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The influence of facilities on fish quality in ports of east waters, North Sumatera (case study in belawan fishing port, North Sumatera)

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ABSTRACT

One of the problems faced in the development of the marine and fisheries sector nationally is the low quality of the fish capture due to the limited capacity and quantity of available port infrastructure resulting in the decrease in competitiveness. The data in this study were related to fish capture from fishing boats to wholesalers. The data obtained was observation of the location of the vessel, the fish auction place, and the marketer. The types of fish taken were Kurisi (*Nemipterus pneumatophores*), Biji Nangka (*Upeneus mulloensis*), Kapas-Kapas (*Gerres erythronium*), Bawal Putih (*Pampus argenteus*), Kembung (*Rastrelliger spp*). Fish examining was done by looking at the organoleptic and pH values. The pH value was obtained by testing the pH meter, while the organoleptic value was obtained by observing the physical condition using a score sheet. To determine the magnitude of the influence of facilities on fish quality, and the correlation between organoleptic values and pH, an analysis using simple linear regression was conducted. The average organoleptic value of fish while on the boat, when distributed, and when in the marketplace were 8,248; 7,024; and 6.6 respectively. Meanwhile, the average pH value was 7.05; 5.51; and 5.15. The quality of fish caught at Class A Fishing Port of Belawan is still of good quality. The pH test showed decline in pH value ever since the fish was brought to the port until they were marketed. The influence of facilities on the fish organoleptic and pH value are 98.3% and 96%. Thus, facilities significantly affect fish quality at Belawan Fishing Port. Between pH and organoleptic values showed a positive correlation, hence when the pH value decreased, the organoleptic value also dropped.

Introduction

Caught fish is one of the food commodities that is prone to deterioration in quality due to their high protein and water content hence allowing a very suitable medium for the proliferation of spoilage bacteria. The quality of fresh dead fish cannot be improved but it can be maintained through the principles of good and correct handling (Rahmatang *et al*, 2019).

The freshness level of fish gradually decreases if it is not handled properly, immediately, and carefully. The factors that affect the decline in fish freshness consist of internal and external factors. Internal factors include types and biological conditions of fish, while external factors include handling methods and facilities. Poor handling of caught fish means it still does not meet the requirements, such as lack use

of ice, and inadequate proper facilities can also worsen the quality of fish (Metusalach *et al*, 2014). Poor handling of fish during fishing until it is distributed, and inadequate facilities allow the appearance of histamine in fish and can cause symptoms of body poisoning (Afiyah *et al*, 2019).

Poor condition of fish prior to the first handling can never be restored at a later stage of handling. For fishermen and the processing industry, fish quality is important because it has something to do with the reputation of the company and the profit they earn. Fish production and processing must always strive for optimal fish quality so that fish is not wasted (Sogn-Grundvåg & Henriksen, 2014). Many studies have been carried out on the quality of the fish capture. The parameters used for testing fish quality are organoleptic parameters and pH values (Deni,

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2015; Kour & Akerina, 2020; Litaay et al., 2020; Mailoa et al., 2020; Metusalach et al., 2014; Suprayitno, 2020), fishbone diagram parameters (Litaay & Deonisius Pelasula, 2019), physical test parameters, microbiological tests, and chemical tests (Nurqaderanie et al., 2016), as well as using a questionnaire (Mramba & Mkude, 2022).

