Poultry waste as an organic fertilizer

LITERATURE REVIEW

The several studies have been reported that the higher amounts of metals are present in different organic wastes, such as poultry fertilizer (Lopes et al., 2011; Bolan et al. 2004) and poultry fertilizer composts (Haroun et al. 2009; Farrell and Jones 2009a; Chen et al. 2008; Cai et al. 2007; Goi et al. 2006; Ihnat and Fernandes 1996; Ayuso et al. 1996; Ciavatta et al. 1993). These metals are potentially bio-transferable to soils and to different crops (Lopes et al., 2011; Achiba et al. 2009; Odlare et al. 2008; Bose and Bhattacharyya 2008; Kidd et al. 2007; Casado-vela et al. 2007; Korboulewsky et al. 2002; Cole et al. 2001; Bazzoffi et al. 1998; Pinamonti et al. 1997). Literature survey have suggested the both concerns of metals availability and mobility to humans & environment, and their necessity for regular agronomic practices.

The application of poultry waste as an organic fertilizer is major source for improving soil productivity and crop yield (Dikinya 2010; Cooperband et al. 2002). However, beside these beneficial applications of poultry waste, it is also responsible for different problems and adverse effects towards soil and plants and the trace level of these metals in plants may pose health hazards to plants consumers such as humans and animals (Singh R 2010; Arroyo et al., 2014; Diaz-Barrientoset al. 2003). The induction of HM due to poultry waste land practices to agricultural land may behave a different role in affecting soil composition and the growth of plant (Zhou et al., 2005; Miyazawa et al. 2002, Walker et al. 2003). Tao and Mancl 2008, estimated daily manure production by a broiler and laying hen to be 0. 09 kg and 0. 18 kg, respectively. Moreki JC and Chiripasi SC 2011; Edwards 1992, described the factors that influence manure production include type of chicken, age and breed, stocking density, feed conversion, kind and amount of feed, litter, floor, moisture content of manure, and even climatic impacts during absorption. Ritz and Merka, 2009 reported, that the factors affecting composition of manure are type of birds, feed nutrient density, bedding material and amount, time in use and other management factors.

2. 1. Beneficial impacts of poultry waste

The poultry waste amendment in soil as a fertilizer is a common practice for centuries and it had been used the most desired natural fertilizer due to contents of high amount of nitrogen (Sloan et al., 2003) and nourishes plants with necessary nutrients. Poultry fertilizer have enhanced the product yield in several crops, such as Bermuda grass, wheat, rice, orchard, grass fescue, and corn (Moore 1995; Edwards and Daniel 1992; Wood 1992; Miller et al. 1991). Such practices of manures to agricultural soil raises organic contents, provides nutrients, improves soil structure and increases nutrients which are induced by crops (Lopes 2011; Singh and Agrawal 2008; Weber et al. 2007). It is reported that the increase in crops yield is due to the higher contents of Nitrogen present in waste, whereas, in rice crop S, Zn, P, K and N cannot duplicated in graded soils (Moore et al. 2005; Miller et al. 1991).

Sunarlim et al., 1999 has been stated that, the application of chicken farm waste provide nutrients as well as134 increases the biological, physical chemical and properties of agricultural soil. It has been investigated by Jamali et al. 2008; Scancar et al., 2000 that, the higher amount of organic content and significant concentrations of P and N in solid waste endorse its usage, in the most cost- effective mode, as an agricultural manure or as a soil conditioner. Caviatti et al., 1993 11 stated that increase in pH of composite lowers the mobility of HM. The disposing of animal waste is the beneficial land disposal method and increases agronomic production (Ekop et al. 2011; Obasi et al., 2008). This is a typical economic sustainable means of changing waste to wealth. Due to the high cost of inorganic fertilizers, small scale farmers now apply livestock and poultry manure, sewage sludge and municipal waste to improve soil fertility (Odoemelam and Ajunwa, 2008; 51).

