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Evaluation of physical properties and heavy metal composition of manure of some domestic animals

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ABSTRACT: Heavy metal content in animal manure could influence soil quality, contaminate crops and cause health risks to both livestock and humans. The objective of this study was to evaluate the physical properties and heavy metal composition of manure of some domestic animals. Manure samples were collected from six domestic animals (goat, cow, donkey, pig, turkey and layer chickens). Standardized protocols were followed for sample preparation and analysis of heavy metal content. The physical properties (physical appearance, moisture content and organic matter) of the samples were observed and recorded. The metals measured were Calcium (Ca), Magnesium (Mg), Iron (Fe), Manganese (Mn), Zinc (Zn), Lead (Pb), Copper (Cu), Cadmium (Cd) and Nickel (Ni). Concentrations of heavy metals were measured using flame atomic absorption spectrometry (FAAS). The results showed that donkey manure had the lowest Zn, Cu, Pb, Ni and Mg contents. Pig manure had the highest Fe content as well as the lowest Mn, Cd and Ca contents. It is recommended that manure of farm animals be cautiously examined for heavy metal content before its application to the soils of agricultural farms or fields.

KEYWORDS: Physical properties, Heavy metals, Animal manure, Bioaccumulation, Health hazards.

1 INTRODUCTION

Animal wastes include livestock manure, beddings, litter materials, dairy parlour waste water, feedlot run-off, silage juices from trench silos and wasted feed [1]. Animal manures are economic sources of Nitrogen (N), Phosphorus (P) and Potassium (K) as well as other nutrients needed for plant growth. They can reduce the need for commercial fertilizer. Their use for crop production is a common practice in many cropping systems. They are well adopted by farmers for crops such as vegetables, potatoes and to a lesser extent, for rice and local tuber crops. Animal manures can add organic matter to the soil, improve water holding capacity, improve soil tilth, increase crop yield and improve soil fertility [2]. Heavy metals such as Zinc (Zn), Copper (Cu), Iron (Fe) and Manganese (Mn) could be considered as useful trace elements for crop growth while Cadmium

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(Cd), Lead (Pb), Nickel (Ni) and Mercury (Hg) are not essential because they increase soil acidity [3]. Reference [4] reported that the concentration of metals can vary considerably among animal manures. The perception of many scientists has been that animal manures contain considerable quantity of heavy metals which could be detrimental to human health. The accumulation of heavy metals in the human body can cause diseases such as heart attack, brain damage, cancer, diseases in digestive system, anaemia, gout, chronic nephritis, encephalopathy etc. [5 and 6]. Some of the heavy metals (e.g. Mercury (Hg), Cadmium (Cd), Arsenic (As), Chromium (Cr)), are dangerous to the environment, some are corrosive (e.g. Zinc and Lead) and others are harmful in other ways [7]. The continuous and heavy application of animal manures could lead to bioaccumulation which increases soil toxicity, affect crops' chemical composition as well as release heavy metals into water supplies [3]. Such manures in surface water reduce oxygen and endanger aquatic life. When this water is allowed to seep into ground water, the water quality is jeopardized. Nitrates in well water can be particularly dangerous to infants due to oxygen depletion in the blood [8]. In consideration of the ever increasing use of animal manure as sources of organic manure for crop production, it is important to evaluate the contribution of heavy metals from different animal manure sources. Therefore, this study was carried out to evaluate the physical properties and heavy metal composition of manure of some domestic animals.

2 SAMPLE COLLECTION

12 manure samples (two samples per animal) were obtained from six domestic animals namely: goat, cow, donkey, pig, turkey and layer chickens. Cow and goat dungs were collected early in the morning from Ipata abattoir, Ilorin, Nigeria. The manure samples were collected fresh to retain their fertility and avoid contamination from sand or other dirts. Pig dung was collected from a piggery in Ilorin and preserved. Donkey dung was collected from the biological garden, University of Ilorin, Nigeria. Poultry (turkey and layer chickens) droppings were collected from the Animal Production Department of the University of Ilorin, Nigeria. The physical properties (physical appearance, moisture content and organic matter) of the manure samples were observed and recorded. The moisture content was determined by observing the differences in weight before and after drying. The percentage moisture content was also obtained using the formula:

% Moisture content = (Initial weight – final weight)/ Initial weight × 100.

The organic matter content was determined by digestion process. The mass of the filter paper used was measured before and after filtering the samples during digestion. The percentage organic matter content was calculated as:

% Organic matter content = (Mass of filter paper + organic matter – mass of filter paper)/ mass of filter paper × 100.

The manure samples were sun-dried for seven days to reduce their moisture content. The dried samples were then grinded with porcelain pestle and mortar into fine particles for easy use. 2g of each sample was then weighed on a weighing balance for the experiment. The reagent, aqua-regia was prepared by mixing concentrated HNO_3 (tetraoxonitrate (V) acid) and concentrated HCl (Hydrochloric acid) in the ratio 3:1. The dried and grinded samples were then digested in 15ml of the prepared aqua-regia in a conical flask. The digestate obtained was cooled, filtered and made up to 50ml by adding distilled water. The digestate were put in labeled sample bottles for further laboratory analysis. Calcium (Ca), Magnesium (Mg), Iron (Fe), Manganese (Mn), Zinc (Zn), Lead (Pb), Copper (Cu), Cadmium (Cd) and Nickel (Ni) contents were measured by flame atomic absorption spectrometry (FAAS) technique using a GBC Avanta flame atomic absorption spectrophotometer, after the previous internal validation. Other apparatus and reagents used include aqua-regia, plastic funnels, pipette, measuring cylinder, standard volumetric flask, beakers, thermometer, paper tape, petri dishes, polythene bags, stirrer, electric hot plate, glass bottles, concentrated HNO_3 (tetraoxonitrate (V) acid), concentrated HCl (Hydrochloric acid), distilled water and tap water.

