The quality of yellow tail fish (*caesio cuning*) with mobile sales system at Makassar City

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Abstract. This study aims to determine the feasibility of consumption of yellow tail fish mobile sales system at Makassar city with physical test parameters (temperature and pH), organoleptic tests, chemical tests (TVB and peroxide numbers), and microbiological tests (TPC and Coliform) and to determine the relationship between time and test parameters. The study was conducted by survey method. Analyzed date using Anova, then the results of significant analysis were further tested using the LSD test to determine differences between points of sale. Relationships between parameters measured were then analyzed using regression. The results showed that the quality of yellow tail fish that mobile sales system to the end point of sale (12.00 pm) was less fresh but was still suitable for consumption with testing parameters of organoleptic value of 6.73, TPC 4.32x10⁵ cfu/g, Coliform bacteria 4, 50 x 10² APM/g, TVB content of 19.93 mgN/100g, and content of peroxide number 23.91 mEq/kg. And the relationship between time and testing parameters in yellow tail fish, the longer time the sale of fish central temperature, TPC, Coliform bacteria, TVB levels and peroxide content in yellow tail fish increased while organoleptic values and pH of fish decreased.

1. Introduction

The fisheries superior commodities in South Sulawesi one of them is yellow tail fish. In international trade, yellow tail fish is known as redbelly yellowtail fusilier. The marketing model of yellow tail fish in the Makassar city area, one of which is by retail selling by mobile fish traders. The freshness of yellow tailed fish sold around affects the selling price of the fish. So to maintain the freshness of the fish as long as it is sold to the hand of consumers, the handling chain must be well considered, starting from the handling of fish on the boat, at the fish auction place (TPI), and when sold around to hands of consumers. pH and organoleptic quality of fish caught with cantrang and purse seine after being auctioned at a Fish Auction Place (TPI) was categorized as good and worthy of being marketed widely [1]. It was further reported that the main causes for the decline in fish quality were limited handling facilities and improper handling methods after the fish were caught on boat until they arrived at Fish Auction Place (TPI).

Based on this, this study was conducted to determine changes in the level of freshness of yellow tail fish that are sold retail by fish traders in Makassar City. The research began from the purchase of fish at the fish auction place until in arrived in the hand of household consumers by observing physical parameters, organoleptic, chemical, and microbiological properties.
2. Material and method

2.1. Time and location of research
This research was conducted in October to November 2018 in three regions, Eastern, Southern and Northern Makassar City, South Sulawesi. The first point location (the first day until the sixth day) is the sampling area for yellow tail fish (fish auction place Paotere). The location a first day and the second day is the eastern part of Makassar City, including Pettarani road (second point of sale) and Borong Raya road (the end point of sale). The location of third day and fourth day is the southern part of Makassar City, including Cenderawasih road (second point of sale) and Andi Tonro road (the end point of sale) and location of the fifth and sixth days is the northern part of Makassar City, covering Racing road (second selling point) and Tamalanrea road (end point of sale).

2.2. Research method
The research was conducted by survey method through observation by directly observing the activities of mobile fish traders (fish broiler) starting from buying fish at the Fish Auction Place (TPI) Paotere and selling it around in Makassar City to collect data on temperature, potential of Hydrogen (pH), organoleptic, Total Plate Figures (TPC), Coliform, Total Volatile Bases (TVB), and yellow tail fish peroxide numbers at three observation points. Data collection covers the Northern, Southern and Eastern region of Makassar City. Three observation points in each region as a sampling place, namely the Fish Auction Place (TPI) after the purchase of fish, at the middle of the point of sale (second), and the final point of sale (the fish sold out). The selection of the three observation points is based on consideration of the time span of the sale and the route (route) of the peddlers selling fish, namely at 08:00 WITA at fish auction place Paotere, the second point at 08:00-10:00 WITA, and the final point at 10:00-12:00 WITA.

2.3. Data analysis
Data from measurements of temperature, pH, organoleptic values, TPC values, Coliform bacteria, peroxide numbers, and TVB levels were analyzed using Anova, then the results of significant analyzes were further tested using the LSD test to determine differences between points of sale.

