Qatar Univ. Sci. J. (1991), 11: 391 - 403

TRACE METALS IN QATARI FISH AND SHELLFISH

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Key Words: Crab, Fish, Marine organisms, Prawn, Qatari seafood, Trace metals.

ABSTRACT

Fish, prawns and crabs purchased at the retail market in Doha, were analysed for cadmium, chromium, copper, lead and zinc. The results indicated significantly elevated concentrations of cadmium in the flesh of the Qatari marine organisms. Chromium concentrations were slightly elevated particularly in prawns and crabs. Lead, copper and zinc were not present in high enough concentrations to cause detrimental health effects for consumers. Further study of selected elements in Qatari seafood is considered necessary both to delineate any temporal change in trace metal levels in locally available marine organisms and to determine concentrations of other toxic metals.

INTRODUCTION

Marine organisms concentrate many pollutants from seawater or from sediments. For certain metals which are particularly toxic to man, e.g. cadmium and chromium, seafoods may thus be responsible for the majority of total metal uptake by man. If significant sources of metals exist in a given area, the contamination of seafood may become sufficiently extreme to give rise to sublethal — or even lethal — effects in the human population. The best known example of deaths attributable to contaminants ingested in seafood is the so called Minimata disease, which was first noted in Japan in 1953 (Kurland *et al.*, 1960). Cadmium is a focus of environmental concern because it is potently toxic and concentrates in some marine organisms. Itai-Itai disease is a good example of enviromentally induced human cadmium toxicity. The toxicity and carcinogenicity of chromium compounds are well known (Levy and Venitt, 1986). Lead is also known to cause a number of acute and chronic human health impacts. These include effects on the nervous, circulatory, renal and excretory systems, reproduction, and carcinogenesis, the most serious of these impacts are related to the central nervous system (Goyer, 1986). Although copper and zinc are considered biologically essential elements,

they also demonstrate acute toxicological effects occurring at small concentration increments above essential levels (Eisler, 1981).

As a result of this potential hazard, many nations currently monitor the trace metal levels in local seafoods in efforts to protect public health. In Qatar, such a programme of study is particularly important, as the indigenous population consumes large amounts of seafood.

The present work gives levels of cadmium, chromium, copper, lead and zinc in local seafood reaching the Qatari consumers. It is a part of a more extensive investigation of the different pollutants in the Qatari marine organisms.

MATERIALS AND METHODS

The studied organisms were:

Portunus pelagicus, an edible crab abundantly seen in the Qatari shores.

Penaeus semisulcatus, a common prawn species in the Arabian Gulf.

Nematalosa nasus, a common species of herring found in coastal Qatari waters. Its flesh is excellent to eat and the fish has considerable economic importance.

Lethrinus nebulosus, a carnivorous fish characterized by its tasty flesh. It is common in the Qatari coastal waters.

Parupeneus pleurotaenia, a shallow water carnivorous fish feeding mainly on worms, crustaceans and snails.

Epinephelus tauvina, a bottom dwelling grouper commonly found in Qatar and characterized by its excellent and tasty flesh.

Siganus oramin, the most common herbivorous fish of Qatar. Its flesh is very delicious and it has a high economic value.

Spyraena jello, a carnivorous fish (barracuda) abundantly found in Qatari waters.

It is excellent to eat and has a very important commercial value.

Fish and macro-crustaceans purchased at the retail market in Doha were identified and prepared for analysis according to Bernhard, 1976. Measurements of cadmium (Cd), copper (Cu), chromium (Cr), zinc (Zn) and lead (Pb) were made by the flame atomic absorpition spectrophotometry technique as described in MOOPAM (1989).

Ten analyses of a standard reference material 1577 "Bovine Liver" from National Bureau of Standards, U.S.A., were carried out and the results are given in Table 1.

Table 1

Results of analysis of 1577 "Bovine Liver" of the N.B.S.-U.S.A., in comparison to the N.B.S. certificated values ($\mu g\ g^{-1}$ Dry Weight).

Element	Our results	N.B.S. values	Efficiency (%)
Lead	0.38±0.09	0.34±0.08	111.8
Cadmium	0.24±0.05	0.27±0.04	88.9
Zinc	135.00±16.00	130±13	103.9
Copper	187.00±13	193±10	96.9

The detection limits for chromium, cadmium, copper zinc and lead were 4.0, 3.0, 4.0, 6.0 and 3.0 ng metal respectively. The relative standard deviations of analysis of trace metals in the organisms are given in Table 2.

