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Independent toxic effects of metallic compounds on Indian major carps

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Abstract

An attempt on individual toxicity of lead nitrate and barium chloride on the Indian major carps, catla, rohu and mrigal was carried out as they are the natural inhabitants of the perennial rivers network of India and neighbouring countries where pollutants are becoming a major stress factor for these commercially important edible fishes. For all the three major carps, the 96 hr LC_{50} and Sub Lethal Concentration (SLC) were in the order of Lead nitrate > Barium chloride. In the individual toxicity studies, the three carps exhibited a decreasing trend in total proteins and total lipids in all the test tissues but liver alone showed an increasing trend with reference to carbohydrate content.

Keywords: Catla, Rohu, Mrigal, Lead nitrate, Proteins, Carbohydrates and Lipids.

Introduction

Aquatic water bodies are frequently polluted with a multitude of potentially hazardous substances (Battaglin and Fairchild, 2002). Thus, protecting the integrity of our water resources is one of the most essential environmental issues of the 21st century. Recently, it has brought increasing concerns for potential adverse ecological health effects resulting from the production, use, and disposal of numerous chemicals that offer improvements in industry, agriculture, medical treatment, and even common household conveniences (Daughton & Ternes, 1999). Heavy metals like lead are one of the major components of the industrial wastes, which along with other products from industrial operations are discharged into the aquatic environment and it is toxic to aquatic life (Korai *et al*., 2008). Contamination by heavy metal in aquatic system is a severe problem and fish are more repeatedly exposed to these pollutants and may be taken in through gills, skin and contaminated foods (Ribeiroa *et al.,* 2005; Ling *et al*., 2011). As an inexpensive, soluble salt of barium, barium chloride finds wide applications in industry; barium chloride is mainly used in the purification of brine solution in caustic chlorine plants and also in the manufacture of heat treatment salts, in the manufacture of pigments and in the manufacture of other barium salts (ATSDR, 2007). Hence, aquatic organisms are often exposed to mixtures of toxicants because it is believed that regardless of where the pollution occurs, it will eventually end up in the aquatic environment (Fıat *et al*., 2011). The effect of pollution on the inhabiting species was found to be more in fresh water than in marine water (Koyama, 1997). Hence, fingerlings of the Indian major carps, *Catla catla* (catla), *Labeo rohita* (rohu) and *Cirrhina mrigala* (mrigal) was selected to assess the independent toxic effects of industrial effluents, lead nitrate and barium chloride.

Materials and methods

The fingerlings of the Indian major carps namely, *Catla catla*, *Labeo rohita* and *Cirrhina mrigala* were collected from the Tamil Nadu Fish Seed Farm Poondi, Thiruvallur Dist. They were quarantined and acclimatized to laboratory condition for three days. During this period they were fed with groundnut oil cake and the water was also renewed alternatively after feeding. The environmental parameters like the temperature, pH, salinity and dissolved oxygen of the water used were well within the acceptable range.

Healthy fishes without any observable pathological symptoms were chosen for the experiments. Fishes were divided into groups of ten each and exposed to the toxicants viz. Lead nitrate and Barium chloride independently. In the independent toxicity experiments, fingerlings of each species of Indian major carps were exposed to the test toxicants individually.

Independent toxicity

Initially the fingerlings of three species of Indian major carps were treated with lead nitrate and barium chloride individually to determine 96hr LC_{50} values for the test toxicants. Based on the range finding bioassay, five different concentrations of investigative toxicants were prepared by dissolving in distilled water. Suitable controls without toxicant were maintained for all the experimental groups. Mortality was recorded for each day and tabulated to arrive at the cumulative per cent mortality at the end of 96hr for the different groups and 96hr LC_{50} value was arrived using Finney (1971) probit analysis method.

One fourth of LC_{50} values obtained from the above experiments was taken as the Sub Lethal Concentration (SLC). Apparently normal and healthy fingerlings of catla, rohu and mrigal were exposed to these concentrations of the toxicant in groups for further experimental studies and sacrificed on 4th, 7th, 14th, 21th and 28th day of post exposure to study the biochemical parameters; total proteins, total carbohydrates and total lipids of fish muscle, liver, brain and kidney.

The proteins, carbohydrates and lipids, were assessed by the procedures of Carrol *et al*., (1956), Lowry *et al.,* (1951) and Jayaraman (2003) respectively.