3. Results and discussion
3.1. Physical testing of yellow tail fish
3.1.1 Fish temperature
In general, the average temperature of yellow-tailed fish that are sold around in Makassar City ranges between 17.54°C-24.96°C. From the results of statistical analysis using the ANOVA test, the temperature of yellow tail fish marketed around was significantly different (p <0.05) from one point of sale to another point of sale. Quality requirements for fresh fish, especially yellow tail fish (Caesio cuning) a maximum center temperature is 5°C [2]. This is different from the temperature of yellow tail fish which is marketed around by fish traders in Makassar City, the average temperature of yellow tail fish is higher than the required central temperature. The difference is due to by the addition of a small amount of bulk ice on uneven fish during the mobile sales process. The application of low temperature by cooling using ice and supported by the availability of facilities and how to apply it properly is one of the most effective ways to inhibit the decline in fish quality. Thus it is important to understand that the cold chain must be maintained from fish die, during distribution, to marketing to consumers [3].

3.1.2 Fish pH
The average pH of yellow-tailed fish sold around in Makassar City is in the range between 6.38-6.84. From the results of statistical analysis using the Anova test, the pH of yellow tailed fish marketed around the city of Makassar was not significantly different (p > 0.05) from one point of sale to another. From the average pH range of yellow tailed fish above, yellow tailed fish are still said to be fresh and fit for consumption. The pH value for fresh fish is in the range below neutral to neutral pH, the pH range indicates that the fish is in a rigor mortis condition [4]. Hydrogen Potential (pH) is an indicator
towards signs of decay or acidic properties in fish that determine the freshness level of fish. The pH value for live fish is around 7.0 and after the fish dies the pH drops to 5.8–6.2 [5]. Changes in pH are indicators of damage to fish, for the pH range of fish that are still in good condition 5.9 – 6.2, the pH has deviated 5.8, and fish that have signs of decay have a pH < 5.2 [6]. The pH of fish meat will decrease only to the limit of 5.5. This is related to the availability of glycogen reserves in fish meat. If the glycogen reserves have been completely decomposed, the pH of the fish meat will stop decreasing [1].

3.1.3 The relationship between time and temperature
The increasing temperature of the center of the yellow tail fish is influenced by the length of time the marketing of yellow tail fish in Makassar City. Figure 1 shows that the initial central temperature after fish was bought at Fish Auction Place Paotere was 18.83°C. At this point, the fish are treated by adding a little bit of bulk ice that is unevenly distributed to the fish before the mobile sales process takes place. After the fish were sold around the temperature it dropped to 17.54°C (the lowest point temperature of the tail fish) for 2.30 hours (138 minutes) from the initial time. Furthermore, the fish's central temperature increased to 24.96°C in 4.28 hours (256.8 minutes). This is due to travelling fish traders no longer add bulk ice during the sales process so that the influence of heat from the environment and heat from the container accelerates the process of rising temperatures from the previous point.

The most effective and commonly implemented effort to maintain the freshness of recently dead fish is the application of low temperatures as soon as possible such as cooling using ice in a good and right way [7]. One of the factors affecting the decline in the quality of the marketed fish is time, the longer the time the faster the fish experiences a process of quality degradation [1]. Ideally the ratio between ice and fish marketed during the mobile sales process, namely 1 : 1 means 1 kg of ice for 1 kg of fish so that the temperature of the fish can be maintained at 0°C until the end point of sale. In tropical waters the fish are lifted to the deck at relatively high temperatures, the sea, and the surrounding air are always hot during travel, so during operation and transportation the same number of fish to ice is needed (1 : 1) for preserving fish until landing [8]. During the mobile sales process in Makassar City, bulk ice is needed to reduce the central temperature to 0°C with an initial central temperature of 18.83°C, which is 0.99 kg of ice. Whereas to maintain the fish center temperature of 0°C as much as 5 kg of fish (equivalent to 20 fish) in 4.28 hours (256.8 minutes), which is 4.26 kg of bulk ice.

![Figure 1. Relationship between time and temperature of yellow tailed fish marketed around Makassar](image-url)
The result of simple linear regression analysis (Figure 1) shows an R value of 0.7448 meaning that time is moderately correlated to temperature. The value of the determinant coefficient (R²) of 0.5974 = 59.74% means that the temperature variable (Y) is affected 59.74% by time (X) while the remaining 40.26% is influenced by other variables outside of time. This might be due to the treatment of adding a little bit of bulk ice so that the fish's temperature actually decreased for 2.30 hours from the time of the initial sale. Temperature is one of the factors that influence the decay process, spoilage occurs quickly at high temperatures otherwise the decay process can be inhibited at low temperatures [9]. Similarly, the temperature of yellow tailed fish sold around in Makassar City, the more addition of bulk ice to the fish sold, the longer the decay process occurs and can maintain the quality of the fish sold around. One of the mechanism for handling fish is by applying the cold chain system [10].

