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QUALITY EVALUATION OF SMOKED FLYING FISH (*Hirundichthys oxycephalus*) THROUGH TOTAL PLATE COUNT METHOD AT THE SOMBA CULINARY TOURISM CENTER, MAJENE

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ABSTRACT

The process of processing smoked fish that does not pay attention to sanitation and hygiene standards, as well as open storage next to the road body, causes dust, germs, and bacteria to contaminate the quality of processed smoked flying fish in the Somba culinary tourism center. This study aims to evaluate the microbiological quality of smoked flying fish based on Total Plate Count (ALT) and water content to assess its compliance with food safety standards. This study used a combination method of sequential exploratory model, which is a combination research method that combines qualitative and quantitative research methods sequentially. Data collection was carried out by purposive sampling, and the parameters for this sampling were based on the 10 stalls with the most production and customers. The results showed that out of 10 samples, there were only four samples that met the SNI requirements of a maximum of 1.0×10^5 colonies/g, including samples S2 (2.74×10^4), S5 (2.53×10^4), S9 (2.33×10^4) and S10 (2.38×10^4). In contrast, the results of the water content test show that out of 10 samples, there are only three smoked flying fish samples that have a water content value that matches the maximum limit of smoked fish based on SNI, which is a maximum of 60% including samples S2, S5, and S9.

Keywords: ALT, Smoked Flying Fish, Water Content

1. INTRODUCTION

One of the Somba areas located in Mosso Village, Sendana Sub-district, Majene Regency, West Sulawesi Province is an area that has a distinctive culinary tour, namely smoked flying fish commonly called tui-tuing by the people of the Somba area[1]. The utilization of flying fish as a culinary specialty of this region has been known for a long time and has become the primary source of income for the community. Culinary tourism of smoked flying fish or tuing-tuing fish can be found when passing the trans-Sulawesi road, precisely in Somba Village[2]. In this area, stalls selling smoked flying fish are lined up on the left and right of the road. Until now, there have been 70 household units running smoked ikan terbang businesses with an average production of 1000-2000 fish per week[3].

Smoked fish is one of the most popular processed fish products in various parts of the world due to its distinctive and long-lasting taste[4]. However, based on field surveys, food safety is crucial in producing and consuming smoked fish. Some of the shortcomings in the smoked flying fish production process in the Somba culinary center include the processing process that is carried out paying less attention to sanitation

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aspects (product hygiene); where according to Fitriah et al.[2], the process of washing flying fish raw materials is still carried out on a floor that is not clean, as well as the processing equipment used is still less sterile. The manufacturing process that does not pay attention to sanitation and hygiene standards[5], as well as an open storage area next to the road body, causes dust, germs, and bacteria to contaminate the quality of processed smoked flying fish. One of the microbiological quality parameters commonly used to assess food freshness and safety is the Total Plate Count (ALT).

Total Plate Count (ALT) testing is a microbiological analysis method used to calculate the total number of aerobic bacterial colonies that grow on solid media under certain conditions. In smoked fish products, ALT is an essential indicator in evaluating the level of cleanliness, freshness, and potential risk of pathogenic microbes present in the product[6].

Several studies discussing general hygiene practices in smoked fish processing have been conducted, such as the research of Hermawan et al.[7], which revealed that smoked catfish has the potential to endanger health because the total number of microbes in several samples exceeds the safe limit set by SNI, this is related to the process of handling, processing, storage, distribution, to serving and handling during poor sales. According to Sirait & Saputra[8], the traditional fish smoking process, where fish is placed directly on an open grill rack for 3 hours, is less hygienic due to exposure to dust around the smoking area. Based on the results of laboratory tests, the water content of the smoked fish produced is still quite high, reaching 79.07%.

From some of the research results above, no research focuses on microbiological standards at the Somba Culinary Tourism Center, especially in processing smoked flying fish. In this context, evaluating the microbial quality of smoked fish through ALT and moisture content testing, one of the media for bacteria to multiply, is critical in maintaining product quality and safety. This study aims to evaluate the microbiological quality of smoked flying fish based on Total Plate Count (ALT) and moisture content to assess its compliance with food safety standards.

