Evaluation of the Effects of Okigwe Cattle Market Wastes on the Surrounding Agricultural Soil Parameters

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Abstract

Soil enzyme activities and bioloads of various organisms as influenced by Cattle Market activities were evaluated in Okigwe, Imo State. All the bacterial groups estimated have their highest values in the soil in which the slaughter house wastes were disposed while the control was the least. Lipolytic bacterial counts ranged from 1.7 x 10^3 – 2.1 x 10^4 cfu/g; proteolytic bacteria 2.1 x 10^3 – 1.7 x 10^5 cfu/g and total coliforms were 2.3 x 10^4 – 2.7 x 10^5 cfu/g. The total heterotrophic bacterial count ranged from 3.7 x 10^6 to 3.7 x 10^8 and nitrifying bacteria 2.1 – 10^4 – 3.7 x $10^{5cfu/g}$. The soil pH changed towards slight alkalinity (6,4-7.6) while the change in temperature was not significant (28.2 – 30.4oC). The total organic carbon, nitrate and phosphate were in the order of control < slaughter house wastes soil < cattle market soil. The ranges of enzyme activities were 24.56 – 41.31mg and 3.2 – 4.89 mg g-1 30min for dehydrogenase and lipase. Alkaline Phosphate had 2.28 – 2.71 umol-p-nitrophenol while protease was quite low (0.31 – 0.68 mg-g $24h^{-1}$). The order for dehydrogenase and phosphatase activities were Market soil> slaughter house waste soil > Control while lipase and urease had slaughter house waste soil > Cattle Market soil > Control. Cellulase activity was also higher in cattle market soil than slaughter house waste and control. The activities caused increase in both bacterial loads and enzyme activities.

Keywords: Physiochemical parameters, Soil enzymes, Cattle waste, Bacteria

Introduction

Man, in his efforts to market his agricultural products and ensure food distribution and security has come face to face with environmental pollution problems. In many parts of the world, especially the developing world, most human economic activities including animal production still impact negatively or positively on environment and biodiversity depending on the effect (Adesemoye *et al*., 2006, Parham et al, 2002). The consequences of these man – made pollution result in either disease transmission or environmental modification (Ezeronye and Ubawa, 2005). Most of the negative effects are preventable but result due to carelessness or lack of adequate planning.

Animal husbandry has resulted in extensive impact on both soil and aquatic habitats. In most cases, the place of production is not usually the place of sale or place of slaughter. The sale, slaughter and dressing of these animals lead to the generation of both solid and liquid wastes which are often carelessly discharged into the available surfaces – water or soil (Adesemoye *et al.,* 2006. Coker *et al.,* 2001 Amisu *et al*. 2003). The effects of the animal wastes on the physiochemical and microbial biodiversity of the soil is enormous (McBriade, 1994, Nair *et al.*, 1998). This in turn alters the soil enzyme activities in accordance with the micro-organisms producing them.

In Nigeria, as in most other developing countries, animals are taken to the market for sale. In the case of cattle, goats and other animals of that type, special markets are set aside for them, and the various activities within the market may affect the soil. A lot of work has been done on the effects of animal wastes and slaughter house wastewater on soil microorganisms and physicochemical properties (Coker *et al.*, 2001, Adesemoye *et al*., 2006). However, none of these studies had examined the effects of cattle selling and slaughtering wastes on soil enzymes. This work therefore seeks to relate the impact of such activities with enzymes activities in the study area.

Materials and Methods

The study area was Okigwe, a town in the typical Guinea Savannah region of Eastern Nigerian. It is at the Northern apex of Imo State of Nigeria.

The temperature of the study area was recorded at the site using a Mercury bulb thermometer inserted 2-3cm into the soil. The reading was done while still in the soil. The pH was obtained using the soil water mixture according to APHA (1998). The total organic carbon, soil nitrate and phosphate were equally determined according to APHA, (1998).

The microbiological analysis was done after a ten-fold serial dilution using 1.0g of each soil sample. The various groups of bacteria were estimated using different culture media. Triptone Soy Agar was used for Total Heterotrophic bacterial (THB), McConkey Agar for Coliform bacteria (CB). Tributyrin Agar for lipolytic bacteria and Caesin Agar for Proteolytic bacteria (PB). Mineral Salt Agar and cellulose Agar were used for nitrifying and cellulolytic bacteria respectively. In each case, the spread plate method was used.