Data analysis was carried out using SPSS statistical package to arrive at mean, standard deviation and test of significance (P value).

Results and discussion

Determination of 96hr LC_{50} values for the test toxicants and fixing of sub lethal concentration (SLC)

Catla catla: Fish was exposed to barium chloride in the range of 100- 400 ppm. 50% mortality was noticed at 400 ppm, which was taken as 96hr LC_{50} for the toxicant.SLC was calculated as 100 ppm being 1/4th of LC50 value (Table 1). Exposure to lead nitrate registered 50 % mortality in 150 ppm and SLC was calculated as 37.5 ppm being 1/4th of LC_{50} value (Table 2).

Labeo rohita: Exposure to barium chloride in the range of 100- 400 ppm exhibited 50% mortality at 400 ppm, which was taken as 96hr LC_{50} for the toxicant.SLC was calculated as 100 ppm being 1/4th of LC_{50} value (Table 3).

The fish was exposed to lead nitrate in the range of 150-400 ppm to determine 96hr LC_{50} concentration. 50% mortality was recorded in the experimental group subjected to 350ppm of the chemical. 87.5ppm being 1/4th of LC_{50} value was taken as SLC for lead nitrate toxicity studies (Table 4).

Table 1. Determination of 96 hr LC_{50} for Barium chloride

Conc. (ppm)	Percentage mortality				Cumulative % Mortality
	Day1	Day 2	Day 3	Day 4	
100	0	0	0	0	0
200	0	0	10	10	20
300	0	0	10	20	30
400	10	10	20	10	50

Table 2. Determination of 96 hr LC_{50} for Lead nitrate

Conc. (ppm)	Percentage mortality				Cumulative % Mortality
	Day 1	Day 2	Day 3	Day 4	
30	0	0	0	0	0
60	0	0	10	10	20
90	0	0	10	20	30
120	0	10	20	10	40
150	10	10	10	20	50

Table 3. Determination of 96 hr LC_{50} for Barium chloride

Conc. (ppm)	Percentage mortality				Cumulative % Mortality
	Day 1	Day 2	Day 3	Day 4	
100	0	0	0	0	0
200	0	0	10	10	20
300	0	0	10	20	30
400	10	10	20	10	50

Table 4. Determination of 96 hr LC_{50} for Lead nitrate

Conc. (ppm)	Percentage mortality				Cumulative % Mortality
	Day 1	Day 2	Day 3	Day 4	
150	0	0	0	0	0
200	0	0	10	10	20
250	0	0	10	20	30
300	0	10	20	10	40
350	10	10	10	20	50

Cirrhina mrigala: 100-400 ppm range was designed for barium chloride noxiousness study. 400 ppm concentration showed 50% death which was taken as 96hr LC_{50} for the toxicant and SLC was calculated as 100 ppm being 1/4th of LC_{50} value (Table 5). For lead nitrate, 50% mortality was recorded at 300 ppm concentration. The toxicant used was in the range of 150-300 ppm. The calculated SLC was 75 ppm (Table 6).

Table 5. Determination of 96 hr LC_{50} for Barium chloride

S. No	Conc. (ppm)	Percentage mortality				Cumulative % Mortality
		Day 1	Day 2	Day 3	Day 4	
1	100	0	0	0	0	0
2	200	0	0	0	10	10
3	300	0	0	0	20	20
4	400	0	0	10	40	50

Table 6. Determination of 96 hr LC_{50} for Lead nitrate

S. No	Conc. (ppm)	Percentage mortality				Cumulative % Mortality
		Day 1	Day 2	Day 3	Day 4	
1	150	0	0	0	0	0
2	200	0	0	0	10	10
3	250	0	0	20	10	30
4	300	0	0	10	40	50

Independent toxic effects on the nutritional content

Total proteins: The fingerlings of three species of Indian major carps exhibited a decreasing trend with reference to total protein content in the assessed tissues during the exposure periods of the tested toxicants (Tables 7-9).

Total carbohydrates

Barring the liver of the three species, the other tissues showed a declining trend in their total carbohydrate content during the experimental periods (Tables 10-12).

Total lipids

The dissected tissues of the fingerlings of the three species recorded a gradual decrease in their total lipid content during the exposure periods of the study toxicants (Tables 13-15).

