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Heavy metals concentration in rock oyster *Crassostrea cattuckensis* from Ratnagiri coast

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Abstract: *Rock oyster Crassostrea cattuckensis of medium (88.99 mm shell length) sizes from Bhatye estuary at Ratnagiri were collected in monsoon, winter and summer seasons. The soft body parts on dry weight basis showed more amounts of zinc (µg/gm) during monsoon from siphon (196.89) followed by mantle (186.61), hepatopancreas (177.19), gill (171.43), gonad (171.28) and adductor muscle (158.62). The lead content was more in mantle (1.52) and hepatopancreas (0.76). The metal was not detected in monsoon. The cadmium was more in hepatopancreas (12.77) than siphon (11.05), gill (10.40), gonad (8.09), mantle (6.65) and adductor muscle (6.17). The copper metal showed more in gill (7.71) followed by siphon (6.89), hepatopancreas (6.46), gonad (4.45), mantle (4.38) and adductor muscle (3.40). The zinc metal during winter was more in siphon (193.51) followed by mantle (179.95), hepatopancreas (175.01), gill (160.28), adductor muscle (155.78) and gonad (145.82). The lead content was more in mantle (31.49) than gill (25.42), siphon (24.66), gonad (16.32), hepatopancreas (14.80) and adductor muscle (14.42). The cadmium was more in gill (23.33) than hepatopancreas (20.88), siphon (18.92), gonad (17.16), mantle (16.95) and adductor muscle (14.94). The copper metal showed more in gill (12.54) followed by siphon (10.22), mantle (7.29), hepatopancreas (7.24), gonad (5.73)and adductor muscle (4.71). During summer zinc metal was more in gills (152.12) followed by siphon (143.86), adductor muscle (118.57), mantle (109.21), gonad (109.10) and hepatopancreas (102.38). The lead content was more in adductor muscle (11.76) than gill (11.39), gonad (11.01), siphon (9.87), mantle (8.73) and hepatopancreas (5.32). The cadmium was more in gonad (8.80), gill (8.38), siphon (7.41), hepatopancreas (6.18), adductor muscle (4.76), and mantle (4.60). The copper metal showed more in gills (6.41) followed by gonad (4.93), siphon (4.55), mantle (3.29), adductor muscle (3.27) and hepatopancreas (2.96). Among the metals zinc was high in monsoon followed by winter and summer seasons. The level of lead was high in winter and low in monsoon. The cadmium and copper metals were high in winter and low in summer.*

Key Words: Oyster, *Crassostrea cattuckensis*, Body parts, Heavy metals,

Introduction

Amongst the marine resources shellfishes are well known to accumulate chemicals from the polluted environments. The chemical residues of concern are certain heavy metals and their abnormal levels in seafood pose hazards to public health. The ability of molluscs to concentrate heavy metals in their tissues to a very high level from the environmental water has been reported by many researchers (Umadevi, 1996; Bigas *et al.,* 1997; Reinfelder *et al.,* 1998 and Mcgeer *et al.,* 2000 and Suryawsanshi and Mane, 2007). This property of the bivalve molluscs may be utilized to monitor metallic pollution in the aquatic-environment. They continuously take up substances from their environment and tissue concentration of the metal reflects the average concentration of the metal in the habitat water. The elements of most concern are cadmium, copper, mercury and lead. Amongst the shellfishes the bivalve molluscs appear to have particularly high capability for concentrating metals in their body

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along with other foreign materials found in their environment when they filter food particles during feeding. The bivalve molluscs are known to accumulate metal ions from the environment to a very high level relative to the concentration in water (Nambison *et al.,*1977). Changes of heavy metals in different seasons in marine bivalves were reported by (Chakravathy and Vass, 1999; Fraysse, *et al.,* 2000; and Suryawanshi and Mane, 2009). The present study was taken up to understand the distribution and seasonal variations of zinc, lead, cadmium and copper in *Crassostrea cattuckensis* inhabiting Bhatye estuary at Ratnagiri coast of Maharashtra.

