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Marketing system, Quality and safety characteristics of mackerel (*Rastrelliger sp*) at the domestic market in Jakarta

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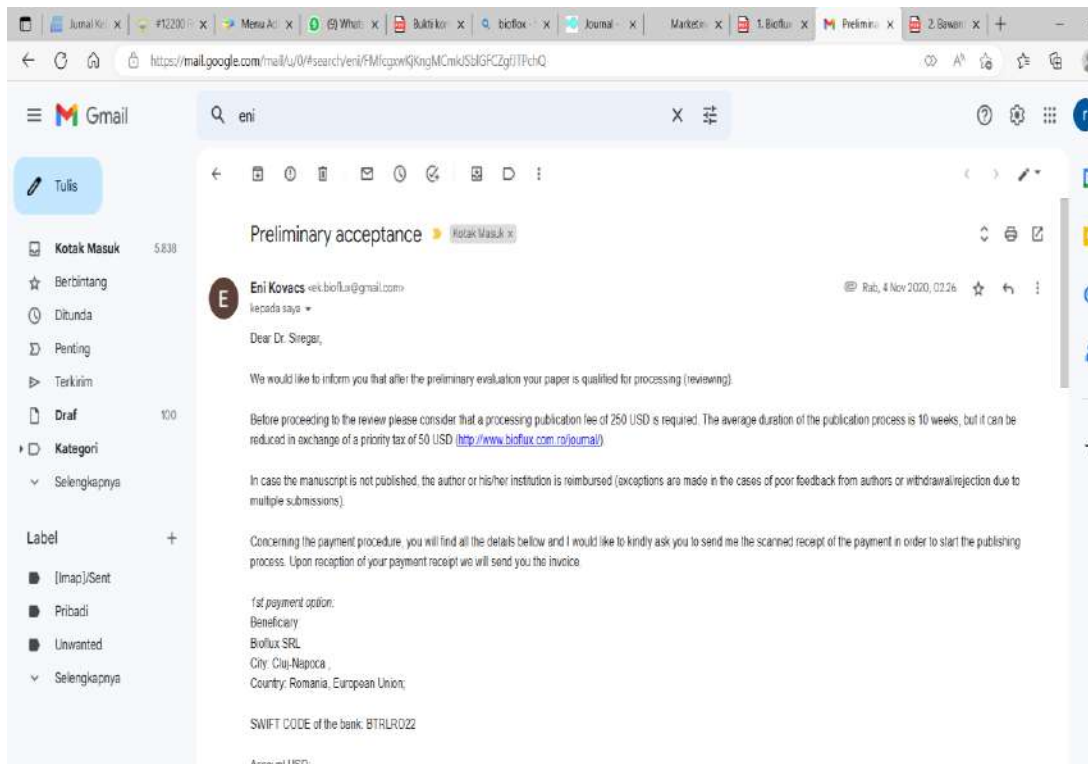
Abstract. Fish is a highly perishable food, which needs proper maintenance during distribution and marketing, to provide a good quality product to consumers. This study aims to identify the distribution chains of fresh fish, socio-economic characteristics of participants, namely fishermen and retailers, and also to analyze the quality and safety of mackerel through domestic distribution. It was conducted at the domestic fish market in Jakarta, Indonesia. The distribution and marketing, involved intermediaries, which were important for fish product delivery to customers. The distribution chain data were collected from retailers through a survey using a questionnaire combined with an interview. Quality characteristics of fish were conducted by taking the same samples from 56 locations, including fish landing, auction, wholesales, supermarkets, and traditional markets. Based on market participants, the distribution chain consisted of fishermen, traders, collectors, wholesalers, retailers/supermarkets, and consumers. The results indicated that majority of the market participants were males, at the productive age, and marketing was their main job, with a low level of education. Based on the total volatile base nitrogen (TVB-N) content, all the fish transported from the landing location to the supermarket complied with the quality standard, while in the traditional trading site 22.09% exceeded the maximum limit. In terms of food safety characteristics, mackerels were contaminated with pathogenic *Escherichia coli* from fish auction and increased during distribution. The presence of this bacteria was mainly due to poor hygiene practices during handling.

Key Words: distribution, quality, *Rastrelliger sp*, Total Volatile Bases, *Escherichia coli*, domestic market.

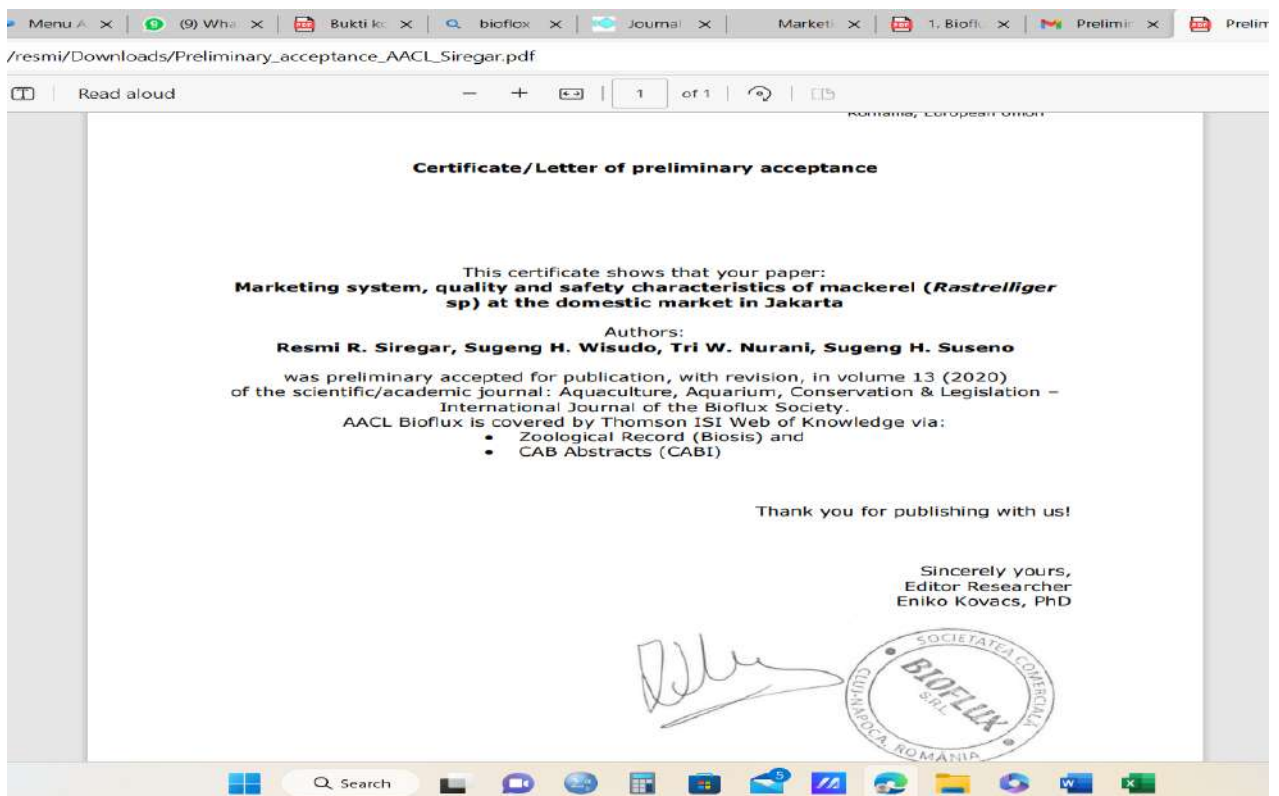
Introduction. The provision of fish to consumers from the production center, require marketing, distribution, and maintenance to keep the quality and safety of the product. This also help in sustaining the economic system in Jakarta, the capital city of Indonesia, making it a trading center for various goods, especially fisheries. The increasing demand for fish products was probably due to its great advantages compared to other foodstuffs. According to Albert & M. Halaman, fish is the most nutritious and healthiest food ingredient with high protein and low fat content. It is also reported by Siam et al (2011), that it is a very important food ingredient and a source of essential amino acid and unsaturated fatty

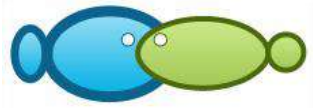
Halaman 11 of 12

2. Primery Acceptance



3. Letter Of Acceptance





Submission letter

Article title:

Marketing system, Quality and safety characteristics of mackerel (*Rastrelliger* sp) at the domestic market in Jakarta

Name of the authors:

Resmi R. Siregar, Sugeng H. Wisudo, Tri W. Nurani, Sugeng H. Suseno

Hereby I would like to submit the manuscript entitled “**Marketing system, Quality and safety characteristics of mackerel (*Rastrelliger* sp) at the domestic market in Jakarta**” to Aquaculture, Aquarium, Conservation & Legislation - International Journal of the Bioflux Society.

This manuscript was not submitted or published to any other journal. The authors declare that the manuscript is an original paper and contain no plagiarized text. All authors declare that they are not currently affiliated or sponsored by any organization with a direct economic interest in the subject of the article. My co-authors have all contributed to this manuscript and approve of this submission.

Corresponding author

Name: Resmi Rumenta Siregar

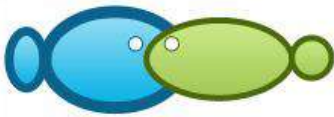
Signature

A handwritten signature in black ink, appearing to be the name 'Resmi Rumenta Siregar'.

Date: 24 October 2020

4. Adjustment dan proses Review

The screenshot displays a Gmail interface on a Windows desktop. The browser address bar shows a search for 'ek.bioflux@gmail.com'. The left sidebar lists folders like 'Kotak Masuk' (5,838), 'Berbintang', 'Ditunda', 'Penting', 'Terakhir', 'Draf' (100), and 'Kategori'. The main content area shows an email from 'Eni Kovacs' (ek.bioflux@gmail.com) dated 'Min, 10 Jan 2021, 23:39'. The email subject is 'Adjustments' and the body text reads: 'Dear Dr. Siregar, Please find the manuscript attached and make the necessary adjustments. Kind regards, Editor AAQL Bioflux, Eniko Kovacs'. Below the text is a 'Satu lampiran' (One attachment) section with a thumbnail of a document titled 'Siregar_Rastrellig...'. A reply from 'resmi.rumenta' (resmi.siregar@gmail.com) dated 'Sen, 11 Jan 2021, 15:13' is partially visible at the bottom, starting with 'Dear Dr. Eni'. The Windows taskbar at the bottom shows the system tray with weather (90°F Partly sunny), search, and various application icons, along with the date and time '1:30 PM 3/13/2023'.



Marketing system, quality and safety characteristics of mackerel (*Rastrelliger sp.*) at the domestic market in Jakarta

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Abstract. Fish is a highly perishable food, which needs proper maintenance during distribution and marketing, to provide a good quality product to consumers. This study aims to identify the distribution chains of fresh fish and the socio-economic characteristics of participants, namely fishermen and retailers, and also to analyze the quality and safety of mackerel throughout the domestic distribution process. ~~The study~~ was conducted at the domestic fish market in Jakarta, Indonesia. The intermediaries involved in distribution and marketing, involved intermediaries, which were play an important role for in fish product delivery to customers. The distribution chain data were collected from retailers through a survey using a questionnaire combined with an interview. Quality characteristics of fish were conducted-determined by taking the same type of samples from 56 locations, including fish landing, auction, wholesales, supermarkets, and traditional markets. Based on market participants, the distribution chain consisted of fishermen, traders, collectors, wholesalers, and retailers/supermarkets, and consumers. The results indicated that majority of the market participants were males, at the productive age, and fish capture, marketing and distribution was their main job, with a low level of education. Based on the total volatile base nitrogen (TVB-N) content, all the fish transported from the landing location to the supermarket complied with the quality standard, while in the traditional trading site 22.09% exceeded the maximum limit. In terms of food safety characteristics, mackerels were contaminated with pathogenic *Escherichia coli* from fish auction and the contamination level increased during distribution. The presence of ~~this-these~~ bacteria was mainly due to poor hygiene practices during handling.

Key Words: distribution, quality, total volatile bases, *Escherichia coli*.

Introduction. The provision of fish to consumers from the production center, require marketing, distribution, and maintenance to keep the quality and safety of the product. This also help in sustaining the economic system in Jakarta, the capital city of Indonesia, making it a trading center for various goods, especially fisheries. The increasing demand for fish products was probably due to its great advantages compared to other foodstuffs. According to Albert & Marc (2013), it is the most nutritious and healthiest food ingredient with high protein and low-fat content. It is also reported by Ström et al (2011), that it is a very important food ingredient and a source of essential amino and unsaturated fatty

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acids, vitamins, and minerals. ~~Besides~~ However, it is a highly perishable commodity, and its quality deteriorates very rapidly. Therefore, its quality is affected when stored for human consumption for a long time, and ~~required~~ requires some efforts to be preserved during distribution and marketing.

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According to DGCF (2016), fish production in Jakarta was dominated by small (30%) and large pelagic (25%), pelagic fish, mollusks (27%), demersal fish (16%), crustaceans and reef fish 1% each. Among the small pelagic fish, mackerel (*Rastrelliger* sp.) is the most consumers-preferred by consumers fish in Jakarta community (Ministry of Marine and Fisheries, 2018). Therefore, its quality and safety related topics need to be special consideration and maintained during distribution and marketing.

Accurate and comprehensive data regarding the quality and safety of fresh mackerel, during distribution and marketing at the domestic market in Jakarta are not available. Therefore, it is necessary to identify the marketing system, as well as the quality and safety of mackerel in the distribution chain. This is a preliminary study aimed to improve the quality and safety of fish, and also in monitoring the distribution monitoring, in order to provide good quality in the domestic market.

Material and Method

Study site and period. This study was conducted for a period of four months, from March to June 2019, at domestic markets in Jakarta. The marketing and distribution chain started from a-fishing vessels, auction places, wholesales stores, supermarkets, and traditional trading sites (Figure 1).

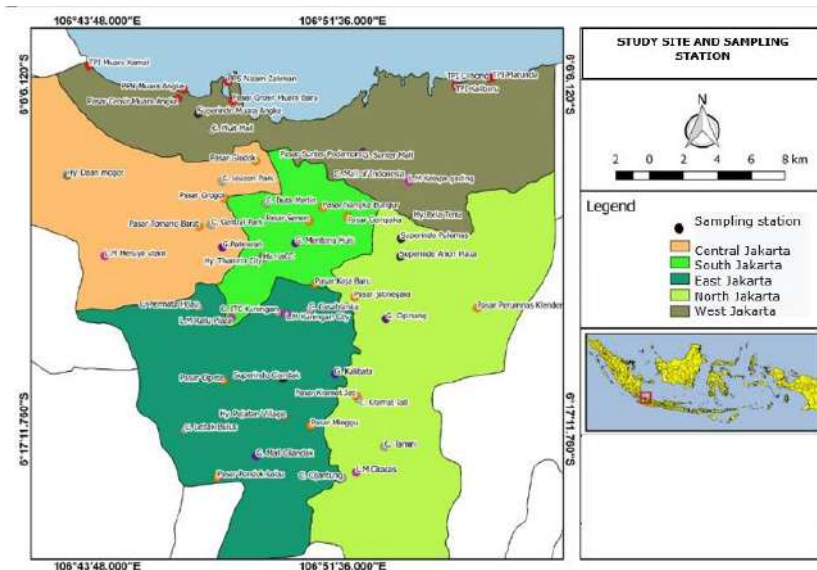


Figure 1. Study side and sampling location.

Material and Method

Material. The materials used were mackerel, ice, some chemicals for *Escherichia coli* analysis and Total Volatile Bases (TVB) assessment. The equipment used included a scale at 0.001 gr of accuracy (Metler Toledo), a Stomacher homogeniser (Interscience), filter paper (Whatman), distillation sets (Foss), incubator (Thermo scientific), autoclave (Chemoto scientific), waterbath (Thermo scientific), oven (Thermo scientific), glassware (pyrex), and micropipette (Eppendorf).

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Research methods. This study used a survey, interviews, and laboratory testing methods. The respondents were 50 fishermen and 270 market participants, including 30 collectors, 60 wholesalers, 5 agents, 3 restaurant owners, 32 quality supervisors at supermarkets, and 140 retailers at traditional markets. For quality and safety testing, 790 samples in total, were obtained from 5 landing side locations (150 samples), 3 fish auction and 2 wholesale markets (150 samples), 32 supermarkets (155 samples), and 14 traditional markets (335 samples). The locations were determined based on random sampling which proportionally represented all districts in Jakarta. The fish samples were placed in a cool box, preserved with crushed ice at a ratio of 1:1 (Wiranata et al 2017-8; Panai et al-7 2013). The samples were then taken to the laboratory for further analysis.

Marketing system. The survey involved interviews, and the study areas were inspected in terms of identifying the fish distribution chain, as well as the socio-economic characteristics of market participants.

Quality and safety characteristics. The quality of mackerel (*Rastrelliger sp.*) was determined by the Total Volatile Bases Nitrogen (TVB-N) analysis, while its safety characteristics were determined by the presence of pathogenic *E. coli*. The TVB-N was analyzed using the Kjeldhal distillation method, based on Indonesia National Standard 2354.8:-2009 (Sepka et al- 2017). The extract was prepared by mixing 10 grams of the sample with 90 ml of 6% pPerchloric acid (PCA), and was homogenized for 2 minutes. The blend was then filtered using Whatman no 1 filter paper to obtain a clear extract. Then, 50 ml of the extract was pipetted into the distillation tube and added a few drops of phenolphthalein indicator and anti-foaming silicone, and placed in the distillation flask. Then, distillation commenced, while 30 ml of 10% NaOH and 100 ml of distilled water were added to the flask. The steam distillate was collected in a flask containing 100 ml of 3% boric acid together with few drops of indicators. The steam distillation procedure was continued until 200 ml of green color distillate was collected in a flask. The blank correction was determined by the steam distillation of 50 ml of distilled water sample, instead of the extract. The green color distillate was titrated with 0.02N Hydrochloric acid using a burette until the green color solution turned pink.- The result was calculated and expressed in mg-TVb-N 100 g⁻¹ of fish.

$$TVB-N (mg-N/100g^{-1}) = \frac{(V_s - V_b) \times N.HCl \times 14.007 \times fp \times 100}{10}$$

Where:

Vs = volume of Hydrochloric acid for sample titration;

Vb = volume of Hydrochloric acid for blank titration;

Fb-df = dilution factor.

E. coli analysis was carried out using a 3-tube Most Probably-Probable Number (MPN) with a 3-tube series method, based on Indonesian National Standard 2332.1:-2015 (Sutiknowati, 2016) which included presumptive, confirmed, isolation, morphological, and biochemical tests. The MPN value was determined according to the number of positive tubes, and compared to MPN-index-table (FDA, 2010). The number of pathogenic *E. coli* bacteria in the sample were expressed in MPN/gr⁻¹.

Data analysis. The descriptive statistical statistics was were used to analyze the data obtained, presented in percentage, and they were displayed as percentages in tables and in graphs using the Microsoft Excel program. The distribution chains were also displayed by represented by diagrams based on the market participants involved.

Results and Discussion

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Fishery production. Fishery production in Jakarta fluctuates every year, as shown in (Figure 2:). The data showed that only 3.63% of Jakarta fisheries production were was obtained through aquaculture, while 96.37% were captured. Between 2012 and 2015, the increasing rate of fish production rate increase was about 10.18%, while in 2016, it decreased to with about 49.94% from, compared to the previous year, then it and lightly decreased increased until 2018. This decrease in production occurred both in aquaculture and capture fisheries. This was probably due to the Jakarta Bay reclamation program, and the enforcement of several regulations related to the fisheries activity regulations. According to Puspasari R. et al (2017), the Jakarta Bay reclamation has had an impact on the aquatic environmental conditions, while The reduction of the fishing area has an impact caused on decreasing the production rate decrease to 82.2 thousands of metric tonstones/ year. Also, the fishing ground pollution significantly reduced the production rate in Jakarta Bay (Mustaruddin et al 2020). This was also supported by Wiryawan et al. (2013), stating state that the estimation of the fishing grounds area, affected by reclamation in 2012 was about 1,527.34 Haha. From 2012 to 2014, the area was concentrated along the Jakarta Bay (Wagiyo et al 2016; & Wiryawan et al 2013); and in 2016, the reclamation area was extended it was moved to the southern part of Seribu Island (Puspasari R. et al 2017). The enforcement of several fisheries regulations, such as the prohibition of using some fishing gear (trawl and seine nets), the interdiction confinement to catch some species (spawning lobsters, crabs, blue swimming crabs), and the licensing suspension of some certain types fishing vessels affected fisheries production. In tuna production, for example, the volume of tuna exports decreased by 16% from October to December 2014, since the enforcement of Regulation No- 56/2014 (Arthatiani F.Y & Apriliani F 2015).

