OBAFEMI AWOLOWO UNIVERSITY

ASSESSMENT OF HEAVY METAL CONCENTRATION IN *AMARANTHUS hybridus*L.ON SOIL SUPPLEMENTED WITH POULTRY LITTER AND SWINE DUNG

BY

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CERTIFICATION

This is to certify that this work was carried out by AGBONMAGBE, BABATUNDE AYO (SCP/11/12/R/0041) of the Institute of Ecology and Environmental Studies, in partial fulfilment of the requirements for the award of the Degree of Master of Science (M.Sc) in Institute of Ecology and Environmental Studies, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria.

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DEDICATION

This project work is dedicated to the Almighty God, who is the most gracious, the most merciful.

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All adoration are ever due to Almighty God, the Lord of the world. I am so much grateful to Jesus Christ for having endowed me with capacity to be able to finish this project work. I pray to Him for guidance and assistance for all the tasks ahead.

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ABSTRACT

This study identified and determined the concentration of heavy metals in poultry litter and swine dung. It also determined the uptake of the heavy metals by *Amaranthushybridus*. This was with the view to providing information on the growth and uptake of the heavy metals by *Amaranthushybridus*grownon soil supplemented with composted poultry litter and swine dung.

The experiment was carried out in the screenhouse of the Faculty of Agriculture, Obafemi Awolowo University (O.A.U.), Ile-Ife, Nigeria. Twenty (20) kilogrammes each of faeces from both poultry and swine were collected from two different locations namely; the O.A.U. Teaching and Research Farm, Ile-Ife and Dare Farms (a commercial farm), Ilesa, Nigeria. The animal wastes collected were aerobically composted for 60 days. The experiment consisted of six compost treatments which were 100% poultry litter, 100% swine dung and 50% poultry litter + 50% swine dung, each from O.A.U. Teaching and Research Farm, and Dare Farms. A treatment with zero compost addition served as control. Each of the treatment was replicated three times to give a total of 21 pots, arranged in a completely randomized design. Each pot contained three kilogrammes of sieved topsoil, and one kilogramme of the compost. Seeds of *A.hybridus* obtained from the International Institute of Tropical Agriculture Ibadan were sown. Growth performance of the test crop was monitored until maturity. Growth parameters such as number of leaves and plant height of the crop were measured 10 days after sowing at an interval of five days till 30 days after sowing. Pre- and post-cropping analyses of soil were done using standard methods. The heavy metals (Ni, Cd, Cr, Cu, As, Pb) in the harvested crop and animal feeds were analysed using Atomic Absorption Spectrophotometry. Transfer factors of the heavy metals from the soil to the crop were determined. Data collected were subjected to Analysis of Variance using SAS statistical package and significant means were separated using Duncan's Multiple Range Test.

The concentration of heavy metals in the poultry litter and swine dung ranged between 0.45 – 62 $mgkg^{-1}$ for Cu, 0.69 – 3.85 $mgkg^{-1}$for Pb, 0.01 – 0.15 $mgkg^{-1}$for Ni, 0.01 – 0.05 $mgkg^{-1}$for Cd, 0.00 – 0.43 $mgkg^{-1}$for Cr and 0.19 – 0.74 $mgkg^{-1}$for As. The concentration of heavy metals in *A.hybridus* ranged from 31.58 – 61.28 $mgkg^{-1}$for Cu, 0.68 1.32 $mgkg^{-1}$for Pb, 2.96 – 5.74 $mgkg^{-1}$for Ni, 0.11 – 0.22 $mgkg^{-1}$for Cd, 0.24 – 0.47 $mgkg^{-1}$for Cr and 0.18 – 0.34 $mgkg^{-1}$for As. The concentration of the heavy metals in the soil samples also ranged between 31.67 – 93.82 $mgkg^{-1}$for Cu, 3.36 – 9.94 $mgkg^{-1}$for Pb, 16.38 – 48.53 $mgkg^{-1}$for Ni, 0.21 – 0.61 $mgkg^{-1}$for Cd, 84.24 –264.37 $mgkg^{-1}$ for Cr and 3.74 – 10.28 $mgkg^{-1}$for As. The order at which heavy metals were transfered from the soil to the crop was Cu > Ni >Pb> Cr >As > Cd.

The study concluded that *A.hybridus* cultivated on soil supplemented with poultry litter and swine dung as manure contained higher concentration of heavy metals than when no supplement was applied.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Animal dung is widely used in agricultural practices, especially in the agronomy aspect of agriculture. It is used as organic matter in order to increase soil fertility and subsequently increase crop yield. However, this practice also results in serious environmental problems, such as nitrate and phosphate contamination of surface waters (Smith *et al.*, 2007). There are evidences of animal dungs with heavy metals contamination in other countries. Sidhu *et al.*1994. Found that lead (Pb) concentration in ruminants during industrial pollution in Punjab China, varied from 48.7 to 146.1 ppm. Gowda *et al.*(2003) also reported that samples of dung examined from dairy Cattles in industrial areas contained higher Pb (0.55ppm) and Cadmium (Cd) (0.032) than the samples from cattle examined in Floor of industrial area in Kerala State, South India.

