Eco. Env. & Cons. 29 (2) : 2023; pp. (856-860)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2023.v29i02.053

Estimation of lead level in the soil of Namakkal District, Tamil Nadu

***R. Yogeswari, A. Arivuchelvan, S. Murugasen, G.A. Balasubramaniam, P. Selvaraj, A. Jagadeeswaran and A. Raja**

Department of Veterinary Pharmacology and Toxicology, Veterinary College and Research Institute, TANUVAS, Namakkal, T.N., India

(Received 17 November, 2022; Accepted 5 January, 2023)

ABSTRACT

Lead is a most common anthropogenic environmental contaminants and non-biodegradable toxic heavy metal, causing major environmental health problems. It bio-accumulates through food chain and this can cause hazardous effects on livestock and human health. Hence in this study, lead level in 6 soil samples in each block (15 blocks) of Namakkal district were estimated and mapped. The sampling sites were the poultry farms, selected based on Systematic Random sampling. The soil samples (4 g) were digested in the microwave digester, and the lead level was determined by flame atomic absorption spectrophotometer (AAS, Model 3030, Perkin - Elmer, USA). Namakkal District map was characterized by large scale detail. ArcGIS 10.1, geographic information system (GIS) software was used for compiling and analysing geographic data using maps. All the soil samples have the lead concentration within the permissible limit, between 6.40 $\pm$ 0.55 and 15.52 $\pm$ 2.21 and within that level Kollimalai block showed significantly ($P \leq 0.01$) higher concentration of lead, 15.52 $\pm$ 2.21 when compared to all blocks except Tiruchengodu and Kabilarmalai block. As the soil in the hilly area strongly accumulates lead, the soil in Kollimalai area might have higher concentration of lead when compared to other blocks. Further Tiruchengodu and Kabilarmalai blocks, which stand next to Kollimalai, are also associated with mountain regions. Hence the backyard reared birds at the hilly areas may bio-accumulate lead and can act as a source of lead to the humans.

Key words: *Lead, Soil, Namakkal, Atomic absorption Spectroscopy*

Introduction

In recent years, environmental contamination by heavy metals has been an increasing ecological and global public health concern (Tchounwou *et al.,* 2012). Apart from anthropogenic activities of human beings, environmental contamination can also occur through metal corrosion, atmospheric deposition, soil erosion of metal ions, leaching of heavy metals, sediment re-suspension and metal evaporation from water resources to soil and ground water (Nriagu, 1989). Natural phenomena such as weathering and volcanic eruptions have also been reported to significantly contribute to heavy metal pollution (Tchounwou *et al.,* 2012). Among them, lead is a ubiquitous, non-biodegradable and one of the earliest metals discovered by the human race (Flora *et al.,* 2012). It is a highly toxic heavy metal occurring naturally in the Earth's crust as lead sulphide (Sanders *et al.,* 2009). They do accumulate in food producing animals via contaminated feed, feed additives, water and soil and ultimately may enter the human

(*Assistant Professor)

body through food chain and threaten human health (Yuan *et al.,* 2013). In recent years, research on the distribution of potentially toxic elements (PTEs) in urban soil has increased and particularly, lead is known for their toxicity and persistence in the soil (Sharma *et al.,* 2007).

Lead intoxication induces cellular damage mediated by the formation of reactive oxygen species (ROS) and also inhibits or mimics the actions of calcium and interacts with proteins (ATSDR, 1999; Hermes-Lima *et al.,* 1991). Lead is a systemic toxicant, which affects several organs in the body including kidneys, liver, central nervous system, hematopoietic system, endocrine system, and reproductive system (ATSDR, 1999). Chronic low dose exposure to lead and the resulting asymptomatic lead toxicity can cause serious and in some cases irreversible neurological damage is the focus of current research (Jack Hsiang and Elva Diaz, 2011). Lead absorbed by the pregnant mother is readily transferred to the developing fetus will result in reduced birth weight, preterm delivery and neurodevelopmental abnormalities in the offspring (Tchounwou *et al.,* 2012).

