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Study of the Nutrient Composition of Organic Fertilizers in the Zone of Bobo-Dioulasso (Burkina Faso)

GOMGNIMBOU Alain P.K[1*], COULIBALY Kalifa[2,3], SANON Abdramane[1], BACYE Bernard[2], NACRO B. Hassan[2], SEDOGO P. Michel[4]

[1]Station de recherche de Farako-Bâ, Institut de l'Environnement et de Recherches Agricoles (INERA), Bobo-Dioulasso, Burkina Faso.
[2]Laboratoire d'étude et de recherche sur la fertilité du sol (LERF), Université Polytechnique de Bobo-Dioulasso (UPB) Bobo-Dioulasso, Burkina Faso.
[3]Unité de Recherche en Production Animale (URPAN)/Centre International de Recherche-Développement sur l'Elevage en zone Sub-humide (CIRDES), Bobo-Dioulasso, Burkina Faso.
[43]Laboratoire Sol-Eau-Plante, Institut de l'Environnement et de Recherche Agricole (INERA), Ouagadougou, Burkina Faso.

ABSTRACT

This study has the aim to do a chemical characterization of the organic fertilizers used in the urban agriculture in Bobo-Dioulasso. For this reason, seven (07) fertilizers of animal's origin were taken away and analyzed in the laboratory. The comparison of the nitrogen averages shows that the poultry droppings and the pig's manure have the respective highest contents of 2.5% and of 2.6% of the studied sample. The poultry droppings (total P=2.7%) were the most affluent in phosphorus followed by the pig's manure (1.4%), while donkeys manure had the lowest content (0.7%). The monogastric animals (poultry, pigs, and rabbits) had the highest contents in total N, total P and the C:N ratio. The lower content in total K was the rabbits and the pig's manure. These results give the possibility to optimize the recovering as fertilizers of the cultures or to make the soils more affluent.

Keywords: Manure, Chemical composition, Fertility, Bobo-Dioulasso

I. INTRODUCTION

The spreading of the manures on the soils constitutes a very important deposit of nutriments representing the nitrogen, the phosphorus and the potassium respectively ingested in 79.66% and 92% (Lancon, 1978).

Whatever the animal is, the solid excrement was constituted of water, some residue of non-digested fodder (vegetal fibers constituted mainly of hemicellulose, cellulose and lignin), of some animals metabolites, of some microorganisms and some microbial metabolites (Haynes and William, 1993; Chevalier and al., 2005).

However, the elements rejected are not distributed equally between the solid manure and the urine. In the solid manure, there were respectively 26, 66 and 11% of digested nitrogen, phosphorus and potassium, as well as the quasi-totality of the non-digestible elements.

The solid manure represented a significant affluent of organic matter (Lancon, 1978; Dupond et al., 1986; Sikuzani et al., 2014).

Without any doubt, there are many literature treating the analytic characterization of the animals manure, however, there are many variations which are sometimes noted among the species, the physiological growth talking about the contents of major elements

(N, P and K) and the oligo-elements (Iron, manganese, copper, zinc, boron, and molybdenum and vanadium) (Dupond et al., 1986; Culot, 2005; Dourmad and Jondreville, 2007 ; Martinez and al., 2009 ; Siboukeur, 2013).

Then, the composition of the manure varied according to the animal species, its food intake and the fodder (water content, content in structural sugar) (Bloor et al., 2012).

Nevertheless, in our context the deficiency of the knowledge about the values of the contents of the nutritive elements contained in the animal manure is to be filled in; anticipating the contents can give some very useful estimation in order to plan.

A good knowledge of the chemical composition of the manure is essential and gives some best strategies in the view to optimize their recovering as fertilizers for the plants or to the soils amending.

It is in the view to cure the deficiency of data about the chemical and physical characteristics of the manure as well as the real compression in nutritive elements that this study was done.

II. METHODS AND MATERIAL

A. Area of samples collecting

The urban and periurban zone of the town of Bobo-Dioulasso were the site of taking away some samples of animal fertilizers. This town is located in the west of Burkina Faso. Referenced at North 11º10' latitude and at West 4º17' longitude, in that town, especially in the periurban part, some mixt running's of farming-breeding are there and contribute to supply the town with food.
The farms where the samples were taken were chosen on the basis of a past study (Gomgnimbou et *al*., 2014).

The method of quotas according to Gouet and Deroo (1992) was referred in the sampling. This empirical technic gives a similar structure of the population to be studied and fixes at least a rate of survey of 14%.
The analysis of the different fertilizers has concerned the following animal species: cattle (14), sheep (12), poultry (13), pigs (12), goats (06), donkeys (05) and rabbits (04) shared in the farms more or less mixt. For each species of animals, some samples of manure were taken. They were taken in different places and in all the depth (1 to 4 m according to the quantity and the height stored) to make a composite sample of about 0.5kg (Coffey and al., 2000; Brown, 2013). In the total, sixty-six (66) samples were gathered.