Although scientists generally have a good knowledge of the toxicity of individual chemical contaminants, there is a great need to bridge the gap between our understanding of the toxic effects of exposure to individual xenobiotics and those effects from exposure to mixtures of such chemicals (Olmstead & LeBlanc, 2005; Lister *et al.,* 2011). To substantiate the nature of toxicity, assessment of biochemical parameters; proteins, carbohydrates and lipids are important as they indicate the vulnerability of organ systems to the pollutants (Fahmy, 2012). In the current research, these metabolic parameters have been utilised to detect the sub lethal effects of the investigative toxicants. Initially, the LC_{50} for two toxicants were determined independently. For all the three major carps, the 96 hr LC_{50} and Sub Lethal Concentration (SLC) were in the order of Lead nitrate > Barium chloride. Later in the individual toxicity studies, the three Indian major carps exhibited a decreasing trend in total proteins and total lipids in all the test tissues but liver alone showed an increasing trend with reference to carbohydrate content. The toxicity responses exhibited by the carps in this study are similar to those reported by other authors under various stress conditions (Palanivelu *et al.,* 2005; Ufodike & Onssiriuka, 2008;

Table 7 Catla catla: TOTAL PROTEINS (mg/g wet wt.)

TOXICANT		CONTROL	4^{th} DAY	7^{th} DAY	14^{th} DAY	21^{st} DAY	28^{th} DAY
MUSCLE							
$BaCl_2$	MEAN	8.30	6.69	6.49	4.58	4.18	8.33
	S.D	0.43	1.00	1.02	0.95	0.94	1.11
	P	-	0.001	0.02	0.001	0.001	NS
$PbNo_3$	MEAN	8.30	6.22	5.88	5.12	4.58	7.14
	S.D	0.43	1.02	1.32	1.96	0.72	1.02
	P	-	0.001	0.001	0.001	0.001	NS
LIVER							
$BaCl_2$	MEAN	28.01	20.77	17.00	14.64	9.70	27.32
	S.D	2.18	1.39	1.14	1.22	1.93	2.59
	P	-	0.001	0.001	0.001	0.001	NS
$PbNo_3$	MEAN	28.01	25.08	17.34	11.46	9.05	10.62
	S.D	2.18	1.77	1.52	1.02	0.73	1.08
	P	-	0.02	0.001	0.001	0.001	0.001
BRAIN							
$BaCl_2$	MEAN	7.11	5.18	4.17	2.71	2.38	5.64
	S.D	1.19	0.86	0.96	0.76	1.13	1.30
	P	-	NS	0.001	0.001	0.001	NS
$PbNo_3$	MEAN	7.11	6.93	5.77	4.86	2.84	4.35
	S.D	1.19	0.97	1.31	1.04	0.93	0.67
	P	-	NS	NS	NS	0.001	0.001
KIDNEY							
$BaCl_2$	MEAN	25.54	22.10	20.30	18.18	16.08	17.40
	S.D	3.98	0.97	0.80	0.98	0.72	1.29
	P	-	0.05	0.05	0.001	0.001	0.001
$PbNo_3$	MEAN	25.54	23.62	21.14	16.05	12.10	13.81
	S.D	3.98	1.56	1.23	1.47	1.24	1.06
	P	-	NS	NS	0.001	0.001	0.001

Table 8. Labeo rohita: TOTAL PROTEINS (mg/g wet wt.)

TOXICANT		CONTROL	4^{th} DAY	7^{th} DAY	14^{th} DAY	21^{st} DAY	28^{th} DAY
MUSCLE							
$BaCl_2$	MEAN	44.09	31.64	30.13	26.70	23.41	40.15
	S.D	1.28	3.83	1.51	1.66	1.56	1.11
	P	-	0.001	0.001	0.001	0.001	NS
$PbNo_3$	MEAN	44.09	38.21	20.44	19.14	17.69	41.35
	S.D	1.28	1.29	1.26	1.68	0.97	1.08
	P	-	0.001	0.001	0.001	0.001	0.001
LIVER							
$BaCl_2$	MEAN	20.27	18.30	17.10	16.28	11.13	18.85
	S.D	1.43	1.29	1.45	1.09	0.94	1.83
	P	-	NS	0.001	0.001	0.001	0.001
$PbNo_3$	MEAN	20.27	15.48	13.29	9.78	6.01	18.76
	S.D	1.43	1.90	1.32	1.38	1.37	1.48
	P	-	0.001	0.001	0.001	0.001	NS
BRAIN							
$BaCl_2$	MEAN	9.91	7.22	5.41	3.07	2.13	6.08
	S.D	0.94	0.90	1.26	0.45	0.21	1.72
	P	-	0.001	0.001	0.001	0.001	0.001
$PbNo_3$	MEAN	9.91	7.84	6.32	3.13	2.11	5.77
	S.D	0.94	1.11	0.72	0.91	0.99	1.25
	P	-	0.02	0.001	0.001	0.001	0.001
KIDNEY							
$BaCl_2$	MEAN	15.06	13.46	12.60	8.59	7.19	12.72
	S.D	1.75	1.47	1.49	0.58	0.97	2.44
	P	-	NS	0.001	0.001	0.001	NS
$PbNo_3$	MEAN	15.06	13.64	12.04	9.86	4.85	12.12
	S.D	1.75	0.80	0.98	0.79	1.17	0.59
	P	-	NS	0.02	0.001	0.001	0.001