Materials and Methods

Crassostrea cattuekensis were collected with help of fishermen from Bhatye estuary at Ratnagiri during monsoon (August), winter (December) and summer (May). Soon after the fishing, they were brought to the laboratory and the shells were brushed to clean the fouling biomass and mud. They were then stocked in continuous aerated filtered seawater pumped in the laboratory from the estuary for 24 to 48 hours for depuration. The five individuals of medium sized (88.99 mm shell length) were sacrificed separately to different body parts. The body parts were weighed and it was then kept in hot air oven at 92^{o}C till constant weight was obtained. The dried product was ground to obtain fine powder for determination of metals. For determination of the metals, 500 mg dry material of the oysters was digested with 10 ml mixture of nitric acid and perchloric acid (4:1) at 100^{0}C temperature till a clear solution was obtained. The samples were cooled at room temperature and filtered through Whattaman No. 43 filter paper and these filtrates were then diluted with 0.1N HNO_3 upto 25 ml with deionized water. These solutions were analyzed for zinc, lead, cadmium and copper metals using atomic absorption spectrophotometer according to the standard methods by (APHA, 2005). The data obtained were statistically analyzed for confirmation of the results and expressed in µg/g dry tissue.

Results and Discussion

The heavy metal pollution is known to be major problem in aquatic environment because of their toxicity tendency to accumulate in organisms and in undergoing food chain amplification (Vinikour *et al.,* 1980). Metal concentrations in aquatic organisms are typically several orders of magnitude higher than that in the water, this is because they became progresively concentrated at higher tropic levels. Sedentary animals like many molluscs which are not subjected to rapid migration can be severely affected if the water column is contaminated by these toxic chemicals (Hiswankar *et al.,* 1988). Amongst the marine resources shellfishes are well known to accumulate chemicals from the polluted environments. This phenomenon is important in assessing the seasonal changes in the availability of metals in an estuarine organism. Since filter feeder such as molluscs can take metal from the ambient water and inorganic particulates, the seasonal fluctuation in metal availability in such organism may be a composite function of these factors.

In the present study from different body parts of medium sized oysters showed more amounts of zinc during monsoon from siphon (196.89) followed by mantle (186.61), hepatopancreas (177.19), gill (171.43), gonad (171.28) and adductor muscle (158.62). The lead content was more in mantle (1.52) and hepatopancreas (0.76) remaining the metal was not detected in monsoon. The cadmium was more in hepatopancreas (12.77) than siphon (11.05), gill (10.40), gonad (8.09), mantle (6.65) and adductor muscle (6.17). The copper metal showed more in gill (7.71) followed by siphon (6.89), hepatopancreas (6.46), gonad (4.45), mantle (4.38) and adductor muscle (3.40). In winter, generally the metal content was decreased when compared with those found in monsoon. The zinc content decreased more from gonad (14.87%, P < 0.001) followed by gill (6.5%, P < 0.001), mantle (3.57%, P < 0.05), adductor muscle (1.79%), siphon (1.72%) and hepatopancreas (1.24%) (all are non significant) when compared with monsoon. The lead content decreased more from mantle (1971.72%) and hepatopancreas (1848.37%) (all at P < 0.001) when compared with monsoon. The cadmium decreased more from mantle (154.89%, P < 0.01), followed by adductor muscle (142.14%), gill (124.33%), gonad (112.12%), siphon (71.23%) and hepatopancreas (63.51%) (P < 0.001) when compared with monsoon of respective metals. Whereas, the copper metal decreased more from mantle (66.44%) followed by gill (62.65%), siphon (48.34%), adductor muscle (38.53%) (P < 0.001), gonad (28.75%, P < 0.01),and hepatopancreas (12.08%)when compared with monsoon.

