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DISTRIBUTION OF TRACE METALS IN THE TISSUES OF FISH FROM SHATT AL-ARAB ESTUARY, IRAQ

H. T. Al-Saad, Y. Z. Mustafa & F. J. M. Al-Imarah
Marine Science Centre, University of Basrah, Iraq

ABSTRACT

Five tissues from ten commerical fresh and marine fish species along with relevant sediment samples from Shatt Al-Arab estuary were analyzed for trace metals; Cd, Co, Cr, Fe, Mn, Ni, Pb, V and Zn by means of atomic absorption spectrophotometry. All tissues in different fish species studied have contained different concentration of trace metals. Minimum and maximum accumulation were found for Cd and Fe respectively in all species, while Ni was found to be accumulated at high levels in the muscle of all studied species except that for *Johnieops sina*. High values of Ni, Pb and V were reported in the sediments from nearby areas.

INTRODUCTION

The quality of marine environment constituents are never constant, they are constantly changing in response to daily, seasonal and climate rhythms.

Trace metals present in water may be of natural origion, atmospheric precipitation or due to man made activities, they have the ability to accumulate in the sediments by 10^2-10^3 fold in concentration than water (Forstner & Wittman, 1979).

Organisms, including fish, in a particular environment can adapt to natural fluctuation of trace metals, amonge other pollutants, as they occur. Certain trace metals such as Cu, Fe, Mn and Zn are essential for the growth and well-being of living organisms if present in normal concentration, while Cd, Hg and Pb are non essential for metabolic activities and exhibit toxic properties, (Viarengo, 1985). Their toxic action indicated by great affinity for amino acids and the SH groups of proteins, (Hodson, 1988).

Trace metals are incorporate through the food chain of fish either from water via gills or from sediments and marine organisms via gut track. Commercial fish from Shatt Al-Arab estuary, Khor Al-Zubair and North-West Arabian Gulf have recieved much interest since high levels of trace metals in these species represent a potential human health hazard.

A few local studies have considered fresh water and marine fish from Iraq and Arabian Gulf (Anderlini et al., 1982; Abaychi and Al-Saad, 1988; Al-Edanee et al., 1991; Fowler et al., 1993 and Abdullah and Abdul-Hassan, 1993). The levels of trace metals determined in the muscle of fish by these studies were lower than those reported by Bryan (1976) and Dallinger and Kautzky (1985) for world-wide and heavily polluted sites respectively.

In this study, the distribution of trace metals Cd, Co, Cr, Fe, Mn, Ni, Pb, V and Zn in the sediments and tissues of fish from Shatt Al-Arab estuary were estimated in order to use these data as a baseline for comparison in future researchs.

MATERIALS AND METHODS

Sediments and fish were collected from Shatt Al-Arab estuary (Fig. 1) during Dec. 1993 - Nov. 1994. Sediment samples were obtained by means of A van Veen grab sampler. Trace metals analysis was performed on the < 63 um fraction of the sediments which had been seperated by sieving after feeeze- drying and grinding. Trace metals were digested with concentrated HNO_3, $HClO_4$ and HF in Teflon beakers placed on a hot plate.

