DYNAMICS OF CARBON AND PHOSPHORUS MINERALIZATION IN WETLAND SOIL AMENDED WITH ORGANIC WASTES

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Abstract
This work investigated the Kinetics of Carbon and phosphorus Mineralization when different organic wastes (Cattle Dung's, Poultry waste and Sewage Sludge) with varying degree of stability were added to wetland soil in Niger Delta. Respiration assays shows that the incorporation of organic waste led mineralization to a greater emission of carbon in form of CO_2 and greater degree of microbial activity in the Soil amended with organic wastes .Reaction rates decrease with time in the amended soil which could be attributed to the mineralization of the most resistant organic product. In a nutshell, mineralization occurs in two phases. The first phase was clearly differentiated from the second slower phrase, most especially in Fadama and acid sulphate soils that were amended. This could be due to high degree of organic matter released with time and the pH of the amended soil which were favorable.
Keywords: *Mineralization, Fadama, Wetland Soil and Organic Wastes*

INTRODUCTION

Organic wastes applications offer a means of restoration of organic matter to the soil. The decomposition of organic matter called mineralization depends on factors such as soil climatic conditions and the quantity of organic matter incorporated. [1,2] Application of organic waste to soil plays an important role in increasing Soil fertility because it supplies the Soil with nutrients (Mg, Ca, N, P etc) required by crops. It releases Carbon (iv) oxide into the air, improves the physical conditions of the Soil and maintain the Soil micro-organisms active state (3). The excretion of dung and urine from domestic animals such as cattle, sheep, goats, pigs and poultry provides the potentials for enormous quantity of plant nutrients. The organic material most community used to improve soil condition and fertility as farmyard manure, animal wastes, crop residues, commercial compost of urban origin, green manure and night soil. It has been reported that 15 tons Nitrogen and 4 tons of phosphorus, 4 tons of potassium are potentially available fromm1000 tons fresh cattle dung (4). An average sewage analysis has been given as 50ppm nitrogen, 7 ppm phosphorous and 25ppm potassium are potentially available per year for person (4) Using fertilizer instead of chemical fertilizer can results in a two-third energy saving (5). All heterotrophic micro organisms are capable of decomposing organic matter and this decomposition process has been used to indicate biological states of Soil (6). Cold wet spring usually result in retardation in plant growth often because of inadequate phosphorus absorption. [7]

The Fadama Soil (Wetland Soil) found in the Middle belt and Northern areas of Nigeria are mostly seen by Farmers as non-Agricultural land hence they are used for growing crops such as maize, guinea corn, tobacco and cattle grazing with little or no addition of organic wastes. When organic matter is added to the soil, production of organic decay such as organic acids and humus are thought to be effective in forming complexes with iron and Aluminum compound thereby releasing phosphorus previously fixed by iron compounds [5]. The effects of organic waste such as cattle dung, sewage sludge and poultry waste on phosphorus and carbon mineralization in Niger Delta wetland Soil is discussed in this work. This is to assist in maximizing the use of wetland Soil in Farming with application of organic waste.

SAMPLING AREA:
Three different soils samples were collected from three different Wetland areas in Delta State. Soil samples for the study were made up of Fadama soil collected from latitude 5^0 45^1N (Uwherun) and longitude 6^0 7^1 E, Eniitsol soil collected from latitude 5^0 15^1 N and longitude 6^0 11 ^{1}E(Patani) and acid Sulphate collected from latitude 5^0 36 ^{1}N and longitude 5^0 46^1E. (Warri)

PHYSICAL PROPERTIES OF SOIL SAMPLES
The Fadam Soil which was collected from Uwherun is grey colour, Sandy about 85% Sand, 5% Silt and 10% Clay, feels gritty when rubbed between fingers, not plastic or sticky when moist. The Acid Sulphate Soil is black Sandy loam Soil with 65% Sand 20% Silt and 15% Clay. It feels a bit smooth when rubbed between hand, powdery and not sticky when moist.
Enitsol Soil is yellow Clay Soil with 55% clay, 32% Silt and 13% sand. It feels smooth, sticky and plastic, when dry.