Table 2

Relative standard deviations of analysis of trace metals in Qatari marine organisms

Trace metal	Relative standard deviation (%)
Chromium	3-6
Lead	6-13
Cadmium	3-6
Zinc	6-10
Copper	4-5

Table 3 gives the percent recovery of standard metal additions from the flesh of *Spyraena jello.*

Table 3

Percent recovery of trace metals from the flesh of *Spyraena jello*

Trace metal	Recovery (%)
Chromium	95.1±8.3
Lead	89.1±7.2
Cadmium	92.9±14.8
Zinc	104.9±8.9
Copper	92.1±10.9

RESULTS AND DISCUSSIONS

Range and mean concentrations of trace metals (Cr, Cd, Cu, Pb and Zn) in the flesh of the organisms collected in December 1989, February and April 1990 are given in Tables 4-6. The overall range and mean concentrations of trace metals in the flesh of the six fish species and the two macro-crustaceans studied are given in Table 7.

Although variability of trace element concentrations within each species was considerable, the marked trend was the greater enrichment of trace metals in crustaceans compared with fish. The sole exception to this pattern was lead, which had similar concentrations in fish and crustaceans (Table 7). Crabs and prawns exhibited significantly elevated concentrations of cadmium. Some samples exceeded the 1000 ug kg^{-1} fw level. The crab *Portunus pelagicus* tended to contain greater concentrations of chromium (436 $\pm$ 193 ug Kg^{-1} fw) compared with the prawn *Penaeus semisulcatus* (237 $\pm$ 93 ug Kg^{-1} fw).

The median International Standards for trace metals in fish and shellfish given in Table 8 are not enforceable in Qatar, but they do give an indication of what other countries have decided are undesirable concentrations of trace metals in fish and shellfish (Nauen, 1983 and Hayes & Phillips, 1987).

None of the average values for edible tissues in Table (7) exceed the International Standards. Cadmium concentrations in the white flesh of 8 samples out of 76 crabs and 4 individuals from the 79 prawns exceeded the limit of 1000 ug Kg^{-1} fw. Chromium concentrations in some crabs (18% of the individuals) were close to the International Standard (1000 ug kg^{-1} fw).

It is assumed that the average intake of fish and shellfish protein is 3.8 g per day and per person out of a total of 68.8 g total protein per day and person (FAO, 1980). These 3.8 g protein correspond to about 20 g edible fish and shellfish per day or 140 g edible tissue (about) one meal of fish and shellfish per week. At present the typical concentrations of trace metals in seafood and the Provisional Tolerable Weekly Intakes (PTWI) are available only for very few trace metals (Table 9). Based on the PTWI's and the average trace metal contents in Qatari seafood, it is possible to estimate the number of meals (150 g fw each) of seafood per week necessary to reach PTWI's (Table 10). From Table 10 one can conclude that only cadmium in crustaceans could pose a problem, since even high consumers of marine food cannot eat a sufficient number of meals to reach the PTWI's for the other trace metals studied. Cadmium presents a potential risk to persons eating crustaceans more than 4-5 meals a week because they can easily reach the PTWI.

Table 11 summarizes the published trace metal concentrations in fish from the Arabian Gulf together with trace metal concentrations presented in this work.

Table 4

Range and mean concentrations of trace metals in Qatari marine organisms (December, 1989)

Species	n	Weight range (g)	Dry weight (%)		Trace metals ($\mu g\ Kg^{-1}$ fw)				
					Chromium	Lead	Cadmium	Zinc	Copper
Portunus pelagicus	27	125-226	35±2	mean	484±178	28±10	462±170	13189±3979	1914±789
				range	255–814	21–62	128±1038	5710–18910	691–3908
Penaeus semisulcatus	30	27-74	28±2	mean	233±89	26±9	448±182	12607±4980	2631±1134
				range	156–475	14–95	174–956	4851–19870	1180–4870
Nematalosa nasus	28	18-40	24±2	mean	101±42	19±6	66±24	9987±3217	879±243
				range	42±179	12–63	41–128	5281–16970	572–1451
Lethrinus nebulosus	29	154-564	23±2	mean	89±28	19±7	94±36	3307±987	301±128
				range	31–147	9±47	54±204	1801–5874	135–641
Parupeneus pleurotaenia	26	114-179	23±2	mean	62±19	16±6	62±22	4966±2501	472±157
				range	25–180	10–51	30–282	1989–9871	150–987
Epinephelus tauvina	18	225-1775	22±2	mean	124±45	19±11	118±34	4985±1345	499±167
				range	39–358	12–60	49–256	3261–6990	287–986
Siganus oramin	16	100-162	24±2	mean	98±42	17±8	76±28	8794±2870	745±168
				range	35–211	11–48	41–116	4280–15896	398–1510
Spyraena jello	10	340-780	22±2	mean	134±39	27±11	122±42	4899±1114	501±163
				range	54–275	14–64	62–236	3081–6987	280–988

(n = number of individual specimens)

