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CADMIUM AND LEAD CONTENT IN AQUATIC ECOSYSTEM, BRACKISWATER PONDS AND FISH IN AREAS AFFECTED LAPINDO MUD

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Abstract

Lapindo mud has led to increased levels of heavy metals in aquatic ecosystem at eastern coastal Porong, sidoarjo, East Java, and therefore contributes to the heavy metals content in fish, especially cadmium and lead. This research aims to (1) determine levels of Cadmium and Lead in waters polluted by Lapindo mud, (2) analyzing the content of Cd and Pb in fish living in waters polluted by Lapindo mud, (3) determine the status of fishery product food safety on the farm affected Lapindo mudflow, (4) determine the recommendation for a solution. Research conducted by observation analytical method. Purposive sample was determined by Lapindo mud pollution maps. Location of research include aquatic ecosystem in Porong, Jabon, and Tanggulangin, Sidoarjo, which is divided into 5 sub locations namely: aquatic ecosystem around the Lapindo mud embankments reservoirs, fish ponds in the Reno Kenongo village, river in the Gempolsari village, brackish water ponds in the Tegalsari village, and ponds in the Permisan village. At each specified sub location, data collection 4 stations, each station is done 3 times repetition. Analysis of the levels of Cd and Pb doing in the Balai Besar Laboratorium Kesehatan Laboratory (BBLK) Surabaya with the method of Atomic Absorption Spectrophotometer (AAS). Data were analyzed descriptively qualitatively and comparing to the Standard Quality (East Java Governor Decree No.45/2002; Kepmen LH No.51/2004; PP.No 82/2001). The results showed the levels of Cd and Pb both in the water and the fish that live in waters polluted by Lapindo mud has exceeded the threshold value quality standard. Levels of Cd in water 0.018–0.080 ppm (>0.01 ppm), and Pb 0.013-0.074 ppm (>0.03 ppm). Cadmium concentration in fishs 0.037-1.542 ppm (>0.001 ppm), and lead 0.179-1.367 ppm (>0.008 ppm), so it does not meet food safety standards. It is necessary for heavy metal remediation.

Key words : cadmium and lead levels, aquatic ecosystem and brackish water ponds contaminated by Lapindo mud, fish, food security status.

INTRODUCTION

East coast Sidoarjo is an area of the largest organic farms in Indonesia. The area of the ponds in Sidoarjo reached 7.762 acres that became the livelihoods of 1.149 owners and 1.272 people of pondsworkers (pandega). The main products of the farms in this area are shrimp and miklfish (Chanos chanos) that besides marketed to consumers in the domestic as well export to

various countries. Approximately 30% of Indonesia's shrimp exports come from farms in Sidoarjo with a value of about 800 billion dollars per year.

One of the requirements that must be met by the fishery products are to be exported must meet the quality standards of food safety, which do not contain heavy metals. This is due to the high awareness of the public/consumers against hazards caused by heavy metal toxicity to health. The Lapindo mudflow containing various heavy metals has led to aquatic ecosystems and aquaculture in Sidoarjo region of heavy metal polluted. Given the nature of bioaccumulation and undegradable, the heavy metals are potentially absorbed by aquatic organism. Thus fishery products in areas contaminated by Lapindo mud, both products of aquaculture and fisheries products harvested by fishermen potentially contain heavy metals. As a result of the fishery products do not meet food safety standards, so it is not suitable for consumption and can't be exported. It is very urgent for research related to the content of heavy metals, especially Cadmium (Cd) and Lead (Pb) in fishery products in areas contaminated by Lapindo mud Sidoarjo, so it can be determined the status of safety (food safety). Thus it can be determined that the policy should be taken by the government in an effort to rehabilitate the environment of aquaculture in Sidoarjo region of heavy metal stress, thus resulting fishery products are safe for consumption.

Aquaculture in Sidoarjo, particularly in the southern region of the flow of water has been polluted by Lapindo mudflow containing heavy metals. As a result, the levels of some heavy metals, especially lead in water has been exceeded threshold quality standard (Purnomo, 2009). After the Lapindo mudflow lasted for 8 years (BPLS, 2007), then allegedly levels of heavy metals in the waters in this region is high, because it is unbiodegradable and bioaccumulation. In addition one of the effects of contamination by Lapindo mud include a decrease pond in productivity of more than 50% (Zulkieflimansyah, 2007).

