



Evaluation of Environmental Suitability and Production Facilities Compliance with Food Safety Standards in the Smoked Fish Industry in Kendari City, Indonesia

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ABSTRACT

Food safety is critical to the food industry, particularly for high-consumption products like smoked fish. Non-compliance with production standards can increase the risk of microbiological contamination, including *Escherichia coli* and *Salmonella* spp. This study endeavors to evaluate the appropriateness of production site locations, environmental conditions, and the conformity of buildings and facilities utilized in smoked fish production in Kendari City, Indonesia, with the standards stipulated in The Good Food Production Practices for Home Industries (CPPB-IRT). A descriptive observational study design involved 13 purposively selected smoked fish producers. Data were collected through direct observations using a CPPB-IRT-based checklist and classified according to the level of non-compliance (critical, serious, major, and minor). The findings revealed that all producers failed to meet the requirements for safe production site locations and environments, categorized as serious non-compliance. Regarding production buildings and facilities, only six producers (46.15%) had spacious production areas that were not mixed with other products, while other aspects such as flooring, walls, ventilation, and doors did not meet the standards. The primary factors contributing to non-compliance included limited resources, lack of awareness regarding hygiene and sanitation standards, and inadequate regulatory oversight. These findings highlight the need for interventions such as increasing producers' awareness, providing technical training, and strengthening regulatory supervision to ensure food safety compliance. This study provides recommendations for producers and policymakers to enhance the quality of smoked fish production, thereby reducing contamination risks and safeguarding public health.

Keywords: CPPB-IRT, Food safety, Hygiene and sanitation, Production facilities, Smoked fish.

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INTRODUCTION

Food safety is one of the key pillars in the food industry, especially for high-consumption products such as smoked fish (Fung et al., 2018). The public widely consumes this product due to its longer shelf life and distinctive flavor. However, processing that does not meet hygiene and sanitation standards can increase the risk of microbiological

contamination, which can potentially cause foodborne illness (Ehuwa et al., 2021).

One of the major challenges in smoked fish production is the high risk of contamination by *Escherichia coli* and *Salmonella* spp., two major pathogens often associated with food poisoning events. WHO (2022) reports that there are about 600 million cases of foodborne illnesses worldwide each year, with 420,000 deaths. Most of these cases are

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caused by poor sanitation in the food production chain, including in the fish processing industry. In Indonesia, BPOM (2021) also noted that about 30% of the total food poisoning incidents that year were related to non-compliance with food safety standards, including in processed fish products such as smoked fish.

Research conducted in various regions shows that microbial contamination of smoked fish is still a serious problem. A study in Probolinggo District, for example, found that 40% of smoked fish samples tested were contaminated with *Shigella* sp., indicating weaknesses in the application of hygiene standards in the production process (Ilhamy et al., 2025). Similar findings were also reported in a study in Sangihe Regency, where samples of smoked fish sold in traditional markets contained *Staphylococcus aureus* exceeding the food safety threshold (Karimela & Mandeno, 2019). In addition, research in Gorontalo revealed that although the Total Plate Count (TPC) value of smoked roa fish was still within safe limits, the number of molds in some samples exceeded the set standard, indicating the need for improvement in the storage and handling aspects of smoked fish products (Adam et al., 2023).

In Indonesia, food safety regulations for the home industry are set out in the standards of the Good Food Production Practices for the Home Industry (CPPB-IRT), which aims to ensure that each stage of production meets strict sanitation requirements (Fadhila et al., 2024). The standard covers aspects of production location, environmental conditions, and compliance with building structures and production facilities to prevent the risk of cross-contamination. However, the implementation of this standard still faces various obstacles. A study in Kota Baru, Jambi showed that almost 73.3% of food household industries (IRTP) have not fully implemented the CPPB-IRT properly, especially in terms of clean water supply, pest control, cleanliness of facilities, and adequate sanitation practices (Hidayati et al., 2021).

The smoked fish industry in Kendari has great economic potential, but the implementation of food safety standards in this sector has not received adequate attention (Rosmawati et al., 2021). Many smoked fish producers still use traditional processing methods without clear separation between production areas and other activities, which can increase the risk of cross-contamination (Pramono et al., 2024). In addition, there are still challenges in regulatory oversight and a lack of training programs for producers to raise awareness of the importance of sanitation and hygiene in the production process (Widodo et al., 2024).

Several studies have shown that smoked fish processing units in several regions have varying levels of microbial contamination, signaling the need for improved food safety standards in this industry. A study in Ambon City, for example, revealed that smoked fish products sold in several markets showed high levels of microbial contamination, making it important to standardize the smoking process and increase the capacity of producers through hygiene and sanitation training (Tuhumuri, 2022). Moreover, research also shows that the low awareness of business actors on the importance of environmental hygiene and management of production facilities contributes to the poor food safety conditions in the smoked fish industry (Ritonga et al., 2024).

