

*Evaluation Of The Implementation Of Good Manufacturing Practices In The Handling Of Scad (*Decapterus* Spp.) At The Sibolga Oceanic Fishing Port (PPN Sibolga)*

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Good Manufacturing Practices (GMP) provide a framework for maintaining sanitation, hygiene, and proper handling practices to preserve the quality and safety of fishery products. This study evaluated the implementation of GMP in the handling of scad (*Decapterus* spp.) at Sibolga Oceanic Fishing Port (PPN Sibolga), North Sumatra, Indonesia, and assessed selected microbiological quality parameters of the handled fish. Data were collected through direct observation of the fish handling process, including unloading, sorting, weighing, washing, packaging, and distribution. GMP implementation was assessed using ten observed aspects related to location and surroundings, facilities, sanitation, equipment, raw materials, handling processes, employee hygiene, ice storage, pest control, and waste management. Microbiological quality was assessed based on Total Plate Count (TPC), *Escherichia coli*, and *Salmonella* spp. The GMP assessment showed that seven of the ten observed aspects complied with the applied criteria, corresponding to a compliance rate of 70%, while three aspects—location and surroundings, buildings and facilities, and employee hygiene—required improvement. The TPC values were 1.87×10^5 CFU/g and 2.13×10^5 CFU/g for Samples A and B, respectively, while *E. coli* and *Salmonella* spp. were not detected in either sample. Based on the criteria used in this study, the tested microbiological parameters complied with the applicable requirements. The findings indicate that fish handling practices at PPN Sibolga were generally adequate, but improvements in environmental conditions, facility maintenance, and employee hygiene are necessary to strengthen the consistency of hygienic handling practices.

Keywords: Good Manufacturing Practices; fish handling; scad; *Decapterus* spp.; microbiological quality; fishing port

1. Introduction

Sibolga Oceanic Fishing Port (PPN Sibolga) is an important fishing port in North Sumatra that supports capture fisheries activities, including fish landing and handling operations. The port is located in Sarudik District, Central Tapanuli Regency, North Sumatra, and serves fishing activities along the western coast of Sumatra [1].

Scad (*Decapterus* spp.) is an economically important small pelagic fish in Indonesia. The species has considerable production potential and is an important source of animal protein because of its relatively affordable price and availability [2]. However, fish are highly perishable food products because of their high moisture and protein contents. Consequently, appropriate handling immediately after capture is essential to maintain freshness and reduce quality deterioration until the product reaches consumers [3].

The application of Good Manufacturing Practices (GMP) is an important component of hygienic food handling. GMP provides general principles for controlling sanitation, hygiene, facilities, equipment, raw materials, processing or handling practices, and storage and transportation conditions. In fish handling operations, appropriate hygiene and temperature control are particularly important because inadequate handling can accelerate microbial growth and quality deterioration [4]. Similar principles have been demonstrated in frozen tuna processing, where the implementation of GMP covered raw material reception, processing, washing, freezing, glazing, packaging, labelling, metal detection, storage, and stuffing, indicating the importance of controlling hygiene and handling conditions throughout the processing chain [5].

Field observations at PPN Sibolga indicated that several aspects of worker hygiene still required attention. In particular, workers were observed smoking in the fish handling area and not consistently using complete personal protective equipment (PPE). Such practices may increase the possibility of contamination and indicate the need for stronger hygiene supervision.

PPN Sibolga also handles substantial quantities of landed fish. Data reported for 2023 indicated approximately 30,534,798 kg of fish landings at PPN Sibolga, with *Decapterus* spp. representing an important component of the catch [6]. The scale of fish handling activities makes the port an important location for evaluating hygienic handling practices and microbiological quality.

Therefore, this study aimed to evaluate the implementation of GMP in the handling of scad (*Decapterus* spp.) at PPN Sibolga and to assess selected microbiological quality parameters of the handled fish. The results are expected to provide information for stakeholders regarding aspects of fish handling that require improvement and to support efforts to maintain the quality and safety of fishery products.

2. Materials and Methods

2.1 Research Period and Location

The research was conducted from October 2025 to August 2026 at Sibolga Oceanic Fishing Port (PPN Sibolga), located at Jl. Letjen Gatot Subroto, Pondok Batu Village, Sarudik District, Central Tapanuli Regency, North Sumatra, Indonesia. Microbiological analyses were conducted at the PADI Laboratory, Universitas Bung Hatta, Padang, West Sumatra.