3.1.4 The relationship between time and pH
The longer the sale time lasts, the faster the process of reducing the pH value of fish meat until it reaches the maximum limit (glycogen is completely decomposed). Figure 2 shows the pH of the yellow tailed fish marketed around Makassar in the earlier time (when the fish was purchased from Fish Auction Paotere) was 6.64. It is suspected that the pH range of 6.64 is caused by the fish that have just been bought at Fish Auction place in fresh condition and the process of the breakdown of glycogen to lactic acid is still very slow. Then the pH drops for 2.30 hours (138 minutes) when the fish are marketed around from the initial time to 6.60. This is presumably due to the activity of enzymes and decomposing bacteria work very quickly to break down complex compounds to be simpler so that the pH of fish decreases 0.04 from the previous pH. Furthermore, the pH of the fish increased for 4.28 hours (256.8 minutes) from the previous sales time to 6.61. This might be influenced by the compounds that want to be decomposed so that the increase in pH occurs very slowly and is supported by fish traders no longer adding bulk ice until the sales process ends.

![Figure 2. Relationship between time and pH of yellow tailed fish marketed around Makassar](image)

After a fish dead the blood circulation stops, which results in changes occurring in the muscle or tissue of the fish [11]. This stops the supply of O₂ resulting in anaerobic glycolysis process which produces lactic acid from glycogen breakdown. The pH of fish during the production and auction process has decreased due to the process of changing glycogen to lactic acid [12].

3.2 Yellow tail fish microbiology testing
3.2.1 Total plate count (TPC)
In general, the average TPC (number of bacteria) of yellow tail fish sold around in Makassar City ranged from $1.1 \times 10^4$ to $2.10 \times 10^6$ cfu/g. The results of statistical analysis using the Anova test, TPC yellow tailed fish marketed around were not significantly different (p> 0.05) from one point of sale to
another point of sale. Fish spoilage is caused by the degradation of fish meat due to the activity of the growth of microorganisms [13][14][15]. As soon as the fish die the enzymes present in the fish begin to actively degrade fish meat into simpler substances and microorganisms in the stomach contents, gills, and skin multiply rapidly [16]. Food damage can be caused by various factors, one of which is the growth and activity of microorganisms (bacteria that cause disease) [6].

3.2.2 Coliform bacteria
In general, the average bacterium of Coliformikan yellow tail that are sold around in Makassar City ranges from 0.4x10^-1.1x10^3 APM/g. From the results of statistical analysis using the Anova test, the yellow tailed fish Coliform bacteria which were marketed around were not significantly different (p> 0.05) from one point of sale to another.

3.2.3 The relationship between time and TPC
The increase in the number of bacteria, one of which is influenced by the time of mobile sales, the longer the sales time, the faster the growth of bacteria takes place if the fish are not in the application of the principle of good and correct handling. Figure 3 shows that the TPC of the yellow tailed fish at the initial time (when the fish was taken from TPI Paotere) was 4.02x10^4 cfu/g. In this case, the number of bacteria in fish is not much because the fish have not been contaminated either from the container, air, touch of the hands of consumers, the treatment of fish traders, and the length of time of sale (pollution and dirt). After the fish were sold around for 2.30 hours (138 minutes) the TPC of the yellow tail fish increased to 21.38x10^4 cfu/g from the previous time. This is thought to be the cause of external environmental factors and the condition of fish accumulating as long as the fish are marketed and are in storage containers so as to support the activity of bacteria to breed even more. Furthermore, the number of bacteria increased for 4.28 hours (256.8 minutes) after the fish were sold around to 43.20 x 10^6 cfu/g. This may be caused by the way of handling (not implementing a cold chain system), the use of facilities from the fish sellers is not good, and environmental conditions in accordance with the growth of spoilage microbes (temperature, pH, oxygen, and storage time) so that over time the amount Yellow tail fish bacteria increase.

