Cadmium and Chromium Accumulation in Cockles along the Estuary of Sungai Tampok and Sungai Sanglang

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ABSTRACT. Sungai Tampok and Sungai Sanglang located in Johor thrives in terms of aquaculture industry. Since most of the villagers are fisherman, the aim of this study is to determine heavy metals on cockles (Anadara granosa), and seawater. Cockles were collected from four stations at Sungai Tampok on 26th December 2016, 16th March 2017. Meanwhile, cockles from Sungai Sanglang were collected from three sampling stations on 11th January to 26th March 2017. The samples were then analysed for cadmium (Cd) and chromium (Cr). Water samples were also collected from the same location as cockle sampling stations. Cd and Cr in seawater were above Class 3 based on Marine Water Quality Criteria and Standard showing that the area is unsuitable for marine aquaculture, aquatic life and fishing activities. Accumulation of heavy metals on cockle also exceeded the Malaysian Food Regulation (1985).

Keywords: Cadmium; Chromium, Cockles (Anadara granosa).

INTRODUCTION

Cockle also known as Anadara granosa is a saltwater clam, a marine bivalve mollusk from the family of CARDIIDAE. Cockle has high economic value as food and it can be kept in aquaculture. Besides being consumed as a protein rich food, they are also used as a bio-indicator for detecting toxicity in aquatic communities (Tu, 2011). Cockles lives in low oxygen environment and ingest more viruses and bacteria unlike other varieties of clams that are safe to eat. Studies has been conducted on the toxicity of heavy metals in the tissue of cockles to ensure that cockles are safe for human consumption (Yap, 2003). Cockle sampling were conducted at Sungai Tampok and Sungai Sanglang which is located in Johor. Human activities such as plantation, industrial and farming at the vicinity of Sungai Sanglang and Sungai Tampok, had affected water quality at the estuary. These factors have an important role to cause heavy metal accumulation in the area. Besides heavy metal accumulation, the distribution and quantity of the cockles are also affected by human activities along the areas. Polluted river can affect the cockles and spats, which resulted in high mortality (Neville, 2016). Both river areas serve as very important natural resources for the local people. It also helps the local people in term of economics where most of them depend on fishery as their income. The water quality at the area has significantly been affected due development. In 2005, Malaysia produced around 100,000 tonnes of cockles during its peak harvesting for local consumption and export. However, in 2015, the amount of cockles per tonnes produced was reduced to 16,000 tonnes. The harvested cockles in the industry were valued at RM160 millions for 2015. The impact are felt by consumers who have to pay between RM10 and RM 15 per kilogram in 2016 compared to just RM 2 and RM 3 a decade ago.

Heavy metals can be absorbed by living organisms because of their high solubility in the aquatic environments. Once they enter the food chain, large concentrations of heavy metals may accumulate in the human body. The metals that are ingested beyond the permitted concentration can cause serious health disorders (Babel, 2003). There are many ways or paths for the heavy metals to emit to the environment for example from the air during combustion, extraction and processing, to the surface waters (e.g. runoff and releases from storage and transport) and to the soil (groundwaters and crops). The greatest concern in terms of human health is the atmospheric emission. The quantities and widespread disperse along with the potential exposure are often ensues. The exposure does not result only from the presence of a harmful agent in the environment, intact contact is the key word to get the exposure (Berglund, 2001). The contact should be between the agent and the outer boundary of human body such as airways, skins and the mouth.

Cadmium compounds are mainly used in rechargeable nickel cadmium batteries such as our mobile phone. The emission has increase dramatically during the 20th century. Its products are often dumped together with household waste because the products are rarely recycled item. Cadmium is also present as a pollutant in phosphate fertilizers, sewage sludge to farm land and industrial emissions. These may lead to contamination of soils and increased cadmium uptake by crops and vegetables. Low pH will enhance the uptake process of soil cadmium by plants (Jaranp, 1998). Cadmium exposure may cause kidney damage and its long term affects in high cadmium exposure may cause skeletal damage.

Cadmium can be exposed through breathing, eating or drinking and through skin contact with cadmium or cadmium compounds. The level of chromium in air and water is generally low. In drinking water, the level of chromium is usually low as well, but contaminated well water may contain chromium (IV). The main human activities that increase the concentrations of chromium (III) are leather and textile manufacturing. The main human activities that increase chromium (VI) concentrations are chemical, leather and textile manufacturing, electroplating and other chromium (VI) applications in the industry. These applications will mainly increase concentrations of chromium in water. Through coal combustion chromium will also end up in air and through waste disposal chromium will end up in soils. Chromium is not known to accumulate in the bodies of fish, but high concentrations of chromium, due to the disposal of metal products in surface waters, can damage the gills of fish that swim near the point of disposal. In animal chromium can cause respiratory...
problems, a lower ability to fight disease, birth defects, infertility and tumor formation. The objectives of this study is to identify accumulation of cadmium and chromium in cockles and level of pollution along the estuary of Sungai Sanglang, Pontian and Sungai Tampok, Benut, Johor, Malaysia

