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Modulatory effect of magnesium hydroxide-nanoparticles on lead-induced toxicity in river *Clarias gariepinus* near mining site

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Abstract

Effluents emerging from unprotected local mining activities pollute the nearby rivers containing aquatic lives. Advent of nanotechnology however, supposedly helps in removal of water contaminants and as well make waste water remediation possible. To this effect, *Clarias gariepinus* from rivers near mining site at Ijero-Ekiti, Ekiti-State, Nigeria were collected and exposed to 62.5, 125 and 250mg/L suspension of 10nm magnesium hydroxide nanoparticles (MgOHNPs) for 14-days under semi-static conditions. The suspected lead concentration in the river water was estimated using atomic absorption spectrophotometer while the quality of the river water was also examined. *Clarias gariepinus* collected were sacrificed and alterations in their biochemical and hematological indices were evaluated. The results showed that water sample from river I exhibit highest (0.033ppm) lead concentration while water sample from river III has the lowest (0.006ppm) lead concentration relative to their proximity to the mining site. Besides, the collected fishes demonstrated significant ($P<0.05$) concentration dependent increase in some biochemical indices and no observable significant alteration in hematologic state of the fishes at tested doses. Hence, results from this study suggest that toxic lead effluent from local mining activities may have elevated lead concentration levels in nearby rivers while exposure to MgOHNPs could evoke alterations in physiological system of the inhabiting aquatic lives.

Keywords: Lead-effluents; Nanoparticles; Magnesium hydroxide; *Clarias gariepinus*; Mining.

1. Introduction

Magnesium hydroxide nanoparticles have gained commercial interest in the areas of waste remediation and recycling of waste water for potable use. Nanoparticles can be prepared from a different materials such as proteins, polysaccharides and synthetic polymers and can as well be formulated as injection consisting of amorphous particles which can be safely administered intravenously (Mohanraj and Chen, 2006). Magnesium nanoparticles are relatively non-toxic and are widely used in industries on the basis of their biodegradability, biocompatibility and are relatively affordable (Aluko *et al*., 2018). Unprofessional mining activity in Nigeria has raised concerns in view of the devastating impact on the ecosystem. The aquatic environment is mostly vulnerable to contamination from mining exploration which is of great concern (Sun *et al*., 2014). However, modulatory effect of nanoparticles on possible alterations in biochemical and hematological profiles of aquatic organisms could be a functional biomarker for evaluating and assessing toxicity. Overtime, series of literatures have reported fish as an appropriate biological model for assessing toxicity induced by nanoparticles due to its use in bioremediation (Verma *et al*., 2018). *Clarias gariepinus* was chosen as an experimental model due to its highly rated aquaculture and commercial value in Nigeria. The research findings of this study will give insights to viability of magnesium hydroxide nanoparticles potential in the treatment of lead-induced toxicity in river water and the inhabiting fishes.

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2. Materials and methods

2.1. Reagent and Kits

Magnesium hydroxide Mg $(OH)_2$ Nanoparticles of 99.5% purity were obtained from USA Nano-materials Research Inc.3302 Twig Leaf Lane, Houston TX77084, USA. The assay kit for the biochemical assay were purchased from Randox Laboratory, UK, while other chemical reagents used were of standard analytical grade.

2.2. Experimental Design

150 adult *Clarias gariepinus* (catfish) of average length of 25-25cm and weight 130-170g were collected at random in three different rivers tagged river I, II and III, near a prominent local mining site in Ijero-Ekiti, Ekiti State, Nigeria. The fishes were maintained in aquarium separately.

2.3. Determination of Lethal Dose (LD_{50})

Lethal dose of magnesium hydroxide nanoparticles was determined for a period of 7-days with five different concentrations (62.5, 125, 250, 500 and 1000mg/L) MgOHNPs. Mortality rate was observed at 500 and 1000mg/L MgOHNPs. Thereafter, 250mg/L MgOHNPs was used as the maximum concentration for the experiment where 62.5, 125 and 250mg/L MgOHNPs were administered into the experimental fishes. Group of five fishes were placed in graded MgOHNPs concentrations immediately after preparation in three different aquaria containing the water from the three rivers (river I, II and III) respectively from the mining site.

2.4. Determination of Lead Concentration

Lead concentrations in the three rivers near the mining site at Ijero-Ekiti were estimated where the river water samples collected were aspirated into atomic absorption spectrophotometer buck 200 fitted with Perkin Elmer-337. The lead estimation was carried out in triplicate with 10 water sample each where few drops of nitric acid were added to the water samples to avoid changes in lead concentration and average concentrations were recorded.

2.5. Physico-chemical and Biochemical Assays

The physico-chemical parameters of water for the different concentrations of the MgOHNPs was monitored using standard procedure of (Machado and Bordalo, 2014) with high sensitive pH meter while the biochemical parameters were determined colorimetrically by employing standard Randox kits. The parameters determined include aspartate amino transferase (AST), alanine amino transferase (ALT), alkaline phosphatase (ALP), acid phosphatase (ACP), albumin while total protein levels were determined using method described by (Gornal *et al.,* 1949).