MATERALS AND METHODS
The three soil samples [Fadama (FA), Enitsol (Es) and acid sulphate(As)] collected from Uwherun, Patani and Warri respectively were selected to represent the major soil series in the Niger delta and include a wide range of chemical properties.

Sample which are of field moist soil were brought to the laboratory, passed through a 2mm sieve and was placed in a polythene bag and stored in a refrigerator at 4^0 C until incubation time. A sub-sample of this was used in the incubation experiment to study the mineralization of Phosphorus and Carbon. 1000grams of each soil samples were weighed into the incubating container. To these containers were added the organic waste fractions which include cattle dung, sewage sludge and poultry waste of 60grams, 40grams and 20grams of cattle dung, sewage sludge, poultry waste respectively for 56 days. De-ionized water was added to each soil mixture to bring it to 60% of its water holding capacity for each soil sample. Throughout the incubation period water losses exceeding 10% of the initial value were compensated by adding fresh distilled water.

After every 14 days of incubation 100grams of mixture we removed from each soil mixture and air dried before they were kept in a clean container which were well labeled awaiting analysis. [8]. The second portion of the soil sample was air dried at room temperature for 48 hours and stored in a tightly sealed bottle. A sub sample of air dried portion was ground to passed a 80 mesh sieve (180mm) for determination of chemical properties [8]. The various organic matters (cattle dung, sewage sludge and poultry waste) were oven dried for 3 days at 65^0C and ground to pas 20 mesh sieve (850mm) and were shared in a glass bottle at 40^oC.

DETERMINATION OF PHYSICO-CHEMICAL PROPERTIES OF SOIL
The pH of the samples was determined as described by Ademoroti.10gramsof soil samples mixtures were weighed into 200ml beaker. 20 ml of distilled water was added and allowed to stand for30 minutes. The pH meter which was standardized with buffer pH4 and pH9 was used

to determined the pH of the supernatant liquid [9]. The Total organic carbon (TOC) of the soil samples was determined using Walkley and Black method. 10 ml of 0.5 $K_2Cr_2O_7$ was added to one gram of each soil mixture and swirled gently. To each, 20ml of conc. H_2SO_4 was added immediately and allowed to stand for 20minutes. Each was diluted to 250ml mark. 10 ml Conc.H_3PO_3 and 0.5% of diphenylamine were added and blue colour appears. The chromic acid not used up in oxidation was titrated with iron(II)ammoniumtetrasulphate (vi) hexahydrate from burette. The solution changed from blue to gree at the end point. Blanck titration was carried out [10 and11]. The emitted CO_2 in the incubated mixtures which was captured in 0.1M NaOH was measured volumetrically with 0.1M HCl in the presence of Barium Chloride solution and phenolphthalein as an indicator [12]. All reagents used were of analytical grade obtained from Sigma BDH and Bulk Scientific.

Determination of Total Phosphorus and Available Phosphorous

The total and available Phosphorus in the soil were determined by using phospho-vanado-molybdate method. 2grams of air dried Soils mixtures were shaken with 400ml of buffer in a stopped bottle for 30 minutes. The filtrates were taken and diluted. Paranitrophenol and ammonia solution were added drop wise until yellow colour appeared. The colour was discharged by adding a drop of HCl. 4ml of ammonium molybdate sulphate was added and mixed properly.0.5M of stannous chloride solution was added and diluted to 100ml. the readings were taken within 10-15 minutes. The same way a blank process was carried out. [9]

RESULTS AND DISCUSSION

The three-soil sample (Fadama, Enitsol and acid sulphate soil) pH values before amendment are moderately acidic with pH values of 6.29, 5.75 and 5.5 respectively which correspond to the pH of the soil in Niger Delta area [13 and14]. Addition of organic wastes (cattle dung, sewage sludge and poultry waste) the pH remains slightly moderately acidic as shown in Table 1. It could be suggested here that in the soil mixture, the aluminum ion do no longer exist as Al^{3+} ion but it has been converted to aluminum hydroxide. This is in line with [15] which says that exchangeable H^+ that are released by base forming cations, move into the solution where it reacts with OH^+ to form water.