The North Sumatra region has a very large capture fishery potential. The territorial waters in North Sumatra borders Indian Ocean on its west coast and borders Malacca Strait on its east coast. Utilization of fisheries in these waters still has enormous potential ranging from 30 to 40 percent, meaning capture fishery production and fish stocks are still abundant. North Sumatra Province has two fishing ports registered in North Sumatra Province Department of Marine, Livestock, and Fisheries, namely Sibolga Nusantara Fishing Port and Belawan Samudera Fishing Port. Belawan Samudera Fishing Port is one of the largest ports in North Sumatra and is the entry point for the economic activities of several countries such as Malaysia, Singapore, Thailand, and Hong Kong. It is the center for fishery activities including anchoring, marketing, and processing the capture done by local community especially fishermen of North Sumatra (Haryani, 2018). Belawan Fishing Port is located on the east coast of North Sumatra with small-scale fisheries activities. The latest estimates indicate that small-scale fisheries contribute over half of the world's marine and inland fish catch of about 140 million tons, nearly all of which is used for direct human consumption (FAO, 2009).

In general, these local problems cannot be separated from other issues in the development of the marine and fisheries sector nationally, such as decreased competitiveness due to low quality of fish, low added value of the products, and limited capacity and quantity of port infrastructure. The purpose of this study was to determine the effect of facility on the quality of fish on the boat, in distribution (fish auction place), and at the marketplace, as well as the relationship between organoleptic values and pH.

Materials and Methods

Location and time of research

This research was conducted at Belawan Samudera Fishing Port in July 2022. The research object are the anchoring place for fishing boats and the marketplace at Tangkahan/Fish Auction Place.



Figure 1. Map showing the location

This research uses survey method through direct observation of freshly caught fish brought to the port. The survey was conducted to collect pH value and organoleptic data. The pH value testing was carried out at three spots, namely: upon the fish was landed (on the boat), when the fish is distributed at the fish auction place, and when the fish is marketed. Observations were also made to look at the condition of the facilities on boats, the Tangkahan/fish auction, and the marketplace. A total of five types of fish were taken as samples, including Kurisi Fish (*Nemipterus nematophorus*), Biji nangka (*Upeneus mulloensis*), Ikan Kapas-kapas (*Gerres erythrourus*), Bawal putih (*Pampus argenteus*), Ikan Kembung (*Rastrelliger spp*). At least five samples were taken from each type of fish. Observations on organoleptic of fish included the eyes, gills, body surface mucus, odor, and texture. The collection of pH data is done first by calibrating the measuring instrument of pH meter before use. Calibration was carried out at pH 4 and pH 7 using a buffer solution. The pH meter is then stabbed into the fish body and left for a few minutes until the value shows a stable number.

Data Analysis

The analysis was conducted to determine the pH value and organoleptic properties. The procedure for determining the pH of fresh flesh of fish refers to the AOAC (1995) and the organoleptic properties of fresh fish refer to Huss (1995). The pH value is one of the parameters to see the quality of fresh fish. The pH scale used is between 0 and 10 where 10 indicates fresh fish, 8 indicates good quality, and 6 indicates neutral. The scale used is the same scale used in the study of Metusalach et al. (2014).

Observations of organoleptic properties were carried out based on the quality parameters of fresh fish (Huss, 1995) with a value range of 1 – 9 (1 = poor; 9 = very good). The same assessment of pH and organoleptic properties was also carried out on

fish upon arrival at the fish auction place before and after the auction.

Assessment of fish handling facilities is governed by the Decree of the Minister of Marine Affairs and Fisheries Number 52A/KEPMEN-KP/2013 concerning Requirements for Quality Assurance and Safety of Fishery Products in Production, Processing, and Distribution Processes. The value for facility standards is taken while on the boat, when fish is distributed, and at the seller at marketplace. Observations of the facilities are carried out based on the scoring method with the value range is 1 – 4.

The next analysis is simple linear regression analysis to determine the effect between the independent variable and the dependent variable. The results of this regression analysis are 1) whether there is a significant relationship between variables and 2) whether there is a significant effect between the dependent variable and the independent variable. This research nature is survey research that involves two dependent quality parameters (pH and organoleptic properties) observed at three observation spots (on the boat, when distributed to fish auction, and when marketed).