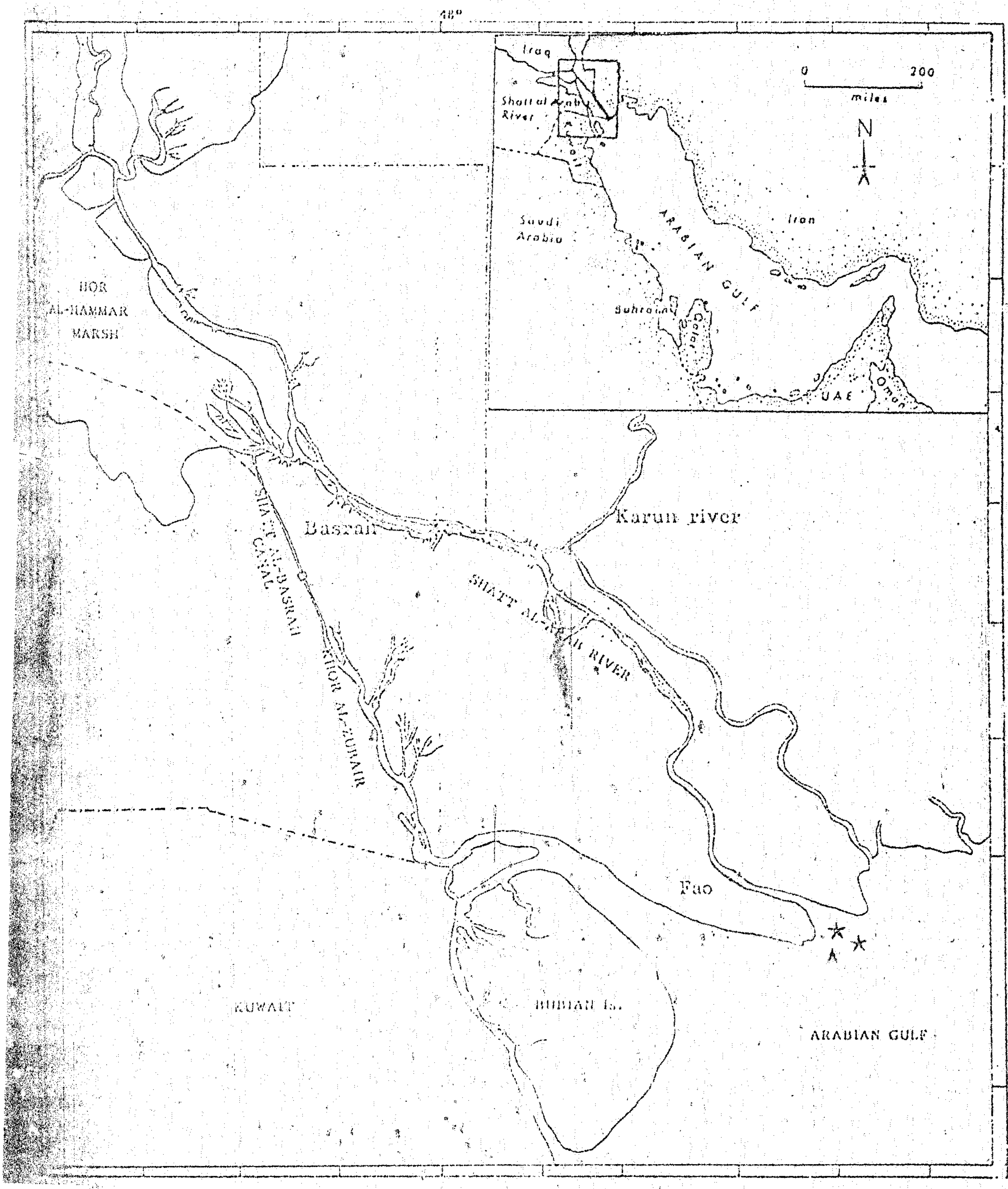

Fig. 1.Map of Shatt Al-Arab estuary and North-West Arabian Gulf showing the position of stations

Fish samples, which caught by gill nets, packed in polythene bags and deep frozen untill required. In the laboratory, fish were rinsed carefully with distilled water and filleted by using stainless steel dissecating knife.

The tissues: kidney, gill, liver, gonad and muscle from 25 individual fishes were isolated and each tissue for a certain type of fish was homogenized, freeze - dried and ground with agate mortar. Samples of 1 g dry weigh were digested according to the procedure described by Goldberg et al., (1983).

The trace metals were determined by a Pye-Unicam flame atomic absorption spectrophotometer model SP9. Blank values were negligible for all metals studies; triplicate samples were analyzed.

RESULTS AND DISCUSSION

The mean concentration and range for trace metals in the sediments from Shatt Al-Arab estuary are listed in Table I, while mean values of trace metals in the tissues of fish species are listed in Tables II and III. The determined trace metal concentrations in the sediments of Shatt Al-Arab estuary are in close agreement with those reported in Khor Al-Zubair (Al-Edanee et al., 1991) with the exception of Ni which exhibit higher concentration in the present work, while Ni and V were lower in this study compared with sediments from Shatt Al-Arab estuary (Abaychi and DouAbul, 1985). Record values estimated for trace metals in sediments from Kuwait were higher (Basaham and Al-Lihaibi, 1993) and lower (Fowler et al., 1993) than in this study. All trace metal concentrations listed in Table I are within the range published in the literature for unpolluted areas.