In summer, generally the metal content was decreased when compared with those found in monsoon and winter seasons. In respect with zinc content decreased more from hepatopancreas (42.23%) followed by mantle (41.48%), gonad (36.31%), siphon (26.94%), adductor muscle (25.25%) and gill (11.27%) (P < 0.001) when compared with monsoon. Further, the content was more decreased from hepatopancreas (41.51%) followed by mantle (39.32%), siphon (25.66%), gonad (25.19%), adductor muscle (23.89%) (P < 0.001) and gill (5.10%), (non significant) when compared with winter of respective metals. The lead content more decreased from hepatopancreas (600%) and mantle (474%) (P < 0.001) when compared with monsoon. But the content compared with winter it decreased from mantle (72.28%, P < 0.001) followed by hepatopancreas (64.06%, P < 0.01), siphon (59.98%, P < 0.001), gill (55.20%, P < 0.001), gonad (32.54%, P < 0.05) and adductor muscle (18.45%). The cadmium decreased more from hepatopancreas (51.61%) followed by siphon (32.95%), mantle (30.83%), (P < 0.001), adductor muscle (22.86%, P < 0.05), gill (19.43%, P < 0.01) and gonad (8.78% P < 0.01), when compared with monsoon. Whereas, the content was more decreased from mantle (72.87%) followed by hepatopancreas (70.41%), adductor muscle (68.14%), gill (64.09%), siphon (60.84 %) and gonad (48.72%) (P < 0.001) when compared with winter of respective metals. The copper metal decreased more from hepatopancreas (54.18%), followed by siphon (33.97%) (all are P < 0.001), mantle (24.89%), gill (16.87%), (P < 0.01), gonad (10.79%, P < 0.05) and adductor muscle (3.83%) when compared with monsoon. On the other hand, the content was decreased when it compared with winter and that was more from hepatopancreas (59.12%), followed by siphon (55.48%), mantle (54.87%), gill (48.89%), adductor muscle (30.58%), (P < 0.001) and gonad (13.97%, P < 0.05). The present results indicate that metals exhibited seasonality, which could possibly be due to variation in the ambient water and sediments. The chemical industries are not situated along the bank of Bhatye estuary but apparently the wastes are getting dried up in barren lands nearby and the freshets bring a heavy load of pollutants into the estuary. The increase in the availability of heavy metals in the ambient water and sediment may be causing accumulation of metals in the oysters. Hung (1990) reported that the oyster *Crassostrea gigas* accumulated very high quantity of copper, along the mariculture area of south-western Taiwan. They also reported that the green colour was due to excessive accumulation of copper in the oyster tissues. Further, in present study it is observed that the higher metal content was observed during when the estuary received heavy freshwater influx during monsoon. At Ratnagiri heavy rainfall was noted during monsoon rains and influx bring heavy load of land drainage and created turbidity that is likely to be impregnated with heavy metals. Thus, monsoon influx in the Bhatye estuary creates drastic siltation on the

Table 1. The levels of metals in different body parts of oyster *Crassostrea cattuckensis* in different seasons.

