i TECH MAG

DOI: http://doi.org/10.26480/itechmag.03.2021.50.54

ISSN: 2710-5873 (Online)
CODEN: ITMNBH

RESEARCH ARTICLE

INFLUENCE OF ANIMAL MANURES ON DEHYDROGENASE ACTIVITIES AND MICROBIAL POPULATION IN TROPICAL SOIL OF SOUTHEASTERN NIGERIA

Afangide A.I.,[a*], N.T. Egboka[a], P. Inyang[b] , C.T. Tom, C. D. Ebele[a]

[a] Department of Soil Science and Technology Federal University of Technology, P.M.B. 1526, Owerri, Imo State, Nigeria.
[b] Department of Agriculture, Faculty of Agriculture Alex Ekwume Federal University, Ndufu-Alike, P.M.B.1010, Abakaliki.
****Corresponding Author Email: afangideakaninyene2000@gmail.com***

ARTICLE DETAILS

Article History:

Received 04 September 2021
Accepted 07 October 2021
Available online 10 October 2021

ABSTRACT

This study assessed the usefulness of poultry and swine manures in the improvement of soil properties, microbial counts and dehydrogenase activities. A randomized complete block design was applied with three replicates consisting of poultry and swine manures as treatments applied at the rate (30 t ha^{-1}) on each of the two experimental plots. Soil samples obtained from depths 0-15 cm and 15-30 cm at week 0, 2, 4, 6, 8, 10 and 12 for dehydrogenase and microbial densities *using* standard procedures. The pH (H_20) slightly increased from 4.08 to 5.60 following manure application. At 0-15 cm soil, poultry manure increased pH by 25% soil while swine manure increases by 21%. Potential dehydrogenase recorded highest amount of production 7.09 Mg g^{-1} at 6 weeks of decomposition treated with swine manure at 15-30 cm soil depth. Bacterial counts increased from 1.27 x10^4 Cfu g^{-1} to 6.00 x10^7 Cfu g^{-1} in soil treated with poultry manure whereas soil amended with swine manure increased from 1.50 x10^4 Cfu g^{-1} to 7.10 x10^7 Cfu g^{-1}. The results revealed that swine manure enhanced dehydrogenase production and microbial diversities than poultry manure.

KEYWORDS

Dehydrogenase microflora, Soil amendments, Soil properties

1. INTRODUCTION

Tropical soils are characterized by low soil organic matter, pronounced weathering effects, low pH, low cation exchange capacity, low base saturation, low fertility and often associated with different nutrients deficiencies. However, animal manures are very important to the soil system because of numerous roles they perform which include; plant nutrients supply, improvement of soil organic matter content of the soil, increased soil pH, increased soil cation exchange capacity, generating the glue critical to stable aggregate, increased water holding capacity of the soil and also improved soil macro-structure as well as erosion resistance (Adebola et al., 2017).

Animal manures potentially hosts microorganisms. The decomposition of larger amount of animal manures are performed by bacteria while fungi decompose the more complex or resistant material found in the manures (Yamamoto and Nakai, 2019). Environmental variables mostly physico-chemical properties of the soil, temperature, moisture level of the as well as the amount of C/N ratio affect the rate of decomposition of animal manures by soil microbes (Meng et al., 2019). The amount of carbon and other nutrients in animal manures increased microbial diversity, most importantly bacteria diversity although fungal are fewer in number in soils treated with animal manures (Rastogi et al., 2020).

These microorganisms are responsible for different agro ecosystem functions such as humus formation through decomposition of animal manures, formation of a stable aggregate, nutrients cycling mostly nitrogen and phosphorus and other key soil transformation processes, bacteria, fungal and actinomycetes are the dorminant microorganism found in animal manures during decomposition (Karnchanawong and Nissaikla 2014; Maeda et al., 2013). For microorganisms to achieve the function of nutrients transformation and decomposition of animal manure, enzymes are produced, but its activities during decomposition of animal manures are often faced by some environmental variables such as soil pH, soil moisture, oxygen availability, quality of substrate present and soil depth (Delgado et al., 2004; Rebollido et al., 2008).

Dehydrogenase occurs in all living microbial cells intracellularly (Yuan and Yue 2012; Zhao et al., 2010). Dehydrogenase is a complete measure of total activity of soil microbes; thus, it is an index of microbial activity in the soil as it plays a vital role in the dynamics of animal manures during its decomposition, important in nutrient cycling and in the improvement of soil structure as the manures decompose (Paradelo and Barral 2009). Dehydrogenase is essential in the oxidation of soil organic matter biologically through the action of transfer of hydrogen from the organic substrate to inorganic acceptors (Zhang et al., 2010). Some researchers reported soil dehydrogenase (EC.1.11) as the main representative of oxidoreductase enzymes (Gue at al., 2009). The role of dehydrogenase is in consonance with microbial biomass.

