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Full Length Research Paper

Physico-chemical Characteristics of Poultry droppings and its Effects on Growth and Yield of Sclerotia of *Pleurotus tuberregium*

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Abstract
The use of poultry droppings has been part of organic crop production for centuries. The poultry droppings composts have lots of beneficial aerobic bacteria and fungi growing in it for soil building and plant fertilization. In this study, experiments were conducted to evaluate the potential of poultry droppings on the growth and yield of sclerotia of pleurotus tuberregium. Physico-chemical analysis of the poultry dropping showed that the dropping contained 0.60 % N, 0.34 % P, 1.20 % Ca, 0.74 % Mg and 0.44 % K. The study revealed that various concentration of poultry dropping had effects on the growth and yield of the sclerotia of pleurotus tuberregium. Soil amendment with poultry droppings significantly reduced the growth of Pleurotus tuberregium .

Keywords: *Poultry dropping, Sclerotia, Pleurotus tuberregium, Growth, Yield.*

Introduction

The utilization of manure is an integral part of sustainable agriculture. Animal manures have been used affectively as fertilizers for centuries. Poultry manure as fertilizer has been part of organic crop production for centuries and has long been recognized as perhaps the most desirable of these natural fertilizers because of its high nitrogen content (Sloan *et al*; 2003). Poultry manures supply other essential plant nutrients and serve as a soil amendment by adding organic matter. Organic matter in soil improves moisture and nutrient retention. The increased size and frequent clean-out of many poultry operations make poultry dropping available in sufficient quantities and on a timely basis to supply most fertilization needs. The poultry manure composts have lots of beneficial aerobic bacteria and fungi growing in it for soil building and plant fertilization. The nitrogen and nutrient content in poultry manure is high. It has been established that chicken manure has a make-up of 1.8% nitrogen, 1.5% phosphate and approximately Nitrogen-Phosphorous – Potassium (NPK) ratio of 2:2:1. (Sloan *et al*; 2003)

It has been noted that poultry manure can harm wildlife, habitat and human health. Holleman (1992) reported that excess nitrogen converts to ammonia and nitrates, burning the fragile cells of land plants. Also, poultry manure has been reported to contain heavy metals (Sloan *et al*; 2003; Holleman, 1992) Demirbas, 2001 and Duncan, 2005). Heavy metals are natural constituents of the earth's crust. They are stable and cannot be degraded or destroyed but they tend to accumulate in soils, sediments and human vital organs. The presence of heavy metals in soil, air and water, even in traces can cause serious problems to all living organisms.

Pleurotus tuberregium is an edible basidiomycete found in the tropical and subtropical regions of the world. It forms a large, spherical to ovoid, subterranean sclerotium, composed of fungus tissue, sometimes up to 30 cm or more diameters (Oso, 1977). The sclerotium is dark brown on the outside and white inside. *Pleurotus tuberregium* initially infects dry wood where it produces the sclerotium which may become buried in the soil. The fungi are common in Nigeria where farmers usually lift the sclerotium out of the soil or wood while cultivating their farms. If the sclerotium is kept in warm humid place, it continues to produce fruit bodies (mushroom). Mushrooms are very low-calories food suited to all those interested in cutting down the calorie intake like obese persons. Being low in fats but desirable fats devoid of cholesterol, these make an ideal diet for the heart patients. As a low calorie, high protein diet with almost no starch and sugars, mushrooms are the "delight of the diabetic (Easter Mirror, 2011).

This study is aimed at analysis of the heavy metals content of poultry droppings and its effects on growth and yield on sclerotia of *Pleurotus tuberregium* (Mushroom) planted on soil amended with the poultry droppings. Four heavy metals to be determined are cadmium, zinc, copper and lead.

Experimental

Samples collection and preparation

Top soil sample (0 – 15cm) was obtained from a plot of land along Oluku road in Benin City. Sclerotia of *Pleurotus tuberregium* plant was supplied from the Department of Plant Biology and Biotechnology, University of Benin.
Poultry droppings were collected from a poultry farm at Iguosa, Benin City, Nigeria. The poultry droppings were composted by heating, resting and tilling until a constant temperature of 30^0C was obtained.