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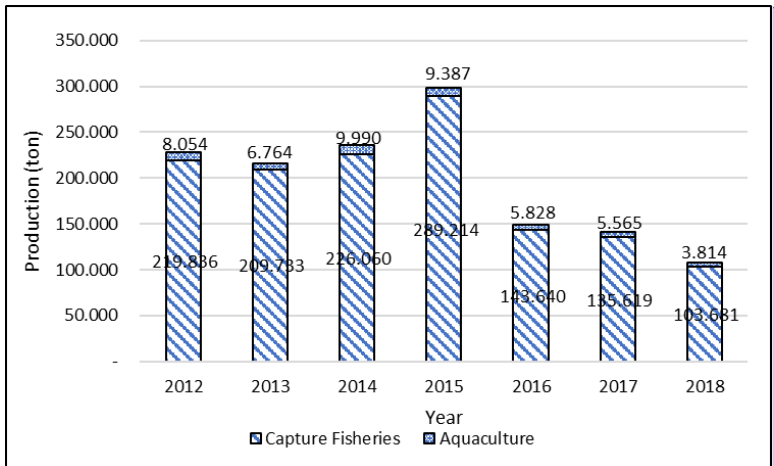


Figure 2. Jakarta fisheries production 2012-2018. (Source: <https://satudata.kkp.go.id>)

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Socio-economic characteristics of market participants. Fish marketing practices in Jakarta domestic market were performed by several institutions and participants, which included fishermen, brokers, collectors, wholesalers, restaurant owners, supermarkets, and retailers. The socio-economic characteristics of the market participants, which included their age, gender, marital status, educational level, marketing experience, and knowledge of Good Handling Practices (GHdP) were presented in Table 1.

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Table 1 shows that the majority (68.75%) of the participants were within the age of 41-60 years, followed by those between 31-40 (21.88%), under 30 (7.81%), and those above 60 years. It was found that most of the market participants were in their economic active years, between 15-64 years (BPS 2018). According to Farikha and Ardyanto (2016), the economic active years produced generated a high productivity. The

table further showed that male respondents have a greater proportion of the market participants (57.50%) compared to females (42.50%). ~~This ratio~~ Very different result were reported in as different with market participants in Adamawa State, Nigeria, with the same comparison of male and female (Madugu & Edward 2011), while in Benue State, 90% of the marketers were female (Lawal and Idega 2004), and also in Oyo State, 85% of the marketers were female (Ayanboye et al 2015). However, this the current study indicated that both males and females participated in fish marketing. This was also supported by Williams and Awoyemi (1998) that in coastal areas, women also perform other types of earnings to supplement the household income.

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Table 1
Socio-economic characteristics of market participants

<i>Socio-economic variables</i>	<i>Frequency</i>	<i>Percentage (%)</i>
Age		
< 30	25	7.81
31-40	70	21.88
41-50	111	34.69
51-60	109	34.06
>60	5	1.56
Total	320	100
Sex		
Male	184	57.50
Female	136	42.50
Total	320	100
Marital status		
Married	307	95.94
Single	13	4.06
Total	320	100
Education		
No formal education to primary education	134	41.88
Secondary education	99	30.94
Tertiary education	69	21.56
Diploma/graduated	18	5.63
Total	320	100
Marketing experience (Year)		
≤10	88	27.50
10-20	126	39.38
20-30	89	27.81
>30	17	5.31
Total	320	100
Job status		
Main job	320	100
Side job	0	0
Total	320	100
GHP knowledge		
Good	57	17.81
Fair	108	33.75
Poor	155	48.44
Total	320	100

The data showed that 95.94% of the market participants were married, while 4.06% were single, and all the respondents (100%) stated that selling fish was their main

occupation and source of family income. About 41.88% of the market participants in the domestic market in Jakarta did not have any formal education, 30.94% attended junior high school, 21.56% attended senior high school, and 5.63 % attended a diploma level of education. Therefore, most of the market participants have a low education level. The same result was also recorded by Robin et al (2018), which stated that the education level of fishermen in some coastal areas in Jakarta was very low. Although some respondents answered that education is not an essential subject for fish marketing, rather than to adapt and be familiar with the new technology. This corroborated the report of Madugu & Edward, (2011), which stated that a low education level indicated low literacy skills of market participants. Furthermore, Triyanti and Shafitri (2012) also stated that a low education level was the major reason for the slow adoption of new technology. The same statement was also made by Dongondaji (2010) that literacy has a positive influence on adopting the technology. Most of the respondents (39.38%) had a marketing experience between 10-20 years, followed by 27.81% with 20-30 years, 27.50% with less than 10 years, and 5.31% with more than 30 years. According to Putri (2016), working experience has a positive effect on productivity, and it indirectly increases profitability (Sri Muliani & Suresmiathi 2015). This was also in line with Ali et al (2008), stating that marketing experience affects participants' profit, the more the experience, the more they understand of the system, condition, trends, and prices. In terms of knowledge of GHP, findings further showed that 48.44% of the participants in Jakarta had a poor level knowledge of Good Handling Practices (GHP), while 33.75 % had fair level and only a few (17.81%) had good knowledge of GHP.

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All these major implied implication, that the majority of the market participants had less a lower knowledge level on how to keep fish in good condition. This was due to the low levels of education level and the lack of training obtained, while fish is the one of the most perishable foods, and the knowledge to maintain its quality maintenance is essential. According to Lusianawaty and Ghani (2015), education and training increase knowledge and skills, which influence personal behavior.

Distribution chain. The distribution chain can be described by a sequence of operators, describes the sequence of markets, which product passes through, from production producers to the final consumers (Apituley et al 2013). In this study, the fresh fish distribution chain was relatively short. There were six places or with only six categories of market participants where fresh fish reached before the final consumer, such as: collectors, suppliers, wholesalers, retailers, restaurants, and supermarkets. The distribution chain of fresh fish in the domestic market, based on the organization of person involved was shown, as shown in Figure 2.

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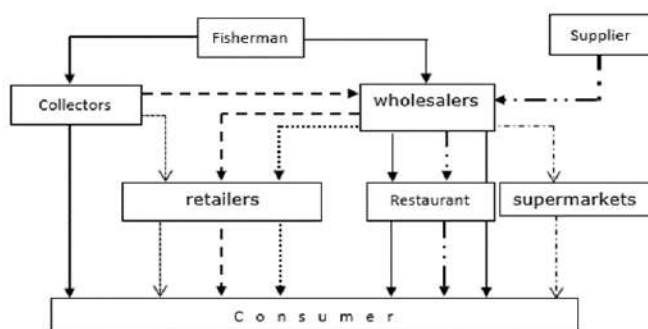


Figure 2. Fish distribution chain at the domestic market in Jakarta.

The main source of fresh fish for domestic consumption in Jakarta are the local fishermen and the suppliers, from other provinces, such as Lampung, Banten, West Java, and

some regions in Central Java. Most fresh fish from local fishermen were marketed through collectors, while those from other regions were traded through the Muara Angke Market and on the Modern Market, located in Nizam Zachman Fishing Port.- Figure 2 showed shows that collectors bought fish directly only from fishermen, while wholesalers obtained it both from fishermen and suppliers. Therefore, fish sold to retailers, restaurant owners, and supermarkets, and are finally get delivered to the consumers. Collectors have a dominant part in domestic fish marketing. This was because of the cooperation between them and, due to their closer cooperation with fishermen, such as involving capital assistance from collectors. However, consequently they conserve fishermen have to contractual privileges sell on the catch to them as a consequence. No In absence of fixed established fish distribution chains was found, therefore, they are formed naturally by the existence of cooperation and agreements between market participants are prevalent. The consideration of selecting selection of the distribution chain by the market participants was influenced by many factors, essentially related to the mutual satisfaction of their requirements, such as: limitations of business capital, transportation capacity, and storage facilities, as well as their mutual need. This was supported by Hanafiah and Saefuddin (1986) stating state that several aspects affecting the distribution chain of fishery products are the company's financial position, production scale, product nature, and the location to the final consumer.

Quality and safety characteristics

Total Volatile Bases (TVB) analysis. Total Volatile Bases (TVB) is a group of biogenic amines formed in non-fermented food products during storage, due to protein enzymatic and bacterial protein degradation by the activity of the enzyme and bacterial (Zeitsev et al 1969). Therefore, TVB levels are the most widely used indicator for the chemical assessment of marine fish spoilage (Zhong-yi et al 2010; & Amegovu et al 2012). The higher the TVB level, the worse the fish quality. According to Connel (1995), an acceptable limit of the total volatile base - nitrogen for fish is 30 mg /100 g⁻¹ muscle. However, Soekarto (1990) recommended TVB-N levels of 10 mg N /100 g⁻¹ or less for very fresh fish, 10-20 mg N /100 g⁻¹ for fresh fish, with 20--30 mg /100 g⁻¹ as a maximum limit for consumption, and resulting that levels over 30 mg /100 g⁻¹ correspond for to spoiltspoiled fish. The average range of TVB-N and the percentage of samples complied with TVB-N level during distribution were presented in Table 2.

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Table 2
Range, average, and percentage of samples complied with TVB-N level

Distribution chains	Range of TVB (mg N 100 g ⁻¹)	Average of TVB (mg N 100 g ⁻¹)	% of sample complied with TVB-N level
Fish landing	8.17-15.92	12.19±2.23	100
Fish auction	9.19-17.91	12.87±2.84	100
Wholesale	10.11-24,09	16.83±3.50	100
Supermarkets	13.02-23.98	18.89±2.29	100
Traditional markets	10.63-44.49	23.16±5.89	77.91

Based on the total volatile base - nitrogen level, Table 2 shows that 100% of mackerel on the landing side, fish auction market, and supermarkets, complied with TVB-N standard limit. While in the traditional trading site only 77.91% complied with the standard limit. The quality of mackerel during marketing tends to decrease as the TVB level increasedincreases, especially in traditional markets. Generally, mackerel on the landing side and fish auction were within the limits of very fresh to fresh quality (8.17-17.91 mg N 100 g⁻¹), those on wholesale and supermarkets were within the range of fresh to a maximum limit for consumption (10.11-24.09 mg N 100 g⁻¹), while those on traditional markets were within the fresh quality to spoiled (10.63-44.49 mg N 100 g⁻¹). This was supported by Deni (2015) also found, stating that fishes tradedobtained at auction

places were was in the category of fresh. Connell JJ, (1980) also stated indicated that the TVB-N level of fresh fish caught was ranges between 5-20 mg N 100 g⁻¹.

Quality loss in the traditional market was due to poor hygiene in handling and unhygienic conditions of, including equipment and location affecting bacterial contamination growth. There was is a direct proportionality relationship between the bacterial load and TVB-N value, the total volatile base nitrogen value increases with higher bacterial load (Immaculate & Jamila, 2018). This was in line with (Baldwin, (1961), stating stated that the Hydrolysis-hydrolysis of protein and other nitrogenous compounds by autolytic enzyme, together with bacterial action, leads to an increased total volatile base - nitrogen value. The poor handling and low awareness of marketer relating to the implement cold chain implementation in traditional markets was also reported in Malawi (Kapute et al 2012) and Sri Lanka (Jinadasa, 2014). This was indicated that the lack of cold chain applications, especially in traditional markets, was a major problem in some countries. Despite that all the samples from supermarkets relatively comply with the TVB-N level, some samples have been rejected by sensory analysis due to poor appearance and texture. The same result was reported by Genç et al (2013) for meagre fillets, which were already unacceptable after 8 days, in terms of off-odors, however, even if their TVB-N content was within the regulated levels. This was supported by Tejada & Huidobro, (2002), stating stated that TVB-N, which is although being appropriate and the most widely used as a legal chemical indicator of seafood spoilage, is appropriate, it is however, is an inadequate sign of quality during the initial stages of fish damage.

In this study, most of the fish marketed in at the traditional trading sites was were kept without ice during display the sales operations, at temperatures ranging from and was between 22.3±3.4°C to 25.2±0.8°C. According to Ola & Oladipo (2004), fish spoiled faster kept at ambient temperature spoiled rapidly than those in the chilling container. Maintaining the quality of fresh fish was carried out through in various methods, however, according to (Ghaly et al 2010), the most ideal method was to keep their preservation at chilling temperature. Therefore, in order to delay the bacteria growth of spoilage bacteria and biochemical processes, which was mainly caused by ing quality deterioration was delayed at low temperatures (Adawyah R, 2014).

Furthermore, Ariyani et al, (2008), stated that at 0-6°C, microorganisms and enzymes activity were retarded. It was also reported that there were significant quality differences between fish stored at cold temperatures compared to those stored in ambient, such as spotted grunter (Osibona AO and MO-Ezekiel, 2014), tilapia (Makawa Z, 2014), and various other fish species (Immaculate & Jamila, 2018).

According to Soekarto, (1990), 15% of mackerel obtained in the distribution chain were very fresh, 47% were fresh, 28% were fit for consumption and 10% were spoilt (Figure 3). All the spoilt fish were found in traditional markets.

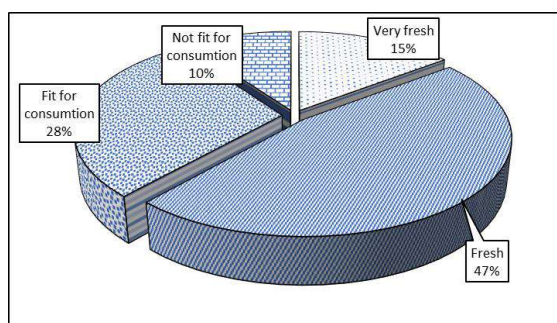


Figure 3. Freshness level of mackerel during distribution.

Escherichia coli analysis. *Escherichia E. coli* is an organism that typically colonizes the intestinal tract of warm-blooded animals, including humans (Cooke & Ewins, 1975, &

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(Melliawati R, 2009), and being the most affluent anaerobe bacteria of the intestinal microflora (Kaper et al 2004). The presence of *E. coli* in water and food is a strong indication of recent sewage or animal fecal contamination, because of poor hygiene practices during handling (Sutiknowati, 2016; & Kim et al, 2017). Also, this bacterium has long been considered as an indicator of recent fecal pollution in food and environment water. Some strains of *Escherichia-E. coli* cause diseases, such as diarrhea, indigestion, and dysentery (Made & Dwipayanti, 2010; & Wong et al, 2012).- Besides as an indicator of poor hygiene practices during handling, *Escherichia-E. coli* was also used as a food safety indicator. The total of *Escherichia-E. coli* in mackerel samples, expressed in Most Probable Number per gram (MPN.g⁻¹) was shown in Table 3.

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Table 3

Number of *Escherichia coli* of mackerel samples

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Distribution chains	Total sample	% of the positive sample	Number of <i>Escherichia coli</i> (MPN g ⁻¹)	Standard (BSN 2013)
Fish Landing	150	12.67	3.0-75	
Fish auction	90	18.89	3.0-120	
Wholesale	60	11.67	6.1-93	<3 (MPN g ⁻¹)
Supermarkets	155	1.29	11-20	
Traditional markets	335	11.64	3.0 to >1100	

The number of *Escherichia-E. coli* of mackerel samples (Table 3) showed that their contamination has occurred from at the landing side (3,0--75 MPN.g⁻¹) and continued to increase during distribution (>1100 in traditional markets). Contamination This indicated indicates that there were contamination and poor hygiene practices during handling.- The poor hygiene of equipment and environment in all stages of distribution (fishing vessel, landing side, fish auction, wholesales, and traditional markets), the lack of some hygiene facilities, as well as the poor application of cool chain system during handling were the main factor of this contamination. This was also supported by Deni, (2015), stating that the implementation of sanitation and hygiene on boats, cleanliness of handling equipment, and fishermen during fishing was not implemented properly. Indrasari (2020) stated that one of the nine major problems related to coastal areas in Jakarta was were waste or and poor sanitation. Field observation also founddetermined that most of Fish Auction and Traditional Market also have poor hygiene during marketing, due to inadequate drainage and building construction.- Some animals, in particular and other rodents were considered a major source of pathogenic *E. coli* contamination and infection (Jang et al, 2017; Ferens & Hovde, 2011).

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It was also reported that there were a presence of *Escherichia-E. coli* was present in fish sold at some traditional markets in Indonesia, such as cuttlefish and fresh shrimp in Pontianak (Sari & Apridamayanti, 2014), fresh and smoked tuna in North Halmahera (Akerina, 2018), Layang (*Decapterus russelli*) in Palu (Maruka et al, 2017), and tuna in Aceh (Ummammie et al, 2017). The same similar easesituations were also reported in other countries, such as Brazil (Lascowski et al 2013), Nigeria (Eze et al, 2011), and Iraq (Abbas, 2014). *Escherichia-E. coli* is known as one of the most important pathogenic microbial in the field of food quality and safety. Their presence in fish and fishery products for human consumption, is not only a potential disease source, and but also mediates allowed the transfer of antibiotic resistance to humans. In addition, *Escherichia coli* is one of the microbes causing disease for humans through Through the food chain contamination, of food *E. coli*; can and also leads to mass mortality, therefore, it needs attention (Fattahi et al, 2015).

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Conclusion. The participants in the domestic market of Jakarta were in their economic active years. Both males and females participated in fish marketing, although males (57.50%) had a greater proportion than females (42.50%). Fish marketing is the main job and source of the family income of the participants. 41.88% Most of them had a low education level, while 41.88% did not. The distribution chain of fresh fish at the domestic

market in Jakarta, based on the participants included was composed of fishermen, traders, collectors, wholesalers, and retailers/supermarkets, and consumers. Based on the total volatile base - nitrogen level, 100% of mackerel at landing side, fish auction, market, and supermarkets complied with the TVB-N limit, while in the traditional trading site, only 77.91% met the standard. Inappropriate cold chain applications, poor sanitation, and hygiene practices during distribution and selling were the main causes of the decline in fish quality. The *Escherichia coli* contamination of mackerel started from the unloading and increased during marketing. Some efforts needed in Measures are required providing in order to preserve the fish safety and good quality of fish including marketers' training related to Good Handling Practices (GHdP), provision of supporting facilities for maintenance during distribution and marketing, as well as monitoring the fresh fish compliance standard and to the safety standards, when necessary by enforcement regulation of fresh fish regularly from the authorized government initiated by the authorities.

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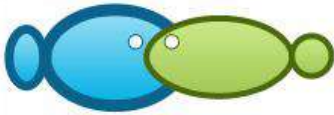
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Marketing system, quality and safety characteristics of mackerel (*Rastrelliger sp.*) at the domestic market in Jakarta

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Abstract. Fish is a highly perishable food, which needs proper maintenance during distribution and marketing, to provide a good quality product to consumers. This study aims to identify the distribution chains of fresh fish and, the socio-economic characteristics of participants, namely fishermen and retailers, and also to analyze the quality and safety of mackerel throughout the domestic distribution process. ~~‡~~ The study was conducted at the domestic fish market in Jakarta, Indonesia. The intermediaries involved in distribution and marketing, ~~involved intermediaries, which were play an~~ important role for in fish product delivery to customers. The distribution chain data were collected from retailers through a survey using a questionnaire combined with an interview. Quality characteristics of fish were ~~conducted~~ determined by taking the same type of samples from 56 locations, including fish landing, auction, wholesales, supermarkets, and traditional markets. Based on market participants, the distribution chain consisted of fishermen, traders, collectors, wholesalers, and retailers/supermarkets, ~~and consumers~~. The results indicated that majority of the market participants were males, at the productive age, and fish capture, marketing and distribution was their main job, with a low level of education. Based on the total volatile base nitrogen (TVB-N) content, all the fish transported from the landing location to the supermarket complied with the quality standard, while in the traditional trading site 22.09% exceeded the maximum limit. In terms of food safety characteristics, mackerels were contaminated with pathogenic *Escherichia coli* from fish auction and the contamination level increased during distribution. The presence of ~~this~~ these bacteria was mainly due to poor hygiene practices during handling.

Key Words: distribution, quality, total volatile bases, *Escherichia coli*.

Introduction. The provision of fish to consumers from the production center, require marketing, distribution, and maintenance to keep the quality and safety of the product. This also help in sustaining the economic system in Jakarta, the capital city of Indonesia, making it a trading center for various goods, especially fisheries. The increasing demand for fish products was probably due to its great advantages compared to other foodstuffs. According to Albert & Marc (2013), it is the most nutritious and healthiest food ingredient with high protein and low-fat content. It is also reported by Ström et al (2011), that it is a very important food ingredient and a source of essential amino and unsaturated fatty acids,

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vitamins, and minerals. ~~Besides~~However, it is a highly perishable commodity, and its quality deteriorates very rapidly. Therefore, its quality is affected when stored for human consumption for a long time, and ~~required~~requires some efforts to be preserved during distribution and marketing.