Therefore, it is worthy of note that microorganisms and dehydrogenase are sensitive to animal manures application to soil. Consequently, the relationship between dehydrogenase and microbial abundance during the period of decomposition of animal manures in soil is not obvious in a tropical soil. Based on above, the aim of the research was to asses microbial diversity and dehydrogenase activities in soil amended with poultry and swine manures in a tropical soil of southeastern Nigeria. The specific objectives were to determine the physico-chemical properties of the studied soil before and after the application of animal manures and establish the relationship between microbial population and potential and actual dehydrogenase activities of the test soil. Thus, the research is key to improving nutrients status of tropical soils as well as knowing the right time to plant after application of animal manures.

2. MATERIALS AND METHODS

2.1 Study Area

The research was conducted in Uyo, southeastern Nigeria, lying between latitude 5^{0}01’ 05’’ and 5^{0}01’10’’N and longitude 7^{0}59′50’’ and 7^{0}59’55’’ E. The climate is tropical hot humid characterized by two distinct rain (Aril to October) and dry (November to March) seasons. Rainfall is bimodal (July and September) and heavy with annual range between 2000 to 3500 mm. Temperatures are uniformly high averaging between 28 to 30 ^{0}C

Cite the Article: Afangide A.I., N.T. Egboka, P. Inyang , C.T. Tom, C. D. Ebele (2021).
Influence of Animal Manures on Dehydrogenase Activities and Microbial Population in Tropical Soil of Southeastern Nigeria. *i TECH MAG, Vol 3: 50-54.*

while relative humidity is high about 75%. The permeability of the soil is high, well-drained, structures are unstable, very low in organic matter content and derived from coastal plain sand (Ojiaka, 1975). The vegetation is rain forest characterized by secondary forest and usually interspersed with wild oil palm. Shifting cultivation is the traditional land us in the area, associated with slash-and-burn. Bush fallow system is the traditional way of replenishing lost nutrients.

2.2 Experimental design

Complete randomized block design (CRBD) was employed for the experiment and the plot size used for manure application measured 4.0 m x 4.0 m with plots separated by 1.5 m apart

2.3 Field Study

A total of six experimental plots were made, three plots for cured poultry manure (PM) amendment and another three plots for cured swine manure (SW) amendment. The experimental plots were cleared, plowed and harrowed prior to applications of amendments. The amendments were obtained from University of Uyo Teaching an Rearch farm, Nigeria. The amendments were applied at a rate of 30t ha^{-1} on each of the experimental plots based on the recommendation for southeastern Nigeria soils and were allowed to decompose for a period of ninety days, soil samples obtained from depths 0-15 cm and 15-30 cm at week 0, 2, 4, 6, 8, 10 and 12 for dehydrogenase activity and microbial diversity through the use of soil auger and sterilized polyethene bags (Afangide et al., 2020). Soil samples were also collected before application of amendments and after twelve weeks of decomposition.

2.4 Experimental design and treatments

The soil samples were allowed to air-dried and sieved through a 2- mm sieve. Particle size distribution, pH was measured using glass electrode organic carbon, available phosphorus, total nitrogen, effective cation exchange capacity, exchangeable acidity (Gee and Or 2002; Thomas 1996; Thomas 1996; Nelson and Sommers 1996; Thomas 1996; Bremner 1996; Olson and Sommers 1982). Manures were properly air-dried, milled by hammer to obtain its particle size less than 1.5 mm. HNO_3 and H_2SO_4 were used to extract chemical constituents of the manures following digestion. PH, total nitrogen, organic carbon, available phosphorus was analyzed using standard methods (Kaira and Maynard, 1991; Cater, 1993).

2.5 Microbial Analyses

Bacteria, actinomycete and fungal counts in the soil amended with animal manures were serially diluted by method outlined by through the use of different sterilized growth media. Nutrient agar (NA) was used for bacterial isolation (Benson, 2002). Actinomycete isolation agar was used to isolate and enumerate. Malt extract agar (MEA) was employed for fungal counts. A serial dilution that varied from 10-1 to 10-5 was then prepared in triplicate and one gram of amended soil with animal manures in nine ml of saline solution and aliquot of about 100ul was spread to each of the plate. The plates were incubated at room temperature and enumeration was done after two days for bacterial count, while actinomycete and fungal counts were enumerated after five days, expressed as colony forming unit per gram (cfug-1). They were characterized and identified based on cultural, microscopic and biochemical features as described (Cheesebrough, 2006). Fungal (Oyeleke and Qksusami, 2008). Actinomycete (Eka and Fogathy, 1992).

2.6 Determination of Dehydrogenase Activity

The method outlined by was used to determine dehydrogenase. 3g of moist soil, 2g of Caco$_3$ was prepared and mixed thoroughly (Tabatabai, 1982).1ml was taken from 3% aqueous solution of 2,3,5- triphenyl terazolium chloride, 2.5ml of distilled water and also 2.5ml of glucose solution were used for both actual and potential dehydrogenase, it was incubated at 37°C for 24 hours and 10ml of methanol added, the contents were shaken for one minute, it was then filtered through filter paper. The dehydrogenase was measured calorimetrically at 485nm and expressed as mgtriphenyl formazan (TPF) per gramme of soil.

2.7 Statistical analysis

Data were subjected to analysis of variance (ANOVA) using the software package (SAS, 1999). Means were compared using Duncan Multiple Range Test at 5% level of probability. Correlation analysis was used to determine the relationship between dehydrogenase and microbial diversity.

