Accumulation of lead (Pb) on fish caught by millennium gillnets (ply) in Musi estuary, Banyuasin waters, South Sumatera, Indonesia

F Agustriani1*, A I S Purwiyanto1, W A E Putri1, Fauziyah1 and Y Suteja2

1Marine Science Department, Sriwijaya University, South Sumatra, Indonesia
2Marine Science Department, Udayana University, Bali, Indonesia

* E-mail: agustrianifitri@gmail.com

Abstract. Millennium gillnet (ply) fishing gear began operating in the coastal waters of Banyuasin in 2016. This tool is a government alternative to replace trawl fishing gear. The catches obtained include economic fish. The study was aimed to analyze the accumulation of lead on fish caught by millennium gillnet (ply) in Musi estuary. Fish were obtained from fishing ground fishermen. The samples taken were fish organs (gills, gastric contents and fish meat) then the samples were reconstructed using HNO3 and analyzed by atomic absorption spectrophotometer (AAS). The results showed that Pb accumulated in all types of fish caught using ply in Musi estuary and the amount exceeded the safe consumption limits applied by FAO, BPOM, and several countries. Overall, there is a tendency for the highest Pb metal accumulation in gills organs.

Keywords: Banyuasin, fish organs, millenium gillnet, Pb

1. Introduction

Banyuasin coast is one of the capture fisheries area in South Sumatra. Variety of catches from coastal such fishes, shrimps, crabs are marketed to various regions even overseas. Furthermore, Regency Banyuasin is a supplier of fish needs for the surrounding area including Palembang city. The total production of marine fish catches in 2009 to 2016 years is 266,323 tonnes refer to fisheries statistics at Banyuasin Regency. The research Fauziah et al (2012) and Anggraini et al (2019) explained that more than 36 species of fish were found in the waters of the Sungang estuary and fish biodiversity in Sungang estuaries has a moderate species diversity (Fauziyah et al 2019). Millenium gillnet (ply) is a type of gillnet fishing gear using multi monofilament twisted fiber net material and the transparent colour. This fishing gear began operating in 2016 as a substitute for trawl fishing equipment which has been banned by the government. Ply’s catches include Barracuda, Fourfinger threadfin, Largehead hairtail, Shortfin scad, Silver pomret, and Mackerel (Anggreini et al 2017). Fish is one of the sources of humans protein in fulfilling their daily needs. Likewise, in the South Sumatra community, a variety of fish-based foods are often found in this area such as “pempek” and “kemplang”. Therefore information regarding seafood security around this area is necessary.
Some previous studies found the presence of certain heavy metals in several fisheries commodities originating from the Banyuasin coastal. Research results of Aryawati and Agustriani (2004) indicated blood samples *Anadara granosa* Linnaeus shells coming from the east coast of South Sumatra contains Cu and Zn ranges from 387-28.6 µg/kg. Pb and Cu metals also accumulated of *Scylla serrata* meat which is sold and consumed by people around Palembang City (Purwiyanto and Lestari 2012). Furthermore, the results of research Setiawan *et al* (2013) found that the mercury content in *Pangasius polyuranodon* meat was 16,750 µg/g. Putri *et al* (2016) found that heavy metals Cu and Pb were concentrated in three organs (gills, liver, and meat) mullet and seluang fish caught in the Musi river downstream to the estuary. Pb absolutely not needed in the metabolic processes of living beings and even classified into heavy metal with high toxicity to organisms (Dartmouth Toxic Metals Research Program in 2001 *in Riani et al* 2014). Therefore the presence of Pb endangers aquatic organisms, and can even result in disability of aquatic biota, as in Chironomus larvae (Riani *et al* 2014). Knowledge of the concentration of heavy metal Pb in fish is known to be related to environmental management and human health because heavy metal toxicity can cause brain and kidney damage even arsenic can cause cancer (Dural *et al* 2007). This study aims to find out the accumulation of Pb metal in fish caught using ply nets which are operated around the Coastal Banyuasin and their feasibility for humans. The results are used as a reference by the public and local authorities.

2. Materials and methods

Sampling was carried out in July 2018 in Musi Estuary, Banyuasin Coastal Waters (figure 1). The target fish in this study were fish caught by ply nets operating in the Musi estuary. Fish samples were obtained from fishermen, then identified species refer to www.fishbase.org, separated by three types of organs observed, namely the contents of the stomach, gills, and meat then stored in the coolbox.

![Figure1. Research location.](image_url)
acetylene mixture has been used for plus variant (Arifin 2011). Detection limits for AAS SpectrAA-20 Plus Variants for Pb 0.01 μg/kg.

3. Result and discussion

The average concentration of lead varies among each type of fish caught using ply nets in the South Sumatra Coast. Besides, variations in concentration were also found in each organ observed (in stomach, gill, and meat) (figure 2 and table 1). The concentration of Pb in the fish stomach ranged from 1.6 to 6.6 mg/kg (average 5.1 mg/kg). The highest concentration is found in the contents of the shark's stomach and the lowest in mackerel fish. Furthermore, the average concentration of Pb in the gills ranged from 5.5-8.3 mg/kg (average of 6.4 mg/kg), the highest concentration was found in the gills of warm fish and the lowest in the gills of mackerel fish. Finally, in meat organs, Pb accumulation ranged from 3.8-5.3 mg/kg (average 4.7 mg/kg), the highest concentration was found in Selangat fish meat and the lowest was in Sembilang fish meat.

![Figure 2](image.png)

**Figure 2.** Pb concentration (mg/kg) stomach, gills, and fish meat caught using ply nets in Musi estuary. (■ = stomach), (■ = gill), (■ = meat).

