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Analysis of Nutrient Content of Some Organic Materials for Soil Amendment in Sokoto Metroplis, Nigeria

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Abstract
A study was undertaken to examine the nutrient contents of some selected organic materials within Sokoto metropolis. The organic materials sampled included; neem leaves, neem seeds, poultry manure, sheep dung, cow dung, refuse dump, millet husk, wood ash and rice husk. The samples were collected in three replicates from different locations, making a total of 27 samples. These samples were air-dried, gentle crushed and sieved through 2mm sieve mesh. The following chemical properties of the samples were analyzed using standard methods; pH, organic carbon, total nitrogen, available phosphorus, exchangeable bases (Ca, Mg, Na, and K) and cation exchange capacity (CEC) and percentage base saturation (PBS) was also calculated. The result showed that the pH value ranged from 5.4 (neem seeds) to 7.54 (sheep dung). The organic matter content ranged from 2.03% in neem leaves to 22.05% in sheep dung, sodium ranged from 0.39 cmol/kg in millet husk to 7.10 cmol/kg in refuse dump, total nitrogen values ranged from 0.30% in wood ash to 1.42% in poultry manure. The available phosphorus showed values ranging from 0.31mg/kg (rice husk) to 3.29 mg/kg (refuse dump), the percentage base saturation was highest in wood ash, showing a value of 95.72% and lowest in rice husk; 82.81%. The organic materials evaluated showed moderate values in all the nutrients tested and therefore could be effectively used for soil fertility amendments.
Keywords: Nutrient, Organic material, Chemical property, Fertility amendment

1. Introduction

Our environment is a houseful of various nutrients which plants require for their normal growth and development (Aina, 1979). Those used in large amounts; carbon, hydrogen and oxygen are non-mineral elements supplied by air and water. Plants need relatively large amounts of nitrogen, phosphorus and potassium; these nutrients are referred to as primary nutrients and are the ones most frequently supplied to plants in fertilizers (Brady and Weil, 1999).
Composted manure is a primary source of soil fertility for organic farmers. It offers a natural means to cycle plant nutrients. As such, animal manure forms an important part of organic soil fertility programs (Baker, 2002). Compost fosters the biological processes in the soil. Its use is a major tool in the creation and preservation of soil fertility (CTA, 2006). Nutrients that leave farm soils must be replaced if crop production is to remain abundant. Organic wastes, many of which are rich in nutrients and organic matter, can be used to replenish soils. The acceptance of the ancient appreciation of organic material will be an important step towards building sustainable cities and farms (Gardner, 1998).
The effect of wastes such as poultry and turkey manures applied solely and their supplement forms, as sources of fertilizer on soil fertility is that, it improves it, making it a better medium for plant growth (Emir, 2008).
The rapid economic expansion during the 1960s in Japan turned conventional agriculture into an enterprise, with the result that farmers were forced into raising either vegetable crop or cattle. This caused a shortage of organic fertilizer for vegetable farmers on the other hand, and created a serious problem of manure disposal for cattlemen. Subsequently, it was found that application of cattle manure to soil improved its quality significantly, even though it was originally considered as a source of nutrients for plants rather than as a component for maintaining soil texture. Thus, it appears likely that an agricultural system that depends on the heavy use of chemical fertilizer has a deleterious effect on soil fertility (Austin, 1994).
Studies have shown that mixing two or more sources of organic matter tends to result in a higher efficiency. For management purposes, it is mechanically easier to handle waste if large quantities of excretions are mixed without separating solids from liquid (Toshihide, 1995). A statistical data shows that the carbon ratio of solid fractions after mechanical separation of excreta is 30 in cow dung and 17 for pig manure. These values are quite different from those in rice straw, which has a ratio of 70 to 80 due to the high content of lignin. Raw faeces have an equal or lower carbon ratio compared to well-matured compost or manure compost. If one judges the maturity of compost by its carbon ratio, raw faeces have a value close to that of fully matured manure compost, and thus is satisfactory (Mithra, 2006).
Organic farming practices are not based only on lists of materials that are acceptable or unacceptable in organic products. Rather, organic farming strives to practice agriculture in a manner that achieves a balance similar to

that found in natural systems. This includes a commitment to building or maintaining soil health practices through practices such as green manures, crop rotations and compost application, thus making it necessary to have wide information on the materials that are used as source of organic fertilizer (John, 2011).
Many commercial fertilizers are made from ammonia, which is extracted from natural gas using a complex chemical process. This process also releases carbon dioxide; the heat-trapping gas primarily responsible for global warming into the atmosphere. Nitrates in the resulting fertilizers can harm both humans and marine mammals by seeping into groundwater or drinking water supplies. And, in the ultimate irony, because these fertilizers are generally very acidic, they eventually have the opposite effect of the one intended, depleting the soil of nutrients and killing healthy bacteria and other essential organisms (Stewart, 2005).
This research inclined towards the evaluation of some nutrient composition of poultry manure, wood ash, cow dung, millet husk, rice husk, neem leaves, neem seeds, sheep dung and refuse dump and perhaps how they can enhance soil fertilizer.