Eventhough, high values of Ni and V in the sediments from Shatt Al-Arab estuary could be attributed to petroleum rich area (Al-Shahrestani and Attiya, 1978), while high levels of Pb may be refered to exhust of vehicels which use leaded fule. It is expected that the anthropogenic source is mainly due to industerial and commericial activities, oil production and gas buring

Table-1-

Mean concentration and range of trace metals in the sediment from Shatt Al-Arab estuary together with those in nearby areas (µg/g dry weight). Range values in paranthesis

Location	Cd	Co	Cr	Fe	Mn	Ni	Pb	V	Zn
Shatt Al-Arab estuary(a)	0.6 (nd-2.2)	15 (6.8-13.[illegible])	69.9 (65.8-76.8)	3774 (1459-7945)	590 (267-710)	153.7 (126.7-[illegible])	5.32 (nd-19.4)	35.2 (12.4-80)	60.5 (52.2-85.[illegible])
Khor Al-Zubair (b)	0.26 (0.2-0.3)	——	——	9640 ([illegible]-12[illegible])	541 (351-621)	[illegible] (51-[illegible])	29 (14-37)	57 (35-73)	72 (23-119)
Shatt Al-Arab river(c)	(0.17-2.[illegible])	([illegible])	([illegible])	(5452-75[illegible])	(521-[illegible])	(53[illegible])	(11.3-28.1)	(153-20[illegible])	(17.6-34.7)
NW Arabian Gulf (d)	——	——	88 (70.9-114.2)	5900 (4450-93[illegible])	1158 (915-1[illegible])	[illegible] ([illegible])	18 (5.[illegible]-25.6)	165 (150-186)	33 (27-43)
Kuwait coast (e)	1.9 (1.2-3.9)	——	69 (73-120)	15000 ([illegible])	410 ([illegible])	[illegible] ([illegible])	27 (17-43)	14 (10-18)	15 (28-88)
Kuwait (f)	—	[illegible] ([illegible])	170 ([illegible])	[illegible] ([illegible])	771.6 (551-[illegible])	[illegible] ([illegible])	——	[illegible] (85.3-1[illegible])	[illegible] (91.[illegible])
Kuwait (g)	0.77	[illegible]	[illegible]	[illegible]	11.7	[illegible]	[illegible]	[illegible]	[illegible]

(a) = present study.
(b) = Al-[illegible] et al., ([illegible])
(c) = Abaychi and DouAbul ([illegible])
(d) = Abaychi and DouAbul ([illegible])
(e) = Anderlini et al., ([illegible])
(f) = [illegible] and Al-[illegible] ([illegible])
(g) = [illegible] et al., ([illegible])

nd = [illegible] detected.

Table-1-

Mean concentration and range of trace metals in the sediment from Shatt Al-Arab estuary together with those in nearby areas (μg/g dry weight). Range values in paranthesis