METHODOLOGY

Samples were collected at 3 different sampling stations for Sungai Sanglang, whereas 4 sampling stations for Sungai Tampok. The cockles were collected manually at low tide from inter-tidal areas. The cockles were then cleaned externally by washing it thoroughly with clean water before being transferred into sampling bags. The collected samples were kept frozen in the refrigerator prior to heavy metal analysis. The samples from every station were grouped into 3 sizes i.e. small, medium and large. The sizing of the samples was based on its size range. Small cockle was around 2 cm and below, while medium and large sizes are around 2-3 cm and more than 4 cm respectively. The samples were prepared before analyzing the heavy metal concentration. The classified samples kept dried in the oven at 60°C for a day until its totally dried. The samples were then grinded. The grinded samples for each size were weighted for 1.0 g and added with 10 mL of HNO₃ diluted with deionized water in the ratio of 1:1. The sample was transferred into a beaker and covered with a watch glass and heated at 95°C for about 10-15 minutes using hot plate without being boiled. The lid of the beaker was kept closed to avoid the steam in the air to evaporate. After that, the sample was cooled and 5 mL of concentrated HNO₃ was added. The sample was refluxed for about 30 minutes with the lid opened and the solution was evaporated to 5 mL without boiling. The sample was then cooled and 2 mL of water and 3 mL of H₂O₂ was added. The lid of the beaker was then closed and warmed on the hot plate until the solution started the peroxide reaction. Samples were then heated until effervescence subsides and cool in the beaker. Then H₂O₂ was continually added in 1 mL with warming until the effervescence is decrease and sample appearance unchanged. However, please ensure the added H₂O₂ was not greater than 10 mL. The solution was added with 5 mL of concentrated HCL and 10 mL of water. The solution in the beaker was covered and returned to hot plate to reflux for 15 minutes without boiling. After cooled, sample was diluted with 100 mL of deionized water using volumetric flask. Atomic Absorption Spectrometer (AAS); Perkin Elmer AAS Pinnacle 900T was used for analysis of heavy metals i.e. chromium (Cr) and cadmium (Cd).

RESULTS AND DISCUSSION

Cadmium

Figure 1.0 shows the concentration of Cd in water for Sungai Tampuk and Sungai Sanglang. Sungai Sanglang has similar concentration for both sampling occasions except for S1 which was slightly higher on 26th December 2016. Water samples at Sungai Tampuk have higher concentration on 11 Jan 2017 compared to 26 March 2017. The highest Cd concentration was recorded at S1-Sg Tampuk at 0.24 mg/L. Based on Malaysia Marine Water Quality Standards (MWQS), Sungai Tampok and Sungai Sanglang are classified as polluted with cadmium because the concentration recorded was more than 0.01 mg/L at Class 3.

Sungai Tampok recorded concentration of Cd in cockles in the range of 0 to 4.28 µg/g as shown in Figure 2.0. The highest concentration of Cd was 4.28 µg/g at S4-Sg Tampuk for medium size. However Cd concentration at Sungai Sanglang was in the range of 0-3.85 µg/g. Based on Malaysian Food Regulation (1985), the limited concentration of Cd in seafood is 1.0 µg/g. It shows that most of the sampling stations for both Sungai Tampok and Sungai Sanglang exceeded the concentration limit. Cockles does not need cadmium in their growth, thus it means the amount of cadmium could be toxic to cockles and is not suitable for food sources.
Chromium

Figure 3.0 shows the concentration of Cr in water with the highest concentration was recorded at sampling S2-Sg Tampuk on 16 March 2017. Meanwhile, concentration of chromium at Sungai Sanglang was highest at 1.177 mg/L at S1-Sg Sanglang. Based on MWQS, Sungai Tampok and Sungai Sanglang are considered polluted with chromium because the concentration was higher compared to class 3 at 0.048 mg/L.

The highest concentration of Cr in cockles was recorded at 98.3 µg/g at S2-Sg Tampuk in medium sizes (Figure 4.0). Cr concentration at Sungai Sanglang was in range of 32.34-89.30 µg/g. Malaysian Food Act 1983 and Regulation 1985 and WHO/FAO 2004 did not set any limit for Cr in bivalves. However, IAEA – 407 reported that a permitted level for Cr in the marine organism is 0.73 mg/kg.
CONCLUSION

The concentration of Cd and Cr in seawater were above Class 3 based on Marine Water Quality Criteria and Standard showing that the area is suitable for ports, oil & gas field and unsuitable for marine aquaculture, aquatic life and fishing activities. Accumulation of heavy metals on cockle also exceeded the Malaysian Food Regulation (1985) for Cd. It shows that the area is polluted and is unsuitable for aquaculture and fishing. Sungai Sanglang has a recreational park near the estuary. Human attraction location may lead to increase of human density, thus the amount of littering is higher. Land-based activities such as development and agriculture increased might decrease the water quality levels.

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