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HAEMOTOXICITY OF LEAD (Pb) ON THE BLOOD PARAMETERS OF FRESH WATER TELEOST *HETEROPNEUSTES FOSSILIS* (BLOCH)

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ABSTRACT: Blood parameters are important indicators for assessing the health status of living organisms subject to changing environment. Blood parameters (Hb%, TEC, TLC, ESR, PCV, MCH, and MCV) of *Heteropneustes fossilis* exposed to lead were investigated at different time intervals. Acclimatized specimens were divided into four groups: Group-A (Control), Group-B (2.25 ppm), Group-C (2.65 ppm), Group-D (2.85 ppm) of Pb and examined at 7, 14, 21 and 28 days' time intervals. The maximum impact of the treated metal was observed on ESR (Erythrocyte Sedimentation Rate) [1.80 mm/h (Control) to 2.90 mm/h at 2.85 ppm of lead] during maximum time exposure (28 Days) whereas PCV (Packed Cell Volume) showed a fall [44.00 % (control) to 28.00% (2.85 ppm] at 28 Days pe (post-exposure). The other parameters also showed changes in their values when exposed to lead being highest at 2.85 ppm doses during maximum time exposure (28 Days). The above findings indicate that lead adversely affects the blood physiology as reflected in hematological values.

INTRODUCTION: Water is an integral constituent of all living things, and it is the universal biological solvent. Modern industrial and agricultural techniques require the use of many million tons of fertilizers, heavy metals and pesticides. These effluents find their way into aquatic systems through surface runoff from industries or as a result of the discharge of these wastes into streams and rivers. They pose a constant threat to non-target organisms such as fish and insects and tend to bio-concentrate the inorganic and industrial wastes [1, 2].

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The industrial complexes have become the focus of environmental pollution [3]. The main pollutant from these industrial complexes is effluent, which contains heavy metals such as Cu, Ni, Zn, Pb, Cr, Hg, Cd, and various organic compounds like phenols and formaldehyde. The recovery of these heavy metals using conventional techniques is neither economical nor eco-friendly [4, 5]. Once aquatic organisms accumulate heavy metals they can be transferred to higher trophic levels of the food chain. Carnivores at the top of the food chain including humans receive most of their heavy metal burden from aquatic ecosystems by way of their food, especially where fish are present [6].

Pb is used in lead-based paints, ceramic and petroleum industries, electronic products, electric storage batteries, pesticides, insecticides, electric cable insulation sheets, floor covering, pipes and ammunition.

The important route of absorption of this heavy metal by man and other aquatic animals is by ingestion and inhalation. Lead accumulation results in various long and short term effects or diseases in humans and animals like memory loss, learning impairment and other diseases [7]. It is one of the most dangerous and insidious metallic poison [8]. The metal is known to impact the blood values in fish [9, 10] to the extent of damaging chromosomal complements [11, 12]. It has toxic effects on a variety of freshwater organisms with low sensitivity of 4 μg/L [13]. Acute toxicity of lead is mainly due to mucous induced respiratory asphyxiation and the disruption of Ca^{2+} and Na^{+} homeostasis [14]. LC_{50} studies of lead in *Clarias batrachus* were reported [15]. The use of hematological techniques in fish culture for toxicological research, environmental monitoring and fish health conditions has grown rapidly in recent years [16, 17, 18]. Hematology is an indicator of immunological status and can provide a definitive diagnosis of fish during toxicant exposure [19, 20, 21]. Hematological indices are of different sensitivity to various environmental factors and chemicals [22]. Studies have shown that when the water quality is affected by toxicants, any physiological change is reflected in values of one or more hematological parameters of aquatic organisms [23, 24]. However, some workers noted that there is a possibility that studies on fish blood might reveal conditions within the body of the fish long before there is an outward manifestation of disease [25]. The effects of heavy metals including lead on hematology and other changes of catfish were observed by several investigators [10, 26-30].

The effluents of the pharmaceutical industry affected the blood of *Clarias gariepinus* indicating that Pb was present in effluents in undesirable amounts, which induced significant changes in hematological parameters (RBC, HCT, HGB, MCV, MCH, WBC and lymphocytes) [31]. In the present study, the hematological parameters (Hb, TEC, TLC, ESR, PCV, MCH and MCV) of catfishes, *Heteropneustes fossilis* subjected to Pb exposure were investigated. It is envisaged that the results will assist in providing base-line information on lead toxicity with respect to *H. fossilis*.

MATERIALS AND METHODS: *Heteropneustes fossilis* (20-30 gms) (n=16) of each group (one control, three lead-exposed) were collected from different fish markets of Bareilly district and acclimatized for 7 days to laboratory conditions. The groups were designed as follows:

Group 'A': Control

Group 'B': Exposed to 2.25 ppm of Pb

Group 'C': Exposed to 2.65 ppm of Pb.