In terms of HM stabilization in polluted sites, very small metal concentration of metals into shoot/stems is acceptable to prevent their induction to food chain via ecosystem described by Pichtel et al., 2000. Singh et al. 2012, reported that the nutrient accumulation amount vary by crop specie and variety. As reported by ul Islam et al. 2007, the association of microbes and root and soil and plant acts an active specie in regulation of HM transference from agricultural soil to edible parts of plants. Chibuike 2014; ul Islam et al. 2007 and Baker 1981, reported that these plants are able to tolerate the HM via three mechanisms, namely, (a). exclusion: restriction of metal transport and maintenance of a constant metal concentration in the shoot within the higher range of soil concentration (b). inclusion: metal concentrations within the shoot reflecting relationship; and (c). bioaccumulation: accumulation of metals in the shoot and roots of plants at both low and high soil concentrations. Thomas et al. 2012, stated that the essential and non-essential metals may accumulated in soils by means of wastewater irrigation, sewage sludge and poultry manure application by the use of fertilizers and agrochemicals.

2. 2. Adverse effects of poultry waste

Nowadays, environmental pollution is of high global concern issue. Regarding to this issue, HM pollution in agricultural soil has always been deeply focused by the scientific community 34. (A. K. Chopra., 2009; 34) reported that the HM are usually present at lower concentrations in soil, due to their toxicity and cumulative behavior HM does not only have toxic effects on plants but also create human health problems. The existence of HM in animal excretion (livestock and poultry manure) may contained in their feed or other supplements (Hamid and Jawaid 2013; Lopes 2011; Petersen et al. 2007; European Commission 2003). Therefore, the extent of HM in manure is usually moderate for lead and cadmium. The micronutrients such as Zn and Cu, generally added to animal feed supplements, to enhance the production and disease prevention (Nicholson et al. 1999).

It was reported by Barathi et al., 2013, Kelleher, et al., 2002, that utilization of poultry waste as fertilizer have many adverse impacts, such as ground and surface water contamination, odors and insect accumulation with decrease in crop production. (FAO, 2006) stated that the aerial emissions of pollutants from poultry production facilities can affect air quality. Ammonia emitted into the atmosphere is arguably the most environmentally significant aerial contaminant related with poultry production. Zhang et al. 2005 reported that, the excreta of poultry farms contain some harmful components, such as HM, pathogenic microorganisms and veterinary drugs.

McLaughlin et al., 1999 has reported that all HM are toxic at higher concentrations. Ligaba 2011 and Barazani 2004 reported that, the HM due to oxidative damage in plants may responsible to create toxicity to higher plants , including enhanced lipid per oxidation, oxidation of protein and reductants in the cell DNA impairment, , 12 stated that the, toxic metals have negative impact on crops may be due to oxidative stress, dislocating of enzymes or essential metals within the pigments present in plants, disruption of the molecules, metabolic processes and reduce the growth and production yield (Stohs and Bagchi, 1995, Zhang, et al., 2000). Bolan et al. 2004 and Park et al. 2011 stated that the beneficial effects, concern over the potential hazards associated with organic manures continues to attract the attention. Dean 2008 stated that, the PM may contain relatively high concentrations of several trace metals such as: Pb, Cu, Cd, Fe and Zn as reported by Unwin, 1998; Sims and Wolf, 1994; Bolan et al., 2010. A. K. Chopra, 2009, reported that, HM are the important pollutant group, these are stable and cannot be degraded or destroyed, therefore these tend to accumulate in soils. The HM also occur in nature, their excessive accumulation can create carcinogenic and other toxic effects in living organisms. Further he reported that, various industries are playing a key role in this context by discharging a large amount of effluents on the land soil.