2.2 Materials and Equipment

The equipment and materials used in the study included a GMP observation checklist, writing instruments, a mobile phone camera, Styrofoam containers, an analytical balance, a laminar air flow cabinet, an incubator, an autoclave, a stomacher or sterile blender, Petri dishes, test tubes, scad (*Decapterus* spp.), Plate Count Agar (PCA) medium, sterile distilled water, 70% alcohol, sterile cotton swabs, flake ice, and sample labels.

C. Research Design and Data Collection

A descriptive research design was used. Primary data were obtained through direct observation of the handling process of scad at PPN Sibolga. The observed handling stages included fish unloading, sorting, weighing, washing, packaging, and distribution. Secondary data were obtained from relevant scientific literature and documents related to fish landing and handling activities at PPN Sibolga.

The implementation of GMP was assessed using an observation checklist covering ten aspects: (1) location and surroundings, (2) buildings and facilities, (3) sanitation facilities, (4) machinery and equipment, (5) raw materials, (6) handling processes, (7) employee hygiene, (8) ice storage, (9) pest control, and (10) waste management.

The GMP assessment was based on the criteria applied in the study with reference to the Regulation of the Minister of Industry of the Republic of Indonesia Number 75/M-IND/PER/7/2010 concerning Guidelines for Good Processed Food Manufacturing Practices [7]. Because the regulation provides general GMP guidance for processed food industries, its criteria were used in this study as an assessment framework for the observed hygiene and handling conditions

D. Microbiological Analysis

Microbiological quality was evaluated using three parameters: Total Plate Count (TPC), *Escherichia coli*, and *Salmonella* spp. Samples were transported to the PADI Laboratory under chilled conditions using ice and were subsequently analyzed using the laboratory procedures applied in the study.

The microbiological results were compared with the quality requirements stated in the study based on SNI 2729 for fresh fish [8].

E. Data Analysis

The GMP assessment was analyzed descriptively. Each observed aspect was classified as either compliant or requiring improvement based on the applied criteria. The overall compliance rate was calculated as:

$$\text{GMP compliance rate (\%)} = (\text{Number of compliant aspects} / \text{Total observed aspects}) \times 100$$

Microbiological results were presented descriptively and compared with the applicable quality criteria

3. Results

A. Handling Process of Scad at PPN Sibolga

The handling of scad (*Decapterus* spp.) at Sibolga Oceanic Fishing Port (PPN Sibolga) consisted of unloading, sorting, weighing, washing, packaging, and distribution. These stages represent critical points in maintaining the quality of fresh fish because deterioration may occur rapidly when time-temperature control, hygiene, and careful handling are not adequately maintained. The Codex Code of Practice for Fish and Fishery Products (CXC 52-2003) specifically emphasizes time and temperature control, hygienic handling, personal hygiene, transportation, training, and facility and equipment conditions as important prerequisite elements for fish and fishery products [11].

1. Unloading

Fish unloading began at approximately 08:00 WIB after the vessel had docked and obtained unloading clearance. Fish were removed from the vessel hold using dip nets and transferred to the deck using plastic buckets. The unloading process continued until approximately 11:00–12:00 WIB.

Rapid unloading is an important practice because prolonged exposure of fish to ambient conditions may accelerate microbial growth, enzymatic activity, and quality deterioration. The observed use of manual handling equipment was functional; however, the hygienic condition of handling personnel and the surrounding environment remains important because fish may be exposed to direct and indirect contamination during unloading.

The present observation identified workers smoking in the handling area and not consistently using complete personal protective equipment (PPE). These practices represent potential hygiene deficiencies because personnel may act as sources of contamination. The Codex Code of Practice for Fish and Fishery Products identifies personal hygiene, health, training, and hygiene control as essential components of prerequisite programmes for fish handling [11]. Therefore, rapid unloading alone is insufficient to ensure hygienic handling if personnel hygiene is not consistently controlled.

This finding is also relevant to recent research on *Decapterus* sp. handling and transportation in Indonesia. Tiaraningtyas et al. [12] identified several potentially hazardous activities during handling and transportation of scad and emphasized the need for standardized operating procedures, compliance, enforcement, and periodic evaluation. Thus, the control of handling risks should extend beyond the landing stage to all subsequent activities in the distribution chain.

2. Sorting and Weighing

Sorting was conducted manually according to fish size and quality. The fish were subsequently weighed and the catch quantity was recorded by port personnel. The observed bucket loads ranged from approximately 30–47 kg and up to 53 kg.