3. RESULTS AND DISCUSSION

3.1 Manure Characterization

Poultry and swine manures characterization are shown in Table1.The results revealed that some chemical properties such as pH, available phosphorus and organic carbon were higher in poultry manure than swine manure. There was a slight increase of pH in poultry manure which may be ascribed to degradation of acid- type compounds and increase in ammonia as reported (Bustamante et al., 2008). The variation in chemical parameters of poultry and swine manures may also be as a result of feed supplied to the animal, age and nutrients dynamics (Chadwick et al., 2000). Consequently, swine manure was higher in organic carbon, total nitrogen and C/N ration than poultry manure, showing that mineralization will be rapid in poultry manure treated soil than swine manure amended soil due to decrease in activity of microorganism because of elevated amount of C/N ratio as reported (Azam, 2002)

Table 1: Chemical Characteristics of the Manures used for the Study

Properties	Poultry manure (PM)	Swine manure (SM)
Total nitrogen g kg^{-1}	56.2	62.4
Organic matter g kg^{-1}	762.3	675
Organic carbon g kg^{-1}	370.4	462.7
Available phosphorus g kg^{-1}	28.2	25.0
C/N	7.5	9.6
pH(H_20)	7.38	6.58

The relative proportion of Sand, silt and clay at 0-15 cm and 15-30 cm soil depths are shown in Table 2. Sand, silt and clay ranged from (838.33-876.46) g kg^{-1}, (42.00-62.47) g kg^{-1} and (78.54-102.98) g kg^{-1} respectively. Variations occur in particle sized distribution following the application of treatments but the changes were not different significantly ($p<0.05$). The textural class was loamy sand irrespective of depths and treatments, although they were not statistically different showing that soil texture is and intrinsic property of the soil. This finding agreed with who reported that variation in texture of the soil does not occur easily but can occur after many years of cropping, irrespective of different agronomic practices employed (Hulugalle, 1994). The pH (in H_20) varied from 4.08 to 5.60, indicating that soil was strongly acidic.

However, it is a discernable proof of soil reaction in southeastern Nigeria which may be attributable to acidic nature of its parent material and high influence of leaching as asserted (Uzoho et al., 2017). Soil organic carbon ranged from (1.30-2.40) g kg-1 ,toal nitrogen varied from (0.08-0.18) g kg-1 and available phosphorus ranged from (35.67-70.00) g kg-1, which were low. Their values were consistently greater than unamended soil (Table 2). The accumulation of soil organic carbon increased by 33 % and 36 % at surface and subsurface soil respectively while swine manure treated soil increased by 33 % and 37 % at top soil and subsoil respectively. Swine manure treated soil recorded highest organic carbon than Poultry manure treated soil. The variations may be due to manure quality and C/N ratio that may influence the deposition of carbon in the soil as asserted (Puttaso et al., 2011). Soil organic carbon was low/ medium based on the rating of who rated SOC as low (0.5-1.5) % and medium (1.5-3) % (Tekalign, 1991). Similarly, the values of total nitrogen was low based on the rating of who rated total nitrogen as low (0.05-0.21) % and also, available phosphorus were low and it characterized the true state of southeastern Nigeria soils due to rapid loss of N by leaching of nitrate and inorganic PO4-1 fixation by Fe and Al compounds as reported by (Chizoba, 2014; Eshett et al., 1990).

Table 3 shows microbial counts in soil treated with animal manures. Total heterotrophic bacterial counts ranged from 1.27 x10^4 Cfu g^{-1} to 6.00 x10^7 Cfu g^{-1} in soil treated with poultry manure whereas soil amended with swine manure increased from 1.50 x10^4 Cfu g^{-1} to 7.10 x10^7 Cfu g^{-1}. Total fungal counts varied from 2.10 x10^3 Cfu g^{-1} t0 3.33 x10^6Cfu g^{-1} in amended soil with poultry manure while amended soil with swine manure varied from 2.00 x10^3 Cfu g^{-1} to 4.73 x10^6 Cfu g^{-1}. Total actinomycetes counts increased from 1.10 x10^3 Cfu g^{-1} to 5.40 x10^5 Cfu g^{-1} in poultry manure treated soil but swine manure treated soil increased from 1.44 x10^3 Cfu g^{-1} to 5.55 x10^5 Cfu g^{-1}. Each of the manures induced an increased in microbial community (Table 3) but the increase was very prominent in swine manure amended soil than poultry manure amended soil.

Increased in microbial diversity in soil amended with swine manure may be attributed to higher carbon contents in swine manure than poultry manure because the autochthonous microorganisms in the soil have been reported to act promptly to manures containing higher content of carbon (Das et al., 2016). Following the application of the manures, the order of increase of microbial counts were as follows; bacteria> fungi > actinomycete. Actinomycete was the least because the soil reaction was strongly acidic that may alter their proliferation as reported (Brady and Weil, 1984). At second week of manures decomposition, bacteria, fungi and actinomycete were remarkably higher at the top soil relative to subsoil which may be due to substantial number of manures at this stage of decomposition, but from 4th week of decomposition subsoil maintain a steady increase in microbial densities throughout the period of decomposition because of effect of leaching. This is in tune with who reported an increase in microbial communities owing to increase in livestock manures which will impact their proliferation (Li et al., 2017).