Table 9. *Cirrhina mrigala*: *TOTAL PROTEINS (mg/g wet wt.)*

MUSCLE							
TOXICANT		CONTROL	4th DAY	7th DAY	14th DAY	21st DAY	28th DAY
$BaCl_2$	MEAN	8.43	6.12	3.89	2.75	1.17	7.70
	S.D	1.33	1.09	1.14	1.23	0.70	1.16
	P	-	NS	0.001	0.001	0.001	NS
$PbNo_3$	MEAN	8.43	6.11	5.28	5.15	4.89	7.05
	S.D	1.33	1.29	0.61	0.91	1.29	1.09
	P	-	0.001	0.001	0.001	0.001	NS
LIVER							
$BaCl_2$	MEAN	4.08	3.25	2.87	2.58	1.32	3.79
	S.D	1.00	1.05	0.98	1.19	0.66	1.34
	P	-	NS	NS	NS	0.001	NS
$PbNo_3$	MEAN	4.08	3.06	2.56	1.66	1.27	3.80
	S.D	1.00	1.07	0.82	0.51	0.81	1.05
	P	-	NS	0.05	0.001	0.001	NS
BRAIN							
$BaCl_2$	MEAN	6.01	5.81	5.15	3.98	2.58	5.16
	S.D	0.95	0.98	1.01	1.27	1.19	1.41
	P	-	NS	NS	0.001	0.001	NS
$PbNo_3$	MEAN	6.01	5.72	5.35	4.81	4.37	5.86
	S.D	0.95	1.32	1.28	1.10	0.96	1.11
	P	-	0.05	0.05	0.001	0.001	0.001
KIDNEY							
$BaCl_2$	MEAN	11.66	10.87	9.15	7.70	6.93	11.21
	S.D	1.07	2.20	1.18	1.16	1.14	0.83
	P	-	NS	NS	NS	0.001	NS
$PbNo_3$	MEAN	11.66	10.81	10.23	9.64	7.87	11.28
	S.D	1.17	1.08	1.01	0.65	1.08	0.76
	P	-	0.001	0.001	0.001	0.001	NS

Table 10. Catla catla: TOTAL CARBOHYDRATES (mg/g wet wt.)

MUSCLE							
TOXICANT		CONTROL	4th DAY	7th DAY	14th DAY	21st DAY	28th DAY
$BaCl_2$	MEAN	0.97	0.81	0.72	0.60	0.58	0.73
	S.D	0.11	0.07	0.07	0.08	0.04	0.08
	P	-	0.001	0.001	0.001	0.001	0.001
$PbNo_3$	MEAN	0.97	0.81	0.73	0.60	0.42	0.80
	S.D	0.11	0.07	0.07	0.15	0.17	0.24
	P	-	0.001	0.001	0.001	0.001	NS
LIVER							
$BaCl_2$	MEAN	26.25	26.75	27.01	27.95	28.35	25.32
	S.D	1.15	2.18	1.13	1.06	1.17	1.46
	P	-	NS	0.001	0.001	0.001	NS
$PbNo_3$	MEAN	26.25	27.15	27.65	28.15	28.45	26.01
	S.D	1.15	2.18	1.08	1.10	1.06	1.11
	P	-	NS	0.001	0.001	0.001	0.001
BRAIN							
$BaCl_2$	MEAN	1.13	0.93	0.75	0.67	0.59	1.06
	S.D	0.15	0.34	0.04	0.10	0.07	0.27
	P	-	NS	0.001	0.001	0.001	NS
$PbNo_3$	MEAN	1.13	0.98	0.63	0.56	0.23	1.06
	S.D	0.15	0.28	0.11	0.09	0.09	0.31
	P	-	NS	0.001	0.001	0.001	NS
KIDNEY							
$BaCl_2$	MEAN	2.86	1.66	1.53	1.12	0.88	1.66
	S.D	0.41	1.09	0.40	0.62	0.28	1.09
	P	-	NS	0.05	0.001	0.001	NS
$PbNo_3$	MEAN	2.86	1.89	1.66	1.44	1.20	2.68
	S.D	0.41	0.45	0.41	0.54	0.27	1.12
	P	-	0.001	0.001	0.001	0.001	NS

