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Earthworm metallothionein production as biomarker of heavy metal pollution in abattoir soil

G.A. Dedeke[a,*], F.O. Owagboriaye[b], A.O. Adebambo[c], K.O. Ademolu[a]

[a] Department of Pure and Applied Zoology, College of Biosciences, Federal University of Agriculture, Abeokuta, Nigeria
[b] Department of Zoology, Faculty of Science, Olabisi Onabanjo University, Ago-Iwoye, Nigeria
[c] Department of Animal Biotechnology, College of Animal Science, Federal University of Agriculture, Abeokuta, Nigeria

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ABSTRACT

The direct response of animals to environmental challenges, such as the production of biomarkers, is a better tool to assess environmental pollution than the conventional methods. In this study, the production of metallothionein (MT) in earthworms (*Libyodrilus violaceous, Eudrilus eugeniae* and *Alma millsoni*) was measured as tool for assessing heavy metal pollution in abattoir soil. Earthworm and abattoir soil samples were collected from three abattoir sites (Lafenwa, Gbonogun and Madojutimi) and a control site located beside an undisturbed stream located in Abeokuta, Ogun State, in South-western Nigeria. Heavy metal (Cu, Zn, Pb, Cd, Co, Cr, Ni and Mn) and MT concentrations were measured in the earthworm tissue and abattoir soil using standard methods. The concentrations of Cu, Zn, Pb, Cd and Mn were highest in the tissue of earthworms obtained from Lafenwa abattoir. The Bioaccumulation Factors (BAFs) for all the metals tested for were less than unity, except for Cd which had a BAF > 1. The MT concentrations recorded in the earthworm samples from the Gbonogun and Lafenwa abattoir sites were significantly higher ($p \leq 0.05$) than in earthworms from Madojutimi. The lowest MT concentration was recorded in earthworms from the control. Significant ($p \leq 0.05$) positive correlations were observed between MT and heavy metal concentrations in all earthworm species indicating that MT concentrations can be used as biomarker of heavy metal pollution in abattoir soils.

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1. Introduction

Pollution has become a global problem that exists in various dimensions and it becomes worse when it is difficult to determine when, how and to what extent the level of pollution is hazardous in a particular environment (Asonye et al., 2007). There has been an enormous increase in soil pollution due to industrial activities, urban wastes, atmospheric deposition and intensive use of biocides and fertilizers in agricultural soil (Criel et al., 2008), leading to the release of metals into the soil, which over the years becomes a sink for these metals. This invariably resulted in decreased soil fertility, alteration of soil structure, disturbance of the balance between flora and fauna residing in the soil, contamination of crops, and contamination of groundwater, constituting a threat to living organisms (Bezchlebova et al., 2007).

Heavy metals have been reported to be one of the most diffusive chemicals in the soil (Lanno et al., 2004) and the reported sources of metal pollution include natural sources (Miranda et al., 2009; Hobbelen et al., 2006), ore mining or metal smelting (Haimi and Mätäsniemi, 2002), municipal waste, industrial effluents, application of sewage sludge and animal manure on agricultural land (Salehi and Tabari, 2008), and aerial deposition of particulates from vehicular emission (Ward and Savage, 1994).

High protein demand has led to a significant increase in meat production with the resultant establishment of more slaughtering (abattoir) and meat processing facilities. These facilities produce solid, liquid and gaseous wastes which tend to be worrisome due to the high content of putrescible organic matter. This can lead to the depletion of oxygen and an impairment or disruption of water and soil eco-functionality and a preponderance of disease-causing organisms. The meat processing wastes come from stockyards, abattoirs and packing plants, etc., all containing blood, fats, protein, gut contents, heavy metals, antibodies, hormones and other substances (Itodo and Awulu, 1991). In Nigeria, many abattoirs dispose their waste directly into streams or rivers and also use water from the same source to wash slaughtered meat (Adelegan, 2002). The situation is not any different in Ghana where

* Corresponding author.
E-mail addresses: gabrieldedekson@gmail.com (G.A. Dedeke), fobillion@yahoo.com (F.O. Owagboriaye), tumininuadebambo@yahoo.com (A.O. Adebambo), ademoluko@unaab.edu.ng (K.O. Ademolu).

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most liquid and gaseous wastes are released into the immediate environment of the abattoir (Weobong, 2001).