Heavy metals Cd and Pb in aquatic ecosystems will lead to the phenomenon of biomagnification in the aquatic food chain. As a result of fishery products in the Sidoarjo region will be contaminated with Cd and Pb (Cheng, S.F. and C.Y.Huang. 2006), thus becoming unsafe for consumption. Of course this is very detrimental, given the Sidoarjo is a main producer of milkfish and shrimp in East Java (Suryadarma, 2007). Heavy metals contained in food products will have a negative impact on human health, as it will be chronic if the food they consume contain heavy metals (Suhendrayatna, 2001).

Contamination of farm aquatic by Lapindo mud containing heavy metals would affect the safety of fishery products. As a logical consequence, fishery products from Sidoarjo region threatened to blacklist entry in the arena of international trade of fishery commodities. During 2006 and 2007, exports of fishery products from East Java has several times experienced rejection in Japan (Suryadarma, 2007), because it does not meet the standards of Safety Assurance of Imported Foods in Japan because it contains heavy metals.

Research of results Purnomo and Soegiyanto (2013) known land in rice fields, swamp land and fish ponds polluted by Lapindo mud contaminated heavy metals, because the levels of Pb, Cd, and Se has exceeded the threshold value standards (SK. Gub.Jatim No.45/2002, PP.No.82/2001), namely rice (Pb 1.611 ppm, Cd 0.086 ppm, and Se 1.049 ppm), sugarcane (Pb 0.305 ppm, Cd 0.034 ppm, and Se 0.325 ppm), kale (Pb 0.814 ppm, Cd 0.624 ppm, and Se 1.086 ppm), fish (Pb 1.225 ppm, Cd 0.583 ppm, and Se 0.066 ppm). Thus the agricultural products was produced in the region polluted by Lapindo mud contaminated by heavy metals, that are not safe for consumption. This is because the agricultural land gets water from irrigation water contaminated by Lapindo mud. Based on the analysis of heavy metal content of known rice, sugar cane, kale, and fish containing Pb, Cd, and Se exceeds the threshold value does not meet the quality standard (PP.No 82/2001). Thus according to health standards are not suitable for consumption, as it is very dangerous to health (Purnomo and Soegiyanto, 2013).

For that needs to be reviewed as a result of contamination of aquatic ecosystems and

aquaculture farm by Lapindo mud and the impact on food safety of fishery products in the Sidoarjo region. On the other hand the results of previous studies showed Typha latifolia L., able to absorb and accumulate heavy metals, so it can be used as phytoremediator (Cunningham, S.D., and D.W. Ow. 1996) heavy metals in soil or ecosystem waters ponds polluted by Lapindo mud. For it is necessary to test the content of heavy metals (Cd and Pb) in fishery products, so it is known as the food security status of the main requirements for fishery products in the Sidoarjo region can still be exported to meet the needs of the world market.

Contamination of fishery products by heavy metals will be used as a reason to reject the fishery product from Sidoarjo region entered into the world market, for reasons not apply ecolabeling or eco friendly in its production system. In the era of free trade, the competition is getting tougher. In addition to product quality, environmental protection issues and other international issues also determine whether or not a product is entered into the world market. In the fisheries sector has been declared an ecolabeling efforts related to sustainable natural resource management. It is very urgent to do research on heavy metals, particularly Cd and Pb contained in fishery products so that food security status can be determined. If the content of heavy metals in the pond exceeded the safe threshold, then the application of phytoremediation of heavy metals in polluted aquaculture area Lapindo mud will do (Maiti, R.K., J.L.H. Pinero, J.A.G. Oreja, and D. L. Santiago. 2004). The purpose of this research is to find a solution to the contamination of the aquaculture area by Lapindo mud so that the status of food security (food safety) of fishery products in the Sidoarjo region is maintained. The specific objectives of this study were (1) determine the extent and distribution of heavy metals (Cd and Pb) on the ecosystem of aquaculture in Sidoarjo areas contaminated by Lapindo mud, (2) determine the levels of heavy metals in fishery products and alternative solutions to minimize heavy metal stress in waters ponds polluted by Lapindo mud, (3) provide policy recommendations to be taken as a solution for the rehabilitation of land aquaculture contaminated by Lapindo mud that produced fishery products meet food safety standards. The end goal is to be achieved in the Sidoarjo area of land acquisition ponds contaminated by Lapindo mud of heavy metal stress, especially Cd and Pb that fishery products produced meet food safety standards so it is safe for consumption.