2.6. Hematological Assay

Hematological analysis was conducted using method described by Alkaladi *et al.*, 2015). The parameters analyzed include packed cell volume (PCV), hemoglobin (HB), red blood cells (RBC), white blood cells (WBC), mean corpuscular volume (MCV).

3. Results

Table 1 Lead concentrations in river I water samples near mining site in Ijero-Ekiti

River water sample	Lead (Pb) concentration (ppm)
1	0.002
2	0.005
3	0.003
4	0.008
5	0.033
6	0.012
7	0.019

8	0.011
9	0.004
10	*0.002*

Table 2 Lead concentrations in river II water samples near mining site in Ijero-Ekiti

River water sample	Lead (Pb) concentration (ppm)
1	0.001
2	0.001
3	0.003
4	0.002
5	0.017
6	0.015
7	0.012
8	0.003
9	0.005
10	*0.001*

Table 3 Lead concentrations in river III water samples near mining site in Ijero-Ekiti

River water sample	Lead (Pb) concentration (ppm)
1	0.002
2	0.004
3	0.002
4	0.001
5	0.003
6	0.004
7	0.003
8	0.005
9	0.003
10	*0.006*

Table 4 Physicochemical properties of river I water before and after exposure to magnesium hydroxide nanoparticles

Parameter	**Before-Experiment**		**After-Experiment**		
		Control	2.5mg/L	5.0mg/L	10.0 mg/L
Temperature °C	28.0	25.0	25.0	25.0	25.0
pH	5.20	6.6	6.5	6.3	6.0
Ammonia Nitrate (ppm)	0.4	0.45	0.56	0.59	0.64

Nitrate (ppm)	0.05	0.05	0.05	0.08	0.09
Alkalinity (ppm)	25.00	192.0	232.0	238.0	241.0
Carbon (IV) Oxide (ppm)	33.0	48.0	53.5	55.2	61.0
Chloride ions (ppm)	13.00	8.0	10.0	9.0	9.0
Total hardness (ppm)	18.00	34.0	40.0	44.0	52.0
Dissolved Oxygen (ppm)	3.30	1.5	1.10	0.52	0.30

Table 5 Biochemical parameters of *Clarias gariepinus* in river I water exposed to magnesium hydroxide nanoparticles for 14-days

Parameter	**Control**	**62.5mg/L**	**125mg/L**	**250mg/L**
ACP (U/L)	0.23±0.04^{a}	0.55±0.66^{c}	0.37±0.04^{b}	0.41±0.04^{b}
ALP (U/L)	20.78±2.10^{a}	17.16±5.26^{a}	48.71±4.40^{b}	133.80±6.52^{c}
ALT (U/L)	2.40±0.90^{a}	3.13±0.90^{a}	3.54±1.41^{a}	3.12±1.40^{a}
AST (U/L)	2.25±3.32^{a}	1.52±0.44^{a}	0.87±0.16^{a}	0.90±0.09^{a}
Total protein (g/L)	17.46±5.63^{a}	42.08±6.37^{c}	38.08±29.40^{bc}	25.62±12.73^{b}
Albumin (mmol/L)	15.23±4.77^{a}	19.80±0.97^{a}	34.67±10.02^{b}	37.00±5.13^{b}

Results are expressed as means ± SD (n=6). Test values with superscript (b-c) are significantly different (P<0.05) from the control (a) for each parameter

Table 6 Hematological parameters of *Clarias gariepinus* in river I water exposed to magnesium hydroxide nanoparticles for 14-days

Dose (mg/L)	**PCV (%)**	**HB (g/dL)**	**RBC (x10^{6}/L)**	**WBC (x10^{3}µ/L)**	**MCV (fL)**
Control	26.01±5.26^{a}	16.58±2.80^{a}	10.45±4.09^{a}	7.63±1.05^{a}	33.02±6.50^{a}
62.5	30.03±6.24^{a}	18.32±5.07^{a}	11.00±4.41^{a}	8.20±1.04^{a}	38.08±6.55^{a}
125	27.06±7.90^{a}	16.62±3.37^{a}	9.37±0.64^{a}	7.80±1.43^{a}	39.41±10.08^{a}
250	25.15±7.10^{a}	15.93±3.83^{a}	9.50±0.39^{a}	7.65±0.95^{a}	36.88±2.93^{a}

Results are expressed as means ± SD (n=6). Test values with superscript (a) are not significantly different (P<0.05) from the control