Substrate Preparation and Cultivation: Poultry dropping were composted and added to the soil samples at different amended levels of 0%, 5%, 10%, 20% and 30% of poultry droppings in four replications. Each of the amended level replicates was then contaminated with 0.3g of salts of Cd, Cu, Pb and Zn respectively and left to acclimatize for two weeks. The sclerotia were soaked for 2hrs before planting and then cut into sizeable pieces of 20g. The experimental pots were left for 2 weeks with periodic addition of water.

Determination of physico-chemical properties of the soil

The physico-chemical properties of the soil; pH, particle size, organic carbon, cation-exchange capacity, phosphorus nitrogen, nitrate and sulphate, were determined by Standard Methods (Black, 1965; Bouyoucos, 1962; Piper, 1944; Jackson, 1962).

Determination of the total Heavy-Metals in the Poultry Dropping

2g of the poultry dropping were weighed into a 250 mL plastic bottle. 100 mL of 0.1M HCl was added and stoppered and placed on the mechanical shaker for 30mins. The mixture was filtered through Whatman filter paper No 42. The heavy metals (Cu, Zn, Cd, and Pb) content in the filtrate was determined by Atomic Absorption Spectrometer.

Sequential extraction of metals (5-steps methods)

Five steps sequential extraction scheme based on the method suggested by Tessier *(*1979*)* with slight modification by Uwamarogie *et al* (2008) was used.

Statistical analysis

The data were subjected to statistical analysis. Student t-test was employed to estimate the significance of results obtained.

Results and Discussion

The result of the physicochemical properties of the soil indicates that the soil is sandy loam with high sand content of 81.60%. The soil was observed to be slightly acid this can pose a problem for agriculture due to lack of nutrients.

In addition to its contribution to plant nutrition, soil organic matter helps to reduce soil erosion by increasing infiltration and aggregate stability. The soil is found to be low in organic matter and exchangeable cations (potassium (K), magnesium (Mg) Calcium (Ca) and Sodium (Na)). Soils with the ability to absorb and retain exchangeable cations have a high cation-exchange capacity and are thus more fertile than those with a low exchange capacity. The soil thus needs amendment if intended for agricultural purpose.

The experimental soil contained low concentration of Cu (0.30mg/kg) and Zn (1.00mg/kg), while Cd and Pb were not detected in the soil sample hence the soil had to be spiked with the metal salts of the metals for this study. The results of the physico-chemical properties of the soil are given in Table 1.

Table 1: Physico-chemical properties of the uncontaminated soil

Soil Parameter	Result
pH	5.20 ± 0.00
Sand (%)	81.60 ± 0.00
Clay (%)	11.70 ± 0.10
Silt (%)	6.70 ± 0.10
C (%)	0.18 ± 0.00
Organic matter (%)	0.31 ± 0.00
N (%)	0.17 ± 0.00
P (mg/kg)	12.40 ± 1.00
Ca (cmol/kg)	14.30 ± 0.30
Mg (cmol/kg)	7.70 ± 0.40
Na (cmol/kg)	0.10 ± 0.40
K (cmol/kg)	0.40 ± 0.05
CEC (cmol/kg)	22.50 ± 0.60
Pb (mg/kg)	< 0.08
Cd (mg/kg)	< 0.01
Cu (mg/kg)	0.30 ± 0.00
Zn (mg/kg)	1.00 ± 0.10

The heavy metals content in the experimental soils sample after spiking with 0.3g of salts of Cd, Cu, Pb and Zn are depicted in Table 2.

Table 2: Concentration of heavy metal of the contaminated soil samples

Metals	Amounts (mg/kg)
Pb	298.90 ± 1.20
Cd	296.40 ± 1.00
Cu	300.10 ± 1.70
Zn	300.70 ± 1.00

Chemical properties of the poultry dropping

The properties of poultry droppings used in this study are as shown in Table 3. The data obtained from the chemical analysis of the poultry dropping used for the experiment revealed that it was high in total nitrogen and low in available phosphorous. It is also evident that the poultry dropping contained traces of the heavy metals (Cd, Cu, Pb and Zn) with Cu being the highest and Cd being the least. Heavy metal traces could result, for instance, from contaminated drinking-water, high ambient air concentrations near emission sources, or intake via the food chain by the poultry. It could also be as a result of sample handling and processing.