Considering the above issues, this study aims to evaluate the suitability of production sites and environmental conditions in the smoked fish industry in Kendari based on CPPB-IRT standards. In addition, this study will also assess the level of compliance with building structures and production facilities and identify the main factors causing non-compliance with food safety standards. The results of this study are expected to provide evidence-based recommendations for industry players, regulators and other stakeholders to improve production standards.

MATERIALS & METHODS

Study Design

This study employed a descriptive observational design with a survey approach, aimed at providing a detailed overview of the compliance of smoked fish production processes with food safety standards.

Study Location and Sampling Technique

The research was conducted in Kendari City, involving 13 smoked fish producers as study samples. The samples were selected purposively based on specific criteria, such as data availability and accessibility for observation. This selection method ensured the representation of various production conditions and practices within the study area.

Variables, Instruments and Analysis

The research instrument used was a checklist based on the CPPB-IRT standard, designed to assess the compliance of smoked fish production processes with established safety requirements. Each indicator in the checklist was evaluated through direct on-site observations, covering environmental conditions, facilities, and production practices. The evaluation results were classified into four levels of non-compliance: Critical (directly endangers food safety), Serious (significantly affects product quality and safety), Major (impacts the effectiveness of quality control measures), and Minor (administrative in nature). The assessment process involved documenting findings in the checklist and identifying unmet indicators. Each non-compliance was categorized according to its level of risk.

Data were analyzed descriptively by classifying each indicator based on the level of non-compliance (critical, serious, major and minor). The results were presented in tables and percentages to illustrate producers' compliance with food safety standards. Interpretation was conducted to identify the most critical non-compliance aspects and formulate recommendations for improvement.

RESULTS & DISCUSSION

Characteristics of Producers

Observations indicate that the majority of smoked fish producers in Kendari City have a low to moderate level of education, with most having completed only high school or junior high school (Table 1). This level of education may influence their understanding of food safety standards and hygiene practices in smoked fish production. Higher education levels are generally associated with increased awareness of the importance of implementing food safety

Table 1: Socioeconomic and Production Characteristics of Smoked Fish Producers in Kendari City

Name of Producer	Level of education	Location	Duration of Production (Year)	Production Capacity	Quantity (Kg)	Smoking technique	Type of fish
Producer A	High school	Antasari	4	Everyday	100	Traditional	Skipjack
Producer B	High school	Andounohu	10	Everyday	30	Traditional	Skipjack
Producer C	High school	Antasari	4	Everyday	25	Traditional	Skipjack
Producer D	High school	Andounohu	20	Everyday	40	Traditional	Various types
Producer E	Higher education	Andounohu	25	Everyday	100	Traditional	Various types
Producer F	High school	Lalonggasumeeto	30	Everyday	100	Traditional	Tuna
Producer G	Primary school	Tolawawo	25	Everyday	40	Traditional	Various types
Producer H	Middle school	Lalonggasumeeto	15	3 times weekly	30	Traditional	Cobs
Producer I	High school	Lalonggasumeeto	15	3 times weekly	30	Traditional	Skipjack
Producer J	Middle school	Lalonggasumeeto	30	3 times weekly	40	Traditional	Tuna
Producer K	Middle school	Lalonggasumeeto	20	3 times weekly	30	Traditional	Cobs
Producer L	Primary school	Lalonggasumeeto	15	3 times weekly	90	Traditional	Various types
Producer M	Middle school	Lalonggasumeeto	20	Everyday	30	Traditional	Cobs

Table 2: Verification of Non-Conformities in Food Safety Standards for Smoked Fish Production in Kendari City

Variable/Indicator	Non-conformance	Smoked fish manufacturer													n (%) for qualified
		A	B	C	D	E	F	G	H	I	J	K	L	M	
Production Site and Environment free from garbage, dirt, and dust	Serious	No	No	No	No	No	No	No	No	No	No	No	No	No	0(0)
Buildings and Production Facilities															
Production space is airy, easy to clean, and not used to Mayor produce other foods		No	Yes	No	No	No	Yes	No	No	Yes	Yes	No	Yes	Yes	6(46,15)
Floors, walls, and ceilings maintained clean and dust-free	Serious	No	No	No	No	No	No	No	No	No	No	No	No	No	0(0)
Ventilation, doors, and windows are maintained and clean	Serious	No	No	No	No	No	No	No	No	No	No	No	No	No	0(0)

**Fig. 1:** Smoked Fish Production Site with Poor Hygiene and Untidy Environment.

procedures, which in turn affects producers' compliance with safe production standards (Baringbing et al., 2023).

Most producers are located in Lalonggasumeeto, which serves as the primary hub for the smoked fish industry in Kendari City (Table 1). The concentration of this industry in a single area can impact product quality, particularly if the production environment does not meet proper hygiene standards. In terms of business experience, more than half of the producers have been operating for

over ten years. However, experience alone does not necessarily correlate with adherence to food safety standards, as traditional smoking methods remain widely used (Fikrunnisa et al., 2024).