Result

Organoleptic Value

The organoleptic properties of the fish were the average organoleptic value of the eyes, gills, mucus, smell, and texture. The average organoleptic value of the samples while on the boat, when distributed to fish auction, and at fish auction was each 8,248; 7,024; and 6.6. The table of the average organoleptic values is presented in Table 1 below.

Table 1. The Average Organoleptic Value of Fish Capture on Fishing Vessel at Belawan Samudera Fishing Port.

NO	Fishes	Organoleptic properties		
		On Board	Fish auction	Market Place
1	Kurisi	8.2	7.52	6.84
2	Biji Nangka	8.24	7	6.64
3	Kapas-kapas	8.32	7.16	6.72
4	Bawal putih	8.28	6.8	6.44
5	Kembung	8.20	6.64	6.36
	Average	8.248	7.024	6.6

Based on the results, it can be said that the fish catch at Belawan fishing port is a type of fish that has declining quality but is still suitable for consumption. One method to find out fish quality can be done through organoleptic testing. This method is proven

to be the simplest way and subjective depending on the respondent's ability to collect data.

pH Values

The pH value of the caught fish is taken from the vessel that lands in the port. Below is the pH value of the catch upon arrival, at the fish auction before being auctioned off, and when it was marketed.

Table 2. The average pH value of the catch at three different spots

NO	Fishes	pH Value		
		On Boat	Fish auction	Market Place
1	Kurisi	7,07	6,31	5,23
2	Biji Nangka	7,05	5,50	5,14
3	Kapas-kapas	7,07	5,23	5,08
4	Bawal putih	7,04	5,27	5,11
5	Kembung	7,04	5,25	5,20
	Average	7,05	5,51	5,15

The data presented in Table 2 shows that there is a decrease in the average pH value from the three different places. When fishermen brought the fish to the port, the average pH value of the fish was 7.05. When the fish were at fish auction, the average pH value was 5.51. Finally, the average pH value when the fish is marketed is 5.15. This means that there is a trend of decline in the pH value from one place to the other. A drastic decrease in pH value occurred at the fish auction place (from 7.05 to 5.51) and at the marketplace. This decline in pH value is an indicator of rigor mortis phase influenced by environmental temperature factors, fish conditions, and fish species.

The effect of facility on organoleptic value and pH value

Good quality fish is highly dependent on how it is handled from the time of capture to the time of when it is marketed. A good method of fish management also needs to be supported by adequate facilities. Fish must always be kept at a low temperature; hence proper facilities are needed to maintain temperature to prevent quick decaying. Like temperature, the process of handling fish must always be kept hygienic through clean and properly sanitized facilities and tools. The results of the study showed the value of determination (R^2) in the results of the linear regression test was 0.983. This means that the effect of facilities on the quality of the fish tested organoleptically is 98.3%. The table of determination values for the results of the facility's linear regression test on fish organoleptic can be seen in the following table.

Table 3. Determination value in facility linear regression on fish organoleptic

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.992 ^a	0,983	0,966	0,15690

The level of fish freshness or newness can also be determined by looking at the pH value of the fish. Changes in pH value have a significant role in determining fish spoilage (Suprayitno, 2020). As the condition of the facility also determines the quality of the fish caught, hence it can also affect the pH value of the fish. The pH conditions of the fish from in the boat to the fish market show decreasing pH value. In this study, the influence of facilities can be analyzed using simple linear regression. The effect of facilities on the pH value of fish can be seen in Table 4.

Table 4. The value from the results of the facility linear regression test on the pH value of fish

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.980 ^a	0,960	0,919	0,28635

The results of the linear regression test show the value of determination (R^2) was 0.960. This means that the effect of the facility on the quality of the fish tested organoleptically is 96.0% and the rest is influenced by other factors unanalyzed in this study. Based on the results of the two analyses, the value of determination in organoleptic and pH tests show the same high percentage value. This means that the facilities greatly influence the quality of fish at Belawan Fishing Port in both organoleptic and in pH despite other smaller factors that also affect it.

