Evaluation of food safety compliance and good manufacturing practices (GMP) in processed fish industry of Bataan, Philippines

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Abstract. Fish has become an increasingly affordable and available source of animal protein, but facing food safety challenges. Improper manufacturing practices are leading to microbial contamination and foodborne illnesses. Small-scale fish processors, producing smoked and dried-salted fish, are of particular concern with traditional preservation methods and inadequate hygiene practices contributing to safety risks. Fish processing industry in the province of Bataan plays a significant role in the livelihood and food source in the area. With the increasing interest and concern over food safety, this study was conducted to assess production practices of backyard fish processors. Evaluation and assessment were carried out on manufacturing practices of small-scale fish processing industry including: a. plants and grounds for structural facilities); b. sanitation and hygiene practices; and c. process and controls through Key Informant Interview and Focus Group Discussion. Effects of the production practices were analyzed using Spearman test. Results showed that analysis of the mean (1.63±0.40) adequacy of facility indicates that parameters were negligible. Analysis of the mean extent of adoption revealed a score of 1.97±0.29, indicating a fair adoption of the hygiene and sanitation practices, but not good enough for a good production. A mean extent of adoption demonstrated a score of 2.37±0.39, revealing a fair adoption of proper processes and controls. Contaminants observed in processed fish products included aerobic plate count (52%), *Staphylococcus aureus* (35.65%), yeast and molds (15.77%), *Escherichia coli* (4.94%), and *Salmonella* (20.71%). Likewise, 66.67% histamine contamination was revealed. Data showed that these did not meet the food safety standards set by the government. Spearman's test revealed a negative correlation ($p < 0.05$) with all food contaminants. An inverse correlation was observed, suggesting that higher production scores link to lower contamination. Results suggest that adoption of good manufacturing practices could positively impact of food safety of processed fish products.

Keywords: food contaminants, foodborne illnesses, production practices, safe food, traditional fish processing.

Introduction. Fish has become an increasingly affordable and available source of animal protein over the past six decades, emerging as a major source of protein that drives global fih production growth (Vergis et al 2021; PSA 2023). Fish functions as a basic dietary component which plays a crucial role in maintaining both human health and food security (Gephart et al 2021). The food chain experiences safety problems because of several factors including microbial contamination and chemical contaminants along inadequate personal and environmental cleanliness practices (Fung et al 2018). The international trade of fish, seafoods, eggs, and cereals continues to face food safety challenges (Pouokam et al 2017), posing risks for paramount items in trade.

In the Philippines, where fish is considered as a staple food and a primary source protein, the lack of awareness of food-borne illneses has contributed to a lack of adherence to proper food handling practices (Vizon et al 2019). With the increase in the country's fish production, probems associated with the quality and safety of fish products have emerged due to poor sanitation, improper handling, and inadequate food storage (Amascual et al 2020; Bigueja 2020). Kumar (2019) demonstrated that people still use traditional food preservation methods which include smoking and drying and fermenting but food safety management processes remain neglected.

The previous outbreaks which occurred in the Philippines (Azanza et al 2019) together with the food poisoning incidents which took place in Palawan and Camarines Sur and Bulacan (Bolado 2011; Collado et al 2015) and Boracay (seafood-related) demonstrate the urgent requirement for better food protection methods. The market distribution of 'double dead' or 'botcha' tainted fish raises alarms because it stems from inadequate fish handling and production methods. Food handling deficiencies together with poor hygiene practices enable pathogenic bacteria to contaminate food products which create major health hazards (Adesetan et al 2017). Food products maintain high microbial levels because of inadequate storage practices and poor hygiene conditions and insufficient sanitation measures (Steele & Odumeru 2004). The research evaluates production methods which affect food safety in Bataan Province's small-scale fish production operations that produce smoked fish and dried-salted fish.

Fish processing industry in the province of Bataan plays a significant role in the livelihood and food source in the area. With the increasing interest and concern over food safety, this study was conducted to assess production practices of backyard fish processors in accordance with FDA (2004) and the Philippine National Standards (PNS).

