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Original paper

THE CHROMIUM (Cr) CONTENT IN WATER AND IN THE TISSUE OF MUD CRAB (*Scylla serrata* Forskal.) IN THE BRACKISHWATER PONDS AROUND BABON RIVER ESTUARY OF SEMARANG COASTAL AREAS IN CENTRAL JAVA INDONESIA

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ABSTRACT

One of the problems that faced by marine aquacultures is the presence of industrial development in the nearby areas. The research aim was to study Chromium (Cr) content in the waters and in the crabs (Scylla serrata) in Brackishwater ponds around Babon River estuary of coastal areas Semarang, in Central Java. Systematical random sampling was used in this study. Analysis of Cr content in the water was compared to water quality criteria by Indonesian Ministry of Environmental. Analysis of Cr content in the tissue of crab was based on Manual Criteria by United States Food and Drug Administration (U.S. FDA). Bioconcentration Factor was used to analyse the accumulative of Chromium content. The results showed that Chromium content in the water was 0,078 ppm (dry season) and 0,065 ppm (rainy season), respectively. *Chromium content in the tissue of mud crab (Scylla serrata) was* 5,237 ppm (*dry season*) and 4,848 ppm (*rainy season*) and *was under of maximum level recommended (12 ppm). The Bio Concentration Factor (BCF) of Cr content has low accumulative characteristic (<100).*

Key word: *Chromium, Barackishwater Pond, Babon river estuary, Crabs (Scylla serrata)*

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INTRODUCTION

Babon river is a river in eastern Semarang which is used for industrial needs as well as aquaculture activities in downstream area. The estuary of Babon river is in Trimulyo village located in Genuk subdistrict Semarang. Babon river estuary has special characteristics as industrial area with aquaculture ecosystem. Geographically, the area is near to Kaligawe industrial area in east Semarang. Mainly this area has been used as brackishwater aquacultures, but there has been growing industry around the river.

Water pollution in Babon river estuary and aquaculture area around it comes from industrial activity which disposes their liquid wastes to the river (Suprapti,1998, Takarina et al, 2004).

The disposal of industrial waste is estimated as the cause of pollution of aquaculture environment and the organisms inside (Alifia and Djawad, 2003). There are three ways of how poisonous substance contaminating the organisms in the water, namely: through organisms' skin or surface, respiration or water ingestion, and through by feeding (zooplankton, phytoplankton) that contains chemical polluted substances (Jardin, 1993).

Waste water contains include of materials poisonous substance that contaminates waters is

heavy metals (Aditya, 2005). One example of heavy metal is Chromium that is dangerous for environment including humans if its existence is upper the threshold. There is research result which shows that the accumulation of Chromium.

Crab is one of potential sea foods which contains high protein. Traditionally, mud crabs are collected from the nature. Due to the increase in market demand, mud crab culture in Semarang areas has developed significantly. Crabs are well know as a deposit feeder biota, so that mud crab (*Scylla serrata*) potential to accumulate heavy metal. This particulary very relevant in the mud crab culture areas of Trimulyo village which is located in the estuary of Babon river which are bordered with industrial development, many of them produced liquid waste containing metals.

The purpose of the study was to estimate the content Chromium in the pondwater and the tissues of mud crab Scylla serrata as a result of metal introduction from industries in the surrounding areas.

MATERIALS AND METHODS

Samples were collected in dry (October 2009) and rainy seasons (July 2010). The research location included 10 stationsin Trimulyo village, based on how far or near from Babon river estuary as pollutant source spot. Crabs were collected by using systemic random sampling (Cochran, 1997).

The sample of crabs were obtained by using trap cages that were set in the pond. The sample collection was done three times for each station. The sample size of crab was 1000 grams (consumption size), then their lengths were measured. The chromium contents in the crab (*Scylla serrata*) and in the aquaculture water were analyzed in Laboratory of Analytic Chemistry, Mathematics and Science Faculty of Diponegoro University by using Atomic Absorption Spectroscopic (AAS). The physical and chemical factors of waters were measured *in-situ* using Water Quality Checker including pH, temperature, salinity, DO, the river flow strength, the river depth, turbidity and conductivity.

The chromium contents in the pond waters were analyzed based on Water Quality Criteria using Setting Guidelines for Quality Standards by Indonesian Ministry of Environment (2004). As for the crab, it was analyzed according Guidelines for the Determination of Food Quality Standards by United States Food and Drug Adminnistration (US FDA, 2009). Bio Concentration was used to know organism ability in accumulating heavy metal (Van Esch, 1977). Bio Concentration Factor (BCF) was calculated to estimate the amount heavy metal input from the surrounding environment. The bio concentration factor is the ratio between the chemical concentration in the organism and the chemical concentration in water, et equilibrium:

$$BCF_{crab} = \frac{C_{crab}}{C_{water}}$$

Where C_{crab} is the chemical concentration in crab (test organism) in mg/kg (preferably wet weight), C_{water} is the chemical concentration in water, in mg/l, and BCF_{crab} is the bio concentration factor for the test organism (Kumar, and Achyuthan, 2007).