Coker et al. (2001) reported contamination by heavy metals, particularly lead and zinc, in many abattoir areas. Due to the increasing concern about chemical contamination of soil by abattoir wastes, there is a need for soil pollution monitoring and assessment in the vicinity of these facilities. Biological approaches to soil monitoring and assessments, such as the measurement of biochemical and cellular responses to pollutants (i.e. biomarkers) in organisms living in the soil (bioindicators), have become of major importance for the assessment of the quality of this environmental compartment (Kammenga et al., 2000).

Kammenga et al. (2000) further pointed out that soil invertebrates such as earthworms, may represent good sentinel

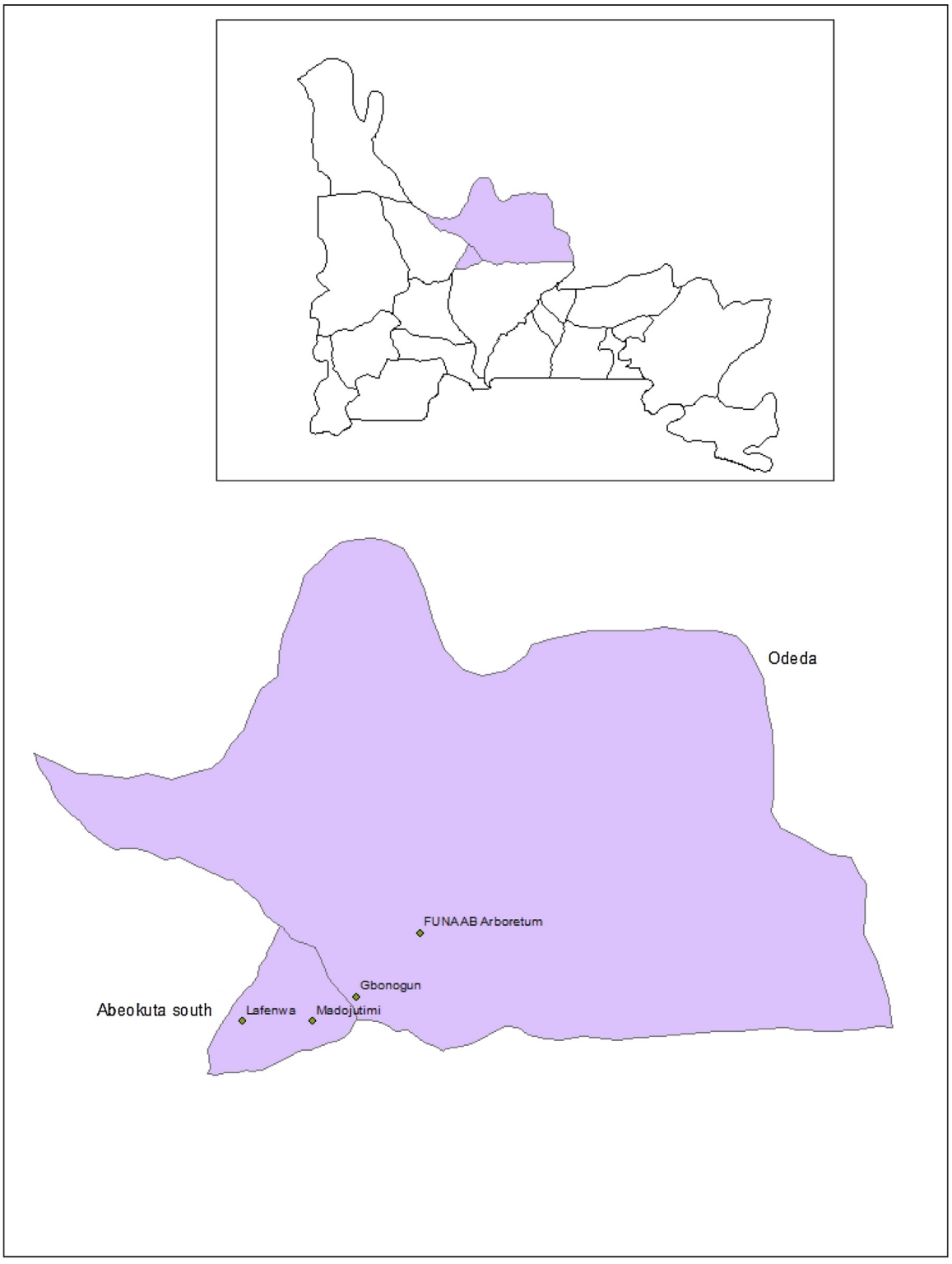

Fig. 1. Map showing the study sites, including abattoirs and a control site in Abeokuta, Ogun State, in South-western Nigeria.

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