Table 2: Physico-chemical properties of the soil of the study area at 0-15 cm and 15-30 cm soil depth tested parameters

	0-15P_1	**15-30P_1**	**0-15S_1**	**15-30S_1**	**0-15P_2**	**15-30P_2**	**0-15S_2**	**15-30S_2**
Sand ($mgkg^{-1}$)	876.46a	871.33a	852.33b	840.47b	868.67a	864.00b	848.67b	838.33b
Silt ($mgkg^{-1}$)	45.00cd	43.38abc	54.00dc	62.47b	42.00abc	42.33abc	52.33cd	58.69cd
Clay ($mgkg^{-1}$) TC	78.54a LS	85.29c LS	93.67b LS	97.06ab LS	89.33cd LS	93.67b LS	99.00bc LS	102.98abc LS
pH ((H_20)	4.20d	4.08d	4.20d	4.10cd	5.60b	5.48cb	5.40ab	5.10bc
OC (gkg^{-1})	1.40b	1.30c	1.52b	1.40b	2.10bc	2.02a	2.40ab	2.04a
TN (gkg^{-1})	0.14a	0.09c	0.12a	0.08c	0.18ab	0.10e	0.16a	0.11cd
AVP ($mgkg^{-1}$)	42.00d	36.33ab	38.33c	35.67ab	70.00a	45.67b	65.00b	43..33bcd
ECEC ($Cmolkg^{-1}$)	12.23b	10.44c	13.10a	10.52c	18.26ab	15.69cd	17.23ab	13.80b

Key: Mean values with the same letter (s) within the rows are not significantly different from one another at $p<0.05$. OC –organic carbon, TN – total nitrogen, AVP – available phosphorus, ECEC – effective cation exchange capacity, P_1 and S_1-represent soil untreated with poultry and swine manures respectively, P_2 and S_2 – represented soil treated with poultry and swine manures respectively. TC- Textural class

Table 3: Total microbial counts (Cfu g-1) in top-soil and sub-soil treated with poultry and swine manures

Microbial counts	**Soil depth (cm)**	**Week 0** ($\times10^{3}$ $x10^{4}$ Cfu g^{-1})	**Week 2** ($\times10^{4}$ $x10^{6}$Cfu g^{-1})	**Week 4** ($\times10^{4}$ $x10^{5}$ $x10^{6}$Cfu g^{-1})	**Week 6** ($\times10^{5}$ $x10^{6}$ $x10^{7}$Cfu g^{-1})	**Week 8** ($\times10^{4}$ $x10^{5}$ Cfu g^{-1})	**Week 10** ($\times10^{3}$ $x10^{4}$ $x10^{5}$Cfu g^{-1})	**Week 12** ($\times10^{3}$ $x10^{4}$ $x10^{5}$Cfu g^{-1})
THBC (pd)	0-15	$1.90x10^{4}$a	$1.60x10^{6}$b	$5.80x10^{6}$a	$4.60x10^{7}$b	$1.50x10^{5}$a	$6.40x10^{4}$a	$4.40x10^{4}$c
	15-30	$1.27x10^{4}$c	$1.30x10^{6}$a	$7.00x10^{6}$ab	$6.00x10^{7}$b	$1.56x10^{5}$a	$6.73x10^{4}$a	$5.60x10^{4}$c
THBC (sm)	0-15	$2.42x10^{4}$a	$1.92x10^{6}$b	$6.62x10^{6}$a	$6.40x10^{7}$ab	$2.30x10^{5}$ab	$1.67x10^{5}$a	$1.50x10^{5}$a
	15-30	$1.50x10^{4}$a	$1.78x10^{6}$a	$8.00x10^{6}$ab	$7.10x10^{7}$a	$3.50x10^{5}$a	$1.80x10^{5}$a	$1.67x10^{5}$a
TFC (pd)	0-15	$2.10x10^{3}$b	$5.30x10^{4}$a	$2.50x10^{5}$a	$2.60x10^{6}$b	$5.63x10^{4}$a	$2.50x10^{4}$c	$2.10x10^{3}$b
	15-30	$1.50x10^{3}$b	$4.00x10^{4}$a	$3.10x10^{5}$a	$3.33x10^{6a}$b	$4.33x10^{4}$b	$2.63x10^{4}$b	$2.40x10^{3}$b
TFC (sm)	0-15	$5.20x10^{3}$b	$5.20x10^{4}$a	$5.40x10^{5}$a	$2.40x10^{6}$b	$7.00x10^{4}$a	$4.20x10^{4}$a	$2.30x10^{3}$b
	15-30	$2.00x10^{3}$a	$4.20x10^{4}$a	$4.67x10^{5}$a	$4.73x10^{6}$a	$6.40x10^{4}$ab	$3.40x10^{4}$a	$3.60x10^{3}$a
TAC (pd)	0-15	$1.50x10^{3}$b	$1.50x10^{4}$a	$3.90x10^{4}$a	$2.70x10^{5}$b	$1.20x10^{4}$ab	$3.00x10^{4}$a	$1.90x10^{3}$b
	15-30	$1.10x10^{3}$a	$1.18x10^{4}$b	$4.43x10^{4}$cb	$5.40x10^{5}$b	$1.10x10^{4}$a	$4.10x10^{4}$a	$2.70x10^{3}$a
TAC (sm)	0-15	$1.92x10^{3}$a	$1.60x10^{4}$a	$5.00x10^{4}$a	$4.20x10^{5}$ab	$1.70x10^{4}$a	$4.20x10^{3}$a	$2.40x10^{3}$b
	15-30	$1.44x10^{3}$a	$1.50x10^{4}$a	$6.70x10^{4}$a	$5.50x10^{5}$ab	$2.50x10^{4}$a	$4.70x10^{3}$a	$3.40x10^{3}$a