Due to increase in population, there has been a rapid increase in the development of intensive animal farms in the world, which led man to a vast expansion of animal production in order to meet up with daily human protein requirement. Approximately about 9.25×10^8 pigs, 2.54×10^8 cattle and 1.58×10^9 chickens are raised in Northeast China annually (Li *et al.*, 2007). While approximately19 billion of chicken, 1.4 billion of cattle and 1 billion of pigs are raised all over the world. This has increased the use of minerals such as copper (Cu), zinc (Zn) and arsenic (As) in animal feeds via mineral additives because of their antimicrobial and growth-stimulating effects in enhancing animal production (Nicholson *et al.*, 1999; Li *et al.*, 2007). In pigs, Linden *et al.*(2002) evaluated the Cd level in the manure of organic and conventionally raised pigs as 51.8 and 39.9μg kg^{-1}, respectively and they concluded that organic pigs has a higher Cd exposure from the environment, such as ingestion of soil. Parkpian *et al.* (2003) investigated that lead and Cd contamination in grazing land located near a highway. The analysis of the manures showed a considerable amounts of Pb and Cd content of 2.55 – 3.34 and 0.14 - 0.31 ppm, respectively. Long term simultaneous application of fertilizer and manure on the commercial farm showed higher metal accumulation in the soil and plants than that of other farms.

It was found that Cu, Pb, Cd and Chromium (Cr) are major heavy metals contaminants found in animal manure. Concentrations of these metals in animal manures were high in China. The copper concentration in manure sample reached as much as 1726.3/ mg kg^{-1} (Cang *et al.*, 2004). Mor, 2005, estimated the Cd and Pb contents in cattle manure taken from four agricultural areas exposed to different degree of environmental pollution. The level of Cd and Pb contamination in the manures of the cattle in the areas far from industries, traffic or urbanization, were less than those that were closer to heavy traffic and industrial activities. A wide range of heavy metals in animal manures has been investigated in intensive animal production in China. According to the report of Li *et al.* (2005), the content range of Cd in pig manures ranged from non-detectable (nd) to 129.76 mg/kg dry matter in Beijing and Fuxin. Luo *et al.* (2009), confirmed that animal manure was an important source of soil pollution caused by heavy metals in China. Xiong *et al.*(2010), suggested that the application of manure would enhance the risk of Cu contamination in Fuxin city in Northeast China.

Lead, Cd, As and Hg are widely dispersed in the environment. They are generally considered the most toxic to humans and animals; the adverse human health effects associated with exposure to them, even at low concentrations, are diverse and include, but are not limited to neuro-toxic and carcinogenic actions (ATSDR, 2003a; 2003b; 2007; 2008; Castro-González *et al.*, 2008; Jomova *et al.*, 2011). Pb as a toxicologically relevant element has been brought into the environment by man in extreme amounts, despite its low geochemical mobility and has been distributed worldwide (Oehlenschläger, 2002).In humans, Pb ingestion may arise from eating lead contaminated vegetation or animal foods. Another source of ingestion is through the use of lead-containing vessels or lead-based pottery glazes (Ming-Ho, 2005). In humans, about 20 to 50% of inhaled, and 5 to 15% of ingested inorganic lead is absorbed. In contrast, about 80% of inhaled organic Pb is absorbed and ingested, organic Pb is absorbed readily. Once in the bloodstream, Pb is primarily distributed among blood, soft tissue, and mineralizing tissue (Ming-Ho, 2005). The bones and teeth of adults contain more than 95% of the total body burden of lead. Children are particularly sensitive to this metal because of their more rapid growth rate and metabolism, with critical effects in the developing nervous system (ATSDR, 2007; Castro-González *et al.,* 2008).

However, the accumulation of As in rice field soils and its introduction into the food chain through uptake by the rice plant is of major concern mainly in Asian countries (Bhattacharya *et al*., 2007). Cadmium ions are readily absorbed by plants. They are equally distributed over the plant and taken up through the roots of plants to edible leaves, fruits and seeds. During the development of grains such as wheat and rice, Cd taken from the soil is concentrated in the core of the kernel.The contamination chain of heavy metals almost always follows a cyclic order: industry, atmosphere, soil, water, foods and human. Although toxicity and the resulting threat to human health of any contaminant are, of course, a function of concentration, it is well-known that chronic exposure to heavy metals and metalloids at relatively low levels can cause adverse effects (Agency for Toxic Substance and Disease Registry [ATSDR], (2003a, 2003b, 2007, 2008; Castro-González). Therefore, there has been increasing concern, mainly in the developed world, about exposures, intakes and absorption of heavy metals by humans. In Nigeria, as in most other tropical countries of Africa where the daily diet is dominated by starchy staple foods, vegetables are the cheapest and most