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CADMIUM UPTAKE IN OYSTER *ISOGNOMON ALATUS* UNDER LABORATORY CONDITION

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ABSTRACT

The uptake of cadmium in Flat tree oyster *Isognomon alatus* was investigated under controlled laboratory conditions for two weeks. Oysters were exposed to 100 $\mu g\ l^{-1}$ cadmium and the accumulation of cadmium in the tissues was measured for every two days. Soft tissues of oyster were digested in concentrated acid and cadmium concentrations were determined by using Atomic Absorption Spectrophotometer. The accumulation of cadmium in the soft tissues of oysters was increased during the first six days from 0.73 $\mu g\ g^{-1}$ to 10.77 $\mu g\ g^{-1}$, and remaining constant for four days at average level of 10.96 $\mu g\ g^{-1}$. The Cd concentrations was increased to 32.70 $\mu g\ g^{-1}$ until the end of experiment. There was no sign of cadmium accumulation approaching saturation for the period of exposure.

Key Words: Cadmium, Uptake, Oyster, Malaysia

Introduction

It is well known that oysters, which are filter-feeders, accumulate high levels of heavy metals concentrations. Oysters have been proposed as an indicator organisms by various authors [1-6] and they have been the objects of choice for kinetics studies of heavy metals bioaccumulation in the laboratory conditions [7-12]. Theoretically, they may also be used to quantify the degree of metals pollution to which they have been exposed [13]. The quantification of metals pollution has two aspects: comparison of metal levels in the tissues of oysters from different areas may be used to assess relative degrees of metals pollution, and rates of metal accumulation in oysters tissues may be used to calculate average metal levels in the surrounding water [13-15].

In evaluating data from the use of oysters as monitoring organisms it is importance to know, how certain levels of metals in the ambient water are reflected in the body burden. In order to understand and interpret data on metals pollution and to plan for future studies, it is necessary to have information on the rates of uptake of metals [16]. As yet, no information is available about the fate of cadmium in flat tree oysters during long-term exposure under defined conditions. Therefore, a comprehensive investigation has been initiated into the dynamics of cadmium in oysters. This study is to assess the uptake of cadmium in flat tree oyster *I. alatus* for short term exposure.

Materials and Methods

Flat tree oyster, *Isognomon alatus*, were collected from Sepang Kecil River in June 1999. The oysters were acclimatized in fiberglass tank, for one week before experiments were begun. Thirty oysters of 50 mm to 60 mm shell length were used to avoid the influence of the reproduction cycle on metals body burdens. Oysters were placed in each of 3 glass aquarium containing 15 L seawater which was continuously aerated. Cadmium was added as $CdCl_2 \cdot H_2O$ (Merck, no. 9960) to a concentration of 100 $\mu g\ l^{-1}$. Oysters were exposed for two weeks. Seawater and cadmium were renewed and redosed every two days in order to clean up the aquarium and to adjust the nominal exposure concentration. At interval of two days, six oysters (2 animals × 3 replicate) were examined individually for cadmium concentrations in the tissues.

Soft tissues were defrosted, shucked, drained, removed from their shells, and pressed to extract excess water and digested in a 10 ml concentrated nitric acid at 140°C for 3 hours. The digests were then made up to volume with double-distilled water and then analyzed by atomic absorption spectrophotometer model Perkin-Elmer 4100. The data are presented in wet weight. To avoid possible contamination, all glassware and other equipment was acid washed and rinsed with double-distilled water before use. In order to assess the accuracy of the method, standard addition experiments were carried out and used of blanks. The recovery of metal analyzed were 90-100%.

Results and Discussion

The time dependent accumulation of cadmium is shown in Figure 1. In general the addition of cadmium in seawater induced increases in the cadmium concentration in the oysters. The results showed that cadmium levels in the oysters increased continually until the sixth day from 0.73 $\mu g\ g^{-1}$ to 10.77 $\mu g\ g^{-1}$. The levels of cadmium in the oysters remained constant for 4 days at 10.77 $\mu g\ g^{-1}$- 10.96 $\mu g\ g^{-1}$ and increased until the end of the exposure. The level of cadmium in the oysters reached 32.70 at 15th day when the exposure were ceased. In 15 days oysters can accumulate 44 times of cadmium and there is no evidence of cadmium saturation levels.

