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Sublethal Effect of Mercury and Lead on Monoamine Oxidase in Different Regions of the Brain in Three Freshwater Teleosts

S. A. Shaffi

Department of Science, Regional College of Education
Shyamla Hills, Bhopal 462013 (M.P) INDIA

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Effect of mercury and lead at 24 and 48 h was investigated on monoamine oxidase (MAO) activity in different regions of the brain (telencephalon, cerebellum, diencephalon and medulla oblongata) in *Labeo rohita*, Ham., *Clarias batrachus*, L. and *Channa punctatus*, Bloch. Highest rise in MAO activity was recorded in telencephalon with mercury followed by lead. Maximum variations in the level of MAO activity in different regions of the brain were recorded at 24 h exposure. The observed alterations were discussed in relation to different parameters.

Key words: Mercury, Lead, MAO, Fresh water teleost, Brain.

To streamline the physiological aspects of Metabolism under stressful conditions, organisms devise new adaptations to keep the homeostasis intact by altering various events of life. Ample information is available to understand the effect of toxicants on different visceral organs of an organism in general (2-10). However, the toxicological studies on individual organ compartmentation is meagre and warranted to diagnose the actual site of pollutant action. The heterogeneous nature of different regions of the brain is a marked interest to pursue the compartmentation studies as some biochemical components act as indicators to understand the intensity of pollution.

The aim of the present paper is an attempt to study the effect of sublethal concentration of mercury and lead on monoamine oxidase (MAO) in different regions of the brain of three bony fishes viz., *Labeo rohita* (Ham.), *Clarias batrachus* (Linn) and *Channa punctatus* Bloch that differ over a number of factors.

Materials and Methods

Alive, mature and healthy *L. rohita*, *C. batrachus* and *C. punctatus* 18-20 cm long

Table I. *Mercury sublethal effect on MAO content in different brain regions of three teleosts.* Values (mmole of benzaldehyde formed/g tissue/min) are means ± SDM of 7 replicates. In parentheses is the increase per cent, respect to the control. a, b $p < 0.01$, c (a) or (b) $p < 0.05$.

Fish	Exposure	Regions of the Brain			Medulla Oblongata
		Telencephalon	Cerebellum	Diencephalon	
L. rohita	(a) Control	7.24 ± 1.43	3.84 ± 0.73	4.90 ± 1.09	6.04 ± 0.72
	(b) 24 h	10.88 ± 2.42[a]	4.76 ± 1.13	7.12 ± 1.52[a]	8.64 ± 1.89[a]
	(c) 48 h	13.40 ± 1.88[b, a]	5.31 ± 0.92[a]	9.33 ± 2.12[c(b)]	9.36 ± 1.86[a]
		(85)	(38)	(90)	(55)
C. batrachus	(a) Control	8.90 ± 1.92	5.10 ± 1.05	6.24 ± 0.82	7.06 ± 1.61
	(b) 24 h	13.12 ± 2.70[a]	6.78 ± 1.24[c(a)]	8.42 ± 1.81[a]	9.28 ± 2.12[c(a)]
	(c) 48 h	15.31 ± 2.77[a]	7.09 ± 0.73[a]	9.92 ± 2.54[a]	10.31 ± 2.76[a]
		(72)	(39)	(59)	(59)
C. punctatus	(a) Control	9.86 ± 2.55	6.68 ± 2.07	7.66 ± 0.93	8.26 ± 1.62
	(b) 24 h	13.74 ± 1.94[a]	7.24 ± 1.23	10.32 ± 1.95[a]	9.92 ± 1.76
	(c) 48 h	11.58 ± 2.91	8.69 ± 2.55	11.34 ± 1.33[a]	10.31 ± 2.76[a]
		(58)	(31)	(48)	(36)

were procured from selected local ponds and acclimatised in the laboratory for a week before exposure and investigation.

Fishes were dissected out for brain and different regions (telencephalon, cerebellum, diencephalon and medulla oblongata) were separated after blotting.

Enzyme assay.– The tissue homogenate (0.25 M, sucrose solution) was preincubated in 0.5 M phosphate buffer. After 5 min preincubation 0.1 M of benzylamine hydrochloride (Sigma grade) was added. After 30 min incubation the reaction was stopped by the addition of 10 % TCA and protein was removed by centrifugation. The clear supernatant was read at 250 nm and the rate of benzyldehyde formation was calculated (11).

Exposure to sublethal levels of mercury and lead.– Twenty fish of each species were exposed to sublethal concentrations of mercury and lead separately for 72 h in aquarium (390 cm/60 cm/45 cm). A similar set was arranged parallel without any toxicant and treated as control. After 24 and 48 h exposure 7 fish of each species were removed, dissected out for brain and separated for different regions and MAO was estimated in exposed (mercury and lead) and control group of fishes.

The experiment was repeated seven times with separate set of fish species and the data was subjected to statistical analysis.

Results

The brains of *L. rohita, C. batrachus* and *C. punctatus* were compartmentalised for MAO. Highest activity of MAO was recorded in telencephalon followed by medulla oblongata, diencephalon and cerebellum in *L. rohita* (table I) in comparison to *C. batrachus* and *C. punctatus.* The differential distribution of the enzymes in various regions of the brain indicate the participation of that region in the amine metabolism of the brain.

Table II. *Lead sublethal effect on MAO content in different brain regions of three teleosts.* Legend as in table I.

