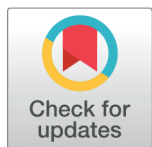


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Assessment of Histamine Levels and Consumer Consumption Patterns of Dried Fish in Northern Iloilo, Philippines

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Abstract

Objectives: This investigation aimed to determine the histamine content in commonly consumed dried fish in Northern Iloilo. **Method:** A descriptive research design was employed. Consumer responses were collected using a Food Frequency Questionnaire. Dried fish specimens were classified at the generic level using FishBase. Samples of dried fish from Carles, Concepcion, and Estancia markets were obtained from various vendors and sealed in polyethylene bags. The analysis focused on the five most commonly consumed dried fish products. Samples were transported under strict sterilization conditions to the laboratory for analysis. Histamine levels were measured using the Fluorometric method as outlined by AOAC, with all analyses conducted in triplicate. **Findings:** Twenty-five commonly consumed dried fish varieties were identified, with *tabagak*, *barignon*, *danggit*, *sapsap*, and *dalinuan* as the primary commodities. Survey results from Carles, Concepcion, and Estancia revealed variable consumption frequencies, with Estancia reporting a high daily intake rate of 18%. Across all sites, price was the most influential factor in consumer selection (up to 43%), followed by freshness and taste, while packaging and size were least influential. Results demonstrated that *barignon* consistently exceeded safety thresholds across all locations, with concentrations ranging from 215.48 mg/kg to 250.16 mg/kg. Notably, *tabagak* from Concepcion exhibited the highest histamine level at 370.55 mg/kg, exceeding regulatory limits by over 85%. Statistical analysis indicated significant site-specific differences for *tabagak* ($p < 0.001$), *sapsap* ($p = 0.002$), and *dalinuan* ($p < 0.001$), with Concepcion identified as a significant outlier with higher accumulation levels across multiple species. Although the identified species are non-scombroid, the elevated histamine concentrations present a substantial public health risk, likely attributable to localized temperature abuse and hygiene deficiencies within the supply chain rather than species-specific factors. **Novelty:** Some samples, including *barignon* from Carles and both *tabagak* and *barignon* from Concepcion, exceeded the FAO regulatory limit, underscoring the need for enhanced quality control in dried fish production.

Keywords: dried fish; histamine levels; consumption pattern; food safety; Northern Iloilo

1 Introduction

Histamine serves as a key indicator for assessing seafood safety and quality⁽¹⁾. Bacterial conversion of the naturally occurring amino acid histidine, present in fish, results in histamine formation⁽²⁾. In dried fish, histamine persists and remains a significant food safety concern. Consumption of fish containing elevated histamine levels can result in scombroid poisoning, which causes adverse reactions in humans. This problem is pronounced in tropical climates where traditional processing methods are often used⁽³⁾.

Although the mechanisms of histamine formation are well understood, most safety assessments rely on generalized data and often overlook variations in small-scale, local processing. This challenge is global, as evidenced by recent reports from the Kakinada Coast⁽⁴⁾, Northern Italy⁽⁵⁾, and Ankara, Türkiye⁽⁶⁾. In the Philippines, research conducted in Samar (Amascual et al., 2020) demonstrates that results vary by region⁽⁷⁾. However, the findings cannot be generalized to other areas due to differences in local processing, salt content, drying times, and ambient humidity.

In tropical regions, fish is a primary source of high-quality animal protein. This protein is essential for human health⁽⁸⁾. Dried fish is an affordable, nutrient-dense protein source for socio-economically disadvantaged populations⁽⁹⁾. In the Philippines, the production of dried-salted fish, or *tuyong isda*, is a key part of coastal livelihoods. It is also a staple of the national diet. People value it for its organoleptic properties and cost-effectiveness^{(10), (11)}.

Despite its importance, the integrity of dried fish is often compromised by contamination. Poor handling and processing techniques can cause spoilage. This process affects the safety and quality of the final product⁽¹²⁾. Some processors also use insecticides to prevent infestation during storage. This practice poses severe health risks and changes the biochemical profile of the fish⁽¹³⁾.

In Northern Iloilo, dried fish remains a dietary staple for coastal communities. However, consumers have little awareness of product quality and safety. The Food Safety Act of 2013 (Republic Act No. 10611) requires these products to be safe. There is a pressing need for data on the dried fish trade in this region. This research answers that need by measuring histamine levels in the most commonly consumed species in Northern Iloilo.

