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Incidence of Lead, Cadmium and Mercury in Freshwater Fish from Saurashtra Region of Gujarat (India)

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The edible meat from fresh water fish *viz.*, Catla (*Catla catla*), Rohu (*Labeo rohita*), fresh water cat fish (*Wallago attu*) and minor carp (*Puntius spp.*) from different reservoirs of Gujarat were analysed for the presence of heavy metals of human health significance. Cadmium levels in these samples were in the range of 0.01 to 0.13 ppm and lead was in the range 0.01 to 0.51 ppm. Mercury was detected in 48% of the samples analysed. Generally, the observed levels of heavy metals in all the samples were well below the maximum residual levels permissible in national and international standards and is not a health hazard to the consumers. However, the pattern of heavy metal incidence could not derive any specific relationship between different species, locations or season.

Key words : Freshwater fish, reservoir, lead, cadmium, mercury, Gujarat

Industrial wastes, sewage and pesticide pollution have been causing detrimental environmental conditions to aquatic life in many water bodies. Incidence of heavy metal accumulation in fish, oysters, mussels, sediments and other components of aquatic ecosystems have been reported from all over the world. Bioaccumulation of trace metals has been extensively studied in field and laboratory. (Boudoud & Ribeyre, 1989, Alam *et. a.l*,2002). Heavy metals pose a serious problem because they do not decompose or become eliminated from ecosystems (Gaal *et. al.*, 1985; Pujin *et. al.*, 1990). Consumption of fish contaminated with heavy metal pose serious health hazard to the consumer. Lakshmanan (1988) observed that the presence of cadmium was maximum in molluscs when compared with fishes and crustaceans. Radhakrishnan (1994) reported a low level of cadmium in different varieties of marine finfishes and shellfishes except in case of mussels, *Perna viridis*. High levels of cadmium causes muscle cell cancer and lead causes kidney cancer in experimental rats. Long-term exposure to lead may give rise to development of irreversible functional and morphological renal changes. Lead exerts its toxic effects directly on the developing foetus (Flora, 2002). Distribution of heavy metals residues in the fresh water fish species from the Calicut region of India has been reported by Sankar *et. al*, (2006). Mercury poisoning through the consumption of contaminated fish and shellfish has been well illustrated in the case of Minamata bay disaster in Japan (GoldWater, 1971). Lakshmanan (2003) has made suggestions to control the contamination of the aquatic environment, preventing the uptake of toxicants and protecting public health.

Carps particularly Indian major carps viz., Catla, Rohu, and Mrigal form the important species in the inland fish production in India which is the second biggest fresh water fish producer, following China (Anon, 2002a). Omnivorous, sediment dwelling, fish species such as carp may accumulate heavy metals more readily than pelagic

species as a result of exposure to the generally higher metal content of the sediment compared with the water column (Philips, 1980).

Gujarat is the largest marine fish producing state in India where the per capita fish consumption is 7.77 Kg/annum (Narayanan & Upadhyay, 1998), which is well above the national average of 4.8 Kg/ annum (Anon, 2002). Of late, significant contributions in inland fish production had been made from rivers and reservoirs of this state. Although the pesticide residues in fresh water fish (Zynudheen, et. al., 2003) and heavy metals levels in cephalopods have been reported from this region (Zynudheen et. al., 2004), bioaccumulation of heavy metals in fresh water fish has not so far been documented. Lead, cadmium and mercury are classified as chemical hazards and maximum residual levels (MRL) have been allowed by many regulatory bodies for human consumption (Anon., 2002b; EC, 2001; FAO, 1983). The present study documents the levels of cadmium(Cd), lead(Pb) and mercury(Hg) in fresh water fish samples collected from different reservoirs of Saurashtra region in Gujarat.

Materials and Methods

The fish samples for the study were collected from different locations in Saurashtra during the year 2005 and analysed for the presence of metals viz. cadmium, lead and mercury. The *Catla catla* (Catla) samples were collected from Junagadh market (source: Aji reservoir-A) and Rajkot market (source: Morbi reservoir-B). *Labeo rohita* (Rohu) samples were from Junagadh market (source: Aji reservoir-A), Rajkot market (source: Morbi reservoir-B) and Kodinar market (source: Una reservoir-C). Fresh water catfish, *Wallago attu* was mainly collected from Junagadh market (source: Aji reservoir- A) and *Puntius* spp. from Kodinar market (source: Una reservoir-C)

Samples were brought to the laboratory in iced condition. The length and weight of the samples were noted with a precision of one cm and five g respectively. The meat was separated, homogenised and wet digested in acid mixture (nitric acid and sulphuric acid in 4:1 ratio) in Bethege's apparatus as per standard methods (AOAC, 1990). Similarly reagent blank was also prepared. The samples and blanks were made up to a known volume. The samples were analysed in Atomic Absorption Spectrophotometer (GBC 903 Avanta) in air-acetylene flame for cadmium and lead using the respective hollow cathode lamps. Mercury was analysed using the Mercury Analyzer (Electronic Corporation of India Limited Model MA 4840). Analytical Grade acids were used for digestion of the samples. The standards used were purchased from Merck, Germany. All the samples were analysed in triplicates and average value noted.

