Study of fresh Frigate Tuna (*Auxis thazard*) quality sold by mobile fish retailer in Makassar

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Abstract. Frigate tuna (*Auxis thazard*) is widely marketed and consumed in Makassar. Most of the fresh fish for household needs are purchased from traditional mobile fish retailer (Pa’gandeng) in Makassar. However, data on the quality of fresh frigate tuna reaching the consumer of household level is still lacking. This research was conducted in three areas, namely east, south, and north of Makassar City, South Sulawesi. This study aimed to describe the quality characteristics of fresh frigate tuna retailed by Pa’gandeng. The study was conducted by randomly taking four samples of fish from Pa’gandeng at three points of sale (sale time) in each part of the city. Physical and organoleptic parameters were measured directly at the sampling locations, while the chemical and microbiological parameters were analyzed in the laboratory. Effect of time on the fish freshness parameters were tested using ANOVA with a confidential level of 95% (α = 0.05). When ANOVA indicated the presence of a significant effect, LSD (Least Significant Difference) test was applied to determine which points of observation that the corresponding parameter exhibited a significant difference. The relationship between the observed parameters was analysed using regression analysis. Results of organoleptic, microbiological, and chemical analysis showed that the fresh frigate tuna retailed by Pa’gandeng in Makassar was in good quality and, therefore, suitable for consumption. The ANOVA test indicated that the parameters that significantly different between the sale points were the temperature and organoleptic values.

1. Introduction
Makassar is one of the big cities in Indonesia with high level of fish consumption. Makassar stretches along a coastal line and has good infrastructures to support the distribution of fish products, such as fishing ports and fish markets. In addition, people in Makassar have high preference to consume fish. Frigate Tuna (*Auxis thazard*) is very popular because it is widely available in the market and its fishing ground is close to Makassar. Frigate tuna has a relatively cheap price, and is known to have a high nutritional value.

Being popular and nutritious fish, frigate tuna has some flaws. Frigate tuna, can be toxic for some reason. Poor handling of frigate tuna often results in high level of histamine (a biogenic amine compound) in the flesh and may cause poisoning when consumed. The red meat of frigate tuna contains high concentration of histidine which is converted to histamine during the deterioration of fish. These histamine compound can cause itching, poisoning, and even death.

The household need of fish in Makassar is mostly supplied by the traditional mobile fish retailers Pa’gandeng). The varieties of fish and the prices offered by Pa’gandeng are competitive with those of in traditional wet markets, so they can meet the consumer need. On the other hand, the fish sold by Pa’gandeng are generally lower in quality. This is due to the poor handling of the fish during the sales and distribution.
[1] reported that the pH and organoleptic parameters of fish caught with trawl and purse seine after being auctioned on the fishing port were categorized as good and marketable. However, data on the quality of fresh fish delivered to the household consumer are still lacking. This study aimed to describe the status of the quality of fresh frigate tuna sold by Pa’gandeng in Makassar based on organoleptic tests, physical (temperature), microbiological (total plate count and coliform), and chemical (total volatile bases and value of peroxide) parameters. The result could be beneficial for the government to take some policies to improve fish handling at Pa’gandeng and to provide safe fish for the community.

2. Materials and methods
This research was conducted from October 2013 until November 2013 in the northern, southern, and eastern part of Makassar City (figure 1). The materials used were fresh frigate tuna, distilled water, ice, tissue paper, styrofoam box, zipped-plastic bags, cutting board, digital balance, stomacher, pipettes, petri dishes, incubator, portable pH meter, portable thermometer, stopwatch, score sheet of organoleptic test, and laboratory equipment for analyzing of total plate count (TPC), coliform, total volatile bases (TVB), and peroxide value. The fish were collected from Pa’gandeng at fishing port in Paotere and in two selling location in 3 parts of Makassar.

![Figure 1](image_url). Research location.

