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INORGANIC ELEMENTS IN FOUR SPECIES OF OYSTERS FROM KARACHI COAST

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The levels of inorganic elements were studied in four species of oysters, namely, *Crassostrea glomerata, C. tuberculata, C. rivularis* and *C. madrasensis,* sampled from Karachi, northern Arabian Sea. The elements studied were calcium, potassium, sodium, magnesium, phosphorus, iron, copper, zinc, manganese and cobalt. The calcium and iron contents were found to be greater in the species occurring at a higher tidal level. The results showed that *C. glomerata* is the least suitable for commercial exploitation as it possesses the lowest dry tissue and highest ash content. Of the four species studied, in *C. rivularis* are concentrated the highest levels of sodium, potassium and phosphorus but the lowest of magnesium and cobalt.

INTRODUCTION

Studies on the accumulation of heavy metals in the soft tissues of bivalve molluscs have received considerable attention on account of their usefulness as specific and precise indicators of the presence of these metals in the surrounding water. This becomes more acute when the presence of some of these metals in higher concentration threatens human health. An elaborate example of the relationship between the metal concentration in the tissues of oysters and in the sea was presented by Coulson *et al.* [1] who demonstrated a high iron content in the tissues of oysters from south Atlantic States as a consequence of the high percentage of iron in the river water discharged into the estuaries. Working on the pearl oyster *Pinctada martensii,* Tanaka and Hatano [2] found that the changes in potassium and phosphate contents were identical with those of ash content; this and other observations led him to suggest that these elements may be related to sexual activity.

A variety of environmental parameters are reported to affect the changes in mineral composition of the bivalve tissues such as season [3–5], habitat [6] and pollutants [7–9]. As compared to mussels the levels of trace metals in species of oysters are less studied [10–14]. Investigations related to the species of Indian Ocean oysters are very few. Venkataraman and Chari [15] analysed four inorganic elements (Fe, Cu, P_2O_5, CaO) in *Ostrea virginica,* whereas a paper by Durve and Bal [16] on *Crassostrea gryphoides* provides information for two elements only, i.e. phosphorus and calcium.

Several species of oysters of the genera *Crassostrea* and *Ostrea* are found on the coast of Karachi [17]. Apart from some basic work on reproductive biology [18–29], the biochemical composition and condition indices of four species of oysters have recently been documented [21–22]. This paper describes the results of a study which aimed at the quantification of the levels of inorganic constituents in four species of oysters, namely, *Crassostrea glomerata, C. rivularis, C. tuberculata* and *C. madrasensis* from the Karachi coast.

MATERIALS AND METHODS

Specimens of four species of oysters were collected from the intertidal zone of the rocky beaches at Buleji *(Crassostrea tuberculata)* and Sands' pit *(C. rivularis, C. glomerata, C. madrasensis)* along the Karachi coast. Individual oysters were cut open and their tissues excised on an absorbent paper. The tissues were weighed after drying at 80^{o} for dry weight. To obtain ash the grounded dried tissues were incinerated at 550^{o} for 8 hrs. Acid-hydrolysed ash was used for the determination of its various inorganic elements. Sodium, potassium and calcium were determined on a flame photometer (Corning-400). The determinations of all other elements were accomplished on Atomic Absorption Spectrophotometer (Unicam SP-90-A).

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Table 1. Mineral composition of oysters from Karachi coast

Parameter	Unit	*Crassostrea rivularis*	*Crassostrea madrasensis*	*Crassostrea tuberculata*	*Crassostrea glomerata*
Dry weight	% w.t.w.	22.0	24.5	26.5	21.4
Ash	% d.t.w.	11.2	9.9	12.8	15.5
Sodium	mg/g d.w.	193.2	144.9	121.4	142.6
Potassium	mg/g d.w.	87.36	69.81	67.08	66.69
Calcium	mg/g d.w.	3.58	3.91	22.53	26.97
Magnesium	mg/ d.w.	1.5	1.88	2.32	1.62
Phosphorus	mg/d.w.	6.02	5.96	4.2	5.01
Iron	mg % d.w.	57.82	50.2	126.12	107.9
Copper	mg % d.w.	33.7	21.3	44.8	49.6
Zinc	mg % d.w.	43.36	55.2	49.7	39.15
Manganese	mg % d.w.	5.3	3.76	5.6	4.77
Cobalt	mg % d.w.	0.48	1.25	3.5	2.38

d.w.: dry weight, w.t.w.: wet tissue weight, d.t.w.: dry tissue weight, mg %: mg/100 g.