This study contributes to the current literature by providing a detailed histamine profile of a major Philippine seafood hub. It moves the focus from export-grade commodities to the local food basket. This approach helps make food safety standards more inclusive of local protein sources that marginalized people rely on. The study also explores local preferences and consumption habits for dried fish products.

2 Methodology

2.1 Research Design

To pursue the study's objectives, a descriptive research design was employed. According to Shuttleworth (2008), this design is a valid approach for investigating specific subjects and serves as a preliminary step for more quantitative studies⁽¹⁴⁾.

2.2 Consumer Survey

To conduct the consumer survey, a structured questionnaire was developed, using the National Cancer Institute's Food Frequency Questionnaire (2023) as a guide⁽¹⁵⁾. The questionnaire was specifically designed to gather essential data on commonly consumed dried fish products, consumption frequency, and selection criteria. A total of one hundred (100) respondents were engaged in this study, aligning with the recommendation by Minoza-Gatchalian (1989), which suggests a minimum of one hundred (100) respondents for consumer surveys⁽¹⁶⁾. The survey took place in the marketplace where dried fish products are available, and respondents were randomly selected.

2.3 Dried Fish Identification and Sample Processing

Dried fish specimens were classified at the generic level using FishBase. Dried fish samples from Carles, Concepcion, and Estancia markets were obtained from multiple vendors and sealed in polyethylene bags. The analysis targeted the five most commonly consumed dried fish products. Each sample was placed in an individual, pre-sterilized polyethylene resealable bag to prevent cross-contamination. Samples were immediately stored in an insulated polystyrene chest with crushed ice, maintaining temperatures below 4°C during transport. Upon arrival at the laboratory, samples were either processed immediately or stored at -20°C until histamine analysis to inhibit further microbial decarboxylation of histidine. All glassware and culture media were sterilized using a vertical pressure steam sterilizer at 121°C and 15 psi for 20 minutes. Samples for microbial analysis were handled under aseptic conditions in a Class II Type A2 laminar flow cabinet to prevent cross-contamination.

2.4 Histamine Analysis

Histamine levels were assessed utilizing the Fluorometric method outlined in AOAC (2016)⁽¹⁷⁾. The analysis was conducted in triplicate for all samples. Sample preparation began with thorough homogenization of the dried fish muscle to address the uneven distribution of biogenic amines in dried products. A 5.0 g test portion was extracted with 50 mL of Methanol (Analytical Grade, Merck KGaA, Darmstadt, Germany). This was followed by heating in a water bath at 60 °C for 15 minutes to ensure complete extraction. The mixture was then cooled to room temperature, adjusted to its initial volume, and filtered through Whatman No. 1 filter paper. For purification, a 1 mL aliquot of the extract was passed through a chromatographic column packed with Dowex 1-X8 ion-exchange resin (50–100 mesh, Sigma-Aldrich, St. Louis, MO, USA). The eluate was collected in a volumetric flask containing 1.0 N HCl to stabilize the histamine before further processing.

The final quantification involved forming a fluorescent derivative through a precisely timed reaction. The purified eluate was alkalized with 1.0 N NaOH, then 0.1% w/v o-Phthalaldehyde (OPT) reagent (Acros Organics, Geel, Belgium) was added. After exactly 4 minutes, the reaction was stopped and the fluorophore stabilized by adding 3.57 N H₃PO₄. Fluorescence intensity was measured using a Jenway Model 6280 Fluorometer (Bibby Scientific Ltd., Essex, UK) with excitation at 350 nm and emission at 444 nm. Concentration was determined against a linear calibration curve of Histamine Dihydrochloride standards (99%+ purity, Sigma-Aldrich, St. Louis, MO, USA), ensuring reproducible results compliant with international food safety standards. ensuring that the results were both reproducible and compliant with international food safety standards.