Table 11. Labeo rohita: TOTAL CARBOHYDRATES (mg/g wet wt.)

MUSCLE							
TOXICANT		CONTROL	4th DAY	7th DAY	14th DAY	21st DAY	28th DAY
$BaCl_2$	MEAN	3.87	2.03	0.90	0.86	0.76	0.84
	S.D	0.30	0.85	0.10	0.06	0.05	0.18
	P	-	0.001	0.001	0.001	0.001	0.001
$PbNo_3$	MEAN	3.87	1.86	0.70	0.61	0.60	1.02
	S.D	0.30	0.25	0.09	0.07	0.06	0.09
	P	-	0.001	0.001	0.001	0.001	0.001
LIVER							
$BaCl_2$	MEAN	20.11	21.75	22.14	23.95	24.36	18.95
	S.D	1.24	0.87	1.45	0.98	1.39	1.28
	P	-	0.001	0.001	0.001	0.001	0.02
$PbNo_3$	MEAN	20.11	21.95	22.35	22.93	23.15	19.75
	S.D	1.24	1.41	1.46	1.23	0.85	1.02
	P	-	0.001	0.001	0.001	0.001	0.001
BRAIN							
$BaCl_2$	MEAN	1.83	0.95	0.91	0.77	0.46	0.76
	S.D	0.44	0.10	0.10	0.07	0.19	0.05
	P	-	0.001	0.001	0.001	0.001	NS
$PbNo_3$	MEAN	1.83	1.39	0.71	0.66	0.61	1.46
	S.D	0.44	0.10	0.06	0.08	0.10	0.10
	P	-	NS	0.001	0.001	0.001	NS
KIDNEY							
$BaCl_2$	MEAN	5.75	3.94	2.19	1.62	1.37	3.14
	S.D	1.07	0.33	0.11	0.06	0.13	1.10
	P	-	0.001	0.001	0.001	0.001	NS
$PbNo_3$	MEAN	5.75	3.10	2.81	1.55	1.43	4.92
	S.D	1.07	0.63	0.14	0.57	0.13	1.02
	P	-	0.001	0.001	0.001	0.001	NS

Table 12. Cirrhina mrigala: TOTAL CARBOHYDRATES (mg/g wet wt.)

MUSCLE							
TOXICANT		CONTROL	4th DAY	7th DAY	14th DAY	21st DAY	28th DAY
$BaCl_2$	MEAN	2.49	1.84	1.74	1.35	1.15	2.36
	S.D	0.72	0.83	0.96	0.56	0.42	1.40
	P	-	NS	NS	NS	0.001	NS
$PbNo_3$	MEAN	2.49	1.43	1.13	1.10	0.98	2.52
	S.D	0.72	0.59	0.61	0.35	0.67	0.81
	P	-	NS	0.001	0.001	NS	NS
LIVER							
$BaCl_2$	MEAN	23.50	24.51	25.10	25.87	26.35	21.09
	S.D	0.81	0.97	2.90	0.98	1.02	1.15
	P	-	0.001	0.001	0.001	0.001	0.001
$PbNo_3$	MEAN	23.50	24.35	25.10	25.96	26.43	22.17
	S.D	0.81	1.58	1.26	1.17	1.30	0.98
	P	-	0.001	0.001	0.001	0.001	0.001
BRAIN							
$BaCl_2$	MEAN	3.54	2.60	1.81	1.05	1.32	3.14
	S.D	0.87	1.13	1.01	0.70	0.72	1.10
	P	-	NS	NS	0.001	0.001	NS
$PbNo_3$	MEAN	3.54	2.35	2.11	1.76	1.68	3.21
	S.D	0.87	0.91	1.43	1.08	1.08	0.87
	P	-	NS	NS	0.001	NS	NS
KIDNEY							
$BaCl_2$	MEAN	7.78	6.87	4.38	3.97	2.36	5.39
	S.D	1.01	1.21	0.95	1.40	1.04	0.86
	P	-	NS	0.001	0.001	0.001	NS
$PbNo_3$	MEAN	7.78	4.07	3.33	2.87	2.65	5.69
	S.D	1.01	1.01	1.41	0.86	1.15	1.01
	P	-	0.001	0.001	0.001	0.001	0.001

Table 13. Catla catla: TOTAL LIPIDS (mg/g wet wt.)

