Plant nutrient content of some animal manure types in the Guinea savanna (GS) agro-ecological zone of Ghana

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INTRODUCTION

Organic manure is a natural fertilizer mainly consisting of waste and residues from plant and animal life (Cooke, 1972); it is also a rich source of nutrients and includes various microorganisms (Taylor and Taylor, 1993). The only naturally occurring sources of major nutrients are the various forms of organic manure (Kauwenbergh, 2006).

The major types of animal manure in the Guinea savanna zone of Ghana are cattle, sheep/goat, and chicken manure. Cattle manure is beneficial in compost preparation and serves as a worm food. Pelletized cow manure is available commercially, and only water is added to reconstitute the manure for application. Sheep/goat manure differs considerably from other ruminant manure; it is dropped as pellets and dehydrated; it is a concentrated product with relatively high potassium content. Various biochemical compounds are also present, including amino acids and enzymes. Chicken manure contains a good balance of the major macro nutrients (NPK) because all bird excreta is highly concentrated with nitrogen rich urea (Taylor and Taylor, 1993).

Due to low inherent soil fertility in the Guinea savanna (GS) agroecological zone of Ghana, farmers continue to rely on fertilizers to improve crop yield. However, for many resource-poor farmers in the GS zone of Ghana, the cost of inorganic fertilizers is prohibitive. Many of these farmers therefore rely on locally available organic soil amendments such as animal manure to improve soil fertility. About 90 % of households in the GS are estimated to use animal manure to fertilize their lands (Anane, 1993), without considerable knowledge on its nutrient composition.

Animal manure is not homogeneous, and the nutrient composition and quality depends on the animal species, feed type, collection method, and storage length (Laegried *et al*. 1999). Therefore, this study which is aimed at determining the nutrient composition of the major animal manure types from the GS zone of Ghana could be a valuable contribution to knowledge that could support extension agents make the right recommendations to meet crop requirements.

MATERIALS AND METHODS

The GS agroecological zone of Ghana is located in the northern part of the country. The GS zone experiences unimodal rainfall pattern with an average of 1034 mm per annum. Temperature

distribution is moderately uniform with monthly mean minimum and maximum values of 23 °C and 38 °C, respectively. The vegetation consist predominantly of grassland interspersed with drought-resistant trees (MoFA, 1998).

Local farmers in Ghana practice extensive system of animal husbandry commonly known as free range. Animals are left to feed on anything during the day and they return to their pens and kraals during the night. Generally, no supplementary feeding is done.

Four samples each of Cattle, sheep/goat and chicken manure were collected from four randomly selected communities (Nyankpala, Cheyohi, Kpalsawgu, and Changnaayili) near Tamale the Northern Region of Ghana. The samples of cattle, sheep/goat, and chicken manure were collected from kraals and pens from the four selected communities. The samples were air-dried and ground to fine particles for laboratory analysis. Kjedahl digestion, ammonium molybdate and flame photometry, and atomic absorption spectrophotometry were used to determine Nitrogen (N), Phosphorous (P), Potassium (K), Magnesium (Mg), Calcium (Ca), and Sulphur (S) contents in the manure types. The results from the laboratory analysis were subjected to Analysis of variance (ANOVA) using Genstat software. Mean separation was done using the Least Significance Difference (LSD). The error bars shown on charts represent standard error.

RESULTS AND DISCUSSION

Nitrogen

The N content of the three manure types across the four communities was similar (Table 1). The highest N content value of 2.51 % for cattle manure was recorded in Kpalsawgu, followed by that for Cheyohi manure with 2.26 %. The lowest value of 1.99 % was recorded in Changnalili and Nyankpala (Table 1). Tisdale *et al*. (1993) reported that the normal plant N composition is between 1 and 5 % . The N content of the manure samples could have been attributed to the mainly vegetarian/plant diet of animals in the study area in particular and northern Ghana in general. The range for N content was found to be lower than that of Tisdale *et al*. (1993) probably due to the homogenous feed source of these animals. Animals in northern Ghana rely on natural vegetation as food source because of the extensive system of animal husbandry.

Table 1 Plant nutrient content of manure from four (4) selected

Manure Types		N (%)	P (%)	Mg (%)	S (mg/kg)
Nyankpala					
	Cattle	1.99	0.03	1.24	0.35
	Sheep/Goat	2.12	0.02	0.90	0.30
	Chicken	1.89	0.05	1.30	0.70
Cheyohi					
	Cattle	2.26	0.03	0.65	0.65
	Sheep/Goat	2.10	0.03	0.72	0.35
	Chicken	2.01	0.03	0.38	0.40
Kpalsawgu					
	Cattle	2.51	0.04	0.82	0.75
	Sheep/Goat	2.45	0.04	0.66	0.65
	Chicken	2.45	0.04	0.24	0.55
Changnalili					
	Cattle	1.99	0.03	0.76	0.70
	Sheep/Goat	1.95	0.05	1.08	0.65
	Chicken	2.05	0.04	0.58	0.70

Phosphorous

The results showed that animal manure might not be a good source of phosphorus (P). The P content ranged from 0.02 to 0.05 % (Table 1). These P values were not significantly different among manure types and among communities. The low P content of animal diets (plants) in the study area might account for the low P in their remains. The P content is significantly lower than those reported for similar studies (Nicholson *et al.* 1996). According to Olaitan *et al*. (1988), P is the most limiting nutrient in plants and agricultural soils. These results suggest that famers who rely entirely on animal manure as their preferred method of soil amendment might have to apply supplementary P from inorganic sources.

