Open Access Research Journal of
Multidisciplinary Studies
Journals home page: https://oarjpublication/journals/oarjms/
ISSN: 2783-0268 (Online)

(Research Article)

Comparative study of bacterial load and organoleptic quality changes between lean fish and fatty fish in fresh, iced and non-iced state under laboratory condition

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Open Access Research Journal of Multidisciplinary Studies, 2024, 07(01), 039–051

Publication history: Received on 24 November 2023; revised on 23 January 2024; accepted on 26 January 2024

Article DOI: https://doi.org/10.53022/oarjms.2024.7.1.0002

Abstract

The study conducted in the laboratory conditions of Sylhet Sadar Upazila compared the bacterial load and organoleptic quality changes in lean fish (*Oreochromis niloticus*) and fatty fish (*Pangasianodon hypophthalmus*) across fresh, iced, and non-iced states. Preservation times of 6- and 8-hours intervals were examined, focusing on organoleptic quality changes and Total Viable Count (TVC). The evaluation of defect points and fish grading revealed that all fresh and iced Tilapia and Pangas samples were in excellent condition (Grade A) at 0, 6, and 8 hours, while non-iced samples at 6- and 8-hours intervals were in acceptable condition (Grade B).

Notably, non-iced Pangas exhibited higher defect points than non-iced Tilapia at the same intervals. The bacterial load varied, with the highest observed in non-iced Pangas at an 8-hour interval in May and the lowest in iced Tilapia at a 6-hour interval in April. Compliance with International Commission on Microbiological Specifications for Foods (ICMSF) standards was noted in both fish types across all states. The temperature dependence of bacterial growth was evident, with the highest bacterial load at 35 °C in May and the lowest at 24 °C in April. Overall, the study suggests that fresh Tilapia and Pangas, whether iced or non-iced at 6- and 8-hour intervals, meet ICMSF standards, ensuring their safety for consumption and potential export.

Key words: Total Viable Count; Defect points; *Oreochromis niloticus*; *Pangasianodon hypophthalmus*; ICMSF

1. Introduction

Fish plays a significant role in the Bangladeshi diet, providing more than 60% of animal source food, representing a crucial source of micro-nutrients, and possessing an extremely strong cultural attachment [1]. Fisheries sectors play a vital role in terms of nutrition, employment, increased GDP growth and foreign exchange earnings. It has been estimated that fisheries and aquaculture supplied the world with about 128 million metric tons of fish food per year [2], providing a per capita supply of 18.4 kg (live weight equivalent). In Bangladesh total fish production 3.87 million metric ton and it contributes 3.65% of our GDP, 23.81% of agricultural sector and 1.97% to foreign exchange earnings [3]. Bangladesh where malnutrition remains a significant development challenge, fish is an irreplaceable diet for the people. Unfortunately, many fish spoil every year in the country due to the growth and activity of pathogenic microorganisms. The quality of fish mainly depends on the time between the harvesting and processing periods. Microbial hazards causing infections and poor health are closely related to food safety concerning animal proteins derived from marketed food such as fish. This creates a burning question for all consumers with a high-risk commodity about pathogenic bacterial contaminations alarming to food safety challenge [1]. Microorganisms are widely distributed in nature whenever favorable environmental factors are present for their growth. Usually food supply, temperature and moisture are the main factors that determine the growth of microorganisms. Bacteria are one of the most important microorganisms present in fishes responsible for economic loss due to mortality and contamination of fish food. Microorganisms are found on all the outer surfaces (gill and skin) and intestine of live and newly caught fishes. A total

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number of bacterium found in fish skin is about 10^2-10^7 CFU/cm^2 [4] and availability of bacterial flora in gill and intestine is 10^3-10^9 CFU/g [5]. Live fish is sterile when it commences to death and then microbial activity start and accelerates the spoilage of fishes. Spoilage and pathogenic bacteria are important for food safety as well as for human health. Bacteria are also known to cause zoonotic disease to the handlers and final consumers. Human infection results from contamination of hands and utensils during processing operations, especially at evisceration. Fish are also known to transmit human food borne infection and intoxication [6]. Fish is a more perishable food material and can be easily undergone in deteriorative changes by autolysis, bacterial action, and oxidative rancidity. Fish need extra preservation action to maintain its quality and food value immediately after harvesting. Lean fishes are less susceptible to spoilage. Fatty fish are more susceptible to microbiological spoilage and quick loss of organoleptic quality. Different types of organoleptic and bacterial degradation occur in both types of fishes if not kept in proper preservation temperature. Icing is the simplest method of controlling spoilage in fish. At or near the temperature of melting ice, many bacteria become inactive, and the onset of spoilage becomes delayed. In tropical conditions, the iced fish will remain in good condition for a few days. Continued storage in ice will result in an increase in the psychrophiles which can thrive at the temperature of iced storage and consequently spoil the fish. In local retail and wholesale fish market, proper icing isn't done. Rapid spoilage and degradation occurred due to unhygienic handling after harvesting, and lack of proper icing in fish markets. Lowering the temperature of the fish greatly retards the bacterial and enzymatic spoilage. The growth of spoilage bacteria is known to be significantly reduced by small decreases in temperature in the range -1 to + 5 °C. Chilling is a very effective method of controlling spoilage in fish. The objective of chilling is to cool the fish as quickly as possible to as low a temperature as possible without freezing it. Therefore, the fish should be washed, sorted, and stored without allowing any long exposure to the sun on the deck and chilled as quickly as possible. The fish shall not be trampled upon, or bruised during shoveling and handling as this will impair the quality of the fish. There are several options for chilling fish that can be advantageously employed [7]. Among the culture species, Tilapia (*Oreochromis niloticus*) and Pangas (*Pangasianodon hypophthalmus*) are very popular lean fish and fatty fish respectively in Bangladesh. The bacterial load and the presence of the bacterial pathogen in Tilapia and Pangas fish is a good indicator of the fish quality and potential health risk consequently it poses to consumers. Very little work in the present research has been done in the past and scared, information on the organoleptic quality changes and bacterial load and pathogenic bacteria in Tilapia and Pangas fish. It is unknown to us about bacterial load and organoleptic quality changes between Tilapia and Pangas in fresh, iced and non-iced state under laboratory condition. The study of this information is very important for public health in terms of food safety as well as export earnings.