Sorting is important because it allows fish to be grouped according to size and quality and facilitates subsequent handling and marketing. However, sorting should be performed rapidly and hygienically because repeated handling may increase the opportunity for physical damage and contamination.

Weighing is primarily an operational and administrative activity, but it also represents a handling point that should be controlled. Fish should not remain unnecessarily exposed during weighing. The combination of rapid handling, clean equipment, and continuous temperature control is therefore more important than the weighing activity itself.

The importance of controlling handling activities is consistent with the Codex approach, which emphasizes minimizing deterioration through appropriate handling and maintaining adequate time-temperature control throughout the fish supply chain [1].

3. Washing

The fish were washed manually using water supplied by PDAM Mual Nauli and supplemented by PDAM Sibolga. Washing was conducted to remove slime and visible impurities from the fish surface before packaging.

The use of clean water is an important prerequisite for fresh-fish handling. SNI 2729:2021 specifies that water used as an auxiliary material in fish handling should meet applicable clean-water requirements and that handling should follow hygienic principles [8]. Washing, however, should not be considered a substitute for overall sanitation control. If the water, equipment, container, or surrounding environment is contaminated, washing may instead become a route for cross-contamination.

Therefore, water quality monitoring should be incorporated into the sanitation programme at the port. This is particularly important because the fish are directly exposed to the washing water before being packed and iced.

4. Packaging and Ice Application

After sorting, weighing, and washing, the fish were packed in clean plastic boxes with flake ice distributed between layers of fish and on the upper surface. The use of ice represents an important component of temperature control during fresh-fish handling.

SNI 2729:2021 specifies that ice used in handling fresh fish should comply with the applicable standard, while the final product should be hygienically packaged to prevent contamination and quality deterioration [11]. Similarly, Codex CXC 52-2003 emphasizes time and temperature control as a fundamental measure for minimizing deterioration in fresh fish [11].

The use of flake ice observed in this study is therefore appropriate. Nevertheless, the arrangement of fish and ice should be standardized to ensure uniform cooling. Uneven ice distribution may produce temperature differences within the container, particularly when fish are densely packed. Temperature measurement at the fish core would provide stronger evidence that the cold chain is being maintained.

This point is particularly important because recent research on fish handling in Indonesian landing and distribution systems has demonstrated that inadequate cold-chain management can lead to substantial increases in fish temperature. A recent study at PPS Belawan reported an increase in fish temperature from approximately 2.9°C before handling to 6.3°C after handling when the cold chain was not adequately maintained [13]. Although temperature data were not measured in the present study, this finding reinforces the importance of adding quantitative temperature monitoring to future assessments at PPN Sibolga.

5. Distribution

Fish distribution at PPN Sibolga was conducted according to consumer orders. Fish were transported using closed containers with ice.

Closed containers provide physical protection against external contamination and can support temperature maintenance. However, the effectiveness of distribution depends not only on the type of container but also on the amount and distribution of ice, duration of transportation, ambient temperature, container opening frequency, and final fish temperature.

The recent study by Tiaraningtyas et al. [12] on *Decapterus* sp. transportation showed that transportation practices that do not meet cold-chain requirements may become important risk points even when fish remain organoleptically acceptable. Therefore, future monitoring at PPN Sibolga should include transportation duration, fish temperature at dispatch and arrival, ice-to-fish ratio, and container condition.

B. Assessment of GMP Implementation

Ten GMP aspects were evaluated at PPN Sibolga. Seven aspects complied with the assessment criteria, while three aspects required improvement. The observed compliance rate was therefore 70%.

Table 1. Assessment of GMP implementation in scad handling at PPN Sibolga

No.	GMP Aspect	Applied Criterion	Result	Risk/Implication
1	Location and surroundings	Free from pollution and accumulated waste	Requires improvement	Potential environmental contamination
2	Buildings and facilities	Adequate drainage and easy-to-clean surfaces	Requires improvement	Standing water and cross-contamination risk
3	Sanitation facilities	Adequate clean water and handwashing facilities	Compliant	Supports hygienic handling
4	Machinery and equipment	Equipment routinely cleaned	Compliant	Reduces contamination risk
5	Raw materials	Fish maintained fresh and supplied with ice	Compliant	Supports freshness and temperature control

6	Handling process	Rapid and hygienic handling	Compliant	Limits deterioration
7	Employee hygiene	Appropriate PPE and no smoking in handling area	Requires improvement	Direct/indirect contamination risk
8	Ice storage	Protected from contamination	Compliant	Supports hygienic temperature control
9	Pest control	Animals prevented from entering handling area	Compliant	Reduces contamination risk
10	Waste management	Solid waste disposed of promptly	Compliant	Reduces environmental contamination

The 70% compliance rate indicates that most of the observed practices were already implemented appropriately. However, this value should not be interpreted as an overall percentage of food safety or product safety. Rather, it represents the proportion of the ten selected observational aspects that met the assessment criteria.