This research was conducted using survey method. The selling activity of Pa’gandeng was directly observed. Temperature and pH of fish, as well as the organoleptic parameters of fish were evaluated and measured on site. The temperature and pH of fish were measured at the center of the fish body. The TPC, coliform, TVB, and peroxide value of the fish were determined in the laboratory. Sampling was done between 07:00 and 12:00 AM. At each sampling (sale) point, 4 fish samples were taken randomly for the analysis. Each part of the city was represented by one Pa’gandeng for three consecutive days of sampling. For the microbiological and chemical analysis, the frigate tuna samples were taken at each point of sales and then wrapped in zipped plastic bag. Samples were then stored in a Styrofoam box along with ice and taken to the laboratory for analysis.

The collected data for each parameter studied were subjected to ANOVA at a 95% of confidential level ($\alpha = 0.05$). When ANOVA indicated the presence of significant differences, LSD (least significant difference) test was employed to determine which points of sale differed from one another. The relationship between parameters and time (duration of sell) was analyzed using simple regression.
analysis. Data were processed SPSS 17.0 computer software and the results were presented in the form of graphs.

3. Results and discussion

3.1. Pa’gandeng

Pa’gandeng is a fish seller who buys fish from a fishing port and sells it again directly to the household consumers. Pa’gandeng generally sells the products or fish directly to consumers by traveling around the village or city using a bicycles or motorcycles. The vehicle used was equipped with fish containers mounted on the motorcycles (figure 2). The containers are covered with large plastic bags so that the fish are protected from direct sunlight and air pollution during the distribution to the consumers. Each Pa’gandeng has his own definitive route to sell the fish.

Figure 2. The vehicle (left) and the container (right) used by Pa’gandeng to distribute and sale the fish around Makassar.

3.1.1 Fish handling process. Fish purchased by Pa’gandeng at the fishing port were sorted and packed separately into plastic bags according to their type. According to [2], the advantages of sorting are maintaining the quality of the fish and preventing cross contamination so that the fish can be marketed longer. Further, the fish were arranged in the fish container as shown in figure 3. On top of the fish layer, small amount of crushed block ice was given to lower the temperature of the fish. For 10-15 kg of fish, Pa’gandeng used only 2-3 kg of ice, which was not proportional to the amount of the fish and was too small for cooling fish in the tropical area. The appropriate ratio of ice to fish in the tropics is 1:1 to ensure the freshness of the fish. Ice is the best cooling medium compared to other cooling medium because ice is able to lower the fish temperature quickly without altering its quality and the required cost is also relatively lower than the other cooling medium [3]. The insufficient amount of ice used by the Pa’gandeng in this study caused rapid increase in the fish temperature. Along the way to the consumer, Pa’gandeng never added ice to the fish containers, and therefore the process of fish handling became ineffective to preserve the quality of the fish.

Figure 3. Frigate tuna sold by Pa’gandeng in Makassar.
3.1.2. Sanitation and hygiene. Based on the observations, all the equipment used were non-hygienic although they were always washed every time after being used. The reason was because the container was used repeatedly and the way of cleaning was not good. According to [4], most of the bacteria causing the fish damage are contaminants that come from the surrounding environment. When the equipment used for the distribution of fishery products was clean, the deterioration process of fish became slow. This is due the less number of contaminants in the surrounding environment. [5] reported that fish prepared under hygienic conditions had a lower microbial value.

3.2. Organoleptic value
Organoleptic test is a subjective test that is based on the assessment from direct observation by the panelists. The assessment followed the score sheet value and standard. This test is the most common way to determine the freshness level of the fish because it is easier, faster, and does not require any laboratory test. The higher the organoleptic value, the better the freshness of the fish [4].

The standard of organoleptic value in this study was calculated based on the examination of condition of eye, gills, body surface slime, odor, and texture of fish using score ranging from 1 to 9. Figure 4 showed changes of the organoleptic value from the first point to the end point of frigate tuna sale in Makassar.