2.5 Statistical Analysis

The commonly consumed dried fish were based on their consumption frequency, from the most to the least consumed. Data regarding the frequency of dried fish consumption and selection criteria were presented as means and percentages. Histamine content values were expressed as mean and standard deviation. Furthermore, differences in histamine content were compared using one-way ANOVA, followed by Tukey post hoc analysis to elucidate variations among different sample species. Significance was denoted by a P-value. The Statistical Package for Social Sciences, SPSS Version 9.0 for Windows (SPSS Inc., Chicago, IL, USA), was employed for all statistical analyses.

3 Results and Discussion

3.1 Commonly Consumed Dried Fish in Northern Iloilo

The consumer survey identified twenty-five commonly consumed dried fish products in Northern Iloilo (Table 1). Tabagak, or gold stripe sardinella (*Sardinella gibosa*), was the most frequently consumed dried fish species in Carles, Concepcion, and Estancia. Balingon, or anchovy (*Engraulis spp.*), ranked as the second most commonly consumed dried fish across the three municipalities. The third most commonly consumed dried fish differed by area: danngit (rabbitfish, *Siganus spp.*) in Carles, sapsap (orange fin ponyfish, *Photopectoralis bindus*) in Concepcion, and dalinuan (yellow stripe scad, *Selaroides leptolepis*) in Estancia. Dalinuan ranked fourth in Carles and Estancia, while danggit held this position in Concepcion. For the fifth most commonly consumed dried fish, dalinuan was reported in Carles and Concepcion, and danngit in Estancia.

Other species identified include aso-os (Silver sillago, *Sillago sihama*) and balanak (Flathead grey mullet, *Mugil cephalus*), which are ranked lower, likely due to reduced consumer preference or limited availability. Bangrus (Milkfish, *Chanos chanos*) and bisugo (Ornate threadfin bream, *Nemipterus hexodon*) occupy mid-level ranks, indicating moderate popularity. Bulao (Indian mackerel, *Rastrelliger kanagurta*) and lagao (Threadfin bream, *Nemipterus spp.*) demonstrate varied levels of preference, reflecting regional differences in taste. Guma-a (Bigeye scad, *Selar crumenophthalmus*) and hasa-hasa (Short mackerel, *Rastrelliger brachysoma*) are more highly preferred in specific areas, which suggests the influence of local culinary trends. Karaho (Brushtooth lizardfish, *Saurida undosquamis*) and lapu-lapu (Greasy grouper, *Epinephelus tauvina*) are among the least favored species, potentially due to factors such as taste, availability, or price. Lobo2x (Lacustrine goby, *Gobiopertus lacustris*) and mamlad (Surgeon fish, *Acanthurus spp.*) consistently receive moderate rankings, indicating a steady but limited preference. Additional species, including palad (Speckled tonguesole, *Cynoglossus spp.*), palid (Pugnose ponyfish, *Deveximentum insidiator*), salmonete (Striped red mullet, *Upeneus moluccensis*), talingtingan (Sandperch, *Parapercis spp.*), tilapia (Nile tilapia, *Oreochromis aureus*), tuloy (Sardine, *Sardinella spp.*), ito (Striped Eel Catfish, *Plotosus lineatus*), and turirik (Butterfly whiptail, *Pentapodus setosus*), also display regional variations in popularity.