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According to DGCF (2016), fish production in Jakarta was dominated by small (30%) and large ~~pelagic~~(25%), ~~pelagic fish~~, mollusks (27%), demersal ~~fish~~ (16%), crustaceans and reef ~~fish~~ 1% each. Among the small pelagic ~~fish~~, mackerel (*Rastrelliger* sp.) is the most ~~consumers~~ preferred ~~by consumers~~ fish in Jakarta community (Ministry of Marine and Fisheries, 2018). Therefore, its quality and safety ~~related topics~~ need ~~to be~~special consideration ~~and maintained during distribution and marketing~~.

Accurate and comprehensive data regarding the quality and safety of fresh mackerel, during distribution and marketing at the domestic market in Jakarta are not available. Therefore, it is necessary to identify the marketing system, as well as the quality and safety of mackerel in the distribution chain. This is a preliminary study aimed to improve the quality and safety of fish, and also ~~in monitoring~~ the distribution ~~monitoring~~, in order to provide good quality in the domestic market.

Material and Method

Study site and period. This study was conducted for a period of four months, from March to June 2019, at domestic markets in Jakarta. The marketing and distribution chain started from ~~a~~fishing vessels, auction ~~places~~, wholesales ~~stores~~, supermarkets, and traditional trading sites (Figure 1).

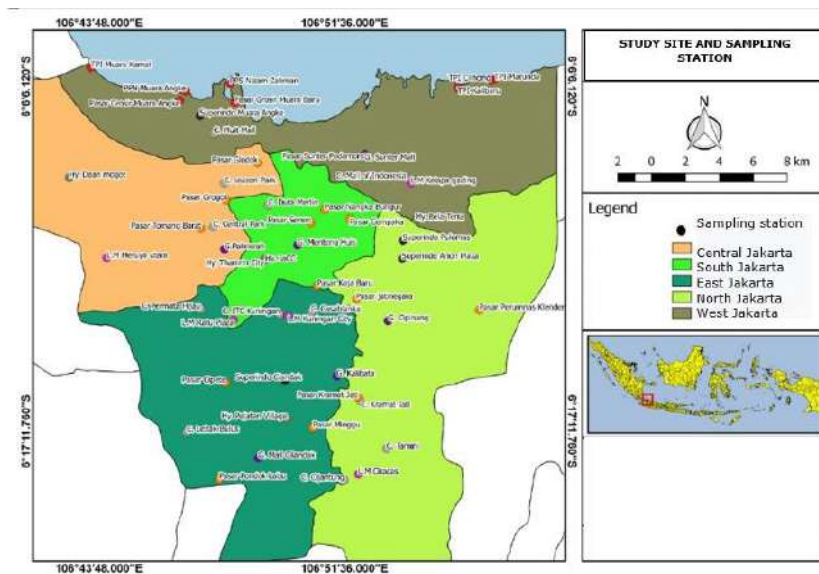


Figure 1. Study side and sampling location.

Material and Method

Material. The materials used were mackerel, ice, ~~some chemicals~~ for *Escherichia coli* analysis and Total Volatile Bases (TVB) assessment, include *Lauryl Triptose Broth*, *EC Broth*, *L-EMB agar*, Tryptone, *Methyl red Voges-Proskauer medium* and *Citrat Agar* ~~and Total Volatile Bases (TVB) assessment~~, *Perklorat Acid (PCA) 6%*, *Phenolftalein indicator*, *anti-foaming silikon*, *NAOH 20%*, *H₃BO₄ 3%*, and *HCl 0,02 N*. The equipment used included ~~a~~

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scale at 0.001 gr of accuracy (Metler Toledo), a Stomacher homogeniser (Interscience), filter paper (Whatman), distillation sets (Foss), incubator (Thermo scientific), autoclave (Chemoto scientific), waterbath (Thermo scientific), oven (Thermo scientific), glassware (pyrex), and micropipette (Eppendorf).

Research methods. This study used a survey, interviews, and laboratory testing methods. The respondents were 50 fishermen and 270 market participants, including 30 collectors, 60 wholesalers, 5 agents, 3 restaurant owners, 32 quality supervisors at supermarkets, and 140 retailers at traditional markets. For quality and safety testing, 790 samples in total, were obtained from 5 landing side locations (150 samples), 3 fish auction and 2 wholesale markets (150 samples), 32 supermarkets (155 samples), and 14 traditional markets (335 samples). The locations were determined based on random sampling which proportionally represented all districts in Jakarta. The fish samples were placed in a cool box, preserved with crushed ice at a ratio of 1:1 (Wiranata et al 2017-8; Panai et al-7 2013). The samples were then taken to the laboratory for further analysis.

Marketing system. The survey involved interviews, and the study areas were inspected in terms of identifying the fish distribution chain, as well as the socio-economic characteristics of market participants.

Quality and safety characteristics. The quality of mackerel (*Rastrelliger sp.*) was determined by the Total Volatile Bases Nitrogen (TVB-N) analysis, while its safety characteristics were determined by the presence of pathogenic *E. coli*. The TVB-N was analyzed using the Kjeldhal distillation method, based on Indonesia National Standard 2354.8:-2009 (Sepka et al- 2017). The extract was prepared by mixing 10 grams of the sample with 90 ml of 6% pPerchloric acid (PCA), and was homogenized for 2 minutes. The blend was then filtered using Whatman no 1 filter paper to obtain a clear extract. Then, 50 ml of the extract was pipetted into the distillation tube and added a few drops of phenolphthalein indicator and anti-foaming silicone, and placed in the distillation flask. Then, distillation commenced, while 30 ml of 10% NaOH and 100 ml of distilled water were added to the flask. The steam distillate was collected in a flask containing 100 ml of 3% boric acid together with 3 to 5 few drops of indicators. The steam distillation procedure was continued until 200 ml of green color distillate was collected in a flask. The blank correction was determined by the steam distillation of 50 ml of distilled water sample, instead of the extract. The green color distillate was titrated with 0.02N Hydrochloric acid using a burette until the green color solution turned pink.- The result was calculated and expressed in mg- TVB-N 100 g⁻¹ of fish.

$$TVB-N (mg-N/100g^{-1}) = (Vs - Vb) \times N.HCl \times 14.007 \times \frac{1}{df} \times 100 \times 10^{-1} \text{ (Sepka et al 2017)}$$

Where:

Vs = volume of Hydrochloric acid for sample titration;

Vb = volume of Hydrochloric acid for blank titration;

Fb-df = dilution factor.

E. coli analysis was carried out using a 3-tube Most Probable Probable Number (MPN) with a 3-tube series method, based on Indonesian National Standard 2332.1:-2015 (Sutiknowati, 2016) which included presumptive, confirmed, isolation, morphological, and biochemical tests. The MPN value was determined according to the number of positive tubes, and compared to MPN-index-table (Blodgett 2010) FDA, 2010). The number of pathogenic *E. coli* bacteria in the sample were expressed in MPN /gr⁻¹.

Data analysis. The descriptive statistical statistics was were used to analyze the data obtained, presented in percentage, and they were displayed as percentages in tables and in graphs using the Microsoft Excel program. The distribution chains were also displayed by represented by diagrams based on the market participants involved.

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Results and Discussion

Fishery production. Fishery production in Jakarta fluctuates every year, as shown in (Figure 2:). ~~The data showed that~~ only 3.63% of Jakarta fisheries production ~~were was~~ obtained through aquaculture, while 96.37% ~~wasere~~ captured. Between 2012 and 2015, the ~~increasing rate~~ of fish production ~~rate increase~~ was about 10.18%, while in 2016, it decreased ~~to with about~~ 49.94% ~~from, compared to~~ the previous year, ~~then it and lightly decreased increased~~ until 2018. This decrease in production occurred both in aquaculture and capture fisheries. ~~This was~~ probably due to the Jakarta Bay reclamation program, and the enforcement of several ~~regulations related to the fisheries activity regulations~~. According to Puspasari ~~R.~~ et al (2017), the Jakarta Bay reclamation ~~has had~~ an impact on ~~the aquatic environmental conditions, such as decreases water clarity, decreases the diversity of phytoplankton and macro zoobenthos, decreases fish production due to eliminating some fishing areas.~~ In addition, ~~Mustaruddin et al (2020) said that while the~~ reduction of the fishing area ~~due to the fishing ground pollution has an impact caused on decreasing the significantly reduced of the production rate decrease to~~ 82.2 ~~thousands of metric tonnes/ year~~¹. ~~Also, the fishing ground pollution significantly reduced the production rate in Jakarta Bay (Mustaruddin et al 2020). This was also supported by~~ Wiryawan et al. (2013), ~~stating state that in 2012, the estimation of lost the fishing grounds area due to, affected by reclamation in 2012 was about 1,527.34 Haha.~~ From 2012 to 2014, the area was concentrated along the Jakarta Bay (Wagiyo et al 2016; & Wiryawan et al 2013), and in 2016, ~~the reclamation area was extended it was moved to the southern part of Seribu Island (Puspasari R. et al 2017).~~ ~~The enforcement of several fisheries regulations, such as the prohibition of using some fishing gear (trawl and seine nets), the interdiction confinement to catch some species (spawning lobsters, crabs, blue swimming crabs), and the licensing suspension of some certain types fishing vessels affected fisheries production.~~ In tuna production, for example, the volume of tuna exports decreased by 16% from October ~~to~~ December 2014, since the enforcement of Regulation No- 56/2014. (Arthatiani ~~F.Y~~ & Apriliani ~~F~~ 2015).

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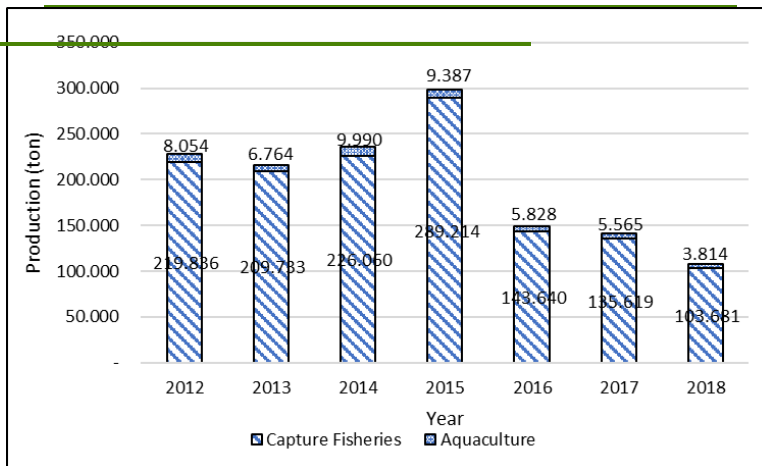
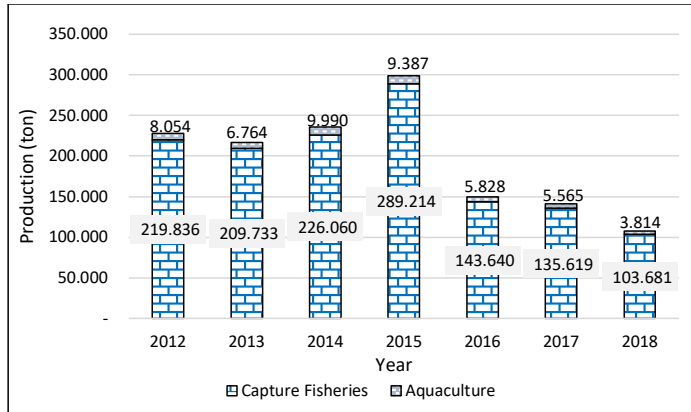


Figure 2. Jakarta fisheries production 2012-2018. (Source: <https://satudata.kkp.go.id>)

Socio-economic characteristics of market participants. Fish marketing practices in Jakarta domestic market were performed by several institutions and participants, which included fishermen, brokers, collectors, wholesalers, restaurant owners, supermarkets, and retailers. The socio-economic characteristics of the market participants, which included their age, gender, marital status, educational level, marketing experience, and knowledge of Good Handling Practices (GHdP) were presented in Table 1.

Table 1 shows that the majority (68.75%) of the participants were within the age of 41-60 years, followed by those between 31-40 (21.88%), under 30 (7.81%), and those above 60 years. It was found that most of the market participants were in their economic active years, between 15-64 years (BPS 2018). According to Farikha and Ardyanto (2016), the economic active years produced generated a high productivity. The table further showed that male respondents have a greater proportion of the market participants (57.50%) compared to females (42.50%). This ratio very different result was different with were reported in frozen fish marketing in Owerri Municipal Nigeria as different with market participants in Adamawa State, Nigeria, with the same comparison of male and female (Madugu & Edward 2011), while in Benue State, that 93.33% of the marketers were female (Esiobu & Onubuogu, 2014) (Lawal and Idega 2004), and also also in Oyo State that 85% of the marketers were female (Ayanboye et al 2015).

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However, ~~this the current study~~ indicated that both males and females participated in fish marketing. This was also supported by (Harper et al (,7-2013) that Williams and & Awoyemi (1998) that women's involvement in fisheries was widespread throughout the world. Their roles range from catching and processing fish, to the sale and finance aspects of this industry.

~~in coastal areas, women also perform other types of earnings to supplement the household income.~~

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Table 1

Socio-economic characteristics of market participants

<i>Socio-economic variables</i>	<i>Frequency</i>	<i>Percentage (%)</i>
Age		
< 30	25	7.81
31-40	70	21.88
41-50	111	34.69
51-60	109	34.06
>60	5	1.56
Total	320	100
Sex		
Male	184	57.50
Female	136	42.50
Total	320	100
Marital status		
Married	307	95.94
Single	13	4.06
Total	320	100
Education		
No formal education to primary education	134	41.88
Secondary education	99	30.94
Tertiary education	69	21.56
Diploma/graduated	18	5.63
Total	320	100
Marketing experience (Year)		
≤10	88	27.50
10-20	126	39.38
20-30	89	27.81
>30	17	5.31
Total	320	100
Job status		
Main job	320	100
Side job	0	0
Total	320	100
GHP knowledge		
Good	57	17.81
Fair	108	33.75
Poor	155	48.44
Total	320	100

The data showed that 95.94% of the market participants were married, while 4.06% were single, and all the respondents (100%) stated that selling fish was their main occupation and source of family income. About 41.88% of the market participants in the domestic market in Jakarta did not have any formal education, 30.94% attended junior high school,

21.56% attended senior high school, and 5.63 % attended a diploma level of education. Therefore, most of the market participants have a low education level. The same result was also recorded by Robin et al (2018), which stated that the education level of fishermen in some coastal areas in Jakarta was very low. Although some respondents answered that education is not an essential subject for fish marketing, rather than to adapt and be familiar with the new technology. This corroborated the report of Madugu & Edward; (2011), which stated that a low education level indicated low literacy skills of market participants. Furthermore, [Triyanti and Shafitri, \(2012\)](#), [Triyanti and Shafitri \(2012\)](#) also stated that a low education level was the major reason for the slow adoption of new technology. The same statement was also made by Dongondaji (2010) that literacy has a positive influence on adopting the technology. ~~Most Those with of the respondents (39.38%) had a~~ marketing experience between 10-20 years ~~were the most (39.38%)~~, followed by 27.81% with 20-30 years, 27.50% with less than 10 years, and 5.31% with more than 30 years. According to Putri (2016), working experience has a positive effect on productivity, and it indirectly increases profitability (Sri Muliani & Suresmiathi 2015). ~~This was also in line with~~ Ali et al (2008), ~~stating state~~ that marketing experience affects participants' profit, ~~the more the experience, the more they through a better~~ understanding of the system, condition, trends, and prices. ~~In terms of knowledge of GHdP, Findings further showed that~~ 48.44% of the participants in Jakarta had a poor level knowledge of Good Handling Practices (GHdP), while 33.75 % had fair level and only a few (17.81%) had good knowledge of GHdP.

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~~All As a these major implied implication, that~~ the majority of the market participants had ~~less a lower~~ knowledge level on how to keep fish in good condition. ~~This was~~ due to the low levels of education level and the lack of training obtained, while Fish fish is the one of the most perishable foods, and the knowledge to maintain its quality maintenance is essential. According to Lusianawaty and Ghani (2015), education and training increase knowledge and skills, which influence personal behavior.

Distribution chain. The distribution chain ~~can be described by a sequence of operators, describes the sequence of markets, which product passes through, from production producers to the final consumers~~ (Apituley et al 2013). In this study, the fresh fish distribution chain was relatively short. ~~There were six places or with only six categories of~~ market participants where fresh fish reached before the final consumer, such as: collectors, suppliers, wholesalers, retailers, restaurants, and supermarkets. ~~The distribution chain of fresh fish in the domestic market, based on the organization or person involved was shown as shown~~ in Figure 2.

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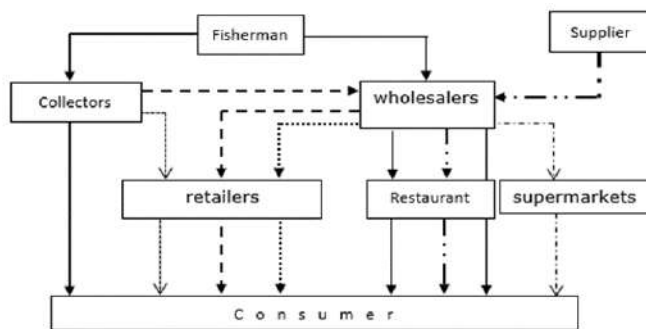


Figure 2. Fish distribution chain at the domestic market in Jakarta.

The main source of fresh fish for domestic consumption in Jakarta are the local fishermen and the suppliers, from other provinces, such as Lampung, Banten, West Java, and some regions in Central Java. Most fresh fish from local fishermen were marketed through collectors, while those from other regions were traded through the Muara Angke Market and on the Modern Market, located in Nizam Zachman Fishing Port. Figure 2

~~showed~~ shows that collectors bought fish directly only from fishermen, while wholesalers obtained it both from fishermen and suppliers. Therefore, fish sold to retailers, restaurant owners, and supermarkets, and are finally ~~get delivered~~ to the consumers. Collectors have a dominant part in domestic fish marketing. ~~This was because of the cooperation between them and, due to their closer cooperation with~~ fishermen, ~~such as involving~~ capital assistance ~~from collectors. However, consequently they conserve~~ fishermen have ~~to contractual privileges sell on~~ the catch to them as a consequence. ~~No~~ In absence of fixed ~~established~~ fish distribution chains ~~was found, therefore, they are formed naturally by the existence of~~ cooperation and agreements between market participants ~~are prevalent~~. The ~~consideration of selecting~~ selection of the distribution chain by ~~the~~ market participants was influenced by many factors, ~~essentially related to the mutual satisfaction of their requirements~~, such as: limitations of business capital, transportation ~~capacity~~, and storage facilities, ~~as well as their mutual need. This was supported by Hanafiah and Saefuddin (1986) stating~~ state that several aspects affecting the distribution chain of fishery products are the company's financial position, production scale, product nature, and the location to the final consumer.

Quality and safety characteristics

Total Volatile Bases (TVB) analysis analyses. Total Volatile Bases (TVB) is a group of biogenic amines formed in non-fermented food products during storage, due to ~~protein enzymatic and bacterial protein~~ degradation ~~by the activity of the enzyme and bacterial~~ (Zeitsev et al 1969). Therefore, TVB levels are the most widely used indicator for the chemical assessment of marine fish spoilage (Zhong-yi et al 2010 & Amegovu et al 2012). The higher the TVB level, the worse the fish quality. According to Connell (1995), an acceptable limit of the total volatile base - nitrogen for fish is 30 mg /100 g⁻¹ muscle. However, Soekarto (1990) recommended TVB-N levels of 10 mg N /100 g⁻¹ or less for very fresh fish, 10-20 mg N /100 g⁻¹ for fresh fish, with 20–30 mg /100 g⁻¹ as a maximum limit for consumption, ~~and resulting that levels over 30 mg /100 g⁻¹ correspond for to~~ ~~spoilt~~ spoiled fish. The average range of TVB-N and the percentage of samples complied with TVB-N level during distribution were presented in Table 2.

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Table 2
Range, average, and percentage of samples complied with TVB-N level

Distribution chains	Range of TVB (mg N 100 g ⁻¹)	Average of TVB (mg N 100 g ⁻¹)	% of sample complied with TVB-N level
Fish landing	8.17-15.92	12.19±2.23	100
Fish auction	9.19-17.91	12.87±2.84	100
Wholesale	10.11-24.09	16.83±3.50	100
Supermarkets	13.02-23.98	18.89±2.29	100
Traditional markets	10.63-44.49	23.16±5.89	77.91

Based on the total volatile base - nitrogen level, Table 2 shows that 100% of mackerel on the landing side, fish auction market, and supermarkets, complied with TVB-N standard limit. ~~While~~ in the traditional trading site only 77.91% complied with the standard limit. The quality of mackerel during marketing tends to decrease as the TVB level ~~increased~~ increases, especially in traditional markets. Generally, mackerel on the landing side and fish auction were within the ~~limits of~~ very fresh to fresh quality (8.17-17.91 mg N 100 g⁻¹), those on wholesale and supermarkets were within the ~~range of~~ fresh to a maximum limit for consumption (10.11–24.09 mg N 100 g⁻¹), while those on traditional markets were within the fresh quality to spoiled (10.63-44.49 mg N 100 g⁻¹). ~~This was supported by~~ Deni (2015) also found, stating that fishes ~~traded~~ obtained at auction ~~places were~~ was in the category of fresh. Connell JJ (1980) also stated ~~indicated~~ that the TVB-N level of fresh fish ~~caught~~ was ranges between 5-20 mg N 100 g⁻¹.