![Figure 4. Changes of the organoleptic value of fresh frigate tuna (Auxis thazard) during the study.](image)

The organoleptic value of fresh frigate tuna decreased from 8.65 to 7.24. At the first point of sale (0 hour), the fish were recently purchased by the Pa’gandeng so that the condition of eye, gills, body slime, odor, and texture of the fish were good. The organoleptic value at the midpoint (2.30 hours) and the end point of sale (4.28 hours) were 8.11 and 7.24. The greatest decrease of the fish quality occurred when the fish were distributed from midpoint to the end point of sales. This might be due to sharp increase of the fish temperature since the ice used by the Pa’gandeng has completely melted and no new ice was added into the fish container. In addition, the fish was also exposed to direct sunlight. Despite the lack of ice and direct exposure to sunlight, the organoleptic test indicated that the frigate tuna marketed by Pa’gandeng in Makassar was of good quality, although there was a decrease in the organoleptic value from the first point to the end point of sales. According to the standard of fresh fish quality, good quality of fish should have organoleptic value of at least 7 [6].

The organoleptic value at each point of sale had a significant difference based on ANOVA results. Least Significant Difference (LSD) test showed that each observation point had an organoleptic value that was significantly different from each other (p <0.05). Based on the result of linear regression analysis, it was known that the duration of sale (time) and the organoleptic value of frigate tuna had a strong relationship ($R^2 = 0.9826$).
3.3. Physical parameter

One of the factors affecting the quality of the fish is temperature. High temperature accelerates the rate of fish deterioration. [7] reported that low temperature can extend the period of rigor mortis and so extending the period of fish quality in a good condition. The average temperature of fresh frigate tuna marketed by Pa’gandeng in Makassar was between 14.67 – 24.17 °C for 4.28 hours of sale duration. The change in temperature of the fish occurred from the first point to the end point of sale (figure 5). The temperature of fish at first point of sale was higher than at the midpoint of sale. This was because the fish at the first point of sale have been without ice for some times since unloaded from the boat, while the fish at the midpoint of sale were still with ice added prior to transport to the midpoint of sale. The increase of the fish temperature from the midpoint to the end point of sale was due to the ice added before the midpoint of sale has completely melted and also the fish were exposed to heat from direct sunlight during transport to the final point of sale.

Based on the results of ANOVA, it was known that there were differences in temperature values from each point of sale. The LSD test showed that the temperature at the end point of sale differed with temperature at the first point and the midpoint of the sale (p <0.05). The duration of sale (time) and temperature of the frigate tuna had normal relationship (R² = 0.6177).

![Figure 5](image)

**Figure 5.** Changes of the temperature of fresh frigate tuna (*Auxis thazard*) retailed by Pa’gandeng in Makassar.

3.4. Microbiological parameters

3.4.1. Total plate count. Total plate count (TPC) is one the fish freshness parameters and is referring to the number of bacteria in one gram of the fish meat. The TPC method is based on a cup count method with assumption that every living cell of bacteria will develop into a colony. This test is used to detect all aerobically grown microorganisms and reflects the general cleanliness of the sample. Figure 6 showed that bacteria in the fish meat grew fast from the first point to the end point of sales. The sharp increase in the TPC was in line with the sharp increase of the fish temperature between the midpoint and the end point of the sale due to the absence of ice in the fish containers. In addition, poor handling applied by the Pa’gandeng may cause contamination, thus contributing to the addition of bacteria to the fish. Nonetheless, the frigate tuna in this study could be categorized as fresh fish. According to SNI 01-2729-1992, the standard of maximum limit of TPC for fresh fish is 5 x 10³ cfu/g [4]. Based on the results of ANOVA, TPC value of frigate tuna at each point of sale had no significant difference (p>0.05). The duration of sale (time) and TPC of the frigate tuna had a strong relationship (R² = 0.9682).
3.4.2. **Coliform.** Coliform bacteria are indicators commonly used to measure the sanitary quality of food and water. When these bacteria are present in foods, they can cause diarrhea, stomach cramps, vomiting, fever, and interfere with the kidney function. These bacteria can be found in the intestine of livestock and humans [8]. Figure 7 showed a decrease in the number of coliform from the midpoint to the end point of sales. This might be due to the effect of washing the fish and the replacement of water in the containers. The number of coliform in the frigate tuna samples were 25.83 MPN/g indicating that the fish were of good quality and suitable for consumption. Based on the results of ANOVA, coliform value of frigate tuna at each point of sale had no significant difference (p> 0.05). The duration of sale (time) and coliform of the frigate tuna had a normal relationship (R² = 0.6118). According to ICMSF [9], the acceptable limit for total coliform and faecal coliform are 10² MPN/g and 10 MPN/g, respectively, and E. coli must not be present in fish. Coliform bacteria contained in the water and the fish's body is not pathogenic to humans, but may indicate the higher presence of pathogenic bacteria [10].