The three non-compliant aspects are particularly important because they involve environmental sanitation, infrastructure, and personnel hygiene. These are foundational components of hygienic fish handling and can affect multiple stages of the handling process.

1. Location and Surroundings

The location and surrounding environment did not fully meet the applied criteria because environmental cleanliness required improvement. In a fish handling area, accumulated waste, dirty surfaces, standing water, and other environmental contaminants may become sources of microbial contamination.

The Codex fishery code emphasizes appropriate facility design, hygiene control, waste management, and prevention of contamination throughout fish handling operations [11]. Therefore, improvement should include routine cleaning schedules, rapid removal of waste, maintenance of drainage systems, and clear separation between clean and potentially contaminated areas.

2. Buildings and Facilities

The second deficiency concerned buildings and facilities, particularly drainage and floor conditions. Poor drainage may result in standing water and facilitate movement of contaminants between areas.

Because fresh-fish handling is inherently a wet operation, adequate drainage is especially important. SNI 2729:2021 requires hygienic handling and packaging practices, while Codex CXC 52-2003 emphasizes facility design and hygiene control as prerequisite measures [1,3].

Improving floor slope, drainage, surface cleanability, and routine sanitation should therefore be considered a priority corrective action.

3. Employee Hygiene

Employee hygiene was the third major deficiency. Workers were observed smoking in the handling area and not consistently using complete PPE.

This finding is important because workers have direct contact with fish, equipment, containers, and handling surfaces. Inadequate personal hygiene can increase the possibility of cross-contamination even when other parts of the handling system are adequately controlled.

Codex CXC 52-2003 specifically identifies personal hygiene, health, training, and hygiene control programmes as important prerequisite elements [11]. Consequently, corrective action should include a clearly enforced no-smoking policy, adequate PPE availability, routine hygiene training, handwashing facilities, and active supervision.

The issue is also consistent with the recent *Decapterus* sp. risk assessment by Tiaraningtyas et al. [12], which emphasized that compliance, SOP implementation, and supervision are important for reducing handling and transportation risks.

C. Microbiological Quality of Scad

The microbiological analysis included Total Plate Count (TPC), *Escherichia coli*, and *Salmonella* spp.

Table 2. Microbiological quality of scad (*Decapterus* spp.)

Parameter	Unit	Sample A	Sample B	SNI 2729:2021
Total Plate Count (TPC/ALT)	CFU/g	1.87×10^5	2.13×10^5	Maksimal $5,0 \times 10^5$
<i>Escherichia coli</i>	APM/g	Negative	Negative	<3 APM/g
<i>Salmonella</i> spp.	per 25 g	Negative	Negative	Negatif/25g

According to SNI 2729:2021, the microbiological criteria for fresh fish use a sampling plan with five units ($n=5$). For ALT/TPC, the criteria are $m=10^5$ CFU/g and $M=10^6$ CFU/g; for *E. coli*, $m=1$ APM/g and $M=10$ APM/g; and *Salmonella* must be absent in 25 g with $c=0$ [8].

The TPC values obtained in the present study were 1.87×10^5 CFU/g for Sample A and 2.13×10^5 CFU/g for Sample B. Both values were below the upper microbiological limit (M) specified by SNI 2729:2021. However, both values were above the lower criterion ($m=10^5$ CFU/g). This distinction is important because compliance with the SNI sampling plan should not be reduced to a simple comparison with a single maximum value.

The increase from Sample A to Sample B was approximately 13.9%. However, because the available data do not provide sufficient information on the number of independent samples, sampling design, and statistical replication, this difference should be interpreted descriptively and should not be attributed statistically to the handling process.

The TPC results nevertheless indicate that the fish contained measurable aerobic microbial populations at the time of analysis. This is expected for fresh fish because microbial contamination can originate from the aquatic environment, fish surface, handling equipment, personnel, water, containers, and subsequent handling conditions.

The absence of *E. coli* in both samples is a favorable finding. *E. coli* is commonly used as an indicator of hygienic conditions and possible fecal contamination. Its non-detection suggests that contamination by this indicator organism was not detected in the tested samples under the analytical conditions used.