TABLE 1: pH of amended soil at 40g loading rates of organic wastes

Soil Mixtures	Day 14	Day 28	Day 42	Day 56
FAC	6.40	6.43	6.45	6.46
FAS	5.93	6.92	6.17	6.21
FAP	6.56	6.75	6.79	6.82
FACD	7.15	7.0	7.05	7.10
ESC	6.01	5.86	5.46	5.38
ESS	5.63	5.75	5.85	5.94
ESP	6.51	6.54	6.56	6.66
ESCD	6.62	6.64	6.68	6.76
ASC	5.88	5.92	5.96	6.00
ASS	5.77	5.93	5.99	6.09
ASP	6.28	6.32	6.40	6.49
ASCD	6.21	6.24	6.34	6.41

FAC = Fadama control
FAS =Fadama +sewage sludge
FAP =Fadama +poultry droppings
FACD = Fadama+ Cattle dung

ESC= Enitsol control
ESS = Enitsol +sewage sludge
ESP = Enitsol +poultry droppings
ESCD = Enitsol+ Cattle dung

ASC = Acid Sulphate control
ASS = Acid Sulphate +sewage sludge
ASP = Acid Sulphate +poultry droppings
ASCD = Acid Sulphate+ Cattle dung

The reaction rate of carbon mineralization in the control soil is higher than the sewage amended soil in the first three days. This is attributed to a rapid decomposition of dead microbial biomass. After the initial flush, the decomposition rate of soil organic matter becomes lower. The initial flush was described by a first order kinetics as shown in Table 2. Independent of time, the organic matter remained in the soil, mineralization occurs in two distinct phases. The first rapid phase which corresponds to decomposition of the most labile produced by the microorganisms and second phase, slower phase between 14 days and 50 during which the most resistant organic product started to mineralize [6]. Data of the CO_2 evolved fitted into the first order equation (log A =log A_o- K^+/2303) indicated that the reaction followed a first order equation.

TABLE 2: Reaction rates (k) estimated according to first order equation at 40g loading rates of organic wastes

Soil samples + organic waste	Day 3	Day 8	Day 14	Day 21	Day 28	Day 39	Day 50
FAC	0.39	0,26	0.04	0.03	0.03	0.01	0.01
FAS	0.15	0.11	0.02	0.03	0.02	0.02	0.02
FAP	0.03	0.01	0.007	.004	0.01	0.006	0.009
FACD	0.05	0.02	0.01	0.01	0.02	0.02	0.02
ESC	0.30	0.13	0.04	0,02	0.01	0.009	0.006
ESS	0.20	0.03	0.03	0.02	0.02	0.01	0.01
ESP	0.09	0.008	0.03	0.01	0.007	0.003	0.003
ESCD	0.14	0.03	0.02	0.01	0.007	0.003	0.002
ASC	0.12	0.12	0.04	0.03	0.01	0.008	0,006
ASS	0.05	0.03	0.02	0.02	0.02	0.02	0.02
ASP	0.03	0.03	0.01	0.01	0.008	0.005	0.004
ASCD	0.05	0.02	0.01	0.01	0.01	0.005	0.004

Among the three amended soil with the three different organic wastes at dosage of 40g as shown in Figure 1- 3, Acid sulphate soil mixture has the highest total organic carbon released at different days of incubation and this is followed by Enitsol and the least being Fadama soil mixture. This can be attributed to the wet nature of the acid sulphate which brings about built up of carbon.

