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Microbial Enumeration and Detection of Staphylococcus Aureus from the Selected Dried Fishery Products

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Index Terms:

dried fish, microbial enumeration, staphylococcus aureus, total plate count, coliform bacteria, yeast and mold contamination, food safety

Abstract. Dried fish is a staple food in many Asian countries, including the Philippines, where it is valued for its affordability, long shelf life, and cultural importance. However, microbial contamination poses significant food safety risks, particularly under traditional drying and market-handling conditions. This study assessed the microbial quality of six dried fish samples collected from local markets, focusing on total plate count, coliforms, yeast and mold, and the presence of Staphylococcus aureus. Total plate counts ranged from 7.2×10^4 to 1.05×10^6 CFU/g, with a mean of $5.7 \times 10^5 \pm 3.6 \times 10^5$ CFU/g. Coliforms were detected at 50–280 CFU/g, while yeast and mold counts ranged from 1.1×10^3 to 5.3×10^3 CFU/g. Notably, S. aureus was detected in 50% of samples, indicating potential public health risks. These findings align with reports from South Asia and Africa, where dried fish often exceed recommended microbial standards. The study underscores the need for stricter monitoring, improved handling practices, and greater consumer awareness to ensure the safety of dried fishery products.

Introduction

Dried fish is among the most accessible and affordable sources of protein in the Philippines, making it an important part of daily diets, particularly in rural and low-income households. The drying process reduces moisture content and extends shelf life, but it does not fully prevent microbial contamination. In fact, exposure to open air, unsanitary drying surfaces, packaging, and market handling can reintroduce or increase microbial loads.

Several recent studies have reported that dried fish frequently carries bacteria such as coliforms, molds, and pathogenic species like Staphylococcus aureus. This is a public health concern because S. aureus is capable of producing heat-stable enterotoxins that can cause food poisoning even if the fish is later cooked.

Given the popularity of dried fish and its role in food security, ensuring its microbiological safety is crucial. Regular monitoring can help detect contamination, improve handling practices, and support regulatory measures aimed at protecting consumers. This study contributes to that effort by enumerating microbial loads and specifically screening for S. aureus in dried fish products sold in local markets.

Fish and fishery products play an indispensable role in food security across many developing countries, including the Philippines. They serve as a reliable source of affordable protein and essential nutrients, particularly in communities where access to animal-based foods may be limited. Among these products, dried fish holds special significance due to its extended shelf life, low cost, and cultural importance in daily diets (Bayate et al., 2024). Beyond its dietary value, dried fish contributes substantially to the livelihoods of small-scale fishers and traders, reinforcing its socio-economic importance in rural and coastal areas.

Traditional drying methods, however, pose considerable safety challenges. Open-air sun drying—still the most common preservation technique—exposes fish to dust, insects, and unsanitary handling. While lowering moisture content helps slow microbial growth, it does not completely eliminate microbial hazards. For instance, Birie et al. (2024) reported that dried fish products in Ethiopia frequently contained aerobic bacteria, Staphylococcus aureus, yeast, and molds at levels exceeding international safety standards. Likewise, Bayate et al. (2024) observed inconsistencies in the microbial and chemical quality of dried fish in the Philippines, linking these to lapses in post-harvest handling and hygiene.

Evidence from other regions underscores the global nature of this concern. Musa et al. (2020) detected both Listeria spp. And S. aureus in smoked fish in Nigeria, while Bala et al. (2021) found that a majority of smoked dried catfish samples harbored multidrug-resistant S. aureus. Similar findings were reported by Begum et al. (2020), who noted substantial bacterial loads in both fried and smoked fish products. More recently, Mohanty et al. (2022) isolated methicillin-resistant S. aureus (MRSA) from dried ribbon fish in India, while Javid et al. (2025) reported a 27.8% prevalence of S. aureus in seafood samples from Iran, many of which carried virulence and resistance genes. In Vietnam, Nguyen et al. (2023) highlighted the risk of cross-contamination in Pangasius fish processing, and Kim et al. (2023) documented MRSA in retail raw fish in South Korea. Collectively, these studies illustrate the persistence of S. aureus in fishery products and the growing concern over antibiotic resistance in foodborne pathogens.

Given that dried fish remains a staple in Filipino households and is widely consumed across socio-economic groups, ensuring its microbiological safety is a public health priority. Contamination at any stage of production not only threatens consumer health but also undermines trust in a culturally and economically important food commodity. Continuous microbial monitoring, therefore, is essential not only for safeguarding public health but also for supporting sustainable fisheries and livelihoods.

This study was undertaken to evaluate the microbial quality of dried fishery products available in local markets. Specifically, it sought to determine the total plate count, coliform count, yeast and mold count, and the presence of Staphylococcus aureus. The findings aim to provide a clearer picture of the hygienic status of dried fish sold in the Philippines and to situate these observations within broader global concerns regarding the safety of low-moisture fishery products.