Key: Mean values followed with the same letter(s) within the rows are not significantly different ($p<0.05$) THBC= Total heterotrophic bacterial count, TFC = Total Fungal count; TAC = Total Actinomycetes count Pd = Poultry dropping; Sm = Swine manure

3.2 Different microbial species isolated from the test soil

Diverse microbial species are shown in (Table 4), bacterial isolates were identified as *Klebsiella Sp, pseudomonas aeroginosa,* Bacillus *subtilis, Escherichia* coli, *Streptococcus sp*, and *Enterobacter sp*. Actinomucete isolates were *Actinoborocallus sp* and *Streptomyces sp*. Fungal isolates were *Aspergillus Flavus, Clasdosporium Flvum, Trichophyton sp, Botrytis Sp, Rhizopus Stolonifer, Mucor mucedo, Fusarium Sp, Cephalosporium sp, Penicillium notatum, Verticillium* alboatrum, *monilia stilophila, Gliocladium sp* etc.

Table 4: Microbial isolates from the test soil

S/N	**BACTERIA**	**FUNGI**	**ACTINOMYCETES**
1.	*Klebsiella sp*	*Aspergillus Flavus*	*Actinoborocallus sp*
2.	*Pseudomonas aeroginosa*	*Clasdosporium Fulvum*	*Streptomyces sp*
3.	*Streptococcus sp*	*Trichophyton sp*	
4.	*Baccilus subtilis*	*Botrytis sp*	
5.	*Escherichia coli*	*Rhizopus stolonifer*	
6.	*Enterobacter sp*	*Mucor mucedo*	
7.		*Fusarium sp*	
8.		*Cephalosporium sp*	
9.		*Penicillium notatum*	
10.		*Verticillum alboatrum*	
11.		*Monilia stilophila*	
12.		*Gliocladium sp*	

Table 5 shows actual and potential dehydrogenase activities in soil treated with poultry and swine manures. Potential dehydrogenase varied from (1.80- 6.72) Mg g^{-1} in soil treated with poultry manure while soil amended with swine manure increased from (1.65-7.09) Mg g^{-1}. Surface layers recorded relatively higher level of potential dehydrogenase than subsurface layers at 0 week and week 2 of manures decomposition due to effect of nutrient cycling and higher levels of manures on the surface soil at the early stage of decomposition. Although, 4th to 12th weeks of decomposition of manures had greater accumulation of enzymes at the subsurface layers owing to intense leaching which is the true characteristics of humid tropical region. Increase of potential dehydrogenase at the surface soil during its early period of decomposition agrees with the finding of Yuan and Yue (2012) who reported that the more the quantity of animal manures, the more enzymes production due to its attendant microbial biomass. Poultry manure increased potential dehydrogenase by 67%, 57%, 45%, 43%,35% and 31% at week 2,4,6,8,10 and 12 of decomposition from the surface layers respectively. Actual dehydrogenase ranged from (0.62-5.63) Mg g^{-1} in poultry manure treated soil whereas swine manure amended soil varied from (0.96-5.18) Mg g^{-1}. Actual dehydrogenase was consistently higher in swine manure treated soil than poultry manure treated soil. This may be ascribable to enrichment of swine manure with nutrients which support higher microbial activities. This is in line with who stated that the amount of enzymes accumulation in the soil has a direct proportion to amount and quality of manure used (Chang et al., 2007).

Table 5: Changes in potential and actual dehydrogenase activity in top-soil and sub- soil treated with poultry and swine manures

Poultry manure treated soil				
Duration	**Potential dehydronase** Mg g^{-1}		**Actual dehyrogenase** Mg g^{-1}	
	0-15 cm	**15-30 cm**	**0-15 cm**	**15-30 cm**
0 Week	2.08ab	1.80a	1.78b	0.62b
Week 2	6.43a	3.82b	4.71a	3.17b
Week 4	4.86b	6.64a	3.79b	4.88a
Week 6	3.75b	6.72a	3.32c	5.63a
Week 8	3.63b	5.68a	3.27d	5.26a
Week 10	3.18b	5.45a	2.94bc	4.45a
Week 12	3.03b	4.57a	2.20c	3.54ab
Swine manure treated soil				
0 Week	2.42b	1.65b	1.88a	0.96b
Week 2	6.91a	4.25b	4.88a	2.99b
Week 4	5.16b	6.60a	3.95b	5.18a
Week 6	3.92b	7.09a	3.49b	5.52a
Week 8	3.60b	6.11a	3.70c	4.73b
Week 10	3.45b	5.76a	3.50bc	4.26ab
Week 12	3.34b	4.55a	3.29bc	3.91a

Key: means values with the same letter(s) within the rows are not significantly different from one another at p<0.05.

