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Heavy Metal Concentrations in the Tissue of *Sparus sarba* Forskål, 1775 from the United Arab Emirates

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Pollution of the marine environment by inorganic and organic chemicals has been recognised as one of the major factors posing serious threat to the survival of marine organisms including fish. Heavy metal contamination of the marine environment has been reported to cause toxicity to aquatic organisms (Buggiani and Vannucchi 1980). Natural processes such as volcanic eruptions, erosion and wind, industrial activities and mining are the major sources of metal contamination. Exposure to heavy metals through air, water and/or the food chain is known to induce a wide variety of toxic effects in humans and animals (Dave and Xiu 1991; Goodrich et al. 1991). Metals such as zinc, manganese and copper are toxic only when present in high enough amounts, but at low levels are considered essential as micronutients (Sarkka et al. 1978). Extensive studies have been carried out in Europe and America to determine toxicity and bio-accumulation of these metals in fish and other marine flora and fauna (Nickless et al. 1972; Peden et al. 1973; Hardisty et al. 1974; Badsha and Sainbury 1978). However, there is a gap in our knowledge of the kind and extent of marine pollution by heavy metals around the coast of the United Arab Emirates (UAE) and the resultant contamination of the aquatic habitat. This study was designed to investigate the concentrations of cadmium, cobalt, copper, manganese, nickel, lead and zinc in the muscle, liver and heart, and mercury in the muscle tissue of ***Sparus sarba***, one of the more nutritionally popular fish of the UAE region.

MATERIALS AND METHODS

Sampling and preparation of samples were carried out by following standard recommended procedures (Bernhard 1976). Samples of *S. sarba* were collected from the western coast of UAE in the months of March, April, May and June 1993 at an interval of 2-3 weeks. Each time about 20-40 fish of varying sizes were collected, placed in an ice

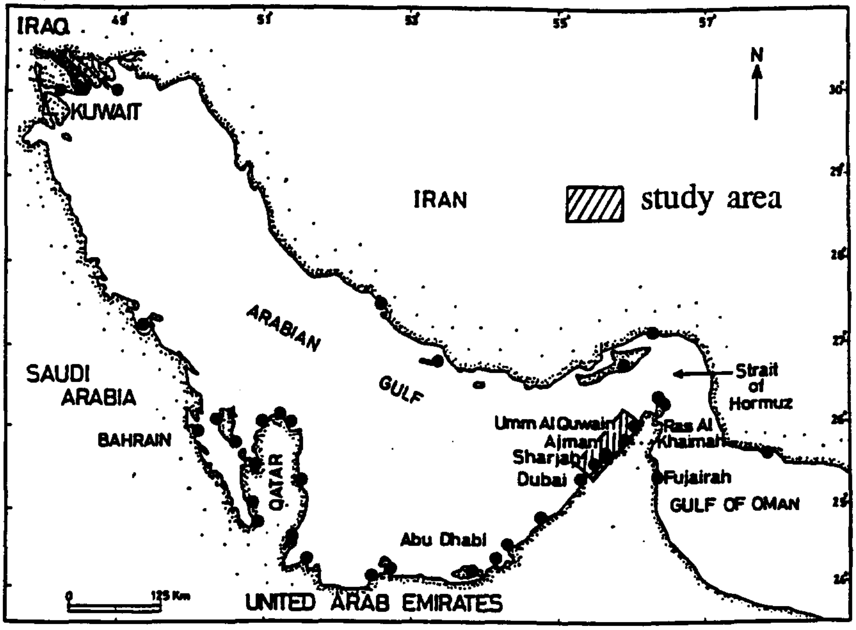

Figure 1. Sample stations where *Sparus sarba*, were collected along the United Arab Emirates coast on the Arabian Gulf.

box, transported to the laboratory and kept in a freezer (-15 °C) prior to analysis. At the time of metals analysis the fish were defrosted and their standard length and weight were recorded. Two to three gram of muscle tissue and whole liver and heart were processed for analysis. Tissues were digested in 10 ml of a nitric/perchloric acid mixture (4:1). Initial digestion was performed at room temperature for 3-4 hr, followed by careful heating at 40-45 °C for 1 hr to prevent frothing. The temperature was raised to 70-80 °C with gentle shaking until the digestion was complete. The resulting residue was allowed to cool to room temperature and made up to 20 ml (or less) with deionized water. Two blanks were run under identical experimental conditions with each set of experiments. Cadmium, cobalt, copper, manganese, nickel, lead and zinc measurements were carried out in triplicate using a double beam atomic absorption spectrophotometer (GBC- 906), equipped with background corrector, autosampler and recorder. Mercury concentrations in the standard solutions, samples and blanks were measured using cold vapour atomic absorption techniques with the same instrument.