In general, the highest average Pb accumulation was found in gill organs (6.4 mg/kg), then in gastric (5.1 mg/kg) and the lowest in meat organs (4.7 mg/kg). There are several factors that cause differences in Pb metal accumulation by each organ. As we know that one of the entry pathways of heavy metals in the body of an organism is through the skin, breathing (gills) and food. Generally, the highest metal accumulation is found in the gill organs because the gills are the entrance and the first filter tool in the body of the fish organism. In addition, the high metal content in gill tissue can be attributed to the respiratory function where the gills always have direct contact with water, besides the gills also have the most delicate epithelium of all organs (Kotze et al 1999). When water enters through the gills, both dissolved Pb ions and suspended particles that bind to the Pb metal are potentially bound to the gill lamella. According to Jezierska and Witeska (2001), gills are a part that binds and absorbs metals in the form of ions in water.

Several other studies also reported that gills have a high tendency to accumulate heavy metals (Wong et al 2001, Coetzee et al 2002). This can be caused by the presence of metal complexing with mucus which does not allow perfect cleaning of lamellae before analysis is carried out. The results of the Putri et al (2016) study found that the gills of seluang and mullets caught in the lower Musi river accumulated higher Cu and Pb metals than meat organs. Furthermore, the contents of the stomach, as a place to process and digest food before being transported throughout the body, then the food scraps are thought
to also contain Lead. Gu et al (2016) found that the entrails of fish contain heavy metals higher than other organs such as muscles and backbone. Variations in the heavy metals concentration accumulated in fish species were caused mainly by their diet. The concentration of heavy metals in meat organs is the smallest compared to gills and stomach (average of 4.7 mg/kg). This condition is found in almost all types of fish. However, this organ becomes important because it is an organ that is consumed by humans. According to Miller et al (1992), meat is the weakest indicator in detecting Cu and Zn contamination at a low level. This also applies to most other metals except mercury (Hg). Allen-Gil and Martynov (1995) mention that the low metal in meat can be caused by the low ability of muscles or meat to bind proteins (metallothionein).

Table 1. The average Pb concentration in the three types of organs of fish caught by ply in the Musi estuary.

| Fish species | Scientific Name* | Pb Concentration in Organ (mg/kg) | Average (mg/kg) |
|--------------|------------------|----------------------------------|----------------|
| Mackerel     | Scomberomorus commerson | Stomach 1.6 Gills 5.5 Meat 5.0 | 4.0            |
| Selangat     | Anodontostoma chacunda | Stomach 6.5 Gills 8.3 Meat 5.3 | 6.7            |
| Shark        | Carcharhinus sp    | Stomach 6.6 Gills 5.4 Meat 4.6 | 5.5            |
| White pomfret| Pampus argenteus   | Stomach 5.5 Gills 6.0 Meat 4.8 | 5.4            |
| Sembilang    | Plotosus canius    | Stomach 5.3 Gills 6.9 Meat 3.8 | 5.3            |
| Average      |                  | Stomach 5.1 Gills 6.4 Meat 4.7 |                |

*source: www.fishbase.org

The accumulation of the average Pb in each type of fish is also different. Figure 3 shows that on average in all organs, the highest Pb metal was found in warm fish (6.7 mg/kg), then sharks (5.5 mg/kg), white pomfret (5.4 mg/kg), Sembilang fish (5.3 mg/kg) and the lowest in mackerel fish species (4.0 mg/kg). Many factors that influence the accumulation of metals in each type of different organism. Zhao et al (2012), Many factors can influence the taking of heavy metals by fish organisms such as gender, size, age, reproductive cycle, movement patterns, eating habits and the environment. El-Moselhy (2014) states that differences in eating habits, habitat and living environment affect the accumulation that occurs. Yilmaz et al (2007) stated that differences in the concentration of heavy metals in meat, liver and, gills showed the capacity of each organ in accumulating heavy metals.

The tendency of each organ to accumulate heavy metals in this study was gills > stomach > meat. Even though it is in the smallest sequence in accumulating Pb metal, in general, the concentration of heavy metal Pb in the meat of all types of fish observed was within the limits that are not safe for consumption. For Pb metal, BPOM only allows 2.4 mg/kg in food products and according to FAO (1983), the maximum residual concentration of Pb allowed for marine products for human health is 1.5 mg/kg BW. When compared with several countries (Soegianto 2008) which applied the threshold for lead in seafood (table 2), it can be concluded that the concentration of lead in the meat of all fish species observed was at a level not safe for consumption. This is important to get mutual attention considering the existence of Pb which is toxic and threatened to enter the body of the organism.

The research that has been carried out regarding heavy metals around the waters of South Sumatra is Setiawan et al (2013) where the average concentration of mercury in Juaro fish meat caught in the Musi river is 16.7 ppb. Furthermore, Putri et al (2016) found the average concentration of lead in fish living in the estuary area, namely mullet fish meat 0.2 ppm and Sembilang fish meat 0.2 ppm.
Figure 3. Pb concentration (mg/kg) average type of fish caught using ply nets in Musi Estuary, Banyuasin Coast.

Table 2. The threshold for lead in food in several countries (mg/kg BW).

| Heavy Metal | Australia | Hongkong | European Regulation | Indonesia* |
|-------------|-----------|----------|----------------------|------------|
| Lead        | 1.8       | 7.2      | 0.5                  | 2.4        |

* Decree of the Director-General of Drug and Food Control Number 03725 / B / SK / VII / 89 concerning the maximum limit of metals in food (Soegianto 2008)

4. Conclusions

Lead (Pb) accumulates in all types of fish caught using ply nets in the Banyuasin Coast and the figure has exceeded the safe consumption threshold applied by FAO, BPOM and several countries. Overall, there is a tendency for the highest lead accumulation in gills organs.

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