed, it undergoes a draining process to remove excess water before the smoking procedure begins. This step is critical to ensuring the fish reaches the desired texture and flavor during the smoking process. The draining typically takes around 30 minutes, or until the remaining water from the washing process stops dripping. According to Sirait (2018), draining the fish before the smoking process also affects the duration of smoking, with the main purpose of reducing the water content in the fish after going through the salting and washing process using clean water. By removing this excess moisture, the smoking process becomes more efficient, allowing the fish to absorb the smoke more evenly and enhancing its flavor.

This drainage process is essential for achieving the best possible smoked fish, as moisture retention can lead to issues like uneven smoking or sogginess. By ensuring the fish is adequately drained, the fish is in optimal condition to be smoked, resulting in a high-quality product that is both flavorful and properly preserved. Therefore, this draining step is crucial for the success of the smoking process at Ms. Nok's MSME.

Fish Smoking

The smoking process involves two main methods, namely the hot smoking method and the cold smoking method. The smoking process at Ms. Nok's MSME is carried out using the traditional method, namely the hot smoking method. The fuel used in the smoking process at Ms. Nok's MSME is coconut fiber and coconut shell. Based on research by Ratna *et al.,* (2011), the shape, color, aroma and taste of smoked fish that are most favored by consumers are obtained from fuel from shell and coconut husk.

The fuel used in the study was 1 kg for each smoking treatment consisting of coconut shell, coconut fiber and a combination of coconut shell and coconut fiber.

The smoking process activities at Ms. Nok's MSME use traditional methods where temperature control is carried out according to experience and visual observations from generation to generation. During the smoking process, the smoked stingray needs to be turned over periodically to ensure that all parts of the fish are evenly exposed to the smoke. The smoking activities carried out at Ms. Nok's MSME generally start at 12.00-14.00 WIB. This time was chosen because from morning until noon is the process of supplying raw materials, weeding, cleaning, cutting and draining the fish.

Protein Content of Smoked Stingray

Based on the results of the analysis of protein content in stingray smoking using different fuels, namely coconut shell, coconut fiber and a combination of both conducted at the Semarang Fishery Product Quality Testing Center (BPMHP), the results are shown in Table 1.

Table 1. Results of Protein Level Examination in Smoked Stingray Fish

No	Type of Smoke Raw Material	Repeat			Amount	Mean (%)
		I	II	III		
1.	A_1	25,06	25,50	26,55	77,11	25,70
2.	A_2	30,78	28,90	31,90	91,58	30,53
3.	$A_1.A_2$	33,45	30,34	31,47	95,26	31,75

The results of protein content in smoking stingrays using coconut shells obtained an average of 25.70%, smoking stingrays using coconut fibers obtained an average of 30.53%, while smoking stingrays using a combination of shells and coconut fibers obtained an average of 31.75%. The results of the protein content of smoked stingrays are contained in Table 1 of the following data, it is known that the protein content in smoked stingrays for 3 repetitions using the type of fuel combination between shell and coconut fiber and coconut fiber fuel is more than using the type of fuel coconut shell.

The difference in protein content of smoked stingray using coconut shell, coconut fiber and a combination of both for 3 repetitions is presented in the following graph.

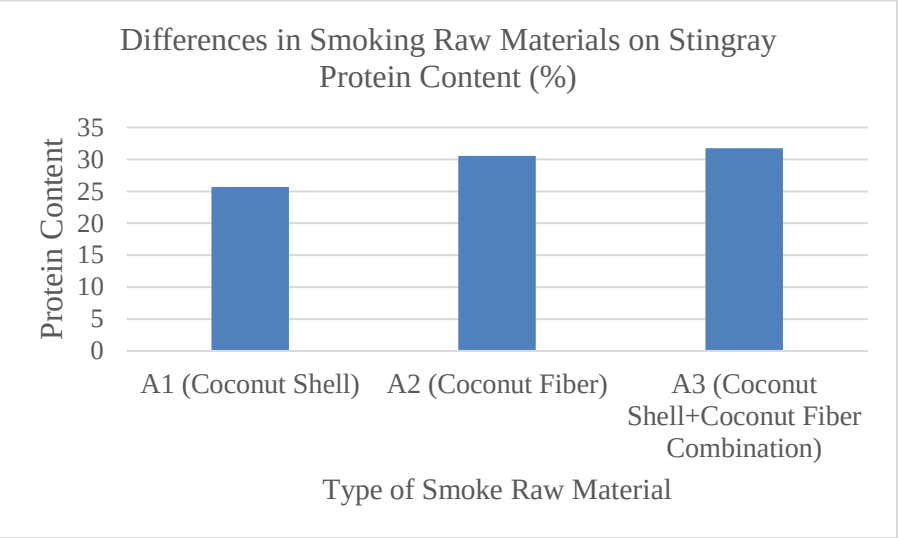

Figure 1. Graph of Differences in Smoking Raw Materials on Stingray Protein Content

The lowest protein content was found in stingrays smoked using coconut shell fuel types because smoking using coconut shell tends to produce higher temperatures than smoking temperatures using coconut fiber fuel types and a combination of shell and coconut fiber. Sirait and Saputra's research (2020) showed that the lowest protein content was found in smoked fish burned using coconut shells reaching 22.94%, this was due to the smoking process which produced higher temperatures so it was not efficient. The smoking process using fuel in the form of coconut fibers produces lower temperatures and tends to burn faster so that it produces less intensive heat compared to smoking using coconut shell fuel types. According to Hadi *et al.*, (2022) smoking using coconut fibers produces more even and stable heat in the smoke chamber so that the protein is not much decomposed.