3.3 Relationship between microbial densities and alkaline and acid phosphatase

The relationship between microbial densities and potential and actual dehydrogenase are shown in (Table 6). Bacterial density showed a positive and significant relationship with potential dehydrogenase at the top soil treated with poultry and swine manures (r= 0.580*, 0.574*) respectively, while sub soil treated with poultry and swine manures were positive but non- significant relationship (r= 0.187^{ns}, 0.373^{ns}). Actual dehydrogenase had positive and non- significant correlation with bacteria in soil amended with poultry and swine manures in the surface layers (r = 0.496^{ns}, 0.498^{ns}) respectively, but subsurface soil amended with poultry and swine manures were positive and non-significant correlation with actual dehydrogenase (r = 0.438^{ns}, 0.336^{ns}) respectively.

Actinomycete and potential dehydrogenase were positively and significantly correlated with poultry and swine manures at the top soil amended with poultry and swine manures (r = 0.654*, 0.772*) respectively, whereas the relationship in subsoil treated with poultry and swine manures were positive and non-significant (r = 0.018^{ns}, 0.132^{ns}) respectively. Actual dehydrogenase showed a positive and significant correlation with actinomycete counts in top soil treated with poultry and swine manures (r = 0.618*, 0.721*) respectively, while subsoil treated with poultry and swine manure were positively and non-significantly correlated with actual dehydrogenase (r = 0.286^{ns}, 0.099^{ns}) respectively. This relationship implies that an increase in actinomycete counts will lead to an increase in dehydrogenase activities, particularly in the surface soils.

The activities of fungi and potential dehydrogenase were significant and positively correlated to poultry and swine at the surface layers (r = 0.764*, 0.840*) respectively, while subsurface layers showed positive and non-significant relationship with poultry and swine manures (r =0.244^{ns}, 0.164^{ns}) respectively. Actual dehydrogenase showed positive and significant relationship with fungi at top soil treated with poultry and swine manures (r = 0.731*, 0.758*) respectively, but subsurface layers were positive and non-significantly correlated with actual dehydrogenase in soil amended with poultry and swine manures (r = 0.017^{ns}, 0.106^{ns}) respectively. This significant and positive relationship of dehydrogenase activities with fungi at the top soil imply that animal manures improve fungi activities and consequently dehydrogenase production in soil.

Table 6: Pearson Correlation between Microbial Densities and Dehydrogenase Activities in Top-soil and Sub-soil Treated with Poultry and Swine Manures (n=5).

Statistical pairs	**r - values**	
Poultry manure treated soil	**Top-soil**	**Sub-soil**
Bacterial density and potential dehydrogenase	0.580*	0.187^{ns}
Bacterial density and actual dehydrogenase	0.496^{ns}	0.438^{ns}
Actinomycete density and potential dehydrogenase	0.654*	0.018^{ns}
Actinomycete density and actual dehydrogenase	0.618*	0.286^{ns}
Fungal density and potential dehydrogenase	0.764*	0.244^{ns}
Fungal density and actual dehydrogenase	0.731*	0.017^{ns}
Swine manure treated soil		
Bacterial density and potential dehydrogenase	0.574*	0.373^{ns}
Bacterial density and actual dehydrogenase	0.498^{ns}	0.336^{ns}
Actinomycete density and potential dehydrogenase	0.772*	0.132^{ns}
Actinomycete density and actual dehydrogenase	0.721*	0.099^{ns}
Fungal density and potential dehydrogenase	0.846*	0.164^{ns}
Fungal density and actual dehydrogenase	0.758*	0.106^{ns}

Key: *= significant at 5% probability level.
ns =non- significant

4. CONCLUSIONS

The results of the experiments showed that poultry and swine manures amended soil improved pH, organic carbon, total nitrogen and available phosphorus content of the soil of the study area relative to unamended soil. Soil amended with swine manure showed a consistent higher level of production of actual dehydrogenase than amended soil with poultry manure. The results also revealed that application of animal manures improved microbial densities with swine manure recording higher microbial counts than poultry manure. Microbial counts increased in the order of bacteria > fungi > actinomycete. Consequently, there was a positive and significant relationship of bacteria with potential dehydrogenase in top soil amended with poultry and swine manures. Further investigation is necessary to assess the potential of animal manures in the improvement of soil properties, dehydrogenase production and microbial densities in a tropical environment.

ACKNOWLEDGEMENTS

The authors appreciate University of Uyo, Nigeria for approving this study.

REFERENCES

Afangide, A.I., Ekpe I.I., Okoli N.H., Egboka N.T., 2020. Dynamics of Phosphatase Enzymes and Microbial Properties in a Degraded Ultisol Amended with Animal Maures. Journal of Clean Was, 4 (1), Pp. 21-27.

Adebola, A.E., Ewulo, B.S., and Arije, D.N., 2017. Effects of Different Animal Manures on Soil Physicacl and Microbial Properties. Applied Tropical Agriculture, 22 (1), Pp. 128-133.