Location	Cd	Co	Cr	Fe	Mn	Ni	Pb	V	Zn
Shatt Al-Arab estuary(a)	0.6 (nd-2.2)	15 (6.8-18.2)	69.9 (65.8-76.8)	3774 (1459-7945)	590 (267-710)	163.[illegible] (126.7-[illegible])	5.32 (nd-19.4)	35.2 (12.4-80)	60.5 (52.2-85.4)
Khor Al-Zubair (b)	0.26 (0.2-0.3)	—	—	9640 (7690-12667)	541 (351-621)	[illegible] (51-[illegible])	29 (14-37)	57 (35-75)	72 (23-119)
Shatt Al-Arab river(c)	(0.17-2.8)	(15.8-17.8)	(81.8-112)	(5452-7584)	(521-998)	(53[illegible]-[illegible])	(11.3-28.1)	(153-208)	(17.6-34.7)
NW Arabian Gulf (d)	—	—	88 (70.9-114.2)	5900 (4450-9371)	1158 (915-1643)	[illegible] ([illegible])	18 (5.6-25.6)	166 (150-186)	33 (27-43)
Kuwait coast (e)	1.9 (1.2-3.9)	—	69 (73-120)	15000 (7000-20000)	410 (767-500)	[illegible] (55-[illegible])	27 (17-43)	14 (10-18)	45 (24-89)
Kuwait (f)	—	32.2 (26.6-37.7)	170 (148.9-204.3)	22600 (12000-28000)	771.6 (551-941.2)	[illegible].5 (14[illegible]-209.1)	—	113.4 (85.3-135.5)	112 (91.4-125.7)
Kuwait (g)	0.77	0.91	2.85	2792	11.7	15	1.03	13.2	1.28

(a) = present study.
(b) = Al-Edanee et al., (1991)
(c) = Abaychi and DouAbul (1985)
(d) = Abaychi and DouAbul (1986)
(e) = Anderlini et al., (1982)
(f) = Basaham and Al-Lihaibi (1993)
(g) = Fowler et al., (1993)
nd = not detected.

Table-II-

Trace metal concentrations in the tissues of fresh water fish from Shatt Al-Arab estuary (µg/g dry weight). Results from 25 individual species.

Species	Cd	Co	Cr	Fe	Mn	Ni	Pb	V	Zn
Aspius vorax									
Kidney	0.38	0.13	nd	34.0	0.40	nd	0.14	1.42	1.00
gill	nd	0.82	0.48	7.60	0.30	16.0	0.76	4.92	nd
liver	0.20	0.17	0.90	26.6	0.40	nd	0.21	2.83	3.00
gonad	nd	0.75	4.68	16.1	0.14	nd	0.99	8.47	7.90
muscle	nd	0.27	0.18	51.6	0.14	6.06	nd	3.64	3.90
Barbus grypus									
Kidney	nd	0.55	nd	88.8	0.21	1.54	0.34	12.64	2.62
gill	nd	0.12	nd	32.0	0.30	8.00	0.20	1.61	nd
liver	nd	0.60	nd	15.1	0.80	nd	0.12	4.34	2.20
gonad	nd	0.33	0.55	39.5	0.60	nd	0.12	3.12	2.60
muscle	nd	0.34	nd	33.6	0.14	4.28	nd	2.31	3.80
Barbus sharpeyi									
Kidney	0.125	0.44	0.52	18.0	0.30	nd	0.03	1.83	0.60
gill	nd	0.70	1.28	25.1	0.30	6.88	0.34	2.55	nd
liver	0.28	0.32	0.96	12.2	0.30	nd	1.04	2.03	1.00
gonad	nd	0.24	0.93	63.7	1.00	nd	nd	7.61	8.80
muscle	nd	0.30	nd	43.9	1.40	4.16	0.33	1.73	2.93
Barbus xanthopterus									
kidney	--	--	--	--	--	--	--	--	--
gill	nd	0.60	2.82	22.2	0.60	nd	0.11	5.93	2.10
liver	nd	2.67	6.11	87.2	1.50	nd	1.81	12.04	4.70
gonad	nd	1.00	1.66	34.1	0.80	nd	nd	3.08	8.50
muscle	nd	0.68	0.51	22.7	1.40	2.25	nd	4.11	3.76
Cyprinus carpio									
Kidney	nd	nd	--	--	--	--	--	--	--
gill	nd	2.23	nd	17.9	0.60	18.0	0.23	16.97	nd
liver	nd	0.49	1.23	40.0	1.60	nd	nd	20.64	1.00
gonad	nd	0.24	4.88	70.0	1.30	nd	nd	13.48	3.30
muscle	nd	0.19	0.17	48.4	1.40	2.42	nd	10.21	4.30

nd = not detected.

Table-III-

Trace metal concentrations in the tissues of marine water fish from Shatt Al-Arab estuary (µg/g dry weight), Results for 25 individual species.