Table 3: Chemical Properties of the Poultry dropping

Parameter	Result
N %	0.60 ± 0.00
P %	0.34 ± 0.10
Ca %	1.20 ± 0.10
Mg %	0.74 ± 0.00
K %	0.44 ± 0.00
Pb (mg/kg)	1.00 ± 0.10
Cd (mg/kg)	0.80 ± 0.10
Cu (mg/kg)	1.70 ± 0.30
Zn (mg/kg)	1.00 ± 0.20

The sequential extraction conducted on the amended contaminated soil samples revealed that the concentration of metals (Cd, Cu, Pb and Zn) were highest in the residual fraction. This shows that metals will not be easily available to plant to absorb. Metal species associated with organic, Fe-Mn oxide and residual fractions are not readily bioavailable and would not be expected to be released under natural conditions as they are tightly bound to the soil. Their release into the soil solution depends on strong depletion of mineral content of the soil, solution, decomposition and oxidation of organic matter.

Table 4: Amount of metals (mg/kg) in poultry dropping amended metal contaminated soils before planting

Amendment	Metal	Exchangeable	Carbonate	Fe-Mn oxide	Organic	Residual	Sum
0 %	Cd	34.70 ± 1.90	48.20 ± 2.10	67.40 ± 1.30	55.20 ± 1.70	73.80 ± 1.20	279.30
	Cu	53.30 ± 2.00	42.10 ± 0.00	56.80 ± 1.20	63.40 ± 1.80	72.30 ± 1.30	287.90
	Pb	42.20 ± 1.80	49.30 ± 1.20	57.60 ± 1.00	64.20 ± 1.00	70.10 ± 1.80	283.40
	Zn	43.40 ± 1.40	48.90 ± 1.30	54.30 ± 1.00	63.70 ± 1.60	81.00 ± 2.10	291.30
5%	Cd	35.30 ± 1.80	46.90 ± 1.90	67.70 ± 1.10	54.90 ± 2.10	73.60 ± 1.70	278.40
	Cu	51.80 ± 2.10	43.30 ± 1.90	56.10 ± 1.40	64.50 ± 1.80	71.90 ± 1.40	287.60
	Pb	41.80 ± 2.10	49.20 ± 1.90	57.90 ± 1.90	65.30 ± 2.10	69.70 ± 1.40	283.90
	Zn	44.80 ± 1.20	47.40 ± 1.90	56.80 ± 2.00	61.20 ± 1.70	80.90 ± 1.40	291.10
10 %	Cd	37.90 ± 2.00	47.80 ± 1.10	67.10 ± 1.80	53.70 ± 1.40	74.60 ± 1.00	281.10
	Cu	55.20 ± 1.00	42.90 ± 1.00	57.70 ± 1.50	64.10 ± 1.30	68.70 ± 1.90	288.60
	Pb	41.40 ± 1.70	49.90 ± 1.80	56.20 ± 2.00	64.70 ± 1.20	70.90 ± 2.10	283.10
	Zn	47.40 ± 3.10	52.10 ± 1.40	55.90 ± 1.90	62.70 ± 2.30	74.80 ± 3.00	292.90
20 %	Cd	35.80 ± 1.90	48.20 ± 1.10	66.40 ± 2.00	54.60 ± 1.20	75.80 ± 1.40	280.80
	Cu	48.70 ± 2.00	43.80 ± 1.00	56.60 ± 1.00	63.90 ±1.40	73.90 ± 1.70	287.90
	Pb	43.60 ± 1.80	51.30 ± 1.40	56.20 ± 2.00	63.70 ± 1.70	69.70 ± 2.10	284.50
	Zn	43.90 ± 0.00	51.70 ± 1.50	57.80 ± 2.10	66.20 ± 1.40	71.80 ± 2.60	291.40
30 %	Cd	37.40 ± 1.80	47.70 ± 2.00	66.90 ± 1.30	53.40 ± 1.70	75.00 ± 1.90	281.40
	Cu	52.40 ± 2.20	41.10 ± 2.10	58.30 ± 2.40	64.60 ± 1.80	72.40 ± 1.70	288.80
	Pb	43.90 ± 2.10	49.40 ± 1.50	57.80 ± 1.60	62.70 ± 1.50	70.50 ± 1.40	284.30
	Zn	45.30 ± 2.00	49.90 ± 1.80	56.20 ± 2.40	64.80 ± 2.70	77.10 ± 2.10	293.30

