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Original Article

Proximate Composition and Post-Production Stability of Poultry Waste Fertilizer Pellets

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ABSTRACT

This paper reports on proximate composition and stability of components of pelleted poultry litter quantifying ash, moisture, weight, oxygen demands and mineral contents of broilers and layers poultry litter. The result indicated that while some of the variables investigated varied between poultry litter type as well as shelf-life post-production, others were more-or-less the same between the different categories of Poultry Litter Pellets (PLP). Ash content was higher in the broilers (14.17 and 13.27%) than layers (13.60 and 12.65%) PLP whether in the fresh or post-production states, respectively. Moisture content, on the other hand, was lower in the fresh than 10-days post-production state (i.e 3.71 and 4.71%, and 3.46 and 4.69%, respectively), for freshly prepared and stored pellets. The quantity of the chemical components of the PLP were exactly the same between the fresh and stored pellets, irrespective of the type of poultry litter. The oxygen demands (i.e. BOD and COD) and elemental components namely, Ca, P, K, Mg and S equally varied between poultry litter type and pellet duration post-production. These results were discussed, and it is hoped that the findings will facilitate the production and utilization of fertilizer from poultry litter.

Keywords: Bedding, Litter, Livestock, Manure, Nutrients, Organic Matter, Waste, Poultry

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INTRODUCTION

Millions of tons of poultry wastes are produced annually in Nigeria. Land application of poultry wastes has been a common practice for centuries; however, in many instances, land area is a limiting factor and waste disposal becomes a liability as well as a potential environmental problem. The compelling need to harness the potentials of the numerous agro-industrial by-products and the so-called “wastes” as part replacement for the more expensive conventional feed ingredients have been seriously expressed (Aletor, 1986; Aletor and Ogunyemi, 1990; Onifade and Babatunde, 1998). This need has arisen mainly from the increasing demand for and supply deficit of various farm produce with a concomitant sharp rise in their cost prices.

There is a need therefore to increase the productivity of marginal soils through appropriate fertilizer application to provide food for an ever increasing population. Economic and environmental issues associated with intensive use of chemical fertilizers generated an interest in alternative management systems. One of the measures being adopted for relieving environmental problems arising from agricultural production is to recycle animal manure and other organic products as fertilizers and soil amendment (Eneji *et al.*, 2003).

Poultry farming have existed many years ago, but chickens were kept in small flocks and reared mainly for home consumption and eggs, with any surplus sold or exchanged for other farm produce. This practice continued, until the 20th century, when poultry farming became commercialized. It started from the production of eggs (by layers), then the production of meat (broilers), and then the production of manure from their litter (Eneji *et al.*, 2001).

In agriculture, poultry litter is a material used as bedding in poultry operations to render the floor more manageable. Common litter materials are wood shavings, saw dust, groundnut hulls, shredded sugar cane, straw, and other dry, absorbent, low-cost organic materials. Sand is also occasionally used as bedding. After use, the litter consists primarily of poultry manure, but also contains the original litter material, feathers and spilled feed.

Poultry litter (combination of accumulated manure and bedding material) is a valuable source of minerals including Nitrogen, Phosphorus, Sulphur and Potassium etc, for soil fertilization (Waterman *et al.*, 1995; Olayinka, 1997). The application of poultry litter to growing crops provides a means of disposing litter and also provides nutrients to the crops and enriches soil organic matter content. This application is determined by the nutritional content of the litter and the nutrient need of the crop. Poultry litter can be used as a source of microorganisms, C co-substrate, N, and P to enhance the biodegradation of petroleum compounds in contaminated soils (Codling, 2006).

Poultry litter is an organic amendment that has successfully been used as an alternative source to inorganic, commercial fertilizers. Poultry litter also has the potential to improve other aspects of soil quality (Devandra and Rooghavan, 1978).

Poultry litter for an increasing number of farmers is becoming a natural choice as a low-cost fertilizer. When properly applied, it can be a valuable resource for cereal crops and row crop production. It is however important to carryout litter analysis before using poultry litter as fertilizer, as the nutrients contained in the litter are highly variable (Bock, 1999).

The term manure, wastes, and livestock and poultry production residues are sometimes used synonymously. Manure refers to a combination of faeces and urine while production residues include manure as well as other material, such as bedding, soil, spilled feed, and water that is spilled or used for sanitary purposes. Small amounts of spilled feed, water, dust, hair, and feathers are unavoidably added to manure and are detectable in the production facility. These small additions must be considered to be a part of manure and a part of the "as excreted" characteristics presented (United States Department of Agriculture, 1992).