2. RESEARCH METHOD

Time and Place

This research was conducted from August to September 2024 in Somba Village. This location was selected based on the consideration that Somba Village is a culinary center, especially smoked flying fish. ALT and water content testing was conducted at the Integrated Laboratory, Universitas Sulawesi Barat.

Method

This research applies a combination method with a sequential exploratory model Sugiyono[9] explains that a sequential exploratory model is a research approach that combines qualitative and quantitative methods in stages. In the initial stage, this research used a qualitative approach, namely by directly observing the processing of smoked flying fish in Somba Village, and in the second stage, quantitative methods, namely by measuring the total plate number of smoked flying fish sold by traders in Somba Village.

Total Plate Count Test

The total plate count (ALT) testing process follows: Prepare and sterilize Nutrient Agar (NA) in an autoclave at 121°C for 10-15 minutes. Pour into Petri dishes and let it harden. Aseptically take 5 g of smoked fish sample and add 45 ml of sterile Nutrient Broth (NB) to obtain a 10^{-1} dilution. Stir the mixture for 1-2 minutes to ensure it is well dispersed. Add 1 mL of the 10^{-1} dilution to 9 ml of sterile NB to make a 10^{-2} dilution. If necessary, repeat this step for further dilutions (e.g., 10^{-3}, 10^{-4}). Inoculate each dilution (0.1 mL) onto NA plates using a micropipette. Spread the inoculum with a sterile spatula until absorbed. Incubate the Petri dishes at 35-37°C for 24-48 hours. After incubation, check for microbial colony

growth. Count the number of colonies on the Petri dishes. Record the dilutions and total number of colonies to calculate the Total Plate Count.

$$N = \frac{\varepsilon C}{[(1 \times n1) + (0{,}1 \times n2)] \times (d)}$$

Description:

N = Number of product colonies, expressed as colonies/mL or colonies/g
εC = Number of colonies in all counted dishes
n_1 = The number of cups in the first dilution counted.
n_2 = The number of cups in the second dilution counted.
d = The first dilution counted.

Moisture Content Test

The moisture content can be determined using a conventional oven or Thermogravimetric method, where water is evaporated by heating it at 105°C for 3 hours. Afterward, the weight of the material is weighed before and after the heating process to calculate the moisture content lost. The formula that can be used is as follows:

$$\text{Water Content (\%)} = \frac{A-(B-C)}{A}$$

Description:
A = Initial sample weight
B = Weight of sample and dry cup
C = Weight of empty cup

Data Analysis

Data from laboratory tests were presented descriptively. The results of observations regarding the number of microbes (ALT) and moisture content were compiled in tabular form. Furthermore, the data were analyzed and compared with the quality standards for smoked fish.

3. RESULT AND DISCUSSION

Total Plate Numbers of Smoked Flying Fish (Tui-Tuing)

Total microbial analysis is used to assess the microbiological quality of food. Knowing the microbiological quality is vital to identify the level of microbial contamination in food products[10]. The results of the total bacterial contamination test of smoked flying fish at the Somba Culinary Tourism Center, Majene Regency, are presented in Table 1.

Table 1. Total plate numbers test results

Sample	(Average Colonies/g)
S1	$2{,}81\times10^5$
S2	$2{,}74\times10^4$
S3	$3{,}97\times10^5$
S4	$3{,}92\times10^6$
S5	$2{,}53\times10^4$
S6	$3{,}31\times10^6$
S7	$3{,}58\times10^6$
S8	$3{,}56\times10^6$
S9	$2{,}33\times10^4$
S10	$2{,}38\times10^4$

The average microbial count of smoked flying fish from 10 stalls in the Somba Culinary Tourism Center of Majene Regency was highest in sample S4 at $3.92\text{x}10^6$ colonies/g and lowest in sample S9 at $2.33\ \text{x}10^4$ colonies/g. The results showed that some smoked flying fish had ALT values that exceeded the maximum limit of microbial contamination based on SNI, which is a maximum of 1.0×10^5 colonies/g. Based on the test results in Table 1, the average total microbes are only 4 samples that meet the SNI requirements of smoked fish, namely S2, S5, S9, and S10.