Group 'D': Exposed to 2.85p pm of Pb

Blood was collected from the caudal vein of fish with the help of an anticoagulated syringe and Hb %, TEC, TLC, ESR, PCV, MCH and MCV were estimated according to established research methodology [32].

RESULTS: When *H. fossilis* were exposed to different concentrations of lead, the minimum value of the hemoglobin percentage was 9.20% (21 and 28 days: 2.85 ppm of Pb) **Table 1**. Maximum percentage changes (33.33%) were observed during the 21 and 28 days exposure period at 2.85ppm of lead **Fig. 1**. A corresponding decrease in the total erythrocyte counts corresponded to an increase in the concentrations of lead. The minimum TEC value was 1.60×10^{6}/Cumm (28 days: 2.85 ppm of Pb). The maximum percentage changes in TEC were 37.25% at a maximum concentration (Group D) during the maximum exposure period (28 Days) **Fig. 2**. TLC of *H. fossilis* increased to a maximum of 36,100/Cumm (28 days: Group D) and a minimum increase was 24,800/Cumm (7 days: Group C) **Table 1** as compared to the control values (21400/Cumm). TLC also recorded the maximum percentage increase of 68.69% in Group D **Fig. 3**.

ESR values increased in different groups showing the peak value (2.90 mm/h) during the highest concentration at higher time exposure (28 days: Group D) while the minimum value of ESR (2.10 mm/h) was recorded during 7 days in Group B **Table 1**. ESR showed the maximum percentage changes (68.69%) at highest concentration during 28 days exposure period **Fig. 4**. PCV value of control group was 44%, the lowest value (28.00%) of PCV was observed in group D (28 days: 2.85) while minimum reduction was observed at 7 days at the lowest concentration (2.25 ppm) **Table 1**.

36.36% changes in PCV were observed at 2.85 ppm of Pb during 28 days pe **Fig. 5**.

As indicated in **Table 1**, the control value of MCH was 54.11(Pg). In Group C, the minimum value 50.27 pg was observed during 21 days and 28 days pe. The maximum values in each treated group (B, C and D) were recorded as 60.00, 62.43 and 67.00 (Pg) at 7 days pe. A maximum decline of 7.09% change were observed in Group C (2.65 ppm of lead) during 21 and 28 days **Fig. 6**. Fluctuations in the values of MCV were observed in all treated groups of *H. fossilis* as compared to the fishes of control groups. The minimum value of MCV was 162.16 μ^3 (28 days: Group C) and the maximum value of MCV was 195.12μ^3 (7 days: Group B) **Table 1**. Percentage change in MCV was merely 1.42% for 28 days at 2.85 ppm of lead **Fig. 7**.

TABLE 1: HAEMATOLOGICAL PARAMETERS OF *H. FOSSILIS* EXPOSED TO VARIOUS CONCENTRATION OF Pb (LEAD)

S. no.	Parameters	Group A (Control)	Group B (2.25 ppm Pb)				Group C (2.65 ppm Pb)				Group D (2.85 ppm Pb)			
			7 Days	14 Days	21 Days	28 Days	7 Days	14 Days	21 Days	28 Days	7 Days	14 Days	21 Days	28 Days
1	Hb %	13.80	12.30	10.40	9.50	9.40	12.80	11.00	9.30	9.30	13.20	11.40	9.20	9.20
2	TEC×10^6/Cumm	2.55	2.05	1.89	1.80	1.78	2.05	1.88	1.85	1.85	1.97	1.90	1.65	1.60
3	TLC /Cumm	21400	27400	25000	26400	27800	24800	27100	30300	31000	26800	30000	35000	36100
4	ESR (mm/h)	1.80	2.10	2.20	2.20	2.30	2.50	2.40	2.50	2.60	2.40	2.20	2.60	2.90
5	PCV %	44.00	40.00	36.00	32.00	32.00	38.00	36.00	33.00	30.00	36.00	34.00	32.00	28.00
6	MCH (Pg)	54.11	60.00	55.02	52.77	52.80	62.43	58.51	50.27	50.27	67.00	60.00	55.75	57.50
7	MCV (μ^3)	172.54	195.12	190.47	177.77	179.77	185.36	191.48	178.37	162.16	182.74	178.94	193.93	175.00