RESULTS

The mineral contents of the four species of oysters, percentage dry tissue and ash weight are shown in Table 1. The table shows that *Crassostrea glomerata*, which is the smallest in size of the four species, possessed the lowest dry tissue and the highest ash content. The highest dry tissue weight was observed for *C. tuberculata.* It appears from the data that elevated levels of copper, calcium and iron contributed to the higher inorganic matter of *C. glomerata* and *C. tuberculata*, whereas these metals were represented in substantially low quantities in *C. rivularis* and *C. madrasensis.*

Sodium was the main component of inorganic matter in all four species of oysters studied. The sodium content of *C. rivularis* was the highest of the components determined. The next dominant element was potassium which showed comparable values among the four species. The lowest values were observed in *C. glomerata* (66.69 mg/g) and highest in *C. rivularis* (87.36 mg/g). It is observed that *C. rivularis* contained the highest levels of sodium, potassium and phosphorus but the lowest of cobalt and magnesium. The calcium, copper and iron contents were remarkably high in *C. tuberculata* and *C. glomerata.* The calcium content of these two species was about six times greater compared to the other two species. The magnesium content of the four species ranged from 1.5 mg/g (*C. rivularis)* to 2.32 mg/g *(C. tuberculata)* exhibiting insignificant differences between them. Similarly the values of zinc, manganese and cobalt did not vary between the four species. Contrarily the iron and copper contents of these species varied considerably. The concentrations of iron in *C. rivularis* and *C. madrasensis* (57.8 and 50.82 mg%, respectively) were about half of the values in *C. tuberculata* and *C. glomerata* (126.12 and 107.8 mg%, respectively).

DISCUSSION

The results show that the highest ash contents were found in the oyster species *Crassostrea glomerata* and *C. tuberculata*, which occur higher in the tidal area. Moreover the calcium content was mainly responsible for the higher ash levels of these species. It is mentioned in the literature that the shell weights of bivalve molluscs increased as the time of their exposure to air increased i.e. shell weights permanently submerged populations are higher compared to those which often get exposed in tidal zone [23–26]. While discussing the sources of calcium for shell building in *Mytilus californianus*, Fox and Coe [24] mentioned that apart from food, large quantities of calcium are obtained from water in particulate or soluble form through digestive tract. From the foregoing account it can be clearly seen that as the oyster species occurring at a higher tidal level possess heavier shells, they naturally consume relatively more calcium and that is why the highest calcium content occurrs in *C. glomerata* and *C. tuberculata.* The results of the present study suggest an investigation centring on the mode of action and concentration of enzymes which control calcium metabolism in these species.

The value of sodium in the oyster species studied here ranged from 121.4 mg/g in *C. tuberculata* to 193.2 mg/g in *C. rivularis.* These values are fairly high compared to the four species of *Crassostrea* from Indian waters [27] where a maximum of 41.6 mg/g was observed in *C. rivularis.* Again, the values of potassium reported here are on the average 2.5 to 3.5 times higher than values determined in Indian oysters. There was not much variation in the magnesium and phosphorus levels of four species. Wide variations have been reported in the phosphorus content in different species of oysters from India. According to Curve and Bal [16] it ranged between 1.0 and 2.0 mg/g in *C. gryphoides* but Patel [27] observed 15–30 mg/g during the year in the same species. Patel [27] studied iron content in four species of oysters from India and found a maximum of 90 mg % in *C. rivularis,* 35 mg % in *C. belcheri,* 14 mg % in *C. gryphoides* and 8 mg % in *C. sp.* whereas Galtsoff [13] observed a maximum of 90 mg % in *C. virginica* from Long Island South, America. Though there was much variation in the values of iron between the species studied here, they are in the range of concentrations reported in the literature.

The concentrations of manganese in this study agree closely with those reported for *C. virginica* [13]. While discussing the role of heavy metals in the physiology of oysters, Galtsoff [13] stated that there is some evidence that the concentration of manganese is related with the reproductive cycle. He did not find this sort of relation in case of iron, zinc and copper. The levels of copper determined in the present investigation did not vary much from the levels mentioned for *C. virginica* [13] but the four species of oysters showed very low concentrations of zinc compared to those of *C. virginica* which contained 400-1400 mg % zinc during the year. Similarly zinc values ranging from 117 to 426 mg % were determined in *Pecten radiata* [28] from Lebanon.

No comparative data are known for cobalt concentration in the oyster species of genus *Crassostrea.* Segar *et al.* [29] reported 8.5 and 5.5 μg of cobalt in the soft parts of *Pecten maximus* and *Modiolus modiolus* from Port Irin in the Irish Sea. The values recorded here varied from 0.48 in *C. rivularis* to 2.38 mg % in *C. glomerata.* It is evident from the data that the levels of cobalt was higher in those species which live higher in the tidal area.

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