RESIDUAL CADMIUM CONTENT IN SOIL AND*EMPON-EMPON* AND THE EFFICIENCY OF BINDING AGENTS ON IMMOBILIZATION OF CADMIUM IN SOIL

THESIS REPORT

Submitted in Partial Fulfillment for the Requirement of Master of Science Degree, in Environmental Science Specialization in Natural Resources and Environmental Management.

By

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ENVIRONMENTAL SCIENCE STUDY PROGRAM

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Surakarta, 6th June 2016

Arlindo Fernando Macie

A.131408019

DEDICATION

First of all I dedicate these outcomes to the Almighty God for His guidance and protection under the sun. I also thank God for boosting me with energy and wisdom, because without Him nothing of which I have achieved would be possible.

This thesis is dedicated to my Father, Fernando Macie and my mother Cecília Muchanga for having brought me to the light, and for being unconditionally supportive whenever I needed them. Special dedication I address to my mother for her moral support every single day; she is a real champion in person. This thesis is also dedicated to some special people in my life namely, Wahyu, Bowen, Heitor, and my grandma Tinhala, for inspiring me on a daily basis, and because of them, I find a reason to stand up, lift my head and fight.

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ABSTRACT

Arlindo Fernando Macie. A.131408019. 2016. Residual Cadmium Content in Soil and *Empon-Empon* and the Efficiency of Binding Agents on Immobilization of Cadmium in Soil. Thesis. 1st Advisor: Dr. Prabang Setyono, M.Si, Lecturer at Environmental Science Department, Postgraduate programme, Sebelas Maret University 2nd Advisor: Dr. Ir. Widyatmani Sih Dewi, MP, Lecturer at Faculty of Agriculture.

Medicinal and spice herbs have been of great importance since the ancient ages. People have relied much on them to fulfill their healthcare needs and as ingredients of diverse cuisines. Currently, the cultivation of medicinal plants based on agro-chemicals has posing lives because chemicals contain toxic elements, including Cadmium. This research determined the Cd concentrations oin soil and medicinal and spice plants, and determined the efficiency of three binding agents on immobilization of Cd in three soil types sampled in Karanganyar. Soil cores and rhizomes were sampled and analyzed for soil properties and Cd content. Three soil types were incubated in triplicate. Each soil (5 g) was treated with 0.2 g of dolomite, 1.0g of charcoal and organic fertilizer by adding 8 ml of distilled water in a 50 ml tube, and then incubated for 24 days after having been shaken for 16 h. were added 1ml of (HNO_3 and 3 ml $KClO_4$ to the mixture. The mixture was first heated at 80^oC and then at 130^oC till the orange smoke gets finished. Finally Cd was extracted with solution of 0.01 $CaCl_2$ (20 ml), and measured by AAS. The results showed that Cd in all the investigated villages still below the limits (1.0 mg Cd/kg). In soils Cd ranged from 0.224 to 0.354 mg Cd/kg, while in herbs ranged from 0.0285 to 0.0594 mg Cd/kg. Dolomite showed the highest efficiency (95.43%) followed by organic fertilizer (92.64%) and charcoal (91.53%) in Alfisols. In general dolomite wasthe better binding agent in each location, while the lowest efficiency was recorded with organic fertilizer (89.30%) in Mediterranean soils from Kemuning.

Keywords: *Immobilization; medicinal plants; Cadmium; binding agents; efficiency.*

ABSTRAK

Arlindo Fernando Macie. A.131408019. 2016. Kadar Residu Kadmium dalam Tanah dan Empom-Empon dan Effisiensi Bahan penyerap pada Imobilisasi Kadmium dalam Tanah. Tesis. Pembimbing I: Dr. Prabang Setyono, M.Si. Program Studi Ilmu Lingkungan, Program Pascasarjana. Pembimbing II: Dr. Ir. Widyatmani Sih Dewi, MP. Fakultas Pertanian, Universitas Sebelas Maret.

Obat herbal dan rempah-rempah sudah menjadi hal yang penting dari zaman dahulu kala. Orang-orang lebih mengandalkan obat herbal dan rempah-rempah untuk perawatan kesehatan ataupun untuk menambah cita rasa dalam masakan. Budidaya tanaman herbal berbasis pupuk kimia telah banyak dikembangkan, oleh karena itu, elemen-elemen toksik termasuk cadmium, memasuki rantai makanan. Penelitian ini bertujuai mengetahui konsentrasi Cd tanah dan tanaman herbal, serta menganalisis efisiensi yang mengikat tiga agen imobilisasi Cd dalam tiga jenis tanah di Karanganyar. Sampel tanah dan rimpang diteliti untuk unsur tanah dan Cd. Tiga diantaranya diinkubasi dalam rangkap tiga. Setiap tanah (5 g) diberi pelakuan 0.2 g dolomit, 1.0 g arang dan pupuk organik dengan menambahkan 8 ml air suling dalam tabung 50 ml, kemudian tanah tersebut diinkubasi selama 24 hari setelah diaduk selama 16 jam. Setelah itu tambahakan 1 ml HNO_3 dan 3 ml $KClO_4$ ke dalam campuran. Pertama panaskan tanah pada suhu 80°C sampai 130°C hingga asap berwarna oranye. Kemudian Cd diektrasi dengan larutan 0,01 $CaCl_2$ (20 ml), lalu diukur dengan AAS. Dari hasil penelitian menunjukan bahwa Cd dari semua desa yang diteliti masih dibawah batas ambang (1,0 mg Cd/kg). Cadmium di tanah berkisar antara 0,224-0,354 mg Cd/kg, sementara di jamu berkisar antara 0.0285 – 0.0594 mg Cd/kg. Dolomit menunjukkan efisiensi tertinggi (95.43%) diikuti oleh pupuk organik (92.64%) dan arang (91.53%) di Alfisols. Pada kesuluruan effisiensi dolomit lebih besar di semua tanah dan lokasi, sedangkan efisiensi terendah tercatat dengan pupuk organik (89.30%) di tanah Mediteran dari Kemuning.

Kata kunci: *Imobilisasi; tanaman herbal; Kadmium; Agen terkait; efisiensi.*

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LIST OF ABBREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
ATP	Adenosine Triphosphate
Cd	Cadmium
CEC	Cation Exchange Capacity
DNA	Deoxyribonucleic Acid
EU	European Commission
EMPON-EMPON	Medicinal and spice plants
NPK	Inorganic fertilizer containing Nitrogen Phosphorus and Potassium
SCL	Sandy Clay Loam
SL	Sandy Loam
SNI	Indonesian National Standards
SOM	Soil Organic Matter
USA	United States of America
WHO	World Health Organization