Heavy metal concentration in oyster tissues

Discussion

As summarised in the above chapter, a wide variation of heavy metal concentration(Zn, Ni, Cu, Cd, Pb and Co) in oyster tissues such as gills, muscle, shell and remaining soft tissue, sediment and seawater have been observed at the studied coastal areas. Therefore the main aim of this chapter is to establish relationship between heavy metal concentration in the oyster tissues namely gills, muscle , shells and remaining soft tissues, seawater and sediments at selected locations namely Poudre d'or, Bras d'eau and Trou d'eau Douce. Finally, correlation between heavy metals analysed in organs with organs was discussed.

Heavy metal accumulation in sediment and seawater at Poudre d'or, Bras d'eau and Trou d'eau Douce.

Sediments act as a major sink for heavy metals in the marine environment and may be good indicators of long and medium term metal input (Palpandi et al., 2012). The availability of metals in sediment provides an opportunity for aquatic animals to bio accumulate these metals and later bio accumulate them through the food chain. (Palpandi et al., 2012). In marine environments, heavy metals discharged from industrial and sewage effluents and from atmospheric deposition may be rapidly removed from the water column and transported to the bottom sediments (Fung, 1977).

In this study. The total average concentration of Nickel was higher in sediments followed by Cadmium, Zinc, Lead, Copper and Cobalt (Ni> Cd> Zn> Pb> Cu> Co) for the three sampling locations. This trend follows a similar pattern in the order of (Zn> Cu) in Kodiayakkarai coastal environment.(Palpandi et al, 2012). The variation in the accumulation of heavy metals in sediment along the North East Coast of Mauritius may be due to their geographical location(Philips, 1977), Moreover the difference in the pattern of heavy metal accumulation in sediment could have been influenced by the discharge of varying amounts of sewage and industrial wastes (Palpandi et al., 2012).

In the present study Cu concentration ranged from 0µg/g to 0. 018µg/g in Poudre d'or in the sediment At the same time differential levels of Cu was reported by different researchers in sediments from different areas (Palpandi et al., 2012). Some of the worth mentioning studies are as follows: 3. 1-30. 2 µg/g in Brisbane river, Australia (Mackey, 1992); 80. 0 µg/g in Deep Bay, Hong Kong(Tam, 2000). Zn concentration 0. 002µg/gto0. 038µg/g in Poudre d'or was lower when comparing with a study done in Hong Kong, 240. 0 µg/g at Deep Bay (Tam, 2000). In the present study Pb concentration was found very low (0 to 0. 026µg/g) in Poudre d'or.

Several studies on Pb in sediments have been conducted in several regions (Palpandi et al, 2012). High levels of Pb, 26-630 µg/g, were detected in North Sea (Everrates et al., 1992). The higher content of Zinc and Cu is largely due to the anthropogenic input and it may be said that it is being immobilized through co-precipitation with carbonates and thus cause a lesser hazard to the ecosystem.

The Lead concentration in in sediment is dependent on the nature, adsorption and retaining capacity of the substrate (Murthy et al., 1985). These variations are considered due grain size, organic carbon content, composition, composition of sediments (De Groot et al., 1981) geological weathering and the presence of well-developed mangrove forests which create physicochemical conditions suitable for the accumulation of the measured metals in the mangrove muds (Harbison, 1986).

The higher content of Ni and Cd may be largely due to the anthropogenic input of the nearby activities such as discarded vehicles, batteries, tires and crude oil spill, atmospheric fallout as well as waste-waters disposal and it may be said that the heavy metals are being immobilized through co-precipitation (Palpandi et al., 2012) of organic matter (Reinson, 1975) and also by the composition of the mineral assemblage which enhance adsorption of heavy metals from seawater and incorporate them in the sediment (Murthy et al., 1985).

The concentration of cadmium (0. 022µg/g) in seawater at Poudre d'or, Bras d'eau and Trou d'eau Douce exceeded the permissible limits for effluent discharge into the oceans as per the EPA 2002 Act of Regulations 2003 of Mauritius Government Notice 2003.

In the present study the results of paired t-test for Zn and Cu concentration showed a positive significant relationship between sediment and tissues in the above metal concentration. From this, it would be inferred that the available metal concentration in the ambient medium might have influenced the uptake of metal as observed (Kumaraguru, 1980).

Heavy metal Accumulation in oyster organs namely gills, muscle , shells and remaining soft tissues with sediment in all the three sampling sites namely Poudre d'or, Bras d'eau and Trou d'eau Douce.

For metals in bottom sediments to be a major source of metals in the tissues of filter feeding organisms, there should be a close relationship of heavy metals in the sediments and the oyster tissues.(Birch et al., 2014). Bivalve molluscs reflect the heavy metal concentration of the particular area in which they settle (Brugmann, 1981).

Results indicated that the pattern of heavy metals accumulation in the oyster *C. gigas* and *S. cucullata* from sediments were more or less similar (Zn> Cu> Cd> Pb> Co> Ni). (P <0. 05) was obtained in a paired t-test in Zn concentration and Cu concentration between remaining soft tissues and sediment showing there is a statistically significant correlations in Zn and Cu between remaining soft tissues and sediments. That means, Zn conc increases or decreases in remaining soft tissues do significantly relate to Zn and Cu availability in sediments.