2. Material and methods

2.1. Collection and preparation of sample

The study sample was Tilapia (*Oreochromis niloticus*) and Pangas (*Pangasianodon hypophthalmus*) from Kazir bazar fish market at Sylhet Sadar Upazila, Sylhet. The lean fish Tilapia (*Oreochromis niloticus*) and fatty fish Pangas (*Pangasianodon hypophthalmus*) samples were collected from Kazir bazar fish market in ice box. Then the samples were transported from the fish market to the laboratory of the Department of Microbiology and Immunology, Faculty of Veterinary, Animal and Biomedical Science, Sylhet Agricultural University (SAU), Sylhet and also Eurocross Frozen Foods (BD) Ltd., Khadimnagar, Sylhet according to the suitability to determine organoleptic quality changes and bacterial load. Total seventy two (72) fish samples were collected during the period of January/ 2017 to June/ 2017. Total twelve (12) fish samples were taken four times per month for the preservation period at 0, 6 and 8 hours interval. Three (03) samples for iced tilapia (*Oreochromis niloticus*), three (03) for iced pangas (*Pangasianodon hypophthalmus*), three (03) for non-iced tilapia and three (03) for non-iced pangas. Total thirty six (36) fresh samples were taken in case of Tilapia and total thirty six (36) fresh samples were also taken for Pangas from January to June. Eighteen (18) fish samples were taken per state of both fishes from January to June. Different preservation times (6- and 8-hours interval) were considered for both types of investigation. During collection of samples, fresh samples were always considered. Fish of approximately the same size were deliberately selected during purchase for fresh Tilapia (about 25 cm TL average) and fresh Pangas (about 39.5 cm TL average). Size of fish is one of the intrinsic factors that affect the rate of spoilage in fresh fish stored in ice [8]. Firstly, organoleptic quality changes of three fresh Tilapia (*Oreochromis niloticus*) samples were determined immediately by determination of defect points and grading of fish with grade points following EC, [9] freshness grade for fishery products.

Table 1 Grading of fish with grade points

Grade	Points	Comments
A	<2	Excellent/ Acceptable
B	2 to <5	Good/ Acceptable
C	5	Bad/ Rejected

Table 2 Determination of defect points of fish

Sl. No.	Characteristics	Defect	Defect Point	Grade
1.	Odor at neck when broken	Natural odor	1	Acceptable
		Faint or sour odor	5	Rejected
2.	Odor of gills	Natural odor	1	Excellent
		Faint sour odor	2	Acceptable
		Slight moderate sour odor	3	Acceptable
		Moderate to strong sour odor	5	Rejected
3.	Color of gills	Slight pinkish red	1	Excellent
		Pinkish red or brownish	2	Acceptable
		Brown or grey color	3	Acceptable
		Bleached, thick yellow slime	5	Rejected
4.	General appearance	Full bloom, bright, shining, iridescent	1	Excellent
		Slight dullness and loss of bloom	2	Acceptable
		Definite dullness and loss of bloom	3	Acceptable
		Reddish lateral line, dull, no bloom	5	Rejected
5.	Slime	Usually clear, transparent and uniformly spread	1	Excellent
		Becoming turbid opaque and milky	2	Acceptable
		Thick, sticky, yellowish or green in color	5	Rejected
6.	Eye	Bulging with protruding lens, transparent eye cap	1	Excellent
		Slight cloudy of lens and sunken	2	Acceptable
		Dull, sunken, cloudy	3	Acceptable
		Sunken eye covered with yellow slime	5	Rejected
7.	Consistency of fish	Firm and elastic	1	Excellent
		Moderately soft and some loss of elasticity	2	Acceptable
		Some softening	3	Acceptable
		Lime and floppy	5	Rejected

For bacterial load count, samples were taken from three regions of fish muscles; these are anterior, middle and caudal region. After taking of sample, these three fish samples were kept in ice for six and eight hours respectively. Secondly, organoleptic quality changes of three fresh fatty fish Pangas (*Pangasianodon hypophthalmus*) samples were also determined immediately by the same process. For bacterial load count, samples were taken from three regions of fish muscles as before. After taking the sample, these three fish samples were kept in ice for six and eight hours respectively.

Thirdly and finally, same procedure was followed for organoleptic quality changes and bacterial load count for three fresh samples of Tilapia and the same for Pangas. After finishing the organoleptic quality test and taking sample for bacterial load of fresh Tilapia and Pangas samples, the samples were kept in non-iced condition for six and eight hours respectively for each time.

2.2. Homogenization and dilution

20 g of samples (Fish scale and muscle) from each sample was taken with the help of sterile scissors, forceps, knives etc. in a sterile polythene bag and poured 180 ml sterile 0.1% peptone water in that bag and placed it in a sterile stomacher and blended for 2 minutes. This homogenate sample's resulting dilution at this stage is 10^{-1}. Again 1 ml of the 10^{-1} dilution was transferred to a screw cap vial containing 9 ml of sterile 0.1% peptone water. The vial was shaken thoroughly, and it gives a dilution of 10^{-2}. In this way 10^{-3}, 10^{-4} and 10^{-5} dilutions were made using separate sterile pipettes of 1 ml volume. Each dilution was planted by pipetting 1 ml of dilutions into a sterile petri plate. To ensure good growth of organisms, 10 ml of melted agar media (cooled to 45 °C) were poured into the plates. Immediately the dishes were rotated on flat surface by hand 5 times in the clockwise direction, 5 times in the anti-clockwise direction. For proper mixing of the inoculum with the media and agar were allowed to solidify. The petri dishes were incubated at 37 °C for 48 hrs. in the inverted position to prevent condensation of moisture on the surface of the agar media during incubation. Two plates corresponding to one dilution and showing between 30 to 300 colonies per plate were selected. All colonies on the plate were counted using colony counter. Standard Plate Count was calculated using the following formula:

$$\mathrm{N} = \frac{\sum \mathrm{C}}{\mathrm{V}(n1 + 0.1\, n2 + 0.001\, n3)d}$$

Where,
N= Total amount of microbes
∑C = Summation of colonies of all petri dishes of three successive dilutions
V= Amount of inoculum mixture poured into each petri dish (generally 1.0 ml)
n1 = Number of petri dish of first dilution
n2= Number of petri dish of second dilution
n3=Number of petri dish of third dilution
d= Dilution factor corresponding to first dilution

2.3. Preliminary analysis of raw data

For preliminary processing of raw data obtained for fishes both Tilapia and Pangas (*Oreochromis niloticus* and *Pangasianodon hypophthalmus*) of this study, the mean, standard deviation were calculated first. These values were useful and other statistical analysis and interpretations thereafter by using computer software like Microsoft Excel, SPSS etc.