Statistic test (SPSS 13.0) was used to figure out the different content of Chromium and physical-chemical factors between dry and rainy season (Uyanto, 2006)

RESULTS AND DISCUSION

As the mud crab (*Scylla serrata*) is a popular seafood (Mirera and Mtile, 2009), it is not surprising that *S. serrata* has a successful culture history in south east Asian and fetches a high price in local and international markets (Cowan, 1984). Mud crab culture in mangroves or tidal flats has been practiced in Indonesia, Vietnam and China and is considered to be ecologically friendly (SEAFDEC Asian Aquac, 1997). However, the development of aquaculture in assciation with the presence of industrial activities in surrounding aquaculture has become a threat since the industries may dispose their waste containing metals into the surrounding.

Data obtained from 10 stations in this research are presented in Table 1, 2, 3 and Figure 1 and 2. The average content of Chromium in pond water

on dry season and rainy season can be seen on Table 1 and shows significantly different content of Chromium on dry season and rainy season in which Chromium content was higher in the rainy season. This finding was in aaccordance with (Sugiyono, 2006) who reported the value of Cr content on rainy season were higher than dry season.

The lower concentration of average Chromium content in pond waters was because of sedimentation of Chromium waste in the sediment and dilution of Chromium waste by raining water (Suprapti,1998). The increasing of the total rainfall can raise the pond volume so that the Chromium waste content was diluted by the big water volume. The dilution waqs also influenced by wind and the high river flow.

Chromium spreads widely on the nature. In the water bodies, Chromium can enter through two ways: naturally and non-naturally. The natural way of Chromium entering the waters is because some physical factors like erosion. The non natural way of Chromium entering the water is as side effect of human activity of industry like electroplating, tannery, textile industry,

Table 1.
Chromium content in the waters

Station	Season	
	Dry (ppm)	Rainy (ppm)
ST.1	0.081	0.057
ST.2	0.063	0.048
ST.3	0.077	0.061
ST.4	0.086	0.069
ST.5	0.072	0.062
ST.6	0.074	0.061
ST.7	0.082	0.072
ST.8	0.079	0.072
ST.9	0.083	0.074
ST.10	0.080	0.074
Average	0.078	0.065
Std.Dev.	0.066	0.086

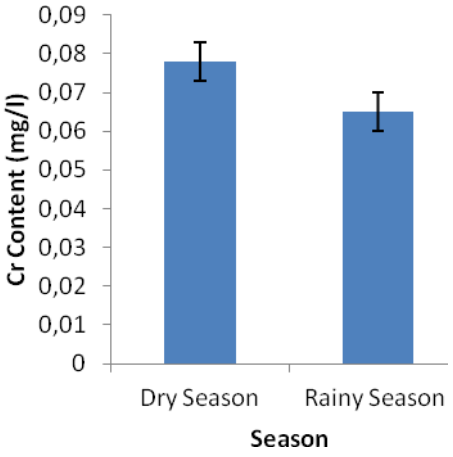

Figure 1.
Histogram of the average of Chromium content in brackishwater pond

paint industry and domestic waste disposal. In this case, the source of Cr pollutant may be from tannery and textile industry around research location. (Suprapti, 1998 and 1999).

According to standard of water quality from Environmental Ministry Decree Number 51 year of 2004 (Kep. *Men. KLH. RI. No.51 / 2004)* State Regulation by Indonesian Ministry of Environment about quality standards of sea for sea biota, the maximum Chromium content in the sea was 0.005 ppm. (Kepmen LH. 2004). The data from Heni *et al* (2008) also shows that the accummulation of heavy metal (include Cr) in the coral reef tissue (at Jepara sea) was higher than environmental threshold value.

Based on standard of water quality State Regulation, the Chromium content (0.065-0.078) in the pond waters were higher than quality standard (Table 1 and Figure 2), however brackishwater pond quality of some physical factors like temperature, river depth, salinity, pH, DO and turbidity were still according to life organisms (Table2).

The result of statistical test for all physical-chemical parameter on dry and rainy season, showed that there was not any difference of turbidity, pH, DO and river depth parameter

between dry season and rainy season. But, there was significant difference of temperature, salinity, conductivity and river flow speed parameter. The Chromium content in rainy season is lower than in dry season because of the rain water. Beside that, the difference was also because of the significant difference of physical-chemical factors like temperature, salinity, conductivity and river flow speed between dry season and rainy season (Table 2).

According to Table 3, the Chromium content in the crab on dry season and rainy season seems almost same, with the average value of 5, 237 ppm for dry season and 4, 848 ppm for rainy season. The result of Difference Test of Chromium content in the crab between dry season and rainy season showed unsignificant different result (Figure 2).