Livestock manure is an important resource for agriculture; it contains a high level of nutrients and organic matter. Many farmers who use compost made from livestock manure are becoming old and are often part-time farmers. They tend to use less compost because they lack time and strength to apply it; thus, even livestock farms in regions where nitrogen content of the soil is low. In these regions, groundwater has become polluted by nitrate because of heavy applications of composted livestock manure onto a limited area of cropland. Therefore, with these problems in mind, it is necessary to create an environmentally safe system for composted livestock manure.

The objectives of this study are to produce fertilizer pellets from poultry litter and to determine the durability of the resulting pelleted poultry litter.

MATERIALS AND METHODS

Source, Collection and Processing of Poultry Litter

Poultry litter of about 52 weeks old consisting of broiler and layer droppings and saw dust was collected from the layers' section of the Teaching and Research Farm of Federal University of Technology, Minna, using shovel and feedbags. The litter was then allowed to go through a heat cycle created by deep stacking. This was achieved by bagging the litter in feedbags, stock piled and exposed to direct sun light for 21 days at a temperature range of 34^0C-40 ^{0}C. The drying process was done to reduce the moisture content and foul odour of the fresh poultry litter. The dried poultry litter was grinded using either a grinding machine or manually using Mortar and Pestle.

Moulding and Pelleting of Poultry Litter

The grounded poultry litter was sieved through a 0.02mm size mesh for easy moulding/pelleting and to prevent foreign materials such as stonnes and straw from entering the pelleting machine. After sieving, the finely textured poultry litter was put in a bowl and mixed with 10 mL distilled water prior to moulding operation for poultry pelleting.

The disc-type pelleting machine was used to produce 2 mm pellets of the organic matter, by gradually forcing the moulded poultry litter into the pelleting machine through the hopper.

The pellets produced were dried to less than 25% of its fresh moisture content using direct sunlight, incubator or oven methods. The pellets a were dried to ensure adequate stability for transportation and storage, and to prevent deterioration in quality, as a result of microbial activities.

The physical properties of the poultry pellets were assessed based on the following parameters colour, texture, durability and size.

Proximate Analysis of Poultry Litter

Proximate analysis was carried out on the poultry litter to determine the following parameters Moisture Content (Mc), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ash Content (% Ash), Weight (mass) and Percentage Weight Loss, using techniques of AOAC (1975).

RESULTS

The proximate composition and physico-chemical properties of freshly prepared and 10-days post-production of pellet poultry litter are presented in Table 1. Generally, while some of the variables investigated varied between poultry litter type (i.e. broilers and layers) as well as shelf-life post-production (i.e. freshly prepared and 10-days post-production). Others were more or less the same between the different categories of poultry litter pellets (PLP). Ash content was higher in the broiler (14.17 and 13.27 %) than layers (13.60 and 1265 %) PLP whether in the fresh or 10-days post-production state, respectively. These results also showed that the broilers litter pellets contained more ash than their layers counterpart. Moisture content, on the other hand, though also higer in broilers than layers PLP were lower in the fresh than 10-days post-production state (i.e. 3.71 and 4.71%, and 3.46 and 4.69%, respectively for freshly prepared and post-production states of the two PLP types). The weight of the individual 2 mm pellets though lighter in the fresh than 10-days post-production states was much higher in the layers PLP (i.e. 38.85/40.85% and 63.47/73.47% for the fresh/post-production pellet weight of the broilers and layers PLP, respectively).

The values of the chemical contents of the PLP were exactly the same between the fresh and 10-days post-production states, irrespective of the type of poultry litter (i.e. broilers or layers). However, except for calcium and sulphur, such values in the layers PLP were consistently higher than those of their broilers counterparts. While, the BOD of the broilers and layers PLP were 5.00 mg/L and 5.20 mg/L respectively, those of COD were 3.20 mg/L and 3.60 mg/L respectively. The broilers and layers PLP contained 2.20 and 1.80 % calcium respectively. The Phosphorus content ranged from 1.60-1.80 % in the respective PLP. While the Potassium content of broilers PLP was 0.90%, those of the layers was slightly higher (i.e. 1.00%). The two respective Magnesium and Sulphur contents of the PLP types were 0.80 and 1.10% and 0.30 and 0.28% respectively.

DISCUSSION

The results of the study showed that ash content was 14.17% and 13.6% for broiler and layers waste litter, respectively when freshly prepared. These values are lower than the acceptable range of 15 – 25% (Ruffin and McCaskey, 1991), probably due to insufficient accumulation of wastes in the litter prior to collection for analysis. On the tenth day after the pellets had been stored in a polythene bag, the ash content of the broiler and layer wastes reduced to 13.27% and 12.65% respectively. This finding suggests post-production disintegration of organic compounds in the pellets. The ash content provides important information about the quality of poultry litter. This is because it measures the mineral content of the litter. Ash is normally high in poultry litter because of the wood shavings or sawdust. The high ash content primarily represents the amount of dirt contamination that has occurred in the litter. Old litter will be very high in ash content since considerable dirt has been mixed into the litter.