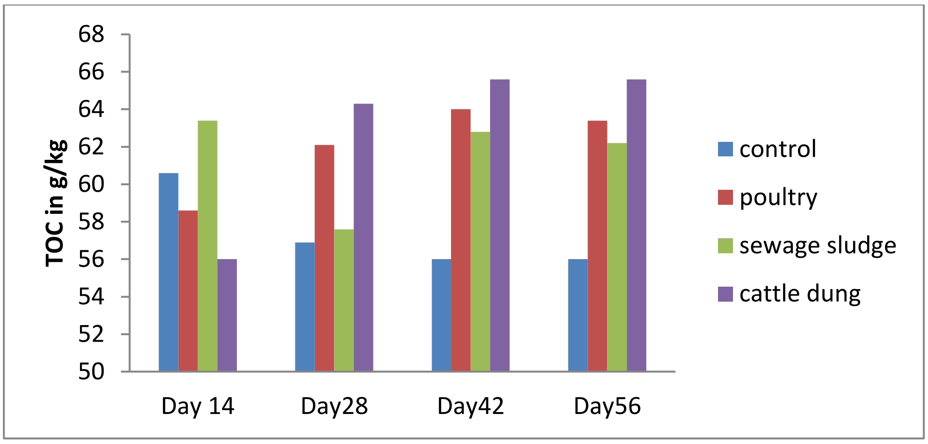

Figure: 1: Total organic carbon (TOC) in g/kg of Eadama soil at 40g loading rates of organic waste

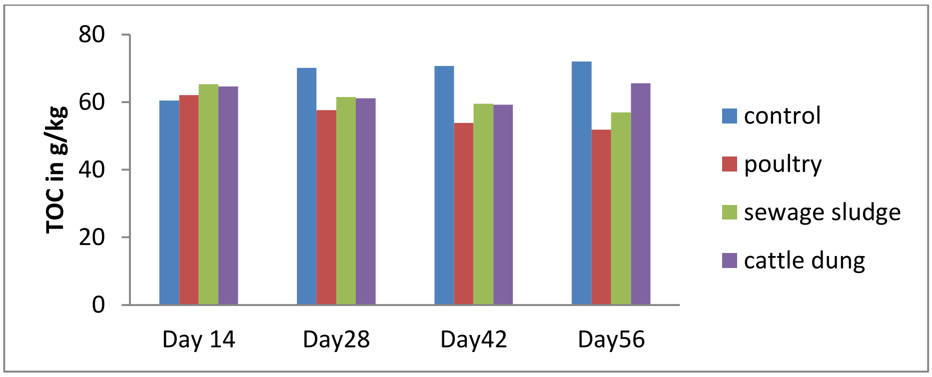

Figure 2: Total organic carbon(TOC) in g/kg of Enitsol soil at 40g loading rates of organic waste

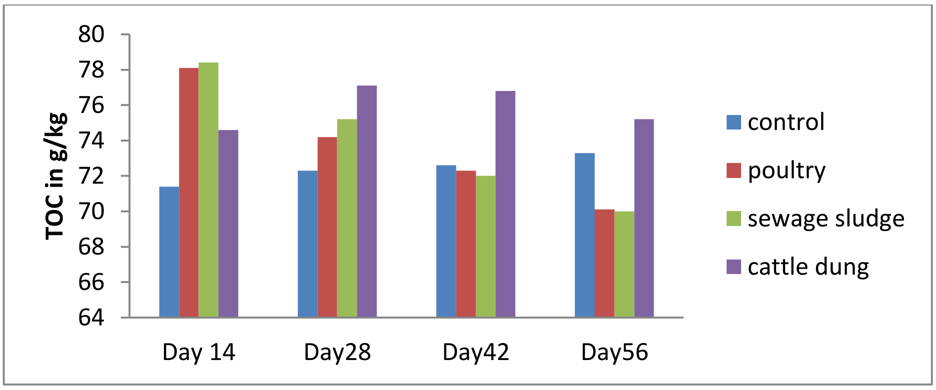

Figure 3: Total organic carbon (TOC) in g/kg of acid sulphate Soil at 40g loading rates of organic waste

There was increase in total phosphorus with time in the three-soil mixture. This could be attributed to the moderately acidic nature of the soil. The increase is more in Enitsol and Acid-sulphate soil due to the presence of high organic matter content in the soil which releases acid and humus which are effective in forming complexes with iron and aluminum compounds thereby releasing phosphorus previously fixed by iron complexes [15].