Fish	Exposure	Regions of the Brain			
		Telencephalon	Cerebellum	Diencephalon	Medulla Oblongata
L. rohita	(a) Control	7.30 ± 0.78	3.84 ± 0.73	4.93 ± 1.91	6.10 ± 1.60
	(b) 24 h	9.78 ± 1.25[a]	4.62 ± 1.45	7.88 ± 1.22[a]	6.24 ± 1.16[c(a)]
	(c) 48 h	12.89 ± 2.09[b,a]	5.18 ± 1.46[c(a)]	8.64 ± 2.31[a]	9.02 ± 1.78[a]
		(76)	(35)	(75)	(48)
C. batrachus	(a) Control	8.94 ± 1.46	5.16 ± 1.91	6.29 ± 1.54	7.09 ± 1.36
	(b) 24 h	12.42 ± 1.36[a]	6.09 ± 1.45	8.16 ± 1.61[c(a)]	9.02 ± 1.77[c(a)]
	(c) 48 h	14.95 ± 2.25[c(b)]	6.73 ± 1.24	9.30 ± 1.65[a]	9.84 ± 2.00[a]
		(67)	(30)	(48)	(39)
C. punctatus	(a) Control	9.90 ± 2.13	6.69 ± 1.69	7.70 ± 1.85	8.30 ± 1.57
	(b) 24 h	13.79 ± 3.87[c(a)]	7.80 ± 2.16	9.16 ± 0.97	10.20 ± 2.31
	(c) 48 h	15.12 ± 1.90[a]	8.29 ± 2.09	10.67 ± 1.80[a]	10.79 ± 2.59[c(a)]
		(53)	(24)	(39)	(30)

Exposure to sublethal concentration of mercury (table I) and lead (table II) induce marked variations in the level of MAO in different regions of the brain of 3 fish species. However, maximum rise in MAO was recorded in telencephalon followed by diencephalon, medulla oblongata and cerebellum in *L. rohita* more than in *C. batrachus* and *C. punctatus* with mercury in comparison to lead (tables I and II). Between 24 and 48 h exposure optimum changes were recorded at 24 h. Among the 3 fish species the change in MAO activity in various regions of the brain with mercury seems to be more pronounced than lead.

Discussion

Heterogeneity in structure and function in different regions of the brain has generated interest to understand the fate of certain biochemical components under contaminated conditions. Pollutants cross blood-brain-barrier, induce stress and activate pituitary gland to secrete ACTH which in turn influences emergency gland to secrete epinephrine to develop regulatory mechanisms against contamination that affects the functioning of cardio-vascular, nervous, excretory, respiratory, digestive, integumentary and receptor system indicating that the entire metabolism is under alterations (1, 8, 9). The highest rise was in the telencephalon MAO with mercury in comparison to lead more than diencephalon, medulla oblongata and cerebellum and was recorded in *L. rohita* rather than in *C. batrachus* and in *C. punctatus* suggesting the deamination of increasing levels of amine in order to monitor homeostasis as stress influence amine level. Telencephalon is the largest part of the brain and any change in the abiotic factors due to contamination in its habitat is bound to effect the behaviour, biochemical components, the same haveing possibly happened in the present investigation.

MAO also registered an increase in medulla oblongata, a vital visceral involuntary centre which reflects pollutants interference with the function of involuntary nature like heart beat, respiratory rate, urine output and even blood supply to skin and digestive system. Biochemical and physiological alterations including the amine rise and the increase in MAO activity in the present investigation may be a sign of disturbed metabolism. These disturbances are probably responsible for the turning upside down of the fish as cerebellum is the centre of buoyancy.

Among the organs, brain consumes more oxygen and intoxication disturbs the oxygen supply at tissue level which must have further enhanced the process of variations to generate biochemical disorders of serious consequences. The rise in MAO in the present investigation to contain amine level may be presumed on the above lines.

Each region of the brain has a specific function and the variation in the rise of MAO activity indicates its participation in the related metabolism to a greater extent in which highest rise in MAO activity was recorded and vice-versa.

MAO activity increase was significant with mercury (21 observations) and lead (17 observations) in various brain regions in the three fishes studied. The changes recorded reflect the influence of mercury and lead on amine metabolism in *L. rohita*, *C. batrachus* and *C. punctatus*.

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S. A. SHAFFI. *Efecto subletal del mercurio y del plomo sobre la actividad monoamino oxidasa en diferentes regiones del cerebro de tres teleósteos de agua dulce.* Rev. esp. Fisiol. (J. Physiol. Biochem.), 51 (3), 125-128, 1995.

Se estudia el efecto de la exposición al mercurio y al plomo (24 y 48 h), sobre la actividad de la monoamino oxidasa (MAO) en diferentes regiones del cerebro (telencéfalo, cerebelo, diencéfalo y medula oblongata), en tres especies de teleósteos de agua dulce, *Labeo rohita*, Ham., *Clarias batrachus*, L. y *Channa punctatus*, Bloch. Se registra el mayor aumento de la actividad MAO en el telencéfalo, con el mercurio. Las variaciones máximas de la actividad MAO se observan en la exposición de 24 h. Se analizan las alteraciones en relación con diferentes parámetros.

Palabras clave: Mercurio, Plomo, MAO, Teleósteo de agua dulce, Cerebro.

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