# SPECIATION AND BIOAVAILABILITY OF LEAD IN COMPLEMENTARY MEDICINES

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## Introduction

Complementary medicines include herbal medicines, vitamin and dietary health supplements, Ayurvedic, Chinese and Homoeopathic medicines (WHO 2005). Although the intent of using complementary medicines is to gain health benefits, there is limited evidence on the efficacy of many of these products and the associated contaminant risk. These contaminants include pesticide residues and heavy metal(loid)s (Harvey et al. 2008). The term 'heavy metal(loid)' includes elements (both metals and metalloids) with an atomic density greater than 6 g $cm^{-3}$ (with the exception of arsenic (As), boron (B) and selenium (Se)) (Adriano, 2001). This group includes both biologically essential (e.g., cobalt (Co), copper (Cu), chromium (Cr), manganese (Mn), Se and zinc (Zn)) and non-essential (e.g., As, cadmium (Cd), lead (Pb) and mercury (Hg)) elements (Denholm 2011).

Three main pathways have been proposed to account for heavy metal(loid) contamination in complementary medicines; contamination during cultivation of plants used for complementary medicines, accidental cross-contamination occurring during processing, and the introduction of heavy metal(loid)s as a therapeutic ingredient. Most countries regulate the distribution and use of complementary medicines. For example, in Australia, while import restrictions provide some degree of commercial regulation, currently individuals are free to import moderate quantities of unlicensed medications produced overseas, without assessment of risk or evidence regarding heavy metal(loid) contamination. This situation allows the continued possibility that people may develop heavy metal(loid) toxicity from the intake of imported complementary medicines. There has been limited work on the speciation and bioavailability of heavy metal(loid)s especially Pb in both locally available and imported complementary medicines..

## Methods

Lead is one of the most common heavy metal(loid)s added as a therapeutic ingredient in some complementary medicines for the treatment of diabetes, spleen enlargement, diarrhea and various skin diseases. The objectives of this study were to: (i) measure total content of various heavy metal(loid)s in selected complementary medicines; (ii) examine speciation and bioavailability of Pb in these complementary medicines; and (iii) quantify the daily intake of Pb. Six herbal and six Ayurvedic medicines were analysed for: (i) total Pb content; (ii) speciation of Pb using sequential fractionation and extended x-ray absorption fine structure (EXAFS) techniques; and (iii) bioavailability of Pb using a physiologically-based *in vitro* extraction test (PBET) (Sanderson et al. 2012). The daily intake of Pb through the uptake of these medicines was compared with the safety guidelines for Pb.

## Results

The results indicated that generally Ayurvedic medicines contained higher levels of heavy metal(loid)s than herbal medicines with the amount of Pb much higher than the other metal(loid)s. Sequential fractionation indicated that while organic-bound Pb species dominated the herbal medicines, inorganic-bound Pb species dominated the Ayurvedic medicines. EXAFS data indicated the presence of various Pb species in Ayurvedic medicines. This implies that Pb is derived from plant uptake and inorganic mineral input in herbal and

Ayurvedic medicines, respectively. Bioavailability of Pb was higher in Ayurvedic than herbal medicines, indicating that Pb added as a mineral therapeutic input are more bioavailable than that derived from plant uptake. There was a positive relationship between soluble Pb fraction and bioavailability indicating that solubility is an important factor controlling bioavailability. The daily intake values for Pb as estimated by total and bioavailable Pb contents are likely to exceed the safe threshold level in certain Ayurvedic medicines.

**Conclusion**

This research demonstrated that some of the medicines tested had bioavailable levels of Pb that would likely lead to metal toxicity as a result from regular intake, which requires further investigation. The bioavailability of Pb in these medicines correlated well to the soluble fraction of the respective metal(loid)s and thus soluble fractions could be used in the future to predict bioavailability.

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