Table 3: Total phosphorus at 40g loading rates of organic wastes

	Day 14	Day 28	Day 42	Day 56
FAC	6.2	8.0	9.1	9.5
FAS	6.9	8.0	11.5	13.7
FAP	10.2	11	12.6	13.1
FACD	6.2	9.9	12.6	13.4
ESC	7.7	6.9	8.0	8.6
ESS	6.9	10.2	11.5	13.7
ESP	6.9	9.1	10.2	12.1
ESCD	6.2	9.1	10.2	12.1
ASC	7.3	9.9	9.9	13.3
ASS	12.1	13.1	28.5	16.1
ASP	6.9	8.6	10.9	13.1
ASCD	6.9	8.6	10.9	12.6

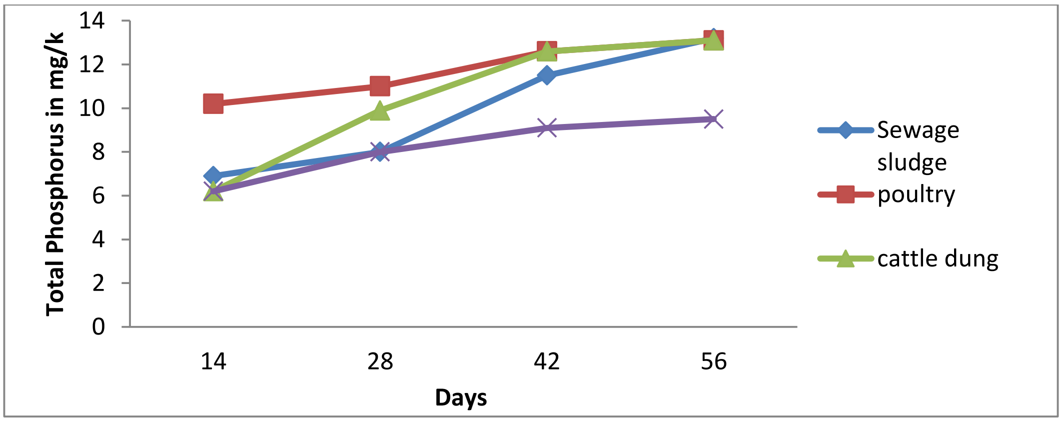

Figure 4: Total phosphorus in mg/kg of Eadama soil at 40g loading rates of organic waste

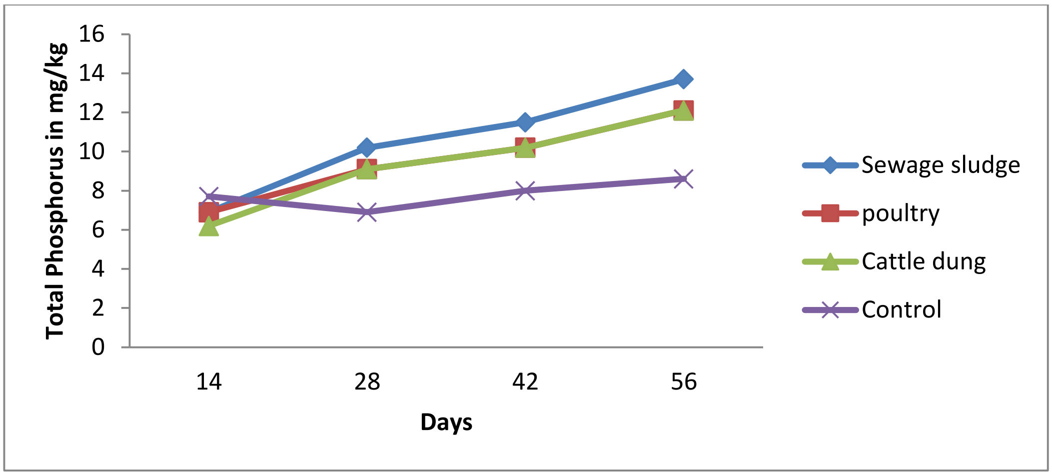

Figure 5: Total phosphorus in mg /kg of Enitsol soil at 40g loading rates of organic waste