3. Result and Discussion

3.1. Changes in organoleptic qualities

The results of organoleptic quality changes in *Oreochromis niloticus* and *Pangasianodon hypophthalmusin* fresh, iced and non-iced state under laboratory condition from January to June are presented. The study evaluated *Oreochromis niloticus* and *Pangasianodon hypophthalmus*'s organoleptic quality using a 1-5 score scale. Fresh and iced fish were in excellent condition (grade A), while non-iced fish (6 and 8 hours) were acceptable (grade B), influenced by temperature variations.

3.1.1. Defect points of Fresh, Iced and Non-iced Tilapia and Pangas at 0-, 6- and 8-hours interval in January

In January, defect points of fresh, iced, and non-iced Tilapia and Pangas were assessed in Figure 1A. Fresh and iced samples were excellent (grade A), non-iced showed acceptable quality (grade B) at 6 and 8 hours with gill, eye, and color changes. Non-iced Pangas exhibited more pronounced defects due to its higher perishability. Quality changes were influenced by attributes, species, season, source, and temperature.

3.1.2. Defect points of Fresh, Iced and Non-iced Tilapia and Pangas at 0-, 6- and 8-hours interval in February

Defect points of fresh, iced and non-iced Tilapia and Pangas at 0-, 6- and 8-hours interval were determined in February. Figure 1B presented all fresh Tilapia and Pangas samples at 0-hour interval were found in excellent condition and fell into grade A. Rest discussions are same as the discussion of previous and it was observed that defect points of both types of fishes increased little-bit due to the fluctuation of temperature.

3.1.3. Defect points of Fresh, Iced and Non-iced Tilapia and Pangas at 0-, 6- and 8-hours interval in March

Defect points of fresh, iced and non-iced Tilapia and Pangas at 0-, 6- and 8-hours interval were determined in March. Figure 1C described all fresh Tilapia and Pangas samples at 0-hour interval were found in excellent condition and fell into grade A. Rest discussions are same as before.

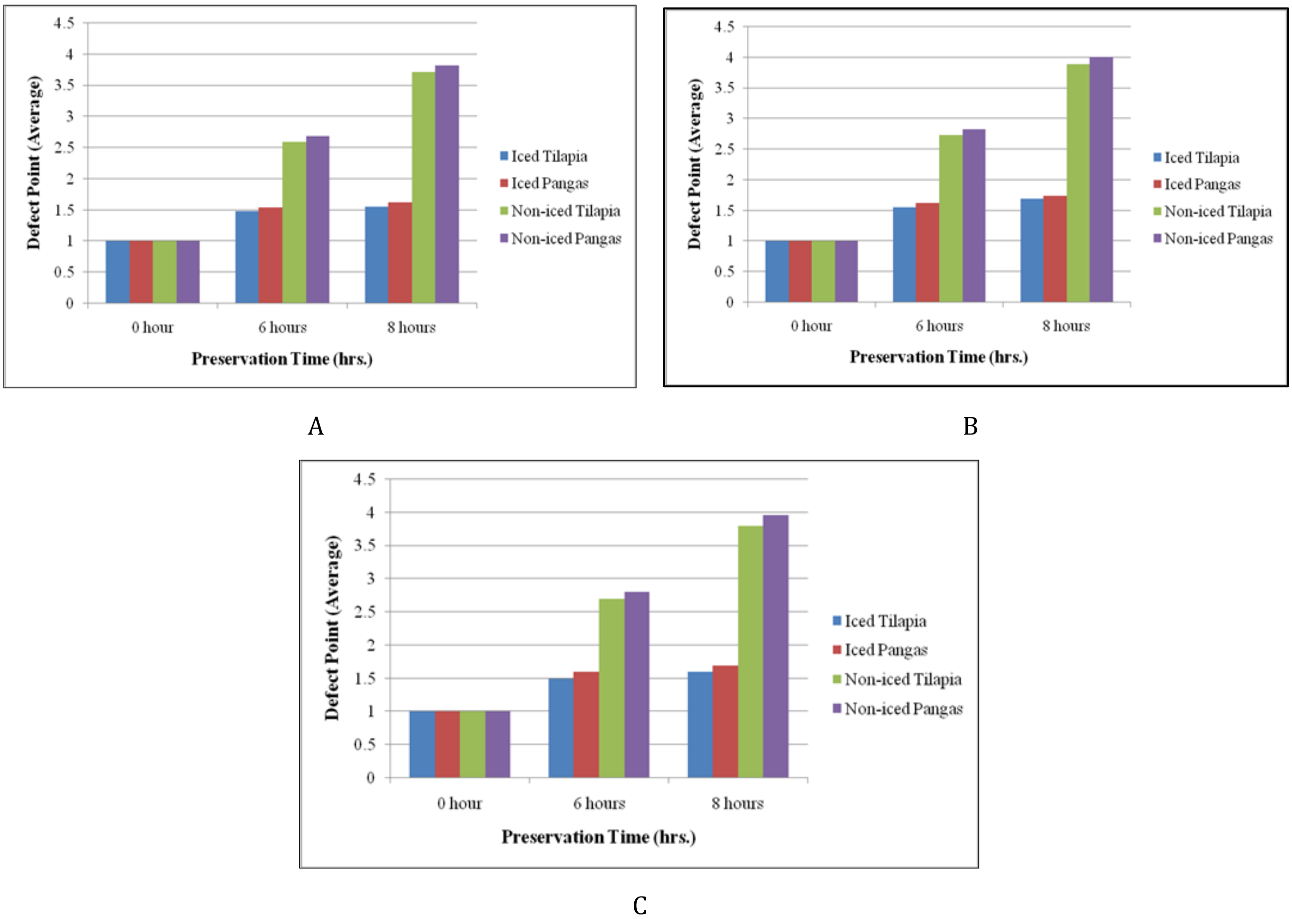
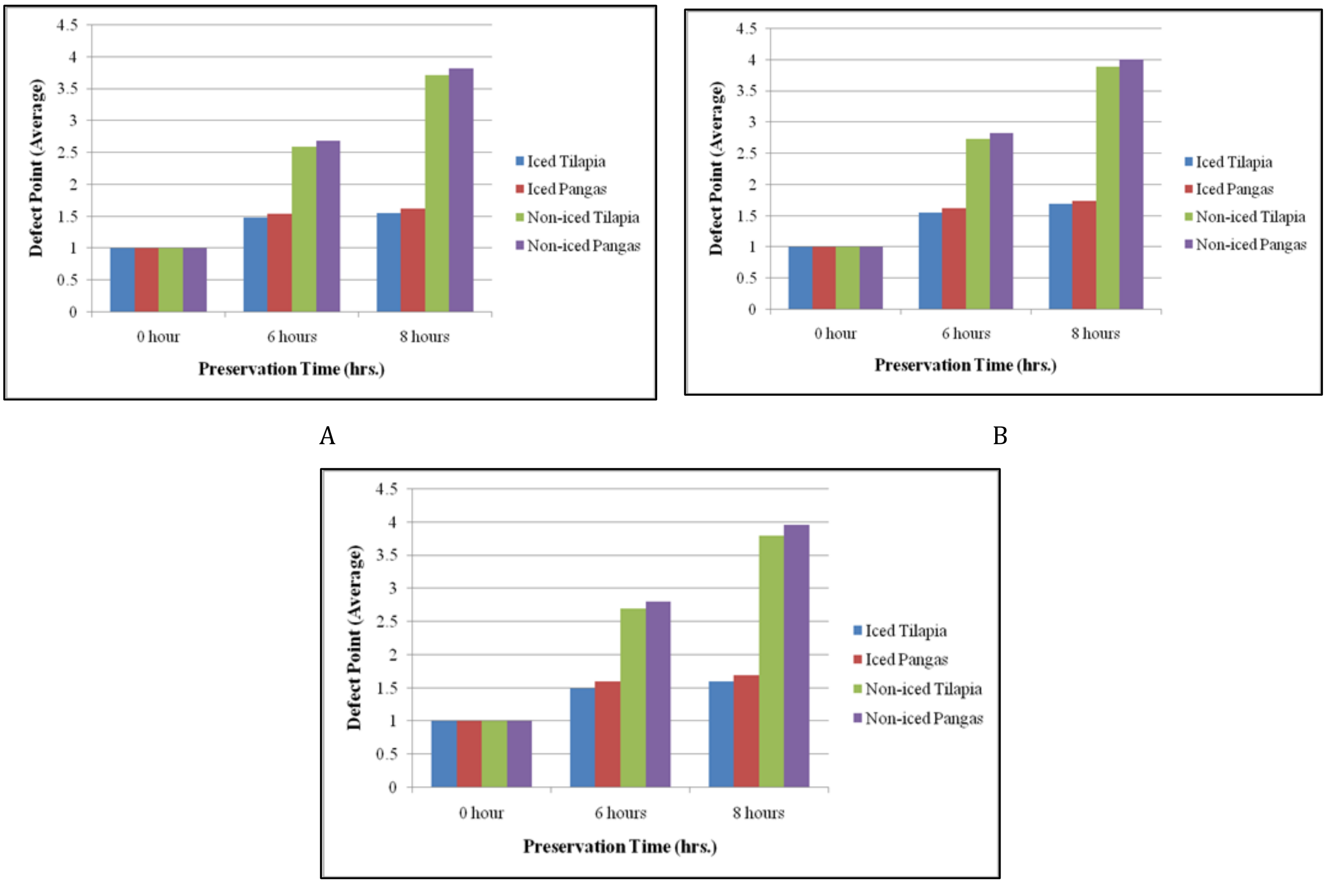