The accuracy of these procedures was carefully studied to determine whether losses of metal particularly cadmium took place. The digestion procedure was applied to known amounts of standards of cadmium, copper, cobalt, manganese, nickel, lead and zinc. Under the experimental conditions, we found 94-103% recovery for these elements. The percentage recovery of each element was found as follows, Cd (98%), Co (94%), Cu (98%), Mn (101%), Pb (103%), Ni (102%) and Zn (96%).

All reagents used were of analytical grade (BDH, England and Merck, Germany). Standard stock solutions of 1000 ppm were also procured from BDH, England. Deionized water was used throughout the study. To avoid contamination, all containers and other materials used in the analysis were glass and polyethylene. Glassware was washed and subsequently treated with HNO_3 for 3-4 hr with a final repeated rinse with deionized water.

RESULTS AND DISCUSSION

A total of 390 *S. sarba* were collected from the several areas of the western coast of the UAE (Fig. 1). The area covered was about 100 km of the sea shore northeast of Dubai. Muscle, liver and heart were analyzed for cadmium, copper, manganese, nickel, cobalt, lead and zinc. The average standard length and weight of fish sampled were 16.8 ± 2.6 cm (12.0 - 23.5 cm) and 168 ± 59 g (59.0 - 407.0 g,) respectively. Notably, the length ranged from 12 to 23.5 cm, whereas the variation in weight was approximately seven fold. The samples also showed remarkable weight differences among the same length groups (Table 1). Table 2 shows the average metal concentrations in the muscle tissues, liver and heart. The mean concentration of metals in different tissues was found well within acceptable limits for human consumption, i.e., Cd in muscles tissue was 0.028 μg/g (wet weight) in the range from <0.009 μg/g (detection limit) to 0.383 μg/g.

Mason (1987) suggested the standard limit for tolerable weekly intake of Cd in fish flesh as 500 μg per person; thus it would require more than 17.5 kg of fish flesh to be consumed by a person per week to reach this limit. The WHO recommendation (1972), cited by Dean and Suess (1985), allows a daily intake of 60-70 μg cadmium which would be equivalent to approximately 2 kg of *S. sarba* muscle tissue per day.

Mean nickel and lead concentrations were 0.116 and 0.163 μg/g (wet weight), respectively, in muscle tissue, whereas several samples were below the detection limit.

Copper, manganese and zinc in trace amounts are considered essential for normal physiological functions of humans and animals, includingfish, but higher concentrations could be harmful. Mean

Table 1. Relationship between length and weight of *S. sarba* occurring in the UAE coastal water

Length group (cm)	Number of fish	Weight (g) Mean ± S.D.	Weight range
12 - 14	29	95 ± 15	59 - 143
14 - 15	71	110 ± 12	84 - 154
15 - 16	95	128 ± 16	96 - 177
16 - 17	84	149 ± 14	125 - 187
17 - 18	53	169 ± 21	137 - 239
18 - 19	29	209 ± 31	157 - 312
19 - 20	17	233 ± 31	199 - 295
20 - 23.5	12	258 ± 59	192 - 407

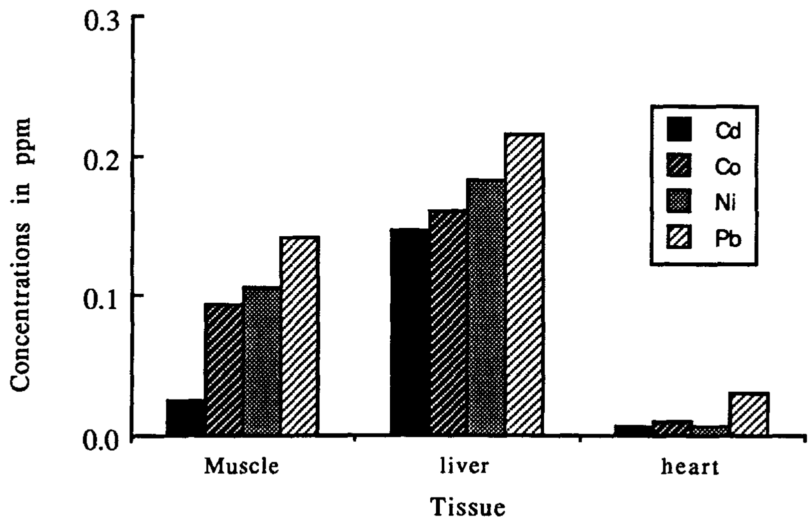

Figure 2. Average concentrations of cadmium, cobalt, nickel and lead in muscle tissue, liver and heart of *S. sarba.*