The mobility factors of the metal in the poultry dropping amended soils are shown in Fig 1. Mobility factor of a metal represent the amount of metal that is available or amount of metal that can be absorbed from a contaminated soil. From the graph, it was observed that the mobility factor of Cu was the highest in the 0, 5 and 10% amended soils while the mobility factor of Pb was the highest in the 20 and 30% amended soils. In all the soil samples, the mobility factor of Cd was the lowest indicating that the amount of Cd available for uptake by the sclerotia was the lowest.

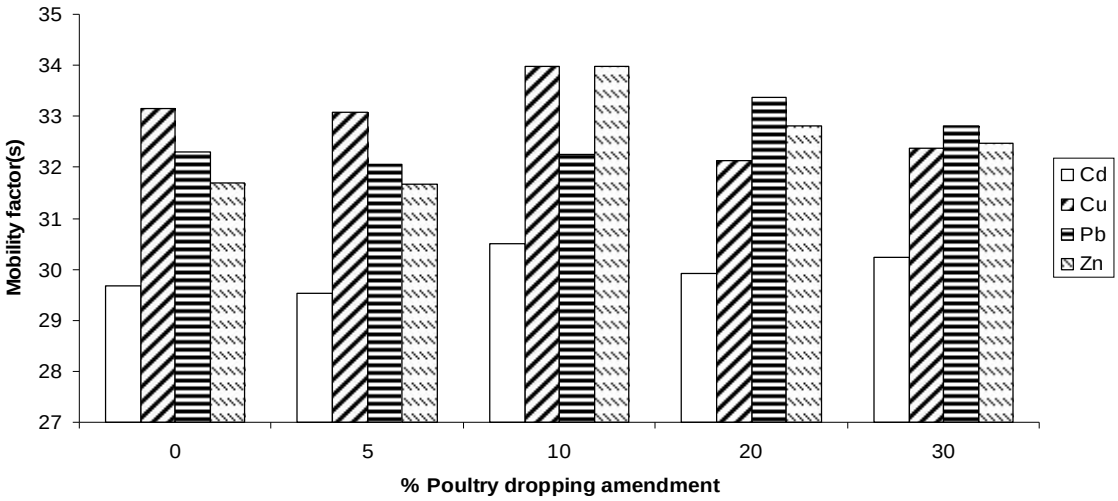

Fig 1: Mobility factors of metals in amended soils before planting

The result given in Table 5 showed that the concentration of metals in the non available fraction of the soil (Fe-mn oxide, Organic and residual fractions) was higher than the levels obtained for amended soils before planting. The result revealed that the amount of metals in the residual fraction decreased with increase in amendment indicating that the added poultry droppings immobilize the metal in the contaminate soil.

Table 5: Amount of metals (mg/kg) in poultry dropping amended metal contaminated soils after planting

	Cu	32.60 ± 3.10	41.30 ± 2.30	50.20 ± 3.40	54.80 ± 3.00	66.30 ± 4.40	245.20
	Pb	32.40 ± 4.80	44.20 ± 4.00	56.70 ± 5.30	63.80 ± 6.10	69.30 ± 5.00	266.40