Material and Method

Study site. This study was conducted from January 2024 to early months of 2025 at Bataan, Philippines (Figure 1), which extends into the South China Sea and northwestward into Subic, while it encloses Manila Bay to the east. Bataan is a historical penisula province with an estimated area 1,372.98 km^2 or about 530.11 sq mi (Philippine Statistic Authority n.d.). The province is known for its fisheries activities, including production of tilapia, milkfish, prawns, shrimps, mangrove crabs, and bivalves. Major processed fish products are fermented shrimp (*Acetes* sp.), smoked fish and dried-salted fish, providing livelihoods specifically in the municipalities of Orion, Limay, Pilar and city of Balanga (Tapang et al 2026; De Leon 2020), which of a great interest for food safety management.

Data gathering procedure. Evaluation and assessment were carried out on manufacturing practices of small-scale fish processing industry including: a. plants and grounds for structural facilities); b. sanitation and hygiene practices; and c. process and controls. Processing facilities were given code rather than actual names for privacy and protection of data subjects. A key informant interview (KII) and focus group discussion (FGD) were conducted to assess the production practices of the producers. For plants and grounds, the adequacy of each parameter was evaluated as described in Table 1. Each parameter was responded with a modified one through five Likert (1932) scale.

Table 1

Adequacy index of structural facilities of backyard fish processors

Adequacy index	*Rating*	*Descriptive analysis*
4.21-5.00	Very adequate	Tangibly present and used regularly
3.41-4.20	Adequate	Good enough for what is required or needed
2.61-3.40	Partially adequate	There is a presence but not good enough for a good production
1.81-2.60	Not adequate	Very little presence in an incomplete manner
1.00-1.80	Absent	No presence at all

On the other hand, assessment of extent of adoption for both sanitation and hygiene and process and controls was presented in Table 2.

Effects of the production practices were analyzed. All municipalities were considered as sampling sites collecting a total of 25 smoked-fish samples and 17 dried-salted fish samples from the producers.

Table 2

Adoption index of sanitation and hygiene and process and controls

Adequacy index	*Rating*	*Descriptive analysis*
4.21-5.00	Always adopted	Excellently adopted and practiced
3.41-4.20	Often adopted	Very good adoption
2.61-3.40	Sometimes adopted	Good enough for what is required
1.81-2.60	Rarely adopted	Fair adoption but not enough for a good production
1.00-1.80	Not adopted	No adoption at all

