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Heavy Metal Content and Microbial Population of Poultry Wastes Disposal Site Soil

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ABSTRACT

The research was designed to investigate the effect of poultry wastes disposal on the soils from Emure, Ipele and Ehinogbe. The samples were collected randomly from four points at same depth. . The pH content of soils from Ipele, Ehinogbe and Emure were 8.22 ± 0.03, 8.03 ± 0.03 and 6.02 ± 0.03 respectively. The heavy metals were in trace amount (mg/kg). Arsenic content of the soil samples ranged from 0.03 ±0.00, 0.05 ± 0.02 and 0.01 ± 0.00 mg/kg respectively with Emure being the least, Cadmium was 0.02 ±0.00, 0.02 ± 0.00 and 0.03 ± 0.00 respectively, Copper was 0.31 ± 0.00, 0.51 ± 0.00 and 0.28 ± 0.00 respectively. Cobalt was 0.01 ± 0.00, 0.01 ± 0.00 and 0.03 ± 0.00 respectively and Lead content were 0.17 ± 0.00, 0.24 ± 0.00 and 0.39 ± 0.00 respectively. Table 2 shows the total microbial counts on the poultry dumpsites. Ipele recorded 167.33±2.15, 85.33±4.15 and 60.00±5.18 for Total Bacterial Count, Total Coliform Count and Total Staphylococcal count respectively. Ehinogbe recorded 136.12±6.14, 106.00±3.00 and 49.67±2.04 respectively while Emure recorded 112.15±3.00, 89.00±7.05 and 67.33±2.10 respectively. The highest Total Bacterial Count was recorded for Ipele (167.33 x 10^5 cfu/g) The isolated bacteria include *E. coli, K. pneumonia, P. aeruginosa, S. aureus, Salmonella spp.* and *E. faecalis* which were present in all soil samples except *Salmonella* spp which was absent in Ipele and Emure. The presence of these bacterial isolates could be as a result of biodegradation of the poultry wastes. From the finding of this study, it is recommended that long term deposition of organic wastes should be discouraged. A sustainable approach such as utilizing them as organic fertilizers should be adopted than dumping them as mean of disposal.

INTRODUCTION

The poultry industry is growing rapidly worldwide and it contributes towards addressing key national and international development goals, as well as improving the standard of living of people through poverty alleviation and creating employment opportunities (Agblevor *et al*., 2017). Waste is defined as anything that is no longer useful and needs to be disposed of. The poultry industry produces large amounts of waste that include solid waste and wastewater. The solid waste consists of bedding material, excreta (manure), feed, feathers, hatchery waste, shells, sludge, abattoir waste (offals, blood, feathers and condemned carcasses) and mortality (Moreki and Chiripasi, 2015). The wastewater results from washing and disinfection of chicken houses and abattoirs.

Reports from Dong and Tollner (2013) stated that poultry densities on farms continue to increase and have caused manure related problems which are water, air and land pollution. Livestock manure can be either a valuable resource or an environmental pollutant. Generally, manure refers to faeces and urine produced by animals, and it contains organic matter and nutrients, that has fertilizer value when applied on the land and used by crops. The proper handling and management of manure can augment or replace purchased commercial fertilizers. On the other hand, poultry litter is a mixture of poultry droppings and bedding materials, such as wood shavings and rice or peanut hulls (Cesoniene et al., 2019).

In Nigeria, like any developing nation, there is a rapid expansion of small and medium scale poultry farms with the attendant effect of huge waste generation. The magnitude of this generated poultry waste has given rise to improper disposal which include over application to land, improper timing of application thereby creating pollution problem to soil water and air environment (Adewumi *et al*., 2016). There are several ways of disposing poultry waste which include burial, rendering, incineration, compositing, feed for livestock, fertilizer or source of energy (Moreki and Kealkitse, 2013). Other waste disposal methods include conversion of poultry waste to energy and use of poultry waste for treatment of heavy metal contaminated water (Moreki and Chiripasi, 2015). Modern management methods for poultry waste like re-feeding to animals, green disposal, gasification and biogas production have not gained prominence in Nigeria probably due to level of awareness, lack of strict regulation from government in respect of poultry waste disposal and care-free attitude of the farm owners (Adeoye *et al*., 2014). It is still a common site in Nigeria to see huge deposit of poultry waste around the farm, flushing of the waste into water courses through open canals from farms are also common sites (Ojolo *et al*., 2007). These methods are not only unsightly, it also creates a lot of environmental nuisance and surface and groundwater pollution.