Amendment	Metal	Exchangeable	Carbonate	Fe-Mn oxide	Organic	Residual	Sum
0 %	Cd	29.90 ± 5.30	41.50 ± 4.80	63.90 ± 4.90	52.80 ± 5.60	71.70 ± 6.30	266.40
	Cu	34.80 ± 4.20	41.60 ± 3.80	47.70 ± 3.40	51.20 ± 3.80	62.60 ± 4.30	237.90
	Pb	33.80 ± 4.60	41.90 ± 5.30	51.70 ± 4.00	58.60 ±3.60	67.70 ± 3.10	253.70
	Zn	31.70 ± 3.00	39.30 ± 2.10	44.80 ± 3.40	59.10 ± 4.00	72.80 ± 3.90	247.70
5%	Cd	31.60 ± 6.20	42.80 ± 4.70	64.80 ± 5.30	54.30 ± 4.80	72.90 ± 4.30	266.40
	Cu	31.80 ± 4.70	40.70 ± 3.30	48.60 ± 2.90	53.60 ± 3.20	64.70 ± 3.30	239.40
	Pb	34.20 ± 6.00	41.30 ± 4.70	53.20 ± 4.30	59.70 ± 5.20	68.60 ± 4.70	257.00
	Zn	29.20 ± 4.60	41.60 ± 3.00	44.90 ± 2.70	59.70 ± 3.20	71.40 ± 3.60	246.80
10 %	Cd	30.30 ± 4.80	39.60 ± 5.40	65.40 ± 6.30	53.30 ± 6.10	73.00 ± 3.80	261.60
	Zn	28.80 ± 3.70	42.70 ± 3.20	46.40 ± 3.90	61.10 ± 3.30	73.60 ± 3.90	252.60
20 %	Cd	25.30 ± 2.40	38.20 ± 4.80	67.90 ± 5.20	53.60 ± 4.90	77.40 ± 2.10	262.40
	Cu	27.60 ± 2.40	41.90 ± 4.40	52.30 ± 5.10	56.60 ± 3.80	71.80 ± 3.90	250.20
	Pb	29.70 ± 4.30	43.40 ± 4.00	57.70 ± 2.70	64.80 ± 3.80	75.40 ± 4.50	271.00
	Zn	25.40 ± 3.00	42.20 ± 3.60	48.20 ± 3.70	62.90 ± 4.10	82.70 ± 3.00	261.40
30 %	Cd	22.60 ± 3.60	37.80 ± 4.00	69.40 ± 3.70	54.90 ± 5.20	79.80 ± 4.80	264.50
	Cu	29.60 ± 4.00	41.40 ± 3.20	56.30 ± 4.20	59.70 ± 3.60	74.80 ± 3.10	261.80
	Pb	28.00 ± 5.40	41.90 ± 3.80	59.40 ± 4.20	66.30 ± 3.70	77.70 ± 6.40	273.30
	Zn	30.70 ± 2.90	41.40 ± 3.10	47.60 ± 3.80	63.80 ± 3.30	83.90 ± 4.20	267.40

The mobility factor of metals in amended contaminated soils after planting is given in Fig 2. The graph revealed that Cu has the highest potential mobility of all the heavy metals in the amended soil samples. The mobility factor of Cd was highest in the 5% amended soil and lowest in the 30% amended soil. The mobility factor of Cu decreased with increase in amount of poultry dropping added to the Cu contaminated soil. The mobility factors of Pb were same for the 0 and 5% amended samples and the factor then decreased with increase in amendment.