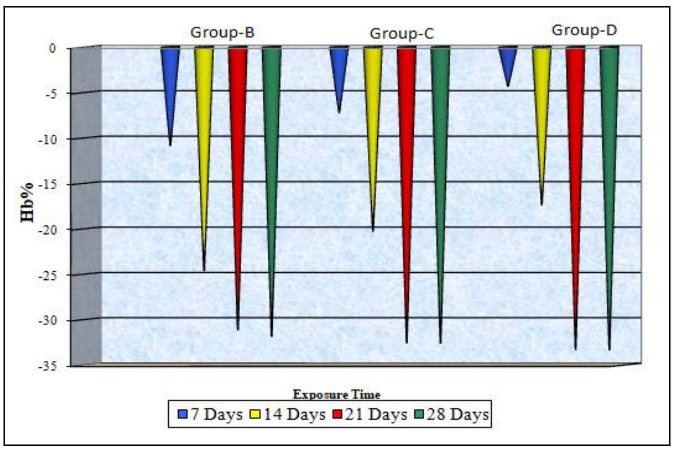

FIG. 1: PERCENTAGE CHANGES IN Hb % OF *H. FOSSILIS* EXPOSED TO VARIOUS CONCENTRATIONS OF Pb

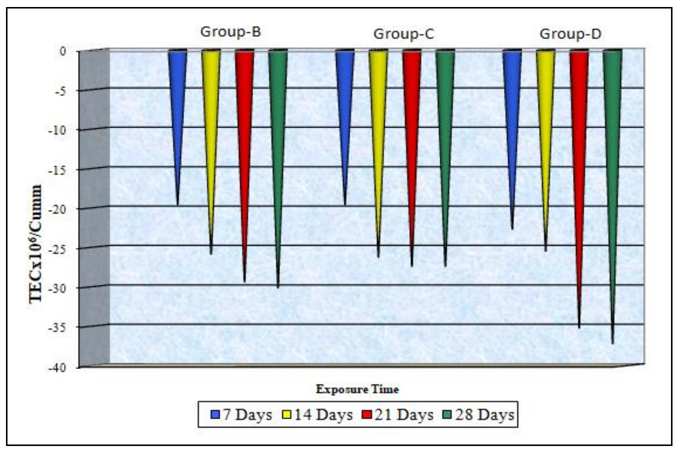

FIG. 2: PERCENTAGE CHANGES IN TEC % OF *H. FOSSILIS* EXPOSED TO VARIOUS CONCENTRATIONS OF Pb

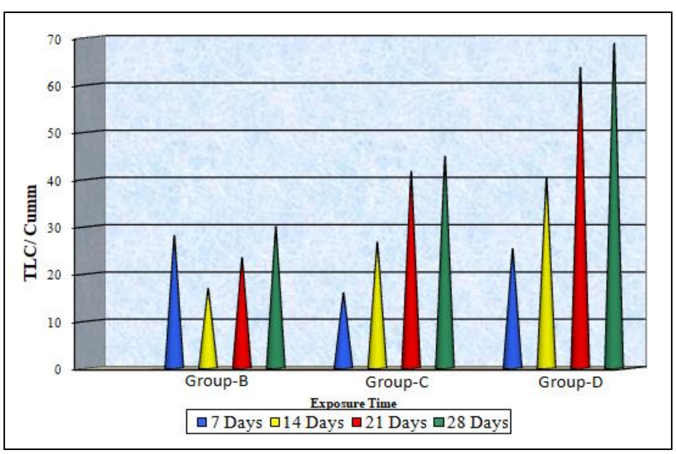

FIG. 3: PERCENTAGE CHANGES IN TLC/ CUMM OF *H. FOSSILIS* EXPOSED TO VARIOUS CONCENTRATIONS OF Pb

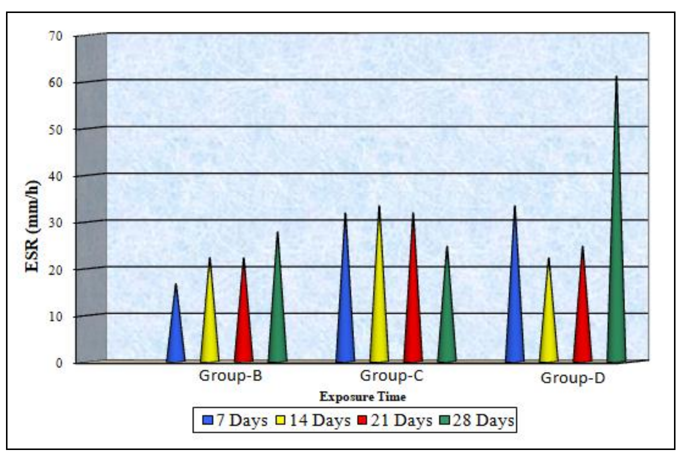

FIG. 4: PERCENTAGE CHANGES IN ESR (MM/H) OF *H. FOSSILIS* EXPOSED TO VARIOUS CONCENTRATIONS OF Pb

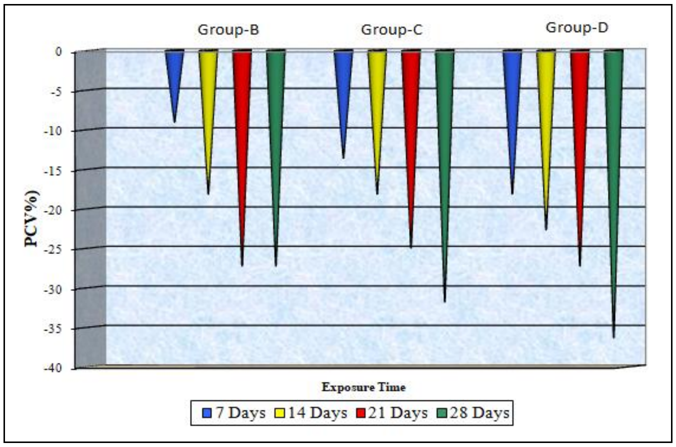

FIG. 5: PERCENTAGE CHANGES IN PCV% OF *H. FOSSILIS* EXPOSED TO VARIOUS CONCENTRATIONS OF Pb

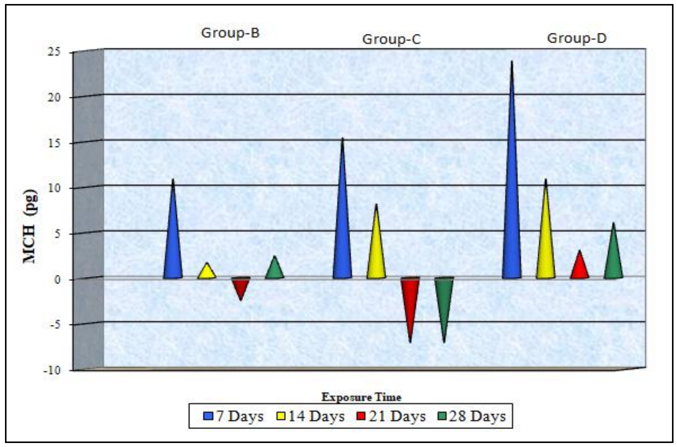

FIG. 6: PERCENTAGE CHANGES IN MCH (PG) % OF *H. FOSSILIS* EXPOSED TO VARIOUS CONCENTRATIONS OF Pb

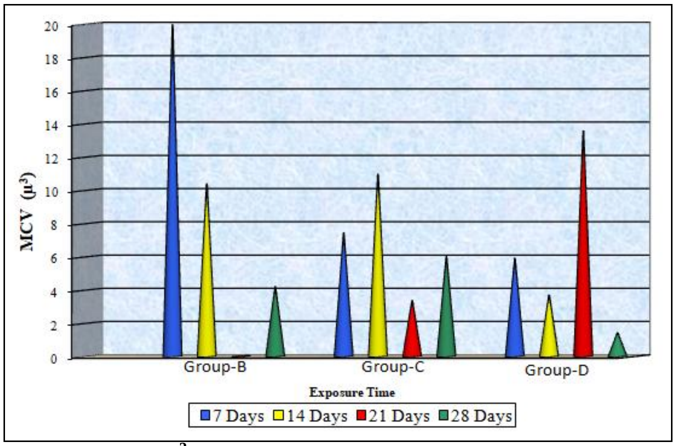

FIG. 7: PERCENTAGE CHANGES IN MCV (μ^3) % OF *H. FOSSILIS* EXPOSED TO VARIOUS CONCENTRATIONS OF Pb

DISCUSSION: The importance of hematology in the diagnosis of fish anomalies and for evaluating the effect of pollution has been accepted widely. The application of hematological techniques like Hb, TEC, TLC, ESR, PCV, MCH and MCV, have proved valuable for fishery biologists in determining the health status of fishes. *H. fossilis* exposed to various concentrations of lead (2.25 ppm, 2.65 and 2.85 ppm) showed variations in hematological parameters. Different fish species show differentiation in sensitivity and reaction to heavy metals including lead, which has been reported by many workers. The influences of heavy metals on hemoglobin reflect the O_2 carrying capacity of blood. Reduction in Hb% was recorded in the blood of *Clarias gariepinus* during short term exposure of lead [33]. Consistent reduction in hemoglobin concentration in white fish *Coreganus* species poisoned with lead has been reported [34].

Hemoglobin percentage declined during lead exposure in (*T. tinca* [35], *C. gariepinus,* [26, 35, 36] *Cyprinus carpio* [37], and *Oreochromis nitoticus* [38]). Research indicated a significant reduction in the Hb% which may lead to anemic condition in *Channa punctatus* [39]. Another research supported our findings on hemoglobin in the bunny fish *Mesopotamichthyssharpeyi* exposed to lead [40]. In another experiment, the same catfish (*H. fossilis*) exposed to cadmium, reported a significant decrease in Hb% during 7, 14 and 21 days as compared to the control fish [41].