Table 1. List of the commonly consumed dried fish products in Northern Iloilo

Local Name	English Name	Scientific Name	Rank		
			Carles	Concepcion	Estancia
a. aso-os	Silver sillago	<i>Sillago sihama</i>	22	25	14
b. balanak	Flathead grey mullet	<i>Mugil cephalus</i>	23	22	22
c. balingon/ gurayan	Anchovy	<i>Engraulis spp.</i>	2	2	2
d. bangrus	milkfish	<i>Chanos chanos</i>	13	12	12
e. bisugo	Ornate threadfin bream	<i>Nemipterus hexodon</i>	14	13	13
f. bulao	Indian mackerel	<i>Rastrelliger kanagurta</i>	12	7	9
g. dalinu-an	yellowstripe scad	<i>Selaroides leptolepis</i>	5	5	3
h. danggit	rabbitfish	<i>Siganus spp.</i>	3	4	5
i. guma-a	Bigeye scad	<i>Selar crumenophthalmus</i>	8	14	21
j. hasa-hasa	Short mackerel	<i>Rastrelliger brachysoma</i>	9	8	7
k. karaho	Brushtooth lizardfish	<i>Saurida undosquamis</i>	24	23	23
l. lagao	threadfin bream	<i>Nemipterus spp.</i>	10	9	8
m. lapu-lapu	Greasy grouper	<i>Epinephelus tauvina</i>	25	24	25
n. lobo2x	Lacustrine goby	<i>Gobiopertus lacustris</i>	11	11	10
o. mamlad	Surgeon fish	<i>Acanthurus spp.</i>	16	15	16
p. palad	Speckled tonguesole	<i>Cynoglossus spp.</i>	17	16	15
q. palid	Pugnose ponyfish	<i>Deveximentum insidiator</i>	15	17	18
r. salmonete	Striped red mullet	<i>Upeneus moluccensis</i>	7	10	11
s. sapsap/ lawayan	Orange fin ponyfish	<i>Photopectoralis bindus</i>	4	3	4
t. tabagak	Goldstripe sardinella	<i>Sardinella gibosa</i>	1	1	1
u. talingtingan	Sandperch	<i>Parapercis spp.</i>	18	21 ^c	20
v. tilapia	Nile tilapia	<i>Oreochromis aureus</i>	19	20	19
w. tuloy	Sardine	<i>Sardinella spp.</i>	6	6	6
x. ito	Striped Eel Catfish	<i>Plotosus lineatus</i>	21	19	24
y. turirik	Butterfly whiptail	<i>Pentapodus setosus</i>	20	18	17

n = 100

**Fig 1.** Dried balingon/gurayan or anchovy (*Engraulis spp.*)



Fig 2. Dried dalinuan or yellowstripe scad (*Selaroides leptolepis*)



Fig 3. Dried danggit or rabbitfish (*Siganus* spp.)

3.2 Preferences and Habits of Dried Fish Consumers

Table 2 provides a comprehensive analysis of dried fish consumption frequencies among consumers in the three study areas: Carles, Concepcion, and Estancia.

In Carles, daily consumption represents 5%. The most common frequency is two times per week (24%), followed by three times per week (22%). Monthly consumption patterns include once a week (20%), once a month (11%), twice a month (13%), and three times a month (5%). These percentages sum to 100%, indicating a diverse range of dried fish consumption habits in Carles.

In Concepcion, daily consumption is slightly higher at 6%. A significant proportion of consumers report consuming dried fish three times per week (27%) and two times per week (22%). Monthly consumption frequencies include once a week (19%), once a month (7%), twice a month (10%), and three times a month (9%). The total percentage equals 100%, reflecting the diversity of consumption patterns in Concepcion.

In Estancia, a distinct pattern is observed, with 18% of consumers reporting daily dried fish consumption. Three times per week (23%) and two times per week (17%) are also common frequencies. Once a week accounts for 12%, while once a month



Fig 4. Dried sapsap/lawayan or Orange fin ponyfish (*Photopectoralis bindus*)



Fig 5. Dried tabagak or Goldstripe sardinella (*Sardinella gibosa*)

(7%), twice a month (10%), and three times a month (13%) comprise the remaining monthly consumption categories. The total percentage demonstrates a similarly diverse range of consumption habits as in the other study areas. And it should be noted that in Northern Iloilo, dried fish is not merely a condiment or flavoring aid but serves as a primary protein source or “main viand” (*ulam*).

The table presents the criteria consumers use when selecting dried fish in Carles, Concepcion, and Estancia. Data are reported as frequency counts and percentages, providing insight into the predominant factors influencing consumer choices in each area.

In Carles, price is the most influential criterion for selecting dried fish (43%), followed by freshness (18%), taste (15%), packaging (10%), and size (14%). These findings indicate that economic considerations are central to purchasing decisions, with a substantial proportion of consumers prioritizing affordability. The emphasis on freshness and taste further suggests that consumers in Carles value product quality.

In Concepcion, price remains the most important factor for 31% of consumers, with freshness following closely at 29%. Taste is also a notable criterion at 19%, while packaging (9%) and size (12%) are less influential. These results underscore the continued importance of both economic and quality considerations in consumer decision-making.