2. Materials and Methods

2.1 The Study Area

Sokoto is located in the extreme North west of Nigerian, near to the confluence of the Sokoto Rima River, it is situated between the Latitudes 11^{o}3'N to 13^{o}50'N and Longitudes 4^{o}0'E to 6^{o}0'E. Sokoto is one of the hottest cities in the world, however the maximum day time temperatures for most of the year are generally under 40^{0}C (104.0^{0}F), and the dryness makes the heat bearable. The average rainfall is about 550mm per annum. Relative humidity is between 15-20% during the dry season and up to 70-75% during the rainy season (Arnborg, 1988). The region's lifeline for growing crops is the floodplains of the Sokoto-Rima River, which are covered with rich alluvial soil. (Arnborg, 1988).

2.2 Sample Collection and Preparation

Nine different sources of organic material were sampled within Sokoto metropolis each replicated 3 times; making a total of 27 samples weighing average of 500g. These samples included; neem leaves, neem seeds, poultry manure, sheep dung, cow dung, refuse dump, millet husk, wood ash and rice husk. The samples were air-dried in the laboratory, gentle ground and then sieved through a 2mm sieve mesh for laboratory analysis.

2.3 Laboratory Analysis

Chemical analyses such as pH, organic carbon, total nitrogen, cation exchange capacity (CEC), exchangeable bases (EB) and available phosphorus were carried out on the collected samples.
The pH was determined by adding 10ml of water to the samples, stirred afterwards taking the reading using a pH meter. The exchangeable bases (Ca, Mg, Na, and K) and (CEC) of the samples were also determined. Na and K were determined from the leached solution and their concentration were read-off photometrically using flame photometer while CEC was determined by the neutral ammonium acetate (NH_4OAC) leachate method while Ca and Mg were determined using the EDTA titration method (Devis and Freitas, 1970). Total nitrogen was determined using the macro Kjeldahl method (Jackson, 1962), available phosphorus by Bray and Kurtz No. 1 method (Bray and Kurtz, 1945) and percentage base saturation (PBS) was thereafter calculated.
Analysis of variance (ANOVA) was conducted on the data obtained to test the significant difference between the obtained means. Significant different means were separated using Least Significant Difference (LSD).

3. Results and Discussion

3.1 Chemical Properties of the Samples

3.1.1 pH

Results obtained for the different parameters analyzed in each material are shown in table 1. The mean values of the pH for the various organic materials were; 6.33, 5.4, 6.60, 7.54, 7.47, 7.16, 6.57, 5.66 and 5.69 for neem leaves, neem seeds, poultry manure, sheep dung, cow dung, refuse dump, millet husk, wood ash and rice husk respectively. These pH values indicated slightly acidic condition for the neem seeds, wood ash and rice husk while others were within the range of neutral to slightly alkaline. The statistical analysis showed significant difference ($P<0.05$), however the highest value was obtained in sheep and cow dungs 7.54 and 7.47, respectively which were statistically the same ($P<0.05$) and the lowest value was in neem seeds. These indicate that, the materials would not have acidic effect on soils when applied.

3.1.2 Organic Matter (O.M) Content

The organic matter content of the various materials analyzed had the following mean values; 2.03%, 2.97%, 21.53%, 22.05%, 13.39%, 6.56%, 9.14%, 18.19% and 10.75% in neem leaves, neem seeds, poultry manure, sheep dung, cow dung, refuse dump, millet husk, wood ash and rice husk, respectively. This indicates a moderate quantity of organic matter content in the materials analyzed; which agrees with the values obtained by Bababe *et al*. (1998) whose values for the minimum, average and maximum organic matter were 2.56%, 19.75% and 53.15%; respectively. Generally, organic materials are usually rich in organic carbon, thus, the organic matter.