3 RESULTS AND DISCUSSION

3.1 PHYSICAL PROPERTIES OF MANURE OF SOME DOMESTIC ANIMALS

Physical properties of manure of some domestic animals are presented on Table 1. Percentage organic matter was highest in pig manure than for other animals. This can be explained by the minerals added to the pig feed for their antimicrobial and growth stimulating effect [9]. Percentage moisture content was highest in turkey manure. This could be attributed to dilution achieved by adding straw and probably also the origin of the samples analyzed [10]. Similar colour, state and percentage moisture content were observed in goat and cow manure. There is a large variety of dry matter content from 16 to 53%. High moisture may be due to rainfall. There is usually no protection of manure heaps, but the storage of run-off is compulsory. Sheep and goat manures are drier than cow manures. Chicken manure is also dry [11]. Similar dark brown

colour was observed in donkey, pig and turkey manures. Similar liquid state was observed in turkey and layer chickens' manures. This could be due to similar nature of feed given and physiology.

Table 1: Physical properties of manure of some domestic animals

Manure sources	Colour	State	% moisture content	% organic matter
Goat	Dark	solid	2.9	43.50
Cow	Dark	solid	2.9	46.90
Donkey	dark brown	mould like	0.9	56.25
Pig	dark brown	semi-solid	3.3	71.90
Turkey	dark brown	liquid	5.7	43.75
Layer chickens	Whitish black	liquid	4.3	53.15

3.2 HEAVY METAL COMPOSITION OF MANURE OF SOME DOMESTIC ANIMALS

Table 2 shows the heavy metal composition of manure of some domestic animals. Zinc (Zn), Lead (Pb), Nickel (Ni) and Magnesium (Mg) were highest in layer chickens' manure. High contents of these heavy metals in layer chickens' manure may be associated with their addition to poultry feed for disease prevention and enhanced feed efficiency. High concentration of trace metals in poultry manure enhanced poultry litter-amended soils [12]. High Pb content can be explained by the fact that Pb is introduced into the agricultural cycle mainly by deposition from the atmosphere. Reference [10] reported that animals with a high proportion of roughages will take up higher amount of Pb than those fed mainly on grains. Manganese (Mn) and Cadmium (Cd) were highest in cow manure. These high values could always be traced back to high inputs in the feed. Iron (Fe) was highest in pig manure. This may be also due to the concentration in the feed consumed and efficiency of feed conversion by the animals. Copper (Cu) and Calcium (Ca) were highest in goat manure. This result is in contrast with the report of Reference [10]. High Cu content was often linked with high Zn content. There is a close dependence between the heavy metal content of the ration and the manure produced. Each of the heavy metals studied have a particular importance in soil economy. Cd and Pb are the heavy metals of most concern because they may affect human health. Cu and Zn represent necessary micro-elements which could be harmful only if the concentration is too high. Additional variation in the concentration of metals in animal manures is associated with the age of the animal, type of ration, housing type and waste management practice. The type of bedding material in animal waste units may influence the litter's dry matter content and other chemical properties [13]. Some countries have established tolerance limits on heavy metal additions to soil because their long-term effects are unknown [14].

Table 2: Heavy metal composition of manure of some domestic animals

	Metals (%)								
Manure sources	**Zn**	**Fe**	**Mn**	**Cu**	**Cd**	**Pb**	**Ni**	**Ca**	**Mg**
Goat	3.94	17.52	4.30	1.50	0.15	0.24	0.24	350.50	79.83
Cow	3.43	21.27	8.03	0.43	0.45	0.34	0.13	132.25	45.40
Pig	3.00	26.47	3.79	0.67	0.02	0.28	0.15	38.25	52.53
Donkey	2.54	18.68	6.50	0.31	0.03	0.16	0.12	86.00	38.88
Turkey	4.66	26.16	5.55	0.67	0.06	0.26	0.34	336.50	73.70
Layer chickens	4.70	23.65	6.39	1.12	0.08	0.36	0.40	135.00	132.10

Zn- Zinc, Fe- Iron, Mn- Manganese, Cu- Copper, Cd- Cadmium, Pb- Lead, Ni- Nickel, Ca- Calcium, Mg- Magnesium

4 CONCLUSION

Heavy metal contents vary considerably between manures from different animal sources and from different farms or locations. Donkey manure had lowest Zn, Cu, Pb, Ni and Mg contents. Pig manure had the highest Fe content as well as the lowest Mn, Cd and Ca contents. It is recommended that manure of farm animals be cautiously examined for heavy metal content before its application to the soils of agricultural farms or fields. It is important to remember not to apply fresh manure to plants and crops as the manure may scorch the plants.

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