According to Yunika *et al.*, (2020), the high protein content is thought to be due to low water content so that protein levels can increase, while the low protein content is thought to be due to the protein denaturation process due to high temperature processing. This is reinforced by Swastawati (2018), proteins exposed to high temperatures will cause denaturation and coagulation processes in proteins that can affect the quality of smoked fish. According to Lestari *et al.*, (2022) the denaturation process is a process that changes the tertiary protein structure to the basic structure. Changes in protein structure usually change the physical and chemical properties of the protein.

Data Normality Test and Variance Homogeneity Test

The classical assumption test applied to the study includes the Data Normality Test and

the Variant Homogeneity Test. The Normality Test aims to test whether the sample used comes from a population that follows a normal distribution pattern or not (Amry, 2011). The Homogeneity Test aims to test whether the variance between several populations is the same or not (Usmadi, 2020). The results of data analysis using the classical assumption test include data normality test and variant homegenity test:

Based on the decision-making criteria for the Normality Test using Kolmogorov-Smirnov, if the significance value (sig. 2-tailed) > 0.05 then H0 is accepted which indicates normally distributed data. Conversely, if the significance value (sig. 2-tailed) <0.05 then H0 is rejected H1 is accepted which indicates the data is not normally distributed. The sig value. (2-tailed) normality test on the use of protein levels and fuel types obtained sig (2-tailed) > 0.05, indicating the use of protein levels and fuel types are normally distributed or H0 is accepted.

Based on the decision-making criteria in the Variant Homogeneity Test using the Levene Test, if the significance value (sig.2-tailed) > 0.05 then H0 is accepted, indicating that the data is homogeneous. Conversely, if the significance value (sig. 2-tailed) < 0.05 then H0 is rejected H1 is accepted which indicates heterogeneous data. The sig. value based on mean is obtained > 0.05, which indicates that the data variance is homogeneous or H0 is accepted.

ANOVA Test and Tukey Test

After the classic assumption test is fulfilled, then the Anova Test "Analysis of Variance" is carried out to test whether there is a significant influence between the averages of two or more groups on the independent variable. According to Alamsyah (2021), the relationship between one dependent variable and one independent variable is known as One Way Anova. This anova test uses One Way Anova because there is a relationship between one dependent variable, namely protein content, and one independent variable, namely fuel type.The following are the results of the anova test:

Based on the decision-making criteria in the Anova Test "Analysis of Variance", if the significance value (sig. 2-tailed) > 0.05 then H0 is accepted, indicating there is no significant effect between the use of different types of smoke fuel on the protein content of stingray. Conversely, if the significance value (sig. 2-tailed) < 0.05 then H0 is rejected H1 is accepted which indicates there is a significant influence between the use of different types of smoke fuel on the protein content of stingray. The value of sig. (2-tailed) < 0.05 in the Anova Test which indicates there is a significant influence between the use of fuel types on the protein content of stingray.

After the Anova Test was conducted, the Tukey Test was used to identify which groups showed significant differences from each other. Based on the decision-making criteria in the

Tukey Test, the use of coconut shell smoke and coconut fiber fuel treatment groups resulted in sig < 0.05, indicating there was a significant difference between the treatment groups of shell and coconut fiber fuel types on protein content. In addition, the use of fuel between the coconut shell group and the combination of coconut shell and coconut fiber also resulted in sig < 0.05, indicating a significant difference. The use of coconut fiber smoke fuel treatment group with a combination of shell and coconut fiber obtained sig. > 0.05, which indicates there is no significant difference between the coconut fiber group and the combination of shell and coconut fiber. Furthermore, the Tukey HSDa test based on the mean value in subset 1, the type of coconut shell fuel produces a protein content of 25.70%, while in subset 2, the type of coconut fiber fuel produces a protein content of 30.53% and the type of fuel combination of shell and coconut fiber produces a protein content of 31.75%. Based on the average in each treatment, the type of fuel with the largest protein content value is the type of fuel with a combination of shell and coconut fiber with a protein content value of 31.75% and coconut fiber fuel with a protein content value of 30.53%.

This can be explained that coconut fibers play a greater role in producing smoke than coconut shells. The observation shows that the smoke produced by coconut fibers is more abundant and evenly distributed compared to the smoke produced by coconut shells. So that smoking with coconut fibers or a combination of coconut shell with coconut fibers produces smoked fish with higher protein levels.

CONCLUSION

Based on the findings and analysis conducted in this study, it is concluded that (1) There is a significant effect between the use of fuel types of coconut shell, coconut fiber and a combination of both on the protein content of stingray, (2) The highest protein content in stingray smoking is obtained by using a combination of fuel types between shell and coconut fiber and coconut fiber fuel, and lower protein levels are obtained from smoking using coconut shell fuel.

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