RESEARCH METHOD

The study used survey in situ method and laboratory analysis. Determination of sampling stations conducted by purposive sampling is based on the purpose of the basic consideration of the different characteristics of the environmental setting and pollutant loads caused by Lapindo mud. Location of study include waters in Porong, Jabon, and Tanggulangin, Sidoarjo East Java, divided into 4 sublocation namely: (1) the waters around the Lapindo mud embankment reservoirs, (2) fish ponds in the village of Reno Kenongo, (3) Gempolsari village river, (4) pond in the village of Tegalsari, and (4) ponds in the village of Permisan. At each specified sublocation data collection 4 stations, each station is done 3 times repetition. Key measurements include physical and chemical parameters of water, content of heavy metals (Cd and Pb) fishery products (milk fish) in ponds and fisheries products (Thilapia mossambicus and Oreochromis mossambicus) in the river. Analysis of the levels of heavy metals doing in the Balai Besar Laboratorium Kesehatan (BBLK) Surabaya with the method of Atomic Absorption Spectrophotometer (AAS). Data were analyzed descriptively and qualitatively compared Quality Standards (SK Gubernur Jatim No.45/2002; Kepmen LH. No.51/2004, and PP.No 82/2001). The results studied are then analyzed with regard to: (a) Characteristics and status of heavy metal pollution in river and pond waters associated with environmental carrying capacity

for environmentally friendly aquaculture, (b) Status of food security (food safety) produced fishery products related to the quality standards of food safety,(c) Government policy is needed to protect fisheries and east coastal of Sidoarjo area as organic aquaculture area to be free of heavy metals stress that fishery products produced meet the quality standards of food safety.

RESULT AND DISCUSSION

Contents of Cadmium and Lead in the waters polluted by Lapindo mud

The results showed the levels of Cd and Pb in the waters polluted by Lapindo mud Sidoarjo has exceeded the threshold value quality standard. Lead concentrations in water ranging from 0.013-0.074 ppm (> 0.03 ppm) and Cd 0.018-0.080 ppm (> 0.01 ppm).

Levels of Cadmium and Lead in aquatic ecosystem around the Lapindo mud embankments reservoirs

Levels of Pb except at station 3 has exceeded the threshold quality standard, while Cd levels at all stations above the quality standard (SK Gub.Jatim No.45/2002; Kepmen LH No.51/2004). Thus the waters around the Lapindo mud shelter polluted Cd and Pb in heavily polluted category. This is possible due to the close proximity and got the water supply directly from the Lapindo mud shelter area. This condition is very worrying because the water from this place then flows into the area of aquaculture in the region Permisan, thus potentially pollute the eastern coastal area of Sidoarjo.

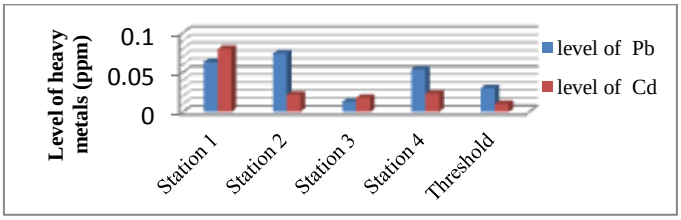

Figure 1. Histogram levels of heavy metals (Pb and Cd) (ppm) in the aquatic ecosystem around the Lapindo mud embankments reservoirs compared to the quality standard.

Levels of Cadmium and Lead in water fish ponds in the village Kenongo Reno

Levels of Pb in water fish ponds on average 0.02 ppm, only at station 4 0.03 ppm, while the average levels of Cd 0.01 ppm, except at station 4 0.02 ppm. Thus both Pb and Cd levels still meet the criteria of the standard. This is due to the water fish pond mostly comes from rain water and only partly derived from river water.

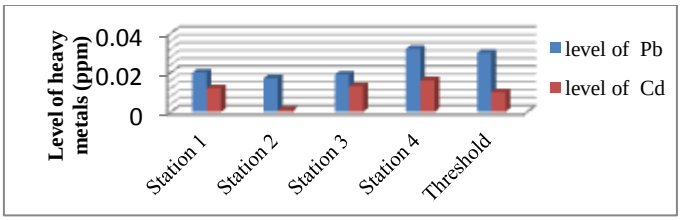

Figure 2. Histogram levels of heavy metals (Pb and Cd) (ppm) in the fish ponds in the Reno Kenongo village compared to the quality standard.

Levels of Cadmium and Lead in water river in the village Gempolsari

The water of the river in the village of Gempolsari, Tanggulangin polluted by heavy metals, because the levels of Cd and Pb in the river water has been exceeded threshold quality

standard. Average levels of Pb 0.050 ppm and Cd 0.028 ppm. High levels of both types of heavy metals is caused aside from upstream rivers, most of the water comes from the waste water stream from the Lapindo mud ponds (Purnomo, 2009). Polluted Gempolsari river water will have implications for fishery products in ponds, because the river water will be the raw material in the aquaculture Tanggulangin area.