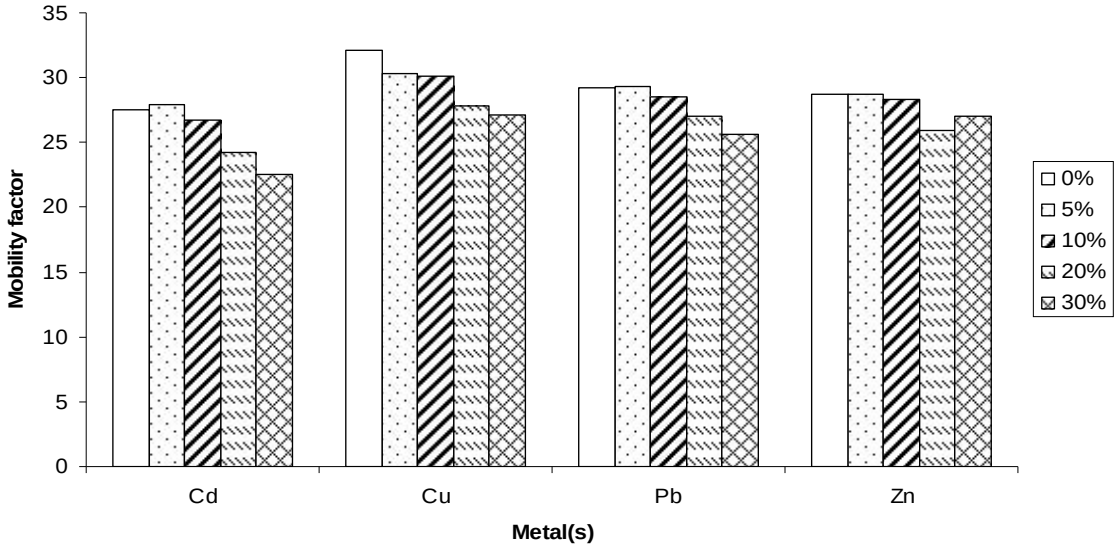

Fig 3: Mobility factor of metals in amended contaminated soils after palnting

Conclusion

The results from this studies showed that soil amendment with poultry dropping can immobilize some heavy metals in contaminated soil. It was also observed from this study that poultry droppings contain the studied heavy metals. The survival and growth of the sclerotia of *Pleurotus tuberregium* can be considerably reduced by soil amendment with poultry droppings. It was also revealed that, various concentrations of poultry droppings had effects on growth and yield of the sclerotia. Sclerotia of *P. tuberregium* produced fruity body (mushroom) in the poultry amendment pots of 0% level. The mushrooms produced were healthy and lively. Fruits from 10% amendment were weak and dying. While with 20% and 30% no fruity body was produced. The results of this study also revealed that white rot fungi can bioaccumulate heavy metals from soil and this fact is of particular importance to mushroom pickers and consumers.

References

Asagba, E.U., Okieimen, F.E. and Osokpor, J. (2007) Screening and speciation of heavy metal contamination soil from an automobile spare part market. Chemical Speciation and Bioavailability, 19(1): 9 – 15.

Black, C.A. (1965). Methods of Soil Analysis. Agronomy No. 9, Part 2 Amer. Soc. Agronomy, Madison, Wisconsin.

Bouyoucos, G.J. (1962). Improved hydrometer method for making particle size analysis of soils. Agron J. 54: 463 – 465.

Carter, M.R. (1993). Soil sampling and methods of analysis. Canadian Society of Soil Science, Lewis Publishers, London. 823pp.

Demirbas, A. (2001). Heavy metal bioaccumulation by mushroom from artificially fortified soils. *Food Chemistry*. 74: 293 – 301.

Duncan, J. (2005). Composting chicken manure WSU Cooperative. Extension, King Country. Master Gardener and Co-operative Extension Livestock Advisor.

Easter Mirror (2011).http.www.esrt.

Holleman, J.T. (1992).In Arkansas, which comes first: the chicken or the environment? *Tulane Environmental Law Journal* 6(1)

Jackson, M.L. (1962). Soil Chemical Analysis. Prentice-Hall. New York.

Nelson, D.W. and Sommers, L.E. (1982). Total carbon, Organic carbon and Organic Matter. Methods of Soil Analysis, Part 2, 2nd edn, pp 539, ASA, SSSA, Madison, WI.

Nottidge, D.O., Ojeniyi, S.O. and Asawalam, D.O. (2005). Comparative effects of plants residues and NPK fertilizer on soils properties in a humid ultisol. Nig. J. Soil Sci. 15: 9 – 13.

Oso ,B.A. (1977).*Pleurotus Tuberregium* from Nigeria. JSTOR: Mycologia 69(2) 271-279. Easter Mirror (2011).http.www.erst.

Piper, C.S. (1944). Soil and Plant Analysis, pp 221 – 222. Interscience Publishers Inc, N. Y.

Sloan, P.R., Kidder, G., and Jacobs, R.D. (2003). Poultry manure as fertilizer. http://edis:ifas.ufl.edu.

Tessier, A., Campbell, P.G.C. and Bisson, M. (1979). Sequential extraction procedures for the speciation of particulate trace metals. Anal. Chemistry; 51 (7): 844 – 851.

Uwumarogie, E.G., Okiemen, F.E. and Sogaike, C. E. (2008). Remediation of heavy metal contaminated soil – case study – CCA contaminated soil. *Chemical Society of Nigeria*, 31st Annual International Conference and Exhibition Conference Proceedings.