Table 2. Dried Fish Consumption Frequency of Consumers

Area	Dried Fish Consumption Frequency	Frequency	Percentage
Carles	Daily	5	5%
	Three times a week	22	22%
	Two times a week	24	24%
	Once a week	20	20%
	Once a month	11	11%
	Twice a month	13	13%
	Thrice a month	5	5%
	Total	100	100%
Concepcion	Daily	6	6%
	Three times a week	27	27%
	Two times a week	22	22%
	Once a week	19	19%
	Once a month	7	7%
	Twice a month	10	10%
	Thrice a month	9	9%
	Total	100	100%
Estancia	Daily	18	18%
	Three times a week	23	23%
	Two times a week	17	17%
	Once a week	12	12%
	Once a month	7	7%
	Twice a month	10	10%
	Thrice a month	13	13%
	Total	100	100%

In Estancia, price is also the most critical factor, with 29% of consumers considering it during selection. Freshness is a close second at 25%, indicating a strong emphasis on product quality. Taste accounts for 22%, while packaging (10%) and size (14%) are less significant. These findings suggest that, similar to other areas, consumers in Estancia prioritize both affordability and quality when choosing dried fish.

The results demonstrate that price is the primary factor influencing consumer choice of dried fish products. This finding is consistent with previous studies, including Sadiq et al. (2020), which indicate that pricing significantly impacts consumer buying patterns, with higher-priced products often experiencing lower sales⁽¹⁸⁾. Conversely, products priced below the market average are generally believed to sell in greater volumes.

Product packaging and presentation significantly influence consumer purchasing attitudes, regardless of the product's intrinsic quality. The relationship established through packaging can strongly affect consumer preferences. Currently, eco-friendly packaging is considered essential⁽¹⁹⁾.

Consumers generally prefer a variety of packaging options when purchasing products. Therefore, marketers should prioritize creative and distinctive packaging that stands out in terms of scale, instructions, convenience, product design, and form compared to competitors in the market segment⁽²⁰⁾.

Table 3 offers detailed insights into the criteria consumers consider when selecting dried fish in Carles, Concepcion, and Estancia. The data encompass price, freshness, taste, packaging, and size.

Across all three areas, price is the top criterion for consumers. In Carles, 43% of consumers consider price the most significant factor, compared to 31% in Concepcion and 29% in Estancia. This consistent ranking highlights the universal importance of pricing in consumer decision-making for dried fish. These findings align with previous studies, including Sadiq et al. (2020), which indicate that higher-priced products often experience lower sales⁽¹⁸⁾, while products priced below the market average are generally believed to sell in greater volumes.

Freshness is the second most valued criterion after price. In Carles, it accounts for 18%, while in Concepcion and Estancia, it is 29% and 25% respectively, indicating a greater emphasis on freshness in the latter two areas. Product quality, including freshness,

Table 3. Consumers' Criteria for Selecting Dried Fish

Area	Criteria	Frequency	Percentage	Rank
Carles	Price	43	43%	1
	Freshness	18	18%	2
	Taste	15	15%	3
	Packaging	10	10%	5
	Size	14	14%	4
	Total	100	100%	
Concepcion	Price	31	31%	1
	Freshness	29	29%	2
	Taste	19	19%	3
	Packaging	9	9%	5
	Size	12	12%	4
	Total	100	100%	
Estancia	Price	29	29%	1
	Freshness	25	25%	2
	Taste	22	22%	3
	Packaging	10	10%	5
	Size	14	14%	4
	Total	100	100%	

significantly affects consumer attitudes toward purchasing and consuming food⁽²¹⁾. Freshness is the primary attribute used to determine the market value of high-value fish and can be assessed using sensory, biochemical, microbiological, and physical tests⁽²²⁾.

Taste, as a quality indicator, consistently ranks third in consumer preference across all regions, with 15% in Carles, 19% in Concepcion, and 22% in Estancia. These figures (Figure 1- 5) indicate a stable appreciation for taste, with a modest upward trend from Carles to Estancia. The quality attributes of fish meat, especially its flavor, significantly influence market prices for seafood, as emphasized by Sikorski (undated)⁽²²⁾.

The criteria of packaging and size are less influential across all regions, ranking fourth and fifth, respectively. Size is slightly more preferred than packaging, with a 14% preference in both Carles and Estancia and 12% in Concepcion. Packaging remains the least influential, with a consistent 10% in Carles and Estancia and 9% in Concepcion. Product packaging serves multiple functions: it provides information about the product and the company, facilitates customer engagement, and ensures product quality⁽²³⁾,⁽²⁴⁾. Packaging also significantly influences customer purchasing decisions, regardless of variations in product quality⁽⁹⁾.

