



3rd
INTERNATIONAL
CONGRESS ON
ENVIRONMENTAL
HEALTH 2014

PORTO, 24th to 26th SEPTEMBER 2014

**PROCEEDINGS
BOOK**

EMERGING RISKS AND CHALLENGES ON ENVIRONMENT,
HEALTH AND SAFETY

Allied Health Sciences School of Polytechnic Institute of Porto,
Portugal

Title:

3th International Congress of Environmental Health: Proceedings Book
3^o Congresso Internacional de Saúde Ambiental: Livro de Resumos

Edition:

1st Edition / Book in 1 Volume, 520 pages

Authors / Editors:

Vieira da Silva, Manuela; Oliveira, Rui; Rodrigues, Matilde; Nunes, Mafalda;
Santos, Joana; Carvalhais, Carlos; Rebelo, Andreia; Freitas, Marisa; Xavier, Ana

Publisher:

(ESTSP-IPP)

Scientific Area of Environmental Health of Allied Health Sciences School of Polytechnic Institute of Porto
Área Científica da Escola Superior de Tecnologia da Saúde do Instituto Politécnico do Porto

Design / Layout:

4CS

Local / Date:

Porto / November 2014

ISBN:

978-989-20-5086-7

Legal Deposit:

384046/14

DISCLAIMER:

This book contains information obtained from authentic sources. Reasonable efforts have been made to publish reliable data and information, but the authors, as well as the publisher, cannot assume responsibility for the validity of all materials or for the consequences of their use. Neither this book nor any part may be reproduced or transmitted in any form or by any means, electronic or physical, including photocopying, microfilming, and recording, or by any information storage or retrieval system, without prior permission in writing from the Scientific Area of Environmental Health of ESTSP.

All rights reserved. Authorization to photocopy items for internal or personal use may be granted by Scientific Area of Environmental Health of ESTSP.

Trademark notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation, without intent to infringe.

(ESTSP-IPP)

**Scientific Area of Environmental Health of
Allied Health Sciences School of Polytechnic Institute of Porto**

Rua de Valente Perfeito, 322
4400-330 Vila Nova de Gaia
Porto - Portugal
t. +351 222 061 000
f. +351 222 061 001
e. geral@estsp.ipp.pt
w. www.estsp.ipp.pt

Mobility of Cd and Pb in a groundwater–soil–plant system: a risk assessment

Authors: Edgar Pinto^{1,2}, Agostinho Almeida³, Isabel M.P.L.V.O. Ferreira¹

¹ REQUIMTE, Department of Chemical Sciences, Laboratory of Bromatology and Hydrology, Faculty of Pharmacy, University of Porto, Portugal

² CISA - Research Center in Environment and Health, ESTSP-IPP

³ REQUIMTE, Department of Chemical Sciences, Laboratory of Applied Chemistry, Faculty of Pharmacy, University of Porto, Portugal.

Presenting Author: Email: ecp@estsp.ipp.pt | Tel.: +351 916 941 708

INTRODUCTION:

Cadmium (Cd) and lead (Pb) are ubiquitous elements and are among the most dangerous metals in the environment. Long-term human exposure is an important public health problem and is associated with kidney failure, neurotoxicity and several types of cancer. The general population is exposed to these metals from several sources, namely food, air and water. Food is the dominant source of exposure to Cd and Pb [1, 2]. Plants can uptake Cd and Pb present in the soil. The mobile fraction of Cd and Pb in soil is very low compared to other elements [3]. Various soil extraction procedures were developed for the determination of plant-available, mobile and potentially mobile pools of trace elements in soils. These procedures offer a reliable approach to investigate possible relationships between water, soil and plants [4].

OBJECTIVES:

The aim of this work was to: (1) assess the Cd and Pb concentration of the groundwater used for irrigation; (2) evaluate the efficiency of three extraction methods (DTPA, Mehlich 3 and NH_4NO_3) to estimate the phytoavailability of Cd and Pb for lettuces; and (3) estimate the daily intake of Cd and Pb from lettuce consumption.

MATERIALS AND METHODS:

The study approach involved an experimental field with 100 lettuces (*Lactuca sativa*) planted in 3 different agricultural fields (A1, A2, A3). To avoid metals contamination from any other sources, groundwater was the only source of irrigation. Soil, water and plants were collected from January to February 2012 every 2 weeks. Determination of Cd and Pb content in groundwater, soil and harvested edible tissues was performed by ICP-MS after microwave acid digestion.