According to Gupta 2007, the distribution and absorption of HM in tissues of vegetable plants are important to assess and monitor the role of phytoremediation in metaliferous soils. Lente, J. 2014; Drechsel, 2014 and Muchuwati M. 2006, described that, the regular assessment in agricultural soils and crops is therefore, very important to analyze concentration and conceive the method to reduce contamination, in order to reduce risks to human health. In vegetables these HM accumulate in edible parts (fruits, leaves and roots) and the HM are most often found in vegetables include cadmium, copper, arsenic, chromium, lead, zinc, cobalt and nickel earlier described by Drechsel, 2014; Lakmalie 2011 and Muchuwati et al., 2006, stated that other than the safety risks, HM higher than the permissible limits also pollute soils and affect quality and growth of crops. The trace levels of HM may create problems in soil, such as food chain contaminations and phytotoxicity as stated by Kumaragamage and Indraratne 2011; Nicholson et al., 2003 and 35, 85. Arunakumara et al., 2013; Sadon et al., 2012; Chand et al., 2012, have been reported that contamination of agricultural soils with HM, created significant environmental problems and Rotkittikhun 2007 stated that, their uptake by plants can have strong adverse impacts on human health contaminated via food chain. McLaughlin et al., 2000; Pierzynski et al., 2000 have documented that synthetic fertilizers and pesticides contain trace metals as impurities or active ingredients. Singh and Aggarwal, 2006 reported, the crop yields get contaminated, the excessive metals in the plant can result in decreased crop yield too due to the inhibition of plant metabolic processes.

Baig et al. 2011; Cooper et al., 2011 and ul Islam 2007 estimated that, thresholds of nutritional toxicity in soil to plant system and accumulation of HM in plants may vary with several factors. Roeper et al. 2005; 41 contended that the problem created due to the poultry industries is the excreted manure, it is hazardous to livings and environment due improper disposing and treatment methods. Furthermore, it spread diseases, contaminate the groundwater resources and agricultural soils, if not handled properly.

2. 3. Sequential Extraction of HM

The bioavailable and mobile HM, and their ecotoxicity to crops, rely and depend upon the origin of bonding and their definite chemical forms 35. In order to evaluate and monitor geochemical forms and harmful effects, these physicochemical forms should be evaluated, rather than the total metal concentration investigated by Fuentes 2004; Pueyo et al., 2001; Fernandez et al., 2000; Perez -Cid et al., 1999; Legret, 1993. The environmental behavior of potentially toxic metals critically rely on their origins (Bacon et al. 2008; Kazi et al. 2006; Ure and Davidson 2002). The way by which HM bound to solid components of environment, like sediments and soils, this act may affect the bioavailability, mobility and toxicity of metals towards livings (Bacon et al. 2008).

The Sequential Extraction scheme was firstly suggested by Lasheen 2009; Kersten and Forstner 1986; Tessier et al. 1979; which comprises five steps: Yao 2009 (i) Exchangeable fraction, (ii) Carbonated bound fraction (extracted by acetic-acetate buffer), 114 (iii) Fe/Mn oxide bound fraction (extracted by hydroxylamine), (iv) Organic matter bound fraction (extracted by hydrogen peroxide in nitric acid) and (v) Residual fraction. The Community Bureau of Reference (BCR) in 1987 also began a scheme to harmonies the procedure used in the sequential extraction schemes to determine the levels of HM in various environmental samples, it was also used to define CRM (certified reference material) by Ure et al., 1993. This procedure has been historically used to various matrix, such as soil (Vieira 2009; Vidaland Rauret, 1993), sewage sludge (Prez-Cid et al., 1996, Alvarez et al., 2002), sediment (Thomas85et al., 1994, Marin et al., 1997), ash (Villar et al., 2001) and composts (Oyeyiola 2011; Greenway and Song, 2002).

The BCR sequential extraction, a simple 70 3-steps and an additional step, which give rise to four different fractions that was thoroughly tested by inter laboratory trials reported by Delgado 2011; Tokalioglu et al., 2000. The original procedure was reported by Quevauviller et al., 1994 and Quevauviller, 1998, Cappuyns 2009, consist 3-extractions which separated ' acid extractable' (CH_3COOH 0. 11 M), ' reducible' (NH_2OH. HCl, 0. 1 M, pH 2) and ' oxidisable' (H_2O_2 30%) fractions.