Large amounts of poultry waste are often a source of pollution in the environment. These are a serious threat, and the quality of surface and subsurface water has deteriorated as a result. The frequent discharge of untreated wastes at dumpsites without regard for the impact on nearby water bodies pollutes the ecosystem greatly. Since the sanitary state of drinking water varies considerably among farms, methods and strategies for identifying major contamination locations for the prevention of waterborne diseases must be found. This present study is aimed at determining the effect of poultry wastes disposal on the receiving soil and water quality.

MATERIALS AND METHODS

Collection of Soil and Water Samples

The samples were collected randomly from four points at same depth. The samples were collected in white plastic containers, which were previously sterilized with 70% alcohol and rinsed with distilled water and properly labeled. At the point of collection, the containers were rinsed twice with the sampled river before being used to collect the water samples.

pH measurement: The pH was determined using a pH meter (Suntex model sp-701) (Ehiagbonare and Ogunrinde, 2010).

Microbial Analysis

Enumeration and Plate Counting of Total Aerobic Bacteria and Fungi

Samples of the receiving soil and water were serially diluted in ten folds. Total viable heterotrophic aerobic plate counts were determined by plating in duplicate, using pour plate technique. Molten nutrient agar, Sabouraud dextrose agar, Salmonella-Shigella agar, Thiosulphate bile citrate salt agar, MacConkey agar and Eosin methylene blue agar at 45^0C were poured into the Petri dishes containing 1mL of the appropriate dilution for the isolation of the total heterotrophic bacteria, fungi, Salmonella Shigella, Vibrio cholerae, coliforms and Escherichia coli respectively. They were swirled to mix and colony counts were taken after incubating the plates at room temperatures for 48 hours.

Identification of isolates was done by using cultural, morphological and biochemical characteristics of the isolates.

Determination of Heavy Metal Content

Heavy metal content of the water sample such as mercury, Nickel, Copper, Zinc, and Lead were determined using Ultra-Violet Atomic Absorption Spectrophotometer (UVAAS) (Essien *et al*., 2016) and their absorption were compared with absorption of standard of these minerals.

RESULTS AND DISCUSSION

The physicochemical property and heavy metal content of soil samples from the three poultry waste dumpsites were presented in Table 1. The pH content of soils from Ipele, Ehinogbe and Emure were 8.22 ± 0.03, 8.03 ± 0.03 and 6.02 ± 0.03 respectively. The heavy metals are in trace amount (mg/kg). Arsenic content of the soil samples ranges from 0.03 ±0.00, 0.05 ± 0.02 and 0.01 ± 0.00 mg/kg respectively with Emure being the least, Cadmium was 0.02 ±0.00, 0.02 ± 0.00 and 0.03 ± 0.00 respectively, Copper was 0.31 ± 0.00, 0.51 ± 0.00 and 0.28 ± 0.00 respectively. Cobalt was 0.01 ± 0.00, 0.01 ± 0.00 and 0.03 ± 0.00 respectively and Lead was 0.17 ± 0.00, 0.24 ± 0.00 and 0.39 ± 0.00 respectively. Table 2 shows the total microbial counts on the poultry dumpsites. Ipele recorded 167.33±2.15, 85.33±4.15 and 60.00±5.18 for Total Bacterial Count, Total Coliform Count and Total Staphylococcal count respectively. Ehinogbe recorded 136.12±6.14, 106.00±3.00 and 49.67±2.04 respectively while Emure recorded 112.15±3.00, 89.00±7.05 and 67.33±2.10 respectively. The highest Total Bacterial Count was recorded for Ipele (167.33±2.15), maybe because of heavy dumping. Table 3 shows the distribution of bacterial isolates from the poultry dumpsites. The bacteria are *E. coli, K. pneumonia, P. aeruginosa, S. aureus, Salmonella spp.* and *E. faecalis* which present (+) in all soil samples except *Salmonella* spp absent (-) in Ipele and Emure. The presence of these bacterial isolates could be as a result of biodegradation of the poultry wastes.