According to World Health Organization, nearly half of the 2 million lives lost to known chemicals exposure in 2019 were due to lead exposure. Lead exposure is estimated to accounts for 21.7 million years lost to disability and death worldwide due to long-term effects on health, with 30% of the global burden of idiopathic intellectual disability, 4.6% of the global burden of cardiovascular disease and 3% of the global burden of chronic kidney diseases. They further insisted that, there is no level of exposure to lead that is known to be without harmful effects. (https://www.who.int/news-room/fact-sheets/detail/lead-poisoning-and-health)

Namakkal district of Tamil Nadu, being a transport city, spilling of used engine oil, motor oil, improperly disposed batteries are the common sights and they serves as good source of lead toxicity (Yogeswari *et al.,* 2021). Hence the present study is undertaken to estimate the level of lead in the soil of Namakkal district, Tamil Nadu, India

Materials and Methods

Study area

Namakkal district is bounded by Salem on the north, Karur on the south, Trichy and Salem on the east and Erode on the West. The Geographical area of the district is 3363.35 Sq. Km which lies between 11.000 and 11.360 North Latitude and 77.280 and 78.300 East Longitude. It consists of 15 blocks namely Namagiripettai, Sendamangalam, Mohanur, Puduchatram, Rasipuram, Vennandur, Namakkal, Erumapatti, Kollihills, Elachipalayam, Mallasamudram, Tiruchengodu, Pallipalayam, Paramathi and Kabilarmalai (https://namakkal.nic.in/aboutdistrict).

Six poultry farms from each block were selected based on its location, which is either nearer to road / lorry repairing units / petrol bunk, following Systematic Random sampling method.

Sample collection

Soil samples were collected from each poultry farm to assess their lead level. Totally 90 samples were collected, 6 from each block (15 blocks). The samples were collected by scooping soil from ½ inch depth and 2 inches diameter and stored in polyethylene bags. From each farm six subsamples were collected in such a way that they should be no closer to each other than 1 ft and no farther apart than 3 ft and they were mixed well to get the sample (Environmental Protection agency Appendix 13.3).

Estimation of lead level

The soil samples were digested by microwave digester (Perkin Elmer) as per the instrument protocol at Central Instruments Laboratory, College of Veterinary and Animal Sciences, Mannuthy, Kerala. The concentrations of lead in the digested soil samples were determined by flame atomic absorption spectrophotometer (AAS, Model 3030, Perkin - Elmer, USA) at the Centralized Instruments Laboratory, College of Veterinary and Animal Sciences, Mannuthy, Kerala (Yuan *et al.,* 2013).

Mapping of Lead level

Namakkal District map was characterized by large scale detail. ArcGIS 10.1 geographic information system (GIS) software was used for compiling and analysing geographic data using maps. Geo-reference coordinates (Latitude and Longitude) along with block average of lead levels for the soil samples were fed to the software to create map with different colours (Choropleth map) with classes like low, moderate and high (Pavithrapriya *et al.,* 2015, Yogeswari *et al.,* 2021).

Results and Discussion

The mean values of lead concentration in soil for each block in Namakkal district of Tamilnadu are presented in the Table 1 and mapped in Map 1.

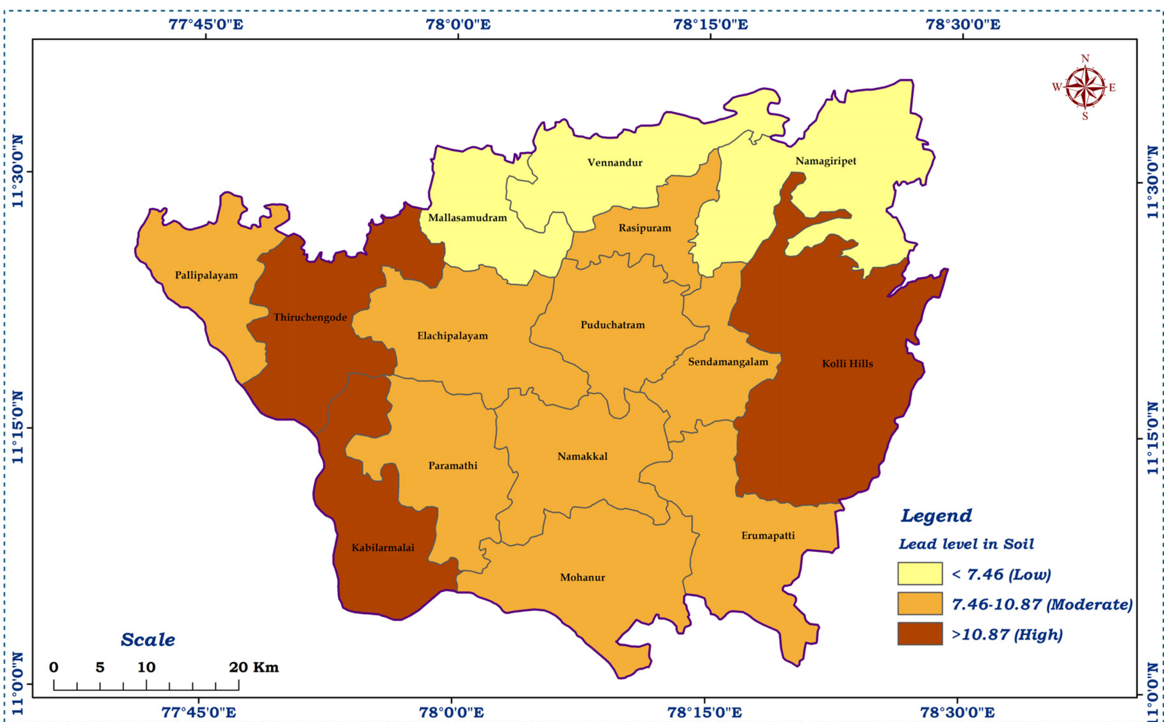
The mean values of lead concentration in soil in Namagiripettai, Sendamangalam, Mohanur, Puduchatram, Rasipuram, Vennandur, Namakkal, Erumapatti, Kollimalai, Elachipalayam, Mallasamudram, Tiruchengodu, Pallipalayam, Paramathi and Kabilarmalai blocks were 6.61 ± 1.35, 10.87 ± 0.91, 9.92 ± 1.00, 10.74 ± 1.79, 10.00 ± 0.67, 6.40 ± 0.55, 8.94 ± 1.08, 10.80 ± 1.11, 15.52 ± 2.21, 10.46 ± 0.86, 7.46 ± 0.99, 14.65 ± 3.34, 10.60 ± 1.16, 9.32 ± 0.78 and 13.62 ± 1.54 ppm respectively.