**Figure 7.** Changes of total coliform in fresh frigate tuna (*Auxis thazard*) retailed by Pa’gandeng in Makassar.

3.5. **Chemical parameters**

3.5.1. **pH.** The pH value expresses the level of acidity or alkalinity of a substance and may be used as an indicator of fish freshness. Prime quality or very fresh fish usually has a pH of about neutral (6.8-7.2) while rotten fish has a pH of over 9. Figure 8 showed that the average pH of fresh frigate tuna was between 5.55 and 5.71. The pH values decreased from the first point to the end point of sale. Based on
the results of ANOVA, pH value of frigate tuna at each point of sale had no significant difference (p > 0.05). The duration of sale (time) and pH of the frigate tuna had a strong relationship ($R^2 = 0.9672$). The decreasing in pH was due to the glycolysis process which produced lactic acid. Lactic acid is a result of the glycogen breakdown by the enzymes in the fish meat. [11] reported that during the production and the auction, the fish pH decreased due to the process of glycogen breakdown into lactic acid.

![Figure 8](image)

**Figure 8.** Changes of pH of fresh frigate tuna (*Auxis thazard*) retailed by Pa’gandeng in Makassar.

Bad quality fish will have a high pH. According to [1], the pH of fish will decrease only to a certain extent (about pH 5.5). This is related to the availability of glycogen in fish meat. If the glycogen has totally been exhausted, the formation of lactic acid will not take place any longer and the pH of the fish meat will stop to decrease. Lactic acid formed during the glycolysis process will be broken further to its simpler derivatives resulting in the decrease of the fish meat acidity, and therefore increasing the pH. The meat of the frigate tuna sold by the Pa’gandeng in Makassar was still acidic indicating that the fish was fresh and good for consumption.

### 3.5.2. Total volatile bases (TVB)

TVB measurement is one of the methods to evaluate the freshness of fish chemically. The principle of TVB measurement is to vaporize the volatile compounds which are formed by the decomposition of amino acids in fish meat [4]. Figure 9 showed that the average TVB of fresh frigate tuna increased from the first point to the end point of sale. The average TVB at the final point of sale was 23.18 mg N/100 g.

![Figure 9](image)

**Figure 9.** Changes of total volatile bases (TVB) of fresh frigate Tuna (*Auxis thazard*) sold by Pa’gandeng in Makassar.
[12] classified the freshness level of fish based on the TVB values as follow:
1. Very fresh fish (TVB <10 mg N/100 g);
2. Fresh fish (10 ≤ TVB ≤ 20 mg N/100 g);
3. Still feasible for consumption (20 ≤ TVB ≤ 30 mg N/100 g);
4. Not feasible for consumption (> 30 mg N/100 g).

Based on the above classification, the frigate tuna sold by Pa’gandeng in Makassar was still fresh at the first point and midpoint of sale, while at the end point of sales the fish was already deteriorate but was still suitable for consumption. ANOVA results showed that TVB value of frigate tuna at each point of sale had no significant difference (p> 0.05). The duration of sale (time) and TVB of the frigate tuna had a strong relationship (R² = 0.9833). An attention has to be paid to controlling the fish temperature since it is correlated positively with the bacterial growth and TVB level in fish. The higher the temperature of fish in handling process, the bacterial growth and the increasing of TVB will be faster [13]. High population of bacterial load in fish is in line with high formation of TVB. [14] reported a significant increase was occurred in TVB during salting of anchovy and this was due to the increasing of bacterial counts and enzyme activity. [5] reported that moisture content and pH could affect the microbial value in fish.