Magnesium

Similarly, Mg content was also very similar among the different manure types (Table 1). The highest Mg content was 1.3 % and the least was 0.24 %. (Tables 1). The results showed that Mg was relatively high compared to the standard Mg concentration of 0.1 % and 0.4 % suggested by Beaton *et al*. (1993). The relatively high content of Mg could be because Mg is more prevalent in critical plant pigments involved in photosynthesis which in turn is consumed by animals in the study area.

Potassium

Significant difference ($p < 0.001$) was noted in the potassium (K) levels among the manure types (Figure 1). Although the K content of manure studied ranged between 0.24 mg·kg^{-1} and 0.53 mg·kg^{-1}, revealing a considerably low K concentration in the manure types, chicken manure appears to be significantly richer in K than cattle and sheep/goat manure.

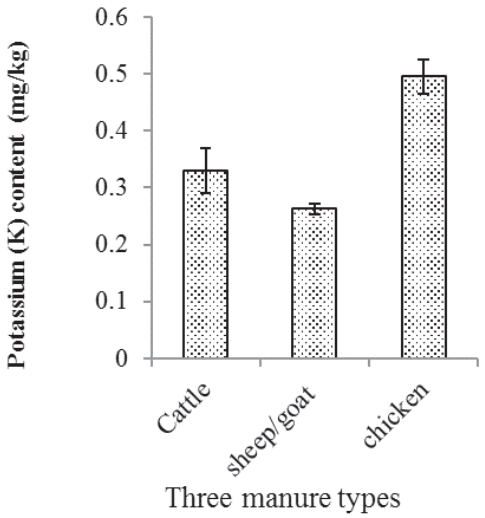

Figure 1 K content of the three manure types in the Guinea savanna agroecology of Ghana

Sulphur

S concentration in the different manure types was very similar (Table 1). The S concentration was highest (0.75 mg·kg^{-1}) in Kpalsawgu cattle manure. The least sulfate concentration of 0.4 mg·kg^{-1} was found in sheep/goat manure from Nyankpala (Table 1).

Calcium

There was significant difference ($p < 0.001$) in Ca levels among the manure types (Figure 2). The sheep/goat manure contained significantly higher amount of Ca compared to that in cattle and chicken manure. Plants growing with adequate Ca in their natural habitats have shoot Ca concentrations between 0·1 and 5 % (Marschner, 1995). The values obtained in this study are within the range reported for plant shoot Ca. The significantly higher Ca concentration in sheep/goat manure could be explained by their feeding pattern. According to Tiessen *et al*. (1991), the annual deposition of dust into northern Ghana by the Harmattan weather system has resulted in top soils that contain moderate levels of Ca. The high content of Ca in sheep/goat

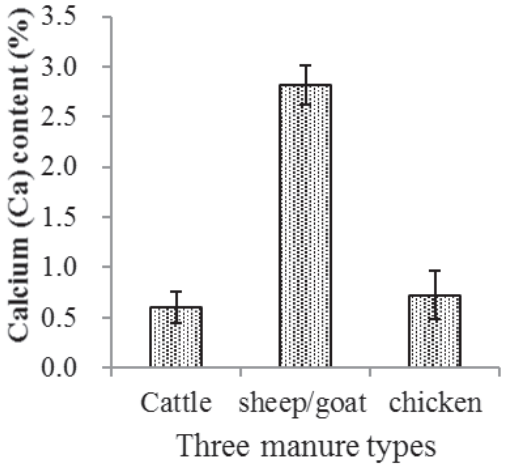

Figure 2 Ca content of three manure types in the Guinea savanna agroecology of Ghana

manure relative to cattle and chicken manure might be because goats have prehensile tongues by which they can graze up to the root levels of plants close to the surface soil that contains appreciable amounts of Ca.

CONCLUSION

This study revealed that the nutrient content of animal manure in the Guinea savanna is low and varied. Nitrogen content is around 2 %, whereas phosphorous content is around 0.05 %. The potassium content is significantly higher in chicken manure, whereas calcium concentration is the highest in sheep/goat manure.

In terms of lowland rice fertilization, no manure type presents any specific advantage. The low nutrient content of the manure types in the Guinea savanna implies that large quantities will have to be applied to meet crop nutrient requirements.

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