Many bacteria are caused by cross-contamination from open sales and unhygienic handling. According to Bardoeet al.[11], pre-smoking and post-smoking along the fish processing chain can affect the number and diversity of microbes growing on smoked fish products. When conducting production activities, smoked flying fish traders in the Somba Region do not apply good sanitation where the fish to be smoked is not weeded (removed gills and entrails) first and washed. When smoked, the fish is turned over using hands without gloves. The smoker is located on the side of the road, which causes flying dust to contaminate the smoked fish. Some documentation of the

process of buying smoked flying fish with traders who do not use gloves can be seen in Figure 1.

Figure 1. Unhygienic smoking and packaging

In the process of smoking flying fish (tui-tuing), not all fish used are freshly caught. Fish processors often use fish they have purchased and stored in the refrigerator. This is done because fresh fish stock may not always be available or because of the need to delay the smoking process until a more appropriate time. After smoking, the fish is left on the smoking rack until a customer buys it. There is no packaging process to protect the product from dust and smoke, so harmful compounds such as tar and benzopyrene can enter the smoked fish product. According to Hermawan et al.[7], the absence of a packaging process on smoked fish and unclean hands during the handling process causes the ALT value of smoked fish not to meet SNI standards. Furthermore, Zakariah et al.[12] explained that products that do not use packaging cause the product to be contaminated with microbes that can cause food poisoning.

Suroso et al.[13] in their research stated that the process of smoking fish, traditionally or by direct combustion, has several negative impacts, namely inconsistent product quality, the accumulation of harmful compounds in products derived from smoke, such as tar and benzopyrene, that also causes air pollution, and smoking efficiency is difficult to control.

In addition, based on observations, it is known that fish that has been smoked and not sold out is often stored back in the refrigerator for three to six days. Before being sold again, the fish is first heated for 5-10 minutes. This storage process can affect the quality of the fish in terms of flavor, texture, and microbiological quality. According to Geraldo et al.[5], storing fish in the refrigerator at low temperatures does help slow the growth of microorganisms, but if not done correctly, contamination or an increase in the number of bacteria can occur, affecting the quality of smoked fish.

Storage practices before and after smoking are critical factors that must be considered in maintaining product quality because fish that are not entirely fresh or stored for too long can experience microbiological deterioration. This can cause an increase in Total Plate Count (ALT) in smoked fish, potentially not meeting food safety standards following SNI.

Meanwhile, according to Suroso et al.[13], in their research on smoked fish in Jayapura, the causes of many bacteria include improper product handling where cross-contamination occurs due to dirty (non-sterile) smoking places and unmaintained smoking places. The number of traders who do not understand how to sell merchandise properly makes the products they sell contaminated with pathogenic microbes because they sell them in the open. The results of research by Hermawan et al.[7] show that smoked catfish purchased by consumers is still unsafe and potentially harmful to health because the total number of microbes in several samples tested exceeds the safe limit set by SNI, which is more than 1.0 x 10^5 colonies/g. Therefore, improvements are needed in various stages, from handling, processing, storage, and distribution to presentation and handling during sales by traders.

Setyowati & Agustin[14] explained that products with high ALT could contain pathogenic bacteria such as *Escherichia coli*, *Salmonella* sp, or *Staphylococcus aureus*, which can cause food poisoning, gastrointestinal infections, diarrhea, nausea, and vomiting. Furthermore, Adeyeye et al.[15] explained that traditionally processed smoked fish needs to be further processed using heat before consumption because non-

heat processing can pose a microbiological risk. *Listeria monocytogenes* was found in some smoked fish samples, which can endanger consumers.

Moisture Content of Smoked Flying Fish (Tui-Tuing)

Moisture content is one of the critical characteristics of food ingredients. Determining moisture content is one of the most essential chemical laboratory test methods in the food industry to determine the quality and resistance of food to damage that may occur[16]. The determination of water content using the gravimetric method was carried out in this study by heating the water with the principle of evaporating the water contained in smoked flying fish (sample). The results of the water content analysis in smoked flying fish products in Somba Culinary Tourism Center, Majene Regency, are presented in Table 2.