Figure 1 Defect Points of Fresh, Iced and Non-iced Tilapia and Pangas at 0-, 6- and 8-hours interval in A) January, B) February, C) March

3.1.4. Defect points of Fresh, Iced and Non-iced Tilapia and Pangas at 0-, 6- and 8-hours interval in April

Defect points of fresh, iced and non-iced Tilapia and Pangas at 0-, 6- and 8-hours interval were determined in April. Figure 2A presented all fresh Tilapia and Pangas samples at 0-hour interval were found in excellent condition and fell into grade A. Rest discussions are same as previous graphs.



A B

C

Figure 2 Defect Points of Fresh, Iced and Non-iced Tilapia and Pangas at 0-, 6- and 8-hours interval in A) April, B) May, C) June

3.1.5. Defect points of Fresh, Iced and Non-iced Tilapia and Pangas at 0-, 6- and 8-hours interval in May

Defect points of fresh, iced and non-iced Tilapia and Pangas at 0-, 6- and 8-hours interval were determined in May. Figure 2B described all fresh Tilapia and Pangas samples at 0-hour interval were found in excellent condition and fell into grade A. Rest discussions are same as before.

3.1.6. Defect points of Fresh, Iced and Non-iced Tilapia and Pangas at 0-, 6- and 8-hours interval in June:

Defect points of fresh, iced and non-iced Tilapia and Pangas at 0-, 6- and 8-hours interval were determined in June. Figure 2C presented all fresh Tilapia and Pangas samples at 0-hour interval were found in excellent condition and fell into grade A. Rest discussions are same as previously mentioned.

3.2. Bacterial Load Analysis

Bacterial load changes in fresh, iced, and non-iced *Oreochromis niloticus* and *Pangasianodon hypophthalmus* were studied from January to June. Viable counts varied with lowest counts in iced samples, temperature impacted bacterial load, with higher temperature associated with higher counts (24 °C-35 °C).

3.2.1. Bacterial Load of Oreochromis niloticus and Pangasianodon hypophthalmus in fresh, iced and non-iced state under laboratory condition in January

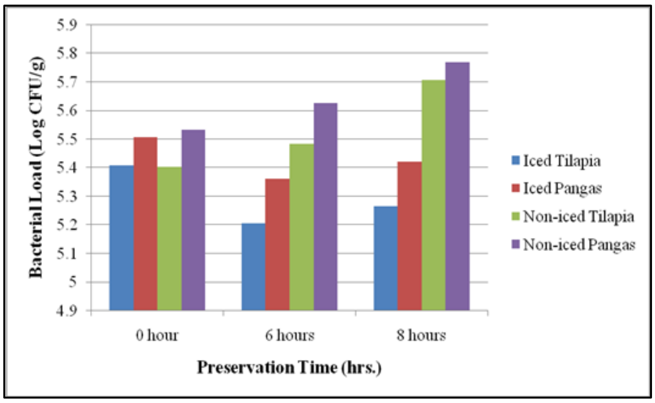
Bacterial load (Log TVC) was evaluated for fresh, iced, and non-iced Tilapia and Pangas at 0-, 6-, and 8-hour intervals in January (Figure 3A). Log TVC varied by state and time; for example, non-iced samples had higher Log TVC values than iced ones. Bacterial load changes were influenced by species, preservation, season, source, and temperature.

3.2.2. Bacterial Load of Oreochromis niloticus and Pangasianodon hypophthalmus in fresh, iced and non-iced state under laboratory condition in February

In February, bacterial load (Log TVC) was assessed for fresh, iced, and non-iced Tilapia and Pangas at 0-, 6-, and 8-hour intervals (Figure 3B). Log TVC values varied by state and time, with non-iced samples having higher values.