Azam, F., 2002. Added Nitrogen Interaction in the soil-plant system A review. Pakistan Journal of Agriculture, 1, Pp. 54–59.

Benson, H., 2002. Microbiological Applications 8th ed, Bacterial Population Counts. McGraw Hill, New York ISBN 0-07-231889-9, Pp. 87.

Brady, N.C., Weil, R.R., 1984. The Nature and Properties of Soils. New York: Macmillan Publishing Company, Pp.10-593.

Bremner, J.M., 1996. Total Nitrogen, In: Methods of Soil Analysis, Part 3. Chemical Methods, Vol.5 of Soil Science society of America. Book Series, eds. By Sparks D.L. Soil Science Society of America/American Society of Agronomy, Madison, WI, Pp. 1085-1122.

Cite the Article: Afangide A.I., N.T. Egboka, P. Inyang , C.T. Tom, C. D. Ebele (2021).
Influence of Animal Manures on Dehydrogenase Activities and Microbial Population in Tropical Soil of Southeastern Nigeria. *i TECH MAG, Vol 3: 50-54.*

Bustamente, M.A., Paredes, C., Marhuenda-Egea, F.C., Perez-Espinosa, A., Bernal, M.P., and Moral, R., 2008. C0-composting of distillery Wastes with Animal Manures: Carbon and Nitrogen transformations in the Evaluation of Compost Stability. Chemosphere, 72, Pp. 551-557.

Cater, M.R., I993. Soil Sampling and Methods of Analysis. Canadian Society of Soil Science, Ontario, Canada.

Chang, E.H., Chung, R.S., Tsai, Y.H., 2007. Effect of Different Application Rates of Organic Fertilizer on Soil Enzyme Activity and Microbial Population. Journal of Soil Science, Plant Nutrient, 53, Pp. 132-140.

Chadwick, D.R., John, F., Pain, B., Chambers, B.J., Williams, J.C., 2000. Plant uptake of nitrogen from the organic nitrogen fraction of animal manures: a laboratory experiment. Journal of Agricultural Science. Camb., 134, 159–168.

Cheesebrough, M., 2006. District Laboratory Practice in Tropical Countries. Part 2. Low Price Edition. Cambridge University Press, London, Pp. 28- 90.

Chizoba, E.N., 2014. Soil Characterization and Land Suitability Evaluation of Anuka Farmland in Nsukka Local Government Area of Enugu State, Nigeria. Msc. Thesis, University of Nigeria, Nsukka.

Das, S., Chou, M.L., Jean, J.S., Liu, C.C., and Yang, H.J., 2016. Water Management Impact on Arsenic Behaviour and Rhizosphere Bacterial Communities and Activities in a Rice Agro-ecosystem. Sci. Tot. Environ., 542, Pp. 642-652.

Degado, A., Solera del Rio, R., Sales, D., Garcia-Morales, J.L., 2004. Study of the Co-composting Process of Municipal Solid Waste and Sewage Sludge: Stability and Maturing. In: Bernal M, Moral r, Clement R, Paredes C (eds). Proceedings of the 11th conference of the FAO on Recycling of Agricultural Municipal and Industrial Residues in Agriculture, Ramiran, Murcia, Pp. 257-260.

Eka, O.U., Fogathy, N.M., 1972. Descriptive Studies on a Streptomyces Species Part 1. Description and some Properties of the Microorganisms. West African Journal of Biological and Applied Chemistry, Pp. 11-17.

Eshett, T.E., John, A.O., and Anthony, S.R., 1990. Physico-chemical, Morphological, and Clay Mineralogical Properties of Soils Overlying Basement Complex rocks in Ogoja, Northern Cross River State of Nigeria. Soil Science and Plant Nutrition; 36 (2), Pp. 203-214.

Gee, G.W. and D. Or, 2002. Particle Size Distribution., In: Dane, J/H and G.C. Topp (eds). Methods of Soil Analysis. Part 4. Physical and Mineralogical Methods. Soil Society of America book Series. No.5 ASAS and SSA. Madison, Wisconsin, Pp. 255-293.

Gu, Y., Wang, P and Kong, C.H., 2009. Urease, Invertase, Dehydrogenase and Polyphenoloxidase Activities in Paddy Soil Inluenced by Aleopathic Rice Variety. European Journal of Soil Biology, 30, Pp. 1-6.

Hulugalle, N.R., 1994. Long- term effect of Land Clearing Methods, Tillage System and Cropping System on Surface Soil Properties of a Tropical Alfisol in Southwestern Nigeria. Soil Use Management, 10, Pp. 25-30.

Kaira, Y.P., Maynard, D.G., 1991. Method Manual for Forest Soil and Plant Analysis. For Can., Northwest Reg., Noth. For. Cent., Edmonton, Alberta.Inf. Rep. NOR-X-319.

Karnchanawong, S., Nissaikla, S., 2014. Effects of Microbial Inoculation Composting of Household Organic Using Passive Aeration bin .int j recycl, org waste Agric., 3 (4), Pp. 113-119 .