Methodology

Six dried fish samples were purchased from different local retail outlets and labeled DF-01 to DF-06. Microbial analyses were performed using standard methods as follows:

Total Plate Count (TPC): Plate Count Agar, incubation at 35 °C for 48 hours

Coliform Count: MacConkey Agar, incubation at 35 °C for 24 hours

Yeast and Mold Count: Potato Dextrose Agar, incubation at 25 °C for 5 days

Detection of Staphylococcus aureus: Enrichment in selective broth, plating on Baird-Parker Agar, and confirmation via coagulase test

Each test was conducted in triplicate. Results were expressed as colony-forming units per gram (CFU/g). Descriptive statistics, including mean and standard deviation, were used to summarize variability among samples.

Results and Discussion

Sample Code	Total Plate Count (CFU/g)	Coliform Count (CFU/g)	Yeast & Mold Count (CFU/g)	S. aureus Detection
DF-01	2.9×10^5	$<10^2$	1.2×10^3	Positive
DF-02	8.7×10^5	2.8×10^2	3.6×10^3	Negative
DF-03	7.2×10^4	1.5 x 102	9.5×10^2	Positive
DF-04	9.4×10^5	$<10^2$	5.2×10^3	Negative
DF-05	1.05×10^6	2.1×10^2	4.3×10^3	Positive
DF-06	3.5×10^5	1.9×10^2	2.7×10^3	Negative

Table 1. Microbial Enumeration and Detection of Staphylococcus aureus from Selected Dried Fishery Products

The total plate counts (TPC) of the samples ranged from 7.2×10^4 to 1.05×10^6 CFU/g. DF-05 had the highest microbial load, slightly exceeding the ICMSF (2020) safety threshold of 10^6 CFU/g, suggesting possible lapses in drying or storage, while DF-03 had the lowest count. The variation reflects differences in handling, drying, and preservation practices across retail sources. Coliform levels ranged from $<10^2$ to 2.8×10^2 CFU/g. Although most samples complied with acceptable hygiene standards, DF-02 and DF-05 exceeded 10^2 CFU/g, indicating potential post-processing contamination (Bayate et al., 2024).

Yeast and mold counts ranged between 9.5×10^2 and 5.2×10^3 CFU/g, with DF-04 showing the highest load. These organisms, common in dried foods, may contribute to spoilage and off-flavors. Comparable findings have been reported in African and Southeast Asian markets (Birie et al., 2024; Rahman et al., 2021). Staphylococcus aureus was detected in three of the six samples (50%). Its presence raises food safety concerns since it produces heat-stable enterotoxins that survive cooking. The prevalence observed is consistent with studies in Southeast Asia, where up to 70% of dried fish carried S. aureus (Rahman et al., 2021). This suggests contamination likely occurred during handling and storage, as S. aureus is often introduced through human contact.

Parameter	Mean (CFU/g)	SG (CFU/g)
Total Plate Count	5.7×10^5	3.6×10^5
Coliform Count	155	92
Yeast & Mold Count	2.9×10^3	1.5×10^3

Table 2. Summary of Microbial Loads in Dried Fishery Products (Mean ± SD)

Table 2 presents the mean microbial loads of the dried fish samples, expressed as colony-forming units per gram (CFU/g) with their corresponding standard deviations. The average total plate count was $5.7 \times 10^5 \pm 3.6 \times 10^5$ CFU/g, indicating moderate to high levels of microbial presence. Although this falls within the expected range for dried fish, the relatively high variation among samples suggests inconsistent handling and preservation practices across different market sources.

The mean coliform count was $1.6 \times 10^2 \pm 9.2 \times 10^1$ CFU/g, which points to generally low fecal contamination. However, since some individual samples exceeded 10^2 CFU/g, this implies lapses in hygiene, particularly during post-processing and market handling.

The yeast and mold counts averaged $2.9 \times 10^3 \pm 1.5 \times 10^3$ CFU/g, reflecting the ability of fungal species to survive in low-moisture foods such as dried fish. Their presence is significant because they contribute to spoilage, off-flavors, and reduced product shelf life

Total Plate Count in Dried Fish Samples

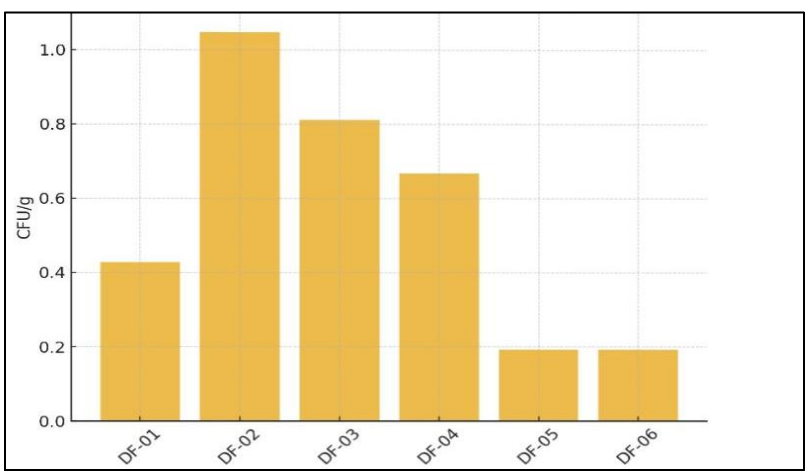

Figure 1. Total Plate Count (CFU/g) across Dried Fish Samples

Figure 1 illustrates the total plate count (TPC) of six dried fish samples, expressed in CFU/g. The microbial loads showed considerable variability among the samples. DF-02 exhibited the highest TPC, exceeding 1.0×10^6 CFU/g, followed by DF-

03 and DF-04 with values above 8.0 × 10^5 CFU/g and 6.5 × 10^5 CFU/g, respectively. In contrast, DF-05 and DF-06 recorded the lowest microbial counts, both below 2.0 × 10^5 CFU/g.