concentrations of copper, manganese and zinc were 0.361 ± 0.246, 0.100 and 4.047 ± 1.694 µg/g (wet weight), respectively, in muscle tissue, whereas the mean concentrations of these metals in liver tissue was 7.667 ± 7.694, 1.240 and 59.15 ± 26.18 µg/g (wet weight), respectively (Table 2).

Copper and zinc concentrations in the heart tissue were 6.168 and 29.18 ± 8.39 µg/g (wet weight), respectively, with other metals present

Table 2. Mean (m) ± SD in *S. Sarba* tissue, are provided for measurements at or above the limits of detection; the number of detectable values used are shown in brackets. The range of metal concentrations is represented as 'r'.

Elements	Concentrations (μg/g, wet weight) in		
	Muscle tissue	Liver	Heart
Cadmium			
m	0.028 (355)	0.157 (362)	0.015 (153)
r	<0.009-0.383	<0.009-1.818	<0.009-0.140
Cobalt			
m	0.114 (321)	0.183 (340)	0.021 (180)
r	<0.050-0.582	<0.050-1.654	<0.050-0.187
Copper			
m	0.361 ± 0.246	7.667 ± 7.694	6.168 (386)
r	0.035-1.684	0.568-49.321	<0.025-23.53
Manganese			
m	0.100 (365)	1.240 (382)	0.098 (279)
r	<0.020-0.478	<0.020-4.989	<0.020-1.494
Nickel			
m	0.116 (352)	0.191 (371)	0.072 (39)
r	<0.040-0.688	<0.040-1.387	<0.040-0.112
Lead			
m	0.163 (339)	0.166 (364)	0.183 (64)
r	<0.060-0.736	<0.060-1.321	<0.060-0.546
Zinc			
m	4.047 ± 1.694	59.15 ± 26.18	29.18 ± 8.39
r	1.336-21.943	19.910-149.41	18.12 - 69.99
Mercury			
m	0.096 ± 0.113		
r	0.012-0.215		

( ) = Number of samples used in average.

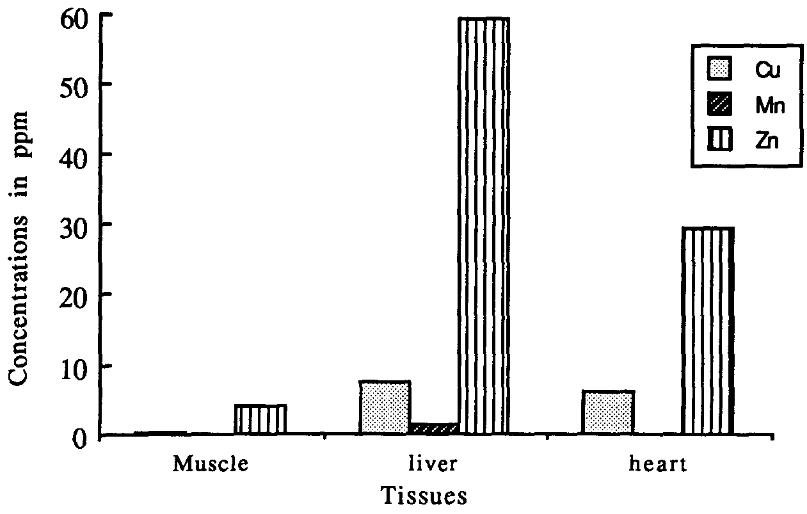

Figure 3. Average concentrations of copper, manganese and zinc in muscle tissue, liver and heart of *S. sarba.*

at low concentrations (Table 2). A comparison of cadmium, cobalt, nickel and lead (Fig. 2) and of copper, manganese and zinc (Fig. 3) in muscle tissue, liver and heart of *S. sarba* indicated that, in general, muscle tissue had markedly lower concentrations of metals as compared to liver.

The current study suggests that the concentrations of heavy metals present in the fish *S. sarba* of the UAE region are well below the documented toxic levels for human consumption and, hence, the fish are safe to eat. Moreover, it also reflects that metal pollution of the marine environment in this region is still relatively limited.

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