Similarly, *Salmonella* spp. were not detected in either sample. This result complied with the criterion requiring absence in 25 g [3].

Nevertheless, the microbiological findings should be interpreted cautiously. SNI 2729:2021 specifies not only microbiological requirements but also sensory quality, chemical contaminants, parasites, and histamine requirements for fresh fish [8]. The present study evaluated only three microbiological parameters. Therefore, the results demonstrate compliance for the tested parameters but cannot by themselves establish overall food safety or fitness for consumption.

D. Relationship between GMP Implementation and Microbiological Quality

The combination of the GMP assessment and microbiological results provides an important picture of the handling system at PPN Sibolga.

The observed 70% GMP compliance indicates that several basic hygiene and handling practices were already in place, including the availability of clean water, equipment cleaning, use of ice, relatively rapid handling, protected ice storage, pest control, and waste management. These practices are consistent with fundamental principles for maintaining fish quality. Previous work on frozen tuna steak processing also showed that GMP implementation can be applied across multiple handling stages to support hygienic processing and product quality [5].

At the same time, the microbiological results were favorable for the parameters tested. The TPC values were below the upper limit of SNI 2729:2021, while *E. coli* and *Salmonella* spp. were not detected.

However, it would be inappropriate to conclude that the 70% GMP compliance rate directly caused the favorable microbiological results. The present study was descriptive and did not employ a controlled experimental design. In addition, quantitative temperature measurements, repeated sampling, and statistical analysis were not available. Therefore, the appropriate interpretation is that acceptable microbiological results were observed under handling conditions in which most of the assessed GMP aspects were compliant, while several important hygiene deficiencies remained.

This distinction strengthens the scientific interpretation of the study because GMP compliance and microbiological quality are related but cannot be assumed to have a direct causal relationship from the present design.

E. Implications for Improving Fish Handling at PPN Sibolga

The findings indicate that improvement at PPN Sibolga should focus on three priority areas: environmental sanitation, infrastructure, and personnel hygiene.

First, environmental sanitation should be strengthened through routine cleaning, immediate waste removal, and improved drainage. Second, facility improvements should ensure that floors and drainage systems are easy to clean and do not allow standing water. Third, employee hygiene should be strengthened through PPE provision, hand hygiene, no-smoking enforcement, training, and direct supervision.

In addition, a more quantitative cold-chain monitoring system should be introduced. Although the present study documented the use of flake ice, fish temperature was not measured. This represents an important limitation because temperature is one of the most critical variables affecting microbial growth and fish deterioration. Research on frozen tuna loin processing at PT. Lintas Laut Samudera identified raw material receiving, packaging, and cold storage as critical control points, demonstrating that temperature and process control should receive particular attention at stages where hazards can be introduced or increased [9]. Recent Indonesian studies have also demonstrated that inadequate temperature control during handling and transportation can substantially increase fish temperature and associated quality risks [2,4].

Future assessments should therefore include fish temperature measurements at critical points, such as immediately after unloading, after washing, after packaging, before transportation, and upon arrival at the destination. Recording these temperatures would allow the relationship between handling practices and product quality to be evaluated more objectively.

Overall, the results demonstrate that PPN Sibolga has established several appropriate fish-handling practices, but the system still requires continuous improvement. A combination of GMP/GHP implementation, cold-chain monitoring, personnel training, infrastructure improvement, and routine microbiological verification would provide a stronger basis for maintaining the quality and safety of fresh scad. The integration of GMP with HACCP-based control is also relevant for strengthening food-safety assurance. Studies on frozen tuna loin and frozen gindara processing identified specific critical control points, including raw material receiving and packaging; the gindara study additionally identified metal detector inspection as a CCP [9,10]. These findings support the need for systematic control at critical stages beyond general hygienic handling.

4. Conclusion

The implementation of Good Manufacturing Practices (GMP) during the handling of scad (*Decapterus* spp.) at the Sibolga National Fishing Port (PPN Sibolga) has generally been carried out quite well. Assessment results indicate that most GMP aspects comply with the requirements of the Minister of Industry Regulation Number 75/M-IND/PER/7/2010, although improvements are still needed regarding location and environment, buildings and facilities, and worker hygiene. Microbiological test results show that the values for Total Plate Count (TPC), *Escherichia coli*, and *Salmonella* sp. remain within the limits set by SNI 2729:2021; consequently, the tested microbiological parameters of the scad handled at PPN Sibolga complied with the applicable requirements.

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