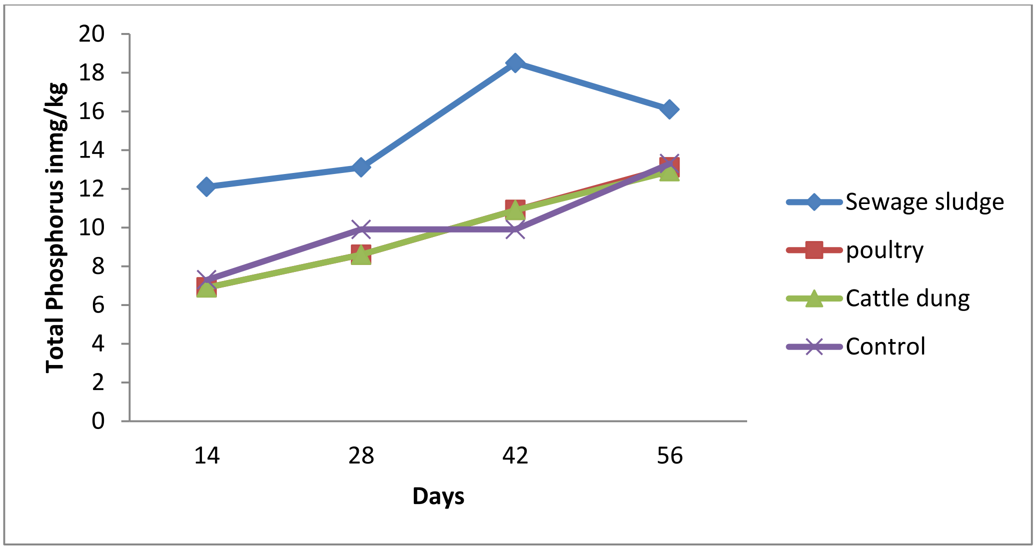

Figure 6: Total phosphorus in mg /kg of acid sulphate soil at 40g loading rates of organic waste

In comparison with the control of the three soil samples with the amended soils, acid sulphate soil has the highest available Phosphorus mineralization followed by Enistol and the least is fadama irrespective of the dose of the organic waste and the type of organic waste. In a nutshell, the three different organic wastes gave reasonable available phosphorus in the three different amended soils as shown in Table 4.

CONCLUSION

In agreement with the authors, [16, 17 and 18] Who demonstrated that CO_2 emission acted as an indicator of soil microorganism activity, once a certain time has elapsed in the amendment of soils (regardless of the material used) the emission of CO_2 was very similar in all cases although its evolution differed.

The biological activity generated depends more on the quality than the quantity of organic materials used since all treatment used in the experiment at the different dosage gave similar results.

In Enitsol amended soil, it was observed that all the organic waste yielded good mineralization values when compared with the control but sewage is preferably recommended. In fadama soil amendment, addition of poultry waste is recommended while cattle dung and poultry waste are are preferred for acid sulphate soil amendment.

In terms of total and available Phosphorus mineralization, increase in mineralization depends on the pH and the total organic matter released by the amended soil. The loading rate and the organic waste type added have little or no effects on the mineralization.

Table 4: Available phosphorus at 40g loading rates of organic wastes

Soil Mixtures	Day 14	Day 28	Day 42	Day 56
FAC	6.0	3.5	3.2	3.2
FAS	3.4	3.2	4.1	4.1
FAP	3.4	4.9	4.7	4.7
FACD	4.1	4.4	4.1	4.4
ESC	3.5	3.5	3.2	2.9
ESS	2.6	5.1	5.1	4.7
ESP	3.2	3.2	4.1	4.1
ESCD	3.2	3.7	3.7	3.7
ASC	3.2	3.5	3.7	3.7
ASS	3.5	3.5	4.4	4.4
ASP	3.7	3.7	4.4	4.7
ASCD	3.5	6.0	5.6	5.6

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