3.5.3. Peroxide value. The process of rancidity, according to [15], is caused by the oxidation of unsaturated fatty acids in fish. Oxidation is a major cause of quality deterioration in pelagic fish such as mackerel and herring. These fish have high levels of fat in their meat. Figure 10 showed that the peroxide value in fresh frigate tuna increased constantly to the end point of sale, with peroxide value at the end point of sale was 33.24 mEq/kg. This peroxide value indicated that the quality of the frigate tuna sold by Pa’gandeng was good and safe for consumption. Based on the results of ANOVA, peroxide value of frigate tuna at each point of sale had no significant difference (p> 0.05). The duration of sale (time) and peroxide value of the frigate tuna had a strong relationship (R² = 0.9833). [16] reported that fresh fish that started to decay typically has a peroxide value between 20-40 mEq/kg.

![Figure 10. Changes of peroxide value of fresh frigate Tuna (Auxis thazard) retailed by Pa’gandeng in Makassar.](image)

4. Conclusion
The frigate tuna (Auxis thazard) sold by Pa’gandeng in Makassar was not of prime quality, but was still fresh (good quality) and therefore suitable for consumption. All fish quality indicators (pH, TPC, coliform, TVB, peroxide value, and organoleptic values) were within the pre-determined standard of quality. However, the high fish temperature during selling and the presence of the coliform bacteria at a relatively high number necessitate more efforts to ensure a better quality of fish to be delivered to the consumer. Application of good handling process of the fish, application of good cold chain system, implementation of good sanitation and hygiene, prevention of contamination and use of more
appropriate containers to store and transport the fish are among the key factors which require further improvements.

References
[1] Metusalach, Kasmiati, Fahrul and Jaya I 2012 Analisis hubungan antara cara penangkapan dan cara penanganan dengan kualitas ikan yang dihasilkan (Makassar: LP2M Hasanuddin University)
[2] Wardani D I 2002 Kajian Sistem Penanganan Pasca Panen Ikan Laut Segar (Studi Kasus Tempat Pelelangan Ikan Muara Angke Jakarta Utara (Bogor: Institut Pertanian Bogor)
[3] Afrianto E dan Liviaiwati E 1989 Pengawetan dan Pengolahan Ikan (Jakarta: Kanisius)
[4] Hadiwiyoto S 1993 Teknologi Pengolahan Hasil Perikanan (Jogjakarta: Penerbit Liberty)
[5] Udochukwu U, Inetianbor J, Akaba S O and Omorotionmwan F O 2016 American Journal of Microbiological Research 4 37–40
[6] [BSN] Badan Standar Nasional 2013a SNI 01-2728.1-2006: Udang Segar (Jakarta: Badan Standardisasi Nasional)
[7] Murniyati AS dan Sunarman 2000 Pendinginan, Pembekuan dan Pengawetan Ikan (Yogyakarta: Penerbit Kanisius)
[8] [BSN] Badan Standar Nasional 2013b SNI 01-2332-1-2006: Penentuan Coliform dan Escherichia coli pada Produk Perikanan (Jakarta: Badan Standardisasi Nasional)
[9] ICMSF 1982 Microorganisms in Food (Canada: Univ. Toronto Press)
[10] Doyle M P and Ericson M C 2006 Microbe 1 162-163
[11] Wangsadinata V 2008 Sistem pengendalian mutu ikan swanggi (Priacantus macracanthus) (studi kasus di CV Bahari Express, Pelabuhan Ratu, Sukabumi) (Bogor: IPB)
[12] Farber L 1965 Fish as Food Vol IV (New York: Academic Press)
[13] Denny H 2004 Evaluasi dan identifikasi tingkat kemunduran mutu hasil perikanan tangkap ikan belanak (Mugil thazard) (Studi kasus Muara Angke, Kecamatan Penjaringan, Jakarta Utara) (Bogor: Institut Pertanian Bogor)
[14] Hernández-Herrero M M, Roig-Sagués A X, López-Sabater E I, Rodríguez-Jerez J J and Mora-Ventura M T 1999 J. Food Sci. 64 344-347
[15] Winarno F G 1997 Kimia Pangan dan Gizi (Jakarta: Gramedia)
[16] Eyo A A 2001 Fish processing technology in the tropics (New Bussa Nigeria: National Institute for Fresh Water Fisheries Research)