The poor correlation between Cd, Ni, Pb and Co concentration and oyster tissues namely gills, muscle, shells and remaining soft tissues may is similar to a study done in Sydney Estuary (Birch et al., 2014) where it was concluded that sediment metal concentration are not good predictors of metals in oyster tissues. But a similar study of the relationship of oyster tissye concentrations and metals in sediments (Birch and Hogg., 2011) indicated a significant relationship between Cu and Zn in sediments and oyster tissue.

This could be explained by Zinc being an essential element and therefore regulated by the animal tissue (Vazquez-Sauceda et al., 2011). Cu is known to be one among the essential element for marine organisms (Lauenstein et al., 2002). Aquatic organisms such as bivalve molluscs use Cu to make haemocyanin which is a respiratory pigment in bivalves (Caussy et al., 2003). The pattern of heavy metal accumulation in the oyster tissues such as gills, muscle, shell and remaining soft tissues suggests that bivalve molluscs probably accumulate Cu in its organs. (Peer et al, 2010). The poor correlation found in the current study may be due to a number of factors, such as natural and anthropogenic processes and homeostasis of heavy metals by the organism. (Birch et al., 2014)

Relationship between heavy metals in different oyster organs namely gills, muscles, shells and remaining soft tissues.

Bivalve molluscs shell and tissues are good indicator of heavy metal contamination along the coasts due to their sessile and sedentary life cycle and they reflect the heavy metal concentration of that particular area in which they settled (Brugmann, 1981). The concentration of cadmium, copper, lead, zinc, nickel and cobalt in oyster tissues and sediments can provide an indication of the degree of pollution in the coastal habitats. The use of oyster shells as bio monitoring material for heavy metal contamination is due to the direct absorption of heavy metals on their shell surface due to the direct contact with the surrounding seawater (Yap et al., 2003). Bivalve mollusc species may use their shell for sequestration of a certain amount of heavy metals uptake (Cravo et al, 2004). This could be as a detoxification process of non-essential and excess essential metals which are present in molluscs system (Cravo et al, 2004)

As shown in table (4), Copper(r= 0. 976, P <0. 05) in gills and muscles, Cadmium(r= 0. 999, P <0. 05) in gills and shells and Cadmium(r= 0. 976, P <0. 05) in gills and remaining soft tissues shows a strong positive statistically significant correlation.

Results indicated that the pattern of heavy metals accumulation in the oyster *C. gigas* and *S. cucullata* organs were (Gills> Muscle> Remaining soft tissue> Shell) and the pattern of metals accumulation in these organs, were more or less similar (Cu> Cd> Zn> Pb> Co> Ni). Gill accumulated the highest Cu concentration as compared to muscle, shells and remaining soft tissues. Unlike the gills which was found to bio accumulate most heavy metals, such as Cd and Copper, the shells of the oysters *C . gigas* and *S. cucullata* accumulated the least heavy metals. The remaining soft tissues was found to contain a higher level was found to be as compared to the shell . This may be due to the soft tissue composition of the oyster which contain various subcellular metal containing granules (Brown, 1984), which may function as a route for the accumulation, storage and excretion of heavy metals by the gills itself.(Simkiss, 1977)

A previous reported data were based on whole soft tissues of T. telescopium. Showed Overall, Cu concentrations in the whole soft tissue from the present study when compared to the previous study by Ismail and Safahieh (2004) are within the ranges.

Metal distribution in the different soft tissues could be due to environmental metal bioavailability of the habitats and biometric characteristics (Cravo and Bebianno, 2005). According to Laskowski and Hopkin (1996), the distribution of metals in the soft tissue and shell indicated that contamination in the soft tissues can pose a more important threat to higher trophic levels because the protein in the soft tissues is easily soluble and readily available for higher trophic levels during consumption.(Yap et al., 2009)

Relationship between size effects and heavy metal uptake

Body size plays an important role in the bioaccumulation of heavy metals (Gupta et al., 2011). Heavy metal contamination may differ according to the species. It was observed that *S. cucullata* from Bras d'eau and Trou d'eau douce accumulated the highest mean concentration of heavy metals in their body. Spearman's rho test showed that there was a positive correlation between the two different sizes of *C. gigas* . The uptake of heavy metals is highly dependent on geochemical and biological factors of the specific location (Gupta et al, 2011). Within a single species bioaccumulation can be a function of age, size and their feeding activity and reproductive state (Boening, 1997).

Generally, harvesting and consumption of oyster species are regardless of their size (Yesudhason et al., 2013). During the current study, oysters sampled ranged in size from a minimum of approximately 2 to 5cm. However, small sized oysters showed relatively higher cadmium and lead concentrations than large sized oysters, but this difference did not show statistical significance. Large sized oysters contained higher mean concentrations heavy metals in their all their organs as compared to smaller sized ones. The relatively low concentrations of cadmium and lead concentration observed in large sized oysters, suggests that oysters of large sizes are sexually mature and have efficient metabolism to undergo a detoxification process (Connell et al., 1999) to keep the concentration of heavy metals in their tissues relatively low.