Body parts	Monsoon				Winte[redacted]				Summer			
	Zinc	Lead	Cadmium	Copper	Zinc	Lead	Cadmium	Copper	Zinc	Lead	Cadmium	Copper
Mantle [redacted]	186.61 [redacted]46 [redacted]	1.52 ±0.66	6.65 [redacted]0.39	4.38 ±0.23 [redacted]	179.95 ±2.07 (3.57%)*	31.49 [redacted] ±1.14 (1971.72%) ***	16.95 [redacted] ±2.72 (154.89%)**	7.29 [redacted] ±0.09 (66[redacted]%) *** [redacted]	109.21 [redacted] ±2.63 (41.48%)*** (39.32%)	8.73 [redacted] ±0.66 (474.35%) ** (72.28%)	4.6 [redacted] ±0.07 (30.83%)** * (72.87%)	3.29 [redacted] ±0.05 (24.89%)** (54.87%)
Gi [redacted]	171.43 ±0.44 [redacted]	N. D. [redacted]	10.40 [redacted]0.37	7.71 [redacted] ±0.13	160.28 ±1.66 (6.51%)* **	25.42 ±0.66 [redacted]	23.33 [redacted] ±0.31 (124.33%)** *	12.54 [redacted] ±0.11 (62.65%) ***	152.12 [redacted] ±3.73 (11.27%)*** (5.10%)	11.39 ±1.19 (55.20%)	8.38 ±0.57 (19.43%)** (64.09%)	6.41 [redacted] ±0.33 (16.87%)** (48.89%)
Hepato-pancreas	177.19 ±2.29 [redacted]	0.76 ±0.66	12.77 [redacted]0.73	6.46 ±0.16 [redacted]	175.01 ±2.02 (1.24%)	14.80 ±1.02 (1848.37%) ***	20.88 [redacted] ±0.33 (63.51%)***	7.24 [redacted] ±0.64 (12.08%)	102.38 [redacted] ±2.02 (42.23%)*** (41.51%)	5.32 [redacted] ±1.14 (600%)*** (64.06%)	6.18 [redacted] ±0.24 (51.61%)** * (70.41%)	2.96 [redacted] ±0.09 (54[redacted]18%)** * [redacted] (59.12%)
Adductor muscle [redacted]	158.62 ±2.27 [redacted]	N. D. [redacted]	6.17 [redacted]0.14	3.40 ±0.15 [redacted]	155.78 ±3.15 (1.79%) [redacted]	14.42 ±2.60 [redacted]	14.94 [redacted] ±0.28 (142.14%)** * [redacted]	4.71 [redacted] ±0.11 (38.53%) *** [redacted]	118.57 [redacted] ±2.61 (25.25%)*** (23.89%)	11.76 [redacted] ±2.37 (18.45%) [redacted]	4.76 [redacted] ±0.52 (22.86%)* (68.14%)	3.27 [redacted] ±0.08 (3.83%) (30.58%)
Siphon [redacted]	196.89 ±1.23 [redacted]	N. D. [redacted]	[redacted]1.05 [redacted]0.46	6.89 ±0.18 [redacted]	193.51 ±2.81 (1.72%) [redacted]	24.66 ±2.63 [redacted]	18.92 [redacted] [redacted]0.37 (71.23%)*** [redacted]	10.22 [redacted] ±0.56 (48.34%) *** [redacted]	143.86 [redacted] ±2.61 (26.94%)*** (25.66%)	9.87 [redacted] ±0.66 (59.98%) [redacted]	7.4[redacted] ±0.58 (32.95%)** * [redacted] (60.84%)	4.55 [redacted] ±0.13 (33.97%)** * [redacted] (55.48%)
Gonad [redacted]	171.28 ±1.14 [redacted]	N. D. [redacted]	8.09 [redacted]0.19	4.45 [redacted] ±0.11	145.82 ±1.65 (14.87%)***	16.32 ±2.37 [redacted]	17.16 [redacted] ±0.28 (112.12%)** *	5.73 [redacted] ±0.41 (28.75%) **	109.10 [redacted] ±3.15 (36.31%)*** (25.19%)	11.01 [redacted] ±0.66 (32.54%)	8.80 [redacted] ±0.13 (8.78%)** (48.72%)	4.93 [redacted] ±0.17 (10.79%)* (13.97%)

[redacted]

oyster beds if the metals levels in the environment increase. Generally, high and low amount of content of metals were found in oysters collected during month of August and May respectively, which coincide with the peak of monsoon and summer in this region.

It is evident from the data that oysters concentrate zinc and lead. Though zinc is the dominant metal observed in the oyster, the concentrations registered in adult oysters do not pose an imminent threat to the consumers or to the oysters themselves as they are having a high threshold level for zinc. Many researchers detected increasing trend of heavy metals in the marine environment and almost all the authors showed that marine fishes and shellfishes carry heavy metals in their body at various degrees (Gorden and Pople, 1993; Joseph and Shrivastava, 1993). Further, Lakshmanam and Nambison (1983) reported concentrations of Fe, Cu, Zn and Pb in *Villorita cyprinoides, Meretix casta* and *Perna viridis*, were influenced by seasons. Highest concentrations of these metals were found during low salinity and low pH of the habitat i.e. in monsoon, metal concentrations decreased in these species in summer a period of high salinity and pH. Joseph and Shrivastava, (1993) found higher heavy metals like Zn, Cd, Cu, Cr, Ni, and Pb in the oyster *Crassostrea madrasensis* from Ennore estuary Madras, during the breeding season and also when estuary received heavy freshwater influx during the monsoon. The breeding season of *C. madrasensis* in that estuary was during monsoon period. Athalye and Gokhale, (1994) reported enhanced level of heavy metals accumulation in gastropods *Dostia voilocia* and *Cerithidiopsilla dgadjaviensis* due to water pollution in Thane Creek, Maharashtra. The present results were correlated with Kumbhar (2001), which was made similar type of observations in clams *M. Meretrix, Katelysia opima* and Mohite (2002) in green mussel *Perna viridis* from Bhatye estuary in different seasons. Further they noted the high metal level was observed during rainy season and low in summer.

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