3.2.3. Bacterial Load of Oreochromis niloticus and Pangasianodon hypophthalmus in fresh, iced and non-iced state under laboratory condition in March

March analysis showed bacterial load (Log TVC) for fresh, iced, and non-iced Tilapia and Pangas at 0-, 6-, and 8-hour intervals (Figure 3C). Log TVC varied, with non-iced samples having higher values.



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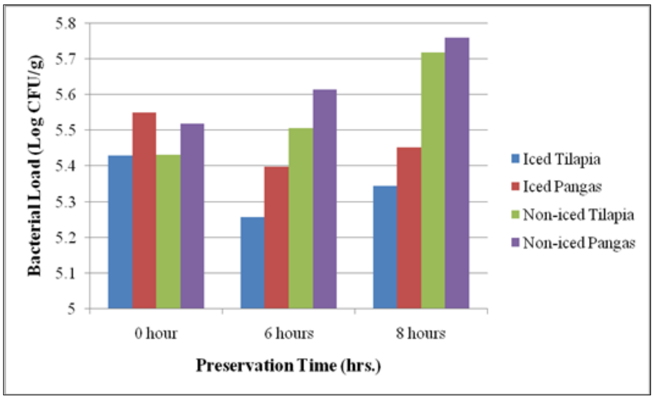

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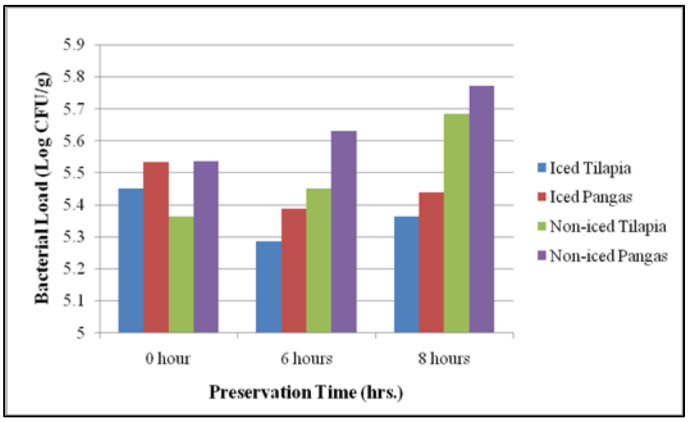


C

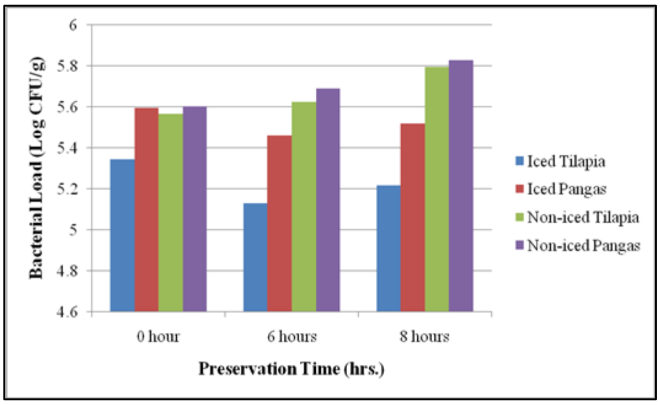
Figure 3 Bacterial Load of Fresh, Iced and Non-iced Tilapia and Pangas at 0-, 6- and 8-hours interval in A) January, B) February, C) March

3.2.4. Bacterial Load of Oreochromis niloticus and Pangasianodon hypophthalmus in fresh, iced and non-iced state under laboratory condition in April

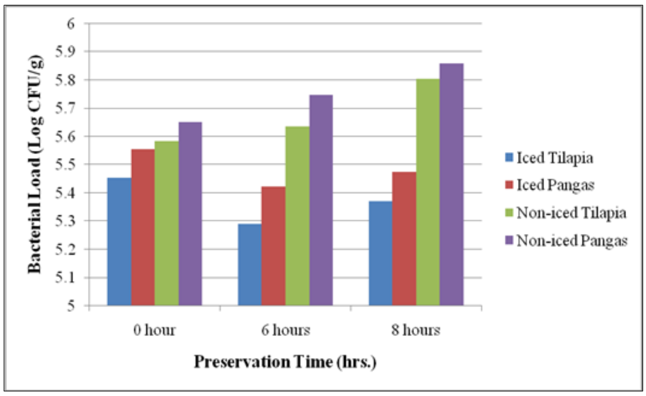
April's evaluation of bacterial load (Log TVC) in fresh, iced, and non-iced Tilapia and Pangas, at 0-, 6-, and 8-hour intervals, revealed varying Log TVC values (Figure 4A). Non-iced samples consistently had higher values.

3.2.5. Bacterial Load of Oreochromis niloticus and Pangasianodon hypophthalmus in fresh, iced and non-iced state under laboratory condition in May

May's bacterial load (Log TVC) assessment in fresh, iced, and non-iced Tilapia and Pangas, at 0-, 6-, and 8-hour intervals, showed varying Log TVC values (Figure 4B). Non-iced samples consistently had higher values.



A



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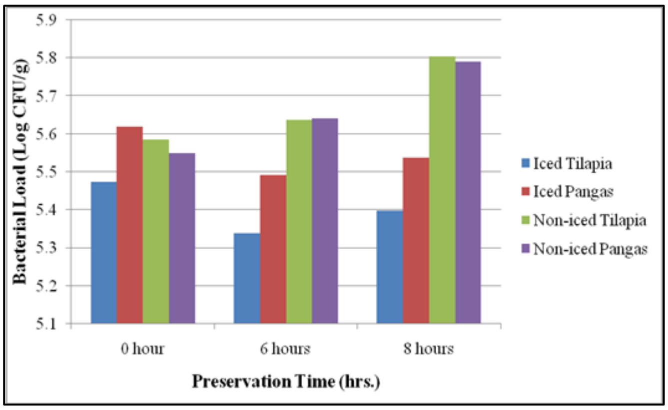


C

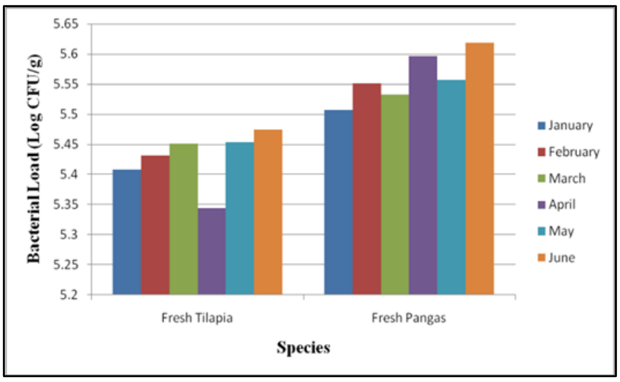
Figure 4 Bacterial Load of Fresh, Iced and Non-iced Tilapia and Pangas at 0-, 6- and 8-hours interval in A) April, B) May, C) June

3.2.6. Bacterial Load of Oreochromis niloticus and Pangasianodon hypophthalmus in fresh, iced and non-iced state under laboratory condition in June

June's Log TVC evaluation for fresh, iced, and non-iced Tilapia and Pangas, at 0-, 6-, and 8-hour intervals, indicated varying values (Figure 4C). Non-iced samples consistently had higher values.