The soil enzyme activities were assessed using soil samples dried at room temperature. The enzymes were dehydrogenase, urease, lipase cellulase and Alkaline Phosphates. The dehydrogenase was determined as described by Cassida *et al.* (1964) using Triphenyl tetrazolium chloride (TTC) with the formation of Triphenyl formazon (TPF) after incubation. Absorbance was read at 485nM after 6 hours incubation Urease activity was determine by the colorimetric method of Nannipieri *et al.* (1980) based on formation of NH_3 – N in Urea – amended soil after 24hr incubation.

Lipase was determined according to Saisuburamaniyan *et al*. (2004) using Olive oil amended soil. Alkaline phosphatase was determined as described by Tabatabai and Bremear (1969) while the activities of cellulase and protease were determined according to the guidelines of Tabatabai (1997) involving the use of spectrophotometer.

Results

Results obtained in the physicochemical properties analysed showed that all the soil properties except the temperature were significantly affected by the process (P = 0.05). The pH changed from very weak acidic condition 6.4 to slightly alkaline 7.6. The difference between the slaughter house waste and market (Cattle) waste impacted soil samples were not statistically significant in total nitrate and phosphate. Only total carbon showed appreciable variation (P = 0.5) in each of the soil samples analysed (Table 1).

Table 1: Some physicochemical parameters analyses

Factor	Soil Samples		
	Control	Slaughter house	Cattle market
pH	6.4	0.6	7.2
Temperature	29.2	30.1	30.4
TOC	6.5	7.2	8.2
TON	0.63	0.86	0.82
TOP	4.5	6.5	6.6

Key: *TOC = Total Organic carbon, TON = Total Organic Nitrate, TOP = Total Organic Phosphate*

Values of bio-loads of the different groups of organisms estimated showed considerable variations. All the groups investigated had their highest counts in the soil impacted by slaughter house wastes and the lowest in the control- the unimpacted soil (Table 2) except the coliforms which had their highest count in the cattle market waste soil. The THB had the highest bioload, varying from 3.7×10^6 to 3.5×10^7 cfu/g and the least was lipolytic bacteria with a range of 1.7×10^3 – 2.1×10^4 cfu/g. The protealytic and nitrifying bacteria had 2.1×10^4 – 2.2×10^4 cfu/g and 2.3×10^4 to 2.7×10^5 cfu/g (Table 2) respectively. The coliforms were between 2.3×10^4 and 2.7×10^5 cfu/g (Table 2).

Table 3 shows the values of the enzyme activities analysed. The activities of the enzymes were highest in the soil disposed of slaughter house wastes except cellalose that had its highest activities in the cattle market waste impacted soil. Cellulase had 4.88 mgl – g^{-1_h-1} in the soil disposed of market wastes, 2.93 in the slaughter house waste and 2.47 in the control Statistical analysis showed significant effects in the cattle market waste disposed soil samples (P=0.05).

Table 2: Bioload of various groups of bacteria analysed

Bacteria Group	Soil Type		
	Control	Slaughter house	Cattle Market
Lipolytic bacteria	1.7×10^3	2.1×10^4	2.3×10^3
Proteolytic bacteria	2.1×10^4	1.7×10^5	2.2×10^4
Coliform bacteria	2.3×10^4	2.2×10^5	2.7×10^5
THB	3.7×10^6	3.5×10^7	3.7×10^7
Nitrifying bacteria	2.6×10^4	2.8×10^5	3.4×10^5

THB: Total Heterotrophic bacteria count.

Table 3: Enzyme activities of the various soil samples

Enzyme	Control	Slaughter house	Cattle Market
Dehydrogenase mg-g^{-1} $6h^{-1}$	24.56	38.71	41.31
Urease mg-g^{-1} $24hr^{-1}$	2.1	4.75	4.31
Lipase mg-g^{-1} – $30m^{-1}$	3.2	4.89	4.71
Alkaline Phosphate u-mol-p-nitrophenol	0.28	2.71	2.68
Protease mg-g^{-1} 24hr	0.31	0.83	0.61
Cellulose mg-g^{-1} $6hr^{-1}$	2.47	2.93	4.88

Dehydrogenase enzyme which had the highest activities had 41.31 mg-g^{-1}– 6hrs in the slaughter house waste soil, which decreased to 38.71 in the cattle soil sample and 24.56 in the control. Similar trends were observed with lipase, urease, and protease.