Results and Discussion

The levels of Cadmium, mercury and lead in fish samples from different locations are given in Tables 1 & 2. 93% of freshwater fish samples contained cadmium in the range of 0 .01 -0 .13 ppm. However only two samples contained marginally higher levels of cadmium as per EC regulations. In catla, cadmium was present in all the samples from different locations. 40% of the samples analysed had Cd within the range of 0.05-0.1 ppm and the remaining being < 0.05 ppm. Cadmium was present in all the samples of rohu and 25% of the samples contained cadmium within the tolerance range of EC standards. No significant difference was noticed in cadmium content of rohu samples collected from different locations during the study. The *Wallago attu*

Table 1. Concentration of heavy metals (wet weight) in Catla and Rohu collected from Saurashtra region

Catla catla	*Sampling site*	*Length (cm)*	*Weight (g)*	*Cadmium (ppm)*	*Lead (ppm)*	*Mercury (ppm)*
January	A	30	350	0.08	0.35	ND
	B	30	540	0.02	0.51	0.03
February	A	25	340	0.09	0.38	0.25
	A	30	300	0.04	0.20	ND
March	A	20	200	0.06	ND	ND
September	A	23	170	0.04	ND	ND
	B	45	2000	0.05	ND	ND
October	B	35	1250	0.03	ND	ND
November	B	38	1300	0.01	0.23	0.03
December	B	30	650	0.01	0.08	0.03
Labeo rohita						
January	B	48	1650	0.01	0.31	0.18
February	A	46	1700	0.02	0.36	0.08
March	A	43	1450	0.04	0.34	0.06
June	A	50	1250	0.13	0.10	ND
September	B	25	260	0.06	ND	ND
	C	63	4200	0.03	0.35	0.08
October	A	35	900	0.08	0.28	ND
	B	28	325	0.04	ND	ND
November	B	40	800	0.06	ND	ND
December	A	35	1000	0.04	0.28	0.05
	B	50	1800	0.01	0.04	0.02
	C	50	3100	0.03	0.45	0.43

A – Junagadh fish market. B – Rajkot Fish Market. C – Kodinar Fish market

samples analysed during the month of February had significantly higher levels of cadmium. Sankar *et. al* (2006) reported cadmium in the range of 0.03-0.19 ppm in the meat of freshwater fish samples collected from Calicut area. However, in *Puntius* samples, cadmium was not detected.

More than 60% of the samples contained lead (0.01–0.51 ppm) in the meat and two of these samples showed marginally higher levels than EC approved limits. Compared to cadmium, the percentage incidence of lead was less in catla. Except in one case, all values were within the limit of EC standards. The presence of lead was noticed in 75% of the rohu samples. The levels of lead was comparatively low and 60% of the samples collected from station B during February-November did not contain lead in the muscle in detectable levels. In case of *W. attu,* lead was detected within the tolerance levels in 40% of the samples. Alam *et. al.,* (2002) observed in wild carps from lake Kasiumigaura, Japan, the lowest levels of cadmium and lead in the muscle compared to other internal organs. The finding that concentration of lead in different samples was independent of the fish size agrees with earleir observations of Wiener & Giesy (1979).

Mercury was detected in 48% of the samples and the range was well below the permissible level of 0.5 – 1 ppm (EC, 2001). Compared with incidence of Cd and Pb in

Table 2. Concentration (wet weight) of heavy metals in *Wallago attu* and *Puntius* spp. from Saurashtra region.

Wallago attu	*Sampling site*	*Length (cm)*	*Weight (g)*	*Cadmium (ppm)*	*Lead (ppm)*	*Mercury (ppm)*
February	A	46	420	0.12	0.01	ND
September	A	65	1200	0.01	ND	ND
October	A	51	800	0.04	0.24	0.12
November	A	46	530	0.05	ND	ND
December	A	47	630	0.05	ND	ND
Puntius spp.						
September	C	15	60	ND	ND	0.06
December	C	13	42	ND	0.37	0.04

A – Junagadh fish market. B – Rajkot Fish Market. C – Kodinar Fish market

the samples, incidence of mercury was the lowest. In catla, mercury level was very low and the incidence was noted in 40% samples. The percentage incidence of mercury in rohu was less than that of lead. In *W. attu*, out of 5 samples analysed, only the samples collected during the month of October had mercury in the muscle. In *Puntius spp*, mercury was present in all the samples. The observed levels of Hg in various samples was in the range of 0.02-0.43 ppm. Jagoe *et.al.* (1997) observed the Hg content in crucian carp from Chernobyl area to be in the range of 0.006-0.25 ppm on wet weight basis. A positive relationship between fish size and mercury content due to bioaccumulation has been documented (Huckebe *et.al.* 1979). Such relationship were not reflected in the present study due to the number. Rajan *et. al.* (1995) observed that there was no relationship between the accumulation pattern of different metals in the different fishes and their feeding habits.

Table 3. Maximum permissible limits (ppm) of heavy metals in fish as recommended by regulatory bodies

Heavy metals Standards	*National	**EC, 2001	***FAO, 1983
Mercury	1.0	0.5-1.0	-
Cadmium	3.0	0.05-0.1	0.5
Lead	1.5	0.2-0.4	0.5

*The Gazette of India No. 614. July 10, 2002
** EC, 2001. Commission Regulation (EC) No. 466/2001 of 8th March 2001. Official Journal of European Communities 1.77/1.
***FAO, 1983. Compilation of legal limits for hazardous substances in fish and fishery products. FAO Fisheries Circular, No. 464, pp. 5-100.

The majority of the freshwater fish samples excluding *Puntius spp.* indicated the presence of cadmium, lead and mercury in the meat. Only four samples showed marginally higher levels of cadmium and lead on the basis of EC standards. None of the samples crossed the MRL as per the FAO or the Indian Standards.

The present study indicates that the major heavy metal residues present in the freshwater fish from the reservoirs of Saurashtra region in Gujarat are well within the MRL. However, no specific relationship was observed between the heavy metal content, different species, locations or season. The presence of Cd, Pb and Hg in majority of the samples point out the need for continuous monitoring of commercially important freshwater species in this region to ensure food safety. Knowledge on the nature of the effluents released from industrial units and agricultural fields to the natural water bodies is also an essential prerequisite for the effective monitoring and

surveillance of heavy metal pollution of Saurashtra area.

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