Crab (*Scylla serrata*) is fishery product which has high economical value. The crab has hard shell, delicious taste and good nutrition, 40 % of its body can be eaten and 60 % of it is carapas and other minerals content. It contains high calcium and low protein. Crab lives in mangrove ecosystem, and also in brakhiswater. As benthic animal, crab likes to sink its body in to the mud. The crab must be able to anticipate any kind of environmental changes, including the pollution of heavy metal. The crab has full meta-morphoses. It is euryhaline animal with salinity 0-35 ‰. The crab is also a nocturnal animal which is so active at night, eating everything (omnivorous) and a deposit feeder animal. The last characteristic of crab makes it contains the highest heavy metal (4.848-5.237 ppm).

Some studies show that metal or any compound that contains Chromium can be accumulated in the human body and if it reaches certain limit it will be carcinogenic (Palar, 2008). Because of that reason, the research on the Chromium content in the crab is so important to do. From the research, it is known that the Chromium content in the crab has not been over the threshold that was <12 ppm (Table 3). According to Ghufran (2007), though the crab is so delicious and contains high protein (its tissue: 65,72%), it is not suggested to eat it everyday since its daily value is lower than 0.12 ppm

.Table 2. Different test of Physical-Chemical Parameter between Dry Season and Rainy Season

Physical-Chemical Parameter	Unit	Dry Season		Rainy Season	
		Average	Sdt.dev	Average	Sdt.dev
Temperature*	^{o}C	29.17	± 0.62	27,5	± 0.56
Turbidity	NTU	42.71	± 13.37	42,71	± 12.57
Depth	Cm	71.88	± 17.67	115.67	± 17.01
pH		7.06	± 0.21	6.28	± 0.14
DO	mg/L	6.05	± 0.78	6.09	± 0.87
Salinity*	‰	30.98	± 1.39	23,33	± 2.37
Conductivity*	mS/cm	49.00	± 0.21	36.5	± 3.47
Flow speed*	cm/sec	0.05	± 0.15	3.97	± 0.50

Note * : Significantly different ($\alpha = 0.05$)

The BCF value is influenced by type of heavy metal, the kinds of organism, how long the heavy metal exposed to, and also the environmental condition. Research by Gagneten and Imhof (2009) concern the Cr accumulation in the freshwater crab, showed that the high efficiency of freshwater crabs to accumulate Cr from water with low BCF value 64.50.

The Chromium content in the crab tissue (*Scylla serrata*) is influenced by the characteristic of the crab which relatively lives in bottom of the waters, or as deposit feeder animal. In this case; based on the measurement of Bio Concentration Factor (BCF) value, shows that the BCF of crab in dry season was 65,86 and rainy season was 74.58., so that the bioaccumulation of Chromium content

in the crab has low accumulative characteristic(BCF < 100).

Tabel 3. Chromium content in the crab

Stasiun	Season	
	Dry (ppm)	Rainy (ppm)
ST-1	6.158	5.123
ST-2	5.796	5.274
ST-3	5.681	4.250
ST-4	6.159	3.845
ST-5	4.836	4.256
ST-6	4.655	5.123
ST-7	4.340	4.126
ST-8	5.085	6.088
ST-9	4.731	4.274
ST-10	4.927	6.124
Average	5,237	4,848
Std	1.812	1.639

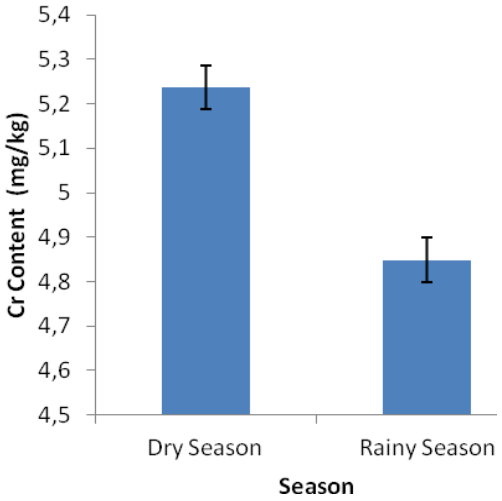

Figure 2. Histogram of the average Chromium content in the crab tissue

CONCLUSIONS

It can be conclude that Chromium content in the pond water was 0,078 ppm (dry season) and 0,065 ppm (rainy season), respectively. Chromium content in the tissue of mud crab (Scylla serrata) was 5,237 ppm (dry season) and 4,848 ppm (rainy season) and was under of maximum level recommended (12 ppm). The Bio Concentration Factor (BCF) of Cr content has low accumulative characteristic (<100). However, considering that *Scylla serrata* is an economically important species of crab found in the estuaries and mangroves of Asia including Indonesia, it is recommended that culture site selection and controlling the introduction of metals especially Chromium from surrounding environment are necessary for successful culture and health consideration.

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