The highest concentration was noticed in Kollimalai block followed by Tiruchengodu and Kabilarmalai blocks. The lowest value was observed in Vennandur followed by Namagiripettai and Mallasamudram blocks. Kollimalai block showed significantly ($P \leq 0.01$) higher concentration of lead when compared to all blocks except Tiruchengodu and Kabilarmalai blocks. According to Environmental Protection Agency there is no single threshold that defines acceptable levels of lead in soil.

Szopka *et al.* (2013) also stated that the concentration of lead in the soil up to the depth of 0-10 cm, in the highest altitude zone was significantly higher than those in lower zones. The areas at the vicinities of mountains were preferential for the inflow of air masses, clouds, fog and rime with pollutants, should be considered as the important factors governing a spatial distribution of lead concentrations in the mountain areas (Blas *et al.*, 2008).

Further the soil situated in the mountain areas are usually very rich in organic matter, classified as Histic Leptosols or Skeleti-Histic Regosols. The layers 0–10 cm and 10–20 cm in those soils are often built of ombrothrophic peat material that strongly accumulates lead. Soil enrichment with lead, particularly in the layers 0–10 cm, may additionally contribute to the kind of parent rock and possible local mineralization of rocks in that part of the mountain range (Mazur, 2002). Because of the above said reasons soil in Kollimalai area might have higher concentration of lead when compared to other blocks. Tiruchengodu and Kabilarmalai blocks, which stand next to Kollimalai, are also associated with mountain regions.

Lead concentration in top soil was strongly influenced by anthropogenic activities, exogenous substances and even meteorology. Hence lead will ex-



Map 1. Lead level in the soil (ppm) of Namakkal district of Tamilnadu

Table 1. Lead level in water, soil, (Mean ± SE) in Namakkal district of Tamilnadu

S.No.	Name of the block	Soil (ppm)
1	Namagiripettai	6.61^{a} ± 1.35
2	Sendamangalam	10.87^{abc} ±0.91
3	Mohanur	9.92^{abc} ± 1.00
4	Puduchatram	10.74^{abc} ± 1.79
5	Rasipuram	10.00^{abc} ± 0.67
6	Vennandur	6.40^{a} ± 0.55
7	Namakkal	8.94^{ab} ± 1.08
8	Erumapatti	10.80^{abc} ± 1.11
9	Kollimalai	15.52^{d} ± 2.21
10	Elachipalayam	10.46^{abc} ± 0.86
11	Mallasamudram	7.46^{a} ± 0.99
12	Tiruchengodu	14.65^{cd} ± 3.34
13	Pallipalayam	10.60^{abc} ± 1.16
14	Paramathi	9.32^{ab} ± 0.78
15	Kabilarmalai	13.62^{bcd} ± 1.54

Overall mean bearing different superscripts between rows differ significantly ($P \leq 0.01$)
n = 6

hibit non-normal distribution. (Yuan, *et al.,* 2014, Binh Nguyen Thi Lan *et al.*, 2018). Mielke *et al.* (1983) stated that the lead generated by vehicular traffic will not evenly distribute and the roadside soil lead levels are directly related to average annual daily traffic.