B. Laboratory and statistical analysis

All the samples which were gathered and dried in the shade were brought to the Soil-Water-Plants laboratory of Institute of Environment and Agricultural Research (INERA, Farako-Bâ station) for some chemical analyses. The different parameters were analyzed as followed:

- Total Nitrogen : following Kjeldahl's method but modified (Hillebrand et al .,1953) ;
- Total Carbon : following Walkley-Black's method (1934) ;
- Total Phosphorus : following the protocol of Novozansky et al. (1983);
- Total Potassium: following Walinga et al. (1989).

The measured parameters (C, N, C:N, P, K) were the object of the analysis of variance (ANOVA) in order to compare the averages at the threshold of 5% through the test of Fisher with the software XLSTAT version 7,5,2. Taking account of the fact that the number of the samples among the animal species was unequal, the unbalanced model was used.

III. RESULTS

The results of the ANOVA about the fertility parameters are shown in table 1. The rates for the whole studied manure have shown some highly significant differences. The carbon rate of the pig manure (29.7%) and goat manure (28.4%) are statistically the same and significantly lower. Poultry and cattle manure are statically comparable. The averages of these manures show a difference highly significant according to the test of Fisher at the threshold of 5% for the rate of C.

We noted a difference highly significant among the animals manure ($P < 0.001$) talking about the C:N ratio. Donkeys manure had the C:N (42.7)

significantly the highest while the lowest C:N (12) was obtained by the pig manure.

The rate of nitrogen (N) in the pig manure and in poultry droppings are significantly the highest followed by the contents of nitrogen in the rabbits, cattle and sheep manure.

The test of Fisher shows a significant difference among the fertilizers for the variables total phosphorus (% P) and total potassium (% K).

Table 1 : Fertility parameters variation of study sample

Type of manure		Parameters				
		C (%)	N (%)	C:N	P (%)	K (%)
Ruminants	Cattle (n=14)	35.56^{ab}	1.96^{b}	18.12^{b}	0.96^{bc}	2.22^{a}
	Goat (n=6)	28.35^{b}	1.61^{bc}	17.60^{bc}	1.06^{bc}	1.36^{b}
	Sheep (n=12)	36.74^{ab}	2.00^{b}	19.54^{b}	0.90^{c}	1.72^{ab}
Monogastrics	Pig (n=12)	29.70^{b}	2.64^{a}	12.01^{d}	1.37^{b}	1.17^{b}
	Donkey (n=5)	41.86^{a}	0.99^{c}	42.76^{a}	0.67^{c}	1.74^{ab}
	Rabbit (n=4)	37.39^{ab}	2.16^{ab}	17.53^{bc}	1.22^{bc}	1.26^{b}
	Poultry (n=13)	33.07^{ab}	2.58^{a}	13.54^{cd}	2.73^{a}	1.45^{b}
Statistical parameters	SD	8.88	0.77	9,12	0.88	0.75
	P	<0.01	<0.001	<0.001	<0.001	<0.01
	M	**	***	***	***	**

The values having the same letter in the same column are not significantly different on the threshold of 5% according to Fisher' test. P: Probability; SD: Standard deviation; (**): Highly significant; (***): Very highly significant.

IV. DISCUSSION

The highest rate of total Carbone was noted in the donkey's manure (41.8%). In the farms of the zone, donkeys had no specific food intake. They were generally fed with some hay and the crops residues, which contributes to increase the rate of lignin (Gueydon, 1996). In the opposite, the other animals had a food intake supplemented with condensed (Hamadou and al., 2008; Kiendrebeogo and al., 2013; Sanon and al., 2014).

The comparison of the averages revealed that the poultry droppings and the pigs manure had the highest contents (2.5% and 2.6%) and is statistically identic. A probable reason was the influence of the food intakes. In the zone, several concentrated foods are given to the animals according to their species and also according to the level of intensification of the activity. So, the cotton oil cake, cattle food, cotton grains, molasses, local bran, cereal grains and the breweries residues (local and industrial) are generally supplied. But these foods have not the same nutritional values (contents of proteins, nitrogen substances, etc.) while they are a determinant factor in the concentration of nitrogen in the manure (Chevalier et al., 2005; Bloor et al., 2012). We noted that the contents of N in the poultry droppings next to ours were obtained elsewhere. Indeed, some rates of 2.21% and 2.25% of N were respectively recorded in Nigeria (Adeniyan et al., 2001) and in Kenya (Coorbeels et al., 2000). In the opposite, Moyin-Jesu (2004) obtained a rate of 5.92% in Nigeria and Maerere et al. (2001) recorded in Tanzania a rate of 1.84%. The rate of nitrogen in the cattle manure had a value quite inferior to the one obtained by Toussaint and Dehareng (1998) but superior to the rates measured by Maerere et al. (2001) and by Khan et al. (2008). The rate of nitrogen (2.67%) in the rabbits manure recorded was similar to those recorded by Moyin-Jesu (2004), Khan et al. (2008) and Adeniyan et al. (2011) who measured 1.4% and 1.04%. It must be noted that in the breeding running's of the zone, pigs and poultry are bred in constant enclosure and have some food intakes specific (case of the poultry) according the aims of production of each producer.

