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Influence of lokpa cattle market wastes on agricultural soil quality

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This paper examined the influence of Lokpa cattle market waste on soil properties. Soil samples were collected from the Central, 3 and 6 m Northwards, Southwards, Eastwards and Westwards of Lokpa cattle market, Umuneochi Local Government Area of Abia State, Nigeria at a depth of 0 to 25 cm (Sample A) and 26 to 50 cm (Sample B) from each spot while the control samples were collected from an unimpacted area devoid of cattle rearing activities. Results of the physicochemical activities show that cattle waste soil had low acid pH range of 4.02 to 5.83 while soil moisture ranged from 14.90 to 21.58, Organic carbon ranged from 1.92 to 2.83. The enzymatic activities of cattle waste soil were found to be higher (P<0.05) than the control. This however could be due to input from the cattle waste leading to increased enzymatic activities. The pH of the cattle waste soils were found to be lower than the control, hence proper care should be taken in the quantity of these waste applied to farms as they can increase soil acidity. The presence of cattle dung could be responsible for the general changes observed.

Key words*:* Cattle, waste, market, soil, quality.

INTRODUCTION

Soil constitutes a dynamic system within which series of changes constantly occur. These changes directly affect the composition, properties and productive potentials of the soil. Oriola and Hammed (2012) reported that soil as a component of landscapes occupies a central position in the landscape balance due to its diverse functions. Soil conditions, constraints on soil quality play an important role on agricultural output and productivity. Livestock production in developing countries has increased rapidly during the last decades (Steinfeld and Chilonda, 2006). In Nigeria and in most developing countries, for animals like cattle and other animals of that type, special markets are kept for them and various activities within the market may affect the soil (Nwaugo et al., 2008). Large quantities of wastes are produced annually in these areas. Oriola and Hammed (2012) reported that the quantity and quality of animal waste are affected by diet composition. These waste materials such as cattle excreta and associated feed losses, wash-water and other materials represent valuable resources that can replace significant amounts of inorganic fertilizers (Leha, 1998).

Animal wastes in the form of manures are valuable

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Map 1. Showing sampling location of Umunneochi.

sources of nutrients and organic matter in the maintenance of soil fertility and crop production (Ogbuewu et al., 2012). Tamminga et al. (2000) reported that 55 to 90% of the nitrogen and phosphorous content of animal feed is excreted in faeces and urine, normally used as manure. Animal wastes are routinely applied to cropland to recycle nutrients, build soil quality, and increase crop productivity. Pinamonti and Zorzi (1996) reported that application of feacal waste could be beneficial for soil conservation especially in degraded soils. Animal manures have been effectively used as organic fertilizer. Such manures are valuable fertilizers and soil conditioners when applied under proper conditions at crop nutrient requirements. As reported by Bell (2002), animal wastes contain all essential plant nutrients. This paper examines the effect of Lokpa cattle market wastes on soil physicochemical parameters, soil anions and enzymatic activities and the implication for soil fertility. Findings will assist in adoption of adequate management practices as a panacea for improved utilization of these wastes for sustained agricultural productivity.

MATERIALS AND METHODS

Study area

The study Area Lokpa cattle market is located in Umuneochi Local Government Area of Abia State, Nigeria (Map 1). It is an open surface littered with cow dung, feed fallout and fallen leafs. The market harbours over 48,000 heads of cattle annually as an open feedlot and operates daily throughout the year. Leftover feedstuff and leaves are rarely carted away but left to rot within the market space. The area lies within latitude 055.33° and 06.03° North and longitude 07.10° and 07.29° East.

Soil sample collection

The study area was divided into transects of Central, North, South, East and West. An unpolluted area adjacent to the South was used as control. Samples were collected from the Centre of the market, 30 meters and 60 meters Northwards from the centre. The same was done Southwards, Eastwards and Westwards respectively using plastic auger. Depths of samples collection at each spot were 0 to 25cm and 26 to 50cm, respectively. Samples were transported in plastic bags containing ice packs to the soil Biochemistry laboratory of Abia State University, Uturu for further analysis.