Li, F., Chen, L., Zhang, J., Yin, J., Huang, S., 2017. Bacterial Community Structure after Long- term Organic and Inorganic Fertilization Reveals Important. Associations Between Soil Nutrients and Specific Taxa involved in Nutrient Transformation. Frontier of Microbiology. 8, Pp. 187.

Maeda, R.N., Barcelos, C.A., Anna, L.M.S., Pereira, N.J.R., 2013. Cellulase Production by Penicillium funiculosu and its application in the hydrolysis of sugarcane bagasse for second generation ethanol production by fed batch operation. J. Biotechnol., 163, Pp. 38-44.

Meng, Q.X., Yang, W., Men, M.Q., Bello, A., Xu, X., Xu, H.X., 2019. Microbial Community Succession and Response to Environmental Variables during Cow Manure and Corn Straw Composting. Frontier of Microbiology, 10, Pp. 529.

Nelson, D.W., L.E. Sommers, 1996. Total carbon, Organic carbon and Organic matter, In: Methods of Soil Analysis. Part 3. Chemical Methods, Vol.5 of Soil Science Society of America Book Series,ed. By Sparks D.L. Soil Science Society of America/American Society of Agronomy, Madison, WI, Pp. 96-101.

Olson, S.R., and Sommers, L.E., 1982. Phosphorus, In: Page et al. (esd). Method of Soil Analysis. Part2, 2nd ed. American Society of Agronomy and Soil Science Society of America. Madison, Wisconsin, Pp. 403-430.

Orjiaka, S.O., 1975. Nigeria in Maps; Eastern States, In:Ofomata G.E.K (eds). Ethiope Publishing House, Benin city, Pp. 5-7.

Oyeleke, S.B., and Qkusanmi, T.A., 2008. Isolation and Characterization of cellulose Hydrolyzing Microorganisms from the Rumen of Ruminants. African Journal of Biotechnology, 7 (9), Pp. 30.

Paradelo, R., Barral, M.T., 2009. Effect of Moisture and Dis-aggregation on the Microbial Activity of Soil, Soil Till. Res., 104 (2), Pp. 317-319.

Puttaso, A., Vityakon, P., Saenjan, P., Trelo-ges, V., Cadiscg, G., 2011. Relationship Between Residue Quality, Decomposition Patterns, and Soil Organic Matter Decomposition in a Tropical Sandy Soil after 13 years. Nutr. Cycl. Agroecosyst., 89, Pp. 159-174.

Rastogi, M., Nandal, M., Khosla, B., 2020. Microbes as Vital Additives for Solid Waste Composting. Heliyon, 6, Pp. e03343.doi: 10.1016/j.heliyon. 2020.e03343.

Rebollido, R., Martinez, J., Aquilera, Y., Melchor, K., Koerner, R., and R. Stegmann, 2008. Microbial Populations During Composting Process of Organic Fraction of Minicipal Soild Waste. Applied Ecololgy and Environment, 6 (3), Pp. 61-67.

SAS Institute. 1999. The SAS System for Windows. Release 8.0. SAS Institute, Cary, NC.

Tabatabai, M.A., 1982. Soil Enzymes. In: Page,A.L. Miller, E.M., Keeney, D.R.(eds). Methods of Soil Analysis, Part 2. Chemical and Microbiological Properties, American Society of Agronomy, Madison, Wisconsin. Pp. 145-183.

Tekalign, T., 1991. Soil, Plant, Water, Fertilizer, Animal and Compost Analysis. Working Document. 13. International Livestock Research Center for Africa, Addis Ababa.

Thomas, G.W., 1996. Soil pH and Soil acidity, In: D.L. Sparks, A.L. Page, P.A. Helmke, R.H. Loeppert, P.N. Soltanpour, M. A. Tabatabai, C.T. Johnson, M.E. Summer (eds.). Methods of Soil Analysis Part 3. Chemical Methods. Soil Science Society of America, inc, and American Society of Agronomy, Madison, WI. USA, Pp. 475-490pp.

Uzoho, B.U., Oti, N.N., Ngwuta, A., 2017. Fertility Status Under Land Use Types on Soils of The Similar lithology. Journal of American Science, 3 (4), Pp. 20-29.

Yamamoto, N., Nakai, Y., 2019. Microbial Community Dynamics during the Composting Process of Animal Manures Analyzed by Molecular Biological Methods, in Understanding Terrestrial Microbial Communities, Pp. 151-172.

Yuan, B., and Yue, D., 2012. Soil Microbial and Enzymes Activities Across a CHronosequence of Chinese Pine Plantation Development on the Loess Plteau of China. Pedosphere, 22, Pp. 1-2.

Zhang, W.M., He, X., Cao, Y., Li, Y., Wang, H., Ma, D., Zhang, R., Yuang, S., 2010. Pedogenic Carbonate and Soil Dehydrogenase Activity in Response to Soil Organic Matter in Prtenisa Ordosica Community. Pedoshere, 20, Pp. 229-235.

* * *

Cite the Article: Afangide A.I., N.T. Egboka, P. Inyang , C.T. Tom, C. D. Ebele (2021).
Influence of Animal Manures on Dehydrogenase Activities and Microbial Population in Tropical Soil of Southeastern Nigeria. *i TECH MAG, Vol 3: 50-54.*