Quality loss in the traditional market was due to poor ~~hygiene in handling~~ and ~~unhygienic~~ conditions ~~of, including~~ equipment and location ~~affecting~~ bacterial

contamination growth. There ~~was is~~ a direct proportionality relationship between the bacterial load and TVB-N value, ~~the total volatile base nitrogen value increases with higher bacterial load~~ (Immaculate & Jamila, 2018). ~~This was in line with~~ (Baldwin, 1961), ~~stating stated~~ that the ~~Hydrolysis hydrolysis~~ of protein and other nitrogenous compounds by autolytic enzyme, together with bacterial action, leads to an increased total volatile base - nitrogen value. The poor handling and low awareness of marketer ~~relating to the implement~~ cold chain implementation in traditional markets was also reported in Malawi (Kapute et al 2012) and Sri Lanka (Jinadasa, 2014). ~~This was indicated that t~~he lack of cold chain applications, especially in traditional markets, was a major problem in some countries. Despite that all the samples from supermarkets relatively comply complied with the TVB-N level, some samples have been rejected by sensory analysis due to poor appearance and texture. The same result was reported by Genç et al (2013) for meagre fillets, which were already unacceptable after 8 days, in terms of off-odors, ~~however, even if~~ their TVB-N content was within the regulated levels. ~~This was supported by~~ Tejada & Huidobro, (2002), ~~stating stated~~ that TVB-N, ~~which is although being appropriate and the most~~ widely used as a legal chemical indicator of seafood spoilage, ~~is appropriate, it is~~ however, ~~is~~ an inadequate sign of quality during the initial stages of fish damage.

In this study, most of the fish marketed ~~in at~~ the traditional trading sites ~~was were~~ kept without ice during ~~display the sales operations, at temperatures ranging from and was~~ between $22.3 \pm 3.4^{\circ}\text{C}$ to $25.2 \pm 0.8^{\circ}\text{C}$. According to Ola & Oladipo (2004), fish ~~spoiled faster kept~~ at ambient temperature ~~spoiled rapidly than those~~ in the chilling container. Maintaining the quality of fresh fish was carried out ~~through in~~ various methods, however, according to ~~(Ghaly et al (2010) and Adawyah (2014), that the most~~ ideal method was ~~to keep their preservation~~ at chilling temperature. ~~Therefore, in order to delay the~~ bacteria growth of spoilage bacteria and biochemical processes, ~~which was mainly caused by ing~~ quality deterioration ~~was delayed at low temperatures (Adawyah R, 2014).~~

Furthermore, Ariyani et al, (2008), stated that at $0-6^{\circ}\text{C}$, microorganisms and enzymes activity were retarded. It was also reported that there were significant quality differences between fish stored at cold temperatures compared to those stored in ambient, such as spotted grunter (Osibona AO and MO Ezekiel, 2014), tilapia (Makawa ~~et al Z,~~ 2014), and ~~various other~~ fish species (Immaculate & Jamila, 2018).

According to Soekarto, (1990), 15% of mackerel obtained in the distribution chain were very fresh, 47% were fresh, 28% were fit for consumption and 10% were spoilt (Figure 3). All the spoilt fish were found in traditional markets.

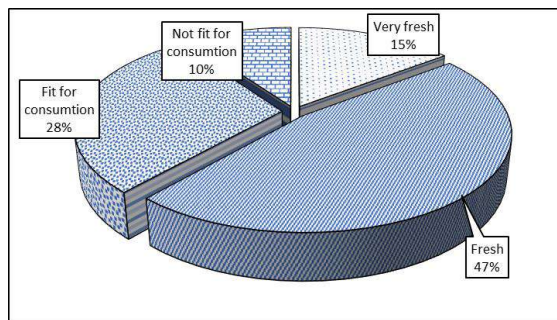


Figure 3. Freshness level of mackerel during distribution.

Escherichia coli analysis. *Escherichia E. coli* is an organism that typically colonizes the intestinal tract of warm-blooded animals, including humans (Cooke & Ewins, 1975), ~~& Melliawati R, 2009), and being~~ the most affluent anaerobe bacteria of the intestinal microflora (Kaper et al 2004). The presence of *E. coli* in water and food is a strong indication of recent sewage or animal fecal contamination, because of poor hygiene practices during handling (Sutiknowati, 2016; ~~& Kim et al et al & , 2017~~). Also, this bacterium has long been considered as an indicator of recent fecal pollution in food and

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environment water. Some strains of *Escherichia-E. coli* cause diseases, such as diarrhea, indigestion, and dysentery (Made & Dwipayanti, 2010; & Wong et al., 2012). Besides as an indicator of poor hygiene practices during handling, *Escherichia-E. coli* was also used as a food safety indicator. The total of *Escherichia-E. coli* in mackerel samples, expressed in Most Probable Number per gram (MPN_g⁻¹) was shown in Table 3.

Table 3
Number of *Escherichia coli* of mackerel samples

Distribution chains	Total sample	% of the positive sample	Number of <i>Escherichia coli</i> (MPN g ⁻¹)	Standard (BSN 2013)
Fish Landing	150	12.67	3.0-75	
Fish auction	90	18.89	3.0-120	
Wholesale	60	11.67	6.1-93	<3 (MPN g ⁻¹)
Supermarkets	155	1.29	11-20	
Traditional markets	335	11.64	3.0 to >1100	

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The number of *Escherichia-E. coli* of mackerel samples (Table 3) showed that their contamination has occurred from at the landing side (3,0---75 MPN_g⁻¹) and continued to increase during distribution (>1100 in traditional markets). Contamination This indicated indicates that there were contamination and poor hygiene practices during handling.- The poor hygiene of equipment and environment in all stages of distribution (fishing vessel, landing side, fish auction, wholesales, and traditional markets), the lack of some hygiene facilities, as well as the poor application of cool chain system during handling were the main factor of this contamination. This was also supported by Deni, (2015), stating that the implementation of sanitation and hygiene on boats, cleanliness of handling equipment, and fishermen during fishing was not implemented properly. Indrasari (2020) stated that one of the ~~five~~ major problems related to coastal areas in Jakarta ~~was were~~ waste ~~or and~~ poor sanitation, which was a source of *E. coli* contamination for fish during landing and marketing in the auction.- Field observation ~~also found~~ determined that most of Fish Auction and Traditional Market also have poor hygiene during marketing, due to inadequate drainage and building construction.- Some animals, in particular ~~and other~~ rodents were considered a major source of pathogenic *E. coli* contamination and infection (Jang et al., 2017, Ferens & Hovde, 2011).

It was also reported that ~~there were a presence of~~ *Escherichia-E. coli* was present in fish sold at some traditional markets in Indonesia, such as cuttlefish and fresh shrimp in Pontianak (Sari & Apridamayanti, 2014), fresh and smoked tuna in North Halmahera (Akerina, 2018), Layang (*Decapterus russelli*) in Palu (Maruka et al., 2017), and tuna in Aceh (Ummamie et al., 2017). The ~~same similar cases situations~~ were also reported in other countries, such as Brazil (Lascowski et al 2013), Nigeria (Eze et al., 2011), and Iraq (Abbas, 2014). *Escherichia-E. coli* is known as one of the most important pathogenic microbial in the field of food quality and safety. Their presence in fish and fishery products for human consumption, ~~is~~ not only a potential disease source, ~~and but~~ also ~~mediates allowed~~ the transfer of antibiotic resistance to humans. ~~In addition, Escherichia coli is one of the microbes causing disease for humans through~~ Through the food chain contamination, ~~of food E. coli, can and also leads to mass mortality, therefore, it needs attention~~ (Fattahi et al., 2015).

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Conclusion. The participants in the domestic market of Jakarta were in their economic active years. Both males and females participated in fish marketing, although males (57.50%) had a greater proportion than females (42.50%). Fish marketing is the main job and source of the family income of the participants. 41.88% ~~Most~~ of them had a low education level, ~~while 41.88% did not~~. The distribution chain of fresh fish at the domestic market in Jakarta, ~~based on the participants included was composed of~~ fishermen, traders, collectors, wholesalers, ~~and~~ retailers/supermarkets, ~~and consumers~~. Based on the total volatile base - nitrogen level, 100% of mackerel at landing side, fish auction, market, and supermarkets complied with the TVB-N limit, while in the traditional trading site, only

77.91% met the standard. Inappropriate cold chain applications, poor sanitation, and hygiene practices during distribution and selling were the main causes of the decline in fish quality. The *Escherichia coli* contamination of mackerel started from the unloading and increased during marketing. ~~Some efforts needed in~~ Measures are required providing in order to preserve the fish safety and good quality, of fish-includ ~~ing~~ ing ~~marketers'~~ training related to Good Handling Practices (GHdP), provision of supporting facilities for maintenance during distribution and marketing, as well as monitoring the fresh fish compliance standard and to the safety standards, when necessary by enforcement regulation of fresh fish regularly from the authorized government initiated by the authorities.

Acknowledgements. ~~Our gratitude~~ The authors would like to thank to the Ministry of Marine Affairs and Fisheries, which supported the research through ~~the a~~ a scholarship program. We are ~~delightful~~ delighted to acknowledge all the ~~laboratory~~ laboratory ~~laboratory~~ laboratories, and also ~~my~~ the ~~students,~~ students, for their ~~help~~ precious contribution.

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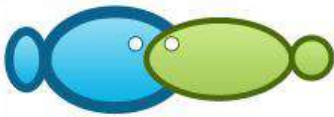
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Marketing system, quality and safety characteristics of mackerel (*Rastrelliger sp.*) at the domestic market in Jakarta

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Abstract. Fish is a highly perishable food, which needs proper maintenance during distribution and marketing, to provide a good quality product to consumers. This study aims to identify the distribution chains of fresh fish and the socio-economic characteristics of participants, namely fishermen and retailers, and also to analyze the quality and safety of mackerel throughout the domestic distribution process. The study was conducted at the domestic fish market in Jakarta, Indonesia. The intermediaries involved in distribution and marketing, play an important role in fish product delivery to customers. The distribution chain data were collected from retailers through a survey using a questionnaire combined with an interview. Quality characteristics of fish were determined by taking the same type of samples from 56 locations, including fish landing, auction, wholesales, supermarkets and traditional markets. Based on market participants, the distribution chain consisted of fishermen, traders, collectors, wholesalers, and retailers/supermarkets. The results indicated that majority of the market participants were males at the productive age and fish capture, marketing and distribution was their main job, with a low level of education. Based on the total volatile base nitrogen (TVB-N) content, all the fish transported from the landing location to the supermarket complied with the quality standard, while in the traditional trading site 22.09% exceeded the maximum limit. In terms of food safety characteristics, mackerels were contaminated with pathogenic *Escherichia coli* from fish auction and the contamination level increased during distribution. The presence of these bacteria was mainly due to poor hygiene practices during handling.

Key Words: distribution, quality, total volatile bases, *Escherichia coli*.

Introduction. The provision of fish to consumers from the production center, require marketing, distribution and maintenance to keep the quality and safety of the product. This also help in sustaining the economic system in Jakarta, the capital city of Indonesia, making it a trading center for various goods, especially fisheries. The increasing demand for fish products was probably due to its great advantages compared to other foodstuffs. According to Albert & Marc (2013), it is the most nutritious and healthiest food ingredient with high protein and low-fat content. It is also reported by Ström et al (2011), that it is a very important food ingredient and a source of essential amino and unsaturated fatty acids, vitamins, and minerals. However, it is a highly perishable commodity and its

quality deteriorates very rapidly. Therefore, its quality is affected when stored for human consumption for a long time, and requires some efforts to be preserved during distribution and marketing.

According to DGCF (2016), fish production in Jakarta was dominated by small (30%) and large (25%) pelagic fish, mollusks (27%), demersal fish (16%), crustaceans and reef fish 1%. Among the small pelagic fish, mackerel (*Rastrelliger* sp.) is the most preferred by consumers in Jakarta community (Ministry of Marine and Fisheries, 2018). Therefore, its quality and safety related topics need special consideration.

Accurate and comprehensive data regarding the quality and safety of fresh mackerel, during distribution and marketing at the domestic market in Jakarta are not available. Therefore, it is necessary to identify the marketing system, as well as the quality and safety of mackerel in the distribution chain. This is a preliminary study aimed to improve the quality and safety of fish, and also the distribution monitoring, in order to provide good quality in the domestic market.

Material and Method

Study site and period. This study was conducted for a period of four months, from March to June 2019, at domestic markets in Jakarta. The marketing and distribution chain started from fishing vessels, auction places, wholesale stores, supermarkets and traditional trading sites (Figure 1).

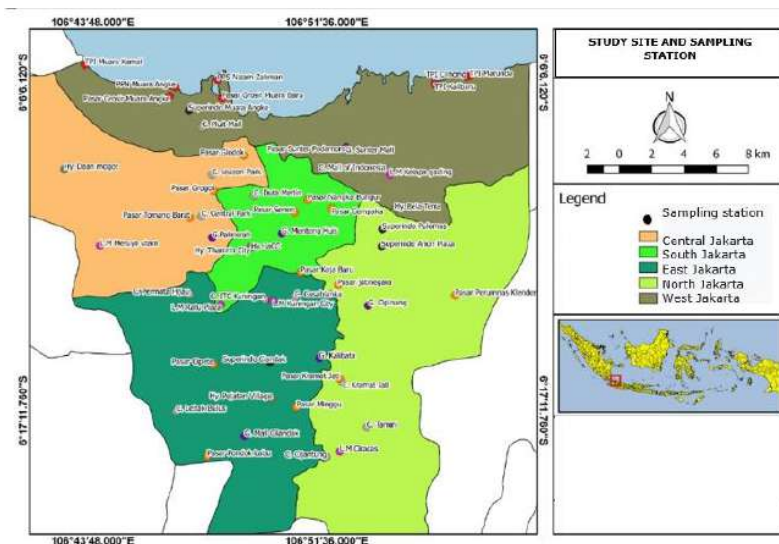


Figure 1. Study site and sampling location.

Material and Method

Material. The materials used were mackerel, ice, some chemicals for *Escherichia coli* analysis and Total Volatile Bases (TVB) assessment, include *Lauryl triptose broth*, EC Broth, *L-EMB agar*, Tryptone, *Methyl red* Voges-Proskauer medium and Citrat Agar, Perchlorat Acid (PCA) 6%, Phenolftalein indicator, anti-foaming silicon, NaOH 20%, H₃BO₄ 3%, and HCl 0,02 N. The equipment used included a scale at 0.001 gr of accuracy (Metler Toledo), a Stomacher homogenizer (Interscience), filter paper (Whatman), distillation sets (Foss), incubator (Thermo scientific), autoclave (Chemoto scientific), water bath (Thermo scientific), oven (Thermo scientific), glassware (pyrex), and micropipette (Eppendorf).

Research methods. This study used a survey, interviews and laboratory testing methods. The respondents were 50 fishermen and 270 market participants, including 30 collectors, 60 wholesalers, 5 agents, 3 restaurant owners, 32 quality supervisors at supermarkets, and 140 retailers at traditional markets. For quality and safety testing, 790 samples in total, were obtained from 5 landing side locations (150 samples), 3 fish auction and 2 wholesale markets (150 samples), 32 supermarkets (155 samples), and 14 traditional markets (335 samples). The locations were determined based on random sampling which proportionally represented all districts in Jakarta. The fish samples were placed in a cool box, preserved with crushed ice at a ratio of 1:1 (Wiranata et al 2017; Panai et al 2013). The samples were then taken to the laboratory for further analysis.

Marketing system. The survey involved interviews, and the study areas were inspected in terms of identifying the fish distribution chain, as well as the socio-economic characteristics of market participants.

Quality and safety characteristics. The quality of *Rastrelliger* sp. was determined by the Total Volatile Bases Nitrogen (TVB-N) analysis, while its safety characteristics were determined by the presence of pathogenic *E. coli*. The TVB-N was analyzed using the Kjeldhal distillation method, based on Indonesia National Standard 2354.8:2009 (Sepka et al 2017). The extract was prepared by mixing 10 grams of the sample with 90 mL of 6% perchloric acid (PCA), and was homogenized for 2 minutes. The blend was then filtered using Whatman no 1 filter paper to obtain a clear extract. Then, 50 mL of the extract was pipetted into the distillation tube and added a few drops of phenolphthalein indicator and anti-foaming silicone, and placed in the distillation flask. Then, distillation commenced, while 30 mL of 10% NaOH and 100 mL of distilled water were added to the flask. The steam distillate was collected in a flask containing 100 mL of 3% boric acid together with 3 to 5 drops of indicators. The steam distillation procedure was continued until 200 mL of green color distillate was collected in a flask. The blank correction was determined by the steam distillation of 50 mL of distilled water sample, instead of the extract. The green color distillate was titrated with 0.02N Hydrochloric acid using a burette until the green color solution turned pink. The result was calculated and expressed in mg TVB-N 100 g⁻¹ of fish (Sepka et al 2017):

$$\text{TVB-N (mg 100g}^{-1}\text{)} = (\text{Vs}-\text{Vb}) \times \text{N.HCl} \times 14.007 \times \text{df} \times 100 \times 10^{-1}$$

Where:

Vs - volume of Hydrochloric acid for sample titration;

Vb - volume of Hydrochloric acid for blank titration;

Df - dilution factor.

E. coli analysis was carried out using a 3-tube Most Probable Number (MPN) method, based on Indonesian National Standard 2332.1:2015 (Sutiknowati 2016) which included presumptive, confirmed, isolation, morphological and biochemical tests. The MPN value was determined according to the number of positive tubes and compared to MPN-index-table (Blodgett 2010). The numbers of pathogenic *E. coli* bacteria in the sample were expressed in MPN gr⁻¹.

Data analysis. The descriptive statistics were used to analyze the data obtained and they were displayed as percentages in tables and in graphs using the Microsoft Excel program. The distribution chains were also represented by diagrams based on the market participants involved.

Results and Discussion

Fishery production. Fishery production in Jakarta fluctuates every year, as shown in Figure 2: only 3.63% of Jakarta fisheries production was obtained through aquaculture, while 96.37% was captured. Between 2012 and 2015, the of fish production rate increase was about 10.18%, while in 2016, it decreased with 49.94%, compared to the previous

year, then it lightly decreased until 2018. This decrease in production occurred both in aquaculture and capture fisheries, probably due to the Jakarta Bay reclamation program, and the enforcement of several regulations related to the fisheries activity. According to Puspasari et al (2017), the Jakarta Bay reclamation had an impact on the aquatic environmental conditions, such as water clarity decrease, the diversity of phytoplankton and macro zoobenthos decrease, fish production decrease due to the elimination of some fishing areas. In addition, Mustaruddin et al (2020) stated that the reduction of the fishing area due to the fishing ground pollution caused the significant reduction of the production rate to 82.2 thousands of metric tons year⁻¹. Wiryawan et al (2013) stated that in 2012, the estimation of lost fishing grounds area due to reclamation was about 1,527.34 ha. From 2012 to 2014, the area was concentrated along the Jakarta Bay (Wagiyo et al 2016; Wiryawan et al 2013) and in 2016 the reclamation area was extended to the southern part of Seribu Island (Puspasari et al 2017). The prohibition of using some fishing gear (trawl and seine nets), the interdiction to catch some species (spawning lobsters, crabs, blue swimming crabs) and the licensing suspension of certain types fishing vessels affected fisheries production. In tuna production, for example, the volume of tuna exports decreased by 16% from October to December 2014, since the enforcement of Regulation No 56/2014 (Arthatiani & Apriliani 2015).

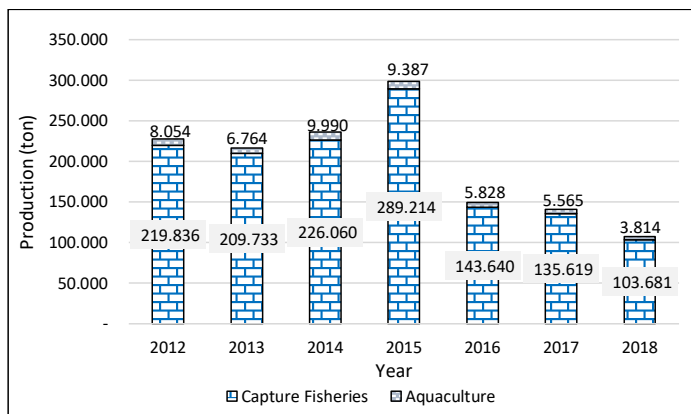


Figure 2. Jakarta fisheries production 2012-2018 (<https://satudata.kkp.go.id>).