3.3 Histamine Content

Table 4 summarizes the histamine concentrations in commonly consumed dried fish from three Northern Iloilo locations: Carles, Concepcion, and Estancia. The results indicate that the histamine content in "barignon" from Carles, at 238.45 mg/kg, exceeds both the FAO regulatory limit of 200 mg/kg and the Philippine National Standards-Bureau of Food and Drugs threshold specified in PNS-BFAD 04-2006 on Ethnic food products – Dried, salted fish – Specification⁽²⁵⁾. In contrast, other dried fish samples from Carles, including "tabagak," "danggit," "sapsap," and "dalinuan," display histamine levels within the acceptable range, complying with the established standard.

In Concepcion, two dried fish products, "tabagak" and "barignon," exceed the regulatory histamine limit, with concentrations of 370.55 mg/kg and 215.48 mg/kg, respectively. The remaining three dried fish samples from Concepcion exhibit histamine levels within the established standard limits. In Estancia, only the "barignon" sample surpasses the histamine threshold, recording 250.16 mg/kg, while the other four samples comply with regulatory standards. A study conducted in Samar, Philippines, by Amascual et al. (2020), also reported elevated histamine levels in dried fish species such as danggit, sapsap, and tamban (locally referred to as tabagak in Iloilo), although these values remained within the FAO regulatory limit⁽⁷⁾.

Among Northern Iloilo markets, Concepcion records the highest number of non-compliant dried fish products regarding histamine content, with levels exceeding those observed in other locations. Although the top five species identified in Northern

Table 4. Histamine content of commonly consumed dried fish in Northern Iloilo

Fish Species	Histamine Content (mg/kg)	Compliance
<i>Carles</i>		
Tabagak	73.14 ± 1	Compliant
Baringon	238.45 ± 28	Non-compliant
Danggit	116.87 ± 104	Compliant
Sapsap	8.92 ± 0	Compliant
Dalinuan	24.75 ± 2	Compliant
<i>Concepcion</i>		
Tabagak	370.55 ± 16	Non-compliant
Baringon	215.48 ± 7	Non-compliant
Danggit	6.42 ± 0	Compliant
Sapsap	38.30 ± 1	Compliant
Dalinuan	148.54 ± 2	Compliant
<i>Estancia</i>		
Tabagak	21.69 ± 2	Compliant
Baringon	250.16 ± 5	Non-compliant
Danggit	36.24 ± 1	Compliant
Sapsap	7.32 ± 0	Compliant
Dalinuan	28.03 ± 1	Compliant

Note: Regulatory limit is 200 mg/kg based on FAO No. 210 s. 2001

Iloilo are non-scombroid, the elevated histamine concentrations present a considerable health risk. These findings are consistent with those of Nguyen et al. (2021), who reported that scombroid poisoning incidents are often associated with non-scombroid species such as sardines and herring when inadequate post-harvest handling promotes bacterial decarboxylation of histidine⁽²⁶⁾.

The Food and Agriculture Organization (FAO) classifies histamine as a mild hazard, while the competent authority of New Zealand categorizes the risk of histamine poisoning as low (Mild). This classification underscores that histamine formation primarily results from temperature abuse during the catch, transportation, storage, and processing of fish species with high free histidine content⁽²⁷⁾.

Table 5 presents the statistical variations in histamine concentrations among the surveyed fish species across the three sampling stations. The most pronounced variance was observed in Tabagak ($p < 0.001$), where post-hoc analysis assigned each municipality to a distinct statistical group (a, b, c). The histamine levels in Concepcion (370.55 mg/kg) were significantly higher than those in Carles and Estancia, exceeding regulatory limits by more than 85%. This substantial disparity suggests that the histamine risk for *Tabagak* is primarily influenced by site-specific factors, such as localized temperature abuse or hygiene failures within the Concepcion supply chain, rather than by species-specific characteristics. In contrast, Baringon and Danggit showed no significant differences across the study sites ($p = 0.142$), forming a single homogeneous group.