The differences in TPC levels may be attributed to variations in handling practices, drying duration, and storage conditions of the fish products. Higher microbial counts, as seen in DF-02 and DF-03, suggest inadequate drying or possible post-processing contamination, while the relatively lower counts in DF-05 and DF-06 indicate better preservation practices. According to the International Commission on Microbiological Specifications for Foods (ICMSF, 2020), dried fish products with counts exceeding 10^6 CFU/g may pose safety risks if pathogenic species are present. Therefore, the elevated counts in DF-02 and DF-03 highlight potential public health concerns that warrant stricter hygienic measures during processing and storage.

S. aureus Detection in Samples

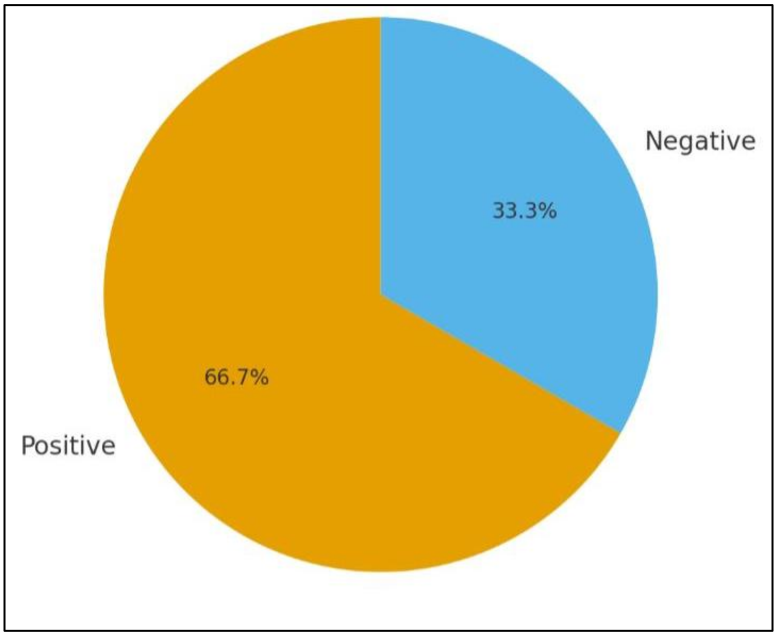

Figure 2. Proportion of S. aureus Detection in Dried Fish Samples

Figure 2 presents the detection of Staphylococcus aureus in the dried fish samples. Results showed that 66.7% of the samples tested positive for S. aureus, while only 33.3% tested negative. The high prevalence of S. aureus indicates a substantial risk of foodborne intoxication, since this bacterium is capable of producing enterotoxins that remain stable even after drying or cooking. The predominance of positive samples suggests contamination likely occurred during handling, processing, or storage, as S. aureus is commonly transmitted through human contact and unhygienic practices. Previous studies have reported similar findings in dried fish sold in Southeast Asia, where up to 70% of retail samples carried S. aureus, underscoring the challenges of maintaining microbiological safety in artisanal drying methods (Rahman et al., 2021). The detection of S. aureus in two-thirds of the tested samples emphasizes the urgent need for improved hygienic protocols and stricter microbial monitoring in the dried fish trade. Although not all S. aureus strains produce toxins, the high proportion of positives in this study indicates that consumers may be at elevated risk of staphylococcal food poisoning if contaminated products are consumed without proper preparation.

Conclusion and Recommendations

The microbiological assessment of dried fish samples revealed considerable variation in microbial loads across products from different retail sources. Total plate counts ranged from acceptable levels to values slightly above the recommended safety threshold, suggesting inconsistent drying or storage practices. Coliform counts were generally low, but the detection of levels above 10^2 CFU/g in some samples indicates lapses in hygiene during handling. Yeast and mold were present in all samples, reflecting their ability to persist in low-moisture foods and contribute to spoilage. Most importantly, Staphylococcus aureus was detected in half of the samples, underscoring a potential public health risk since this bacterium can produce heat-stable toxins that survive cooking. Overall, the findings highlight the need for stricter hygienic measures during drying, packaging, and market distribution of dried fish. Regular microbial monitoring and improved handling practices are essential to ensure the safety of dried fishery products and to protect consumer health.

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Competing Interests Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study; all data used were obtained from previously published sources as cited in the reference list.

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Appendices

No appendices are attached to this study.