Large variations in cadmium accumulation have been demonstrated in different species of marine organisms. Frazier and George [9] in the exposure of *Crassostrea gigas* and *Ostrea edulis* to 100 μg Cd l^{-1}, have found that the cadmium uptake rate was a linear function of time over the period investigated (111 days). The Cd accumulation pattern in the gastropod (*Viviparus georgianus* and *Elliptio complanata*) was observed [17] by a fast uptake during the first 5 days followed by a slower absorption rate for the rest of the exposure period (15 days). In the exposure of snail *Lymnaea stagnalis* to 100 $\mu g\ g^{-1}$ Cd for two months , there was linear uptake pattern till the 16th day, followed by an intensive increase till the 21st day, and then Cd level occurred at 200 $\mu g\ g^{-1}$ at the end of exposure time [18].

Cadmium uptake patterns have previously been studied in *Mytilus edulis* [19,20,21]. In some cases the cadmium uptake was found to be linear with time without evidence that the cadmium accumulation was approaching saturation, but Borchardt [19] for example found that the uptake of Cd-115 via sea water during a 33-d exposure period fitted a type of exponential-function better than a straight line. Amiard et al. [22] has reported when, *Mytilus edulis* were exposed to a large range of concentrations of cadmium (2.5, 25, 250, 2500 $\mu g\ l^{-1}$), at the lowest concentration, a significant increase of cadmium was observed. At the two lowest cadmium additions, the tissue levels of this metal remained steady between 4 and 8 d of exposure. At higher experimental concentrations, linear accumulation has been recorded [14,22,23]. In the experiment carried out by Riisgard et al. [21] on mussel results showed that the total uptake of cadmium (100 ppb) in as a function of exposure time (apparently) was linear throughout the experimental period of 162 h.

The results of the study show that cadmium uptake by flat tree oyster *Isognomon alatus* is biphasic, with relatively slow increase at the beginning, after that no significant increase, followed by high rate of uptake. The same pattern has reported in some marine organisms by other authors [12,24,25,26]. Hemelraad et al. [24]

showed the biphasic kinetics of Cd accumulation in *Anodonta cygnea* exposed to 25 $\mu g\ l^{-1}$ Cd. Results from the study on Cd uptake in *Crassostrea virginica,* also showed biphasic accumulation pattern [12]. Same pattern was reported by Giesy et al. [25] for Crayfish, *Procambarus acutus* which exposed to Cd (10 $\mu g\ l^{-1}$) for 80 days. Biphasic phenomenon are also found by Hardy and Roesijadi [26] in the clam, *Protothaca staminea* after exposure to cadmium for 48 hr.

In this study slow rate uptake was observed at the first 6 days of exposure. This phenomenon may be due to biochemical activities, cadmium must be complexed before fast uptake can occur [21,27]. Viarengo et al. [28] and Simkiss and Mason [29] present evidence for the occurrence of metal-binding ligands in molluscs which are induced by exposure to metals. This pattern of uptake is consistent with the suggestion that cadmium must be complexed before fast accumulation can occurs. Coleman et al. [27] in the study on cadmium uptake in *Mytilus edulis* also reported that this lag phase occurred because of the need to synthesize ligands to complex metal ions.

There are two possibilities for delaying and remaining of uptake during the next four days. One possibility applies, when the uptake occurs across the plasma membrane of the gill. Whenever the gill concentration of free cellular Cd would equal the ambient concentration, no further accumulation would take place [30]. A second possibility could imply a behavioral response of the animal to adverse effects of accumulating Cd in the gill. Thus the animal could stop ventilation as soon as continued entrance of metal can no longer be accommodated for [31]. At the beginning of experimental contamination the gills play the most important part in cadmium accumulation [32]. According to Zaroogian [12] gills serve as an excretory organ. Therefore, cadmium could be eliminated through the gills. If gills are functioning in both uptake and excretion of cadmium, that could account for localization of cadmium in the gills [12]. Amiard et al. [22] established that cations can be complexed by mucous secretions. He also demonstrated that metal intoxication induced increased mucus production by the gills. The combination of these two mechanisms and subsequent mucus delamination could limit the rate of entry of the metals.

Conclusion

The knowledge of Cd uptake dynamics in the oysters contributes to an improved estimation of the survey data for the use of this species as a biomonitoring agent. The present study has confirmed that *I. alatus* has a capacity for accumulating cadmium, since high accumulation was observed in oysters cultured in sea water containing 100 $\mu g\ l^{-1}$ cadmium. On the basis of our results, it may be established that after a short pollution period (1-2 weeks), *I. alatus* can reflect the higher Cd concentrations. More study need to be carry out to understand more on the uptake of cadmium in oysters.

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