3.2.7. Bacterial Load of Fresh Tilapia and Pangas at 0-hour interval under laboratory condition from January to June

From January to June, bacterial load (Log TVC) was assessed in fresh Tilapia and Pangas at 0-hour interval (Figure 5A). The mean Log CFU/g±SD values were 5.43±0.05 for Tilapia and 5.56±0.04 for Pangas, indicating a higher load in Pangas. Statistical analysis revealed a significant difference (<0.05) between the two species.



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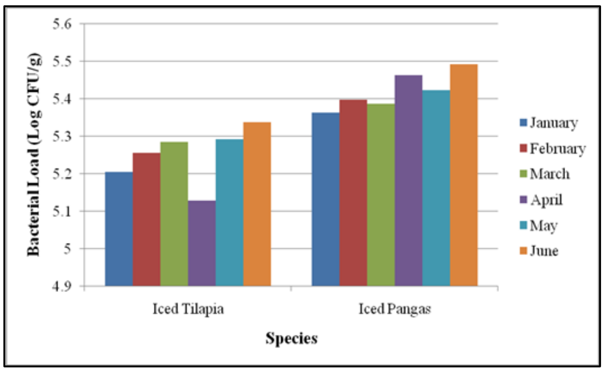

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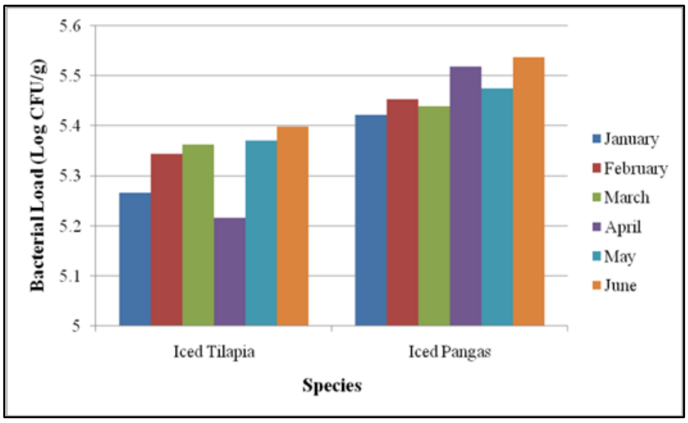


C

Figure 5 Bacterial Load of Fresh Tilapia and Pangas at A) 0-hour, B) 6-hour, C) 8-hour interval

3.2.8. Bacterial Load of Iced Tilapia and Pangas at 6 hours interval under laboratory condition from January to June

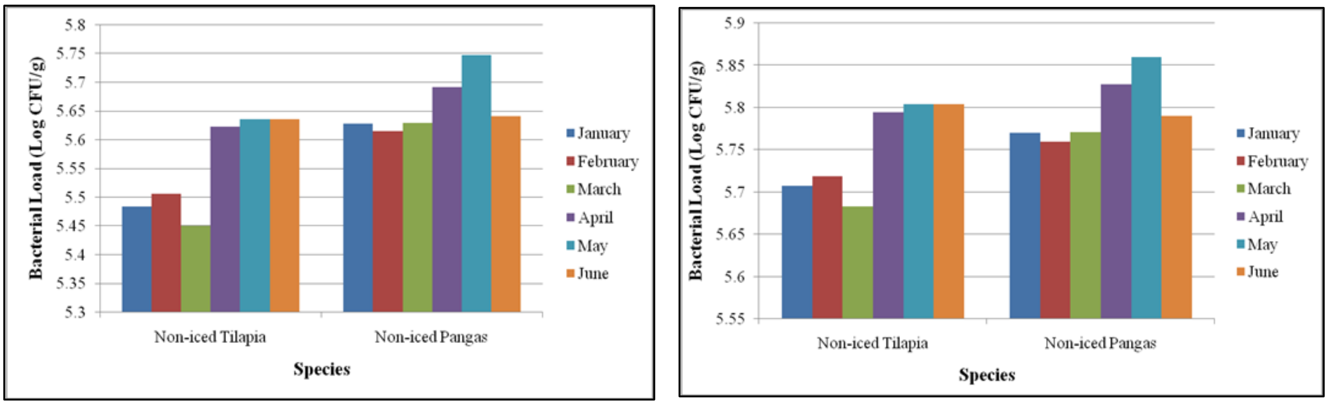
From January to June, bacterial load (Log TVC) was assessed in iced Tilapia and Pangas at 6-hour intervals (Figure 5B). The mean Log CFU/g±SD values were 5.25±0.07 for Tilapia and 5.42±0.05 for Pangas, indicating higher load in iced Pangas. Statistical analysis revealed a significant difference (<0.05) between the two species.

3.2.9. Bacterial Load of Iced Tilapia and Pangas at 8 hours interval under laboratory condition from January to June

From January to June, bacterial load (Log TVC) was evaluated in iced Tilapia and Pangas at 8-hour intervals (Figure 5C). The mean Log CFU/g±SD values were 5.33±0.07 for Tilapia and 5.47±0.05 for Pangas, indicating higher load in iced Pangas. Statistical analysis revealed a significant difference (<0.05) between the two species.

3.2.10. Bacterial Load of Non-iced Tilapia and Pangas at 6 hours interval under laboratory condition from January to June

From January to June, bacterial load (Log TVC) was assessed in non-iced Tilapia and Pangas at 6-hour intervals (Figure 6A). The mean Log CFU/g±SD values were 5.56±0.09 for Tilapia and 5.66±0.05 for Pangas, indicating higher load in non-iced Pangas. Statistical analysis revealed a significant difference (<0.05) between the two species.