Species	Cd	Co	Cr	Fe	Mn	Ni	pb	V	Zn
Acanthopagrus latus									
Kidney	0.42	0.72	1.44	105.0	1.70	nd	2.60	nd	5.70
gill	nd	0.11	1.20	12.3	0.50	2.59	0.71	nd	2.50
liver	nd	0.03	nd	62.2	1.90	2.27	0.15	nd	5.60
gonad	0.44	0.17	nd	55.8	1.20	nd	0.46	nd	6.10
muscle	nd	0.18	0.48	40.1	1.40	7.84	nd	5.70	1.20
Hilsa ilisha									
Kidney	nd	0.96	nd	nd	0.53	nd	nd	8.79	3.60
gill	nd	0.20	1.57	22.7	0.50	1.62	0.32	3.34	nd
liver	nd	0.73	1.49	47.8	1.30	nd	0.21	5.18	1.70
gonad	nd	0.41	nd	129.1	3.60	nd	nd	10.47	1.40
muscle	nd	0.42	2.80	53.8	1.40	3.10	nd	4.54	2.19
Johnieops sina									
Kidney	0.22	0.25	nd	97.5	4.30	nd	nd	nd	18.97
gill	nd	0.06	1.06	20.0	0.40	0.48	0.24	0.58	0.95
liver	nd	0.12	nd	70.0	1.60	nd	0.23	nd	5.26
gonad	nd	0.10	nd	60.2	2.00	nd	nd	0.72	6.80
muscle	nd	0.20	4.08	61.0	1.40	nd	nd	5.71	0.42
Liza subviridis									
Kidney	nd	0.13	2.33	73.3	1.30	nd	0.44	1.33	8.70
gill	nd	0.01	1.60	30.0	0.30	0.43	0.36	1.31	2.40
liver	nd	0.25	1.82	35.0	1.00	nd	0.56	2.41	2.40
gonad	nd	0.57	1.35	14.6	0.70	nd	0.28	2.30	1.50
muscle	nd	0.18	0.21	30.6	1.40	4.99	nd	2.80	5.00
Otolithes argenteus									
Kidney	--	--	--	--	--	--	--	--	--
gill	nd	0.06	0.77	21.4	0.50	nd	0.47	nd	2.20
liver	nd	0.08	nd	31.8	0.70	nd	0.76	nd	3.20
gonad	nd	0.19	2.47	63.1	1.20	nd	2.24	nd	1.50
muscle	nd	0.20	nd	41.7	1.40	6.39	nd	1.81	0.50

nd = not detected

and dust fallout which transport a significant amount of pollutants to the estuary" (Al-Saad, 1995).

The bottom sediments are considered to be important ecologically, since the substances that accumulated their tend to become incorporated into food chains and thus become a hazard to both fish and consumer (Polprasert, 1982). Species of fish investigated in this study represent locally preferable commercial species, those in Table II are fresh water and their feeding habit is mainly plants and diatoms while those in Table III are primerly omnivorous feeding mainly on crustacein, alge and aquatic plants, some overlape between the two groups may occur on occasion.

Tissues of studied fish species showed different accumulation of trace metals. Minimum values were found in all species, mostly accumulated in Kidney and liver for a maximum values of 0.42 ug/g in the kidney of Acanthopagrus latus.

Values of Co and Cr were higher in fresh water than marine fish with maximum values recorded in the liver of Barbus xanthopterus for 2.67 and 6.11 ug/g respectively.

Iron is the metal present in the highest concentrations in all tissues of all studied fish. Maximum values recorded were 105 and 129 ug/g in the kidney of Acanthopagrus latus and gonad of Hilsa ilisha respectively. Kidney is the tissue which accumulated higher values of Mn, especially in marine fish. Values of 7.84 and 6.39 ug/g for Ni were determined in the muscle of Acanthopagrus latus and Otolitha argentus respectively. Muscle of all studied species accumlated Ni in greater amount than all other tissues. Kidney is the tissue which accumulated higher values of Pb and Zn in which a values of 2.6 and 18.97 ug/g were determined in the kidney of Acanthopagrus latus and Johnieops sina respectively.