Alkaline phosphase which was the least affected enzyme had some differences observed in the various soil samples though, they were marginal (P = 0.05) (Table 3). Protease had very low activities compared to other enzymes but the values observed followed that of lipase, urease and dehydrogenase.

DISCUSSION

Results obtained in this work suggest that the soil parameters (physicochemical) were affected by the various activities inferred in the process. The change in pH was due to the release of ammonia following the metabolism of blood and meat trimmings in the slaughter house waste and the feacal matter in the cattle market soil. The ammonia dissolved in the available moisture to cause the change in pH. Parham *et al*., (2002) reported a similar observation following cattle manure application in soil. Mentellium and Tauraine (2004) also reported similar trend. The increase of total nitrate and phosphate followed the same pattern as pH. However, the observed higher total organic

carbon value in the cattle market soil than slaughter house waste soil could be suggestive of the components of the wastes. The wastes from cattle in the market were mainly cellulolistic components of foraged feeds (Grasses and other weeds-digested and undigested). These helped to add extra carbon to the soil. There was no such addition in the control hence the lower level observed.

Observations in the various bio-loads of bacterial groups indicated that THB was the most prevalent, followed by the coliforms while lipolytic bacteria were the least. Since the THB is the total bacterial group that could be seen on general purpose media, it is not a specialized group. Some bacteria of the other groups could be found among the THB. The specificity of the other groups caused their lower numbers. In addition, the contents of the wastes influenced the prevalence of the available organisms in the soil. The faecal matter from the cattle in the market had little or no protein, and lipids, but high cellulose content unlike the blood and meat components of the slaughter house wastes. This resulted in high proteolytic and lipolytic organisms in soil disposed of slaughter house waste than the soil disposed of cattle market wastes while the reverse was the case with cellulolytic organisms. Similarly the faecal matter which was the major animal waste in the market, contained more of the coliforms which simply increased the market soil coliforms than the slaughter house waste polluted soil sample. A similar increase in lipolytic organisms, THB, and cellulolytic bacterial counts had been observed by Nwaugo *et al.,* (2007ab) while working on petroleum produced water and cassava mill effluent contaminated soil samples in Egbema. Adesemoye *et al*., (2002) also reported increase in proteolytic bacteria in abattoir waste soil.

The increase in the nitrifying bacterial count could be referred to as additive effect or improved nutrient induced. Both the cattle market and slaughter house wastes contamination of the soil resulted in addition of metabolizable nutrients for the nutrifiers. This resulted in their increased proliferation which agrees well with the observations made by Parhan *et al.* (2003).

The results obtained in the enzyme assays positively correlated with bacterial bioloads observed earlier. Dehydrogenase is produced by every organism, no matter the species, hence the high enzymatic actions observed. It could be said to be from all the organisms whether heterotrophic or specialized. This accounts for its highest activities in the slaughter house waste disposed soil with the highest THBC. On the other hand, the activities of the other enzymes, urease, protease, lipase and cellulose could be said to be substrate – induced following the contents of the wastes. The proteins, and lipids contained in the blood and meat trimmings in the slaughter house waste were metabolized by their urease, lipase and protease, hence higher activities in such soil. On the other hand, cellulase had higher activities in the soil disposed of cattle market waste with its high cellulose and starch content following the incompletely digested foraged materials in the faecal matter passed out. Parham *et al.,* (2002, 2003) agreed with such observations. However the observation in phosphatase activities in this work did not completely tally with that of Parham et al (2003). While a non significant increase was observed in this work, Parham et al., (2003) reported a significant increase in their works. The observed changes in the Phosphatase activities in this work could even be attributed to the slight change in environmental factor – pH. Alkaline phosphatase activity increased, while acid phosphatase remained low.

In conclusion, this work shows that Cattle Market and slaughter house wastes could influence the bio-indicators of soil pollution. This agrees with the findings of Li *et al*., (2005) and Wyszskowka and Wyskowski (2004) who suggested that bio-indicators should form an integral part of impact assessment programme for soil. This work also agrees that animal wastes are good organic manure (fertilizer) for agriculture only in small quantities as soil microbial biodiversity and enzyme activities are increased in such contaminated or treated soil.

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