A B

Figure 6 Bacterial Load of Non-iced Tilapia and Pangas at A) 6 hours, B) 8 hours interval

3.2.11. Bacterial Load of Non-iced Tilapia and Pangas at 8 hours interval under laboratory condition from January to June

Bacterial load (Log TVC) was determined in non-iced Tilapia and Pangas at 8-hour intervals from January to June (Figure 6B). Mean Log CFU/g±SD were 5.75±0.05 for Tilapia and 5.71±0.04 for Pangas, showing slightly higher load in non-iced Tilapia. Statistical significance wasn't observed at 8 hours due to temperature fluctuations and various factors impacting the results.

3.2.12. Bacterial Load between Fresh Tilapia and Iced Tilapia (6 hours interval) under laboratory condition from January to June

Bacterial load (Log TVC) was assessed in fresh Tilapia and iced Tilapia (6-hour interval) from January to June (Figure 7A). Mean Log CFU/g±SD were 5.43±0.05 for fresh Tilapia and 5.25±0.07 for iced Tilapia, indicating higher load in fresh Tilapia. Statistical analysis revealed a significant difference (<0.05) between the two at 6 hours interval.

Figure 7 Bacterial Load of Fresh Tilapia and Iced Tilapia at A) 6 hours, B) 8 hours interval

3.2.13. Bacterial Load between Fresh Tilapia and Iced Tilapia (8 hours interval) under laboratory condition from January to June

Bacterial load (Log TVC) in fresh and iced Tilapia (8-hour interval) was assessed from January to June (Figure 7B). Mean Log CFU/g±SD were 5.43±0.05 for fresh Tilapia and 5.33±0.07 for iced Tilapia, indicating higher load in fresh Tilapia. Statistical analysis revealed a significant difference (<0.05) between the two at 8 hours interval.

3.2.14. Bacterial Load between Fresh Pangas and Iced Pangas (6 hours interval) under laboratory condition from January to June

Bacterial load (Log TVC) in fresh and iced Pangas (6-hour interval) was studied from January to June (Figure 8A). Mean Log CFU/g±SD were 5.56±0.04 for fresh Pangas and 5.42±0.05 for iced Pangas, indicating higher load in fresh Pangas. Statistical analysis revealed a significant difference (<0.05) between the two at 6 hours interval.

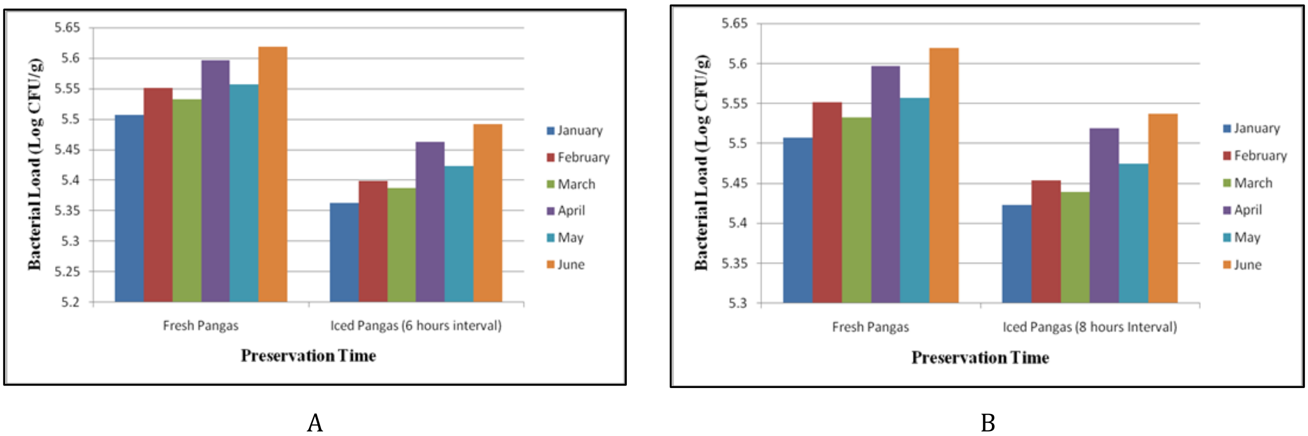


Figure 8 Bacterial Load of Fresh Pangas and Iced Pangas at A) 6 hours, B) 8 hours interval

3.3. Results of Bacterial Load between Fresh Pangas and Iced Pangas (8 hours interval) under laboratory condition from January to June

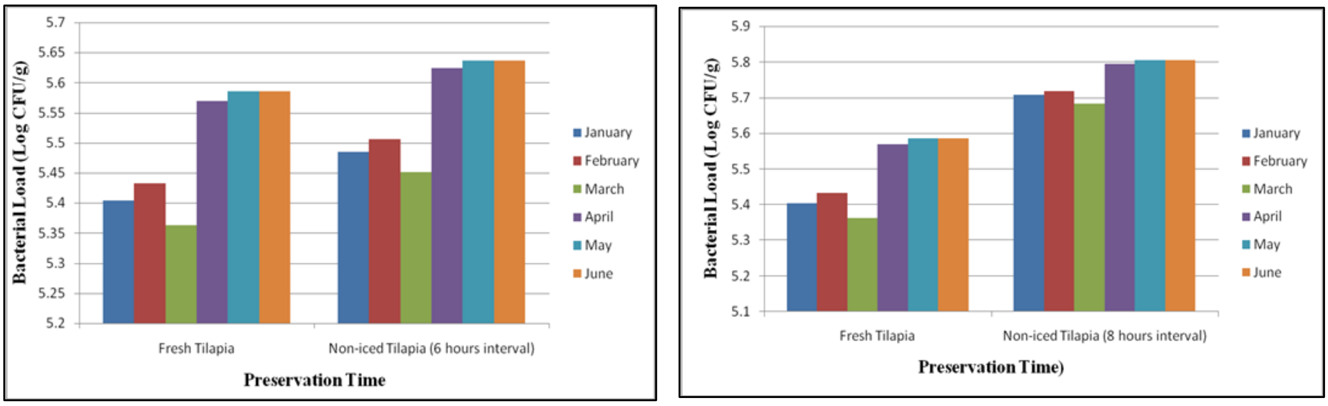
Bacterial load (Log TVC) in fresh and iced Pangas (8-hour interval) was investigated from January to June (Figure 8B). Mean Log CFU/g±SD were 5.56±0.04 for fresh Pangas and 5.47±0.05 for iced Pangas, indicating higher load in fresh Pangas. Statistical analysis revealed a significant difference (<0.05) between the two at 8 hours interval.