![Figure 3. Relationship between time and TPC of yellow tail fish marketed around Makassar](image)

Fish handling is basically intended to maintain the freshness of fish that must be done since the fish is lifted from the water until it reaches the consumer [17]. The cause of rapid bacterial growth in the process of handling fresh fish is not done by cooling, fresh fish that have been captured are less likely to get enough ice crushed to arrive at the Fish Auction Place (TPI) until the fish are sold retail [9]. TPC testing has a standard, namely the Indonesian National Standard (SNI) for raw materials 5x10^5 and a final product 3x10^3 which means that if the TPC test results are more than SNI, the product has a low quality or poor quality (not good) and can be said that the product is not feasible to be consumed in the final product and not suitable for processing in raw materials [18].
3.2.4 The relationship between time and coliform bacteria

The importance of controlling the sanitation and hygienic conditions of fish traders to the condition of the equipment (facilities) used, namely to reduce and prevent the growth of microorganisms that cause disease, one of which is Coliform bacteria so that fish sold around can be consumed and do not endanger the health of consumers. Figure 4 shows that bacteria Yellow tailed fish coliform at initial time was 1.03x10^2 APM/g. After the fish were sold around for 2.30 hours (138 minutes), the yellow tail fish Coliform bacteria increased to 1.70x10^2 APM/g from the previous time. Furthermore, the number of Coliform bacteria increased for 4.28 hours (256.8 minutes) after the fish were sold around to 4.50x10^2 APM/g. This is suspected of contamination from the facilities used, water for washing equipment using polluted water, the presence of dirt, dust, insects (flies), and poor sanitary conditions from fish traders and consumers (potential buyers). The safety limit of fresh fish from contamination of Coliform bacteria is 1x10^2 APM/g [2]. Coliform bacteria are a group of bacteria that are used as indicators of impurities pollution and poor sanitary conditions [19]. Good handling and sanitation is very necessary to maintain the freshness of fish, the longer the fish are in the open air, the lower the freshness level [9].

![Figure 4. Relationship between time and coliform yellow tail fish marketed around Makassar](image)

3.3 Yellow tail fish chemical testing

3.3.1 Total volatile bases (TVB)

The average value of TVB yellow tail fish sold around in Makassar City, which ranges from 8.18 to 28.73 mgN/100g. From the results of statistical analysis using the Anova test, the TVB content of yellow tailed fish which is marketed in a mobile city in Makassar City is not significantly different (p > 0.05) from one point of sale to another point of sale. Zakaria (1998) states that TVB levels of sea fish differ in each condition, for fresh fish TVB values <20 mg/100g, starting to decay TVB values > 30 mg/100g, and not worth consuming TVB values of 40 mg/100g. The index of fish rot for TVB levels is 30 mgN/100g [20]. TVB is an indicator of fish quality with a maximum level of 20 mg/100g for consumption limits including Trimethylamine, Dimethylamine, Ammonia, and other Nitrogen bases which are the work of bacteria and autolytic enzymes during the decay process [21].

3.3.2 Peroxide number

The average content of peroxide numbers of yellow tailed fish sold around in Makassar City is in the range of 1.99-72.65 mEq/kg. The results of statistical analysis using the Anova test, the peroxide number of yellow tail fish marketed in Makassar City was not significantly different (p > 0.05) from one point of sale to another. In moderate fatty fish like yellow-tailed fish, it is easy to oxidize fat which causes rancid odor in fish. The process of rancidity is caused by oxidation of unsaturated fats in fat [22], and the peroxide content is the amount or limit used to estimate the existence of a rancidity process [23].
3.3.3 The relationship between time and total volatile base (TVB)

The longer the sale time lasts, the higher the level of TVB in the body of the fish. Figure 5 shows that the TVB level at the earliest time (when the fish was taken at TPI Paotere) was 13.12 mgN/100g in this case the fish was still said to be fresh. After the fish were sold around for 2.30 hours (138 minutes) the TVB levels of the fish increased to 17.12 mgN/100g from the initial time. Furthermore TVB levels increased to 19.93 mgN/100g for 4.28 hours (256.8 minutes) from the previous time. During the mobile sales in Makassar City, yellow-tailed fish were still classified as fresh fish and contained TVB levels that were suitable for consumption. TVB value > 30 mg/100g, and not suitable for consumption TVB value of 40 mg/100g [24]. The index of fish rot for TVB levels is 30 mgN/100g [20].