With respect to the moisture content, the result indicated moisture content of 3.71 and 3.46% for broiler and layers fresh litter pellets respectively. From earlier reports Ruffin and McCaskey (1991); Burdine *et al.* (1993); Bagley *et al.* (1994), it was

Table 1: Proximate Composition and Physico-chemical properties of freshly pelleted poultry litter

Parameters	Fresh Broiler Litter Pellets	10-days Post-production	Layers waste	10-days Post-production
Ash (%)	14.17	13.27	13.6	12.65
Moisture (%)	3.71	4.71	3.46	4.69
Weight (g)	38.85	40.85	63.47	73.47
% Weight Lost	10.60	95.10	10.50	86.39
BOD_5 (mg/L)	5.00	5.00	5.20	5.20
COD (mg/L)	3.20	3.20	3.60	3.60
Calcium (%)	2.20	2.20	1.80	1.80
Phosphorous (%)	1.60	1.60	1.80	1.80
Potassium (%)	0.90	0.90	1.00	1.00
Magnesium (%)	0.80	0.80	1.10	1.10
Sulphur (%)	0.30	0.30	0.28	0.28

concluded that moisture in the litter should range between 12 and 25 per cent. Results obtained in the present study are strongly in agreement with their findings. However, the range of moisture in the poultry litter obtained in this study should enhance easy processing when applied to crop fields, as well as improve the shelf-life of the pelleted litters and also the gradual release of stored nutrients within the litter to the soil. The moisture content of the pellets after 10 days post-production storage decreased (especially the layer pellets) compared to the moisture content taken when they were freshly produced. These results shows that the broiler pellets are more durable than the layer pellets by been less vulnerable to microbial growth that requires high moisture content. Generally, the poultry pellets increased slightly in their moisture content after 10days, showing that the poultry pellets are durable.

The weight of the broiler and the layer litter after it had been processed into pellets were 38.85 and 63.47 grams per pellet respectively. This shows that the weight of the pellets makes allowance for easy carriage around the farm according to the various/desired weight by the applicator. This will also enhance its maximum application on the farm since it is light in weight when compared with the other fertilizers available in Nigeria. The poultry wastes samples were measured using an electronic weighing balance to determine their mass before other analyses were done. On observation, the weight of the litter when grinded into fine particles was relatively less than when dried. The moulded weight of the broiler litter was relatively higher than that of the layer litter compared to their initial weight respectively.

The Biological Oxygen Demand of the broiler and layer wastes samples was experimentally determined as 5.0 mg/L and 5.2 mg/L respectively. The COD of the waste that was obtained from the broiler and layers are 3.2 mg/L and 3.6 mg/L respectively. The BOD_5 and COD did not show any significant change in result obtained when the proximate test was carried out.

The mineral composition provides important information about the quality of poultry litter. This is because it measures the mineral content of the litter. Poultry litter is a good source of Calcium and Phosphorus. El-Sabban *et al.* (1969); Polin *et al.* (1971); Lamidi (1995); Fontenot (1996) reported Calcium and Phosphorus levels of 5.7 and 2.5%, respectively, as standards while in this study values of 2.2 mg/L and 1.8 mg/L was obtained for Calcium in broilers and layers waste respectively, and values of 1.6 mg/L and 1.8 mg/L was obtained for Phosphorus in broilers and layers waste respectively. The other minerals obtained during this study are Potassium, Magnesium and Sulphur which are important components that can improve various soil conditions for arable agricultural practice. Uniquely, it was observed in this study that the Phosphorus level was high in the layers waste litter when compared to that obtained from the broilers. This difference may be due to variation in the dietary components of broiler and layers feeds since the two types of birds are used for different reasons and hence, have different dietary requirements. The results obtained after ten days of storage showed that the minerals did not change. This may not be surprising because phosphorous is poorly digested by monogastric animals. The primary constituents of diets for monogastric animals are plant based ingredients.

CONCLUSION

The production of high-quality broiler and layer pellets was done to meet the demands of crop cultivators and crop needs. The durability of the poultry pellets reduces as the moisture content decreases. Pelleting of poultry wastes is a means of recycling wastes into forms which are acceptably safe to the environment. After pelleting, the pellets were found to possess relatively low moisture content, and were highly durable after storage.

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