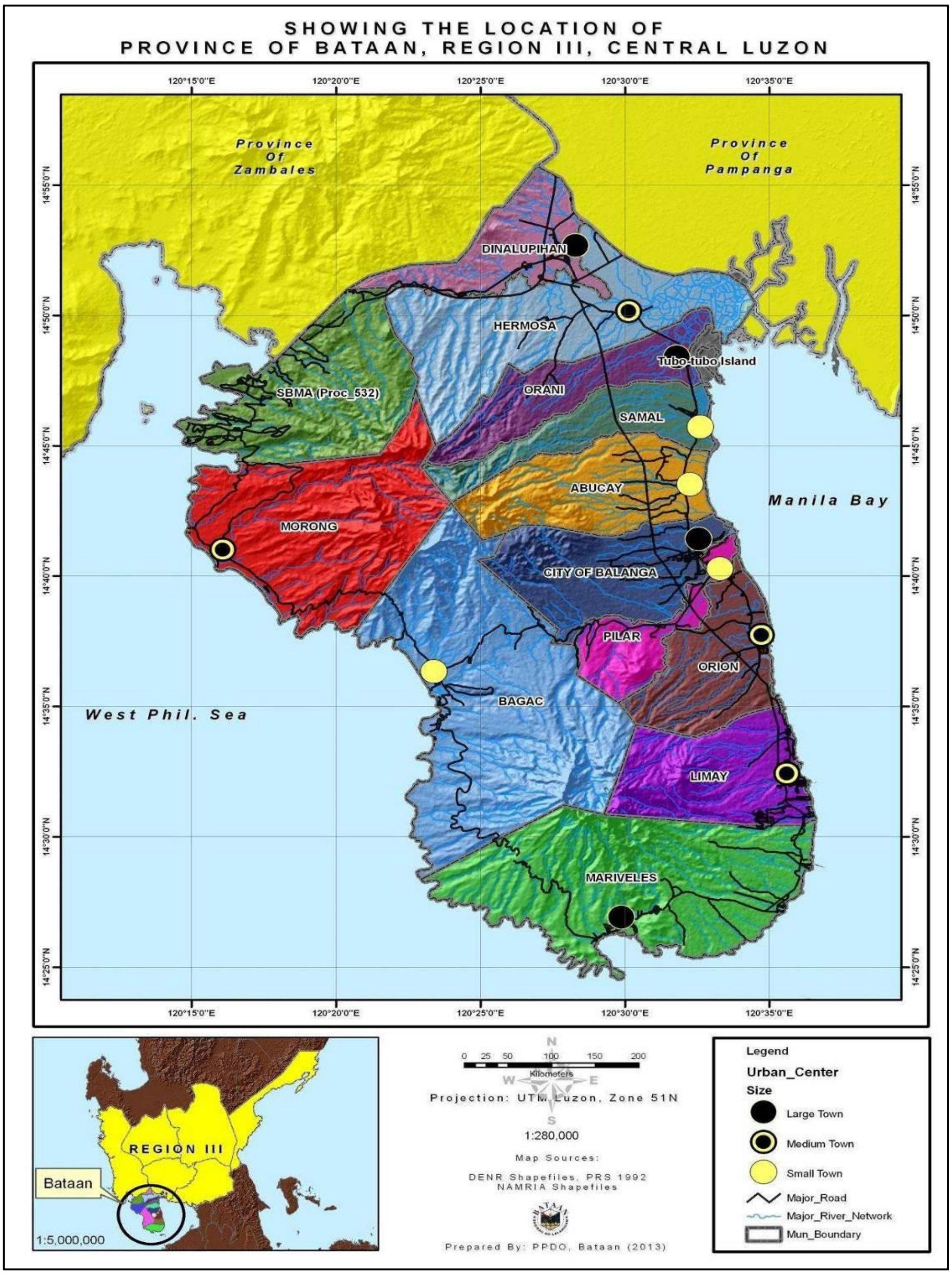

Figure 1. The location of province of Bataan, Philippines, Region III, Central Luzon (source: https://bataan.gov.ph/wp-content/uploads/2025/01/SOCIO-ECONOMIC-PROFILE-2023.pdf).

Sample collection and analyses. Manufactured fish products were collected from the production area using an aseptic technique. In aseptic technique, collector's hands were sanitized with 70% ethanol and sterile gloves were worn prior to collection of samples. Samples were weighed, sealed in a ziplocked bag, and brought to the Department of

Science & Technology (DOST) laboratory for food contaminant analyses. Microbial profiling and chemical analysis were performed using Petri film plating and AOAC (2012), respectively.

***Statistical analysis**.* All data were consolidated and analyzed using descriptive statistics. The data were summarized and presented, including mean and standard deviation. Results for microbial and chemical profiling were compared to the existing food safety standars: Food and Drugs Administration (FDA:-Administrative Order 153, series of 2004 (FDA: AO153, s. 2004) and the Philippine National Standards (PNS), which were anchored to the Codex Alimentarius (FAO & WHO 2023). Spearman's correlation was used to measure the strength of relationship between the production practices and microbial contents of the processed fish products.

Results

***Plants and grounds**.* The adequacy of the structural facilities in the plants and grounds is generally absent (Table 3).

Table 3
Adequacy of the structural facilities in the plants and grounds of small-scale fish processors