The value of WBCs increased in the blood due to pollution and stress corresponding to the lead concentration and time exposure when *Anguilla anguilla* was exposed to different concentrations of lead [42]. A significant increase in immunological parameters (TLC) following lead exposure suggests that lead may weaken the immune system, resulting in increased susceptibility to infection [43]. Increased WBC counts due to exposure to Pb in the blood of *Oreochromis niloticus* [38] and *Channa punctatus* [39] further support our findings.

The results fall on similar lines when the same species of experimental fish were treated with lead nitrate [30]. WBC count and serum enzyme also increased in fish exposed to Dioatylphthalate [44].

Contrary to the findings of WBC, the total erythrocyte counts in the blood of the investigated catfish constantly depleted corresponding to the increases in concentration and time exposure to lead. These findings are in concurrence to those reported in *Oreochromis niloticus* [45] and also studies by other authors [27, 46, 47, 48]. Various heavy metals and toxins enter the aquatic system and exert a specific toxic effect on fish blood [49]. Similar results on RBC depletion are supported in other fish species as well, *Clarias gariepinus* [30], *Mesopotamichthys sharpeyi* [40] and *Channa punctatus* [30]. ESR values showed an increase in different exposed groups. Heavy metal toxicity causes inflammatory lesions associated with tissue damage, anemia and neoplasia. Further, an increase in fibrinogen or serum globulins or a decrease in serum albumin may also cause an increase in the ESR. An increase in ESR values suggests that anemia was of macrocytic type [51]. These findings are supported by research [52, 53, 54].

The values of PCV showed a fall to 28% during the highest concentration and maximum exposure period. Anemia is a manifestation of acute and chronic in toxification by heavy metals. A decrease in PCV% treated with lead occurred in *Clarias gariepinus* [55] and the results are supported by other findings [56, 53, 57]. PCV gradually increased up to 45 days but declined after 60 days of exposure to chromium in *Channa punctatus* [54]. Contrarily, elevated values of PCV in the blood of Coruh trout occurred after treatment with Pb [58]. The level of hematocrit in control fish was not significantly different but Pb exposed fish showed a significant difference when compared to the control fish [59].

MCH expresses the average hemoglobin concentration in individual erythrocyte counts. In the present study, MCH increased rapidly during the initial exposure of lead and values further reduced when lead concentration and exposure time increased. This is in agreement to the finding who reported a short term exposure of lead in *T. tinca* [35], *Clarias gariepinus* [26] and *Hetroclarias* [56] exposed to zinc and a significant fall in *Channa punctatus* exposed to copper [53]. The recovery in MCH values were also recorded who identified that lead toxicity affected the concerned hematological parameters and its recovery in long term exposure [57]. Notable works on zinc [60] and Pb and Cd [61] exposure in common carp have been reported. Pb showed a higher significant decrease in MCH values as compared to other heavy metals. Lower values of MCH occurred during 7, 14, and 30 days exposure period but these were recovered after 60 days of exposure to chromium trioxide in fresh water teleosts [54].

The decrease in hemoglobin concentration represents that the capability of the fish to supply adequate oxygen to the tissues gets limited considerably and this results in the decline of physical stir [62]. Elevation in MCV and MCH (Group D) shows macrolytic type anemia in *Clarias gariepinus* [27] and rainbow trout [63]. High values of MCV subsequent to lead exposure were recorded in *O. niloticus* [57]. Significant reduction in MCV in the blood of common carp exposed to lead [61] was reported but no significant changes occurred in MCV when the same fish was exposed to cadmium [64]. Most of the hematological parameters of the market fishes, *Channa punctatus* and *Heteropnestes fossilis* showed significant alteration from their control values when subjected to heavy metals [65].

CONCLUSION: The present study suggests that heavy metals are responsible for causing a variety of hematological anomalies. The studies also infer that blood may be utilized as a pathophysiological reflector of the whole body and therefore blood parameters may be regarded as important diagnostic tools for assessing the structural and functional status of fish exposed to toxicants.

The toxicity test helps in evaluating the nature and degree of the harmful effect produced on the aquatic organism, especially fish by toxic substances and provides valuable information that can be used for the protection of the aquatic ecosystem as a whole.

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CONFLICTS OF INTEREST: The authors have no conflict of interest.

REFERENCES:

1. Patil GP and Dhanda RR: Effects of $HgCl_2$ and $CdCl_2$ on haemato biochemical parameters of fresh water fish *Channa punctatus* (Bloch). Journal of Ecotoxicology Environment Monitoring 2000; 10: 177-81.
2. Shin HW, Sidharthan M and Young KS: Forest fire ash heavy metal, cadmium impact on two representatives of micro and macro algae of the receiving water of the east coast of South Korea. Marine Pollution Bulletin 2002; 45: 203-09.
3. Shukla OP, Rai UN, Singh NK, Dubey S and Baghel VS: Isolation and characterization of chromate resistant bacteria from tannery effluent. Journal of Environmental Biology 2007; 28: 399-03.
4. Sarkar S and Gupta A: Treatment of chrome plating waste water by using activated alumina. Indian Journal of Environmental Health 2003; 45: 73-82.
5. Shukla V, Dhankhar M, Jaiprakash C and Sastry KV: Bio-accumulation of Zn, Cu and Cd in *Channa punctatus*. Journal of Environmental Biology 2007; 28: 395-97.
6. Sivaperumal P, Sankar TV and Nair PGV: Heavy metal concentrations in fish, shellfish and fish products from internal markets of India vis-a-vis international standards. Food Chemistry 2007; 102: 612-20.
7. Lockitch G: Perspective on lead toxicity. Clinical Biochemistry 1993; 26 (5): 371-81.
8. Yadav J and Akela BP: Aldrin induced haematological changes in the common Indian catfish, *Clarias batrachus* (Linn). Comp Physiol and Ecol 1993; 18(4): 156-59.
9. Gupta N and Gupta DK: Aberrations in blood values of a catfish experimentally exposed to lead nitrate. Himalayan Journal of Environment and Zoology2000; 14: 99-102.
10. Gupta N, Gupta DK and Verma VK: Assessment of some haematological parameters in *Heteropneustes fossilis* exposed to lead nitrate. Himalayan Journal of Environment and Zoology 2002; 16: 63-66.
11. Verma VK, Gupta N, Gupta DK, Krishna G and Shalaby SI: Clastogenic effects of lead on the chromosomal complements of *Clarias batrachus*. Bulletin of the National Research Centre2008; 33(5):537-548.
12. Verma VK, Gupta N, Gupta DK and Krishna G: Chromosomal aberration on *Heteropneustes fossilis* due to lead in toxification, In: Bioresources for rural livelihood: Narendra Publishing House, New Delhi, Eds. Kulkarni GK, Pandey BN, Vol II 2010; 247-54.
13. Grosell M, Gerdes RM and Brix KV: Chronic toxicity of lead to three freshwater invertebrates at *Brachionus calyciflorus*, *Chironomus tentans* and *Lymnaea stagnalis*. Environmental Toxicology and Chemistry 2006; 25(1): 97-104.
14. Birceanu O, Chowdhury MJ, Gillis PL, McGeer JC, Wood M and Wilkie MP: Modes of metal toxicity and impaired branchial ion regulation in rainbow trout exposed to mixtures of Pb and Cd in soft water. Aquatic Toxicology 2008; 89(4): 222-31.
15. Das S and Das A: Preliminary evaluation of the acute toxicity of $Pb(NO_3)_2$ in catfish, *Clarias batrachus* (Linnaeus). World Journal of Zoology 2012; 7(3): 174-77.
16. Gabriel UU, Anyanwu PE and Akinrotimi OA: Effect of freshwater challenge on the blood characteristics of *Sarotherodon melanotheron*. Agriculture Journal 2007; 2: 388-91.
17. Akinrotimi OA: Comparative haematology of some culturable clariids raised in fresh water tidal and stagnant earthen ponds. Master of Science (MSc) Thesis. Rivers State University, Port Harcourt, Nigeria 2008.
18. Akinrotimi OA, Bekibele DO and Orokotan OO: Selected haematological values of African catfish (*Clarias gariepinus*) raised in water recirculating system. International Journal of Recirculating Aquaculture 2011; 12: 1-12.
19. Akinrotimi AO, Gabriel UU, Anyanwu PE and Anyanwu AO: Influence of sex, acclimation methods and period on haematology of *Sarotherodon melanotheron* (Cichilidae). Research Journal ofBiological Sciences 2007; 2: 348-52.
20. Campbell T and Ellis C: Avian and exotic animal haematology and cytology. Blackwell Publishing Limited Iowa, 3rd Edition 2007.
21. Nte MD, Hart AI, Edun OM and Akinrotimi OA: Effect of industrial effluent on haematological parameters of Black jaw tilapia *Sarotherodon melanotheron*. Continental Journal of Environmental Science 2011; 5: 29-37.
22. Akinrotimi OA, Orlu EE and Gabriel UU: Haematological responses of *Tilapia guineensis* treated with industrial effluents. Applied Journal of Ecology and Environmental Sciences 2013; 1: 10-13.
23. Akinrotimi OA, Ansa EJ, Owhonda KN, Onunkwo DN Edun OM, Anyanwu PE, Opara JY and Cliff PT.: Effects of transportation stress on haematological parameters of Black Chin Tilapia, *Sarotherodon melanotheron*. Journal of Animal Veterinary Advances 2007; 6: 841-45.
24. Gabriel UU, Anyanwu PE and Akinrotimi OA: Blood characteristics associated with confinement stress in black chin Tilapia *Sarotherodon melanotheron*. Journal of Fisheries International 2007; 2: 186-89.
25. Sampath K, James R and Akbar-Ali KM: Effects of copper and zinc on blood parameters and prediction of their recovery in *Oreochromis mossambicus*. Indian Journal of Fisheries 1998; 45: 129-39.
26. Adeyemo OK: Haematological profile of *Clarias gariepinus* (Burchell, 1822) exposed to lead. Turkish Jounal of Fisheries and Aquatic Sciences 2007; 7: 163-69.
27. Adeyemo OK, Adedeji OB and Offor CC: Blood lead level as biomarker of environmental lead in feral and cultured African catfish (*Clarias gariepinus*). Nigerian Veterinary Journal 2010; 31(2): 139-47.
28. Witeska M, Kondera E, Szymańska M and Ostrysz M: Hematological changes in common carp (*Cyprinus carpio* L.) after short-term lead (Pb) exposure. Polish Journal of Environmental Studies 2010; 19(4): 825-31.
29. Ikeogu CF, Nsofor CI and Igwilo IO: Toxicity of lead nitrate and crude oil on the growth of the African catfish *Clarias gariepinus*. International Journal of Agriculture and Biosciences 2013; 2(6): 337-39.
30. Ikeogu CF, Nsofor CI, Igwilo IO and Ngene AA: Haematological and serological responses of *Clarias gariepinus* to sub lethal concentrations of lead nitrate. Journal of Pharmaceutical Science and Bioscientific Research Publication 2016; 6(3): 442-46.
31. Alimba CG, Adekoya KO and Soyinka OO: Exposure to effluent from pharmaceutical industry induced cyto-genotoxicity, haematological and histopathological alterations in *Clarias batrachus* (Burchell, 1822). Experimental and Clinical Sciences Journal 2019; 18: 63-78.
32. Wintrobe MM: In: Clinical haematology. Lea and Febiger, Philadelphia, VIII Edition 1981: 202.
33. Demayo A, Taylor MC, Taylor KW and Hodson PV: Toxic effects of lead and lead compounds on human