**Fig. 2:** Unhygienic and Constrained Smoked Fish Processing Facility.

Production frequency is relatively high, with most producers manufacturing smoked fish daily, at capacities ranging between 25 and 100kg. Approximately 38.5% of producers have production capacities reaching up to 100kg per day, while the remainder produce between 30 and 40kg

per day (Table 1). The high market demand is the primary driver of this production volume (Wurlina et al., 2021); however, the continued reliance on traditional smoking methods presents challenges in implementing stricter sanitation and hygiene standards.

The types of fish used vary, including skipjack, mackerel tuna, and yellowfin tuna, demonstrating flexibility in raw material selection (Saputra et al., 2022). However, this variation necessitates stringent management to ensure that each type of smoked fish complies with food safety standards (Af'e et al., 2021). Overall, the characteristics of smoked fish producers in Kendari City reflect an industry that still depends on traditional production methods, with varying levels of awareness regarding food safety standards. Factors such as education, business experience, production location and smoking techniques play a critical role in efforts to improve quality and food safety (Mishra et al., 2023).

Production Location and Environment

The ideal location for smoked fish production should be in a clean area, free from potential sources of contamination, and have adequate road access (Table 2) (Onesmo et al., 2023). Additionally, the layout of the building and its surroundings should be designed to prevent cross-contamination of processed fish products (Wu et al., 2023). However, observations revealed that none of the producers met the requirements for production location and environment. This situation places the production environment in the category of serious risk, directly impacting the safety of smoked fish.

Producers' inability to meet production location and environmental standards may stem from a lack of understanding of the importance of hygiene and proper environmental management to prevent contamination (Okpala et al., 2021). Additionally, resource constraints, such as financial limitations for facility improvements (Mangla et al., 2020) and insufficient technical assistance from relevant authorities (O'Hara et al., 2021), further exacerbate the issue. This situation is compounded by weak regulatory oversight of small-scale producers in certain regions (Thilmany et al., 2020), leading them to neglect fundamental food safety principles. If left unaddressed, this could result in smoked fish products that pose significant health risks to consumers (Sheng et al., 2020).

Production Buildings and Facilities

Smoked fish production buildings and facilities should be designed to provide optimal protection against potential contamination (Table 2) (Ahmad et al., 2021). These standards can be achieved through the use of hygienic and easy-to-clean building materials, a layout that facilitates smooth production flow, and regular facility maintenance (Lelieveld et al., 2023). A crucial element is the separation of work areas, such as raw material reception, processing, and final product storage, to prevent cross-contamination during production (Candrianto et al., 2024).

Findings from this study indicate that the majority of smoked fish producers in the study area do not meet the required standards for production buildings and facilities. Among all producers, only six (46.15%) have spacious

production areas that are not used for processing other food products. Furthermore, none of the producers meet the required criteria in terms of floor, wall, ventilation, door maintenance, and cleanliness. This highlights significant weaknesses in compliance with infrastructure standards that could impact product safety (Okpala et al., 2021).

The low level of compliance with production building and facility standards can be attributed to several factors. One major issue is the limited knowledge among producers regarding the importance of facility management by food safety standards (Haiyan et al., 2020). Additionally, economic factors, such as the high costs associated with renovations or facility upgrades, serve as major obstacles (Liao et al., 2023). The lack of regulatory support from local governments, including minimal inspections and technical guidance (Borraz et al., 2020), further exacerbates this situation. As a result, producers tend to maintain existing facilities without making necessary improvements (Baur et al., 2020).

The absence of work area separation and unhygienic building conditions create significant opportunities for cross-contamination during production (Pakdel et al., 2023). For example, contaminated raw materials can easily affect the final product if work areas are not properly organized (Luo et al., 2021). Additionally, inadequate facility maintenance, such as failing to repair damaged floors or walls, fosters an environment conducive to the growth of pathogenic microorganisms (Fig. 1) (Andres et al., 2024). If these conditions are not promptly addressed, the smoked fish produced could become a public health hazard (Andhikawati et al., 2021), ultimately jeopardizing both the reputation and sustainability of producers' businesses (Conroy et al., 2022).

Conclusion and Recommendations

The results of this study indicate that the production locations, environmental conditions, and infrastructure of smoked fish processing facilities in Kendari City do not meet the food safety standards outlined in CPPB-IRT. None of the producers comply with the requirements for safe production locations and environments, with most classified under serious non-compliance. Additionally, only 46.15% of producers possess production spaces that meet the standards, while aspects such as flooring, walls, ventilation, and overall cleanliness remain inadequate (Fig. 2). The primary factors contributing to these deficiencies include limited resources, a lack of awareness regarding hygiene and sanitation standards, and insufficient regulatory oversight. These inadequacies elevate the risk of microbiological contamination, potentially endangering consumer health.

To enhance compliance with food safety standards, continuous education and training programs on hygiene and sanitation practices in smoked fish production are necessary. Regulatory authorities must also enforce stricter monitoring and provide technical assistance to ensure better adherence to food safety regulations. Furthermore, producers should be encouraged to improve their production locations, environmental conditions, and infrastructure to align with established standards. Implementing these measures is expected to

enhance the safety of smoked fish products and better protect public health.

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