2. 4. Modified BCR Procedure

The reducing extraction ($NH_2OH \cdot HCl$) fraction in the BCR sequential extraction scheme was found to suffer from a lack of reproducibility (Cappuyns 2007). After testing different reaction conditions (concentration of the reagent, pH), the $NH_2OH \cdot HCl$ concentration was changed to 0. 5 M and the pH of the reagent was adjusted to 1. 5 by addition of a fixed volume of HNO_3 instead of 0. 1 M NH_2OH. HCl at pH 2 39. Original BCR procedure recently being superseded by a modified version and this procedure is very popular during recent years and their application has increased lately, during the certification of Reference Materials reported by Sahuquillo et al., 1999, Rauret et al., 2000; 103 Perez Cid et al., 2001, Sutherland and Tack, 2002, Mossop and Davidson, 2003; Kazi et al., 2006. The revised protocol involves use of an increased concentration of NH_2OH •HCl and lower pH (Mossop

2003). It improves reproducibility due, it is thought, to a more efficient dissolution of the reducible fraction of the soil matrix, most probably the iron oxyhydroxide phase.

2. 5. Single Extractions

The single extraction procedures are widely used as a general tool to evaluate metal polluted sediments, sewage sludge (MarguÃ± 2004; Hardaway et al., 1999), construction materials and soils (van der Sloot et al., 1996). Ph. Quevauviller et al., 1997, investigated that for soil and environmental samples the most commonly used leaching/extraction tests were selected in order to identify the degree of similarity, exchangeability and/or complementary nature of data. These tests consisted of single extractions using water, mild ($CaCl_2$, $NaNO_3$), acid (CH_3COOH) and complexing extractants (EDTA, DTPA) (Houba et al., 1990, Gupta and Aten, 1993).

According to MarguÃ± 2004, the leaching test, which is based on a German Standard Method (DIN 38414-S4) was developed to assess leaching of sludge and sediments from water and wastewater treatment. Among single extraction methods, $CaCl_2$ and DTPA were the most widely used extractants (Wang 2004; Houba et al., 1996; Novozamsky et al., 1993).

2. 5. 1. Complexing extractant (EDTA)

Beckett, 1989, McLaughlin et al., 2000, 33 has been to express heavy-metal levels in soils as plant- or potentially plant-available metal levels rather than “ total” concentrations. This implies that “ weaker” extractants or chelating agents be used in heavy-metal studies. EDTA, in either the di-sodium or di-ammonium salt form, has been used extensively in a host of studies as an extractant of potentially plant- available heavy metals. Baig et al. 2010; David Fangueiro 2002; Ure et al., 1993, Quevauviller et al. 1998 reported using a single extraction scheme such as extraction with EDTA has been suggested by the Measurement and Testing Programme, in order to analyze the bioavailable HM. However, these methods of evaluation are attained under equilibrium conditions and the bioavailability and distribution of species, achieved only by thermodynamic considerations is also of limited application.

2. 5. 2. Calcium chloride ($CaCl_2$)

0. 01 M Calcium Chloride (Jones 2007; McBride et al., 2003; Houba et al., 2000; van Erp et al., 1998) have been suggested as measure of phytoavailability for selected HM in soil and solid samples. The bioavailable extractable trace and toxic HM were also evaluated by using 0. 01 M $CaCl_2$ as an extractant (Menzies et al., 2007; Kuo et al., 2006). Xiao-ping et al., 2004 have described that the $CaCl_2$ is one of the main constituents of soil background electrolytes. The HM, which are accumulated in soil, may weaken and break the bonding sites of calcium (Razic 2006).

2. 5. 3. Water extraction fraction(DIN test 38414-S4)

Leita and Nobili, 1991, examined that most readily bioavailable fractions of organics and HM are the water-soluble in composts applied to soils. So that the water soluble extraction in soil is always thought to be the portion of the most weakly bound forms to the solid phase (Akira Takeda. 2006). The deionized water was used for the water extraction, these extraction methods were initiated with 1: 10 ratio of soil and extract volume, at room temperature and shaken for 2-hours then flirted and analyzed (Berti and Jacob, 1996).