The results of the present study show that different species of fish concentrate trace metals in their tissues to varying levels. These differences could be explained on the basis that certain metals being rapidly discharged and excreted from the tissues of the same fish due to species and/or site-dependent

(Williams and Giesy, 1978; Wiener and Giesy, 1979).

There are few data available on the concentrations of trace metals in different tissues of fish from Shatt Al-Arab river and its estuary and other area of the Arabian Gulf which could be used together with values from world wide and heavily polluted sites for comparitive purposes.

Anderlini et al., (1982) reported values of trace metals in the muscle of commericial fish from Kuwait in which they represented unpolluted in comparison with world wide values given by Bryan (1976). Abaychi and Al-Saad (1988) studied fish from Shatt Al-Arab river and Arabian Gulf, they found low concentrations of Cd, Mn and Pb while other metals were high in concentration. Al-Edanee et al., (1991) determined trace metals in muscle of marine fish from Khor Al-Zubair, they reported high values for Ni, Pb and V. Fowler et al., (1993) determined trace metals in the edible muscle of fish from Arabian Gulf, they reported low values indicating no heavy metal contamination originated from anthropogenic sources.

Abdullah and Abdul-Hassan (1993) recorded the distribution of Cu and Zn in tissues of some fish from Shatt Al-Arab estuary, values reported were 35 and 155 ug/g for Cu and Zn in the gonad of <u>Thryssa hamiltoni</u> respectively. For comparison, mean values for trace metals in the muscle of fish determined in this study are listed in Table IV together with values reported for nearby area, world wide and polluted sites. All the concentrations of trace metals obtained in the tissues of fish in the present study are much lower than those reported at heavily polluted sites (Dallinger and Kautzky, 1985), except high values for Ni and V which could be attributed to petroleum rich area (Al-Shahrestani and Al-Attiya, 1978). No significant correlation was observed between trace metal concentrations in fish tissues and their feeding habits, this could be related to factors other than food habits (Wiener and Giesy, 1979). Low concentrations of trace metls in the water of Shatt Al-Arab estuary (Al-Khafaji et al., 1997) supported by lack of industrial or municipal waste inputs directly to the

Trace metal concentrations in muscle of fish (µg/g dry weight) from Iraqi and NW Arabian Gulf in comparison with world wide average concentration and polluted site

Location	Cd	Co	Cr	Fe	Mn	Ni	Pb	V
Shatt Al-Arab estuary(a)	nd	0.30	nd	43.9	1.40	4.16	0.33	1.73
Khor Al-Zubair (b)	0.90	---	---	51.5	1.70	6.00	3.90	5.40
Shatt Al-Arab (c)	0.10	0.60	4.50	60.5	7.30	--	0.46	1.00
Kuwait (d)	0.80	0.40	0.60	148	2.00	0.60	1.40	1.00
Arabian Gulf (c)	0.05	1.20	0.80	55.2	6.90	4.80	0.50	4.60
Kuwait (e)	0.35	0.04	0.14	12.5	0.52	--	0.27	0.07
World wide(f)	0.10	0.20	0.10	50	10.0	1.00	3.00	1.00
Polluted (g)	0.92	--	8.90	--	3.90	7.80	20.1	--

(a) = present study
(b) = Al-Edanee et al., (1991)
(c) = Abaychi and DouAbul (1988)
(d) = Anderlini et al., (1982)
(e) = Fowler et al., (1993)
(f) = Bryan (1978)
(g) = Dallinger and Kautzky (1985)

estuary close to sampling station. Waste effluents introduce to Shatt Al-Arab river from highly urbanized Basrah city (DouAbul et al. 1987) and those from Abadan city and its refineries via Karun river (Al-Saad, 1995). Both sources are located about 100 and 40 Km upstream respectively from sampling stations, the already existing trace metals are therefore diluted until the water reaches the Shatt Al-Arab estuary.

Comparison of present data may be difficult since data determined for this region of the world are being judged in relation to selected individual area and sites, moreover, different fractions of sediments and species of fish were analyzed, lacking of information on sex and presentation of analytical results.

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