Table 5. Significant difference of histamine content of commonly consumed dried fish in Northern Iloilo

Fish Species	Carles (mg/kg)	Concepcion (mg/kg)	Estancia (mg/kg)	p-value
Tabagak	73.14±1 ^a	370.55±16 ^b	21.69±2 ^c	<0.001
Baringon	238.45±28	215.48±7	250.16±5	0.142 (ns)
Danggit	116.87±104	6.42±0	36.24±1	0.210 (ns)
Sapsap	8.92±0 ^a	38.30±1 ^b	7.32±0 ^a	0.002
Dalinuan	24.75±2 ^a	148.54±2 ^b	28.03±1 ^a	<0.001

Notes: Means with different superscript letters (a,b,c) within the same row are significantly different ($p < 0.05$). (ns) indicates No Significant difference between locations for that specific species.

A consistent pattern identified Concepcion as a significant statistical outlier across multiple species. For Sapsap ($p = 0.002$) and Dalinuan ($p < 0.001$), Concepcion exhibited significantly higher histamine levels (group b) compared to the other two locations (group a). Although these concentrations remained within safe thresholds, the repeated elevation in Concepcion indicates

that local environmental or procedural conditions may be more conducive to bacterial decarboxylation of histidine, thereby increasing the potential for histamine accumulation.

4 Conclusion

In Northern Iloilo, twenty-five dried fish varieties are commonly consumed, with tabagak, balingon, dalinuan, danggit, and sapsap being the most popular. Each region exhibits distinct dried fish consumption patterns, with Carles favoring consumption twice or thrice weekly and less daily. Concepcion displays a similar range but with a marginally higher daily intake. In Estancia, a notable 18% consume dried fish daily among other frequencies. Across these areas, while freshness, taste, packaging, and size vary in importance, price is the consistently dominant factor influencing dried fish purchases. It has been found that not all dried fish in Carles, Concepcion, and Estancia markets meet the FAO and PNS-BFAD standards for histamine content. Specifically, the baringon from Carles, and both tabagak and baringon from Concepcion, do not conform to these standards. Additionally, the histamine level in baringon from Estancia exceeds the regulatory limit. This non-compliance raises concerns about the potential risk of histamine poisoning in sensitive individuals. Therefore, it is crucial to enhance the quality of dried fish products in Northern Iloilo, particularly in terms of their histamine content.

This study concludes that while the dried fish trade in Northern Iloilo is characterized by significant biodiversity—encompassing 25 commonly consumed species—the market is dominated by a core group of five species: Tabagak (Goldstripe sardinella), Balingon (Anchovy), Danggit (Rabbitfish), Sapsap (Ponyfish), and Dalinuan (Yellowstripe scad). Consumption patterns are deeply integrated into the local diet, with a high frequency of intake (typically 2–3 times per week), particularly in Estancia where daily consumption is most prevalent (18%).

The research identifies a critical "Affordability-Quality" paradox in consumer decision-making. Price consistently emerges as the primary determinant for selection across all municipalities, yet consumers remain discerning regarding freshness and taste. This economic sensitivity suggests that consumers may inadvertently accept higher health risks if lower-priced products are available, as secondary factors like packaging and size remain less influential.

From a food safety perspective, the study reveals a significant public health concern regarding histamine levels in non-scombroid species. Baringon (Anchovy) demonstrated a consistent failure to meet the FAO and Philippine National Standards (PNS-BFAD) safety limit of 200 mg/kg across all three study areas. Furthermore, Concepcion was identified as a critical geographical outlier; it not only hosted the highest number of non-compliant products but also recorded the highest histamine concentration in Tabagak (370.55 mg/kg).

Statistical analysis ($p < 0.05$) confirms that while species like Baringon show uniform risk across the region, the significant variance in Tabagak, Sapsap, and Dalinuan levels in Concepcion suggests that site-specific post-harvest failures—such as localized temperature abuse or hygiene deficiencies—are the primary drivers of histamine accumulation rather than inherent biological factors of the fish. Consequently, the core contribution of this study is the shift in focus from scombroid species to small pelagics (sardines and anchovies) as the primary histamine risk in Northern Iloilo, necessitating urgent, location-specific interventions in artisanal processing and cold-chain management to protect the local consumer base.

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