Plants and grounds	*Mean*	*SD*	*Remarks*
1. Availability of good working facility of the right design, construction, and size based on the process	1.37	0.67	Absent; no presence at all
2. Water treatment facilities	1.00	0.00	Absent; no presence at all
3. Effluent treatment facilities	1.00	0.00	Absent; no presence at all
4. Drainage facilities	2.03	0.17	Not adequate; there is a very little presence in an incomplete manner
5. Toilet facilities	2.09	0.34	Not adequate; there is very little presence in an incomplete manner
6. Waste disposal facilities	1.49	0.53	Absent; no presence at all
7. Availability of equipment and machinery	1.52	0.86	Absent; no presence at all
8. Laboratory equipment facilities	1.00	0.00	Absent; no presence at all
9. Rest/dining room for the processors	1.21	0.59	Absent; no presence at all
10. Availability of insect netting	1.16	1.23	Absent; no presence at all
11. Cold storage facilities	2.00	0.39	Not adequate; there is very little presence in an incomplete manner
12. Receiving and processing area	2.01	0.51	Not adequate; there is very little presence in an incomplete manner
13. Storage facilities	2.52	0.70	Not adequate; there is very little presence in an incomplete manner
14. Handwashing facilities	1.97	0.24	Not adequate; there is very little presence in an incomplete manner
15. Lift cages and auxiliary structures	1.00	0.00	Absent; no presence at all
16. Visible GMP posters, signages and labels	1.00	0.00	Absent; no presence at all
17. Presence of standard operating procedure (SOP) and work instruction (WI)	1.03	0.24	Absent; no presence at all
18. Availability of potable water	3.12	0.77	Adequate; good enough for what is required or needed
19. Enough location for handwashing and sanitation facility	2.15	0.53	Partially adequate; there is a presence but not good enough for the production
20. Space from the walls for the ease of cleaning and moving	2.07	0.59	Partially adequate; there is a presence but not good enough for the production
21. Calibration and preventive maintenance program	1.00	0.00	Absent; no presence at all
22. Availability of appropriate tools, apparatus and processing facilities	2.15	0.40	Not adequate; there is very little presence in an incomplete manner
Overall	1.63	0.40	Absent; no presence at all

Note: Values presented were the mean per row computed based on the assessment of different facilities of processors. Average presented on the bottom is based on the mean of all parameters.

The facilities used in the production were located close to, adjacent to or even inside the residential showing unavailability of good working facility of the right design, construction, and size based on the process (1.37±0.67).

For fermented shrimp production, small production of around 160-200kg per day was implemented in a small facility near or adjacent to producers' home while those producing a smaller volume, around 40-50 kg daily processed inside the residential homes specifically in the kitchen. Some carried out the processing of the raw materials in the laundry area or even on the terrace. Toilet (2.09±0.34) and drainage facilities (2.03± 0.17) are shared by processors and occupants. Most of the processors live near the sea or river, hence, serving as the drainage area. With this, despite that water was observed to be available and adequate in all visited areas, water treatment facility (1.00±0.00) was not observed at all. Some facilities were observed in a partial manner which did not meet the requirements for a good processing facility. Lift cages and auxiliary (1.00±0.00) structures were not observed, as all site activities were performed to ground-level operations. Given the moderate to low production, these are deemed unnecessary. Furthermore, analysis of the mean (1.63±0.40) adequacy of facility indicates that other parameters were negligible.

Sanitation and hygiene*.* The findings for sanitation and hygiene revealed a rare extent of adoption (Table 4). There was a very low to no adoption of training program on food safety (1.12±0.37). This led to unclear work flows (1.10±0.35) resulted in overlapping roles and procedural ambiguity. Production staff, usually 1-5, worked on all stages of the processing such as smoked fish processing with barely 1-3 processors who receive, sort, process, pack, and distribute the final product in the markets. Production of fermented shrimp and dried-salted fish commonly hire a higher number of staff. Personnel claimed to practice health and personal hygiene, but no updated medical records (1.10±0.31) were available during the visit. Most of the personnel were neighbors or family members, relying on general health knowledge. No sick or wounded staff/processors were observed during the visit, though this practice was rarely adopted (2.26±0.75). Wearing of proper protective equipment (PPE) was observed in some processors; however, most wore no PPE or only a hairnet suggesting a very low to no adoption at all (1.29±0.75). Washing of hands was regularly (4.94±0.29) observed during the processing of raw materials. This parameter was adopted by most producers. Hand washing area was present in the area; however, it was a shared facility within the household. Analysis of the mean extent of adoption revealed a score of 1.97±0.29, indicating fair adoption of the hygiene and sanitation practices, but not good enough for a good production.