Socio-economic characteristics of market participants. Fish marketing practices in Jakarta domestic market were performed by several institutions and participants, which included fishermen, brokers, collectors, wholesalers, restaurant owners, supermarkets and retailers. The socio-economic characteristics of the market participants, which included their age, gender, marital status, educational level, marketing experience, and knowledge of Good Handling Practices (GHdP) were presented in Table 1.

Table 1 shows that the majority (68.75%) of the participants were within the age of 41-60 years, followed by those between 31-40 (21.88%), under 30 (7.81%), and those above 60 years. It was found that most of the market participants were in their economic active years, between 15-64 years (BPS 2018). According to Farikha & Ardyanto (2016), the economic active years generated a high productivity. The table further showed that male respondents have a greater proportion of the market participants (57.50%) compared to females (42.50%). This result was different with frozen fish marketing in Owerri Municipal, Nigeria, that 93.33% of the marketers were female (Esiobu & Onubuogu 2014) and also in Oyo State that 85% of the marketers were female (Ayanboye et al 2015). However, the current study indicated that both males and females participated in fish marketing. This was also supported by Harper et al (2013), that women's involvement in fisheries was widespread throughout the world. Their roles ranged from catching and processing fish to the sale and finance aspects of this industry.

Table 1

Socio-economic characteristics of market participants

<i>Socio-economic variables</i>	<i>Frequency</i>	<i>Percentage (%)</i>
Age		
< 30	25	7.81
31-40	70	21.88
41-50	111	34.69
51-60	109	34.06
>60	5	1.56
Total	320	100
Sex		
Male	184	57.50
Female	136	42.50
Total	320	100
Marital status		
Married	307	95.94
Single	13	4.06
Total	320	100
Education		
No formal education to primary education	134	41.88
Secondary education	99	30.94
Tertiary education	69	21.56
Diploma/graduated	18	5.63
Total	320	100
Marketing experience (Year)		
≤10	88	27.50
10-20	126	39.38
20-30	89	27.81
>30	17	5.31
Total	320	100
Job status		
Main job	320	100
Side job	0	0
Total	320	100
GHdP knowledge		
Good	57	17.81
Fair	108	33.75
Poor	155	48.44
Total	320	100

The data showed that 95.94% of the market participants were married, while 4.06% were single, and all the respondents (100%) stated that selling fish was their main occupation and source of family income. About 41.88% of the market participants in the domestic market in Jakarta did not have any formal education, 30.94% attended junior high school, 21.56% attended senior high school and 5.63 % attended a diploma level of education. Therefore, most of the market participants have a low education level. The same result was also recorded by Robin et al (2018), which stated that the education level of fishermen in some coastal areas in Jakarta was very low. Although some respondents answered that education is not an essential subject for fish marketing, rather than to adapt and be familiar with the new technology. This corroborated the report of Madugu & Edward (2011), which stated that a low education level indicated low literacy skills of market participants. Furthermore, Triyanti & Shafitri (2012) also stated that a low education level was the major reason for the slow adoption of new technology. The same statement was also made by Dongondaji (2010) that literacy has a positive

influence on adopting the technology. Most of the respondents (39.38%) had a marketing experience between 10-20 years, followed by 27.81% with 20-30 years, 27.50% with less than 10 years, and 5.31% with more than 30 years. According to Putri (2016), working experience has a positive effect on productivity, and it indirectly increases profitability (Sri Muliani & Suresmiathi 2015). Ali et al (2008) state that marketing experience affects participants' profit through a better understanding of the system, condition, trends, and prices. In terms of knowledge of GHdP, 48.44% of the participants had a poor level, while 33.75% had fair level and only a few (17.81%) had good.

As a major implication, the majority of the market participants had a lower knowledge level on how to keep fish in good condition, due to the low levels of education and training, while fish is one of the most perishable foods and its quality maintenance is essential. According to Lusianawaty & Ghani (2015), education and training increase knowledge and skills, which influence personal behavior.

Distribution chain. The distribution chain can be described by a sequence of operators, from producers to the final consumers (Apituley et al 2013). In this study, the fresh fish distribution chain was relatively short, with only six categories of market participants before the final consumer, such as: collectors, suppliers, wholesalers, retailers, restaurants, and supermarkets, as shown in Figure 2.

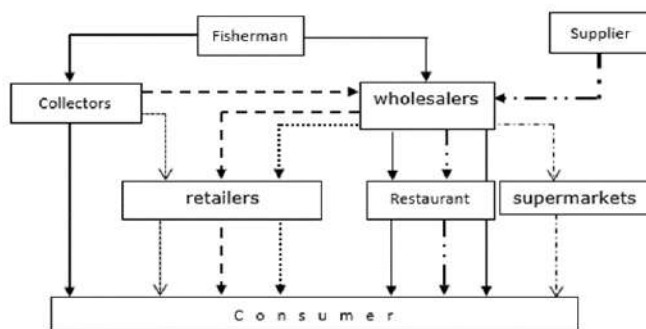


Figure 2. Fish distribution chain at the domestic market in Jakarta.

The main source of fresh fish for domestic consumption in Jakarta are the local fishermen and the suppliers from other provinces, such as Lampung, Banten, West Java and some regions in Central Java. Most fresh fish from local fishermen were marketed through collectors, while those from other regions were traded on the Muara Angke Market and on the Modern Market, located in Nizam Zachman Fishing Port. Figure 2 shows that collectors bought fish directly only from fishermen, while wholesalers obtained it both from fishermen and suppliers. Therefore, fish sold to retailers, restaurant owners, and supermarkets, and are finally delivered to the consumers. Collectors have a dominant part in domestic fish marketing, due to their closer cooperation with fishermen, involving capital assistance, consequently they conserve contractual privileges on the catch. In absence of established fish distribution chains, cooperation and agreements between market participants are prevalent. The selection of the distribution chain by the market participants was influenced by many factors, essentially related to the mutual satisfaction of their requirements, such as: limitations of business capital, transportation capacity and storage facilities. Hanafiah & Saefuddin (1986) state that several aspects affecting the distribution chain of fishery products are the company's financial position, production scale, product nature and the location to the final consumer.

Quality and safety characteristics

Total Volatile Bases (TVB) analysis. Total Volatile Bases (TVB) is a group of biogenic amines formed in non-fermented food products during storage, due to enzymatic and bacterial protein degradation (Zeitsev et al 1969). Therefore, TVB levels are the most widely used indicator for the chemical assessment of marine fish spoilage (Zhong-yi et al 2010; Amegovu et al 2012). The higher the TVB level, the worse the fish quality. According to Connel (1995), an acceptable limit of the total volatile base - nitrogen for fish is 30 mg 100 g⁻¹ muscle. However, Soekarto (1990) recommended TVB-N levels of 10 mg N 100 g⁻¹ or less for very fresh fish, 10-20 mg N 100 g⁻¹ for fresh fish, with 20-30 mg 100 g⁻¹ as a maximum limit for consumption, resulting that levels over 30 mg 100 g⁻¹ correspond to spoiled fish. The average range of TVB-N and the percentage of samples compliant with TVB-N level during distribution were presented in Table 2.

Table 2
Range, average and percentage of samples complied with TVB-N level

<i>Distribution chains</i>	<i>Range of TVB (mg N 100 g⁻¹)</i>	<i>Average of TVB (mg N 100 g⁻¹)</i>	<i>% of sample complied with TVB-N level</i>
Fish landing	8.17-15.92	12.19±2.23	100
Fish auction	9.19-17.91	12.87±2.84	100
Wholesale	10.11-24.09	16.83±3.50	100
Supermarkets	13.02-23.98	18.89±2.29	100
Traditional markets	10.63-44.49	23.16±5.89	77.91

Based on the total volatile base - nitrogen level, Table 2 shows that 100% of mackerel on the landing side, fish auction market and supermarkets complied with TVB-N standard limit, while in the traditional trading site only 77.91% complied with the standard limit. The quality of mackerel during marketing tends to decrease as the TVB level increases, especially in traditional markets. Generally, mackerel on the landing side and fish auction were within the limits of very fresh to fresh quality (8.17-17.91 mg N 100 g⁻¹), those on wholesale and supermarkets were within the range of fresh to maximum limit for consumption (10.11-24.09 mg N 100 g⁻¹), while those on traditional markets were within the fresh quality to spoiled (10.63-44.49 mg N 100 g⁻¹). Deni (2015) also found that fish traded at auction places was in the category of fresh. Connell (1995) indicated that the TVB-N level of fresh fish ranges between 5-20 mg N 100 g⁻¹.

Quality loss in the traditional market was due to poor hygiene in handling conditions, including equipment and location bacterial contamination. There is a direct proportionality relationship between the bacterial load and TVB-N value (Immaculate & Jamila 2018). Baldwin (1961), stated that the hydrolysis of protein and other nitrogenous compounds by autolytic enzyme, together with bacterial action, leads to an increased total volatile base - nitrogen value. The poor handling and low awareness of marketer relating to the cold chain implementation in traditional markets was also reported in Malawi (Kapute et al 2012) and Sri Lanka (Jinadasa 2014). The lack of cold chain applications, especially in traditional markets, was a major problem in some countries. Despite that all the samples from supermarkets relatively complied with the TVB-N level, some samples have been rejected by sensory analysis due to poor appearance and texture. The same result was reported by Genç et al (2013) for meagre fillets, which were already unacceptable after 8 days, in terms of off-odors, even if their TVB-N content was within the regulated levels. Tejada & Huidobro (2002) stated that TVB-N, although being appropriate and widely used as a legal chemical indicator of seafood spoilage, it is however an inadequate sign of quality during the initial stages of fish damage.

In this study, most of the fish marketed at the traditional trading sites were kept without ice during the sales operations, at temperatures ranging from 22.3±3.4°C to 25.2±0.8°C. According to Ola & Oladipo (2004), fish spoiled faster at ambient temperature than in the chilling container. Maintaining the quality of fresh fish was carried out through various methods, however, according to (Ghaly et al 2010), the ideal method was their preservation at chilling temperature, in order to delay bacteria growth and biochemical processes causing quality deterioration (Adawyah 2014).

Furthermore, Ariyani et al (2008), stated that at 0-6°C, microorganisms and enzymes activity were retarded. It was also reported that there were significant quality differences between fish stored at cold temperatures compared to those stored in ambient, such as spotted grunter (Osibona & Ezekiel 2014), tilapia (Makawa 2014) and other fish species (Immaculate & Jamila 2018).

According to Soekarto (1990), 15% of mackerel obtained in the distribution chain were very fresh, 47% were fresh, 28% were fit for consumption and 10% were spoilt (Figure 3). All the spoilt fish were found in traditional markets.

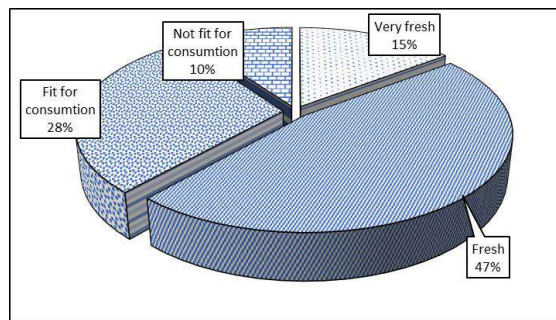


Figure 3. Freshness level of mackerel during distribution.

Escherichia coli analysis. *E. coli* is an organism that typically colonizes the intestinal tract of warm-blooded animals, including humans (Cooke & Ewins 1975; Melliawati 2009), being the most affluent anaerobe bacteria of the intestinal microflora (Kaper et al 2004). The presence of *E. coli* in water and food is a strong indication of recent sewage or animal fecal contamination, because of poor hygiene practices during handling (Sutiknowati 2016; Kim et al 2017). Also, this bacterium has long been considered as an indicator of recent fecal pollution in food and environment water. Some strains of *E. coli* cause diseases, such as diarrhea, indigestion, and dysentery (Made & Dwipayanti 2010; Wong et al 2012). Besides as an indicator of poor hygiene practices during handling, *E. coli* was also used as a food safety indicator. The total of *E. coli* in mackerel samples, expressed in Most Probable Number per gram (MPN g⁻¹) was shown in Table 3.

Table 3

Number of *Escherichia coli* of mackerel samples

Distribution chains	Total sample	% of the positive sample	Number of <i>Escherichia coli</i> (MPN g ⁻¹)	Standard (BSN 2013)
Fish Landing	150	12.67	3.0-75	
Fish auction	90	18.89	3.0-120	
Wholesale	60	11.67	6.1-93	<3 (MPN g ⁻¹)
Supermarkets	155	1.29	11-20	
Traditional markets	335	11.64	3.0 to >1100	

The number of *E. coli* of mackerel samples (Table 3) showed that their contamination has occurred at the landing side (3.0-75 MPN g⁻¹) and continued to increase during distribution (>1100 in traditional markets). Contamination indicates poor hygiene practices during handling. The poor hygiene of equipment and environment in all stages of distribution (fishing vessel, landing side, fish auction, wholesales, and traditional markets), the lack of some hygiene facilities, as well as the poor application of cool chain system during handling were the main factor of this contamination. This was also supported by Deni (2015), stating that the implementation of sanitation and hygiene on boats, cleanliness of handling equipment, and fishermen during fishing was not implemented properly. Indrasari (2020) stated that one of the major problems related to

coastal areas in Jakarta were waste and poor sanitation, which was a source of *E. coli* contamination for fish during landing and marketing in the auction. Field observation determined that most of Fish Auction and Traditional Market also have poor hygiene during marketing, due to inadequate drainage and building construction. Some animals, in particular rodents were considered a major source of pathogenic *E. coli* contamination and infection (Jang et al 2017; Ferens & Hovde 2011).

It was also reported that *E. coli* was present in fish sold at some traditional markets in Indonesia, such as cuttlefish and fresh shrimp in Pontianak (Sari & Apridamayanti 2014), fresh and smoked tuna in North Halmahera (Akerina 2018), Layang (*Decapterus russelli*) in Palu (Maruka et al 2017), and tuna in Aceh (Ummamie et al 2017). The similar situations were also reported in other countries, such as Brazil (Lascowski et al 2013), Nigeria (Eze et al 2011), and Iraq (Abbas 2014). *E. coli* is known as one of the most important pathogenic microbial in the field of food quality and safety. Their presence in fish and fishery products for human consumption is not only a potential disease source, but also mediates the transfer of antibiotic resistance to humans. Through the food chain contamination, *E. coli* can lead to mass mortality (Fattahi et al 2015).

Conclusion. The participants in the domestic market of Jakarta were in their economic active years. Both males and females participated in fish marketing, although males (57.50%) had a greater proportion than females (42.50%). Fish marketing is the main job and source of the family income of the participants. 41.88% of them had a low education level. The distribution chain of fresh fish at the domestic market in Jakarta was composed of fishermen, traders, collectors, wholesalers and retailers/supermarkets. Based on the total volatile base - nitrogen level, 100% of mackerel at landing side, fish auction, market and supermarkets complied with the TVB-N limit, while in the traditional trading site only 77.91% met the standard. Inappropriate cold chain applications, poor sanitation, and hygiene practices during distribution and selling were the main causes of the decline in fish quality. The *Escherichia coli* contamination of mackerel started from the unloading and increased during marketing. Measures are required in order to preserve the fish safety and quality, including training related to GHdP, provision of supporting facilities for maintenance during distribution and marketing, as well as monitoring the fresh fish compliance to the safety standards, when necessary by enforcement regulation initiated by the authorities.

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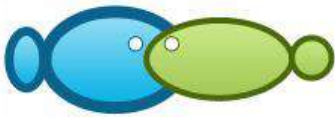
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Marketing system, quality and safety characteristics of mackerel (*Rastrelliger* sp.) at the domestic market in Jakarta

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Abstract. Fish is a highly perishable food, which needs proper maintenance during distribution and marketing, to provide a good quality product to consumers. This study aims to identify the distribution chains of fresh fish and the socio-economic characteristics of participants, namely fishermen and retailers, and also to analyze the quality and safety of mackerel throughout the domestic distribution process. The study was conducted at the domestic fish market in Jakarta, Indonesia. The intermediaries involved in distribution and marketing, play an important role in fish product delivery to customers. The distribution chain data were collected from retailers through a survey using a questionnaire combined with an interview. Quality characteristics of fish were determined by taking the same type of samples from 56 locations, including fish landing, auction, wholesales, supermarkets and traditional markets. Based on market participants, the distribution chain consisted of fishermen, traders, collectors, wholesalers, and retailers/supermarkets. The results indicated that majority of the market participants were males at the productive age and fish capture, marketing and distribution was their main job, with a low level of education. Based on the total volatile base nitrogen (TVB-N) content, all the fish transported from the landing location to the supermarket complied with the quality standard, while in the traditional trading site 22.09% exceeded the maximum limit. In terms of food safety characteristics, mackerels were contaminated with pathogenic *Escherichia coli* from fish auction and the contamination level increased during distribution. The presence of these bacteria was mainly due to poor hygiene practices during handling.

Key Words: distribution, quality, total volatile bases, *Escherichia coli*.

Introduction. The provision of fish to consumers from the production center, require marketing, distribution and maintenance to keep the quality and safety of the product. This also help in sustaining the economic system in Jakarta, the capital city of Indonesia, making it a trading center for various goods, especially fisheries. The increasing demand for fish products was probably due to its great advantages compared to other foodstuffs. According to Albert & Marc (2013), it is the most nutritious and healthiest food ingredient with high protein and low-fat content. It is also reported by Ström et al (2011), that it is a very important food ingredient and a source of essential amino and unsaturated fatty acids, vitamins, and minerals. However, it is a highly perishable commodity and its quality deteriorates very rapidly. Therefore, its quality is affected when stored for human

consumption for a long time, and requires some efforts to be preserved during distribution and marketing.

According to [BPS, 2018](#) fish production in Jakarta was dominated by small (30%) and large (25%) pelagic fish, mollusks (27%), demersal fish (16%), crustaceans and reef fish 1%. Among the small pelagic fish, mackerel (*Rastrelliger* sp.) is the most preferred by consumers in Jakarta community (Ministry of Marine and Fisheries, 2018). Therefore, its quality and safety related topics need special consideration.

Accurate and comprehensive data regarding the quality and safety of fresh mackerel, during distribution and marketing at the domestic market in Jakarta are not available. Therefore, it is necessary to identify the marketing system, as well as the quality and safety of mackerel in the distribution chain. This is a preliminary study aimed to improve the quality and safety of fish, and also the distribution monitoring, in order to provide good quality in the domestic market.

Material and Method

Study site and period. This study was conducted for a period of four months, from March to June 2019, at domestic markets in Jakarta. The marketing and distribution chain started from fishing vessels, auction places, wholesale stores, supermarkets and traditional trading sites (Figure 1).

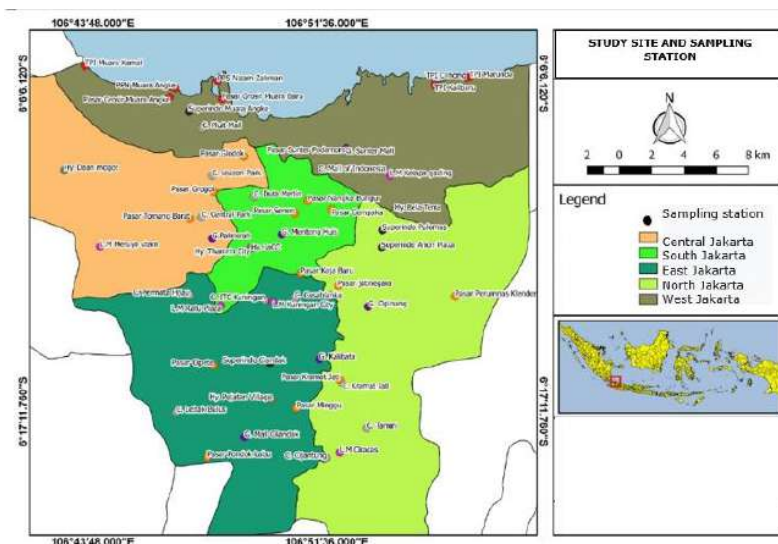


Figure 1. Study side and sampling location.

