COBALT IN MANGROVE SNAILS, NERITA LINEATA AND SEDIMENTS FROM PENINSULAR MALAYSIA

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Abstract- Rapid growth of the industries have generated various trace metal pollutions in the coastal waters of Peninsular Malaysia. Therefore it is essential to establish baseline studies of trace metal levels in marine species for biomonitoring purposes. This study aimed to provide the baseline concentration and the ability of the Nerita linaeta as a good biomonitoring agent for Co. Mangrove snails, N. lineata, and sediments were collected from at least 10 geographical sites of the western and southern part of Peninsular Malaysia from 2010 to 2011. The concentration of Co was determined in the shells, opercula and soft tissues of the N. lineata and the sediments by using ICPMS. The range of mean concentration of Co in the snail samples collected from Peninsular Malaysia were BDL – 0.96 µg/g dry weight, while the sediments range were 2.5 – 16.7 dry weight. The distribution of Co in the snails was in the decreasing order of soft tissues > opercula ≥ shell. The BSAF data and Person's correlation coefficient between the sediments and the snails (shells, opercula and soft tissues) showed poor ability of the snail as a biomonitor for the Co.

Keywords- Cobalt, biomonitor, Nerita lineata, biota-sediment accumulation factor, gastropods

I. INTRODUCTION

Cobalt is a silvery metal element with an atomic number 27 [5]. It is categorized in the transition elements of the periodic table with a tendency to share their electrons with other elements to form complex ions [12]. Excessive exposure to cobalt was documented to cause damage to lungs, heart, and thyroid [11]. Since the beginning of the 20th century, the production of Co has increased due to its high demand in electronic and pottery industry [7]. The massive production of Co in the industry has also become one of the major sources of pollution to the environment [11]. Like many other metals, upon release into the environment, Co reacts with sediments and living organisms in a range of biogeochemical reactions that might increase the toxicity characteristics of the metal as well as the uptake of the metal by organisms [9]. The main concern of this issue is that the uptake of Co by marine organisms might biomagnify through the food chain as humans are one of the top predators [8].

In this study, the mangrove snails, Nerita lineata and sediments were collected for Co determination. Sediment has a well established reputation of the ultimate agent that represents the degree of pollution in a particular environment [15]. The N. lineata were common marine snails found in the mangrove area of Malaysia, Indonesia and Singapore. Although several attempts to investigations the potential of on the N. lineata as a biomonitor heavy metals were conducted by previous researchers (1, 3, 14), no reported data on Co in this species were recorded in the literature. This research aims to determine the baseline level of Co in the snails and sediments collected from Peninsular Malaysia.

II. MATERIALS AND METHODS

2.1. Sample preparation

Snails and sediment samples were collected from 11 sites and 10 sites of Peninsular Malaysia, respectively between the periods of 2010 to 2011. The shells, opercula, and tissues of the snails and sediments were dried separately at 60 °C until constant dry weights are achieved. Triplicates of each samples were prepared to be digested with 7 ml of HNO_3 65% + 1 ml H_2O_2 30% for the snails and 9 ml of HCl + 3 ml of HNO_3 65% for sediments in a microwave digester. Digested samples were then analyzed for Co concentrations by using the Perkin Elmer SCIEX ELAN DRC-e ICP-MS. The limit of detection for Co was < 0.1 ppt.

2.2. Data treatment

One-way ANOVA Student-Newman-Keuls test (statistical analysis) and biota-sediment accumulation factors (BSAF) (Equation 1) were calculated as suggested by Szefer et al. [10] to determine the relationship between sediments and snails.

Equation 1:

$$BSAF=\frac{Cx}{Cs}$$

where Cx and Cs are the mean metal concentrations in the different parts of the snails and in the surface sediment, respectively.

III. RESULTS AND DISCUSSION

Table 1 shows the averages of Co levels for shells (0.13 µg/g dw), opercula (0.17 µg/g dw) and soft tissues 0.28 µg/g dw) in the snails. The highest levels of Co were found in Tj. Harapan for shells (0.55 µg/g dw) and opercula (0.45 µg/g dw) while the highest in soft tissues (0.96 µg/g dw) were found in Lukut of the snails. The ranges of shell, opercula and soft tissues (µg/g dw) for Co were BDL – 0.55, BDL – 0.45 and BDL – 0.96 µg/g dw, respectively. The results showed visible pattern of Co accumulation in the snails in a decreasing order of soft tissues > opercula ≥ shell. This could be due to the fact that Co is an essential metal for the normal functions of organisms [12]. Cobalt is known to be an important component of vitamin B12 (cyanocobalamin) involving in various enzymatic processes in human body [6]. This is supported by previous studies which reported that essential metals were recorded higher in the soft tissues as compared to the shells of gastropods [14].