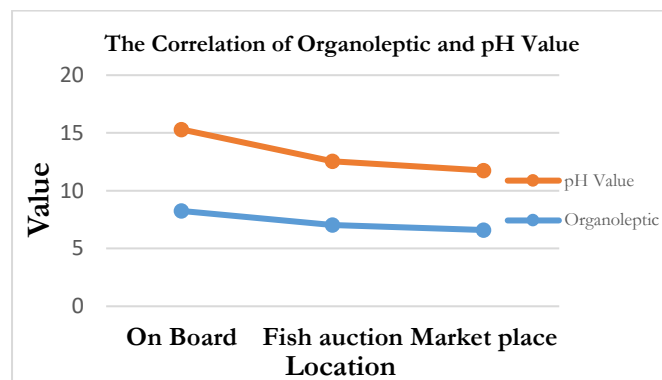
The correlation between organoleptic value and pH value

Organoleptic value and pH value can indicate the quality of fish. The collection of organoleptic and pH data to analyze the relationship between the two was carried out upon the fish arrival at the port. The analysis was done using linear regression.

Table 5. Result of simple linear regression analysis on the relationship between values of organoleptic and pH of caught fish

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.998 ^a	,995	,990	,10082

The analysis result in the table above shows that the organoleptic and pH values have a positive correlation with the R-value, that is at 0.998. This means that the pH value of the capture fishery has a strong relationship with its organoleptic properties. The graph of the relationship between the organoleptic value and pH value of capture fishery is shown in Figure 2.

**Figure 2.** Organoleptic and pH Value Correlation

Based on the graph shown in Figure 2, the relationship between organoleptic values and pH values shows a positive correlation; as the organoleptic value decreases, the pH value also decreases despite the slightly uneven line pattern. Both graphs of organoleptic value and pH value show a not very sharp decrease at the three locations.

Immediately after fish are caught and taken to the boat, fish would undergo changes from the muscles, including physicochemical reactions and autolysis which causes changes in proteins and lipids and followed by microbial biochemical activity in the fish muscle which causes loss of fish freshness (Venugopal, 2002). In the process of fish spoilage, the pH value would increase until it reaches 10-11 digit (Rahmatang et al, 2019). Therefore, it can be said that the fish sampled are fish that are currently undergoing the process of glycolysis.

Discussion

The distribution of catches from Belawan Fishing Port landed at Tangkahan in Belawan area. The distribution of the catch uses a pickup truck for then received by wholesalers directly. Wholesalers would sell the fish to marketers. Marketers would sell the fish to end users or consumers in traditional markets. Organoleptic data collection is only on fish sold to marketers. The unloading of the fish until it is distributed to the fish auction and to the marketers takes about three hours. The wholesalers would filter the fish again before marketers or sellers would purchase them. However, some fish are still held in captivity as fishmongers have not bought them yet.

The good quality of fish is defined by a short transit time, which is around three hours. This relatively short duration can help make the fish condition in a state of rigor mortis. At high temperature, fish stiffness occurs starting within one to two hours (Abbas *et al.*, 2009). Meanwhile, Liviawaty & Afrianto, (2014) in their research identified that the rigor mortis phase on fresh fish occurs within one to seven hours.

The management of capture fishery such as the use of ice for storing also affects the quality of fish as it can slow down the growth of spoilage bacteria which can decrease the quality of fish. Maintaining a low temperature can inhibit the activity of amino acids and bacteria that cause spoilage (Wijana *et al.*, 2018). This keeping of low temperature by fishermen still needs to be improved. For instance, fishermen can use lobby for unloading fish to avoid exposure to direct sunlight. The implementation of low temperature can inhibit the growth of bacteria and biochemical processes that take place in fish body, hence leading to quality deterioration (Prasetyo *et al.*, 2016).