Material and Method

Material. The materials used were mackerel, ice, some chemicals for *Escherichia coli* analysis and Total Volatile Bases (TVB) assessment, include *Lauryl triptose broth*, EC Broth, *L-EMB agar*, Tryptone, *Methyl red* Voges-Proskauer medium and Citrat Agar, Perklorat Acid (PCA) 6%, Phenolftalein indicator, anti-foaming silicon, NaOH 20%, H₃BO₄ 3%, and HCl 0,02 N. The equipment used included a scale at 0.001 gr of accuracy (Metler Toledo), a Stomacher homogenizer (Interscience), filter paper (Whatman), distillation sets (Foss), incubator (Thermo scientific), autoclave (Chemoto scientific), water bath (Thermo scientific), oven (Thermo scientific), glassware (pyrex), and micropipette (Eppendorf).

Research methods. This study used a survey, interviews and laboratory testing methods. The respondents were 50 fishermen and 270 market participants, including 30 collectors,

60 wholesalers, 5 agents, 3 restaurant owners, 32 quality supervisors at supermarkets, and 140 retailers at traditional markets. For quality and safety testing, 790 samples in total, were obtained from 5 landing side locations (150 samples), 3 fish auction and 2 wholesale markets (150 samples), 32 supermarkets (155 samples), and 14 traditional markets (335 samples). The locations were determined based on random sampling which proportionally represented all districts in Jakarta. The fish samples were placed in a cool box, preserved with crushed ice at a ratio of 1:1 (Wiranata et al 2017; Panai et al 2013). The samples were then taken to the laboratory for further analysis.

Marketing system. The survey involved interviews, and the study areas were inspected in terms of identifying the fish distribution chain, as well as the socio-economic characteristics of market participants.

Quality and safety characteristics. The quality of *Rastrelliger* sp. was determined by the Total Volatile Bases Nitrogen (TVB-N) analysis, while its safety characteristics were determined by the presence of pathogenic *E. coli*. The TVB-N was analyzed using the Kjeldhal distillation method, based on Indonesia National Standard 2354.8:2009 (Sepka et al 2017). The extract was prepared by mixing 10 grams of the sample with 90 mL of 6% perchloric acid (PCA), and was homogenized for 2 minutes. The blend was then filtered using Whatman no 1 filter paper to obtain a clear extract. Then, 50 mL of the extract was pipetted into the distillation tube and added a few drops of phenolphthalein indicator and anti-foaming silicone, and placed in the distillation flask. Then, distillation commenced, while 30 mL of 10% NaOH and 100 mL of distilled water were added to the flask. The steam distillate was collected in a flask containing 100 mL of 3% boric acid together with 3 to 5 drops of indicators. The steam distillation procedure was continued until 200 mL of green color distillate was collected in a flask. The blank correction was determined by the steam distillation of 50 mL of distilled water sample, instead of the extract. The green color distillate was titrated with 0.02N Hydrochloric acid using a burette until the green color solution turned pink. The result was calculated and expressed in mg TVB-N 100 g⁻¹ of fish (Sepka et al 2017):

$$\text{TVB-N (mg 100g}^{-1}\text{)} = (V_s - V_b) \times N.\text{HCl} \times 14.007 \times \text{df} \times 100 \times 10^{-1}$$

Where:

V_s - volume of Hydrochloric acid for sample titration;

V_b - volume of Hydrochloric acid for blank titration;

D_f - dilution factor.

E. coli analysis was carried out using a 3-tube Most Probable Number (MPN) method, based on Indonesian National Standard 2332.1:2015 (Sutiknowati 2016) which included presumptive, confirmed, isolation, morphological and biochemical tests. The MPN value was determined according to the number of positive tubes and compared to MPN-index-table (Blodgett 2010). The numbers of pathogenic *E. coli* bacteria in the sample were expressed in MPN gr⁻¹.

Data analysis. The descriptive statistics were used to analyze the data obtained and they were displayed as percentages in tables and in graphs using the Microsoft Excel program. The distribution chains were also represented by diagrams based on the market participants involved.

Results and Discussion

Fishery production. Fishery production in Jakarta fluctuates every year, as shown in Figure 2: only 3.63% of Jakarta fisheries production was obtained through aquaculture, while 96.37% was captured. Between 2012 and 2015, the of fish production rate increase was about 10.18%, while in 2016, it decreased with 49.94%, compared to the previous year, then it lightly decreased until 2018. This decrease in production occurred both in aquaculture and capture fisheries, probably due to the Jakarta Bay reclamation program,

and the enforcement of several regulations related to the fisheries activity. According to Puspasari et al (2017), the Jakarta Bay reclamation had an impact on the aquatic environmental conditions, such as water clarity decrease, the diversity of phytoplankton and macro zoobenthos decrease, fish production decrease due to the elimination of some fishing areas. In addition, Mustaruddin et al (2020) stated that the reduction of the fishing area due to the fishing ground pollution caused the significant reduction of the production rate to 82.2 thousands of metric tons year⁻¹. Wiryawan et al (2013) stated that in 2012, the estimation of lost fishing grounds area due to reclamation was about 1,527.34 ha. From 2012 to 2014, the area was concentrated along the Jakarta Bay (Wagiyo et al 2016; Wiryawan et al 2013) and in 2016 the reclamation area was extended to the southern part of Seribu Island (Puspasari et al 2017). The the prohibition of using some fishing gear (trawl and seine nets), the interdiction to catch some species (spawning lobsters, crabs, blue swimming crabs) and the licensing suspension of certain types fishing vessels affected fisheries production. In tuna production, for example, the volume of tuna exports decreased by 16% from October to December 2014, since the enforcement of Regulation No 56/2014 (Arthatiani & Apriliani 2015).

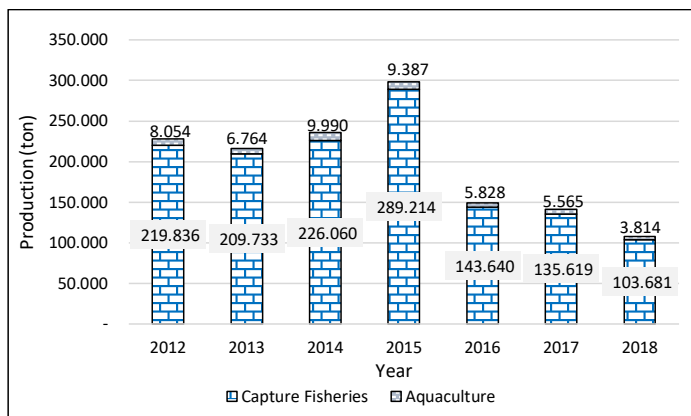


Figure 2. Jakarta fisheries production 2012-2018 (<https://satudata.kkp.go.id>).

Socio-economic characteristics of market participants. Fish marketing practices in Jakarta domestic market were performed by several institutions and participants, which included fishermen, brokers, collectors, wholesalers, restaurant owners, supermarkets and retailers. The socio-economic characteristics of the market participants, which included their age, gender, marital status, educational level, marketing experience, and knowledge of Good Handling Practices (GHdP) were presented in Table 1.

Table 1 shows that the majority (68.75%) of the participants were within the age of 41-60 years, followed by those between 31-40 (21.88%), under 30 (7.81%), and those above 60 years. It was found that most of the market participants were in their economic active years, between 15-64 years (BPS 2018). According to Farikha & Ardyanto (2016), the economic active years generated a high productivity. The table further showed that male respondents have a greater proportion of the market participants (57.50%) compared to females (42.50%). This result was different with frozen fish marketing in Owerri Municipal, Nigeria, that 93.33% of the marketers were female (Esiobu & Onubuogu 2014) and also in Oyo State that 85% of the marketers were female (Ayanboye et al 2015). However, the current study indicated that both males and females participated in fish marketing. This was also supported by Harper et al (2013), that women's involvement in fisheries was widespread throughout the world. Their roles ranged from catching and processing fish to the sale and finance aspects of this industry.

Table 1

Socio-economic characteristics of market participants

<i>Socio-economic variables</i>	<i>Frequency</i>	<i>Percentage (%)</i>
Age		
< 30	25	7.81
31-40	70	21.88
41-50	111	34.69
51-60	109	34.06
>60	5	1.56
Total	320	100
Sex		
Male	184	57.50
Female	136	42.50
Total	320	100
Marital status		
Married	307	95.94
Single	13	4.06
Total	320	100
Education		
No formal education to primary education	134	41.88
Secondary education	99	30.94
Tertiary education	69	21.56
Diploma/graduated	18	5.63
Total	320	100
Marketing experience (Year)		
≤10	88	27.50
10-20	126	39.38
20-30	89	27.81
>30	17	5.31
Total	320	100
Job status		
Main job	320	100
Side job	0	0
Total	320	100
GHdP knowledge		
Good	57	17.81
Fair	108	33.75
Poor	155	48.44
Total	320	100

The data showed that 95.94% of the market participants were married, while 4.06% were single, and all the respondents (100%) stated that selling fish was their main occupation and source of family income. About 41.88% of the market participants in the domestic market in Jakarta did not have any formal education, 30.94% attended junior high school, 21.56% attended senior high school and 5.63 % attended a diploma level of education. Therefore, most of the market participants have a low education level. The same result was also recorded by Robin et al (2018), which stated that the education level of fishermen in some coastal areas in Jakarta was very low. Although some respondents answered that education is not an essential subject for fish marketing, rather than to adapt and be familiar with the new technology. This corroborated the report of Madugu & Edward (2011), which stated that a low education level indicated low literacy skills of market participants. Furthermore, Triyanti & Shafitri (2012) also stated that a low education level was the major reason for the slow adoption of new technology. The same statement was also made by Dongondaji (2010) that literacy has a positive influence on adopting the technology. Most of the respondents (39.38%) had a marketing experience between 10-20 years , followed by 27.81% with 20-30 years, 27.50% with less than 10 years, and 5.31% with more than

30 years. According to Putri (2016), working experience has a positive effect on productivity, and it indirectly increases profitability (Sri Muliani & Suresmiathi 2015). Ali et al (2008) state that marketing experience affects participants' profit through a better understanding of the system, condition, trends, and prices. In terms of knowledge of GHdP, 48.44% of the participants had a poor level, while 33.75 % had fair level and only a few (17.81%) had good.

As a major implication, the majority of the market participants had a lower knowledge level on how to keep fish in good condition, due to the low levels of education and training, while fish is one of the most perishable foods and its quality maintenance is essential. According to Lusianawaty & Ghani (2015), education and training increase knowledge and skills, which influence personal behavior.

Distribution chain. The distribution chain can be described by a sequence of operators, , from producers to the final consumers (Apituley et al 2013). In this study, the fresh fish distribution chain was relatively short, with only six categories of market participants before the final consumer, such as: collectors, suppliers, wholesalers, retailers, restaurants, and supermarkets, as shown in Figure 2.

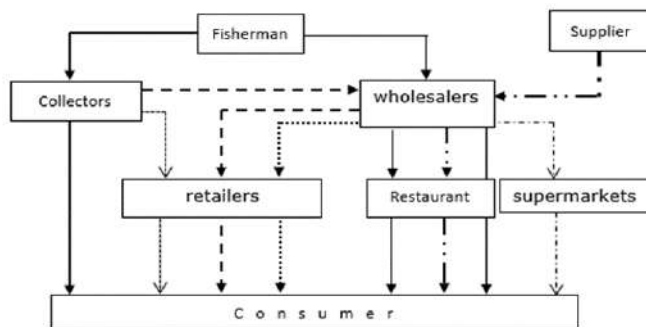


Figure 2. Fish distribution chain at the domestic market in Jakarta.

The main source of fresh fish for domestic consumption in Jakarta are the local fishermen and the suppliers from other provinces, such as Lampung, Banten, West Java and some regions in Central Java. Most fresh fish from local fishermen were marketed through collectors, while those from other regions were traded on the Muara Angke Market and on the Modern Market, located in Nizam Zachman Fishing Port. Figure 2 shows that collectors bought fish directly only from fishermen, while wholesalers obtained it both from fishermen and suppliers. Therefore, fish sold to retailers, restaurant owners, and supermarkets, and are finally delivered to the consumers. Collectors have a dominant part in domestic fish marketing, due to their closer cooperation with fishermen, involving capital assistance, consequently they conserve contractual privileges on the catch. In absence of established fish distribution chains, cooperation and agreements between market participants are prevalent. The selection of the distribution chain by the market participants was influenced by many factors, essentially related to the mutual satisfaction of their requirements, such as: limitations of business capital, transportation capacity and storage facilities. Hanafiah & Saefuddin (1986) state that several aspects affecting the distribution chain of fishery products are the company's financial position, production scale, product nature and the location to the final consumer.

Quality and safety characteristics

Total Volatile Bases (TVB) analysis. Total Volatile Bases (TVB) is a group of biogenic amines formed in non-fermented food products during storage, due to enzymatic and bacterial protein degradation (Connell 1995). Therefore, TVB levels are the most widely used indicator for the chemical assessment of marine fish spoilage (Zhong-yi et al 2010; Amegovu et al 2012). The higher the TVB level, the worse the fish quality. According to Connell (1995), an acceptable limit of the total volatile base - nitrogen for fish is 30 mg 100 g⁻¹ muscle. However, Soekarto (1990) and Barber (1965) recommended TVB-N levels of 10 mg N 100 g⁻¹ or less for very fresh fish, 10-20 mg N 100 g⁻¹ for fresh fish, with 20–30 mg 100 g⁻¹ as a maximum limit for consumption, resulting that levels over 30 mg 100 g⁻¹ correspond to spoiled fish. The average range of TVB-N and the percentage of samples compliant with TVB-N level during distribution were presented in Table 2.

Table 2
Range, average and percentage of samples complied with TVB-N level

Distribution chains	Range of TVB (mg N 100 g ⁻¹)	Average of TVB (mg N 100 g ⁻¹)	% of sample complied with TVB-N level
Fish landing	8.17-15.92	12.19±2.23	100
Fish auction	9.19-17.91	12.87±2.84	100
Wholesale	10.11-24.09	16.83±3.50	100
Supermarkets	13.02-23.98	18.89±2.29	100
Traditional markets	10.63-44.49	23.16±5.89	77.91

Based on the total volatile base - nitrogen level, Table 2 shows that 100% of mackerel on the landing side, fish auction market and supermarkets complied with TVB-N standard limit, while in the traditional trading site only 77.91% complied with the standard limit. The quality of mackerel during marketing tends to decrease as the TVB level increases, especially in traditional markets. Generally, mackerel on the landing side and fish auction were within the limits of very fresh to fresh quality (8.17-17.91 mg N 100 g⁻¹), those on wholesale and supermarkets were within the range of fresh to maximum limit for consumption (10.11–24.09 mg N 100 g⁻¹), while those on traditional markets were within the fresh quality to spoiled (10.63-44.49 mg N 100 g⁻¹). Deni (2015) also found that fish traded at auction places was in the category of fresh. Connell (1995) indicated that the TVB-N level of fresh fish ranges between 5-20 mg N 100 g⁻¹.

Quality loss in the traditional market was due to poor hygiene in handling conditions, including equipment and location bacterial contamination. There is a direct proportionality relationship between the bacterial load and TVB-N value (Immaculate & Jamila 2018). Eyo (2001) stated that the prime cause of spoilage in fish are bacteria and enzymatic action which result in the production of various volatile compounds. and chemical action involving the oxygen of the air and fat in the flesh of the fish.

Baldwin (1961), stated that the hydrolysis of protein and other nitrogenous compounds by autolytic enzyme, together with bacterial action, leads to an increased total volatile base - nitrogen value. The poor handling and low awareness of marketer relating to the cold chain implementation in traditional markets was also reported in Malawi (Kapute et al 2012) and Sri Lanka (Jinadasa 2014). The lack of cold chain applications, especially in traditional markets, was a major problem in some countries. Despite that all the samples from supermarkets relatively complied with the TVB-N level, some samples have been rejected by sensory analysis due to poor appearance and texture. The same result was reported by Genç et al (2013) for meagre fillets, which were already unacceptable after 8 days, in terms of off-odors, even if their TVB-N content was within the regulated levels. Tejada & Huidobro (2002) stated that TVB-N, although being appropriate and widely used as a legal chemical indicator of seafood spoilage, it is however an inadequate sign of quality during the initial stages of fish damage.

In this study, most of the fish marketed at the traditional trading sites were kept without ice during the sales operations, at temperatures ranging from 22.3±3.4°C to

25.2±0.8°C. According to Ola & Oladipo (2004), fish spoiled faster at ambient temperature than in the chilling container. Maintaining the quality of fresh fish was carried out through various methods, however, according to (Ghaly et al 2010), the ideal method was their preservation at chilling temperature, in order to delay bacteria growth and biochemical processes causing quality deterioration (Adawyah 2014).

Furthermore, Ariyani et al (2008), stated that at 0-6°C, microorganisms and enzymes activity were retarded. It was also reported that there were significant quality differences between fish stored at cold temperatures compared to those stored in ambient, such as spotted grunter (Osibona & Ezekiel 2014), tilapia (Makawa 2014) and other fish species (Immaculate & Jamila 2018).

According to the TVB Level by Farber (1965), indicated that Sockarto (1990), 15% of mackerel obtained in the distribution chain were very fresh, 47% were fresh, 28% were fit for consumption and 10% were spoilt (Figure 3). All the spoilt fish were found in traditional markets.

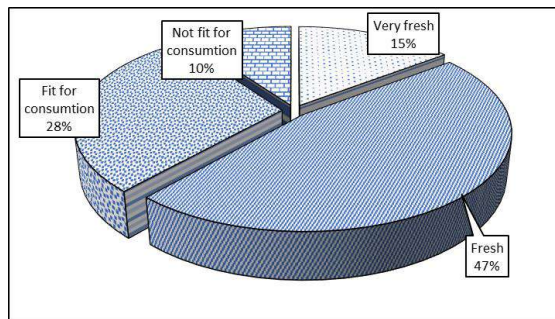


Figure 3. Freshness level of mackerel during distribution.

Escherichia coli analysis. *E. coli* is an organism that typically colonizes the intestinal tract of warm-blooded animals, including humans (Cooke & Ewins 1975; Melliawati 2009), being the most affluent anaerobe bacteria of the intestinal microflora (Cooke & Ewins 1975; Kaper et al 2004). The presence of *E. coli* in water and food is a strong indication of recent sewage or animal fecal contamination, because of poor hygiene practices during handling (Sutiknowati 2016; Kim et al 2017). Thus, this bacterium has long been considered as an indicator of recent fecal pollution in food and environment water. Some strains of *E. coli* cause diseases, such as diarrhea, indigestion, and dysentery (Made & Dwipayanti 2010; Wong et al 2012). Besides as an indicator of poor hygiene practices during handling, *E. coli* was also used as a food safety indicator. The total of *E. coli* in mackerel samples, expressed in Most Probable Number per gram (MPN g⁻¹) was shown in Table 3.

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Table 3

Number of *Escherichia coli* of mackerel samples

Distribution chains	Total sample	% of the positive sample	Number of <i>Escherichia coli</i> (MPN g ⁻¹)	Standard (BSN 2013)
Fish Landing	150	12.67	3.0-75	
Fish auction	90	18.89	3.0-120	
Wholesale	60	11.67	6.1-93	<3 (MPN g ⁻¹)
Supermarkets	155	1.29	11-20	
Traditional markets	335	11.64	3.0 to >1100	

The number of *E. coli* of mackerel samples (Table 3) showed that their contamination has occurred at the landing side (3.0-75 MPN g⁻¹) and continued to increase during distribution (>1100 in traditional markets). Contamination indicates poor hygiene practices during

handling. The poor hygiene of equipment and environment in all stages of distribution (fishing vessel, landing side, fish auction, wholesales, and traditional markets), the lack of some hygiene facilities, as well as the poor application of cool chain system during handling were the main factor of this contamination. This was also supported by Deni (2015), stating that the implementation of sanitation and hygiene on boats, cleanliness of handling equipment, and fishermen during fishing was not implemented properly. Indrasari (2020) stated that one of the major problems related to coastal areas in Jakarta were waste and poor sanitation, which was a source of *E. coli* contamination for fish during landing and marketing in the auction. Field observation determined that most of Fish Auction and Traditional Market also have poor hygiene during marketing, due to inadequate drainage and building construction. Some animals, in particular rodents were considered a major source of pathogenic *E. coli* contamination and infection (Jang et al 2017; Ferens & Hovde 2011).

It was also reported that *E. coli* was present in fish sold at some traditional markets in Indonesia, such as cuttlefish and fresh shrimp in Pontianak (Sari & Apridamayanti 2014), fresh and smoked tuna in North Halmahera (Akerina 2018), Layang (*Decapterus russelli*) in Palu (Maruka et al 2017), and tuna in Aceh (Ummamie et al 2017). The similar situations were also reported in other countries, such as Brazil (Lascowski et al 2013), Nigeria (Eze et al 2011), and Iraq (Abbas 2014). *E. coli* is known as one of the most important pathogenic microbial in the field of food quality and safety. Their presence in fish and fishery products for human consumption is not only a potential disease source, but also mediates the transfer of antibiotic resistance to humans. Through the food chain contamination, *E. coli* can lead to mass mortality (Fattahi et al 2015).