MUSCLE							
TOXICANT		CONTROL	4th DAY	7th DAY	14th DAY	21st DAY	28th DAY
$BaCl_2$	MEAN	8.43	5.14	4.05	3.37	2.72	6.99
	S.D	0.77	0.79	0.79	0.27	0.67	1.18
	P	-	0.001	0.001	0.001	0.001	NS
$PbNo_3$	MEAN	8.43	6.73	5.10	4.57	3.62	4.81
	S.D	0.77	1.11	0.84	0.76	0.81	0.96
	P	-	NS	0.001	0.001	0.001	0.001
LIVER							
$BaCl_2$	MEAN	8.38	6.79	6.00	3.40	2.48	7.10
	S.D	1.14	1.02	1.00	0.71	0.72	1.04
	P	-	NS	0.001	0.001	0.001	NS
$PbNo_3$	MEAN	8.38	7.66	6.67	5.45	4.95	7.85
	S.D	1.14	0.54	1.16	0.61	1.15	1.08
	P	-	NS	0.05	0.001	0.001	NS
BRAIN							
$BaCl_2$	MEAN	7.55	5.14	4.58	4.36	3.41	6.67
	S.D	1.47	0.79	0.95	1.27	1.01	1.16
	P	-	0.001	0.02	0.05	0.001	NS
$PbNo_3$	MEAN	7.55	5.41	4.77	3.65	4.36	7.28
	S.D	1.47	0.76	0.89	0.40	1.60	0.84
	P	-	NS	0.001	0.001	0.001	NS
KIDNEY							
$BaCl_2$	MEAN	4.76	3.92	2.48	1.32	0.99	1.55
	S.D	0.58	0.95	0.60	0.66	0.28	0.56
	P	-	NS	0.001	0.001	0.001	0.001
$PbNo_3$	MEAN	4.76	3.87	3.33	2.54	1.87	4.17
	S.D	0.58	1.00	0.92	0.82	0.72	0.94
	P	-	NS	0.001	0.001	0.001	NS

Table 14. Labeo rohita: TOTAL LIPIDS (mg/g wet wt.)

MUSCLE							
TOXICANT		CONTROL	4th DAY	7th DAY	14th DAY	21st DAY	28th DAY
$BaCl_2$	MEAN	3.66	3.07	2.79	2.47	1.81	3.40
	S.D	0.41	0.45	0.35	0.73	0.58	1.04
	P	-	NS	0.001	NS	0.05	0.001
$PbNo_3$	MEAN	3.66	2.78	1.81	0.98	0.61	2.61
	S.D	0.41	0.55	0.58	0.24	0.10	1.00
	P	-	NS	0.001	0.001	0.001	NS
LIVER							
$BaCl_2$	MEAN	14.60	12.81	11.93	10.13	10.10	14.33
	S.D	1.34	1.37	1.23	1.24	1.33	1.22
	P	-	0.001	0.001	0.001	0.001	NS
$PbNo_3$	MEAN	14.60	12.84	8.55	7.57	4.12	13.37
	S.D	1.34	1.20	0.56	0.90	0.77	1.60
	P	-	NS	0.001	0.001	0.001	NS
BRAIN							
$BaCl_2$	MEAN	19.00	18.90	15.10	13.01	11.12	18.22
	S.D	1.15	1.18	1.04	0.99	1.14	1.09
	P	-	0.001	0.001	0.001	0.001	0.001
$PbNo_3$	MEAN	19.00	16.70	14.34	13.15	11.99	15.21
	S.D	1.15	1.24	0.86	0.89	1.60	0.86
	P	-	NS	0.001	0.001	0.001	0.001
KIDNEY							
$BaCl_2$	MEAN	10.68	7.15	5.41	4.37	3.95	9.38
	S.D	1.09	1.45	1.26	0.87	0.32	1.04
	P	-	0.001	0.001	0.001	0.001	0.001
$PbNo_3$	MEAN	10.68	8.02	6.82	3.90	2.48	7.22
	S.D	1.09	0.69	1.12	0.85	0.72	0.90
	P	-	0.001	0.001	0.001	0.001	0.001

Table 15. Cirrhina mrigala: TOTAL LIPIDS (mg/g wet wt.)