Determination of soil physicochemical parameters

Soil Temperature was determined at the site of soil sample collection using mercury in glass thermometer as described by APHA (1998). Soil pH was measured using fresh soil samples according to the methods described by Bates (1954). Similarly soil moisture content was determined according to the procedure described by APHA (1998). Soil Electrical Conductivity was obtained using conductivity meter in 1:2 soil/water ratio as described by Whitney (1998).

Soil Organic Carbon was obtained according to the procedure presented by Walkely and Black (1934) while soil cation exchange capacity (CEC), sulphur (SO_4^{2-}), phosphate (PO_4^{2-}), nitrate (NO_3) were determined by the method of Dewis and Freitas (1970) and soil calcium carbonate determined by the method of Buuman et al. (1996).

Determination of soil enzymatic activities

The soil enzymes determined were Dehydrogenase, Urease, Hydrogen peroxidase and Alkaline phosphatase. Soil Urease activity was obtained according to the method of Tabatabai and Bremner (1972). Similarly, soil Alkaline Phosphatase, Dehydrogenase and acid Phosphatase activities were determined by the methods described by Tabatabai (1982) while Hydrogen Peroxidase activity was obtained by the method of Alef and Nannipieri (1995).

Statistical analysis

Data collected were subjected to statistical analyses using One Way Analysis of Variance (ANOVA) procedure and difference in means were separated using standard students t - Test. Values were mean ± standard deviation of triplicate determinations. Mean in the same column having different alphabet were statistically significantly ($p<0.05$).

RESULTS AND DISCUSSION

Table 1 and 2 shows the physicochemical properties and soil anions samples analyzed.

Results indicate that cattle waste soils had low acidity than the control. The low acid pH could be due to the presence of cattle dung and urine in the area. This change in pH is due to the release of ammonia following the metabolism of feacal matter which combines with the available moisture to cause change in pH. This agrees with Nwaugo et al. (2008) who observed low acid pH in cattle market waste soil. This pH however is not conducive for plant growth. Joan et al. (2000) reported that cattle manure amendment can increase the pH of soils. However, crop production on acid soil can be improved greatly when soil pH is adjusted to neutrality.

The higher ($P<0.05$) organic carbon content recorded from cattle market waste soils could be due to high input received from cattle waste and feed fallout which are mainly grasses and other weeds; and due to the fact that the initial site preparation does not involve clearing of vegetation hence the organic matter is not lost. This is in consonance with Lakshmikanti and Pramod (2012) who observed high organic carbon in poultry dung amended soils. Olaitan and Lombin (1988) reported that organic matter is a major indicator of soil nutrient due to its colloidal nature. These accumulated organic manures on the surface could be responsible for provision of conducive environment for high enzyme activities.

Jangid et al. (2008) reported that accumulation of organic carbon as a result of manure addition not only results in increased microbial biomass but has also been linked to changes in microbial community, structure and increased functional diversity. Moisture content of cattle waste soil were found to be higher than the control ($P<0.05$). This could be due to the capability of the cattle waste to increase soil infiltration of water. This agrees with Oriola and Hammed (2012) who observed high moisture content in cattle shed soils. Similarly, other nutrients namely calcium carbonate, Phosphate (PO_4^{2-}), Sulphate (SO_4^{2-}) are also higher in the cattle waste soil than the control. This higher values ($P<0.05$) is due to addition through animal manure (Dung and Urine).

Olaitan and Lombin (1988) reported that organic waste is a good and dependable source of these nutrients. Cation Exchange capacity of the cattle waste soil were lower than the control ($P>0.05$). This correlated negatively with the cattle waste soil. This decline could be due to lower concentration of heavy metals in the cattle waste soil since cation exchange capacity is directly related to the capacity of the absorbing metals. This agrees with Oriola and Hammed (2012) who observed that with increase in exchangeable cation, soil acidity may decline. This reduction in cation exchange capacity of the cattle waste soil correlated positively with pH of the control soil.