Conclusion. The participants in the domestic market of Jakarta were in their economic active years. Both males and females participated in fish marketing, although males (57.50%) had a greater proportion than females (42.50%). Fish marketing is the main job and source of the family income of the participants. 41.88% of them had a low education level. The distribution chain of fresh fish at the domestic market in Jakarta was composed of fishermen, traders, collectors, wholesalers and retailers/supermarkets. Based on the total volatile base - nitrogen level, 100% of mackerel at landing side, fish auction, market and supermarkets complied with the TVB-N limit, while in the traditional trading site only 77.91% met the standard. Inappropriate cold chain applications, poor sanitation, and hygiene practices during distribution and selling were the main causes of the decline in fish quality. The *Escherichia coli* contamination of mackerel started from the unloading and increased during marketing. Measures are required in order to preserve the fish safety and quality, including training related to GHdP, provision of supporting facilities for maintenance during distribution and marketing, as well as monitoring the fresh fish compliance to the safety standards, when necessary by enforcement regulation initiated by the authorities.

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Siregar R. R., Wisudo S. H., Nurani T. W., Suseno S. H., 2020 Marketing system, quality and safety characteristics of mackerel (*Rastrelliger* sp.) at the domestic market in Jakarta, Indonesia. AACL Bioflux ...

Submission Document

The screenshot shows a web browser displaying a document titled "Marketing system, Quality and safety characteristics of mackerel (*Rastrelliger* sp) at the domestic market in Jakarta". The document is authored by Rasmi R. Siregar, Sugeng H. Wisudo, Tri W. Nurani, and Sugeng H. Suseno. It is from the Department of Fisheries Resources Utilization, Faculty of Fisheries and Marine Sciences, IPB University, Bogor, Indonesia. The abstract discusses the distribution and marketing of mackerel in Jakarta, mentioning the involvement of intermediaries and the collection of data from various markets. The introduction highlights the importance of fish in the Indonesian economy and the need for quality and safety standards. The document is displayed in a window titled "Manuscript_Resmi_FINAL.doc".

Primery Acceptance

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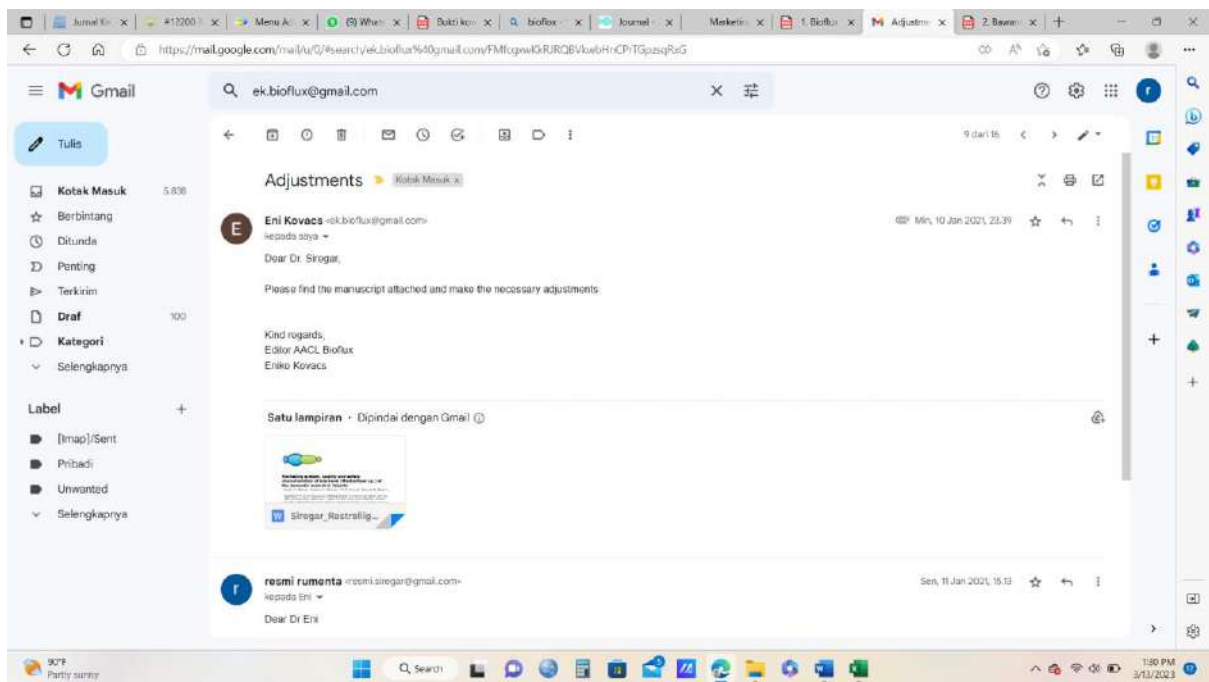
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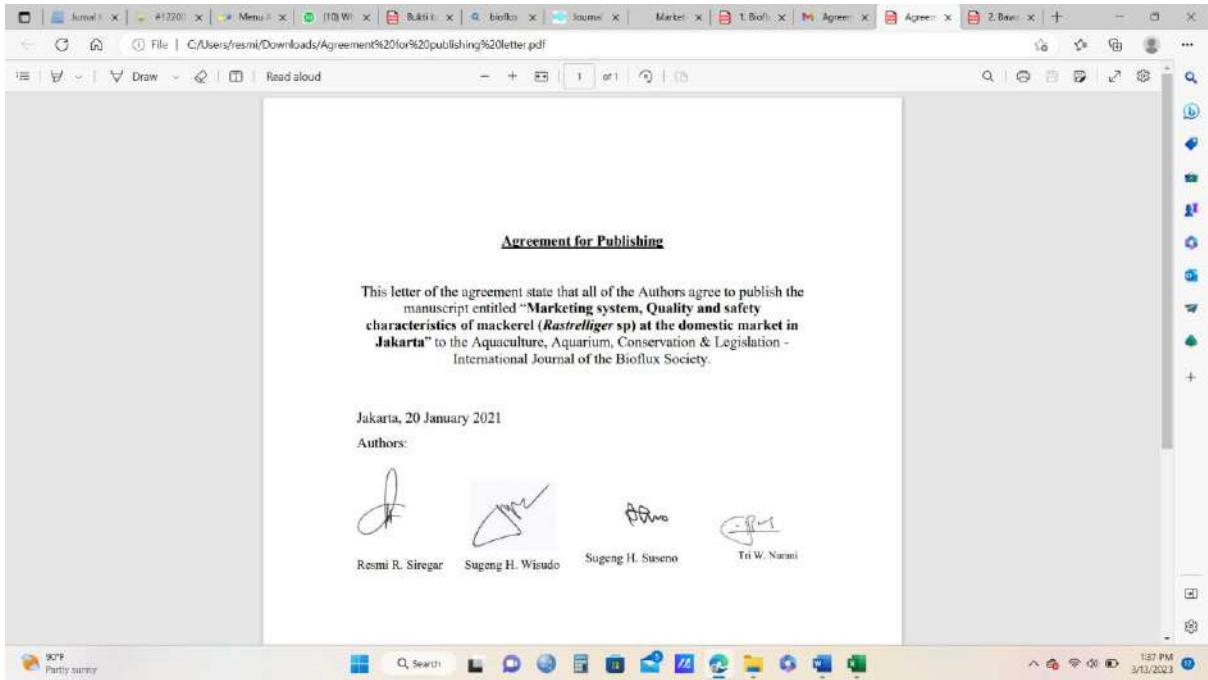


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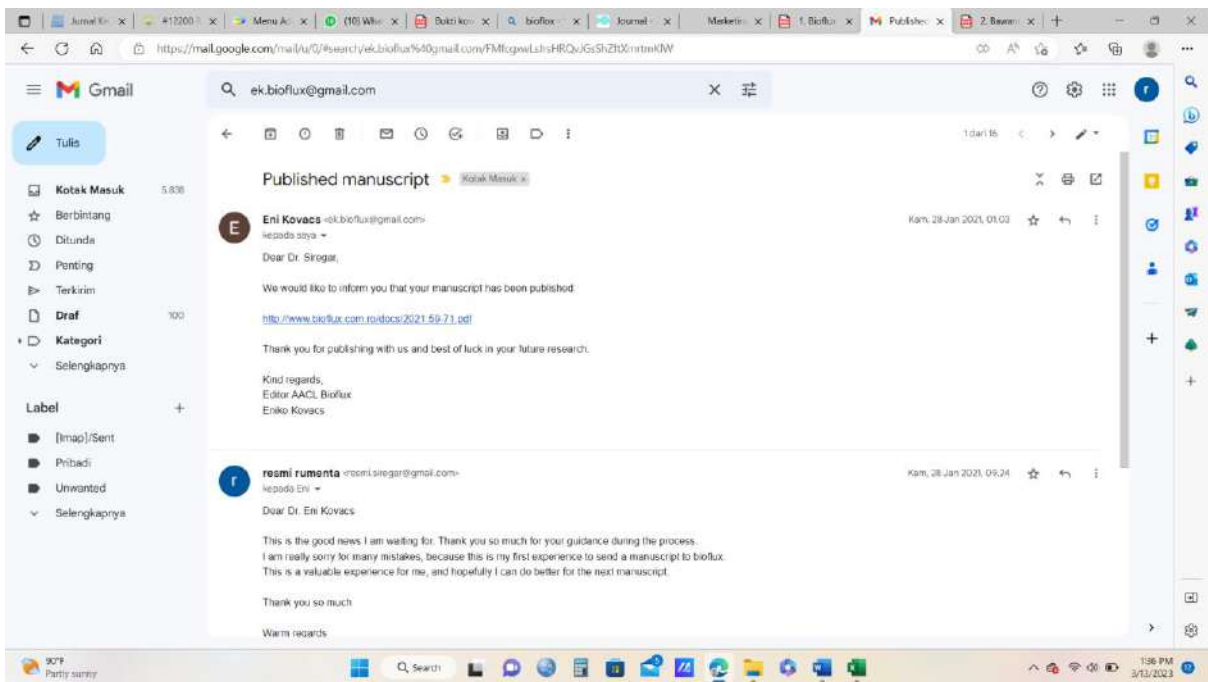
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Jakarta, 20 January 2021

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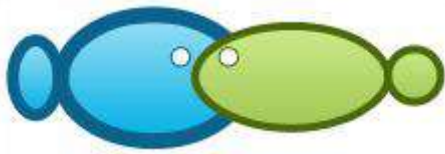
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Sugeng H. Suseno



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Marketing system, quality and safety characteristics of mackerel (*Rastrelliger sp.*) at the domestic market in Jakarta, Indonesia

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Abstract. Fish is a highly perishable food, which needs proper maintenance during distribution and marketing, to provide a good quality product to consumers. This study aims to identify the distribution chains of fresh fish and the socio-economic characteristics of participants, namely fishermen and retailers, and also to analyze the quality and safety of mackerel throughout the domestic distribution process. The study was conducted at the domestic fish market in Jakarta, Indonesia. The intermediaries involved in distribution and marketing, play an important role in fish product delivery to customers. The distribution chain data were collected from retailers through a survey using a questionnaire combined with an interview. Quality characteristics of fish were determined by taking the same type of samples from 56 locations, including fish landing, auction, wholesales, supermarkets and traditional markets. Based on market participants, the distribution chain consisted of fishermen, traders, collectors, wholesalers, and retailers/supermarkets. The results indicated that majority of the market participants were males at the productive age and fish capture, marketing and distribution was their main job, with a low level of education. Based on the total volatile base nitrogen (TVB-N) content, all the fish transported from the landing location to the supermarket complied with the quality standard, while in the traditional trading site 22.09% exceeded the maximum limit. In terms of food safety characteristics, mackerels were contaminated with pathogenic *Escherichia coli* from fish auction and the contamination level increased during distribution. The presence of these bacteria was mainly due to poor hygiene practices during handling.

Key Words: distribution, quality, total volatile bases, *Escherichia coli*.

Introduction. The provision of fish to consumers from the production center, require marketing, distribution and maintenance to keep the quality and safety of the product. This also help in sustaining the economic system in Jakarta, the capital city of Indonesia, making it a trading center for various goods, especially fisheries. The increasing demand for fish products was probably due to its great advantages compared to other foodstuffs. According to Albert & Marc (2013), it is the most nutritious and healthiest food ingredient with high protein and low-fat content. It is also reported by Ström et al (2011), that it is a very important food ingredient and a source of essential amino and unsaturated fatty acids, vitamins, and minerals. However, it is a highly perishable commodity and its quality deteriorates very rapidly. Therefore, its quality is affected when stored for human consumption for a long time, and requires some efforts to be preserved during distribution and marketing.

According to BPS (2018), fish production in Jakarta was dominated by small (30%) and large (25%) pelagic fish, mollusks (27%), demersal fish (16%), crustaceans and reef fish 1%. Among the small pelagic fish, mackerel (*Rastrelliger sp.*) is the most

preferred by consumers in Jakarta community (Ministry of Marine and Fisheries 2018). Therefore, its quality and safety related topics need special consideration.

Accurate and comprehensive data regarding the quality and safety of fresh mackerel, during distribution and marketing at the domestic market in Jakarta are not available. Therefore, it is necessary to identify the marketing system, as well as the quality and safety of mackerel in the distribution chain. This is a preliminary study aimed to improve the quality and safety of fish, and also the distribution monitoring, in order to provide good quality in the domestic market.

Material and Method

Study site and period. This study was conducted for a period of four months, from March to June 2019, at domestic markets in Jakarta. The marketing and distribution chain started from fishing vessels, auction places, wholesale stores, supermarkets and traditional trading sites (Figure 1).

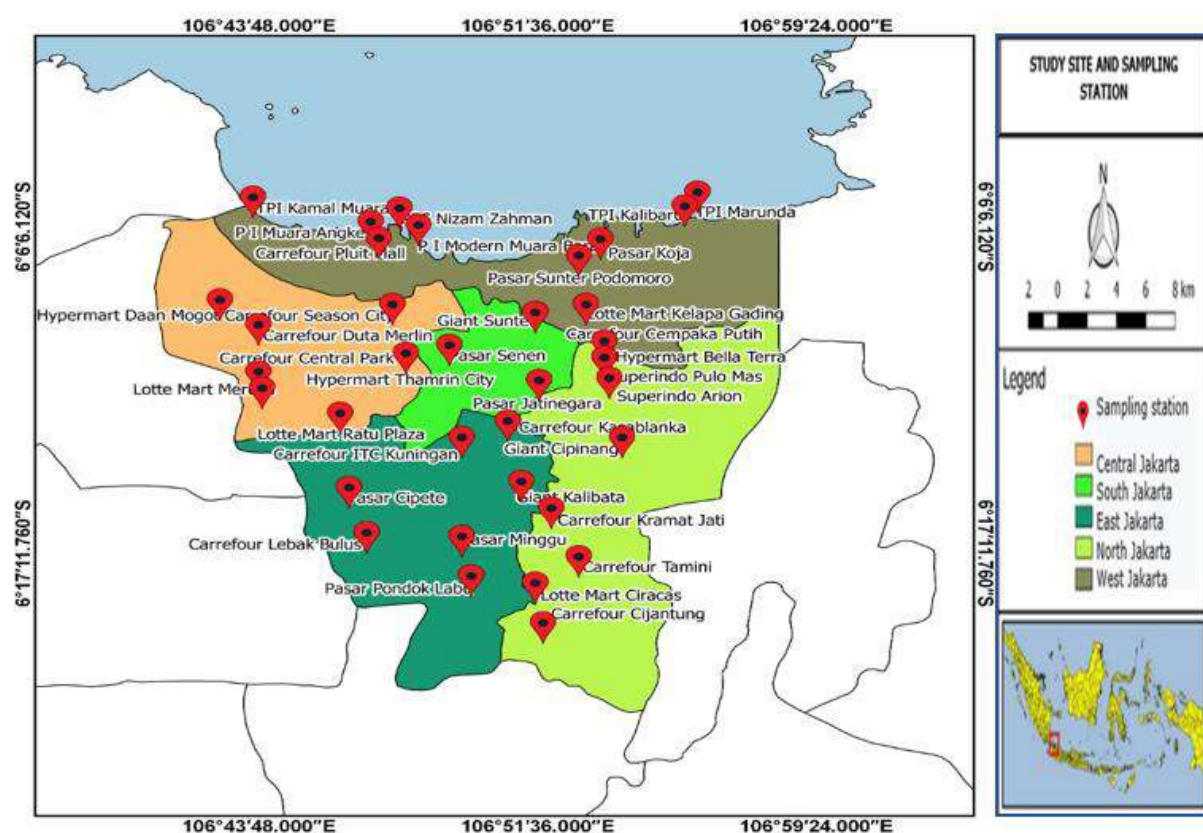


Figure 1. Study side and sampling location.

Material. The materials used were mackerel, ice, some chemicals for *Escherichia coli* analysis and Total Volatile Bases (TVB) assessment, include *Lauryl triptose* broth, EC broth, L-EMB agar, tryptone, methyl red Voges-Proskauer medium and citrat agar, perklorat acid (PCA) 6%, phenolftalein indicator, anti-foaming silicon, NaOH 20%, H₃BO₄ 3%, and HCl 0.02 N. The equipment used included a scale at 0.001 g of accuracy (Metler Toledo), a Stomacher homogenizer (Interscience), filter paper (Whatman), distillation sets (Foss), incubator (Thermo Scientific), autoclave (Chemoto Scientific), water bath (Thermo Scientific), oven (Thermo Scientific), glassware (Pyrex), and micropipette (Eppendorf).

Research methods. This study used a survey, interviews and laboratory testing methods. The respondents were 50 fishermen and 270 market participants, including 30 collectors, 60 wholesalers, 5 agents, 3 restaurant owners, 32 quality supervisors at supermarkets, and 140 retailers at traditional markets. For quality and safety testing,

790 samples in total, were obtained from 5 landing side locations (150 samples), 3 fish auction and 2 wholesale markets (150 samples), 32 supermarkets (155 samples), and 14 traditional markets (335 samples). The locations were determined based on random sampling which proportionally represented all districts in Jakarta. The fish samples were placed in a cool box, preserved with crushed ice at a ratio of 1:1 (Wiranata et al 2017; Panai et al 2013). The samples were then taken to the laboratory for further analysis.

Marketing system. The survey involved interviews, and the study areas were inspected in terms of identifying the fish distribution chain, as well as the socio-economic characteristics of market participants.

Quality and safety characteristics. The quality of *Rastrelliger* sp. was determined by the Total Volatile Bases Nitrogen (TVB-N) analysis, while its safety characteristics were determined by the presence of pathogenic *E. coli*. The TVB-N was analyzed using the Kjeldhal distillation method, based on Indonesia National Standard 2354.8:2009 (Sepka et al 2017). The extract was prepared by mixing 10 grams of the sample with 90 mL of 6% perchloric acid (PCA), and was homogenized for 2 minutes. The blend was then filtered using Whatman no 1 filter paper to obtain a clear extract. Then, 50 mL of the extract was pipetted into the distillation tube and added a few drops of phenolphthalein indicator and anti-foaming silicone, and placed in the distillation flask. Then, distillation commenced, while 30 mL of 10% NaOH and 100 mL of distilled water were added to the flask. The steam distillate was collected in a flask containing 100 mL of 3% boric acid together with 3 to 5 drops of indicators. The steam distillation procedure was continued until 200 mL of green color distillate was collected in a flask. The blank correction was determined by the steam distillation of 50 mL of distilled water sample, instead of the extract. The green color distillate was titrated with 0.02 N hydrochloric acid using a burette until the green color solution turned pink. The result was calculated and expressed in mg TVB-N 100 g⁻¹ of fish (Sepka et al 2017):

$$\text{TVB-N (mg 100 g}^{-1}\text{)} = (\text{Vs}-\text{Vb}) \times \text{NHCl} \times 14.007 \times \text{df} \times 100 \times 10^{-1}$$

Where:

Vs - volume of hydrochloric acid for sample titration;

Vb - volume of hydrochloric acid for blank titration;

df - dilution factor.

E. coli analysis was carried out using a 3-tube Most Probable Number (MPN) method, based on the Indonesian National Standard 2332.1:2015 (Sutiknowati 2016) which included presumptive, confirmed, isolation, morphological and biochemical tests. The MPN value was determined according to the number of positive tubes and compared to MPN-index-table (Blodgett 2010). The numbers of pathogenic *E. coli* bacteria in the sample were expressed in MPN gr⁻¹.

Data analysis. The descriptive statistics were used to analyze the data obtained and they were displayed as percentages in tables and in graphs using the Microsoft Excel program. The distribution chains were also represented by diagrams based on the market participants involved.