health, aquatic life, wildlife plants and livestock. Critical Reviews in Environmental Control 1982; 12(4): 257-05.
34. Larson A, Haux C and Sjobeck ML: Fish physiology and metal pollution: results and experiences from laboratory and field studies. Ecotoxicology and Environmental Safety 1985; 9: 250-81.
35. Shah SL: Hematological parameters in tench *Tinca tinca* after short term exposure to lead. Journal of Applied Toxicology 2006; 26: 223-28.
36. Tawari-Fufeyin P, Igetei J and Okoidigun EM: Changes in the catfish (*Clarias gariepinus*) exposed to acute cadmium and lead poisoning. Bioscience Research Communications 2008; 20(5): 271-76.
37. Vinodhini SR and Narayanan M: The impact of toxic heavy metals on the haematological parameters in common carp (*Cyprinus carpio*). Irani Journal of Environmental Health Science Engineering 2009; 6(1): 23-28.
38. Çoğun HY and Şahin M: The effect of lead and zeolite on hematological and some biochemical parameters in nile fish (*Oreochromis niloticus*). Current Progress in Biological Research 2013; 277-86.
39. Dutta B, Sharma SR and Deka P: Lead nitrate toxicity on haematological changes in a live fish *species Channa punctatus* (Bloch). International Journal of Fisheries and Aquatic Studies 2015; 3(2): 196-98.
40. Al-Rudainy AJ: Effects of sub-lethal exposure to lead acetate on haematological indices and growth rate of bunni *Mesopotamichthyssharpeyi*. Advances in Animal and Veterinary Sciences 2015; 3: 569-73.
41. Bujjamma P and Padmawati P: Effects of cadmium on haematological changes in a freshwater catfish *Heteropneustes fossilis*. International Journal of Zoology Studies 2018; 132-41.
42. Santos MA and Hall A: Influence of inorganic lead on the biochemical blood composition of the eel, *Anguilla anguilla* L. Ecotoxicology and Environmental Safety 1990; 20: 7-9.
43. Shah SL and Altindag A: Alterations in the immunological parameters of tench (*Tinca tinca* L. 1758) after acute and chronic exposure to lethal and sublethal treatments with mercury, cadmium and lead. Turkish Journal of Veterinary and Animal Sciences 2005; 29: 1163-68.
44. Satpathi M and Singh R: Study of the haematological and biochemical parameters of *Clarias batrachus* (Linn.) exposed to sublethal concentration of dioctylphthalate. International Journal of Bioassays 2018; 7(2): 5574-77.
45. Shalaby AM: Protective effect of ascorbic acid against mercury intoxication in nile tilapia (*Oreochromis niloticus*). Journal of Egyptian Academy Environment Development (Developmental Studies) 2001; 2(3): 79-97.
46. Mousa MA and Khattab YA: The counteracting effect of vitamin C (L- ascorbic acid) on the physiological perturbations induced by ochratoxin intoxication in the African catfish (*Clarias gariepinus*). Journal of Egyptian Academy Environment Development (Developmental Studies) 2003; 4 (1): 117-28.
47. Vosyliene MZ and Kazlauskienė N: Evaluation of the Svede pond water effect on fish (after accidental discharge of the kairiai dump filtrate into the environment). Protection and management of water bodies. Proceedings of International Scientific Conference, Kaunas 2004; 219-23.
48. Vutkuru SS: Acute effects of hexavalent chromium on survival, oxygen consumption, hematological parameters and some biochemical profiles of the Indian major Carp, *Labeo rohita*. International Journal of Environmental Research and Public Health2005; 2: 456-62.
49. Salman NM: Haematological and histopathological effects of cadmium chloride on *Mesopotamichthyssharpeyi*. Msc. Thesis, Veterinary and Medical College, Baghdad University 2014; 168.