Table 1: Physicochemical property and heavy metal content of soil from poultry waste dumpsite soil

Parameters (mg/kg)	**Ipele**	**Ehinogbe**	**Emure**
pH	8.22 ± 0.03	8.03 ± 0.03	6.02 ± 0.03
Arsenic	0.03 ±0.00	0.05 ± 0.02	0.01 ± 0.00
Cadmium	0.02 ±0.00	0.02 ± 0.00	0.03 ± 0.00
Copper	0.31 ± 0.00	0.51 ± 0.00	0.28 ± 0.00
Cobalt	0.01 ± 0.00	0.01 ± 0.00	0.03 ± 0.00
Lead	0.17 ± 0.00	0.24 ± 0.00	0.39 ± 0.00

Table 2: The total microbial count on the poultry dumpsites

Sample	Total Bacterial Count	Total Coliform Count	Total Staphylococcal count
Ipele	167.33±2.15	85.33±4.15	60.00±5.18
Ehinogbe	136.12±6.14	106.00±3.00	49.67±2.04
Emure	112.15±3.00	89.00±7.05	67.33±2.10

Table 3: Distribution of bacterial isolates from the poultry dumpsites

Organism	Ipele	Ehinogbe	Emure
E. coli	+	+	+
K. pneumoniae	+	+	+
P. aeruginosa	+	+	+
S. aureus	+	+	+
Salmonella spp.	-	+	-
E. faecalis	+	+	+

Key: += present, -= absent

The pH is one of the most important parameters of soil quality. It is defined as the negative logarithm of the hydrogen ion concentration (Edzwald, 2010). The observed pH values ranged from 6.02 ± 0.03 to 8.22 ± 0.03. All the values are intolerable to crops except that from Emure (6.02) which falls within the World Health Organization (WHO, 2019) limits and indicated that the Emure soil did not have much alkaline compare to others. Application or usage of soil with pH outside the threshold could cause nutritional disparity or lead to toxic ion build up in the soil (Ayers *et al*., 2015).

Trace elements, including those potentially harmful (As, Co, Cu, Cd and Pb), are added as nutritional supplements to poultry feeds to enhance feed efficiency (e.g. to improve weight gain, feed conversion and increase egg production) or as chemical preparations for the treatment or prevention of disease (Oyewale *et al*., 2019). In excess, these elements can become toxic to plants, can adversely affect the organisms that feed on these plants, and can enter water systems through surface run-off and leaching (Kyakuwaire *et al.*, 2019). Long-term repeated application of poultry manure contaminated with heavy metals may result in accumulation of these elements in agricultural soils, increasing their potential bioavailability and toxicity in the environment (Muhammad *et al*., 2020).

Intensive poultry farming is associated with the application of a wide range of antimicrobials for prevention and treatment of animal infections. In some countries (predominantly developing nations), veterinary antibiotics are used at sub-therapeutic levels, as additives to animal feed and growth promoters (Muhammad *et al*., 2019; Topi and Spahiu, 2020). In the European Union the use of antibiotics as growth promoters has been banned since January 1st 2006 (EC, 2017). Antibiotics and other pharmaceuticals are not fully metabolized in the animal body and are excreted with urine and faeces in native form or as metabolites, which results in the presence of their residues in poultry manure and thus affect the microflora of the soil. Also, poultry wastes can contain infectious agents such as *E. coli, K. pneumonia, P. aeruginosa, S. aureus, Salmonella spp.* and *E. faecalis* which can contaminate the soil (Oyewale *et al*., 2019).

Conclusion

The present study has shown that poultry waste has physicochemical, heavy metals and biological effects on dumpsite soil. The outcome of this study has been able to show the diverse types of bacteria (*E. coli, K. pneumonia, P. aeruginosa, S. aureus, Salmonella spp.* and *E. faecalis*) isolated from dumpsite which is influence by poultry waste. The trace elements, including those potentially harmful (As, Co, Cu, Cd and Pb) were also detected. Therefore, it is recommended that alternative disposal methods should be encouraged for the poultry wastes disposal.

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