![Figure 5. Relationship between time and yellow tailed fish TVB which are marketed around Makassar](image)

Indicator of fish quality with a maximum level of 20 mg/100g for consumption limits including trimethylamine, dimethylamine, ammonia, and other nitrogen bases that are the result of the work of bacteria and enzymes during the decay process [21]. The lemuru fish stored at room temperature was rejected by panelists at a TVB level of 20 mgN/100g after 10 hours of storage [26]. Fatty fish such as herring and mackerel fish, the maximum limit of TVB level is 20 mgN/100g [25]. Sardines in Australia were rejected by panelists after 12 hours of storage at room temperature reaching 23 mgN/100g [27].

The result of simple linear regression analysis (Figure 5) shows an R value of 0.9983 meaning that time correlates very strongly to TVB levels. The value of the determinant coefficient ($R^2$) of 0.9901 = 99.01% means that the variable TVB (Y) is influenced 99.01% by time (X) while the remaining 0.99% is influenced by other variables outside of time. Things outside the time that affect TVB levels increase with the time of sale the possibility of damage occurs due to the breakdown of proteins by microorganisms so that food forms compounds, such as ammonia, H2S, indole, and amines [6]. The simple linear regression model, namely $Y = 13.2279 + 1.5931x$ means that each time increases as much as one unit then the TVB content will rise by 1.5931x.

3.3.4 The Relationship Between Time and Peroxide Number

Long mobile sales affect the peroxide content in fish meat. The longer the time of the mobile sales, the more peroxide content in the yellow-tailed fish meat increases Figure 6 shows that the initial content of the peroxide number (when fish were taken at the Paotere TPI) was 11.46 mEq/kg. After the fish were sold around for 2.30 hours (138 minutes) the content of fish peroxide numbers increased to 22.32 mEq/kg from the initial time. Then the peroxide content increased to 23.91 mEq/kg for 4.28 hours (256.8 minutes) from the previous time. This causes the yellow-tailed fish to begin to experience a rancid process due to direct contact with the air so that the process of fat oxidation in fish takes place quickly for 4.28 hours (256.8 minutes) of sales.
Spoilage in fish is oxidative rancidity due to oxidation of fat, causing undesirable rancid odors [5]. The highest value of peroxide that can be tolerated in fish is 10-20 mEq/kg [28]. For peroxide numbers in fish to be rancid in the range of 10 - 20 mEq/kg [29].

3.4 Organoleptic testing of yellow tailed fish
In general, the average organoleptic value of yellow-tailed fish sold around in Makassar City ranges from 4.95 to 9.00. Anova statistical test results of organoleptic value of yellow tailed fish which are marketed around are significantly different (p < 0.05) from one selling point to another. Next, an LSD (Least Significant Difference) follow-up test is performed, where only the average organoleptic value at point one is significantly different from the average organoleptic value at the third point of sale (p < 0.05).

The longer the sales time around the organoleptic value decreases because of the process of breaking down macrocomplex compounds into simpler compounds by bacteria and enzyme activity that affects the appearance (physical condition) of fish. Figure 7 shows that the initial organoleptic value was 8.47. Furthermore, the organoleptic value decreased to 7.62 when the fish were sold around for 2.30 hours (138 minutes) from the initial time. After that the organoleptic value of the fish decreased to 6.73 within 4.28 hours (end point of sale) around from the previous time.

The rate of decline in the quality of fish injured or bruised is higher compared to the condition of physically intact fish [7]. The quality and safety requirements of fresh whole yellow tailed fish for organoleptic testing are a minimum of 7.0 (score 1-9). The result of simple linear regression analysis
(Figure 7) shows an R value of 0.9985 meaning that time correlates very strongly to the organoleptic value and the organoleptic value of the yellow tailed fish is significantly affected (p <0.05) by the time of mobile sales. The value of the determinant coefficient (R²) of 0.9999 = 99.99% means that the organoleptic variable (Y) is affected 99.99% by time (X) while the remaining 0.01% is influenced by other variables outside of time.

4. Conclusion
The quality of yellow tailed fish which is marketed around to the end point of sale (12.00 pm) is less fresh but is still suitable for consumption with an organoleptic test parameter of 6.73, the number of bacteria (TPC) 4.32x10⁵ cfu/g, Coliform bacteria 4.50 x10² APM/g, TVB content of 23.91 mEq/kg. The relationship between time and testing parameters (physical, microbiological, chemical, and organoleptic) in yellow tailed fish, namely the longer time the sale of fish central temperature, TPC, Coliform bacteria, TVB levels and peroxide content in yellow tails increased while organoleptic value and pH of fish decreases.

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