As for sediments (Table 1), the average of Co level is 6.77 µg/g dw, with the highest level recorded in Sg. Ayam (16.7 µg/g dw). The range of Co in sediments is 2.50 – 16.7 µg/g dw. Sungai Ayam is located in one of the most polluted area of Johore which could be the reason of higher levels of Co in the sediments of this site [13]. It was also reported that elevated levels of high metal in Sg. Ayam was related to industrial and domestic effluents in that area [14].

Table 1: Mean, standard deviation (SD), minimum and maximum (µg/g dry weight) of Co in the shells, opercula and soft tissues of Nerita linata (n=11) and sediments (n=10) collected from Peninsular Malaysia.

Sites	Shell		Opercula		Soft Tissues		Sediments	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Kpg. Pasir Puteh	BDL		BDL		BDL		5.54	0.15
Sg. Ayam	BDL		BDL		0.05	0.005	16.7	2.01
Jetty to Pulau Ketam	0.03	0.004	BDL		0.17	0.02	5.94	1.2
Sg Janggut	0.02	0.004	0.02	0.007	0.1	0.02	5.56	0.08
Kukup	0.01	0.004	BDL		0.1	0.004	10.7	0.11
Lukut	0.02	0.008	BDL		0.96	0.02	2.5	0.05
Kpg. Sg. Melayu	BDL		BDL		0.43	0.02	6.93	0.1
Tg. Langsat	BDL		BDL		0.08	0.02	3.35	0.11
Tj. Harapan	0.55	0.003	0.45	0.009	0.78	0.08	NA	NA
Sepang	0.14	0.02	0.11	0.011	0.09	0.003	5.97	0.52
Tg. Piai	0.13	0.001	0.12	0.009	0.12	0.04	4.45	0.18
Mean	0.13	0.19	0.17	0.19	0.29	0.33	6.77	4.14
Min	BDL		BDL		BDL		2.5	
Max	0.55		0.45		0.96		16.7	

***BDL = Below Detection Limit; NA = Not Available**

The average BSAF values for Co are presented in Table 2 which showed the general pattern of metal accumulation in the different parts of the snails. Generally the BSAF values ranged from 0.001 – 0.092, 0.003 – 0.076 and 0.003 – 0.383 for shells, opercula and soft tissues, respectively. All values of the three parts of the snails for Co were categorized as deconcentrators (BSAF<1) according to Dallinger [4] which indicated that Co was not significantly bioaccumulated in N. lineata from their environmental habitats. This is supported by Pearson's correlation coefficient which showed no positive relationships between the snails (shells, opercula and soft tissues) and sediments (P>0.05).

Table 2: Biota-Sediment Accumulation Factor (BSAF) of the Shells (S), opercular (Oper) and soft tissues (ST) of Nerita lineata based on mean metal concentrations of 10 sampling sites

Sites	S/SED	Oper/SED	ST/SED
Kpg. Pasir Puteh	-	-	-
Sg. Ayam	-	-	0.003
Jetty to Pulau Ketam	0.005	-	0.029
Sg Janggut	0.003	0.003	0.018
Kukup	0.001	-	0.009
Lukut	0.006	-	0.383
Kpg. Sg. Melayu	-	-	0.062
Tj. Langsat	-	-	0.022
Tj. Harapan	0.092	0.076	0.131
Sepang	0.031	0.024	0.020

CONCLUSIONS

This study provides the baseline data of Co concentrations in the shells, opercula and total soft tissues of N. lineata and the surface sediment collected from Peninsular Malaysia. Both BSAF and Person's correlation coefficient data does not support the N. lineata as a good biomonitor for Co. However further research is required to verify this finding.

ACKNOWLEDGEMENT

The authors wish to acknowledge the financial support provided through the Research University Grant Scheme (RUGS), [Vote no.: 9199791], by Universiti Putra Malaysia.

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