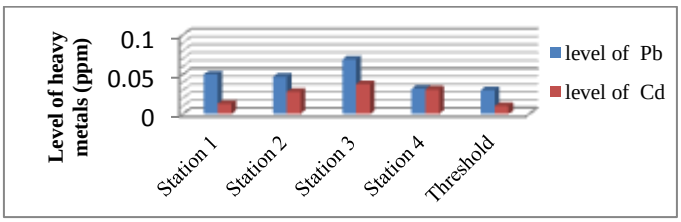

Figure 3. Histogram levels of heavy metals (Pb and Cd) (ppm) in the water river in the Gempolsari village compared to the quality standard.

Levels of Cadmium and Lead in Brackish water ponds in the village Tegalsari

Brackishwater ponds in Tegalsari was polluted by heavy metals, because both Cd and Pb levels have exceeded the threshold standards. Average levels of Pb 0.028 ppm and Cd 0.056 ppm. The second high heavy metals is possible as raw water for irrigation ponds in this area most of the river water has been polluted both the heavy metals. This fact is certainly very worrying will contaminate fish and shrimp are cultivated in ponds the region.

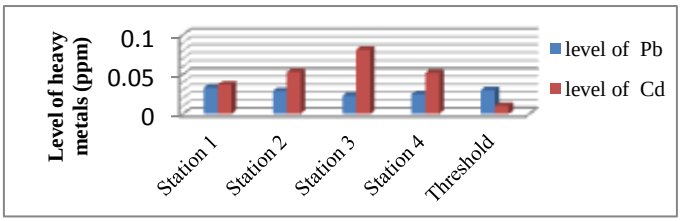

Figure 4. Histogram levels of heavy metals (Pb and Cd) (ppm) in the brackish water ponds in the Tegalsari village compared to the quality standard.

Levels of Cadmium and Lead in Brackishwater ponds in the village Permisan

Brackishwater ponds in the village of Permisan Porong had been contaminated Pb and Cd. Both types of heavy metal levels in the water has been exceeded threshold quality standard, the levels of Pb 0.064 ppm and Cd 0.023 ppm. High levels of both of these metals in the brackishwater ponds Permisan because the water supply received directly from the river water by Lapindo mud. It is therefore very likely that aquatic organism is also cultivated in ponds contaminated by heavy metals.

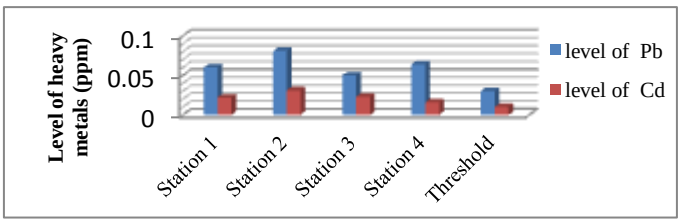

Figure 5. Histogram levels of heavy metals (Pb and Cd) (ppm) in the brackish water ponds in the Permisan village compared to the quality standard.

Contents of Cadmium and Lead in fish living in waters polluted by Lapindo mud

The content of Cd and Pb in fish living in polluted waters of the Lapindo mudflow has exceeded threshold the quality standard (PP.No 82/2001). Content of Pb in fish range from 0.179-1.367 ppm (> 0.008 ppm), and Cd 0.037-1.542 ppm (> 0.001 ppm) that does not meet food safety standards.

The content of Cadmium and Lead in fish living in rivers Polluted by Lapindo mudflow

The content of Cd and Pb in Thilapia mossambicus fish and Oreochromis mossambicus fish taken from river polluted by Lapindo mud has exceeded the threshold standards. The content of Pb in Thilapia mossambicus fish on average 1.080 ppm and 0.914 ppm in Oreochromis mossambicus fish, far above the quality standard, which is 0.008 ppm. While the content of Cd in Thilapia mossambicus fish reach the 0.023 ppm and 0.006 ppm in Oreochromis mossambicus fish, also has exceeded the threshold quality standard (PP.No 82/2001). Thus both of these fish have been contaminated metals Cd and Pb and do not meet food safety standards for consumption.