Table 4

Adoption of sanitation and hygiene practice of small-scale fish processors

Sanitation and hygiene practice	*Mean*	*SD*	*Remarks*
1. Attend training program on food safety and relevant activity	1.12	0.37	Never adopted; no adoption
2. Task a person in charge in each stage of the process	1.10	0.35	Never adopted; no adoption
3. Update medical records and health certificate	1.10	0.31	
4. Personnel with wounds, infections, or diseases are not allowed to perform production activity	2.26	0.75	Rarely adopted; fair adoption but not enough for a good production
5. Wearing of appropriate personal protective equipment (PPE) including hairnet, facemask, apron, etc.)	1.29	0.75	Never adopted; no adoption
6. Washing and sanitizing of hands regularly	4.94	0.29	Always adopted; excellently adopted and practiced
Overall	1.97	0.29	Rarely adopted; fair adoption but not enough for a good production

Processes and controls. Processes and controls varied by fish products. Processes and controls data are presented in Table 5. Checking and assessing of raw materials for processed fish products was never adopted (1.00±0.00). These were commonly acquired through the fishers or by purchasing in the wet market where Certificate of Analysis (COA) to prove the quality was deemed unnecessary for the producers. Processes and controls with no adoption include proper storage facility (1.35±0.79), proper processing tables (1.00±0.00), monitoring of control parameters (0.99±0.12), coding scheme (0.99±0.12), subjecting products to laboratory analyses (1.01±0.12), and proper packaging, labeling, and distribution (1.07±0.31). Other processes with fair adoption include a clean place for processing (2.13±0.42), handling substandard or rejected products (2.13±0.54), and ice usage (2.37±0.91). Additionally, commendable adoption was observed for the use of clean and appropriate water (4.72±0.81), cleaning and preparing raw materials (4.75±0.74), separating and categorizing items (4.87±0.45), and First-In-First-Out (FIFO) policy (5.00±0.00). A mean extent of adoption demonstrated a score of 2.37±0.39, revealing a fair adoption of proper processes and controls.

Table 5

Adoption of processes and controls of small-scale fish processors

Practices description	*Mean*	*SD*	*Remarks*
1. Check and assess the quality of raw materials by securing a Certificate of Analysis (COA)	1.00	0.00	Never adopted; no adoption at all
2. Raw materials are properly stored in a warehouse/storage facility	1.35	0.79	Never adopted; no adoption at all
3. Use of clean and appropriate water for operation	4.72	0.81	Always adopted; excellently adopted the practice
4. Proper cleaning and preparation of raw materials	4.75	0.74	Always adopted; excellently adopted the practice
5. Suitable and clean place for processing	2.13	0.42	Rarely adopted; fair adoption but not enough for a good production
6. Use of stainless-steel tables for processing	1.00	0.00	Never adopted; no adoption at all
7. Designate locations for handwashing and sanitation	2.16	0.56	Rarely adopted; fair adoption but not enough for a good production
8. Separate and categorize items: raw materials, final products, rejects, etc.	4.87	0.45	Always adopted; excellently adopted the practice
9. Observe First-In-First-Out (FIFO) policy	5.00	0.00	Always adopted; excellently adopted the practice
10. Observe proper procedure for handling substandard or rejected materials/products	2.13	0.54	Rarely adopted; fair adoption but not enough for a good production
11. Monitor control parameters and limits such as temperature and moisture content	0.99	0.12	Never adopted; no adoption at all
12. Follow the proper coding scheme	0.99	0.12	Never adopted; no adoption at all
13. Subject products to laboratory analyses in accordance with Philippine National Standards (PNS)	1.01	0.12	Never adopted; no adoption at all
14. Handling of ice hygienically to avoid bacterial contamination	2.37	0.91	Rarely adopted; fair adoption but not enough for a good production
15. Proper packaging, labeling and distributing of the product	1.07	0.31	Never adopted; no adoption at all
Overall	2.37	0.39	Rarely adopted; fair adoption but not enough for a good production

Food contaminants. Contaminants observed in processed fish products (Table 6) included aerobic plate count (52%), *Staphylococcus aureus* (35.65%), yeast and molds (15.77%), *Escherichia coli* (4.94%), and *Salmonella* (20.71%). Likewise, 66.67% histamine contamination was revealed. Threat of food contamination can come from different situations (Kantiani et al 2010), through varied environmental vectors such as water, air, and soil or human-centric factors, including negligence of proper production practices. An inverse relationship was observed between production practices scores and presence of food contaminants.