Table 2. Water content test results

Sample	Test(%)			Average (%)
	1	2	3	
S1	65	60	60	62
S2	60	60	60	60
S3	65	65	65	65
S4	70	70	70	70
S5	60	60	60	60
S6	65	65	60	63
S7	70	65	70	68
S8	70	70	70	70
S9	60	60	60	60
S10	60	60	65	62

The average water content of smoked flying fish from 10 stalls in the Somba Culinary Tourism Center of Majene Regency is highest in samples S4 and S8 at 70%, while the lowest is in samples S2, S5, and S9 at 60%. This shows that only three samples of smoked flying fish have water content values that match the maximum limit of smoked fish based on SNI, which is a maximum of 60%. Smoking aims to give the product a distinctive aroma and flavor of smoke and as a preservation method that reduces moisture content[17]. During the smoking process, the heat generated helps evaporate the water in the fish. The longer the smoking process, the more water is evaporated from the fish, so the moisture content in the final product will be lower[18]. A decrease in moisture content can be relevant for water activity, which can affect the rate of microbial proliferation in fish[5].

The cause of the high value of water content in smoked flying fish is that the smoking process carried out by traders in the Somba area only lasts 1-1.5 hours. Fish smoked for 1 hour at too close a distance from the heat source is likely to have a reasonably high water content still, so sometimes smoked flying fish in the Somba area only lasts for two to three days. Furthermore, Darianto[19] explains that high water content is caused by a relatively short smoking time and fluctuating smoking temperatures, so the water evaporation process becomes unstable and the reduction in the water content value in the product is less. To get a stable water content and meet SNI requirements, it is better to use a closed smoking device.

According to Sirait & Saputra[8], the fish smoking process applied by the community in Maluku is done traditionally, where smoked fish is placed directly on an open grill rack for 3 hours. This method is less hygienic due to exposure to dust around the smoking area. Based on the results of laboratory tests, the moisture content of smoked fish produced is still quite high, reaching 79.07%, and has not met the standards of SNI Smoked Fish 2727.1-2009, where the maximum allowable moisture content is 60%[20]. The distance between the smoked fish and the heat source, as well as the duration of the smoking process, significantly impacts the quality of smoked fish[21]. The ideal distance between the smoked fish and the heat source is about 40 cm, with a smoking time of 6 hours. At this distance, the average moisture content of smoked catfish was 55.61%. Ensuring a stable temperature in the smoking chamber and adequate smoke density is crucial to maintaining the quality of smoked fish[8].

From the data above, samples S2, S5, and S9 have a moisture content that complies with SNI standards (≤60%) and meets ALT requirements, suggesting that controlling moisture content can contribute to microbiological quality contro[15]. Other samples that did not meet the moisture content requirement may have potential ALT increases or microbial problems in the future, even though some (such as S10) met the current ALT standard. Effective moisture content control plays a vital role in maintaining the microbiological safety and quality of smoked flying fish, as lower moisture content tends to inhibit the growth of microorganisms and keep ALT within safe limits. This is in line with. Sari et al.[22] stated that the development of microorganisms dramatically affects the water activity in smoked fish. A decrease in water activity in smoked fish of less than 60% can inhibit the growth of microorganisms such as molds, yeasts, and bacteria.

4. CONCLUSION

Based on the results of the study, it can be concluded that the microbiological quality of smoked flying fish based on the Total Plate Numbers (ALT) parameter that meets SNI requirements is found in samples S2 (2.74×104), S5 (2.53×104), S9 (2.33×104) and S10 (2.38×104). Meanwhile, the water content test results showed that out of 10 samples, only three smoked flying fish samples had water content values that matched the maximum limit of smoked fish based on SNI, which is a maximum of 60%, including samples S2, S5, and S9. This indicates that although some samples meet the microbiological standards, more attention needs to be paid to the moisture content to ensure the overall product meets food safety standards.

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