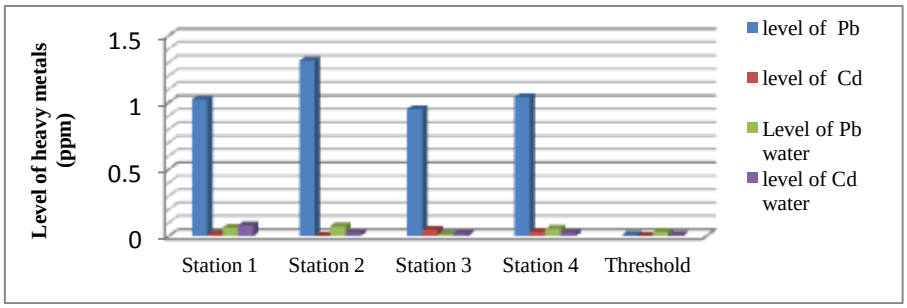

Figure 6. Histogram levels of heavy metals (Pb and Cd) (ppm) in Thilapia mossambicus fish living in waters polluted by Lapindo mud compared to the quality standard.

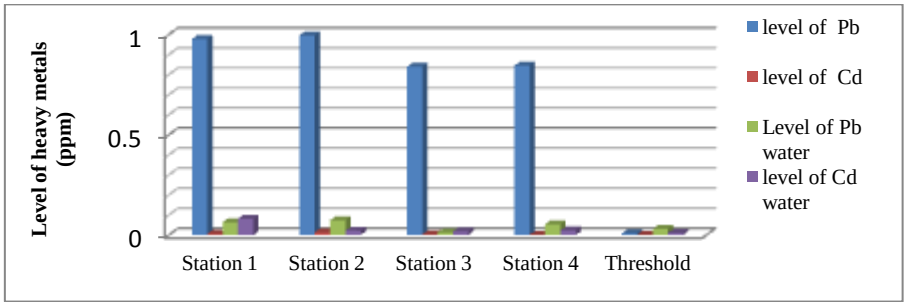

Figure 7. Histogram levels of heavy metals (Pb and Cd) (ppm) in Oreochromis mossambicus fish living in waters polluted by Lapindo mud compared to the quality standard.

The content of Cd and Pb in fish cultivated in ponds contaminated by Lapindo mudflow

Lead content in fish (Chanos chanos) cultivated in ponds of contaminated by Lapindo mud reach 0.741 ppm and Cadmium 0.814 ppm. Thus this fish does not meet food safety standards. The high content of both metals is due to the relatively stagnant water pond resulting in the accumulation of heavy metals from the input stream as a raw water pond. Besides its hard to unravel, these metals are absorbed and accumulated in phytoplankton and algae who is a natural food milkfish (Chanos chanos) (Prasad, M.N.V and H.M.O. Freitas, 2003). In the body of this milkfish is the second metal bioaccumulation so experience levels will be higher with age and biomass milkfish.

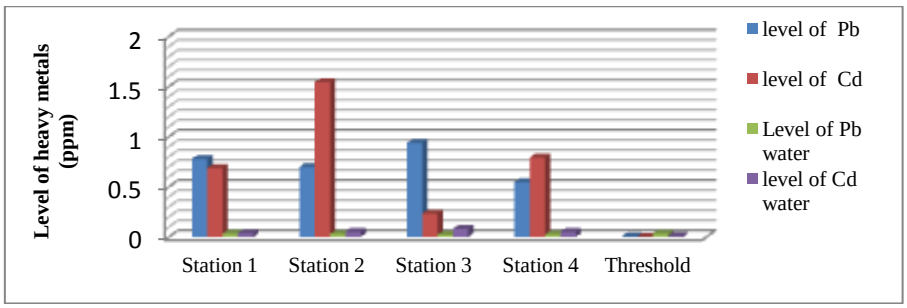

Figure 8. Histogram levels of heavy metals (Pb and Cd) (ppm) in Chanos chanos living in brackishwaters pond polluted by Lapindo mud compared to the quality standard.

CONCLUSION AND SUGGESTION

The results showed the levels of Cadmium and Lead both in the water and the fish that live in waters polluted by Lapindo mud has exceeded value the threshold of standards for quality. Lead concentrations in water ranged from 0.013-0.074 ppm (> 0.03 ppm), Cd 0.018-0.080 ppm (> 0.01 ppm), and lead concentrations in fish ranged from 0.179-1.367 ppm (> 0.008 ppm), and Cd 0.037-1.542 ppm (> 0.001 ppm) that does not meet food safety standards. It is necessary for heavy metal remediation.

Levels of heavy metals Cadmium and Lead in waters polluted by Lapindo mud above threshold quality standard, for it to be done restoration by way of bioremediation at waters polluted by Lapindo mud.

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