The highest values of organic matter were obtained in sheep dung and poultry manure which were statistically the same (P<0.05), while the lowest values were obtained in neem leaves (2.03%) and neem seeds (2.97%).

3.1.3 Total Nitrogen (N)

The mean total N value obtained in different samples were statistically significant (P<0.05). Table 1 indicates the following total nitrogen obtained; neem leaves; 0.83%, neem seeds; 1.08%, poultry manure; 1.42%, sheep dung; 0.86%, cow dung; 0.69%, refuse dump; 0.45%, millet husk; 0.50%, wood ash; 0.3% and rice husk; 0.38%. These values are within the range obtained by Bababe *et al.* (1998) which indicated percentage nitrogen range of 0.35 to 1.88% with an average of 1.13% in some organic substances.

The result indicates that the highest total N value was obtained in poultry manure followed by neem seeds, sheep dung and neem leaves. While that of cow dung, refuse dump, millet husk, wood ash and rice husk were relatively low; this may be attributed to the nature of the material and N loss through volatilization during drying, as also observed by Bababe *et al*., (1998).

3.1.4 Available Phosphorus

The mean available phosphorus values obtained in various organic materials were; 2.01mg/kg, 1.81mg/kg, 3.04mg/kg, 1.30mg/kg, 2.14mg/kg, 3.29mg/kg, 1.85mg/kg, 2.05mg/kg and 0.31mg/kg for neem leaves, neem seeds, poultry manure, sheep dung, cow dung, refuse dump, millet husk, wood ash and rice husk, respectively. The available phosphorus levels obtained in all the materials were comparatively low just as in nitrogen. These phosphorus values are within the range observed to be low by Purseglove (1985) whose values for the phosphorus levels were 0-11.5 mg/kg, 12-25.2 mg/kg and greater than 25.2mg/kg as low, medium and high; respectively. The result obtained were statistically significant (P<0.05) with refuse dump and poultry manure having the highest values which were statistically the same (Tab. 1).

3.1.5.Cation Exchange Capacity (CEC)

The result of the cation exchange capacity of the various organic materials is shown in Table 1 which were significantly different (P<0.05) statistically. The CEC of the materials had the following mean values; 7.80 Cmol/kg for neem leaves, 9.88 Cmol/kg for neem seeds, 8.5 Cmol/kg for poultry manure, 9.65 Cmol/kg for sheep dung, 7.03 Cmol/kg for cow dung, 13.68 Cmol/kg for refuse dump, 7.92 Cmol/kg for millet husk, 5.85 Cmol/kg for wood ash and 5.82 Cmol/kg for rice husk.

The values obtained were moderate. According to Adepetu *et al.* (1979), substances having high CEC are likely to have high organic matter as the higher amount of colloids, the greater is the CEC. Thus these values obtained were due to the influence of the organic matter.

3.1.6 Exchangeable Bases (Ca, Mg, K and Na) and Base Saturation

The mean values obtained for Ca as shown in Table 5 were; 1.29 Cmol/kg, 2.21 Cmol/kg, 0.86 Cmol/kg, 2.04 Cmol/kg, 1.71 Cmol/kg, 1.00 Cmol/kg, 1.54 Cmol/kg, 1.13 Cmol/kg and 1.21 Cmol/kg for the neem leaves, neem seeds, poultry manure, sheep dung, cow dung, refuse dump, millet husk, wood ash and rice husk, respectively. However, the result showed significant difference (P<0.05) in Ca content between the materials analyzed. The highest and lowest values were obtained in neem seeds and poultry manure; respectively.

Mg content in the organic materials had the following mean values; 1.42 Cmol/kg, 2.31 Cmol/kg, 1.45 Cmol/kg, 3.32 Cmol/kg, 1.79 Cmol/kg, 3.86 Cmol/kg, 3.09 Cmol/kg, 3.34 Cmol/kg and 2.29 Cmol/kg for neem leaves, neem seeds, poultry manure, sheep dung, cow dung, refuse dump, millet husk, wood ash and rice husk; respectively. The statistical analysis showed significant difference (P<0.05) between the materials, however, the highest value of magnesium was obtained in refuse dump (3.86 cmol/kg) followed by wood ash, sheep dung and millet husk which were statistically the same (Tab. 1).