Table 3 and 4 shows soil enzyme activities of soil samples analyzed. Soil enzymes increase the reaction rate at which plant residues decompose and release plant available nutrients. Soil enzymes play an important role in organic matter decomposition and nutrient cycling. Soil enzymes analysed were found to be higher in the cattle market waste soil than the control. However, the presence of cattle dung which ultimately leads to high microbial activities could be responsible for the general increase in the enzyme activities. This agrees with Oriola and Hammed, (2012) who also observed increased enzyme activities in cattle waste soil. The majority of soil enzymes are extracellular enzymes produced by soil microbes. Similar to microbial biomass, enzymes are very

Table 1. shows soil physicochemical properties of Lokpa cattle market waste soil.

Parameters	**Temperature (°C)**		**pH**		**Moisture (%)**		**Organic carbon (%)**		**C.E.C (cmol/kg)**	
Soil Depth	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
Location ↓										
Control	25.01±0.01^{a}	26.00±2.00^{a}	6.49±0.08^{a}	6.23±0.08^{a}	11.91±0.01^{a}	10.41±0.02^{a}	1.29±0.19^{a}	0.54±0.39^{a}	50.40±0.26^{a}	13.20±0.40^{a}
C	27.30±0.70^{b}	26.20±0.10^{a}	5.32±0.38^{b}	4.33±0.12^{b}	21.58±0.37^{b}	11.61±0.03^{a}	2.83±0.27^{b}	1.42±0.02^{b}	17.20±0.26^{b}	19.60±0.20^{b}
N_1	29.53±0.60^{c}	28.00±0.40^{c}	5.07±0.03^{b}	5.82±0.32^{c}	19.47±0.51^{c}	12.89±0.07^{b}	2.33±0.19^{b}	1.51±0.03^{b}	9.60±0.02^{c}	10.40±0.35^{c}
N_2	28.00±1.00^{d}	26.40±0.10^{a}	4.26±0.28^{d}	3.04±0.02^{e}	14.81±0.26^{d}	11.41±0.01^{a}	2.63±0.09^{b}	3.51±0.01^{d}	14.00±0.44^{d}	15.23±0.51^{a}
S_1	27.00±0.26^{b}	27.00±0.40^{b}	4.27±0.22^{d}	4.12±0.14^{b}	13.72±0.42^{d}	15.83±0.034^{e}	2.10±0.11^{c}	0.94±0.05^{a}	12.80±0.20^{d}	15.20±0.53^{a}
S_2	27.10±0.10^{b}	26.33±0.12^{a}	4.02±0.01^{d}	4.07±0.01^{b}	17.63±0.01^{f}	15.53±0.01^{a}	3.51±0.01^{d}	3.22±0.01^{d}	12.70±0.20^{d}	16.60±0.30^{e}
E_1	28.00±0.20^{g}	28.33±0.58^{c}	4.95±0.13^{d}	4.22±0.30^{b}	23.42±0.39^{g}	10.66±0.42^{a}	1.72±0.03^{d}	1.62±0.02^{b}	23.20±0.20^{e}	24.67±0.23^{f}
E_2	27.00±0.40^{b}	27.00±1.00^{b}	4.12±0.01^{d}	4.00±0.10^{b}	17.81±0.17^{f}	11.49±0.05^{a}	2.71±0.01^{h}	0.18±0.02^{a}	11.20±0.36^{b}	11.60±0.20^{a}
W_1	29.0±1.11^{i}	28.80±0.10^{c}	4.30±0.01^{d}	5.91±0.01^{c}	10.88±0.05^{e}	8.12±0.02^{d}	1.92±0.10^{c}	1.68±0.01^{b}	26.40±0.36^{f}	35.17±0.15^{g}
W_2	27.00±0.10^{b}	28.00±1.00^{c}	4.20±0.01^{d}	5.69±0.23^{c}	14.90±0.05^{d}	10.57±0.31^{a}	2.92±0.16^{b}	1.74±0.02^{h}	21.30±0.60^{e}	22.20±0.10^{f}

Values are mean ± standard deviation of triplicate determinations. Mean in the same column, having different alphabet are statistically significant ($P<0.05$).
N/B: A = 0-25cm soil depth, B = 26 – 50cm soil depth. N, S, E, and W are North, South, East, and West from discharge point C.