Table 5

Range and mean concentration of trace metals in Qatari marine organisms (February, 1990)

Species	n	Weight range (g)	Dry weight (%)		Trace metals ($\mu g\ Kg^{-1}$ fw)				
					Chromium	Lead	Cadmium	Zinc	Copper
Portunus pelagicus	24	119-208	35±1	mean	421±212	29±9	438±164	14218±4500	2180±945
				range	201–869	23–71	194–1142	5490–21841	775–426
Penaeus semisulcatus	28	24-71	27±2	mean	268±112	25±9	480±208	11870±4450	2489±978
				range	138–514	15–84	158–1020	5640–17998	1231–4599
Nematalosa nasus	34	19-39	24±2	mean	109±38	18±8	72±26	9541±4011	798±201
				range	38–185	11–61	39–144	4897–15879	498–1514
Lethrinus nebulosus	25	168–456	22±2	mean	82±26	25±11	86±38	3280±894	334±135
				range	40–197	14–54	42–226	1695–4989	148–658
Parupeneus pleurotaenia	21	98-186	23±2	mean	65±18	20±8	66±28	5486±3104	434±148
				range	21–148	9–55	36–270	2350–11450	173–1014
Epinephelus tauvina	22	289-1895	22±2	mean	132±54	20±12	130±40	5671±1580	530±180
				range	62–287	18–75	52–268	3879–7513	271–1310
Siganus oramin	14	104-174	24±2	mean	95±39	19±9	72±30	7985±2581	690±176
				range	31–198	14–61	36–124	3970–13558	380–1215
Spyraena jello	12	339-699	22±2	mean	128±38	25±10	114±38	5180±1319	525±180
				range	55–302	18–71	52–250	2879–7410	322–951

(n = number of individual specimens)

Table 6

Range and mean concentrations of trace metals in Qatari marine organisms (April, 1990)

Species	n	Weight range (g)	Dry weight (%)		Trace metals ($\mu g\ Kg^{-1}$ fw)				
					Chromium	Lead	Cadmium	Zinc	Copper
Portunus pelagicus	25	121-194	35+2	mean	402±189	27±9	470±159	12110±4125	1725±753
				range	231–725	19–72	156–894	7189–17800	851–3519
Penaeus semisulcatus	21	31-80	28±2	mean	211±79	23±8	387±159	10281±4600	2301±1056
				range	117–392	12±67	164–875	6217–17500	1290–4760
Nematalosa nasus	*20*	*22-38*	*23±2*	*mean*	*82±29*	*23±10*	*48±20*	*10875±3870*	*910±198*
				range	29±193	13–57	24–108	4580–15092	510–1289
Lethrinus nebulosus	23	142-399	23±2	mean	76±24	26±8	81±40	4100±1055	282±110
				range	41–185	15–59	47–189	1725–5219	127±541
Parupeneus pleurotaenia	22	110-172	22±2	mean	51±14	19±8	54±19	4580±2980	492±135
				range	22–154	10–47	29–214	3519–8972	213–875
Epinephelus tauvina	20	359-2910	24±2	mean	140±39	35±14	152±65	4817±1601	581±195
				range	40–275	21–92	64–297	4120–6517	243–1280
Siganus oramin	18	110-189	24±2	mean	114±35	21±9	87±29	8463±2817	708±148
				range	39–241	13–51	29–135	4102–14890	412–1066
Spyraena jello	15	485-1128	23±2	mean	111±30	31±11	132±48	4414±1018	422±140
				range	62–287	15–69	69–271	2910–7635	259–970

(n = number of individual specimens)

Table 7

Overall range and mean concentrations of trace metals in Qatar marine organisms

Species	n		Trace metals ($\mu g\ Kg^{-1}$ fw)				
			Chromium	Lead	Cadmium	Zinc	Copper
Portunus pelagicus	76	mean	436±193	28±9	457±164	13172±4201	1920±829
		range	201–869	19–72	156–1142	5710–2184	691–4261
Penaeus semisulcatus	79	mean	237±93	25±9	438±183	11586±4677	2474±1056
		range	117–514	12–95	158–1020	4851–17500	1180–4870
Nematalosa nasus	82	mean	97±36	20±8	62±23	10134±3699	860±214
		range	29–193	11–63	24–144	4580–16970	498–1514
Lethrinus nebulosus	77	mean	82±26	23±9	87±38	3562±979	306±124
		range	31–197	9–59	4 42–226	1695–5874	127–658
Parupeneus pleurotaenia	69	mean	59±17	18±7	61±23	5011±2862	467±147
		range	21–180	9–55	29–282	2350–11450	150–1014
Epinephelus tauvina	60	mean	132±46	25±12	133±46	5158±1509	537±181
		range	39–358	12–92	49–297	3261–7513	243–1310
Siganus oramin	48	mean	102±39	19±9	78±29	8414±2756	714±164
		range	31–241	11–61	29–135	3970–15896	380–1510
Spyraena jello	37	mean	124±36	28±11	123±45	4831±1150	483±161
		range	54–302	15–71	52–271	2879–7635	259–988