RESULTS AND DISCUSSION:

Groundwater Cd concentration showed no significant spatial variations between the 3 experimental fields. Overall, Cd concentrations were below 0.1 $\mu\text{g}/\text{L}$. As regard to Pb, significant differences were observed between the 3 experimental fields; A1 groundwater showed the highest Pb concentration (1.48 $\mu\text{g}/\text{L}$), which was 25 times higher than the Pb concentration in A2 and A3 groundwaters.

As regard to soil, the total Cd content was 1.12 ± 0.09 , 0.68 ± 0.08 and 2.21 ± 0.12 mg/kg in A1, A2 and A3 soils, respectively. A3 soil had the highest Cd content while A2 the lowest, which were significantly different. The total Pb content was 17.0 ± 0.73 , 24.2 ± 0.93 , 18.9 ± 0.73 mg/kg in A1, A2 and A3 soils, respectively. Significant differences were observed with A2 soil showing the highest Pb content, whereas A3 the lowest.

Cd content showed a steady decreased during the plant growth period with a final mean content of 5.6, 8.6 and 9.7 $\mu\text{g}/\text{kg}$ in A1, A2 and A3 lettuces, respectively. However, it should be notice that Cd content in the initial stages of growth was around 40 $\mu\text{g}/\text{kg}$. In a similar way, Pb content decrease during the plant growth

period in both A1 and A3 lettuces (final Pb content of 6.5 and 4.8 µg/kg for A1 and A3 lettuces, respectively). By contrast, the level of Pb in A2 lettuces increased, reaching a Pb content in the final product of 35.6 µg/kg.

Cd and Pb content in soil and lettuce were significantly and positively correlated with each other in all three soil extraction procedures (DTPA, Mehlich 3 and NH₄NO₃). The increased of Pb content in A2 lettuces seems to be related to the increase of Pb availability, estimated by the different extraction methods.

A Provisional Tolerable Weekly Intake (PTWI) of 2.5 and 25 µg/kg body weight has been established for Cd and Pb, respectively [1, 2]. In the present study, lettuce consumption only contributes less than 1% of the established PTWIs. Therefore, the consumption of this plant food can be considered safe as long as Cd and Pb levels are around the values obtained in the present study.

CONCLUSION:

The content of Cd and Pb in the groundwater of all the experimental fields was very low and do not seem to contribute to the accumulation of these metals in soils or lettuces. Each extractant (DTPA, Mehlich 3 and NH₄NO₃) provide useful information in the study of Cd and Pb mobility in the groundwater-soil-plant system. However, the NH₄NO₃ extractant showed the higher correlation between the soil extractable Cd/Pb and the Cd/Pb content of lettuces. Thus, this extraction method was considered to be the most suitable to estimate Cd and Pb phytoavailability.

ACKNOWLEDGMENTS:

One of the authors (E. Pinto) wants to thank FCT (Portuguese Foundation for Science and Technology) for Ph.D. grant SFRH/BD/67042/2009.

REFERENCES:

1. EFSA (2012) Cadmium dietary exposure in the European population. EFSA Journal; 10(1):2551. [37 pp.] doi:10.2903/j.efsa.2012.2551.
2. EFSA (2010) Scientific Opinion on Lead in Food. EFSA Journal; 8(4):1570. [151 pp.]. doi:10.2903/j.efsa.2010.1570.
3. Pinto, E.; Almeida, A.A.; Aguiar, A.A.R.M.; Ferreira, I.M.P.L.V.O. (2014) Changes in macrominerals, trace elements and pigments content during lettuce (*Lactuca sativa* L.) growth: Influence of soil composition. Food Chemistry 152: 603-611.
4. Fedotov, P.S.; Kördel, W.; Miró, M.; Peijnenburg, W.J.G.M.; Wennrich, R.; Huang, P.M. (2012) Extraction and Fractionation Methods for Exposure Assessment of Trace Metals, Metalloids, and Hazardous Organic Compounds in Terrestrial Environments. Critical Reviews in Environmental Science and Technology, 42:11, 1117-1171.