Table 6

Food contaminants observed in processed fish products

Food contaminant	*Uncontaminated (n = 42)*	*Contaminated (n = 42)*	*Spearman ρ (approx.)*
Aerobic plate count	48.00	52.00	-0.30
Staphylococcus aureus	64.36	35.65	-0.25
Yeast and mold	84.24	15.77	-0.20
Escherichia coli	95.06	4.94	-0.10
Salmonella	79.30	20.71	-0.15
Histamine	33.33	66.67	-0.77

Discussion

Plants and grounds. Generally, all visited facilities did not meet the specified design and requirements stipulated in AO153, s.2004 and PNS. Good working facility plays crucial role in delivering operational efficiency, product quality, and economic viability (Yadav et al 2025). Similarly, proper design, construction, and right sizing may affect the temperature, pH, water activity, and initial microbial contamination levels (Sharma & Kumbhar 2020) of which processed fish products may be susceptible to microbial attack and infestation. In addition, considering water treatment facilities is also a concern as wastewaters contain contaminants (Al Mamun et al 2013; Muthukumaran & Baskaran 2013; Cristóvão et al 2015) which could impact economic and environmental situations. Drainage facilities are integral part affecting the hygienic and operational efficiency of fish processing facility (Fairley 2011; Evrendilek 2026). Inadequate basic processing facilities such as processing area, handwashing facility, potable water, equipment, and product handling facility was considered unhygienic (Bedane et al 2022) posing fish borne infections to humans. A relevant study by Otilla et al (2022) on GMP adoption of smoked fish processing in Camarines Sur, Philippines revealed that the premises of all the visited enterprises failed to conform to the specified requirements. While food safety has become more essential both in developed and developing countries, it is significantly more challenging to developing countries due to the situation of the food facilities of small and medium enterprises (Purwantiningrum et al 2018), more so, for those who are producing in the backyard scheme. The study of Purwantiningrum et al (2018) in Indonesia also reported that all of the small and medium-scale fish processing facilities were located close to or inside residential areas suggesting that practices should be performed with caution due to the possibility of contamination. Facilities such as cold storage, plant design, and size, are one of the key factors in attaining sanitary operations and protection against contamination (Otilla et al 2022; Purwantiningrum et al 2018; Bigueja 2020).

Sanitation and hygiene. Rare adoption of sanitation and hygiene practices were attributed to varied causes. Most of the processors involved in the processing of fish do not attend training programs on food safety and relevant activities. While some claimed to have attended, no certificates of attendance or participation had been presented during the visit. Processors claimed that attendance to seminars and training would jeopardize the daily production, especially to those who produce on a one-staff scheme. This would mean a stop of production, no final product, no distribution, and therefore no profit for the day. Kussaga et al (2014) suggested that training of employees could lower the risk of microbial hazards. Moreover, training of processors (foods handlers) play crucial role in the implementation of food safety systems ensuring transmission and application of knowledge and increase in hygienic condition (Agüeria et al 2018; Oliveira et al 2024) which is a recognized strategy in preventing foodborne diseases (Malavi et al 2021). Proper knowledge of food safety training programs is also deemed necessary to reduce ambiguity of work contribution. Processors asserted that distribution of labor requires more personnel which adds up to the input cost reducing the profit. Based on the data collected, processors showed overlapping roles during the productions which could be a contributor to contamination. Food processors worked from one area to another wearing the same clothes and using the same utensils prompting to cross contamination. Several reported foodborne outbreaks were linked to food processors, due to lack of hygiene and improper use of gloves (Todd et al 2010). Direct contact with raw materials with processors was reported to be one major food contaminants (Malavi et al 2021). Similarly, infected processors were reported to be a contributing factor in the contamination of utensils during production activity. A commendable observation in had washing and sanitizing was observed as a mean of reducing contamination. Availability of clean water and frequent handwashing increase adherence to improve personnel hygiene reducing the risk of contamination. Despite showing rarely adoption of the practices, these were not fair enough for a good production. There is a need to improve the sanitation and hygiene to all personnel and facilities to ensure that employees and the environment are not a contributing source of contamination (Purwantiningrum et al 2018; Bigueja 2020; Otilla et al 2022). Further, personnel is one of the most common carriers of contamination, therefore, their practices play a crucial role in the food safety of the products through the prevention of food contamination (AO 153, s.2004; RA10611). Rustia et al (2021) emphasized that one of major keys to ensure food safety is sanitation and hygiene.