(n = number of individual specimens)

Table 8

Median International Standards for some trace metals concentrations in fish and shellfish ($\mu g\ Kg^{-1}$ fw) (NOAA, 1988)

Trace metal	Median Standard	Range	Number of countries with a standard
Chromium	1000		1
Lead	2000	1000-6000	10
Cadmium	1000	100-2000	5
Zinc	70000	40000-100000	2
Copper	20000	10000-30000	6

Table 9

Typical Concentrations of Trace Metals ($\mu g\ Kg^{-1}$ fw) in Seafood and Provisional Tolerable Weekly Intakes (PTWI) in micrograms (FAO, 1973; WHO, 1977).

Trace metal	Typical Concentration	PTWI per 70 Kg Person
Lead		2800
Cadmium	25	300
Zinc	5000	
Copper	1000	245000

Table 10
Number of seafood meals necessary to reach Provisional Tolerable Weekly Intakes (PTWI).

Trace metal	Average concentration ($\mu g\ Kg^{-1}$ fw)	Kg consumed to reach PTWI	Number of meals per week to reach PTWI
Potunus pelagicus			
Lead	28	100.00	667
Cadmium	457	0.66	4
Copper	1940	126.23	840
Penaeus semisulcatus			
Lead	25	112.00	747
Cadmium	438	0.69	5
Copper	2474	99.03	660
Nematalosa nasus			
Lead	20	140.00	933
Cadmium	62	4.84	32
Copper	860	284.88	1899
Lethrinus nebulosus			
Lead	23	121.74	812
Cadmium	87	3.45	23
Copper	306	800.65	5338
Parupeneus pleurotaenia			
Lead	18	155.56	1037
Cadmium	61	4.92	33
Copper	467	524.63	3498
Epinephelus tauvina			
Lead	25	112.00	747
Cadmium	133	2.26	15
Copper	537	456.24	3042
Siganus oramin			
Lead	19	147.37	983
Cadmium	78	3.85	26
Copper	714	343.14	2288
Spyraena jello			
Lead	28	100.00	667
Cadmium	123	2.44	16
Copper	483	507.25	3382

Table 11

Trace Metal Concentrations in the Flesh of Fish and Shellfish from the Arabian Gulf (μg^{-1} dry weight)

Species	Region	Trace metal					References
		Cadmium	Chromium	Copper	Lead	Zinc	
Penaeus semisulcatus	Kuwait	0.80	0.20	14.00	0.70	46.0	Anderlini *et al.*, 1986
	Qatar	0.18	0.99	9.22	0.09	44.0	Present Study
Epinephelus tauvina	Oman (Salala)	0.05	3.30	0.65	0.21	13.6	Burns *et al.*, 1982
	Kuwait	0.20	0.30	1.00	2.90	20.0	Anderlini *et al.*, 1986
	Qatar	0.59	0.60	2.41	0.09	25.8	Present Study
Lethrinus nebulosus	Oman (Salala)	0.13	3.20	0.51	0.24	10.6	Burns *et al.*, 1982
	Oman (Masira)	0.04	3.40	0.41	0.25	9.9	Burns *et al.*, 1982
	Qatar	0.35	0.33	1.23	0.11	17.8	Present Study

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الفلزات النذرة في الأسمـــاك والقشـــريات القطرية

أسـامة أبو الذهـب

تم في هذا البحث تحليل أنسجة عدة أصناف من الأسماك والقشريات القطرية ذات القيمة الاقتصادية لمعرفة محتواها من الفلزات النذرة المختلفة ، واستخدم جهاز طيف الامتصاص الذري لتعيين تركيز كل من الكروم والكادميوم والنحاس والرصاص والزنك . وأوضحت النتائج أن عنصر الكادميوم يوجد بتركيزات مرتفعة نسبياً في أنسجة الكائنات البحرية القطرية التي يستهلكها السكان بينما عنصر الكروم يزداد بدرجة طفيفة في أنسجة القشريات . وأوضحت الدراسة أن التركيزات الحالية للفلزات النذرة وخاصة الرصاص والنحاس والزنك في أنسجة الكائنات البحرية القطرية لا تشكل أية خطورة على المستهلكين لها . وأوضحت الدراسة أيضاً أهمية الاستمرار في البحث في هذا المجال لمعرفة التغيرات الموسمية والسنوية وكذلك لدراسة بعض الفلزات الضارة الأخرى .