50. Javed M, Ahmad I, Ahmad A, Usman N and Ahmad M: Studies on the alterations in haematological indices, micronuclei induction and pathological marker enzyme activities in *Channa punctatus* (spotted snakehead) Perciformes, Channidae exposed to thermal power plant effluent. Springer Plus 2016; 5(1): 761.
51. Sinha AK, Sinha MK and Adhikari S: Effect of the copper toxicity on haematological profile of Indian major carp, *Labeo rohita*. Hand book Industry and Pollution 2000; 166-72.
52. Gupta A K, Pandey P and Srivastava S: Effect of pesticides on biological and haematological parameters in the fish *Channa punctatus*. Nature Environmentand Pollution Technology 2007; 6(3): 673-76.
53. Singh D, Nath K, Trivedi SP and Sharma YK: Impact of copper on haematological profile of freshwater fish, *Channa punctatus*. Journal of Environmental Biology 2008; 29(2): 253-57.
54. Pal M and Trivedi SP: Impact of chromium trioxide on haematological parameters of freshwater fish, *Channa punctatus* (Bloch). European Journal of Experimental Biology 2016; 6(2): 40-42.
55. Adeyemo O, Ajani F, Adedji O and Ajiboye O: Acute toxicity and blood profile of adult *Clarias gariepinus* exposed to lead nitrate. The Internet Journal of Haematology 2008; 4(2): 1-8.
56. Kori-Siakpere O and Oghoghene UE: Sublethal haematological effects of zinc on the freshwater fish, Heteroclarias sp. (Osteichthyes: Clariidae). African Journal of Biotechnology 2008; 7(12): 2068-73.
57. Sharaf SM, Mohamed KA, Hagar SD and Eldanasoury MA: Haematological, biochemical and histological alterations in Nile tilapia *Oreochromis niloticus* exposed to sublethal concentrations of lead. Egyptian Journal of Aquatic Biology and Fisheries 2011; 15(3): 425-39.
58. Serezli R, Akhan, S and Delihasan-Sonay F: Acute effects of copper and lead on some blood parameters on coruh trout (*Salmo coruhensis*). African Journal of Biotechnology 2011; 10(16): 3204-09.
59. Adhim MH, Zainuddin A, Putrantp TWC, Irwan B, Salinities and Soegianto: Effect of sub-lethal lead exposure at different on osmoregulation and haematological changes in tilapia, *Oreochromis niloticus*. Archives of Polish Fisheries 2017; 25: 173-85.
60. Raina S and Sachar A: Effect of heavy metal, zinc and carbamate pesticide, sevin on haematological parameter of fish *Labeo boga*. International Journal of Innovative Research in Science Engineering and Technology 2014; 3: 12636-44.
61. Khalesi MK, Abedi Z, Berouzi S and Eskandari SK: Haematological, blood biochemical and histopathological effects of sublethal cadmium and lead concentration in common carp. Bulgarian Journal of Veterinary Medicine 2016; 20(2): 1-5.
62. Kumar S, Lata S and Gopal K: Deltamethrin induced physiological changes in freshwater catfish *Heteropneustes fossilis*. Bulletin on Environmental Contamination and Toxicology 1999; 62: 254-58.
63. Talas ZS and Gulhan MF: Effects of various propolis concentrations on biochemical and hematological

parameters of rainbow trout (*Oncorhynchus mykiss*). Ecotoxicol and Environmental Safety 2009; 72: 1994-98.

64. Arya S: Comparative account of impact of heavy metals cadmium and chromium on haematological parameters of *Channa punctatus*. International Journal of Environmental Rehabilitation and Conservation 2017; 8(2): 95-102.

65. Shamim AR, Khan F, Mansoor A and Waseem H: Analysis of heavy metal concentrations and haematological parameters of two fishes, *Channa punctatus* and *Heteropneustes fossilis* from a fish market, Aligarh, India. EC Pharmacology and Toxicology 2019; 523-30.

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