It is commonly recognized that, more the C:N ratio of a product is high, more this latter deteriorates slowly in the soil and supplies a stable humus (Chevalier et al., 2005 ; Bouajila et al., 2014). These rates allow saying that poultry droppings and pigs manure will be quickly mineralized and will release much mineral nitrogen for the soils, while rabbits, goats and cattle manure will have an average speed of mineralization. In the opposite, donkeys manure will have a quite slow speed of mineralization of the organic nitrogen.

This situation will cause an important need of nitrogen (organic fraction) in the microorganism's activity (Reddy & Dronachari, 2014). The variability of the C:N ratio is explained by the presence or the absence of some macromolecules strongly molded difficult to

decompose limiting then, the mineralization of the nitrogen (Zech et al.,1997).

Moreover, this C:N ratio is influenced by the quantity of these macromolecules contained in the different manures which are themselves strongly dependent of the food fertilizers ,the intensity of the operations done in each system of breeding and especially the content of nitrogen contained in these manures (Culot et al., 2005 ; Fasae et al., 2009 ; Bouajila et al., 2014). However, the variability of the content in these different manures is clearly established. Indeed, the manures which have the highest rate of nitrogen had the lowest C:N ratio. This was the case of pig's manure (2.6%), rabbit's manure (2.16%) and poultry droppings (2.5%). This affluence in N can cause a quick mineralization of the insoluble soluble parts of the organic substance through a depolymerization. This depolymerization will make the components available to the microbe's absorption and the metabolism (Fontaine et al., 2003).

The cattle manure and the sheep manure had the equal contents (0.9%). Poultry droppings (total P=2.7%) were the most affluent in phosphorus, followed by pigs manure (1.4%), while donkeys manure had the lowest rate (0.7%). The interesting fact is that the rate of total phosphorus of the sheep manure, cattle manure and goats manure scarcely exceeded 1%. These results show the great variability of the contents of phosphorus contained in animal's manures. This difference is noted in the bosom of the animals of the same category, but also according to the season and the food supplied (Dupond et al., 1984; Diallo et al., 2002; Fasae et al., 2009). Fasae et al. (2002) had observed that the content of total phosphorus in the lambs manure during the fattening was higher than the one in ewes manure. Usman and Burt (2013) noted the rates of total phosphorus to the cattle (0.42%), sheep (0.68%), goats (0.7%) and donkeys (0.7%). These rates were in the completely less high than ours. The low contents were also gathered in Kenya in the poultry, goats, sheep, cattle and donkeys (Corbeels et al., 2000). In the opposite, Adeniyan et al. (2011) in Nigeria gathered some contents similar to ours found in the pigs, rabbits, poultry and cattle manures.

The cattle manure (total K=2.2%) has an average content, the rest of the six (6) manures had a poor content in K_2O (content<5kg/ton of raw product) (Chevalier et al., 2005). The lowest contents were recorded in rabbits and pigs manure. Indeed, many authors (Chevalier et al., 2006; Katuromunda et al., 2012; Brown, 2013) showed that the content of potassium in the manures is generally linked to the urines. In our context, the explanatory factor of this noted poorness of K in this manure could be the system of gathering and storage of the manure. If the cattle manure is mixed to the urines compared to the other manure, it will have probably a higher content of K, which is noted here.

V. CONCLUSION

This study about the chemical composition of the manure allowed seeing the variability among the different studied fertilizers. The monogastric animals manure (poultry, pigs and rabbits) had the highest contents of total N and total P and the lower C:/N ratio.

The food diet of the different studied species was the most explanatory factor of the different contents of the chemical elements.

As agronomic consequences of this work, it could be said that the raw fertilizers of the monogastric animals (pigs, rabbits and poultry) in general and especially poultry droppings constitute a good organic fertilizer for the cultures and could have the same impact as the mineral fertilizer NPK. However, to optimize the affluence of NH_4-N, a spreading followed by a quick burying is necessary. On the other hand, donkeys manure could be a good organic fertilizer for the soils.

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