MUSCLE							
TOXICANT		CONTROL	4th DAY	7th DAY	14th DAY	21st DAY	28th DAY
$BaCl_2$	MEAN	3.82	3.00	2.76	1.26	1.05	3.57
	S.D	0.94	1.11	1.62	0.37	0.22	0.51
	P	-	NS	NS	0.001	0.001	NS
$PbNo_3$	MEAN	3.82	2.36	2.64	1.59	1.14	3.33
	S.D	0.94	0.84	1.10	0.34	0.49	0.68
	P	-	NS	NS	0.001	0.001	NS
LIVER							
$BaCl_2$	MEAN	10.38	8.57	8.03	7.13	6.39	9.60
	S.D	1.14	0.73	1.10	1.04	1.04	0.99
	P	-	0.05	0.001	0.001	0.001	NS
$PbNo_3$	MEAN	10.38	8.62	7.68	5.14	4.92	9.21
	S.D	1.14	0.70	1.07	0.79	0.86	1.41
	P	-	0.001	0.001	0.001	0.001	NS
BRAIN							
$BaCl_2$	MEAN	15.42	14.35	13.19	11.53	10.13	14.58
	S.D	1.15	0.64	1.15	1.26	0.91	1.17
	P	-	NS	NS	0.001	0.001	NS
$PbNo_3$	MEAN	15.42	13.83	12.26	11.53	10.56	14.96
	S.D	1.15	1.10	1.45	1.26	1.16	1.02
	P	-	NS	NS	0.001	0.001	NS
KIDNEY							
$BaCl_2$	MEAN	34.26	18.91	16.31	13.02	11.06	20.15
	S.D	1.33	1.48	1.24	1.08	1.07	1.73
	P	-	0.001	0.001	0.001	0.001	0.001
$PbNo_3$	MEAN	34.26	23.82	21.01	19.40	10.80	26.12
	S.D	1.33	1.08	1.14	0.90	1.01	1.32
	P	-	0.001	0.001	0.001	0.001	0.001

Capkin *et al*., 2010). The reduced protein levels in pollutant stressed tissues strongly suggest the toxicant induced proteolysis to meet the increased energy demand. (Saravanan *et al*., 2000; Kumar *et al*., 2005). This non carbohydrate source of energy is achieved with the escalation of aspartate amino transferase (AST) and alanine amino transferase (ALT) in the stressed tissues of carps (Tilak *et al*., 2005; Saravanan, 2010). Thus proteins can be expected to be involved in the compensatory mechanism of stressed organisms (Fahmy, 2012). The lipid content decreased in all the test tissues during the experimental period for toxicants studied justify the utilization of energy storehouse to meet the necessity of more energy for detoxification process and also to balance the hindrance of normal metabolism (Remia, *et al*., 2008). The detoxifying role in combating xenobiotics of the liver was evident in the present experiment as it alone depicted a slightly elevated level of total carbohydrates during the post exposure of individual toxicants.

Conclusion

In a contaminated aquatic environment, addition of toxicants and its exposure to non-target organisms like fishes is becoming a continuous process. This constant environmental stress will have a detrimental effect on freshwater fishes and it is of grave concern when edible ones are affected. In the present study, this was evident in the depletion of nutritional content of fingerlings of three important Indian major carps when exposed to individual xenobiotics and the damage would be much more in combination effect (successive) and additive outcome would be obvious when the fishes were in continuous stress. Pesticide and heavy metal are known to accumulate even at the fingerlings stage and usually gets magnified in the adults. If this situation prevails, the consequence of the toxicants may be the production of less nutritive fish foods. Unless scientific monitoring of water bodies and the quality of aqua wealth, particularly the edible ones is undertaken, fish food health hazards are in the waiting for the present and future human population. The present finding is an alarming signal to the Indian community, which is already fronting many issues of nutrition concern. Finally, the alterations in the biochemical parameters as observed in the current investigation may be used as one of the biomarker against anthropogenic stress.

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