4. Discussion

The river water analyzed for lead toxicity based on standard procedure in this research indicate lead contamination where highest lead level (0.033ppm) was obtained in river I while (0.006ppm) was the lowest obtained in river III. The proximity of river I to the mining site could be responsible for such high lead level. The values of lead level obtained in this study suggest no health risk as the highest value does not exceed the permissible lead level. However, this overtime may have harmful effect on the depending local community due to bioaccumulation of lead in their bodies. The findings also showed that the water quality parameters were significantly (P<0.05) altered by magnesium hydroxide nanoparticles. It has been reported that water quality largely regulates the distribution and productivity levels of aquatic organisms (Spaak and Bauchrowitz, 2010). The significant alteration recorded in water quality in this study may affect the physiological state and metabolic rates of the test organisms (Ogbuagu *et al.*, 2015). Variations observed in levels of ACP, ALP, albumin and total protein are associated with hepatic damage. Elevated levels of the marker enzymes in the blood was as a result of leakages from tissues (Pendota *et al.*, 2010). The elevation of plasma levels of albumin and total proteins could be attributed to derangement in the functionality of the liver cells (Adedara *et al.*, 2014). However, activities of ALT and AST remained unaltered regardless of significant increase in activities of ACP and ALP in the plasma which could be attributed to compromised membrane integrity of the fish organs (Aluko *et al*, 2018). Besides, results from the hematological parameters used as tools to ascertain the structural and functional status of the fish exposed to the contaminants indicate no significant effect of magnesium hydroxide nanoparticles. This is an indication that the nanoparticles did not affect the hematopoietic system of the fishes at tested doses.

5. Conclusion

The results obtained in this study are clear indications that lead effluents in mining sites have high propensity to contaminate the nearby rivers which may be harmful to the aquatic organisms. It also reveal that magnesium hydroxide nanoparticles could alter the physicochemical properties of water and as well impose deleterious effects on tissue functionality and biochemical status of the *Clarias gariepinus* at the tested doses.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors hereby declare no conflict of interest in this research work

References

[1] Adedara, I.A., Abolaji, O.A., Odion, B.E., Okwudi, I.J., Omojola, A.A., and Farombi, E.O. (2014). Impairment of hepatic and renal functions by 2, 5-hexanedione accompanied by oxidative stress in rats. Journal of Toxicology, 1.0: 1-8.

[2] Alkaladi, A., El-Deen, N.A.M.N., Afifi, M. and Zinadah, O.A.A. (2015). Hematological and biochemical investigations on the effect of vitamin E and C on Oreochromis niloticus exposed to zinc oxide nanoparticles. Saudi Journal of Biological Science, 21 (6): 556-563.

[3] Aluko, B.T., Oloyede, O.I., Adewale, O.B., Odesanmi, E.O., Alli Smith, Y.R. and Ogundare, M.A.B. (2018). Toxicological evaluation of magnesium hydroxide nanoparticles in rats following 28-days of repeated oral exposure. Pharmacology Online, 18 (2): 263-273.

[4] Aluko, B.T., Oloyede, O.I., Molehin, O.R. and Alli Smith, Y.R. (2017). Effect of acute doses of magnesium hydroxide nanoparticles on some biochemical parameters of wistar rats. Annual Research and Review in Biology, 21(6): 1-11.

[5] Gornal, A.C., Bardawill, C.J. and David, M.M. (1949). Protein-Biuret colorimetric method. Journal of Biological Chemistry, 177: 751.

[6] Machado, A. and Bordalo, A.A. (2014). Analysis of bacterial community composition in acidic well water used for drinking in Guinea Bissau. Journal of Environmental Sciences, 26 (8): 1605-1614.

[7] Mohanraj, V.J. and Chen, Y. (2006). Nanoparticles. Tropical Journal of Pharmaceutical Research, 5 (1): 561-370.

[8] Ogbuagu, D.H., Adebayo, E.T., Ayoade, A.A., Ugwu, O.B. and Mba, D.O. (2015). Lead accumulation in and its hematological effects on African catfish Clarias gariepinus. African Journal of Aquatic Sciences, 15: 1-4.

[9] Pendota, S.C., Yakubu, M.T., Grierson, D.S. and Afolayan, A.J. (2010). Effect of administration of aqueous extract of Hippobromus pauciflorus leaves in male wistar rats. African Journal of Traditional, Complentary and Alternative medicine, 7 (1): 40-46.

[10] Spaak, P. and Bauchrowitz, M. (2010). Environmental influences and plankton dynamics. Eawag News (Swiss Federal Institute of Aquatic Science and Technology) 69: 25-27.

[11] Sun, T.Y., Gottschalk, F., Hungerbuhler, K. and Nowack, B. (2014). Comprehensive probabilistic modelling of environmental emission of engineered nanomaterials. Environmental Pollution, 185: 69-76.

[12] Verma, S.K., Jha, E., Panda, P.K.K., Mukherjee, M., Thirumurugan, A., Makkar, H., Das B., Parashar, S.K.S. and Suar, M. (2018). Mechanistic insight to ROS and neutral lipid alteration-induced toxicity in human model with fins via industrially synthesized Titanium dioxidenanoparticles. Toxicological Research, 7: 244-257.