In addition to low temperature keeping, sanitation and hygiene also needs to be considered. Belawan Samudera Fishing Port still lacks in hygiene thus allowing for easy physical damage to capture fishery. This can have an impact on the price based on the quality. Furthermore, lack of cold storage facilities and poor management skills can shrink the quality and nutrition in fish (Akintola and Fakoya, 2017). As FAO (2005) said that quality decline in post-harvest is still a critical issue. Fishermen are affected in the form of decreased selling price, thus reducing the income of fishermen and diminishing amount of fish for human consumption.

The results of field data show that the pH value of fish becomes acidic due to the burning of energy that produces lactic acid as a waste product (Abbas *et al.*, 2009). The pH of fish meat will cease to decrease when it is at 5, it will increase again until it passes digit 7 until it reaches the final value at digit 10 – 12 (Metusalach, *et al.* 2014). Suprayitno (2020) stated that the pH value for pre-rigor fish is at 6.9 - 7.2, rigor mortis is at 6.2 - 6.6, and post-rigor is at 7.5 - 8.0. Fish of poor quality have a pH > 8. Fish pH value never goes below 5.3 because under such condition, the enzymes involved in anaerobic glycolysis do not actively work (Rahmatang, 2019). Therefore, based on existing references, the fish landed at Belawan Fishing Port are still fit for consumption.

Facilities are not the only factor that can affect the deteriorating quality of fish. Several other factors are transit time, fishing method, handling method,

weather, and fishing gears. Transit time is related to the duration of transporting fish from the sea to market. Management of capture fishery is related to the procedures of preserving fish, such as the use of ice and proper storage.

The transit time and method of handling fish is related to the ratio of ice and fresh fish used especially during the transportation and marketing process. The greater the ratio and the longer the marketing process, the lower the organoleptic value of fish. It is influenced by the amount of heat penetrating fish meat and high temperature outside cool boxes. The higher the temperature in the insulated cool box, the quicker the bulk ice melts (Panai *et al.*, 2013).

The use of fishing gear can also trigger diminishing quality of fish. The type of gear used can cause defects in fish body, especially the use of purse seine and gillnet as opposed to the use of fishing rods (Akande & Diei-Ouadi, 2010). Statistical analysis conducted by (Sogn-Grundvåg *et al.*, 2022) showed that fishing gear affects fish quality. At a different stage, fishing method using nets are widely favored by fishermen despite having negative impact on the quality of fish caught.

All fishery products can easily spoil if not properly packaged, distributed, and stored, (Giannakorou *et al.*, 2005). Capture fishery around the world has generally undergone about 10% decrease in quality due to poor handling, processing, storage, and distribution (Mramba & Mkude, 2022). Most studies showed that the most important factor of good fishery products lies in the ways to manage and process (Ingibjorg Karlsdottir & David Cook, 2021). Considering the selling price of fish in the market, fishermen should focus on catching high-intensity fish, maximizing catches with low costs but with declining quality. However, for catching low-frequency fish, they can prioritize on good quality fish with but high costs.

Conclusion

The purpose of this study is to determine the effect of the facility on the quality of fish on fishing vessels upon arrival at the fish auction place and at the marketplace, as well as the correlation between organoleptic value and pH. The average organoleptic value of fish while on the vessel, while it is distributed to fish auction place, and at the marketplace is at 8.248; 7.024; and 6.6. The capture fishery at Belawan Fishing Port is a type of fish that is still of good quality. The results of pH test showed a decrease in pH value ever since the fish arrived at the port until the fish is marketed. A significant decrease in fish pH

occurred when fish in auction place (from 7.05 to 5.51) as opposed to the pH value they are marketed to smaller sellers.

The value of determination in the organoleptic and pH tests showed similar high percentage value. This means that the facilities greatly affect the quality of fish in the port both in organoleptic and in pH.

The correlation analysis between organoleptic value and pH value showed a positive correlation, as the organoleptic value decreased, the pH value also declined.

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