Processes and controls. A fair adoption of proper processes and controls for the fish processing activities could present an increased contamination risk. Application of labeling, coding, and monitoring of production parameters were not observed during the visit. Fish processors, especially dried-salted fish do not practice labeling as the products were packed using used newspaper. In addition, most of the parameters indicated were new to them or they have very low to no awareness at all. The owner acts as the quality control officer, checking finished products to separate good final products from rejects or lower quality goods. This observation suggests that most processors were not familiar to food safety, good manufacturing practices, and how to apply these. The commendable adoption for the use of clean and appropriate water, cleaning and preparing raw materials, separating and categorizing items, and First-In-First-Out (FIFO) policy showed significant positive effect on the management efficiency, reduced waste management, and prevented food contamination (Wijinindyah et al 2024; Sutejo & Amsirun 2025). Clean water plays a major and fundamental role as food ingredient in fish processing (Bhagwat 2019; Sehgal et al 2024) which could also be a paramount source of contamination, along with equipment and employees (Marriott et al 2018). Other processes and controls derived from the study could be of alarming concerns as these directly affect the quality and edibility of the fish products. Empirical evidence showed that there was a positive relationship between food contamination and food borne illnesses suggesting that higher food contamination led to increased food borne illnesses as this could also associated with the decreased in food quality (Shaltout 2024). Alum et al (2016) reported that food contamination could be a factor of varied reasons. One important contamination vector is during food processing including the food preparation and handling of raw materials, food contact equipment factors, unhygienic practices of food handlers, and use of poor water quality. Adoption of good manufacturing practices was deemed necessary in the adherence to reduced microbial contamination (Maldonade et al 2019) and an important food safety strategy (De Oliveira et al 2016). Poor processes and lack of controls led to microbial and histamine contamination (Moniente et al 2021).

Food contaminants. Presence of food contaminants including APC, *S. aureus*, yeast and molds, *E. coli*, *Salmonella*, and histamine increased concern on the adoption of food safety awareness. Results showed that these did not meet the food safety standards set by the government. Spearman's test revealed a negative correlation ($p < 0.05$) with all food contaminants. An inverse correlation was observed, suggesting that higher production scores link to lower contamination (%), and vice versa. Evaluation of food contaminants is essential to identify proper control to reduce the risk of producing tainted fish products (Köse 2010; Kussaga et al 2014; Sheng & Wang 2021), helping prevent foodborne illnesses. Odeyemi (2016) noted that foodborne disease outbreaks in developing countries have risen due to raw food contamination, lack of awareness, poor hygiene, and improper handling, including Ghana and Nigeria. In the Philippines, a total of foodborne disease outbreaks was reported by Azanza et al (2019) primarily caused by *Salmonella* spp., *Henipavirus*, *Entamoeba histolytica*, and *Vibrio parahaemolyticus*. Dumaloan-Canini et al (2024) reported occurrence of potentially pathogenic bacteria, *Vibrio* sp., *S. aureus* and *Salmonella*, in commercially sold seafood from Misamis Occidental, Philippines. Study of Simora & Peralta (2018) disclosed high level of histamine and histamine-forming bacteria in dried-salted fish which is an indicative of poor standards of process hygiene and sanitation as well as mishandling during storage. Even developed countries experienced this issue as Barrett et al (2017) reported a total of 857 fish-associated foodborne disease outbreaks in the United States from 1998 to 2015 resulting in 4,815 illnesses, 359 hospitalizations, and 4 deaths caused by scombrotoxin, *Salmonella* and ciguatoxin. Results of the study of Geraldo et al (2024) showed that hygiene intervention decreased the microbial load (aerobic plate count, coliforms, and *E. coli*) observed in smoked fish. This caused a significant decrease ($p < 0.05$) in the microbial counts of smoked fish.

Conclusions. This study presented the current production practices of small-scale smoked fish and dried-salted processors in Bataan, Philippines. Production practices including plants and grounds, sanitation and hygiene, and processes and controls need to adhere to standards set by the government. Some of the samples showed that APC, *Staphylococcus aureus*, *E. coli*, Salmonella, and histamine were found to be higher than the set standards. Analysis of data revealed that there was an inverse relationship between productio scores and food contaminants in the study. Results suggest that adoption of good manufacturing practices could positively impact of food safety of processed fish products.

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Author's Contributions. MFD confirms being the sole contributor of this paper, including conceptualizing the study, collecting and analyzing the data, and writing the manuscript for publication.

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