Hence in this study, due to the above said reasons it is not possible to correlate the level of lead in the soil and the location of the farm (near to road or away from the road) and the lead level in the soil is influenced by many factors.

The lead level in the soil has high spatial variability. As the lead level in the mountain soil is significantly higher when compared to the plain regions, the backyard poultry might be at the risk of lead toxicity and can leave the lead residues in their products which could become a public health concern. Further studies are needed to ascertain the above mentioned statement.

Acknowledgement

The authors wish to thank the authorities of Tamilnadu Veterinary and Animal Sciences University, Chennai, for providing the facilities to carry out the work.

Conflict of interest

No conflict of interest was reported by the authors.

References

Agency for Toxic Substances and Disease Registry (ATSDR. Public Health Service. Atlanta: U.S. Department of Health and Human Services, 1999. Toxicological Profile for Lead.

Binh Nguyen Thi Lan, Takeshi Kobayashi, Atsushi Suetsugu, Xiaowei Tian and Takashi Kameya, 2018. Estimating the possibility of surface soil pollution with atmospheric lead deposits using the ADMER model. *Sustainability.* 10 : 1-12.

Blas, M., Sobik, M. and Twarowski, R. 2008. Changes of cloud water chemical composition in the Western Sudety Mountains. *Atmospheric Research*. 87: 224–231

Flora, G., Deepesh Gupta and Archana Tiwari, 2012. Toxicity of lead: A review with recen updates. *Interdiscip Toxicol.* 5(2): 47-58.

Hermes-Lima, M., Pereira, B. and Bechara, E, J. 1991. Are free radicals involved in lead poisoning? Xenobiotica. 8:1085–1090. [PubMed: 1776279].

https://namakkal.nic.in/aboutdistrict

https://www.who.int/en/news-room/fact-sheets/detail/lead-poisoning-and-health

Jack Hsiang and Elva Diaz, 2011. Lead and developmental neurotoxicity of the central nervous system. *Current Neurobiol.* 2(1): 35-42.

Mielke, H.W., Anderson, J. C., Berry, K. J., Mielke, P. W., Chaney R. L. and Leech, M.1983. Lead concentrations in inner-city siuks as a factor in the child lead problem. *AJPH.* 73: 1366-1369.

Nriagu, J.O. 1989. A global assessment of natural sources of atmospheric trace metals. *Nature.* 338: 47–49.

Pavithrapriya, S., Mahimairaja, S. and Sivasubramanian, K. 2015. Pollution due to heavy metals in coimbatore wetlands, India. *Res. J. Agriculture and Forestry Sci.* 3(6): 1-5

Sanders, T., Yiming Liu, Virgnia Buchner and Paul B. Tchounwou, 2009. Neurotoxic effects and Biomarkers of lead exposure: A review. *Rev Environ Health.* 24(1): 15-45.

Sharma, R. K., Agrawal, M. and Marshall, M. F. 2007. Heavy metals contamination of soil and vegetables in suburban areas of Varanasi, India. *Ecotoxicol Environ Safety.* 66 : 258-266.

Szopka, K., Karczewska, A., Jezierski, P. and Kaba³a, C. 2013. Spatial distribution of lead in the surface layers of mountain forest soils, an example from the Karkonosze National Park, Poland. *Geoderma.* 192: 259–268

Tchounwou, P. B., Clement G Yedjou, Anita K Patlolla, and Dwayne J Sutton. Heavy Metals Toxicity and the Environment. NIH-PA Author Manuscript EXS. 2012 ; 101: 133–164. doi:10.1007/978-3-7643-8340-4.

Yogeswari, R., Arivuchelvan, A., Murugasen, S., Balasubramaniam, G. A., P. Selvaraj, A.

Jagadeeswaran and Raja, A. 2021. Lead level in the poultry feed and egg/meat in Namakkal district of Tamil Nadu. *The Pharma Innovation Journal*. SP-10 (6): 289-293.

Yuan, C., Song, H. H., Jiang, Y. J., Azzam, M.M.M., Zhu, S and Zou, X.T. 2013. Effects of lead contamination in feed on laying performance, lead retention of organs and eggs, protein metabolism and hormone levels of laying hens. *Appl. Poult. Res.* 22: 878-884.

Yuan, G. L., Sun, T. H., Han, P., Li, J. and Lang, X. X. 2014. Source of identification and ecological risk assessment of heavy metals in topsoil using environmental geochemical mapping: Typical urban renewal area in Beijing, China. *J Geochem Explor*. 136: 40-47.