Table 2. Soil anions of Lokpa market waste soil.

Parameters	**Calcium carbonate (mg/kg)**		**PO_4^{3-} (mg/kg)**		**SO_4^{2-}(mg/kg)**		**Cl^- (mg/kg)**	
Soil depth	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
Location ↓								
Control	24.71±0.30^{a}	31.22± 0.11^{a}	29.50±1.00^{a}	27.12±0.01^{a}	26.51±0.17^{a}	25.90±1.08^{a}	163.37±4.37^{a}	106.50±2.00^{a}
C	23.50±0.31^{b}	25.20± 0.02^{b}	46.40±0.10^{c}	39.13±0.03^{b}	1.59±0.62^{b}	1.20±0.16^{b}	14.20±0.10^{b}	14.47±0.31^{b}
N_1	21.89±0.32^{c}	28.22± 0.26^{c}	40.13±0.01^{b}	37.29±0.23^{f}	0.28±0.08^{c}	0.72±0.05^{c}	23.27±0.15^{c}	85.20±0.60^{c}
N_2	26.20±0.27^{d}	27.14± 0.02^{d}	48.97±0.85^{c}	29.61±0.01^{d}	1.57±0.30^{a}	1.54±0.05^{d}	28.40±4.84^{f}	49.20±0.20^{d}
S_1	24.45±0.09^{a}	28.95± 0.10^{c}	35.04±0.03^{d}	55.62±0.38^{c}	0.49±0.04^{d}	0.32±0.04^{e}	21.30±0.56^{e}	63.90±0.61^{e}
S_2	25.01±0.01^{a}	26.59± 0.06^{d}	46.23±0.15^{c}	44.26±0.02^{f}	0.32±0.01^{d}	0.73±0.01^{c}	21.50±0.10^{e}	51.13±0.15^{f}
E_1	27.15±0.14^{d}	30.47± 0.38^{a}	56.32±0.03^{e}	64.44±0.05^{g}	1.09±0.38^{b}	0.18±0.01^{f}	14.20±0.79^{b}	42.52±1.99^{d}
E_2	22.92±0.03^{b}	29.00± 0.13^{c}	33.58±0.46^{f}	53.14±0.37^{c}	0.97±0.07^{b}	0.13±0.01^{f}	21.30±0.20^{e}	78.10±1.13^{h}
W_1	23.30±0.29^{b}	25.12± 0.01^{b}	52.96±0.01^{g}	35.47±0.34^{i}	0.56±0.02^{d}	0.52±0.02^{c}	35.50±0.36^{d}	60.20±0.20^{e}
W_2	21.47±0.32^{c}	24.45± 0.30^{e}	39.42±0.71^{b}	41.02±0.03^{j}	1.04±0.02^{b}	0.40±0.06^{e}	30.40±0.20^{f}	85.20±0.90^{c}

Values are mean ± standard deviation of triplicate determinations. Mean in the same column, having different alphabet are statistically significant ($P<0.05$).
N/B: A = 0-25cm soil depth, B = 26 – 50cm soil depth. N, S, E, and W are North, South, East, and West from discharge point C.

Table 3. Soil dehydrogenase, acid and alkaline phosphate activities of Lokpa market waste soil.