Results and Discussion

Fishery production. Fishery production in Jakarta fluctuates every year, as shown in Figure 2: only 3.63% of Jakarta fisheries production was obtained through aquaculture, while 96.37% was captured. Between 2012 and 2015, the fish production rate increase was about 10.18%, while in 2016, it decreased with 49.94%, compared to the previous year, then it lightly decreased until 2018. This decrease in production occurred both in aquaculture and capture fisheries, probably due to the Jakarta Bay reclamation program, and the enforcement of several regulations related to the fisheries activity. According to Puspasari et al (2017), the Jakarta Bay reclamation had an impact on the aquatic

environmental conditions, such as water clarity decrease, the diversity of phytoplankton and macro zoobenthos decrease, fish production decrease due to the elimination of some fishing areas. In addition, Mustaruddin et al (2020) stated that the reduction of the fishing area due to the fishing ground pollution caused the significant reduction of the production rate to 82.2 thousands metric tons year⁻¹. Wiryawan et al (2013) stated that in 2012, the estimation of lost fishing grounds area due to reclamation was about 1,527.34 ha. From 2012 to 2014, the area was concentrated along the Jakarta Bay (Wiryawan et al 2013) and in 2016 the reclamation area was extended to the southern part of Seribu Island (Puspasari et al 2017). The the prohibition of using some fishing gear (trawl and seine nets), the interdiction to catch some species (spawning lobsters, crabs, blue swimming crabs) and the licensing suspension of certain types fishing vessels affected fisheries production. In tuna production, for example, the volume of tuna exports decreased by 16% from October to December 2014, since the enforcement of Regulation No 56/2014 (Arthatiani & Apriliani 2015).

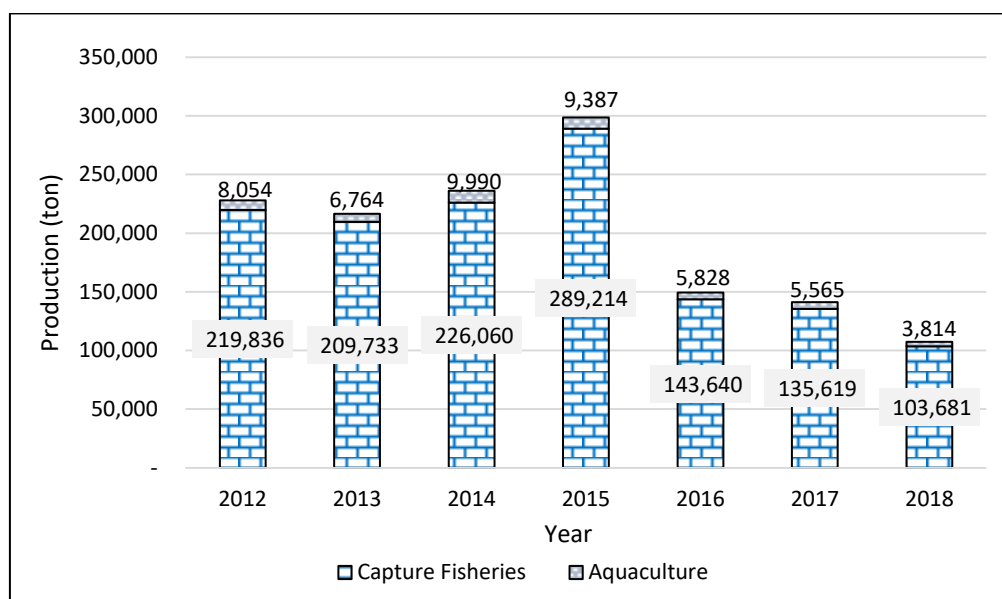


Figure 2. Jakarta fisheries production 2012-2018 (<https://satudata.kkp.go.id>).

Socio-economic characteristics of market participants. Fish marketing practices in Jakarta domestic market were performed by several institutions and participants, which included fishermen, brokers, collectors, wholesalers, restaurant owners, supermarkets and retailers. The socio-economic characteristics of the market participants, which included their age, gender, marital status, educational level, marketing experience, and knowledge of Good Handling Practices (GHdP) were presented in Table 1.

Table 1 shows that the majority (68.75%) of the participants were within the age of 41-60 years, followed by those between 31-40 (21.88%), under 30 (7.81%), and those above 60 years. It was found that most of the market participants were in their economic active years, between 15-64 years (BPS 2018). According to Farikha & Ardyanto (2016), the economic active years generated a high productivity. Table 1 further showed that male respondents have a greater proportion of the market participants (57.50%) compared to females (42.50%). This result was different with frozen fish marketing in Owerri Municipal, Nigeria, that 93.33% of the marketers were female (Esiobu & Onubuogu 2014) and also in Oyo State that 85% of the marketers were female (Ayanboye et al 2015). However, the current study indicated that both males and females participated in fish marketing. This was also supported by Harper et al (2013), that women's involvement in fisheries was widespread throughout the world. Their roles ranged from catching and processing fish to the sale and finance aspects of this industry.

Table 1

Socio-economic characteristics of market participants

<i>Socio-economic variables</i>	<i>Frequency</i>	<i>Percentage (%)</i>
Age		
< 30	25	7.81
31-40	70	21.88
41-50	111	34.69
51-60	109	34.06
>60	5	1.56
Total	320	100
Sex		
Male	184	57.50
Female	136	42.50
Total	320	100
Marital status		
Married	307	95.94
Single	13	4.06
Total	320	100
Education		
No formal education to primary education	134	41.88
Secondary education	99	30.94
Tertiary education	69	21.56
Diploma/graduated	18	5.63
Total	320	100
Marketing experience (Year)		
≤10	88	27.50
10-20	126	39.38
20-30	89	27.81
>30	17	5.31
Total	320	100
Job status		
Main job	320	100
Side job	0	0
Total	320	100
GHdP knowledge		
Good	57	17.81
Fair	108	33.75
Poor	155	48.44
Total	320	100

The data showed that 95.94% of the market participants were married, while 4.06% were single, and all the respondents (100%) stated that selling fish was their main occupation and source of family income. About 41.88% of the market participants in the domestic market in Jakarta did not have any formal education, 30.94% attended junior high school, 21.56% attended senior high school and 5.63% attended a diploma level of education. Therefore, most of the market participants have a low education level. The same result was also recorded by Robin et al (2018), which stated that the education level of fishermen in some coastal areas in Jakarta was very low. Although some respondents answered that education is not an essential subject for fish marketing, rather than to adapt and be familiar with the new technology. This corroborated the report of Madugu & Edward (2011), which stated that a low education level indicated low literacy skills of market participants. Furthermore, Triyanti & Shafitri (2012) also stated that a low education level was the major reason for the slow adoption of new technology. The same statement was also made by Dongondaji (2010) that literacy has a positive influence on adopting the technology. Most of the respondents (39.38%) had a marketing

experience between 10-20 years, followed by 27.81% with 20-30 years, 27.50% with less than 10 years, and 5.31% with more than 30 years. According to Putri (2016), working experience has a positive effect on productivity, and it indirectly increases profitability (Sri Muliani & Suresmiathi 2015). Ali et al (2008) stated that marketing experience affects participants' profit through a better understanding of the system, condition, trends, and prices. In terms of knowledge of GHdP, 48.44% of the participants had a poor level, while 33.75 % had fair level and only a few (17.81%) had a good level.

As a major implication, the majority of the market participants had a lower knowledge level on how to keep fish in good condition, due to the low levels of education and training, while fish is one of the most perishable foods and its quality maintenance is essential. According to Lusianawaty & Ghani (2015), education and training increase knowledge and skills, which influence personal behavior.

Distribution chain. The distribution chain can be described by a sequence of operators, from producers to the final consumers (Apituley et al 2013). In this study, the fresh fish distribution chain was relatively short, with only six categories of market participants before the final consumer, such as: collectors, suppliers, wholesalers, retailers, restaurants, and supermarkets, as shown in Figure 3.

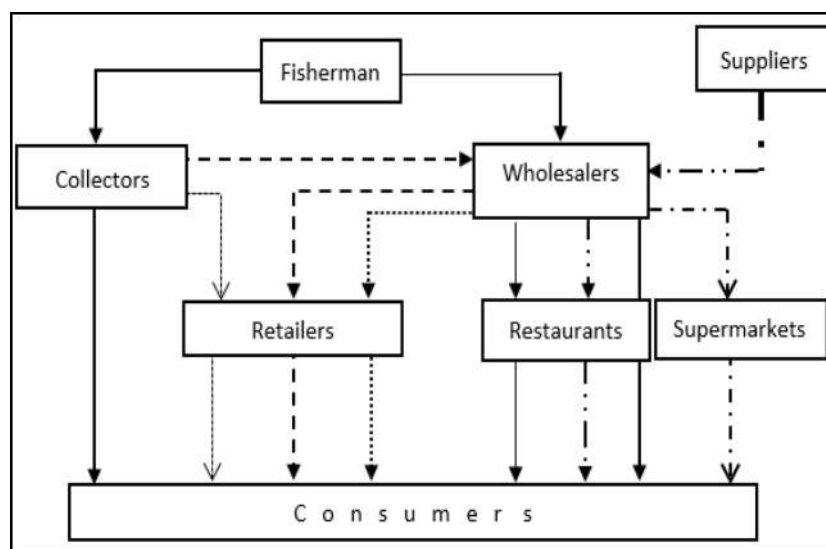


Figure 3. Fish distribution chain at the domestic market in Jakarta.

The main source of fresh fish for domestic consumption in Jakarta are the local fishermen and the suppliers from other provinces, such as Lampung, Banten, West Java and some regions in Central Java. Most fresh fish from local fishermen were marketed through collectors, while those from other regions were traded on the Muara Angke Market and on the Modern Market, located in Nizam Zachman Fishing Port. Figure 3 shows that collectors bought fish directly only from fishermen, while wholesalers obtained it both from fishermen and suppliers. Therefore, fish sold to retailers, restaurant owners, and supermarkets, and are finally delivered to the consumers. Collectors have a dominant part in domestic fish marketing, due to their closer cooperation with fishermen, involving capital assistance, consequently they conserve contractual privileges on the catch. In absence of established fish distribution chains, cooperation and agreements between market participants are prevalent. The selection of the distribution chain by the market participants was influenced by many factors, essentially related to the mutual satisfaction of their requirements, such as: limitations of business capital, transportation capacity and storage facilities. Hanafiah & Saefuddin (1986) state that several aspects affecting the distribution chain of fishery products are the company's financial position, production scale, product nature and the location to the final consumer.

Quality and safety characteristics

Total Volatile Bases (TVB) analysis. Total Volatile Bases (TVB) is a group of biogenic amines formed in non-fermented food products during storage, due to enzymatic and bacterial protein degradation (Connell 1995). Therefore, TVB levels are the most widely used indicator for the chemical assessment of marine fish spoilage (Zhong-yi et al 2010; Amegovu et al 2012). The higher the TVB level, the worse the fish quality. According to Connel (1995), an acceptable limit of the total volatile base - nitrogen for fish is 30 mg 100 g⁻¹ muscle. However, Farber (1965) recommended TVB-N levels of 10 mg N 100 g⁻¹ or less for very fresh fish, 10-20 mg N 100 g⁻¹ for fresh fish, with 20-30 mg 100 g⁻¹ as a maximum limit for consumption, resulting that levels over 30 mg 100 g⁻¹ correspond to spoiled fish. The average range of TVB-N and the percentage of samples compliant with TVB-N level during distribution were presented in Table 2.

Table 2
Range, average and percentage of samples complied with TVB-N level

<i>Distribution chains</i>	<i>Range of TVB (mg N 100 g⁻¹)</i>	<i>Average of TVB (mg N 100 g⁻¹)</i>	<i>% of sample complied with TVB-N level</i>
Fish landing	8.17-15.92	12.19±2.23	100
Fish auction	9.19-17.91	12.87±2.84	100
Wholesale	10.11-24.09	16.83±3.50	100
Supermarkets	13.02-23.98	18.89±2.29	100
Traditional markets	10.63-44.49	23.16±5.89	77.91

Based on the total volatile base - nitrogen level, Table 2 shows that 100% of mackerel on the landing side, fish auction market and supermarkets complied with TVB-N standard limit, while in the traditional trading site only 77.91% complied with the standard limit. The quality of mackerel during marketing tends to decrease as the TVB level increases, especially in traditional markets. Generally, mackerel on the landing side and fish auction were within the limits of very fresh to fresh quality (8.17-17.91 mg N 100 g⁻¹), those on wholesale and supermarkets were within the range of fresh to maximum limit for consumption (10.11-24.09 mg N 100 g⁻¹), while those on traditional markets were within the fresh quality to spoiled (10.63-44.49 mg N 100 g⁻¹). Deni (2015) also found that fish traded at auction places were in the category of fresh. Connell (1995) indicated that the TVB-N level of fresh fish ranges between 5-20 mg N 100 g⁻¹.

Quality loss in the traditional market was due to poor hygiene in handling conditions, including equipment and location bacterial contamination. There is a direct proportionality relationship between the bacterial load and TVB-N value (Immaculate & Jamila 2018). Eyo (2001) stated that the prime cause of spoilage in fish is bacteria and enzymatic action which result in the production of various volatile compounds and chemical action involving the oxygen of the air and fat in the flesh of the fish. The poor handling and low awareness of marketer relating to the cold chain implementation in traditional markets was also reported in Malawi (Kapute et al 2012) and Sri Lanka (Jinadasa 2014). The lack of cold chain applications, especially in traditional markets, was a major problem in some countries. Despite that all the samples from supermarkets relatively complied with the TVB-N level, some samples have been rejected by sensory analysis due to poor appearance and texture. The same result was reported by Genç et al (2013) for meagre fillets, which were already unacceptable after 8 days, in terms of off-odors, even if their TVB-N content was within the regulated levels. Tejada & Huidobro (2002) stated that TVB-N, although being appropriate and widely used as a legal chemical indicator of seafood spoilage, it is however an inadequate sign of quality during the initial stages of fish damage.

In this study, most of the fish marketed at the traditional trading sites were kept without ice during the sales operations, at temperatures ranging from 22.3±3.4°C to 25.2±0.8°C. According to Ola & Oladipo (2004), fish spoiled faster at ambient temperature than in the chilling container. Maintaining the quality of fresh fish was

carried out through various methods, however, according to (Ghaly et al 2010), the ideal method was their preservation at chilling temperature, in order to delay bacteria growth and biochemical processes causing quality deterioration (Adawyah 2014).

Furthermore, Ariyani et al (2008), stated that at 0-6°C, microorganisms and enzymes activity were retarded. It was also reported that there were significant quality differences between fish stored at cold temperatures compared to those stored in ambient, such as spotted grunter (Osibona & Ezekiel 2014), tilapia (Makawa 2014) and other fish species (Immaculate & Jamila 2018).

According to the TVB level by Farber (1965), 15% of mackerel obtained in the distribution chain were very fresh, 47% were fresh, 28% were fit for consumption and 10% were spoilt (Figure 3). All the spoilt fish were found in traditional markets.

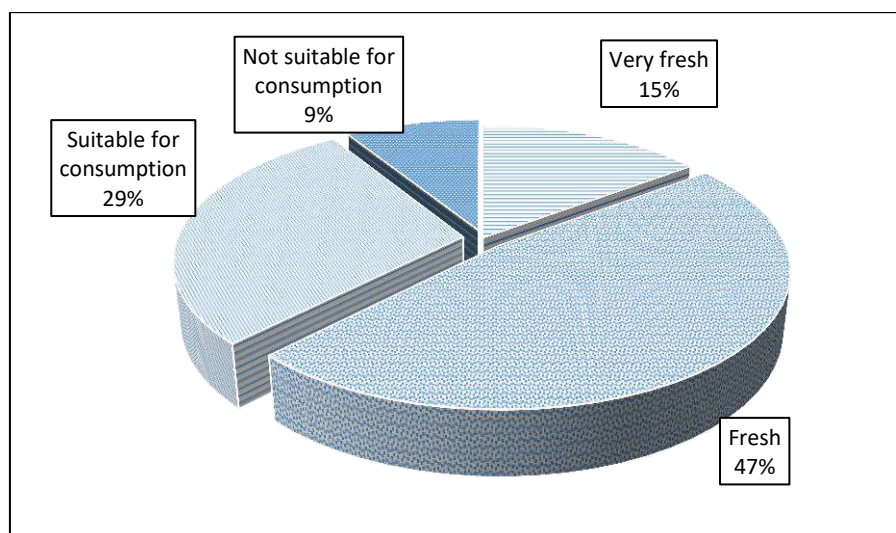


Figure 3. Freshness level of mackerel during distribution.

***Escherichia coli* analysis.** *E. coli* is an organism that typically colonizes the intestinal tract of warm-blooded animals, including humans being the most affluent anaerobe bacteria of the intestinal microflora (Cooke & Ewins 1975; Kaper et al 2004). The presence of *E. coli* in water and food is a strong indication of recent sewage or animal fecal contamination, because of poor hygiene practices during handling (Sutiknowati 2016; Kim et al 2017). Thus, this bacterium has long been considered as an indicator of recent fecal pollution in food and environment water. Some strains of *E. coli* cause diseases, such as diarrhea, indigestion, and dysentery (Made & Dwipayanti 2010; Wong et al 2012). Besides as an indicator of poor hygiene practices during handling, *E. coli* was also used as a food safety indicator. The total of *E. coli* in mackerel samples, expressed in Most Probable Number per gram (MPN g⁻¹) was shown in Table 3.

Table 3

Number of *Escherichia coli* of mackerel samples

Distribution chains	Total sample	% of the positive sample	Number of <i>Escherichia coli</i> (MPN g ⁻¹)	Standard (BSN 2013)
Fish Landing	150	12.67	3.0-75	
Fish auction	90	18.89	3.0-120	
Wholesale	60	11.67	6.1-93	<3 (MPN g ⁻¹)
Supermarkets	155	1.29	11-20	
Traditional markets	335	11.64	3.0 to >1100	

The number of *E. coli* of mackerel samples (Table 3) showed that their contamination has occurred at the landing side (3.0-75 MPN g⁻¹) and continued to increase during distribution (>1100 in traditional markets). Contamination indicates poor hygiene

practices during handling. The poor hygiene of equipment and environment in all stages of distribution (fishing vessel, landing side, fish auction, wholesales, and traditional markets), the lack of some hygiene facilities, as well as the poor application of cool chain system during handling were the main factor of this contamination. This was also supported by Deni (2015), stating that the implementation of sanitation and hygiene on boats, cleanliness of handling equipment, and fishermen during fishing was not implemented properly. Indrasari (2020) stated that one of the major problems related to coastal areas in Jakarta were waste and poor sanitation, which was a source of *E. coli* contamination for fish during landing and marketing in the auction. Field observation determined that most of Fish Auction and Traditional Market also have poor hygiene during marketing, due to inadequate drainage and building construction. Some animals, in particular rodents were considered a major source of pathogenic *E. coli* contamination and infection (Jang et al 2017; Ferens & Hovde 2011).

It was also reported that *E. coli* was present in fish sold at some traditional markets in Indonesia, such as cuttlefish and fresh shrimp in Pontianak (Sari & Apridamayanti 2014), fresh and smoked tuna in North Halmahera (Akerina 2018), Layang (*Decapterus russelli*) in Palu (Maruka et al 2017), and tuna in Aceh (Ummamie et al 2017). The similar situations were also reported in other countries, such as Brazil (Lascowski et al 2013), Nigeria (Eze et al 2011), and Iraq (Abbas 2014). *E. coli* is known as one of the most important pathogenic microbial in the field of food quality and safety. Their presence in fish and fishery products for human consumption is not only a potential disease source, but also mediates the transfer of antibiotic resistance to humans. Through the food chain contamination, *E. coli* can lead to mass mortality (Fattahi et al 2015).

Conclusions. The participants in the domestic market of Jakarta were in their economic active years. Both males and females participated in fish marketing, although males (57.50%) had a greater proportion than females (42.50%). Fish marketing is the main job and source of the family income of the participants. 41.88% of them had a low education level. The distribution chain of fresh fish at the domestic market in Jakarta was composed of fishermen, traders, collectors, wholesalers and retailers/supermarkets. Based on the total volatile base - nitrogen level, 100% of mackerel at landing side, fish auction, market and supermarkets complied with the TVB-N limit, while in the traditional trading site only 77.91% met the standard. Inappropriate cold chain applications, poor sanitation, and hygiene practices during distribution and selling were the main causes of the decline in fish quality. The *E. coli* contamination of mackerel started from the unloading and increased during marketing. Measures are required in order to preserve the fish safety and quality, including training related to GHdP, provision of supporting facilities for maintenance during distribution and marketing, as well as monitoring the fresh fish compliance to the safety standards, when necessary by enforcement regulation initiated by the authorities.

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