3.3.1. Bacterial Load between Fresh Tilapia and Non-iced Tilapia (6 hours interval) under laboratory condition from January to June

Bacterial load (Log TVC) in fresh and non-iced Tilapia (6-hour interval) was analyzed from January to June (Figure 9A). Mean Log CFU/g±SD were 5.49±0.10 for fresh Tilapia and 5.56±0.09 for non-iced Tilapia, with no statistically significant difference (>0.05) due to temperature fluctuations and various factors impacting the results.

3.3.2. Bacterial Load between Fresh Tilapia and Non-iced Tilapia (8 hours interval) under laboratory condition from January to June

Bacterial load (Log TVC) in fresh and non-iced Tilapia (8-hour interval) was examined from January to June (Figure 9B). Mean Log CFU/g±SD were 5.49±0.10 for fresh Tilapia and 5.75±0.05 for non-iced Tilapia, indicating higher load in non-iced Tilapia. Statistical analysis revealed a significant difference (<0.05) between the two at 8 hours interval.

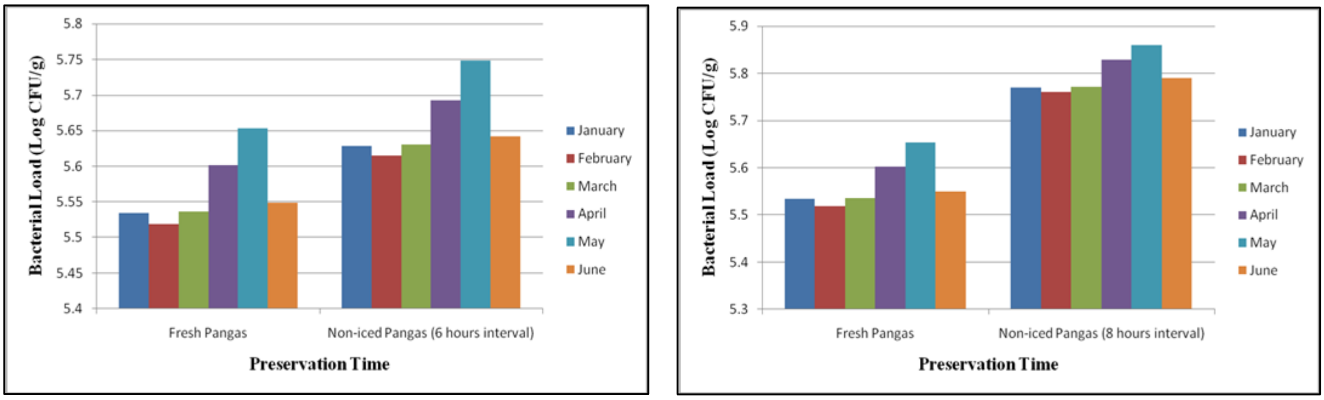


A B

Figure 9 Bacterial Load of Fresh Tilapia and Non-iced Tilapia at A) 6 hours, B) 8 hours interval

3.3.3. Bacterial Load between Fresh Pangas and Non-iced Pangas (6 hours interval) under laboratory condition from January to June

Bacterial load (Log TVC) in fresh and non-iced Pangas (6-hour interval) was evaluated from January to June (Figure 10A). Mean Log CFU/g±SD were 5.57±0.05 for fresh Pangas and 5.66±0.05 for non-iced Pangas, indicating higher load in non-iced Pangas. Statistical analysis revealed a significant difference (<0.05) between the two at 6 hours interval.



A B

Figure 10 Bacterial Load of Fresh Pangas and Non-iced Pangas at A) 6 hours, B) 8 hours interval

3.3.4. Bacterial Load between Fresh Pangas and Non-iced Pangas (8 hours interval) under laboratory condition from January to June

Bacterial load (Log TVC) in fresh and non-iced Pangas (8-hour interval) was studied from January to June (Figure 10B). Mean Log CFU/g±SD were 5.57±0.05 for fresh Pangas and 5.71±0.04 for non-iced Pangas, indicating higher load in non-iced Pangas. Statistical analysis revealed a significant difference (<0.05) between the two at 8 hours interval.

Fish marketing impacts frozen fish quality due to thawing, causing nutrient loss and bacterial differences between retail and pond samples [10,1]. Fish in various water bodies can be contaminated by pollutants like human and animal waste, especially during rainy seasons, impacting water quality. Run-off from roads, animals, and birds also contribute to bacterial contamination, affecting fish safety, health, and economic aspects [11,12]. Tilapia and Pangas fish samples were studied for organoleptic quality and bacterial load in Sylhet Sadar Upazila. Organoleptic assessment revealed excellent conditions for fresh and iced fish (0, 6, 8 hours), with non-iced samples at grade B. Changes in gills, eyes, and color was more pronounced in non-iced Pangas. Similar findings were observed by Kapute [13] and Adoga [14] regarding sensory quality and storage duration. Bacterial growth is a primary cause of fish spoilage, reflecting fish quality. Study found bacterial counts in fresh Tilapia (2.21×10^5 to 3.86×10^5) and Pangas (3.22×10^5 to 4.50×10^5) within accepted limits. Results align with previous research [1,15], confirming the relationship between bacterial counts, storage conditions, and fish quality. The study found varying bacterial loads in different fish and conditions, complying with ICMSF [16] standards. Significant differences ($P<0.05$) observed in TVC between fresh/iced Tilapia, Pangas (6/8 hours) and non-iced Pangas (6 hours). Insignificant differences ($P>0.05$) between some comparisons. Seasonal variation reported in other studies [17,18], with fish consumption affecting bacterial load [19]. Seasonal variations in bacterial load observed were higher from April to June in Tilapia and Pangas, lower from January to March. Temperature impact on bacterial load was lower in winter (25-32 °C), higher in April-June (24-35 °C), lowest at 24 °C in April, highest at 35 °C in May.

4. Conclusion

From the investigation of this study, it can be concluded that samples showed excellent/acceptable quality (grade A/B) across fresh, iced, non-iced Tilapia and Pangas (0, 6, 8 hrs). Pangas (fatty) had a higher bacterial load than lean Tilapia. Peak bacterial load in non-iced pangas (8 hrs) in May; lowest in iced tilapia (6 hrs) in April. Compliance with ICMSF standards. Temperature influenced bacterial growth, highest at 35 °C (May), lowest at 24 °C (April).

Compliance with ethical standards

Acknowledgement

The authors acknowledged the SAURES (Sylhet Agricultural University Research System) for providing fund for this research project.

Disclosure of conflict of interest

I declare that I have no conflicts of interest, financial or otherwise.

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