Parameters	Alkaline phosphatase mg/g/h		Acid phosphatase mg/g/h		Dehydrogenase mgTPFg^{-1} dry-soil 6h^{-1}	
Soil Depth (cm^2)	**A**	**B**	**A**	**B**	**A**	**B**
Location ↓						
Control	8.69±0.036[a]	6.72±0.026[a]	3.71±0.02[a]	1.08±0.01[a]	0.34±0.02[a]	0.36±0.02[a]
C	7.69±0.060[b]	6.81±0.015[b]	14.86±0.06[b]	8.03±0.02[b]	0.42±0.01[b]	0.40±0.01[b]
N_1	6.90±0.026[c]	6.24±0.01[b]	9.65±0.00[c]	10.40±0.02[c]	0.88±0.01[c]	0.32±0.03[c]
N_2	5.53±0.030[d]	5.40±0.01[c]	7.44±0.02[d]	6.07±0.02[d]	0.40±0.01[b]	0.37±0.02[b]
S_1	6.24±0.053[c]	6.30±0.08[b]	17.08±0.02[e]	3.71±0.00[e]	0.72±0.01[d]	0.34±0.04[c]
S_2	6.18±0.010[c]	5.27±0.03[c]	10.04±0.02[f]	7.04±0.04[f]	0.77±0.01[d]	0.53±0.01[d]
E_1	5.68±0.010[d]	4.27±0.00[d]	7.43±0.06[d]	5.20±0.01[g]	0.45±0.05[b]	0.53±0.0[d]
E_2	5.68±0.030[d]	7.46±0.05[e]	5.94±0.03[e]	9.65±0.02[h]	0.40±0.01[b]	0.74±0.01[e]
W_1	6.09±0.020[c]	6.02±0.03[b]	8.01±0.01[f]	6.05±0.02[d]	0.87±0.01[c]	0.77±0.01[e]
W_2	7.28±0.026[b]	8.39±0.07[f]	7.43±0.06[d]	29.72±0.06[j]	0.64±0.01[e]	0.41±0.01[b]

Values are mean ± standard deviation of triplicate determinations.Mean in the same column, having different alphabet are statistically significant (P<0.05). N/B: A = 0-25cm soil depth, B = 26 – 50cm soil depth. N, S, E, and W are North, South, East, and West from discharge point C.

Table 4. Soil Urease and Hydrogen peroxidase activities of Lokpa market waste soil.

Parameter	Urease mgNH$_3$-Ng^{-1}drysoil		Hydrogen peroxidase Ml 0.1Ml^{-1}kmno$_4$g^{-1}	
Soil depth(cm^2)	**A**	**B**	**A**	**B**
Location↓				
Control	124.24±3.29[a]	108.76±0.82[a]	0.0019±0.0002[a]	0.0018±0.00020[a]
C	101.12±0.59[b]	101.55±0.94[a]	0.0013±0.0087[a]	0.0040±0.0010[b]
N_1	107.70±2.67[b]	180.39±0.51[c]	0.0016±0.0012[a]	0.0023±0.0000[c]
N_2	166.61±0.65[c]	156.97±0.01[d]	0.0018±0.00079[a]	0.0090±0.0000[d]
S_1	153.85±0.10[d]	268.73±5.49[e]	0.0029±0.00036[b]	0.0022±0.00030[c]
S_2	164.81±0.02[c]	154.01±0.01[d]	0.0023±0.00010[b]	0.0019±0.00010[a]
E_1	190.91±0.07[e]	120.93±0.05[e]	0.0032±0.00031[c]	0.0028±0.00044[c]
E_2	187.71±0.33[e]	384.44±29.98[f]	0.0027±0.00017[b]	0.0024±0.0002[c]
W_1	141.30±1.18[f]	132.65±0.01[b]	0.0021±0.60053[b]	0.0014±0.00015[a]
W_2	186.75±0.02[e]	125.13±0.105[e]	0.0029±0.00036[b]	0.0025±0.00052[c]

Values are mean ± standard deviation of triplicate determinations. Mean in the same column, having different alphabet are statistically significant (P<0.05). N/B: A = 0-25cm soil depth, B = 26 – 50cm soil depth. N, S, E, and W are North, South, East, and West from discharge point C.

responsive to manure availability.

Conclusion

Recycling of these wastes via land application could lead to improvement in agricultural soil properties. Since high concentration of chemical elements, enzyme activities and organic matter determine fertility status of soil, it thus implies that these waste can be used as fertilizers for increased agricultural productivity. The pH of the analyzed soil sample is not conducive for plant growth hence, care should be taken in the quantity of these manure applied to crops as it can increase the pH of soil and have adverse effect on the plants.

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