Potassium had the following mean values for the different organic materials; neem leaves; 3.44 Cmol/kg, neem seeds; 2.16 Cmol/kg, poultry manure; 1.19 Cmol/kg, sheep dung; 1.03 Cmol/kg, cow dung; 0.64 Cmol/kg, refuse dump; 0.69 Cmol/kg, millet husk; 1.12 Cmol/kg, wood ash; 0.74 Cmol/kg and rice husk; 0.80 Cmol/kg. Statistical analysis discovered that cow dung, refuse dump, wood ash and rice husk were statistically the same with relatively low values compared to other materials. The highest value of K was obtained in neem leaves (3.44 cmol/kg). The average Na values obtained in each sample were; 1.25 Cmol/kg, 3.05 Cmol/kg, 4.05 Cmol/kg 1.58 Cmol/kg, 2.17 Cmol/kg, 7.10 Cmol/kg 1.34 Cmol/kg, 0.39 Cmol/kg and 0.52 Cmol/kg for neem leaves, neem seeds, poultry manure, sheep dung, cow dung, refuse dump, millet husk, wood ash and rice husk; respectively which were significantly different statistically (P<0.05). The neem leaves, millet husk and sheep dung were statistically the same ($P \leq 0.05$). The relative high value of Na obtained in refuse dump (7.1 cmol/kg) was far higher than values of comparatively other parameters in different materials.

Sodium level was also higher in neem seeds, poultry manure, cow dung and refuse dump than the other exchangeable bases (Ca, Mg and K). Whereas Mg was higher in sheep dung, millet husk, wood ash and rice husk than the other exchangeable bases (Ca, K and Na). The potassium level was higher in the neem leaves than all other exchangeable bases.

The mean value obtained for base saturation in the organic materials were; 95.00%, 93.50%, 88.78%, 82.59%, 89.75%, 92.47%, 89.52% and 95.72% for neem leaves, neem seeds, poultry manure, sheep dung, cow dung, refuse dump, millet husk, wood ash and rice husk respectively. According to Munich (1989), these values indicated a high percentage base saturation compared to the standard ratings for low, medium and high (<45, 45 – 80 and >80%) (Munich, 1989).

Though the percentage base saturation was not justified by the pH values but this may be due to variation in the concentration of exchangeable bases on the exchange sites of the organic materials and the CEC of the materials. However, those having higher concentration of sodium on the exchange sites tend to have higher values of pH over the others.

Conclusion

Based on the results obtained, it could be concluded that the organic materials in the study area were found to be neutral to slightly acid; low to high in nitrogen; low in phosphorus; moderate in CEC and organic matter contents; high in percentage base saturation; moderate to high in exchangeable bases. The organic materials analyzed could therefore be good fertilizing materials that can be used to sustain soil fertility and improve crop production.

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Table 1. Chemical Properties of the Organic Materials

Source	pH	OC	OM	N	Avail. P	CEC	Exchangeable Bases (cmol kg^{-1})				BS
		%			mg kg^{-1}	Cmol kg^{-1}	Ca	Mg	K	Na	%
Neem leaves	6.33d	1.18f	2.03f	0.83c	2.01bc	7.80 c	1.29bc	1.42e	3.44a	1.25e	95.00
Neem seeds	4.40f	1.72f	2.97f	1.08b	1.81c	9.88b	2.21a	2.31c	2.16b	3.05c	98.50
Poultry manure	6.60c	12.52a	21.53a	1.42a	3.04b	8.50bc	0.86c	1.45e	1.19c	4.05b	88.78
Sheep dung	7.54a	12.82a	22.05a	0.86c	1.30d	9.65b	2.04ab	3.32b	1.03c	1.58e	82.59
Cow dung	7.47a	7.79c	13.39c	0.69d	2.14b	7.03d	1.71abc	1.79d	0.64d	2.17d	89.75
Refuse dump	7.16b	3.81e	6.56e	0.45ef	3.29a	13.68a	1.00c	3.86a	0.69d	7.10a	92.45
Millet husk	6.57cd	5.31de	9.14de	0.50e	1.85c	7.92c	1.54abc	3.09b	1.12c	1.34e	89.52
Wood ash	5.66e	10.58b	18.19b	0.30g	2.05bc	5.85f	1.13c	3.34b	0.74d	0.39f	95.72
Rice husk	5.69e	6.25	10.75cd	0.38fg	0.31e	5.82f	1.21bc	2.29c	0.80d	0.52f	82.81
Sig.	*	*	*	*	*	*	*	*	*	*	ns
Standard Error (SE)	0.15	0.82	1.42	0.07	0.16	0.46	0.11	0.17	0.17	0.39	4.12

Means followed by same letter(s) in column are not significantly different (P>0.05), ns- Not significant, * - significant at 5% level